

# axiom<sup>TM</sup>



## The 30 Year Horizon

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## New Foreword

On October 1, 2001 Axiom was withdrawn from the market and ended life as a commercial product. On September 3, 2002 Axiom was released under the Modified BSD license, including this document. On August 27, 2003 Axiom was released as free and open source software available for download from the Free Software Foundation's website, Savannah.

Work on Axiom has had the generous support of the Center for Algorithms and Interactive Scientific Computation (CAISS) at City College of New York. Special thanks go to Dr. Gilbert Baumslag for his support of the long term goal.

The online version of this documentation is roughly 1000 pages. In order to make printed versions we've broken it up into three volumes. The first volume is tutorial in nature. The second volume is for programmers. The third volume is reference material. We've also added a fourth volume for developers. All of these changes represent an experiment in print-on-demand delivery of documentation. Time will tell whether the experiment succeeded.

Axiom has been in existence for over thirty years. It is estimated to contain about three hundred man-years of research and has, as of September 3, 2003, 143 people listed in the credits. All of these people have contributed directly or indirectly to making Axiom available. Axiom is being passed to the next generation. I'm looking forward to future milestones.

With that in mind I've introduced the theme of the "30 year horizon". We must invent the tools that support the Computational Mathematician working 30 years from now. How will research be done when every bit of mathematical knowledge is online and instantly available? What happens when we scale Axiom by a factor of 100, giving us 1.1 million domains? How can we integrate theory with code? How will we integrate theorems and proofs of the mathematics with space-time complexity proofs and running code? What visualization tools are needed? How do we support the conceptual structures and semantics of mathematics in effective ways? How do we support results from the sciences? How do we teach the next generation to be effective Computational Mathematicians?

The "30 year horizon" is much nearer than it appears.

Tim Daly  
CAISS, City College of New York  
November 10, 2003 ((iHy))

# Chapter 1

## Numerical Analysis [4]

We can describe each number as  $x^*$  which has a machine-representable form which differs from the number  $x$  it is intended to represent. Quoting Householder we get:

$$x^* = \pm(x_1\beta^{-1} + x_2\beta^{-2} + \cdots + x_\lambda\beta^\lambda)\beta^\sigma$$

where  $\beta$  is the base, usually 2 or 10,  $\lambda$  is a positive integer, and  $\sigma$  is any integer, possibly zero. It may be that  $\lambda$  is fixed throughout the course of the computation, or it may vary, but in any case it is limited by practical considerations. Such a number will be called a representation. It may be that  $x^*$  is obtained by “rounding off” a number whose true value is  $x$  (for example,  $x = 1/3$ ,  $x^* = 0.33$ ), or that  $x^*$  is the result of measuring physically a quantity whose true value is  $x$ , or that  $x^*$  is the result of a computation intended to give an approximation to the quantity  $x$ .

Suppose one is interested in performing an operations  $\omega$  upon a pair of numbers  $x$  and  $y$ . That is to say,  $x\omega y$  may represent a product of  $x$  and  $y$ , a quotient of  $x$  by  $y$ , the  $y$ th power of  $x$ , .... In the numerical computation, however, one has only  $x^*$  and  $y^*$  upon which to operate, not  $x$  and  $y$  (or at least these are the quantities upon which one does, in fact operate). Not only this, but often one does not even perform the strict operation  $\omega$ , but rather a pseudo operation  $\omega^*$ , which yields a rounded-off product, quotient, power, etc. Hence, instead of obtaining the desired result  $x\omega y$ , one obtains a result  $x^*\omega^*y^*$ .

The error in the result is therefore

$$x\omega y - x^*\omega^*y^* = (x\omega y - x^*\omega y^*) + (x^*\omega y^* - x^*\omega^*y^*)$$

Since  $x^*$  and  $y^*$  are numbers, the operation  $\omega$  can be applied to them, and  $x^*\omega y^*$  is well defined, except for special cases as when  $\omega$  represents division and  $y^* = 0$ . But the expression in the first parentheses on the right represents propagated error, and that in the second parentheses represents generated error, or round-off. Hence the total error in the result is the sum of the error propagated by the operation and that generated by the operation.

Householder notes that, given two operations  $\omega$  and  $\phi$ , it may be true that the operations are associative, e.g:

$$(x^* \omega y^*) \phi z^* = x^* \omega (y^* \phi z^*)$$

but if we expand these in terms of the above definitions of propagation and generation error we get two different expressions:

$$\begin{aligned} (x^* \omega y^*) \phi z^* - (x^* \omega^* y^*) \phi^* z^* &= [(x^* \omega y^*) \phi z^* - (x^* \omega^* y^*) \phi z^*] \\ &+ [(x^* \omega^* y^*) \phi z^* - (x^* \omega^* y^*) \phi^* z^*] \end{aligned}$$

$$\begin{aligned} x^* \omega (y^* \phi z^*) - x^* \omega^* (y^* \phi^* z^*) &= [x^* \omega (y^* \phi z^*) - x^* \omega (y^* \phi^* z^*)] \\ &+ [x^* \omega (y^* \phi^* z^*) - x^* \omega^* (y^* \phi^* z^*)] \end{aligned}$$

These are not always equal which implies that the strictly machine operations are not necessarily commutative.

Householder distinguishes a third class of error (besides propagation and generative) called residual errors. This occurs because some functions are approximated by infinite series. The finite computation of the series forces the truncation of the remaining terms causing these residual errors.

We will try to perform an analysis of each of the routines in this library for the given inputs to try to see the propagation errors and generation errors they introduce. Every effort will be made to minimize these errors. In particular, we will appeal to the machine generated code to see what approximations actually occur.

## Chapter 2

# Chapter Overview

Each routine in the Basic Linear Algebra Subroutine set (BLAS) has a prefix where:

- C - Complex
- D - Double Precision
- S - Real
- Z - Complex\*16

Routines in level 2 and level 3 of BLAS use the prefix for type:

- GE - general
- GB - general band
- SY - symmetric
- HE - hermitian
- TR - triangular
- SB - symmetric band
- HB - hermetian band
- TB - triangular band
- SP - Sum packed
- HP - hermitian packed
- TP - triangular packed

For level 2 and level 3 BLAS options the options argument is CHARACTER\*1 and may be passed as character strings. They mean:

- **TRANx**
  - **N**o transpose
  - **T**ranspose
  - **C**onjugate transpose ( $X$ ,  $X^T$ ,  $X^H$ )
- **UPLO**
  - **U**pper triangular
  - **L**ower triangular
- **DIAG**
  - **N**on-unit triangular
  - **U**nit triangular
- **SIDE**
  - **L**eft - A or op(A) on the left
  - **R**ight - A or op(A) on the right

For real matrices, TRANSx=T and TRANSx=C have the same meaning. For Hermitian matrices, TRANSx=T is not allowed. For complex symmetric matrices, TRANSx=H is not allowed.

## Chapter 3

# Algebra Cover Code

### 3.1 package BLAS1 BlasLevelOne

```
<BlasLevelOne.input>≡
)set break resume
)sys rm -f BlasLevelOne.output
)spool BlasLevelOne.output
)set message test on
)set message auto off
)clear all

--S 1 of 10
t1:Complex DoubleFloat := complex(1.0,0)
--R
--R
--R (1) 1.
--R
--R                                          Type: Complex DoubleFloat
--E 1

--S 2 of 10
dcabs1(t1)
--R
--R
--R (2) 1.
--R
--R                                          Type: DoubleFloat
--E 2

--S 3 of 10
t2:Complex DoubleFloat := complex(1.0,1.0)
--R
```

```
--R  
--R      (3)  1. + %i  
--R                                                    Type: Complex DoubleFloat  
--E 3  
  
--S 4 of 10  
dcabs1(t2)  
--R  
--R  
--R      (4)  2.  
--R                                                    Type: DoubleFloat  
--E 4  
  
--S 5 of 10  
t3:Complex DoubleFloat := complex(1.0,-1.0)  
--R  
--R  
--R      (5)  1. - %i  
--R                                                    Type: Complex DoubleFloat  
--E 5  
  
--S 6 of 10  
dcabs1(t3)  
--R  
--R  
--R      (6)  2.  
--R                                                    Type: DoubleFloat  
--E 6  
  
--S 7 of 10  
t4:Complex DoubleFloat := complex(-1.0,-1.0)  
--R  
--R  
--R      (7)  - 1. - %i  
--R                                                    Type: Complex DoubleFloat  
--E 7  
  
--S 8 of 10  
dcabs1(t4)  
--R  
--R  
--R      (8)  2.  
--R                                                    Type: DoubleFloat  
--E 8  
  
--S 9 of 10
```

```

t5:Complex DoubleFloat := complex(-2.0,-2.0)
--R
--R
--R   (9)  - 2. - 2. %i
--R
--R                                          Type: Complex DoubleFloat
--E 9

--S 10 of 10
dcabs1(t5)
--R
--R
--R   (10)  4.
--R
--R                                          Type: DoubleFloat
--E 10

a:PRIMARR(DFLOAT):=[ [1.0,2.0,3.0,4,0,5,0,6,0] ]
dasum(3,a,-1) -- 0.0    neg incx
dasum(3,a,0)  -- 0.0    zero incx
dasum(-1,a,1) -- 0.0    neg elements
dasum(0,a,1)  -- 0.0    no elements
dasum(1,a,1)  -- 1.0    1.0
dasum(2,a,1)  -- 3.0    1.0+2.0
dasum(3,a,1)  -- 6.0    1.0+2.0+3.0
dasum(4,a,1)  -- 10.0   1.0+2.0+3.0+4.0
dasum(5,a,1)  -- 15.0   1.0+2.0+3.0+4.0+5.0
dasum(6,a,1)  -- 21.0   1.0+2.0+3.0+4.0+5.0+6.0
dasum(7,a,1)  -- 21.0   1.0+2.0+3.0+4.0+5.0+6.0
dasum(1,a,2)  -- 1.0    1.0
dasum(2,a,2)  -- 4.0    1.0+3.0
dasum(3,a,2)  -- 9.0    1.0+3.0+5.0
dasum(4,a,2)  -- 9.0    1.0+3.0+5.0
dasum(1,a,3)  -- 1.0    1.0
dasum(2,a,3)  -- 5.0    1.0+4.0
dasum(3,a,3)  -- 5.0    1.0+4.0
dasum(1,a,4)  -- 1.0    1.0
dasum(2,a,4)  -- 6.0    1.0+5.0
dasum(3,a,4)  -- 6.0    1.0+5.0
dasum(1,a,5)  -- 1.0    1.0
dasum(2,a,5)  -- 7.0    1.0+6.0
dasum(3,a,5)  -- 7.0    1.0+6.0
dasum(1,a,6)  -- 1.0    1.0
dasum(2,a,6)  -- 1.0    1.0
dasum(1,a,7)  -- 1.0    1.0

)spool
)lisp (bye)

```



`<BlasLevelOne.help>=`

```
=====
BlasLevelOne examples
=====
```

The `dcabs1` routine computes the sum of the absolute value of the real and imaginary parts of a complex number.

```
t1:Complex DoubleFloat := complex(1.0,0)
1.
```

```
dcabs1(t1)
1.
```

```
t2:Complex DoubleFloat := complex(1.0,1.0)
1. + %i
```

```
dcabs1(t2)
2.
```

```
t3:Complex DoubleFloat := complex(1.0,-1.0)
1. - %i
```

```
dcabs1(t3)
2.
```

```
t4:Complex DoubleFloat := complex(-1.0,-1.0)
- 1. - %i
```

```
dcabs1(t4)
2.
```

```
t5:Complex DoubleFloat := complex(-2.0,-2.0)
- 2. - 2. %i
```

```
dcabs1(t5)
4.
```

See Also:

```
o )show BlasLevelOne
```

**3.1.1 BlasLevelOne (BLAS1)**

```

(package BLAS1 BlasLevelOne)≡
)abbrev package BLAS1 BlasLevelOne
++ Author: Timothy Daly
++ Date Created: 2010
++ Date March 24, 2010
++ Description:
++ This package provides an interface to the Blas library (level 1)
BlasLevelOne() : Exports == Implementation where

SI ==> SingleInteger
DF ==> DoubleFloat
DX ==> PrimitiveArray(DoubleFloat)
CDF ==> Complex DoubleFloat

Exports == with

dcabs1: CDF -> DF
++ dcabs1(z) computes (+ (abs (realpart z)) (abs (imagpart z)))
++
++X t1:Complex DoubleFloat := complex(1.0,0)
++X dcabs(t1)

dasum: (SI, DX, SI) -> DF
++ dasum(n,array,incx) computes the sum of n elements in array
++ using a stride of incx
++
++X dx:PRIMARR(DFLOAT):=[ [1.0,2.0,3.0,4.0,5.0,6.0] ]
++X dasum(6,dx,1)
++X dasum(3,dx,2)

daxpy: (SI, DF, DX, SI, DX,SI) -> DX
++ daxpy(n,da,x,incx,y,incy) computes a y = a*x + y
++ for each of the chosen elements of the vectors x and y
++ and a constant multiplier a
++ Note that the vector y is modified with the results.
++
++X x:PRIMARR(DFLOAT):=[ [1.0,2.0,3.0,4.0,5.0,6.0] ]
++X y:PRIMARR(DFLOAT):=[ [1.0,2.0,3.0,4.0,5.0,6.0] ]
++X daxpy(6,2.0,x,1,y,1)
++X y
++X m:PRIMARR(DFLOAT):=[ [1.0,2.0,3.0] ]
++X n:PRIMARR(DFLOAT):=[ [1.0,2.0,3.0,4.0,5.0,6.0] ]
++X daxpy(3,-2.0,m,1,n,2)
++X n

```

```

dcopy: (SI, DX, SI, DX,SI) -> DX
++ dcopy(n,x,incx,y,incy) copies y from x
++ for each of the chosen elements of the vectors x and y
++ Note that the vector y is modified with the results.
++
++X x:PRIMARR(DFLOAT):=[ [1.0,2.0,3.0,4.0,5.0,6.0] ]
++X y:PRIMARR(DFLOAT):=[ [0.0,0.0,0.0,0.0,0.0,0.0] ]
++X dcopy(6,x,1,y,1)
++X y
++X m:PRIMARR(DFLOAT):=[ [1.0,2.0,3.0] ]
++X n:PRIMARR(DFLOAT):=[ [0.0,0.0,0.0,0.0,0.0,0.0] ]
++X dcopy(3,m,1,n,2)
++X n

```

Implementation == add

```

dcabs1(z:CDF):DF ==
  DCABS1(z)$Lisp
dasum(n:SI,dx:DX,incx:SI):DF ==
  DASUM(n,dx,incx)$Lisp
daxpy(n:SI,da:DF,dx:DX,incx:SI,dy:DX,incy:SI):DX ==
  DAXPY(n,da,dx,incx,dy,incy)$Lisp
dcopy(n:SI,dx:DX,incx:SI,dy:DX,incy:SI):DX ==
  DCOPY(n,dx,incx,dy,incy)$Lisp

```

$\langle BLAS1.dotabb \rangle \equiv$

```

"BLAS1" [color="#FF8844",href="bookvol10.5.pdf#nameddest=BLAS1"]
"FIELD" [color="#4488FF",href="bookvol10.2.pdf#nameddest=FIELD"]
"RADCAT" [color="#4488FF",href="bookvol10.2.pdf#nameddest=RADCAT"]
"BLAS1" -> "FIELD"
"BLAS1" -> "RADCAT"

```

## 3.2 dcabs1 BLAS

```

⟨dcabs1.input⟩≡
)set break resume
)sys rm -f dcabs1.output
)spool dcabs1.output
)set message test on
)set message auto off
)clear all

--S 1 of 10
t1:Complex DoubleFloat := complex(1.0,0)
--R
--R
--R (1) 1.
--R
--R                                          Type: Complex DoubleFloat
--E 1

--S 2 of 10
dcabs1(t1)
--R
--R
--R (2) 1.
--R
--R                                          Type: DoubleFloat
--E 2

--S 3 of 10
t2:Complex DoubleFloat := complex(1.0,1.0)
--R
--R
--R (3) 1. + %i
--R
--R                                          Type: Complex DoubleFloat
--E 3

--S 4 of 10
dcabs1(t2)
--R
--R
--R (4) 2.
--R
--R                                          Type: DoubleFloat
--E 4

--S 5 of 10
t3:Complex DoubleFloat := complex(1.0,-1.0)
--R
--R

```

```

--R (5) 1. - %i
--R                                          Type: Complex DoubleFloat
--E 5

--S 6 of 10
dcabs1(t3)
--R
--R
--R (6) 2.
--R                                          Type: DoubleFloat
--E 6

--S 7 of 10
t4:Complex DoubleFloat := complex(-1.0,-1.0)
--R
--R
--R (7) - 1. - %i
--R                                          Type: Complex DoubleFloat
--E 7

--S 8 of 10
dcabs1(t4)
--R
--R
--R (8) 2.
--R                                          Type: DoubleFloat
--E 8

--S 9 of 10
t5:Complex DoubleFloat := complex(-2.0,-2.0)
--R
--R
--R (9) - 2. - 2. %i
--R                                          Type: Complex DoubleFloat
--E 9

--S 10 of 10
dcabs1(t5)
--R
--R
--R (10) 4.
--R                                          Type: DoubleFloat
--E 10

)spool
)lisp (bye)

```

`<dcabs1.help>=`

```
=====
dcabs1 examples
=====
```

The `dcabs1` routine computes the sum of the absolute value of the real and imaginary parts of a complex number.

```
t1:Complex DoubleFloat := complex(1.0,0)
1.
```

```
dcabs1(t1)
1.
```

```
t2:Complex DoubleFloat := complex(1.0,1.0)
1. + %i
```

```
dcabs1(t2)
2.
```

```
t3:Complex DoubleFloat := complex(1.0,-1.0)
1. - %i
```

```
dcabs1(t3)
2.
```

```
t4:Complex DoubleFloat := complex(-1.0,-1.0)
- 1. - %i
```

```
dcabs1(t4)
2.
```

```
t5:Complex DoubleFloat := complex(-2.0,-2.0)
- 2. - 2. %i
```

```
dcabs1(t5)
4.
```

```
=====
Man Page Details
=====
```

```
The argument is:
\begin{itemize}
\item z - Complex DoubleFloat
\end{itemize}
```

```

The result is
\begin{itemize}
\item (+ (abs (realpart z)) (abs (imagpart z)))
\end{itemize}

```

See Also:

```

o )show BlasLevelOne
o )display operations dcabs1
o )help dcabs1

```

Axiom represents the type `Complex(DoubleFloat)` as a pair whose `car` is the real part and whose `cdr` is the imaginary part. This fact is used in this implementation.

This should really be a macro.

```

⟨BLAS dcabs1⟩≡
(defun dcabs1 (z)
  "Complex(DoubleFloat) z is a pair where (realpart . imaginarypart).
  The result is a DoubleFloat (+ (abs (realpart z)) (abs (imagpart z)))"
  (the double-float
    (+
      (the double-float (abs (the double-float (car z))))
      (the double-float (abs (the double-float (cdr z)))))))

```

### 3.3 lsame BLAS

The `lsame` function returns `t` if `ca` and `cb` represent the same letter regardless of case.

This has been replaced everywhere with common lisp's `char-equal` function which compares characters ignoring case. The type `(simple-array character (*))` has been replaced everywhere with `character`.

### 3.4 xerbla BLAS

The `xerbla` routine is an error handler. It is called if an input parameter has an invalid value.

This function has been rewritten everywhere to use the common lisp error function.

## Chapter 4

# BLAS Level 1

### 4.1 dasum BLAS

```
<dasum.input>≡
)set break resume
)sys rm -f dasum.output
)spool dasum.output
)set message test on
)set message auto off
)clear all

--S 1 of 28
a:PRIMARR(DFLOAT):=[ [ 1.0, 2.0, 3.0, 4.0, 5.0, 6.0] ]
--R
--R
--R (1) [1.,2.,3.,4.,5.,6.]
--R
--R                                          Type: PrimitivesArray DoubleFloat
--E 1

--S 2 of 28
dasum(3,a,-1) -- 0.0 neg incx
--R
--R
--R (2) 0.
--R
--R                                          Type: DoubleFloat
--E 2

--S 3 of 28
dasum(3,a,0) -- 0.0 zero incx
--R
```



```
--R
--R (3) 0.
--R
--R Type: DoubleFloat
--E 3

--S 4 of 28
dasum(-1,a,1) -- 0.0 neg elements
--R
--R
--R (4) 0.
--R
--R Type: DoubleFloat
--E 4

--S 5 of 28
dasum(0,a,1) -- 0.0 no elements
--R
--R
--R (5) 0.
--R
--R Type: DoubleFloat
--E 5

--S 6 of 28
dasum(1,a,1) -- 1.0 1.0
--R
--R
--R (6) 1.
--R
--R Type: DoubleFloat
--E 6

--S 7 of 28
dasum(2,a,1) -- 3.0 1.0+2.0
--R
--R
--R (7) 3.
--R
--R Type: DoubleFloat
--E 7

--S 8 of 28
dasum(3,a,1) -- 6.0 1.0+2.0+3.0
--R
--R
--R (8) 6.
--R
--R Type: DoubleFloat
--E 8

--S 9 of 28
```

```
dasum(4,a,1) -- 10.0    1.0+2.0+3.0+4.0
```

```
--R
```

```
--R
```

```
--R    (9)  10.
```

```
--R
```

```
--E 9
```

Type: DoubleFloat

```
--S 10 of 28
```

```
dasum(5,a,1) -- 15.0    1.0+2.0+3.0+4.0+5.0
```

```
--R
```

```
--R
```

```
--R    (10) 15.
```

```
--R
```

```
--E 10
```

Type: DoubleFloat

```
--S 11 of 28
```

```
dasum(6,a,1) -- 21.0    1.0+2.0+3.0+4.0+5.0+6.0
```

```
--R
```

```
--R
```

```
--R    (11) 21.
```

```
--R
```

```
--E 11
```

Type: DoubleFloat

```
--S 12 of 28
```

```
dasum(7,a,1) -- 21.0    1.0+2.0+3.0+4.0+5.0+6.0
```

```
--R
```

```
--R
```

```
--R    (12) 21.
```

```
--R
```

```
--E 12
```

Type: DoubleFloat

```
--S 13 of 28
```

```
dasum(1,a,2) -- 1.0     1.0
```

```
--R
```

```
--R
```

```
--R    (13) 1.
```

```
--R
```

```
--E 13
```

Type: DoubleFloat

```
--S 14 of 28
```

```
dasum(2,a,2) -- 4.0     1.0+3.0
```

```
--R
```

```
--R
```

```
--R    (14) 4.
```

```
--R
```

```
--E 14
```

Type: DoubleFloat

```

--S 15 of 28
dasum(3,a,2) -- 9.0  1.0+3.0+5.0
--R
--R
--R   (15)  9.
--R
--R                                          Type: DoubleFloat
--E 15

--S 16 of 28
dasum(4,a,2) -- 9.0  1.0+3.0+5.0
--R
--R
--R   (16)  9.
--R
--R                                          Type: DoubleFloat
--E 16

--S 17 of 28
dasum(1,a,3) -- 1.0  1.0
--R
--R
--R   (17)  1.
--R
--R                                          Type: DoubleFloat
--E 17

--S 18 of 28
dasum(2,a,3) -- 5.0  1.0+4.0
--R
--R
--R   (18)  5.
--R
--R                                          Type: DoubleFloat
--E 18

--S 19 of 28
dasum(3,a,3) -- 5.0  1.0+4.0
--R
--R
--R   (19)  5.
--R
--R                                          Type: DoubleFloat
--E 19

--S 20 of 28
dasum(1,a,4) -- 1.0  1.0
--R
--R
--R   (20)  1.

```

```

--R
--E 20
Type: DoubleFloat

--S 21 of 28
dasum(2,a,4) -- 6.0 1.0+5.0
--R
--R
--R (21) 6.
--R
--E 21
Type: DoubleFloat

--S 22 of 28
dasum(3,a,4) -- 6.0 1.0+5.0
--R
--R
--R (22) 6.
--R
--E 22
Type: DoubleFloat

--S 23 of 28
dasum(1,a,5) -- 1.0 1.0
--R
--R
--R (23) 1.
--R
--E 23
Type: DoubleFloat

--S 24 of 28
dasum(2,a,5) -- 7.0 1.0+6.0
--R
--R
--R (24) 7.
--R
--E 24
Type: DoubleFloat

--S 25 of 28
dasum(3,a,5) -- 7.0 1.0+6.0
--R
--R
--R (25) 7.
--R
--E 25
Type: DoubleFloat

--S 26 of 28
dasum(1,a,6) -- 1.0 1.0
--R

```

```
--R
--R (26) 1.
--R
--R                                          Type: DoubleFloat
--E 26

--S 27 of 28
dasum(2,a,6) -- 1.0 1.0
--R
--R
--R (27) 1.
--R
--R                                          Type: DoubleFloat
--E 27

--S 28 of 28
dasum(1,a,7) -- 1.0 1.0
--R
--R
--R (28) 1.
--R
--R                                          Type: DoubleFloat
--E 28

)spool
)lisp (bye)
```

$\langle dasum.help \rangle \equiv$

```
=====
dasum examples
=====
```

```
a:PRIMARR(DFLOAT):=[ [ 1.0, 2.0, 3.0, 4.0, 5.0, 6.0] ]
  [1.,2.,3.,4.,5.,6.]
```

```
dasum(3,a,-1) -- 0.0   neg incx
0.
```

```
dasum(3,a,0) -- 0.0   zero incx
0.
```

```
dasum(-1,a,1) -- 0.0   neg elements
0.
```

```
dasum(0,a,1) -- 0.0   no elements
0.
```

```
dasum(1,a,1) -- 1.0   1.0
1.
```

```
dasum(2,a,1) -- 3.0   1.0+2.0
3.
```

```
dasum(3,a,1) -- 6.0   1.0+2.0+3.0
6.
```

```
dasum(4,a,1) -- 10.0  1.0+2.0+3.0+4.0
10.
```

```
dasum(5,a,1) -- 15.0  1.0+2.0+3.0+4.0+5.0
15.
```

```
dasum(6,a,1) -- 21.0  1.0+2.0+3.0+4.0+5.0+6.0
21.
```

```
dasum(7,a,1) -- 21.0  1.0+2.0+3.0+4.0+5.0+6.0
21.
```

```
dasum(1,a,2) -- 1.0   1.0
1.
```

```
dasum(2,a,2) -- 4.0   1.0+3.0
4.
```

```
dasum(3,a,2) -- 9.0  1.0+3.0+5.0
9.
```

```
dasum(4,a,2) -- 9.0  1.0+3.0+5.0
9.
```

```
dasum(1,a,3) -- 1.0  1.0
1.
```

```
dasum(2,a,3) -- 5.0  1.0+4.0
5.
```

```
dasum(3,a,3) -- 5.0  1.0+4.0
5.
```

```
dasum(1,a,4) -- 1.0  1.0
1.
```

```
dasum(2,a,4) -- 6.0  1.0+5.0
6.
```

```
dasum(3,a,4) -- 6.0  1.0+5.0
6.
```

```
dasum(1,a,5) -- 1.0  1.0
1.
```

```
dasum(2,a,5) -- 7.0  1.0+6.0
7.
```

```
dasum(3,a,5) -- 7.0  1.0+6.0
7.
```

```
dasum(1,a,6) -- 1.0  1.0
1.
```

```
dasum(2,a,6) -- 1.0  1.0
1.
```

```
dasum(1,a,7) -- 1.0  1.0
1.
```

```
=====
Man Page Details
=====
```

Computes doublefloat  $\$asum \rightarrow ||re(x)||_1 + ||im(x)||_1$

Arguments are:

```
\begin{itemize}
\item n - fixnum
\item dx - array doublefloat
\item incx - fixnum
\end{itemize}
```

Return values are:

```
\begin{itemize}
\item 1 nil
\item 2 nil
\item 3 nil
\end{itemize}
```

NAME

DASUM - BLAS level one, sums the absolute values of the elements of a double precision vector

SYNOPSIS

```
DOUBLE PRECISION FUNCTION DASUM ( n, x, incx )
      INTEGER                n, incx
      DOUBLE PRECISION      x
```

AXIOM SIGNATURE:

```
SI ==> SingleInteger
DF ==> DoubleFloat
DX ==> PrimitiveArray(DoubleFloat)
```

```
dasum: (SI, DX, SI) -> DF
```

DESCRIPTION

This routine performs the following vector operation:

$$\text{DASUM} \leftarrow \sum_{i=1}^n \text{abs}(x(i))$$

ARGUMENTS

```
n      INTEGER. (input)
      Number of vector elements to be summed.
      if n <= 0, the result will be 0.0
      if n > length(x) then the whole array is summed.
```



x        DOUBLE PRECISION. (input)  
           Array of dimension (n-1) \* abs(incx)+ 1.  
           Vector that contains elements to be summed.

incx     INTEGER. (input)  
           Increment between elements of x.  
           If incx <= 0, the results will be 0.0

RESULT:

DASUM    DOUBLE PRECISION. (output)  
           Sum of the absolute values of the elements of the vector x.  
           If n <= 0, DASUM is set to 0.0

NOTES:

Axiom uses 0-based arrays. Fortran uses 1-based arrays.

if the index of the array exceeds the length of x  
 then no additional elements are added. Thus,  
 if x = #(1.0 2.0 3.0 4.0 5.0 6.0)  
 then

```
(dasum 3 a -1) = 0.0 ; neg incx
(dasum 3 a 0)  = 0.0 ; zero incx
(dasum -1 a 1) = 0.0 ; neg elements
(dasum 0 a 1)  = 0.0 ; no elements
(dasum 1 a 1)  = 1.0 ; 1.0
(dasum 2 a 1)  = 3.0 ; 1.0+2.0
(dasum 3 a 1)  = 6.0 ; 1.0+2.0+3.0
(dasum 4 a 1)  = 10.0 ; 1.0+2.0+3.0+4.0
(dasum 5 a 1)  = 15.0 ; 1.0+2.0+3.0+4.0+5.0
(dasum 6 a 1)  = 21.0 ; 1.0+2.0+3.0+4.0+5.0+6.0
(dasum 7 a 1)  = 21.0 ; 1.0+2.0+3.0+4.0+5.0+6.0
(dasum 1 a 2)  = 1.0 ; 1.0
(dasum 2 a 2)  = 4.0 ; 1.0+3.0
(dasum 3 a 2)  = 9.0 ; 1.0+3.0+5.0
(dasum 4 a 2)  = 9.0 ; 1.0+3.0+5.0
(dasum 1 a 3)  = 1.0 ; 1.0
(dasum 2 a 3)  = 5.0 ; 1.0+4.0
(dasum 3 a 3)  = 5.0 ; 1.0+4.0
(dasum 1 a 4)  = 1.0 ; 1.0
(dasum 2 a 4)  = 6.0 ; 1.0+5.0
(dasum 3 a 4)  = 6.0 ; 1.0+5.0
(dasum 1 a 5)  = 1.0 ; 1.0
(dasum 2 a 5)  = 7.0 ; 1.0+6.0
(dasum 3 a 5)  = 7.0 ; 1.0+6.0
(dasum 1 a 6)  = 1.0 ; 1.0
(dasum 2 a 6)  = 1.0 ; 1.0
```

```
(dasum 1 a 7) = 1.0 ; 1.0
```

```
(BLAS 1 dasum)≡
(defun dasum (n dx incx)
  (declare (type (simple-array double-float (*)) dx) (type fixnum incx n))
  (let ((dasum 0.0) (maxlen (length dx)))
    (declare (type (double-float) dasum) (type fixnum maxlen))
    (when (> incx 0)
      (when (> n maxlen) (setq n maxlen))
      (unless (<= n 0)
        (do ((i 0 (1+ i)) (j 0 (+ j incx)))
            ((or (>= i n) (>= j maxlen)))
          (setq dasum
            (the double-float
              (+ (the double-float dasum)
                 (the double-float (abs (the double-float (svref dx j))))))))))
    dasum))
```

## 4.2 daxpy BLAS

```

<daxpy.input>≡
)set break resume
)sys rm -f daxpy.output
)spool daxpy.output
)set message test on
)set message auto off
)clear all

--S 1 of 22
a:PRIMARR(DFLOAT):=[ [ 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0] ]
--R
--R
--R (1) [1.,2.,3.,4.,5.,6.,7.]
--R
--R                                          Type: PrimitiveArray DoubleFloat
--E 1

--S 2 of 22
b:PRIMARR(DFLOAT):=[ [ 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0] ]
--R
--R
--R (2) [1.,2.,3.,4.,5.,6.,7.]
--R
--R                                          Type: PrimitiveArray DoubleFloat
--E 2

--S 3 of 22
daxpy(3,2.0,a,1,b,1)
--R
--R
--R (3) [3.,6.,9.,4.,5.,6.,7.]
--R
--R                                          Type: PrimitiveArray DoubleFloat
--E 3

--S 4 of 22
b:PRIMARR(DFLOAT):=[ [ 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0] ]
--R
--R
--R (4) [1.,2.,3.,4.,5.,6.,7.]
--R
--R                                          Type: PrimitiveArray DoubleFloat
--E 4

--S 5 of 22
daxpy(7,2.0,a,1,b,1)
--R
--R

```

```

--R (5) [3.,6.,9.,12.,15.,18.,21.]
--R                                          Type: PrimitivesArray DoubleFloat
--E 5

--S 6 of 22
b:PRIMARR(DFLOAT):=[ [ 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0] ]
--R
--R
--R (6) [1.,2.,3.,4.,5.,6.,7.]
--R                                          Type: PrimitivesArray DoubleFloat
--E 6

--S 7 of 22
daxpy(8,2.0,a,1,b,1)
--R
--R
--R (7) [1.,2.,3.,4.,5.,6.,7.]
--R                                          Type: PrimitivesArray DoubleFloat
--E 7

--S 8 of 22
b:PRIMARR(DFLOAT):=[ [ 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0] ]
--R
--R
--R (8) [1.,2.,3.,4.,5.,6.,7.]
--R                                          Type: PrimitivesArray DoubleFloat
--E 8

--S 9 of 22
daxpy(3,2.0,a,3,b,3)
--R
--R
--R (9) [3.,2.,3.,12.,5.,6.,21.]
--R                                          Type: PrimitivesArray DoubleFloat
--E 9

--S 10 of 22
b:PRIMARR(DFLOAT):=[ [ 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0] ]
--R
--R
--R (10) [1.,2.,3.,4.,5.,6.,7.]
--R                                          Type: PrimitivesArray DoubleFloat
--E 10

--S 11 of 22
daxpy(4,2.0,a,2,b,2)

```

```

--R
--R
--R   (11)  [3.,2.,9.,4.,15.,6.,21.]
--R                                             Type: PrimitiveArray DoubleFloat
--E 11

--S 12 of 22
b:PRIMARR(DFLOAT):=[ [ 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0] ]
--R
--R
--R   (12)  [1.,2.,3.,4.,5.,6.,7.]
--R                                             Type: PrimitiveArray DoubleFloat
--E 12

--S 13 of 22
daxpy(5,2.0,a,2,b,2)
--R
--R
--R   (13)  [1.,2.,3.,4.,5.,6.,7.]
--R                                             Type: PrimitiveArray DoubleFloat
--E 13

--S 14 of 22
b:PRIMARR(DFLOAT):=[ [ 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0] ]
--R
--R
--R   (14)  [1.,2.,3.,4.,5.,6.,7.]
--R                                             Type: PrimitiveArray DoubleFloat
--E 14

--S 15 of 22
daxpy(3,2.0,a,2,b,2)
--R
--R
--R   (15)  [3.,2.,9.,4.,15.,6.,7.]
--R                                             Type: PrimitiveArray DoubleFloat
--E 15

--S 16 of 22
b:PRIMARR(DFLOAT):=[ [ 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0] ]
--R
--R
--R   (16)  [1.,2.,3.,4.,5.,6.,7.]
--R                                             Type: PrimitiveArray DoubleFloat
--E 16

```

[illegible]

```
--E 22
```

```
)spool  
)lisp (bye)
```

`<daxpy.help>≡`

```
=====
daxpy examples
=====
```

For each of the following examples we assume that we have preset the variables to the following values. Note that the daxpy function will modify the second array. Each example assumes we have reset the variables to these values.

```
a:PRIMARR(DFLOAT):=[ [ 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0] ]
b:PRIMARR(DFLOAT):=[ [ 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0] ]
```

then we compute the sum of the first 3 elements of each vector and we show the steps of the computation with trailing comments. The comments show which elements are changed and what the computation is.

```
daxpy(3,2.0,a,1,b,1) ==> [3.,6.,9.,4.,5.,6.,7.]
  dy(0)[3.0] = dy(0)[1.0] + ( da[2.0] * dx(0)[1.0] )
  dy(1)[6.0] = dy(1)[2.0] + ( da[2.0] * dx(1)[2.0] )
  dy(2)[9.0] = dy(2)[3.0] + ( da[2.0] * dx(2)[3.0] )
```

or we compute the first 7 elements of each vector

```
daxpy(7,2.0,a,1,b,1) ==> [3.,6.,9.,12.,15.,18.,21.]
  dy(0) [3.0] = dy(0)[1.0] + ( da[2.0] * dx(0)[1.0] )
  dy(1) [6.0] = dy(1)[2.0] + ( da[2.0] * dx(1)[2.0] )
  dy(2) [9.0] = dy(2)[3.0] + ( da[2.0] * dx(2)[3.0] )
  dy(3) [12.0] = dy(3)[4.0] + ( da[2.0] * dx(3)[4.0] )
  dy(4) [15.0] = dy(4)[5.0] + ( da[2.0] * dx(4)[5.0] )
  dy(5) [18.0] = dy(5)[6.0] + ( da[2.0] * dx(5)[6.0] )
  dy(6) [21.0] = dy(6)[7.0] + ( da[2.0] * dx(6)[7.0] )
```

or we compute the first 8 elements, which fails due to the fact that the vectors are not long enough.

```
daxpy(8,2.0,a,1,b,1) ==> [1.,2.,3.,4.,5.,6.,7.]
```

or we compute the 3 elements, taking every 3rd element, giving the index of 0, 3, 6

```
daxpy(3,2.0,a,3,b,3) ==> [3.,2.,3.,12.,5.,6.,21.]
  dy(0) [3.0] = dy(0)[1.0] + ( da[2.0] * dx(0)[1.0] )
  dy(3) [12.0] = dy(3)[4.0] + ( da[2.0] * dx(3)[4.0] )
  dy(6) [21.0] = dy(6)[7.0] + ( da[2.0] * dx(6)[7.0] )
```



or we compute 4 elements, taking every 2nd element, giving the index of 0, 2, 4, 6

```
daxpy(4,2.0,a,2,b,2) ==> [3.,2.,9.,4.,15.,6.,21.]
dy(0) [3.0] = dy(0) [1.0] + ( da[2.0] * dx(0) [1.0] )
dy(2) [9.0] = dy(2) [3.0] + ( da[2.0] * dx(2) [3.0] )
dy(4) [15.0] = dy(4) [5.0] + ( da[2.0] * dx(4) [5.0] )
dy(6) [21.0] = dy(6) [7.0] + ( da[2.0] * dx(6) [7.0] )
```

or we compute 5 elements, taking every 2nd element, which fails due to vector length

```
daxpy(5,2.0,a,2,b,2) ==> [1.,2.,3.,4.,5.,6.,7.]
```

or we compute 3 elements, taking every 2nd value, giving the index of 0, 2, 4

```
daxpy(3,2.0,a,2,b,2) ==> [3.,2.,9.,4.,15.,6.,7.]
dy(0) [3.0] = dy(0) [1.0] + ( da[2.0] * dx(0) [1.0] )
dy(2) [9.0] = dy(2) [3.0] + ( da[2.0] * dx(2) [3.0] )
dy(4) [15.0] = dy(4) [5.0] + ( da[2.0] * dx(4) [5.0] )
```

or we compute 3 elements, taking every 2nd value, giving the index of 0, 2, 4 but with a negative multiplier

```
daxpy(3,-2.0,a,2,b,2) ==> [- 1.,2.,- 3.,4.,- 5.,6.,7.]
dy(0) [-1.0] = dy(0) [1.0] + ( da[-2.0] * dx(0) [1.0] )
dy(2) [-3.0] = dy(2) [3.0] + ( da[-2.0] * dx(2) [3.0] )
dy(4) [-5.0] = dy(4) [5.0] + ( da[-2.0] * dx(4) [5.0] )
```

or we change the lengths of the input vectors, making them unequal. So for the next two examples we assume the arrays look like:

```
a:PRIMARR(DFLOAT):=[ [ 1.0, 2.0, 3.0] ]
b:PRIMARR(DFLOAT):=[ [ 1.0, 2.0, 3.0, 4.0, 5.0] ]
```

We compute 3 elements, with a negative multiplier, and different increments using an index for the 'a' array having values 0, 1, 2 using an index for the 'b' array having values 0, 2, 3

```
daxpy(3,-2.0,a,1,b,2) ==> [- 1.,2.,- 1.,4.,- 1.]
dy(0) [-1.0] = dy(0) [1.0] + ( da[-2.0] * dx(0) [1.0] )
dy(2) [-1.0] = dy(2) [3.0] + ( da[-2.0] * dx(1) [2.0] )
dy(4) [-1.0] = dy(4) [5.0] + ( da[-2.0] * dx(2) [3.0] )
```

or we compute 3 elements with a multiplier of 0.0 which fails

```
daxpy(3,0.0,a,1,b,2) ==> [1.,2.,3.,4.,5.,6.,7.]
```

```
=====
Man Page Details
=====
```

## NAME

DAXPY - BLAS level one axpy subroutine

## SYNOPSIS

```
SUBROUTINE DAXPY      ( n, alpha, x, incx, y, incy )
```

```
      INTEGER          n, incx, incy
```

```
      DOUBLE PRECISION alpha, x, y
```

## DESCRIPTION

DAXPY adds a scalar multiple of a double precision vector to another double precision vector.

DAXPY computes a constant alpha times a vector x plus a vector y. The result overwrites the initial values of vector y.

This routine performs the following vector operation:

```
y <-- alpha*x + y
```

incx and incy specify the increment between two consecutive elements of respectively vector x and y.

## ARGUMENTS

n        INTEGER. (input)  
Number of elements in the vectors. If n <= 0, these routines return without any computation.

alpha    DOUBLE PRECISION. (input)  
If alpha = 0 this routine returns without any computation.

x        DOUBLE PRECISION, (input)  
Array of dimension (n-1) \* |incx| + 1. Contains the vector to be scaled before summation.

incx     INTEGER. (input)  
Increment between elements of x.

If  $\text{incx} = 0$ , the results will be unpredictable.

$y$       DOUBLE PRECISION, (input and output)  
array of dimension  $(n-1) * |\text{incy}| + 1$ .  
Before calling the routine,  $y$  contains the vector to be summed.  
After the routine ends,  $y$  contains the result of the summation.

$\text{incy}$     INTEGER. (input)  
Increment between elements of  $y$ .  
If  $\text{incy} = 0$ , the results will be unpredictable.

#### RETURN VALUES

When  $n \leq 0$ , double precision  $\alpha = 0.$ , this routine returns immediately with no change in its arguments.

```

⟨BLAS 1 daxpy⟩≡
  (defun daxpy (n da dx incx dy incy)
    (declare (type (simple-array double-float) dx dy)
              (type double-float da) (type fixnum incy incx n))
    (let ((maxx (length dx)) (maxy (length dy)))
      (declare (type fixnum maxx maxy))
      (when (and (> n 0) (/= da 0.0)
                (> incx 0) (< (* (1- n) incx) maxx)
                (> incy 0) (< (* (1- n) incy) maxy)))
        (if (and (= incx 1) (= incy 1))
            ; unit increments
            (dotimes (i n)
              ; (format t "dy(~s)[~s] = dy(~s)[~s] + ( da[~s] * dx(~s)[~s] )~%"
                ; i (+ (svref dy i) (* da (svref dx i)))
                ; i (svref dy i)
                ; da i (svref dx i))
              (setf (the double-float (svref dy i))
                    (+ (the double-float (svref dy i))
                      (* (the double-float da)
                        (the double-float (svref dx i))))))
            ; non-unit increments
            (let ((ix 0) (iy 0))
              (declare (type fixnum ix iy))
              (when (< incx 0) (setq ix (* (1+ (- n)) incx)))
              (when (< incy 0) (setq ix (* (1+ (- n)) incy)))
              (dotimes (i n)
                ; (format t "dy(~s)[~s] = dy(~s)[~s] + ( da[~s] * dx(~s)[~s] )~%"
                  ; iy (+ (svref dy iy) (* da (svref dx ix)))
                  ; iy (svref dy iy)
                  ; da ix (svref dx ix))
                (setf (the double-float (svref dy iy))
                      (+ (the double-float (svref dy iy))
                        (* (the double-float da)
                          (the double-float (svref dx ix)))))
                (setq ix (+ ix incx))
                (setq iy (+ iy incy)))))
              dy)

```

### 4.3 dcopy BLAS

```

⟨dcopy.input⟩≡
)set break resume
)sys rm -f dcopy.output
)spool dcopy.output
)set message test on
)set message auto off
)clear all

--S 1 of 23
a:PRIMARR(DFLOAT):=[ [ 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0] ]
--R
--R
--R (1) [1.,2.,3.,4.,5.,6.,7.]
--R
--R                                          Type: PrimitiveArray DoubleFloat
--E 1

--S 2 of 23
b:PRIMARR(DFLOAT):=[ [ 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0] ]
--R
--R
--R (2) [0.,0.,0.,0.,0.,0.,0.]
--R
--R                                          Type: PrimitiveArray DoubleFloat
--E 2

--S 3 of 23
dcopy(3,a,1,b,1)
--R
--R
--R (3) [1.,2.,3.,0.,0.,0.,0.]
--R
--R                                          Type: PrimitiveArray DoubleFloat
--E 3

--S 4 of 23
b:PRIMARR(DFLOAT):=[ [ 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0] ]
--R
--R
--R (4) [0.,0.,0.,0.,0.,0.,0.]
--R
--R                                          Type: PrimitiveArray DoubleFloat
--E 4

--S 5 of 23
dcopy(7,a,1,b,1)
--R
--R

```

```

--R (5) [1.,2.,3.,4.,5.,6.,7.]
--R                                          Type: PrimitivesArray DoubleFloat
--E 5

--S 6 of 23
b:PRIMARR(DFLOAT):=[ [ 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0] ]
--R
--R
--R (6) [0.,0.,0.,0.,0.,0.,0.]
--R                                          Type: PrimitivesArray DoubleFloat
--E 6

--S 7 of 23
dcopy(8,a,1,b,1)
--R
--R
--R (7) [0.,0.,0.,0.,0.,0.,0.]
--R                                          Type: PrimitivesArray DoubleFloat
--E 7

--S 8 of 23
b:PRIMARR(DFLOAT):=[ [ 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0] ]
--R
--R
--R (8) [0.,0.,0.,0.,0.,0.,0.]
--R                                          Type: PrimitivesArray DoubleFloat
--E 8

--S 9 of 23
dcopy(3,a,3,b,3)
--R
--R
--R (9) [1.,0.,0.,4.,0.,0.,7.]
--R                                          Type: PrimitivesArray DoubleFloat
--E 9

--S 10 of 23
b:PRIMARR(DFLOAT):=[ [ 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0] ]
--R
--R
--R (10) [0.,0.,0.,0.,0.,0.,0.]
--R                                          Type: PrimitivesArray DoubleFloat
--E 10

--S 11 of 23
dcopy(4,a,2,b,2)

```

```

--R
--R
--R   (11)  [1.,0.,3.,0.,5.,0.,7.]
--R                                             Type: PrimitivesArray DoubleFloat
--E 11

--S 12 of 23
b:PRIMARR(DFLOAT):=[ [ 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0] ]
--R
--R
--R   (12)  [0.,0.,0.,0.,0.,0.,0.]
--R                                             Type: PrimitivesArray DoubleFloat
--E 12

--S 13 of 23
dcopy(5,a,2,b,2)
--R
--R
--R   (13)  [0.,0.,0.,0.,0.,0.,0.]
--R                                             Type: PrimitivesArray DoubleFloat
--E 13

--S 14 of 23
b:PRIMARR(DFLOAT):=[ [ 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0] ]
--R
--R
--R   (14)  [0.,0.,0.,0.,0.,0.,0.]
--R                                             Type: PrimitivesArray DoubleFloat
--E 14

--S 15 of 23
dcopy(3,a,2,b,2)
--R
--R
--R   (15)  [1.,0.,3.,0.,5.,0.,0.]
--R                                             Type: PrimitivesArray DoubleFloat
--E 15

--S 16 of 23
a:PRIMARR(DFLOAT):=[ [ 1.0, 2.0, 3.0] ]
--R
--R
--R   (16)  [1.,2.,3.]
--R                                             Type: PrimitivesArray DoubleFloat
--E 16

```

[illegible]



```
--E 22
```

```
--S 23 of 23  
dcopy(5,a,1,b,1)
```

```
--R
```

```
--R
```

```
--R (23) [1.,2.,3.]
```

```
--R
```

Type: PrimitivesArray DoubleFloat

```
--E 23
```

```
)spool
```

```
)lisp (bye)
```

`<dcopy.help>≡`

```
=====
dcopy examples
=====
```

Assume we have two arrays which we initialize to these values:

```
a:PRIMARR(DFLOAT):=[ [ 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0] ]
```

```
b:PRIMARR(DFLOAT):=[ [ 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0] ]
```

Note that after each call to dcopy the b array is modified.  
The changed value is shown. We reset it after each bcopy but we  
do not show that here.

```
dcopy(3,a,1,b,1) ==> [1.,2.,3.,0.,0.,0.,0.]
```

```
dcopy(7,a,1,b,1) ==> [1.,2.,3.,4.,5.,6.,7.]
```

```
dcopy(8,a,1,b,1) ==> [0.,0.,0.,0.,0.,0.,0.]
```

```
dcopy(3,a,3,b,3) ==> [1.,0.,0.,4.,0.,0.,7.]
```

```
dcopy(4,a,2,b,2) ==> [1.,0.,3.,0.,5.,0.,7.]
```

```
dcopy(5,a,2,b,2) ==> [0.,0.,0.,0.,0.,0.,0.]
```

```
dcopy(3,a,2,b,2) ==> [1.,0.,3.,0.,5.,0.,0.]
```

The arrays can be of different lengths:

```
a:PRIMARR(DFLOAT):=[ [ 1.0, 2.0, 3.0] ]
```

```
b:PRIMARR(DFLOAT):=[ [ 1.0, 2.0, 3.0, 4.0, 5.0] ]
```

```
dcopy(3,a,1,b,1) ==> [1.,2.,3.,4.,5.]
```

```
dcopy(3,a,1,b,2) ==> [1.,2.,2.,4.,3.]
```

```
a:PRIMARR(DFLOAT):=[ [ 1.0, 2.0, 3.0, 4.0, 5.0] ]
```

```
b:PRIMARR(DFLOAT):=[ [ 1.0, 2.0, 3.0] ]
```

```
dcopy(5,a,1,b,1) ==> [1.,2.,3.]
```

```
=====
Man Page Details
```

=====

#### NAME

DCOPY - BLAS level one, copies a double precision vector into another double precision vector

#### SYNOPSIS

```
SUBROUTINE DCOPY    ( n, x, incx, y, incy )
```

```
    INTEGER          n, incx, incy
```

```
    DOUBLE PRECISION x, y
```

#### DESCRIPTION

DCOPY copies a double precision vector into another double precision vector. DCOPY copies a vector x, whose length is n to a vector y. incx and incy specify the increment between two consecutive elements of respectively vector x and y.

This routine performs the following vector operation:

$$y \leftarrow x$$

where x and y are double precision vectors.

#### ARGUMENTS

n	INTEGER. (input) Number of vector elements to be copied. If n <= 0, this routine returns without computation.
x	DOUBLE PRECISION, (input) Vector from which to copy.
incx	INTEGER. (input) Increment between elements of x. If incx = 0, the y vector is unchanged
y	DOUBLE PRECISION, (output) array of dimension (n-1) *  incy  + 1, result vector.
incy	INTEGER. (input) Increment between elements of y. If incy = 0, the y vector is unchanged

```

⟨BLAS 1 dcopy⟩≡
  (defun dcopy (n dx incx dy incy)
    (declare (type (simple-array double-float) dy dx)
              (type fixnum incy incx n))
    (let ((maxx (length dx)) (maxy (length dy)))
      (declare (type fixnum maxx maxy))
      (when (and (> n 0)
                  (> incx 0) (< (* (1- n) incx) maxx)
                  (> incy 0) (< (* (1- n) incy) maxy))
        (if (and (= incx 1) (= incy 1))
            ; unit increments
            (dotimes (i n)
              (setf (the double-float (svref dy i)) (the double-float (svref dx i))))
            ; non-unit increments
            (let ((ix 0) (iy 0))
              (declare (type fixnum ix iy))
              (when (< incx 0) (setq ix (* (1+ (- n)) incx)))
              (when (< incy 0) (setq ix (* (1+ (- n)) incy)))
              (dotimes (i n)
                (setf (the double-float (svref dy iy)) (the double-float (svref dx ix)))
                (setq ix (+ ix incx))
                (setq iy (+ iy incy))))))))
    dy)

```

## 4.4 ddot BLAS

```

⟨ddot.input⟩≡
  )set break resume
  )sys rm -f ddot.output
  )spool ddot.output
  )set message test on
  )set message auto off
  )clear all

  )spool
  )lisp (bye)

```

`<ddot.help>`≡

```
=====
ddot examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

DDOT - BLAS level one, computes a dot product (inner product) of two double precision vectors

#### SYNOPSIS

```
DOUBLE PRECISION FUNCTION DDOT ( n, x, incx, y, incy )
```

```
      INTEGER                                n, incx, incy
```

```
      DOUBLE PRECISION                      x, y
```

#### DESCRIPTION

DDOT computes a dot product of two double precision vectors (1 double precision inner product).

2

This routine performs the following vector operation:

$$\text{DDOT} \leftarrow (\text{transpose of } x) * y = \sum_{i=1}^n x(i) * y(i)$$

where x and y are double precision vectors.

If n <= 0, DDOT is set to 0.

#### ARGUMENTS

n        INTEGER. (input)  
         Number of elements in each vector.

x        DOUBLE PRECISION. (input)  
         Array of dimension (n-1) \* |incx| + 1.  
         Array x contains the first vector operand.

incx     INTEGER. (input)  
         Increment between elements of x.  
         If incx = 0, the results will be unpredictable.

y        DOUBLE PRECISION, (input)  
          Array of dimension  $(n-1) * |incy| + 1$ .  
          Array y contains the second vector operand.

incy     INTEGER. (input)  
          Increment between elements of y. If incy = 0, the results will  
          be unpredictable.

## RETURN VALUES

DDOT     DOUBLE PRECISION. Result (dot product). (output)

## NOTES

When working backward ( $incx < 0$  or  $incy < 0$ ), each routine starts at the end of the vector and moves backward, as follows:

$x(1-incx * (n-1)), x(1-incx * (n-2)), \dots, x(1)$

$y(1-incy * (n-1)), y(1-incy * (n-2)), \dots, y(1)$

```

<BLAS 1 ddot>≡
  (defun ddot (n dx incx dy incy)
    (declare (type (simple-array double-float (*)) dy dx)
              (type fixnum incy incx n))
    (f2cl-lib:with-multi-array-data
      ((dx double-float dx-%data% dx-%offset%)
       (dy double-float dy-%data% dy-%offset%))
      (prog ((i 0) (ix 0) (iy 0) (m 0) (mp1 0) (dtemp 0.0) (ddot 0.0))
        (declare (type (double-float) ddot dtemp)
                  (type fixnum mp1 m iy ix i))
        (setf ddot 0.0)
        (setf dtemp 0.0)
        (if (<= n 0) (go end_label))
        (if (and (= incx 1) (= incy 1)) (go label20))
        (setf ix 1)
        (setf iy 1)
        (if (< incx 0)
            (setf ix
              (f2cl-lib:int-add
               (f2cl-lib:int-mul (f2cl-lib:int-sub 1 n) incx)
               1)))
        (if (< incy 0)
            (setf iy
              (f2cl-lib:int-add
               (f2cl-lib:int-mul (f2cl-lib:int-sub 1 n) incy)
               1)))
        (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                      ((> i n) nil)
          (tagbody
            (setf dtemp
              (+ dtemp
                (* (f2cl-lib:fref dx-%data% (ix) ((1 *)) dx-%offset%)
                  (f2cl-lib:fref dy-%data% (iy) ((1 *)) dy-%offset%))))
            (setf ix (f2cl-lib:int-add ix incx))
            (setf iy (f2cl-lib:int-add iy incy))))
        (setf ddot dtemp)
        (go end_label)
      label20
      (setf m (mod n 5))
      (if (= m 0) (go label40))
      (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                    ((> i m) nil)
        (tagbody
          (setf dtemp
            (+ dtemp
              (* (f2cl-lib:fref dx-%data% (i) ((1 *)) dx-%offset%)

```

```

                                (f2cl-lib:fref dy-%data% (i) ((1 *)) dy-%offset%))))))
  (if (< n 5) (go label60))
label40
  (setf mp1 (f2cl-lib:int-add m 1))
  (f2cl-lib:fd0 (i mp1 (f2cl-lib:int-add i 5))
    ((> i n) nil)
    (tagbody
      (setf dtemp
        (+ dtemp
          (* (f2cl-lib:fref dx-%data% (i) ((1 *)) dx-%offset%)
             (f2cl-lib:fref dy-%data% (i) ((1 *)) dy-%offset%))
          (*
            (f2cl-lib:fref dx-%data%
                          ((f2cl-lib:int-add i 1))
                          ((1 *))
                          dx-%offset%)
            (f2cl-lib:fref dy-%data%
                          ((f2cl-lib:int-add i 1))
                          ((1 *))
                          dy-%offset%))
          (*
            (f2cl-lib:fref dx-%data%
                          ((f2cl-lib:int-add i 2))
                          ((1 *))
                          dx-%offset%)
            (f2cl-lib:fref dy-%data%
                          ((f2cl-lib:int-add i 2))
                          ((1 *))
                          dy-%offset%))
          (*
            (f2cl-lib:fref dx-%data%
                          ((f2cl-lib:int-add i 3))
                          ((1 *))
                          dx-%offset%)
            (f2cl-lib:fref dy-%data%
                          ((f2cl-lib:int-add i 3))
                          ((1 *))
                          dy-%offset%))
          (*
            (f2cl-lib:fref dx-%data%
                          ((f2cl-lib:int-add i 4))
                          ((1 *))
                          dx-%offset%)
            (f2cl-lib:fref dy-%data%
                          ((f2cl-lib:int-add i 4))
                          ((1 *))
                          dy-%offset%))
        )
      )
    )

```



```
dy-%offset%))))))  
label60  
  (setf ddot dtemp)  
end_label  
  (return (values ddot nil nil nil nil nil)))))
```

## 4.5 dnrn2 BLAS

```
<dnrm2.input>≡  
  )set break resume  
  )sys rm -f dnrn2.output  
  )spool dnrn2.output  
  )set message test on  
  )set message auto off  
  )clear all  
  
  )spool  
  )lisp (bye)
```

`<dnrm2.help>=`

```
=====
dnrm2 examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

DNRM2 - BLAS level one, computes the Euclidean norm of a vector

#### SYNOPSIS

DOUBLE PRECISION FUNCTION DNRM2 ( n, x, incx )

INTEGER n, incx

DOUBLE PRECISION x

#### DESCRIPTION

DNRM2 computes the Euclidean (L2) norm of a double precision real vector, as follows:

$$\text{DNRM2} \leftarrow \sqrt{\sum_{i=1}^n x_i^2}$$

where x is a double precision real vector.

#### ARGUMENTS

n        INTEGER. (input)  
           Number of elements in the operand vector.

x        DOUBLE PRECISION. (input)  
           Array of dimension (n-1) \* |incx| + 1.  
           Array x contains the operand vector.

incx     INTEGER. (input)  
           Increment between elements of x.  
           If incx = 0, the results will be unpredictable.

#### RETURN VALUES

DNRM2    DOUBLE PRECISION. Result (Euclidean norm). (output)  
           If n <= 0, DNRM2 is set to 0d0.

#### NOTES

When working backward ( $\text{incx} < 0$ ), each routine starts at the end of the vector and moves backward, as follows:

$$x(1-\text{incx} * (n-1)), x(1-\text{incx} * (n-2)), \dots, x(1)$$

```

<BLAS 1 dnorm2>=
  (let* ((one 1.0) (zero 0.0))
    (declare (type (double-float 1.0 1.0) one)
              (type (double-float 0.0 0.0) zero))
    (defun dnorm2 (n x incx)
      (declare (type (simple-array double-float (*)) x)
                (type fixnum incx n))
      (f2cl-lib:with-multi-array-data
        ((x double-float x-%data% x-%offset%))
        (prog ((absxi 0.0) (norm 0.0) (scale 0.0) (ssq 0.0) (ix 0) (dnrm2 0.0))
          (declare (type fixnum ix)
                    (type (double-float) absxi norm scale ssq dnorm2))
          (cond
            ((or (< n 1) (< incx 1))
              (setf norm zero))
            ((= n 1)
              (setf norm (abs (f2cl-lib:fref x-%data% (1) ((1 *)) x-%offset%))))
            (t
              (setf scale zero)
              (setf ssq one)
              (f2cl-lib:fd0 (ix 1 (f2cl-lib:int-add ix incx))
                ((> ix
                  (f2cl-lib:int-add 1
                    (f2cl-lib:int-mul
                      (f2cl-lib:int-add n
                        (f2cl-lib:int-sub 1))
                    incx)))
                  nil)
              (tagbody
                (cond
                  ((/= (f2cl-lib:fref x (ix) ((1 *))) zero)
                    (setf absxi
                      (abs
                        (f2cl-lib:fref x-%data% (ix) ((1 *)) x-%offset%)))
                    (cond
                      ((< scale absxi)
                        (setf ssq (+ one (* ssq (expt (/ scale absxi) 2))))
                        (setf scale absxi))
                      (t
                        (setf ssq (+ ssq (expt (/ absxi scale) 2))))))
                    (setf norm (* scale (f2cl-lib:fsqrt ssq))))
                  (setf dnorm2 norm)
                end_label
                (return (values dnorm2 nil nil nil)))))))

```

## 4.6 drotg BLAS

```
<drotg.input>=  
  )set break resume  
  )sys rm -f drotg.output  
  )spool drotg.output  
  )set message test on  
  )set message auto off  
  )clear all  
  
  )spool  
  )lisp (bye)
```

`<drotg.help>=`

```
=====
drotg examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

DGROTG - BLAS level one rotation subroutines

#### SYNOPSIS

```
SUBROUTINE DROTG    ( a, b, c, s )
```

```
DOUBLE PRECISION  a, b, c, s
```

#### DESCRIPTION

DROTG computes the elements of a Givens plane rotation matrix such that:

$$\begin{bmatrix} c & s \\ -s & c \end{bmatrix} * \begin{bmatrix} a \\ b \end{bmatrix} = \begin{bmatrix} r \\ 0 \end{bmatrix}$$

where  $r = \pm \sqrt{a^2 + b^2}$  and  $c^2 + s^2 = 1$ .

The Givens plane rotation can be used to introduce zero elements into a matrix selectively.

#### ARGUMENTS

a (input and output) DOUBLE PRECISION

First vector component. On input, the first component of the vector to be rotated. On output, a is overwritten by r, the first component of the vector in the rotated coordinate system where:

$r = \text{sign}(\sqrt{a^2 + b^2}, a)$ , if  $|a| > |b|$

$r = \text{sign}(\sqrt{a^2 + b^2}, b)$ , if  $|a| \leq |b|$

b (input and output) DOUBLE PRECISION  
Second vector component.

On input, the second component of the vector to be rotated. On output, b contains z, where:

```

z=s    if |a| > |b|
z=1/c  if |a| <= |b| and c != 0 and r != 0
z=1    if |a| <= |b| and c = 0 and r != 0
z=0    if r = 0

```

c (output) DOUBLE PRECISION  
Cosine of the angle of rotation:

```

c = a/r if r != 0
c = 1   if r = 0

```

s (output) DOUBLE PRECISION  
Sine of the angle of rotation:

```

s = b/r if r != 0
s = 0   if r = 0

```

#### NOTE

The value of z, returned in b by DROTG, gives a compact representation of the rotation matrix, which can be used later to reconstruct c and s as in the following example:

```

IF (B .EQ. 1. ) THEN
  C = 0.
  S = 1.
ELSEIF( ABS( B) .LT. 1) THEN
  C = SQRT( 1. - B * B)
  S = B
ELSE
  C = 1. / B
  S = SQRT( 1 - C * C)
ENDIF

```

Double precision. Computes plane rotation. Arguments are:

- da - double-float
- db - double-float
- c - double-float
- s - double-float

Returns multiple values where:

- 1 da - double-float
- 2 db - double-float
- 3 c - double-float
- 4 s - double-float

$\langle \text{BLAS 1 drotg} \rangle \equiv$

```
(defun drotg (da db c s)
  (declare (type (double-float) s c db da))
  (prog ((roe 0.0) (scale 0.0) (r 0.0) (z 0.0))
    (declare (type (double-float) z r scale roe))
    (setf roe db)
    (when (> (the double-float (abs da)) (the double-float (abs db)))
      (setf roe da))
    (setf scale (+ (the double-float (abs da)) (the double-float (abs db))))
    (if (/= scale 0.0) (go label10))
    (setf c 1.0)
    (setf s 0.0)
    (setf r 0.0)
    (setf z 0.0)
    (go label20)
  label10
    (setf r
      (* scale (f2cl-lib:dsqrt (+ (expt (/ da scale) 2) (expt (/ db scale) 2)))))
    (setf r (* (f2cl-lib:dsign 1.0 roe) r))
    (setf c (/ da r))
    (setf s (/ db r))
    (setf z 1.0)
    (when (> (the double-float (abs da)) (the double-float (abs db)))
      (setf z s))
    (if (and (>= (the double-float (abs db)) (the double-float (abs da)))
          (/= c 0.0))
      (setf z (/ 1.0 c)))
  label20
    (setf da r)
```



```
(setf db z)
(return (values da db c s)))
```

## 4.7 drot BLAS

```
<drot.input>≡
)set break resume
)sys rm -f drot.output
)spool drot.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

`<drot.help>=`

```
=====
drot examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

DROT - BLAS level one, plane rotation subroutines

#### SYNOPSIS

```
SUBROUTINE DROT      ( n, x, incx, y, incy, c, s )
```

```
      INTEGER          n, incx, incy
```

```
      DOUBLE PRECISION x, y, c, s
```

#### DESCRIPTION

DROT applies a plane rotation matrix to a real sequence of ordered pairs:

$$\begin{pmatrix} x_i \\ y_i \end{pmatrix}, \text{ for all } i = 1, 2, \dots, n.$$

#### ARGUMENTS

<code>n</code>	INTEGER. (input) Number of ordered pairs (planar points in DROT) to be rotated. If <code>n &lt;= 0</code> , this routine returns without computation.
<code>x</code>	DOUBLE PRECISION, (input and output) Array of dimension $(n-1) *  incx  + 1$ . On input, array <code>x</code> contains the x-coordinate of each planar point to be rotated. On output, array <code>x</code> contains the x-coordinate of each rotated planar point.
<code>incx</code>	INTEGER. (input) Increment between elements of <code>x</code> . If <code>incx = 0</code> , the results will be unpredictable.
<code>y</code>	DOUBLE PRECISION, (input and output) array of dimension $(n-1) *  incy  + 1$ . On input, array <code>y</code> contains the y-coordinate of each planar point to be rotated. On output, array <code>y</code> contains the y-coordi-

nate of each rotated planar point.

- incy    INTEGER. (input)  
         Increment between elements of y. If incy = 0, the results will  
         be unpredictable.
- c        DOUBLE PRECISION, Cosine of the angle of rotation.  
         (input)
- s        DOUBLE PRECISION, Sine of the angle of rotation. (input)

#### NOTES

This routine applies the following plane rotation to each pair  
 of elements (x , y):

$$\begin{bmatrix} x(i) \\ y(i) \end{bmatrix} \leftarrow \begin{bmatrix} c & s \\ -s & c \end{bmatrix} \cdot \begin{bmatrix} x(i) \\ y(i) \end{bmatrix}$$

for i = 1,...,n

If coefficients c and s satisfy  $c^2 + s^2 = 1.0$ , the rotation matrix  
 is orthogonal, and the transformation is called a Givens plane  
 rotation. If c = 1 and s = 0, DROT returns without modifying any  
 input parameters.

To calculate the Givens coefficients c and s from a two-element  
 vector to determine the angle of rotation, use SROTG(3S).

When working backward (incx < 0 or incy < 0), each routine starts  
 at the end of the vector and moves backward, as follows:

x(1-incx \* (n-1)), x(1-incx \* (n-2)), ..., x(1)

y(1-incy \* (n-1)), y(1-incy \* (n-2)), ..., y(1)

```

⟨BLAS 1 drot⟩≡
  (defun drot (n dx incx dy incy c s)
    (declare (type (double-float) s c)
      (type (simple-array double-float (*)) dy dx)
      (type fixnum incy incx n))
    (f2cl-lib:with-multi-array-data
      ((dx double-float dx-%data% dx-%offset%)
       (dy double-float dy-%data% dy-%offset%))
      (prog ((i 0) (ix 0) (iy 0) (dtemp 0.0))
        (declare (type (double-float) dtemp) (type fixnum iy ix i))
        (if (<= n 0) (go end_label))
        (if (and (= incx 1) (= incy 1)) (go label20))
        (setf ix 1)
        (setf iy 1)
        (if (< incx 0)
          (setf ix
            (f2cl-lib:int-add
              (f2cl-lib:int-mul (f2cl-lib:int-sub 1 n) incx)
              1)))
        (if (< incy 0)
          (setf iy
            (f2cl-lib:int-add
              (f2cl-lib:int-mul (f2cl-lib:int-sub 1 n) incy)
              1)))
        (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
          ((> i n) nil)
          (tagbody
            (setf dtemp
              (+ (* c (f2cl-lib:fref dx-%data% (ix) ((1 *)) dx-%offset%))
                 (* s (f2cl-lib:fref dy-%data% (iy) ((1 *)) dy-%offset%))))
            (setf (f2cl-lib:fref dy-%data% (iy) ((1 *)) dy-%offset%)
              (- (* c (f2cl-lib:fref dy-%data% (iy) ((1 *)) dy-%offset%)
                 (* s (f2cl-lib:fref dx-%data% (ix) ((1 *)) dx-%offset%))))
            (setf (f2cl-lib:fref dx-%data% (ix) ((1 *)) dx-%offset%) dtemp)
            (setf ix (f2cl-lib:int-add ix incx))
            (setf iy (f2cl-lib:int-add iy incy))))
          (go end_label)
        label20
        (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
          ((> i n) nil)
          (tagbody
            (setf dtemp
              (+ (* c (f2cl-lib:fref dx-%data% (i) ((1 *)) dx-%offset%))
                 (* s (f2cl-lib:fref dy-%data% (i) ((1 *)) dy-%offset%))))
            (setf (f2cl-lib:fref dy-%data% (i) ((1 *)) dy-%offset%)
              (- (* c (f2cl-lib:fref dy-%data% (i) ((1 *)) dy-%offset%)
                 (* s (f2cl-lib:fref dx-%data% (i) ((1 *)) dx-%offset%))))

```

```

                                (* s (f2cl-lib:fref dx-%data% (i) ((1 *)) dx-%offset%)))
      (setf (f2cl-lib:fref dx-%data% (i) ((1 *)) dx-%offset%) dtemp)))
end_label
      (return (values nil nil nil nil nil nil nil)))

```

## 4.8 dscal BLAS

```

⟨dscal.input⟩≡
)set break resume
)sys rm -f dscal.output
)spool dscal.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)

```

`<dscal.help>=`

```
=====
dscal examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

DSCAL - BLAS level one, scales a double precision vector

#### SYNOPSIS

```
SUBROUTINE DSCAL      ( n, alpha, x, incx )
```

```
      INTEGER          n, incx
```

```
      DOUBLE PRECISION alpha, x
```

#### DESCRIPTION

DSCAL scales a double precision vector with a double precision scalar. DSCAL scales the vector x of length n and increment incx by the constant a.

This routine performs the following vector operation:

$$x \leftarrow \alpha x$$

where alpha is a double precision scalar, and x is a double precision vector.

#### ARGUMENTS

n	INTEGER. (input) Number of elements in the vector. If n <= 0, this routine returns without computation.
alpha	DOUBLE PRECISION scalar alpha. (input)
x	DOUBLE PRECISION, (input and output) Array of dimension (n-1) *  incx  + 1. Vector to be scaled.
incx	INTEGER. (input) Increment between elements of x. If incx = 0, the results will be unpredictable.

## NOTES

When working backward ( $\text{incx} < 0$  or  $\text{incy} < 0$ ), each routine starts at the end of the vector and moves backward, as follows:

$$x(1-\text{incx} * (n-1)), x(1-\text{incx} * (n-2)), \dots, x(1)$$

```

⟨BLAS 1 dscal⟩≡
(defun dscal (n da dx incx)
  (declare (type (simple-array double-float (*)) dx)
            (type (double-float) da)
            (type fixnum incx n))
  (f2cl-lib:with-multi-array-data
    ((dx double-float dx-%data% dx-%offset%))
    (prog ((i 0) (m 0) (mp1 0) (nincx 0))
      (declare (type fixnum nincx mp1 m i))
      (if (or (<= n 0) (<= incx 0)) (go end_label))
      (if (= incx 1) (go label20))
      (setf nincx (f2cl-lib:int-mul n incx))
      (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i incx))
        ((> i nincx) nil)
        (tagbody
          (setf (f2cl-lib:fref dx-%data% (i) ((1 *)) dx-%offset%)
                (* da (f2cl-lib:fref dx-%data% (i) ((1 *)) dx-%offset%))))
          (go end_label))
      label20
      (setf m (mod n 5))
      (if (= m 0) (go label40))
      (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
        ((> i m) nil)
        (tagbody
          (setf (f2cl-lib:fref dx-%data% (i) ((1 *)) dx-%offset%)
                (* da (f2cl-lib:fref dx-%data% (i) ((1 *)) dx-%offset%))))
          (if (< n 5) (go end_label))
          label40
          (setf mp1 (f2cl-lib:int-add m 1))
          (f2cl-lib:fdo (i mp1 (f2cl-lib:int-add i 5))
            ((> i n) nil)
            (tagbody
              (setf (f2cl-lib:fref dx-%data% (i) ((1 *)) dx-%offset%)
                    (* da (f2cl-lib:fref dx-%data% (i) ((1 *)) dx-%offset%)))
              (setf (f2cl-lib:fref dx-%data%
                                ((f2cl-lib:int-add i 1))
                                ((1 *))
                                dx-%offset%)
                    (* da
                      (f2cl-lib:fref dx-%data%
                                ((f2cl-lib:int-add i 1))
                                ((1 *))
                                dx-%offset%)))
              (setf (f2cl-lib:fref dx-%data%
                                ((f2cl-lib:int-add i 2))
                                ((1 *))

```



```

                                dx-%offset%)
(* da
  (f2cl-lib:fref dx-%data%
    ((f2cl-lib:int-add i 2))
    ((1 *))
    dx-%offset%)))
(setf (f2cl-lib:fref dx-%data%
  ((f2cl-lib:int-add i 3))
  ((1 *))
  dx-%offset%)
(* da
  (f2cl-lib:fref dx-%data%
    ((f2cl-lib:int-add i 3))
    ((1 *))
    dx-%offset%)))
(setf (f2cl-lib:fref dx-%data%
  ((f2cl-lib:int-add i 4))
  ((1 *))
  dx-%offset%)
(* da
  (f2cl-lib:fref dx-%data%
    ((f2cl-lib:int-add i 4))
    ((1 *))
    dx-%offset%))))))
end_label
(return (values nil nil nil nil))))

```

## 4.9 dswap BLAS

```

⟨dswap.input⟩≡
)set break resume
)sys rm -f dswap.output
)spool dswap.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)

```

`<dswap.help>≡`

```
=====
dswap examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

DSWAP - BLAS level one, Swaps two double precision vectors

#### SYNOPSIS

```
SUBROUTINE DSWAP      ( n, x, incx, y, incy )
```

```
      INTEGER          n, incx, incy
```

```
      DOUBLE PRECISION x, y
```

#### DESCRIPTION

DSWAP swaps two double precision vectors, it interchanges *n* values of vector *x* and vector *y*. *incx* and *incy* specify the increment between two consecutive elements of respectively vector *x* and *y*.

This routine performs the following vector operation:

$$x \leftrightarrow y$$

where *x* and *y* are double precision vectors.

#### ARGUMENTS

<i>n</i>	INTEGER. (input) Number of vector elements to be swapped. If <i>n</i> ≤ 0, this routine returns without computation.
<i>x</i>	DOUBLE PRECISION, (input and output) Array of dimension (n-1) *  incx  + 1.
<i>incx</i>	INTEGER. (input) Increment between elements of <i>x</i> . If <i>incx</i> = 0, the results will be unpredictable.
<i>y</i>	DOUBLE PRECISION, (input and output) array of dimension (n-1) *  incy  + 1. Vector to be swapped.

incy     INTEGER. (input)  
         Increment between elements of y. If incy = 0, the results will  
         be unpredictable.

#### NOTES

When working backward ( $\text{incx} < 0$  or  $\text{incy} < 0$ ), each routine starts at the end of the vector and moves backward, as follows:

$x(1-\text{incx} * (n-1)), x(1-\text{incx} * (n-2)), \dots, x(1)$

$y(1-\text{incy} * (n-1)), y(1-\text{incy} * (n-2)), \dots, y(1)$

```

⟨BLAS 1 dswap⟩≡
  (defun dswap (n dx incx dy incy)
    (declare (type (simple-array double-float (*)) dy dx)
      (type fixnum incy incx n))
    (f2cl-lib:with-multi-array-data
      ((dx double-float dx-%data% dx-%offset%)
       (dy double-float dy-%data% dy-%offset%))
      (prog ((i 0) (ix 0) (iy 0) (m 0) (mp1 0) (dtemp 0.0))
        (declare (type (double-float) dtemp)
          (type fixnum mp1 m iy ix i))
        (if (<= n 0) (go end_label))
        (if (and (= incx 1) (= incy 1)) (go label20))
        (setf ix 1)
        (setf iy 1)
        (if (< incx 0)
          (setf ix
            (f2cl-lib:int-add
              (f2cl-lib:int-mul (f2cl-lib:int-sub 1 n) incx)
              1)))
        (if (< incy 0)
          (setf iy
            (f2cl-lib:int-add
              (f2cl-lib:int-mul (f2cl-lib:int-sub 1 n) incy)
              1)))
        (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
          (> i n) nil)
        (tagbody
          (setf dtemp (f2cl-lib:fref dx-%data% (ix) ((1 *)) dx-%offset%))
          (setf (f2cl-lib:fref dx-%data% (ix) ((1 *)) dx-%offset%)
            (f2cl-lib:fref dy-%data% (iy) ((1 *)) dy-%offset%))
          (setf (f2cl-lib:fref dy-%data% (iy) ((1 *)) dy-%offset%) dtemp)
          (setf ix (f2cl-lib:int-add ix incx))
          (setf iy (f2cl-lib:int-add iy incy))))
        (go end_label)
      label20
        (setf m (mod n 3))
        (if (= m 0) (go label40))
        (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
          (> i m) nil)
        (tagbody
          (setf dtemp (f2cl-lib:fref dx-%data% (i) ((1 *)) dx-%offset%))
          (setf (f2cl-lib:fref dx-%data% (i) ((1 *)) dx-%offset%)
            (f2cl-lib:fref dy-%data% (i) ((1 *)) dy-%offset%))
          (setf (f2cl-lib:fref dy-%data% (i) ((1 *)) dy-%offset%) dtemp)))
        (if (< n 3) (go end_label))
      label40

```

```

(setf mp1 (f2cl-lib:int-add m 1))
(f2cl-lib:fdo (i mp1 (f2cl-lib:int-add i 3))
  (> i n) nil)
(tagbody
  (setf dtemp (f2cl-lib:fref dx-%data% (i) ((1 *)) dx-%offset%))
  (setf (f2cl-lib:fref dx-%data% (i) ((1 *)) dx-%offset%)
    (f2cl-lib:fref dy-%data% (i) ((1 *)) dy-%offset%))
  (setf (f2cl-lib:fref dy-%data% (i) ((1 *)) dy-%offset%) dtemp)
  (setf dtemp
    (f2cl-lib:fref dx-%data%
      ((f2cl-lib:int-add i 1))
      ((1 *))
      dx-%offset%))
  (setf (f2cl-lib:fref dx-%data%
    ((f2cl-lib:int-add i 1))
    ((1 *))
    dx-%offset%)
    (f2cl-lib:fref dy-%data%
      ((f2cl-lib:int-add i 1))
      ((1 *))
      dy-%offset%))
  (setf (f2cl-lib:fref dy-%data%
    ((f2cl-lib:int-add i 1))
    ((1 *))
    dy-%offset%)
    dtemp)
  (setf dtemp
    (f2cl-lib:fref dx-%data%
      ((f2cl-lib:int-add i 2))
      ((1 *))
      dx-%offset%))
  (setf (f2cl-lib:fref dx-%data%
    ((f2cl-lib:int-add i 2))
    ((1 *))
    dx-%offset%)
    (f2cl-lib:fref dy-%data%
      ((f2cl-lib:int-add i 2))
      ((1 *))
      dy-%offset%))
  (setf (f2cl-lib:fref dy-%data%
    ((f2cl-lib:int-add i 2))
    ((1 *))
    dy-%offset%)
    dtemp)))
end_label
(return (values nil nil nil nil nil))))

```

## 4.10 dzasum BLAS

```
<dzasum.input>≡  
  )set break resume  
  )sys rm -f dzasum.output  
  )spool dzasum.output  
  )set message test on  
  )set message auto off  
  )clear all  
  
  )spool  
  )lisp (bye)
```

`<dzasum.help>≡`

```
=====
dzasum examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

DZASUM - BLAS level one, sums the absolute values of the real and imaginary parts of the elements of a double complex vector

#### SYNOPSIS

```
DOUBLE PRECISION FUNCTION DZASUM ( n, x, incx )
```

```
      INTEGER                      n, incx
```

```
      DOUBLE COMPLEX              x
```

#### DESCRIPTION

This routine performs the following vector operation:

$$\text{DZASUM} \leftarrow \sum_{i=1}^n \text{abs}(\text{real}(x(i))) + \text{abs}(\text{aimag}(x(i)))$$

#### ARGUMENTS

**n**        INTEGER. (input)  
Number of vector elements to be summed.

**x**        DOUBLE COMPLEX. (input)  
Array of dimension  $(n-1) * \text{abs}(\text{incx}) + 1$ .  
Vector that contains elements to be summed.

**incx**     INTEGER. (input)  
Increment between elements of x.  
If  $\text{incx} = 0$ , the results will be unpredictable.

#### RETURN VALUES

**DZASUM**   DOUBLE PRECISION. (output)  
Sum of the absolute values of the real and imaginary parts of the elements of the vector x.  
If  $n \leq 0$ , DZASUM is set to 0.

## NOTES

When working backward ( $\text{incx} < 0$ ), each routine starts at the end of the vector and moves backward, as follows:

$$x(1-\text{incx} * (n-1)), x(1-\text{incx} * (n-2)), \dots, x(1)$$



Computes (complex double-float)  $asum \leftarrow \|re(x)\|_1 + \|im(x)\|_1$

Arguments are:

- n - fixnum
- dx - array (complex double-float)
- incx - fixnum

Return values are:

- 1 nil
- 2 nil
- 3 nil

$\langle BLAS\ 1\ dzasum \rangle \equiv$

```
(defun dzasum (n zx incx)
  (declare (type (simple-array (complex double-float) (*)) zx)
           (type fixnum incx n))
  (f2cl-lib:with-multi-array-data
    ((zx (complex double-float) zx-%data% zx-%offset%))
    (prog ((i 0) (ix 0) (stemp 0.0) (dzasum 0.0))
      (declare (type (double-float) dzasum stemp)
                (type fixnum ix i))
      (setf dzasum 0.0)
      (setf stemp 0.0)
      (if (or (<= n 0) (<= incx 0)) (go end_label))
      (if (= incx 1) (go label20))
      (setf ix 1)
      (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                    ((> i n) nil)
        (tagbody
          (setf stemp
                (+ stemp
                  (dcabs1
                   (f2cl-lib:fref zx-%data% (ix) ((1 *)) zx-%offset%))))
          (setf ix (f2cl-lib:int-add ix incx))))
      (setf dzasum stemp)
      (go end_label)
    label20
      (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                    ((> i n) nil)
        (tagbody
          (setf stemp
                (+ stemp
```

```

                                (dcabs1
                                (f2c1-lib:fref zx-%data% (i) ((1 *)) zx-%offset%))))))
    (setf dzasum stemp)
end_label
    (return (values dzasum nil nil nil))))

```

## 4.11 dznrm2 BLAS

```

⟨dznrm2.input⟩≡
)set break resume
)sys rm -f dznrm2.output
)spool dznrm2.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)

```

`<dznorm2.help>≡`

```
=====
dznorm2 examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

DZNRM2 - BLAS level one, computes the Euclidean norm of a vector

#### SYNOPSIS

DOUBLE PRECISION FUNCTION DZNRM2 ( n, x, incx )

INTEGER n, incx

DOUBLE COMPLEX x

#### DESCRIPTION

DZNRM2 computes the Euclidean (L2) norm of a double precision complex vector:

$$DZNRM2 \leftarrow \sqrt{\sum |x_i|^2}$$

where x is a double precision complex vector.

#### ARGUMENTS

n INTEGER (input)  
Number of elements in the operand vector.

x DOUBLE COMPLEX (input)  
Array of dimension (n-1) \* |incx| + 1.  
Array x contains the operand vector.

incx INTEGER (input)  
Increment between elements of x.  
If incx = 0, the results will be unpredictable.

#### RETURN VALUES

DZNRM2 DOUBLE PRECISION Result (Euclidean norm). (output)  
If n <= 0, DZNRM2 is set to 0d0.

## NOTES

When working backward ( $\text{incx} < 0$ ), DZNRM2 starts at the end of the vector and moves backward, as follows:

$$x(1-\text{incx} * (n-1)), x(1-\text{incx} * (n-2)), \dots, x(1)$$

```

<BLAS 1 dznrm2>≡
  (let* ((one 1.0) (zero 0.0))
    (declare (type (double-float 1.0 1.0) one)
              (type (double-float 0.0 0.0) zero))
    (defun dznrm2 (n x incx)
      (declare (type (simple-array (complex double-float) (*)) x)
                (type fixnum incx n))
      (f2cl-lib:with-multi-array-data
        ((x (complex double-float) x-%data% x-%offset%))
        (prog ((norm 0.0) (scale 0.0) (ssq 0.0) (temp 0.0) (ix 0) (dznrm2 0.0))
          (declare (type fixnum ix)
                    (type (double-float) norm scale ssq temp dznrm2))
          (cond
            ((or (< n 1) (< incx 1))
              (setf norm zero))
            (t
              (setf scale zero)
              (setf ssq one)
              (f2cl-lib:fdo (ix 1 (f2cl-lib:int-add ix incx))
                ((> ix
                  (f2cl-lib:int-add 1
                    (f2cl-lib:int-mul
                      (f2cl-lib:int-add n
                        (f2cl-lib:int-sub 1))
                      incx)))
                  nil)
                (tagbody
                  (cond
                    (("/=
                      (coerce (realpart (f2cl-lib:fref x (ix) ((1 *))) 'double-float
                        zero)
                      (setf temp
                        (abs
                          (coerce (realpart
                            (f2cl-lib:fref x-%data% (ix) ((1 *)) x-%offset%)
                            'double-float)))
                      (cond
                        ((< scale temp)
                          (setf ssq (+ one (* ssq (expt (/ scale temp) 2))))
                          (setf scale temp))
                        (t
                          (setf ssq (+ ssq (expt (/ temp scale) 2))))))
                    (cond
                      (("/= (f2cl-lib:dimag (f2cl-lib:fref x (ix) ((1 *))) zero)
                        (setf temp
                          (abs

```

```

(f2cl-lib:dimag
 (f2cl-lib:fref x-%data% (ix) ((1 *)) x-%offset%)))
(cond
 ((< scale temp)
  (setf ssq (+ one (* ssq (expt (/ scale temp) 2))))
  (setf scale temp))
 (t
  (setf ssq (+ ssq (expt (/ temp scale) 2))))))
(setf norm (* scale (f2cl-lib:fsqrt ssq)))
(setf dznrm2 norm)
end_label
(return (values dznrm2 nil nil nil))))

```

## 4.12 icamax BLAS

```

<icamax.input>≡
)set break resume
)sys rm -f icamax.output
)spool icamax.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)

```

`<icamax.help>`≡

```
=====
icamax examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

ICAMAX - BLAS level one, maximum index function

#### SYNOPSIS

```
INTEGER FUNCTION ICAMAX ( n, x, incx )
```

```
        INTEGER                n, incx
```

```
        COMPLEX                x
```

#### DESCRIPTION

ICAMAX searches a complex vector for the first occurrence of the maximum absolute value.

ICAMAX determines the first index  $i$  such that

$$|\text{Real}(x_i)| + |\text{Imag}(x_i)| = \text{MAX}(|\text{Real}(x_j)| + |\text{Imag}(x_j)|): j = 1, \dots, n$$

where  $x_j$  is an element of a complex vector.

#### ARGUMENTS

**n**        INTEGER. (input)  
 Number of elements to process in the vector to be searched. If  $n \leq 0$ , these routines return 0.

**x**        COMPLEX. (input)  
 Array of dimension  $(n-1) * |\text{incx}| + 1$ .  
 Array x contains the vector to be searched.

**incx**     INTEGER. (input)  
 Increment between elements of x.

#### RETURN VALUES

**ICAMAX**   INTEGER. (output)  
 Return the first index of the maximum absolute value of vector

x. The vector x has length n and increment incx.

#### NOTES

When working backward ( $\text{incx} < 0$ ), each routine starts at the end of the vector and moves backward, as follows:

$x(1-\text{incx} * (n-1)), x(1-\text{incx} * (n-2)), \dots, x(1)$

The largest absolute value is:

$\text{ABS}(x(1+(\text{index}-1) * \text{incx}))$  when  $\text{incx} > 0$

$\text{ABS}(x(1+(n-\text{index}) * |\text{incx}|))$  when  $\text{incx} < 0$



```

<BLAS 1 icamax>≡
(defun icamax (n cx incx)
  (declare (type (simple-array (complex single-float) (*)) cx)
    (type fixnum incx n))
  (f2cl-lib:with-multi-array-data
    ((cx (complex single-float) cx-%data% cx-%offset%))
    (labels ((cabs1 (zdum)
              (+ (abs (coerce (realpart zdum) 'single-float))
                 (abs (f2cl-lib:aimag zdum))))))
      (declare (ftype (function (complex single-float)
                                (values single-float &rest t))
                    cabs1))
      (prog ((zdum #C(0.0f0 0.0f0)) (i 0) (ix 0) (smax 0.0f0) (icamax 0))
        (declare (type (single-float) smax)
          (type fixnum icamax ix i)
          (type (complex single-float) zdum))
        (setf icamax 0)
        (if (or (< n 1) (<= incx 0)) (go end_label))
        (setf icamax 1)
        (if (= n 1) (go end_label))
        (if (= incx 1) (go label20))
        (setf ix 1)
        (setf smax (cabs1 (f2cl-lib:fref cx-%data% (1) ((1 *)) cx-%offset%)))
        (setf ix (f2cl-lib:int-add ix incx))
        (f2cl-lib:fdo (i 2 (f2cl-lib:int-add i 1))
          (> i n) nil)
        (tagbody
          (if
            (<= (cabs1 (f2cl-lib:fref cx-%data% (ix) ((1 *)) cx-%offset%))
              smax)
            (go label5)
            (setf icamax i)
            (setf smax
              (cabs1 (f2cl-lib:fref cx-%data% (ix) ((1 *)) cx-%offset%)))
            label5
            (setf ix (f2cl-lib:int-add ix incx))))
          (go end_label)
        label20
        (setf smax (cabs1 (f2cl-lib:fref cx-%data% (1) ((1 *)) cx-%offset%)))
        (f2cl-lib:fdo (i 2 (f2cl-lib:int-add i 1))
          (> i n) nil)
        (tagbody
          (if
            (<= (cabs1 (f2cl-lib:fref cx-%data% (i) ((1 *)) cx-%offset%))
              smax)
            (go label30))
          label30
          (setf smax (cabs1 (f2cl-lib:fref cx-%data% (i) ((1 *)) cx-%offset%)))
          (setf ix (f2cl-lib:int-add ix incx))
          (go label20))
        label30
        (setf ix (f2cl-lib:int-add ix incx))
        (go end_label)
      )
    )
  )

```

```

                (setf icamax i)
                (setf smax
                    (cabs1 (f2cl-lib:fref cx-%data% (i) ((1 *)) cx-%offset%)))
label30))
end_label
    (return (values icamax nil nil nil))))))

```

### 4.13 idamax BLAS

```

<idamax.input>≡
)set break resume
)sys rm -f idamax.output
)spool idamax.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)

```

`<idamax.help>`≡

```
=====
idamax examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

IDAMAX - BLAS level one, maximum index function

#### SYNOPSIS

```
INTEGER FUNCTION IDAMAX ( n, x, incx )
```

```
        INTEGER                n, incx
```

```
        DOUBLE PRECISION      x
```

#### DESCRIPTION

IDAMAX searches a double precision vector for the first occurrence of the the maximum absolute value. The vector x has length n and increment incx.

#### ARGUMENTS

n        INTEGER. (input)  
Number of elements to process in the vector to be searched. If n <= 0, these routines return 0.

x        DOUBLE PRECISION. (input)  
Array of dimension (n-1) \* |incx| + 1.  
Array x contains the vector to be searched.

incx     INTEGER. (input)  
Increment between elements of x.

#### RETURN VALUES

IDAMAX   INTEGER. (output)  
Return the first index of the maximum absolute value of vector x. The vector x has length n and increment incx.

#### NOTES

When working backward (incx < 0), each routine starts at the end of the vector and moves backward, as follows:

$x(1-incx * (n-1)), x(1-incx * (n-2)), \dots, x(1)$

The largest absolute value is:

$ABS(x(1+(index-1) * incx))$  when  $incx > 0$

$ABS(x(1+(n-index) * |incx|))$  when  $incx < 0$

```

<BLAS 1 idamax>=
(defun idamax (n dx incx)
  (declare (type (simple-array double-float (*)) dx)
    (type fixnum incx n))
  (f2cl-lib:with-multi-array-data
    ((dx double-float dx-%data% dx-%offset%))
    (prog ((i 0) (ix 0) (dmax 0.0) (idamax 0))
      (declare (type (double-float) dmax)
        (type fixnum idamax ix i))
      (setf idamax 0)
      (if (or (< n 1) (<= incx 0)) (go end_label))
      (setf idamax 1)
      (if (= n 1) (go end_label))
      (if (= incx 1) (go label20))
      (setf ix 1)
      (setf dmax
        (the double-float (abs
          (the double-float
            (f2cl-lib:fref dx-%data% (1) ((1 *)) dx-%offset%))))))
      (setf ix (f2cl-lib:int-add ix incx))
      (f2cl-lib:fdo (i 2 (f2cl-lib:int-add i 1))
        (> i n) nil)

      (tagbody
        (if
          (<=
            (the double-float (abs
              (the double-float
                (f2cl-lib:fref dx-%data% (ix) ((1 *)) dx-%offset%))))
            dmax)
          (go label5))
        (setf idamax i)
        (setf dmax
          (the double-float (abs
            (the double-float
              (f2cl-lib:fref dx-%data% (ix) ((1 *)) dx-%offset%))))))
        label5
          (setf ix (f2cl-lib:int-add ix incx))))
        (go end_label)
        label20
          (setf dmax
            (the double-float (abs
              (the double-float
                (f2cl-lib:fref dx-%data% (1) ((1 *)) dx-%offset%))))))
          (f2cl-lib:fdo (i 2 (f2cl-lib:int-add i 1))
            (> i n) nil)

          (tagbody

```

```

      (if
        (<=
          (the double-float (abs
            (the double-float
              (f2cl-lib:fref dx-%data% (i) ((1 *)) dx-%offset%))))
          dmax)
          (go label30))
      (setf idamax i)
      (setf dmax
        (the double-float (abs
          (the double-float
            (f2cl-lib:fref dx-%data% (i) ((1 *)) dx-%offset%))))))
label30))
end_label
(return (values idamax nil nil nil))))

```

## 4.14 isamax BLAS

```

<isamax.input>≡
)set break resume
)sys rm -f isamax.output
)spool isamax.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)

```

`<isamax.help>`≡

```
=====
isamax examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

ISAMAX - BLAS level one, maximum index function

#### SYNOPSIS

```
INTEGER FUNCTION ISAMAX ( n, x, incx )
```

```
INTEGER                n, incx
```

```
REAL                   x
```

#### DESCRIPTION

ISAMAX searches a real vector for the first occurrence of the the maximum absolute value. The vector x has length n and increment incx.

ISAMAX returns the first index i such that

$$|x_i| = \max_j |x_j| : j = 1, \dots, n$$

where  $x_j$  is an element of a real vector.

#### ARGUMENTS

n        INTEGER. (input)  
Number of elements to process in the vector to be searched. If n <= 0, these routines return 0.

x        REAL. (input)  
Array of dimension (n-1) \* |incx| + 1.  
Array x contains the vector to be searched.

incx     INTEGER. (input)  
Increment between elements of x.

#### RETURN VALUES

ISAMAX   INTEGER. (output)  
Return the first index of the maximum absolute value of vector x. The vector x has length n and increment incx.

## NOTES

When working backward ( $\text{incx} < 0$ ), each routine starts at the end of the vector and moves backward, as follows:

$$x(1-\text{incx} * (n-1)), x(1-\text{incx} * (n-2)), \dots, x(1)$$

The largest absolute value is:

$$\text{ABS} (x(1+(\text{index}-1) * \text{incx})) \text{ when } \text{incx} > 0$$
$$\text{ABS} (x(1+(n-\text{index}) * |\text{incx}|)) \text{ when } \text{incx} < 0$$



```

⟨BLAS 1 isamax⟩≡
  (defun isamax (n sx incx)
    (declare (type (simple-array single-float (*)) sx)
              (type fixnum incx n))
    (f2cl-lib:with-multi-array-data
      ((sx single-float sx-%data% sx-%offset%))
      (prog ((i 0) (ix 0) (smax 0.0f0) (isamax 0))
        (declare (type (single-float) smax)
                  (type fixnum isamax ix i))
        (setf isamax 0)
        (if (or (< n 1) (<= incx 0)) (go end_label))
        (setf isamax 1)
        (if (= n 1) (go end_label))
        (if (= incx 1) (go label20))
        (setf ix 1)
        (setf smax (abs (f2cl-lib:fref sx-%data% (1) ((1 *)) sx-%offset%)))
        (setf ix (f2cl-lib:int-add ix incx))
        (f2cl-lib:fdo (i 2 (f2cl-lib:int-add i 1))
                      (> i n) nil)

        (tagbody
          (if
            (<= (abs (f2cl-lib:fref sx-%data% (ix) ((1 *)) sx-%offset%)) smax)
            (go label15))
          (setf isamax i)
          (setf smax (abs (f2cl-lib:fref sx-%data% (ix) ((1 *)) sx-%offset%))))
        label15
          (setf ix (f2cl-lib:int-add ix incx))))
        (go end_label)
        label20
          (setf smax (abs (f2cl-lib:fref sx-%data% (1) ((1 *)) sx-%offset%)))
          (f2cl-lib:fdo (i 2 (f2cl-lib:int-add i 1))
                        (> i n) nil)

          (tagbody
            (if (<= (abs (f2cl-lib:fref sx-%data% (i) ((1 *)) sx-%offset%)) smax)
              (go label30))
            (setf isamax i)
            (setf smax (abs (f2cl-lib:fref sx-%data% (i) ((1 *)) sx-%offset%))))
          label30))
        end_label
        (return (values isamax nil nil nil))))

```

## 4.15 izamax BLAS

```
<izamax.input>=  
  )set break resume  
  )sys rm -f izamax.output  
  )spool izamax.output  
  )set message test on  
  )set message auto off  
  )clear all  
  
  )spool  
  )lisp (bye)
```

`<izamax.help>`≡

```
=====
izamax examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

IZAMAX - BLAS level one, maximum index function

#### SYNOPSIS

```
INTEGER FUNCTION IZAMAX ( n, x, incx )
```

```
        INTEGER                n, incx
```

```
        DOUBLE COMPLEX        x
```

#### DESCRIPTION

IZAMAX searches a double complex vector for the first occurrence of the maximum absolute value.

IZAMAX determines the first index  $i$  such that

$$|\text{Real}(x_i)| + |\text{Imag}(x_i)| = \text{MAX}(|\text{Real}(x_j)| + |\text{Imag}(x_j)|): j = 1, \dots, n$$

where  $x_j$  is an element of a double complex vector.

#### ARGUMENTS

**n**            INTEGER. (input)  
Number of elements to process in the vector to be searched. If  $n \leq 0$ , these routines return 0.

**x**            DOUBLE COMPLEX. (input)  
Array of dimension  $(n-1) * |\text{incx}| + 1$ .  
Array x contains the vector to be searched.

**incx**        INTEGER. (input)  
Increment between elements of x.

#### RETURN VALUES

**IZAMAX**      INTEGER. (output)  
Return the first index of the maximum absolute value of vector

x. The vector x has length n and increment incx.

#### NOTES

When working backward ( $\text{incx} < 0$ ), each routine starts at the end of the vector and moves backward, as follows:

$x(1-\text{incx} * (n-1)), x(1-\text{incx} * (n-2)), \dots, x(1)$

The largest absolute value is:

$\text{ABS}(x(1+(\text{index}-1) * \text{incx}))$  when  $\text{incx} > 0$

$\text{ABS}(x(1+(n-\text{index}) * |\text{incx}|))$  when  $\text{incx} < 0$

```

<BLAS 1 izamax>≡
(defun izamax (n zx incx)
  (declare (type (simple-array (complex double-float) (*)) zx)
           (type fixnum incx n))
  (f2cl-lib:with-multi-array-data
    ((zx (complex double-float) zx-%data% zx-%offset%))
    (prog ((i 0) (ix 0) (smax 0.0) (izamax 0))
      (declare (type (double-float) smax)
                (type fixnum izamax ix i))
      (setf izamax 0)
      (if (or (< n 1) (<= incx 0)) (go end_label))
      (setf izamax 1)
      (if (= n 1) (go end_label))
      (if (= incx 1) (go label20))
      (setf ix 1)
      (setf smax (dcabs1 (f2cl-lib:fref zx-%data% (1) ((1 *)) zx-%offset%)))
      (setf ix (f2cl-lib:int-add ix incx))
      (f2cl-lib:fdo (i 2 (f2cl-lib:int-add i 1))
                    (> i n) nil)

      (tagbody
        (if
          (<= (dcabs1 (f2cl-lib:fref zx-%data% (ix) ((1 *)) zx-%offset%))
              smax)
          (go label5))
        (setf izamax i)
        (setf smax
          (dcabs1 (f2cl-lib:fref zx-%data% (ix) ((1 *)) zx-%offset%)))

label5
      (setf ix (f2cl-lib:int-add ix incx))))
      (go end_label)
label20
      (setf smax (dcabs1 (f2cl-lib:fref zx-%data% (1) ((1 *)) zx-%offset%)))
      (f2cl-lib:fdo (i 2 (f2cl-lib:int-add i 1))
                    (> i n) nil)

      (tagbody
        (if
          (<= (dcabs1 (f2cl-lib:fref zx-%data% (i) ((1 *)) zx-%offset%)) smax)
          (go label30))
        (setf izamax i)
        (setf smax
          (dcabs1 (f2cl-lib:fref zx-%data% (i) ((1 *)) zx-%offset%)))

label30))
end_label
      (return (values izamax nil nil nil))))

```

## 4.16 zaxpy BLAS

```
<zaxpy.input>=  
  )set break resume  
  )sys rm -f zaxpy.output  
  )spool zaxpy.output  
  )set message test on  
  )set message auto off  
  )clear all  
  
  )spool  
  )lisp (bye)
```

`<zaxpy.help>`≡

```
=====
zaxpy examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

ZAXPY - BLAS level one axpy subroutine

#### SYNOPSIS

```
SUBROUTINE ZAXPY      ( n, alpha, x, incx, y, incy )
```

```
      INTEGER          n, incx, incy
```

```
      DOUBLE COMPLEX   alpha, x, y
```

#### DESCRIPTION

ZAXPY adds a scalar multiple of a double complex vector to another double complex vector.

ZAXPY computes a constant alpha times a vector x plus a vector y. The result overwrites the initial values of vector y.

This routine performs the following vector operation:

```
y <-- alpha*x + y
```

incx and incy specify the increment between two consecutive elements of respectively vector x and y.

#### ARGUMENTS

n        INTEGER. (input)  
Number of elements in the vectors. If n <= 0, these routines return without any computation.

alpha    DOUBLE COMPLEX. (input)  
If alpha = 0 this routine returns without any computation.

x        DOUBLE COMPLEX. (input)  
Array of dimension (n-1) \* |incx| + 1. Contains the vector to be scaled before summation.

`incx`    INTEGER. (input)  
         Increment between elements of `x`.  
         If `incx = 0`, the results will be unpredictable.

`y`        DOUBLE COMPLEX. (input and output)  
         array of dimension  $(n-1) * |\text{incy}| + 1$ .  
         Before calling the routine, `y` contains the vector to be summed.  
         After the routine ends, `y` contains the result of the summation.

`incy`    INTEGER. (input)  
         Increment between elements of `y`.  
         If `incy = 0`, the results will be unpredictable.

## NOTES

This routine is Level 1 Basic Linear Algebra Subprograms (Level 1 BLAS).

When working backward (`incx < 0` or `incy < 0`), each routine starts at the end of the vector and moves backward, as follows:

$x(1-\text{incx} * (n-1)), x(1-\text{incx} * (n-2)), \dots, x(1)$

$y(1-\text{incy} * (n-1)), y(1-\text{incy} * (n-2)), \dots, y(1)$

## RETURN VALUES

When `n <= 0`, double complex `alpha = 0 = 0.+0.i`, this routine returns immediately with no change in its arguments.



Arguments are:

- Return values are:

- $\langle BLAS\ 1\ zaxpy \rangle \equiv$

```
(defun zaxpy (n za zc incx zy incy)
  (declare (type (simple-array (complex double-float) (*)) zy zc)
    (type (complex double-float) za)
    (type fixnum incy incx n))
  (f2cl-lib:with-multi-array-data
    ((zc (complex double-float) zc-%data% zc-%offset%)
     (zy (complex double-float) zy-%data% zy-%offset%))
    (prog ((i 0) (ix 0) (iy 0))
      (declare (type fixnum iy ix i))
      (if (<= n 0) (go end_label))
      (if (= (dcabs1 za) 0.0) (go end_label))
      (if (and (= incx 1) (= incy 1)) (go label20))
      (setf ix 1)
      (setf iy 1)
      (if (< incx 0)
        (setf ix
              (f2cl-lib:int-add
                (f2cl-lib:int-mul (f2cl-lib:int-sub 1 n) incx)
                1))))))
```

```

      (if (< incy 0)
        (setf iy
              (f2cl-lib:int-add
               (f2cl-lib:int-mul (f2cl-lib:int-sub 1 n) incy)
               1)))
      (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                    ((> i n) nil)
        (tagbody
          (setf (f2cl-lib:fref zy-%data% (iy) ((1 *)) zy-%offset%)
                (+ (f2cl-lib:fref zy-%data% (iy) ((1 *)) zy-%offset%)
                  (* za
                     (f2cl-lib:fref zx-%data% (ix) ((1 *)) zx-%offset%))))
          (setf ix (f2cl-lib:int-add ix incx))
          (setf iy (f2cl-lib:int-add iy incy))))
      (go end_label)
label20
      (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                    ((> i n) nil)
        (tagbody
          (setf (f2cl-lib:fref zy-%data% (i) ((1 *)) zy-%offset%)
                (+ (f2cl-lib:fref zy-%data% (i) ((1 *)) zy-%offset%)
                  (* za (f2cl-lib:fref zx-%data% (i) ((1 *)) zx-%offset%))))))
      end_label
      (return (values nil nil nil nil nil nil))))

```

## 4.17 zcopy BLAS

```

⟨zcopy.input⟩≡
)set break resume
)sys rm -f zcopy.output
)spool zcopy.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)

```

`<zcopy.help>=`

```
=====
zcopy examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

ZCOPY - BLAS level one, copies a double complex vector into another double complex vector

#### SYNOPSIS

```
SUBROUTINE ZCOPY    ( n, x, incx, y, incy )
```

```
      INTEGER          n, incx, incy
```

```
      DOUBLE COMPLEX   x, y
```

#### DESCRIPTION

ZCOPY copies a double complex vector into another double complex vector. ZCOPY copies a vector x, whose length is n to a vector y. incx and incy specify the increment between two consecutive elements of respectively vector x and y.

This routine performs the following vector operation:

```
y <-- x
```

where x and y are double complex vectors.

#### ARGUMENTS

n        INTEGER. (input)  
          Number of vector elements to be copied.  
          If n <= 0, this routine returns without computation.

x        DOUBLE COMPLEX, (input)  
          Vector from which to copy.

incx     INTEGER. (input)  
          Increment between elements of x.  
          If incx = 0, the results will be unpredictable.

y        DOUBLE COMPLEX, (output)

array of dimension  $(n-1) * |incy| + 1$ , result vector.

incy     INTEGER. (input)  
          Increment between elements of y. If incy = 0, the results will  
          be unpredictable.

#### NOTES

When working backward ( $incx < 0$  or  $incy < 0$ ), each routine starts at the end of the vector and moves backward, as follows:

$x(1-incx * (n-1)), x(1-incx * (n-2)), \dots, x(1)$

$y(1-incy * (n-1)), y(1-incy * (n-2)), \dots, y(1)$

```

<BLAS 1 zcopy>≡
  (defun zcopy (n zx incx zy incy)
    (declare (type (simple-array (complex double-float) (*)) zy zx)
      (type fixnum incy incx n))
    (f2cl-lib:with-multi-array-data
      ((zx (complex double-float) zx-%data% zx-%offset%)
       (zy (complex double-float) zy-%data% zy-%offset%))
      (prog ((i 0) (ix 0) (iy 0))
        (declare (type fixnum iy ix i))
        (if (<= n 0) (go end_label))
        (if (and (= incx 1) (= incy 1)) (go label20))
        (setf ix 1)
        (setf iy 1)
        (if (< incx 0)
          (setf ix
            (f2cl-lib:int-add
              (f2cl-lib:int-mul (f2cl-lib:int-sub 1 n) incx)
              1)))
        (if (< incy 0)
          (setf iy
            (f2cl-lib:int-add
              (f2cl-lib:int-mul (f2cl-lib:int-sub 1 n) incy)
              1)))
        (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
          ((> i n) nil)
          (tagbody
            (setf (f2cl-lib:fref zy-%data% (iy) ((1 *)) zy-%offset%)
              (f2cl-lib:fref zx-%data% (ix) ((1 *)) zx-%offset%))
            (setf ix (f2cl-lib:int-add ix incx))
            (setf iy (f2cl-lib:int-add iy incy))))
        (go end_label)
      label20
      (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
        ((> i n) nil)
        (tagbody
          (setf (f2cl-lib:fref zy-%data% (i) ((1 *)) zy-%offset%)
            (f2cl-lib:fref zx-%data% (i) ((1 *)) zx-%offset%))))
      end_label
      (return (values nil nil nil nil nil))))

```

## 4.18 zdotc BLAS

```
<zdotc.input>=  
  )set break resume  
  )sys rm -f zdotc.output  
  )spool zdotc.output  
  )set message test on  
  )set message auto off  
  )clear all  
  
  )spool  
  )lisp (bye)
```

`<zdotc.help>=`

```
=====
zdotc examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

ZDOTC - BLAS level one, computes the hermitian dot product of vector x and vector y.

#### SYNOPSIS

```
DOUBLE COMPLEX FUNCTION ZDOTC ( n, x, incx, y, incy )
```

```
INTEGER                                n, incx, incy
```

```
COMPLEX*16                             x, y
```

#### DESCRIPTION

ZDOTC computes a dot product of the conjugate of a complex vector and another complex vector (1 complex inner product).  
2

ZDOTC computes a dot product of the conjugate of a complex vector and another complex vector (1 complex inner product).  
2

This routine performs the following vector operation:

$$\begin{aligned} \text{ZDOTC} &\leftarrow (\text{conjugate transpose of } x) * y \\ &= \sum_{i=1}^n (\text{complex conjugate of } x(i)) * y(i) \end{aligned}$$

where x and y are complex vectors, and x is the conjugate transpose of x.

If n <= 0, ZDOTC is set to 0.

#### ARGUMENTS

```
n      INTEGER. (input)
        Number of elements in each vector.
```

x        COMPLEX\*16. (input)  
          Array of dimension  $(n-1) * |incx| + 1$ .  
          Array x contains the first vector operand.

incx     INTEGER. (input)  
          Increment between elements of x.  
          If incx = 0, the results will be unpredictable.

y        COMPLEX\*16. (input)  
          Array of dimension  $(n-1) * |incy| + 1$ .  
          Array y contains the second vector operand.

incy     INTEGER. (input)  
          Increment between elements of y.  
          If incy = 0, the results will be unpredictable.

## RETURN VALUES

ZDOTC     DOUBLE COMPLEX. Result (dot product). (output)

## NOTES

When working backward ( $incx < 0$  or  $incy < 0$ ), each routine starts at the end of the vector and moves backward, as follows:

$x(1-incx * (n-1)), x(1-incx * (n-2)), \dots, x(1)$

$y(1-incy * (n-1)), y(1-incy * (n-2)), \dots, y(1)$



```

<BLAS 1 zdotc>≡
  (defun zdotc (n zx incx zy incy)
    (declare (type (simple-array (complex double-float) (*)) zy zx)
      (type fixnum incy incx n))
    (f2cl-lib:with-multi-array-data
      ((zx (complex double-float) zx-%data% zx-%offset%)
        (zy (complex double-float) zy-%data% zy-%offset%))
      (prog ((i 0) (ix 0) (iy 0) (ztemp #C(0.0 0.0)) (zdotc #C(0.0 0.0)))
        (declare (type (complex double-float) zdotc ztemp)
          (type fixnum iy ix i))
        (setf ztemp (complex 0.0 0.0))
        (setf zdotc (complex 0.0 0.0))
        (if (<= n 0) (go end_label))
        (if (and (= incx 1) (= incy 1)) (go label20))
        (setf ix 1)
        (setf iy 1)
        (if (< incx 0)
          (setf ix
            (f2cl-lib:int-add
              (f2cl-lib:int-mul (f2cl-lib:int-sub 1 n) incx)
              1)))
        (if (< incy 0)
          (setf iy
            (f2cl-lib:int-add
              (f2cl-lib:int-mul (f2cl-lib:int-sub 1 n) incy)
              1)))
        (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
          ((> i n) nil)
          (tagbody
            (setf ztemp
              (+ ztemp
                (*
                  (f2cl-lib:dconjg
                    (f2cl-lib:fref zx-%data% (ix) ((1 *)) zx-%offset%))
                    (f2cl-lib:fref zy-%data% (iy) ((1 *)) zy-%offset%))))
              (setf ix (f2cl-lib:int-add ix incx))
              (setf iy (f2cl-lib:int-add iy incy))))
            (setf zdotc ztemp)
            (go end_label)
          label20
            (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
              ((> i n) nil)
              (tagbody
                (setf ztemp
                  (+ ztemp
                    (*

```

```

                                (f2cl-lib:dconjg
                                (f2cl-lib:fref zx-%data% (i) ((1 *)) zx-%offset%))
                                (f2cl-lib:fref zy-%data% (i) ((1 *)) zy-%offset%))))))
    (setf zdotc ztemp)
end_label
    (return (values zdotc nil nil nil nil nil))))

```

## 4.19 zdotu BLAS

```

⟨zdotu.input⟩≡
)set break resume
)sys rm -f zdotu.output
)spool zdotu.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)

```

`<zdotu.help>=`

```
=====
zdotu examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

ZDOTU - BLAS level one, computes computes a dot product (inner product) of two complex vectors

#### SYNOPSIS

```
DOUBLE COMPLEX FUNCTION ZDOTU ( n, x, incx, y, incy )
```

```
      INTEGER                      n, incx, incy
```

```
      COMPLEX*16                  x, y
```

#### DESCRIPTION

ZDOTU computes a dot product of two complex vectors.

This routine performs the following vector operation:

$$\text{ZDOTU} \leftarrow (\text{transpose of } x) * y = \sum_{i=1}^n x(i)*y(i)$$

where  $x$  and  $y$  are real vectors, and  $x$  is the transpose of  $x$ .

If  $n \leq 0$ , ZDOTU is set to 0.

#### ARGUMENTS

$n$         INTEGER. (input)  
          Number of elements in each vector.

$x$         COMPLEX\*16. (input)  
          Array of dimension  $(n-1) * |incx| + 1$ .  
          Array  $x$  contains the first vector operand.

$incx$      INTEGER. (input)  
          Increment between elements of  $x$ .  
          If  $incx = 0$ , the results will be unpredictable.

y        COMPLEX\*16. (input)  
          Array of dimension (n-1) \* |incy| + 1.  
          Array y contains the second vector operand.

incy     INTEGER. (input)  
          Increment between elements of y.  
          If incy = 0, the results will be unpredictable.

## RETURN VALUES

ZDOTU    DOUBLE COMPLEX. Result (dot product). (output)

## NOTES

When working backward (incx < 0 or incy < 0), each routine starts at the end of the vector and moves backward, as follows:

x(1-incx \* (n-1)), x(1-incx \* (n-2)), ..., x(1)

y(1-incy \* (n-1)), y(1-incy \* (n-2)), ..., y(1)

```

<BLAS 1 zdotu>≡
  (defun zdotu (n zx incx zy incy)
    (declare (type (simple-array (complex double-float) (*)) zy zx)
              (type fixnum incy incx n))
    (f2cl-lib:with-multi-array-data
      ((zx (complex double-float) zx-%data% zx-%offset%)
       (zy (complex double-float) zy-%data% zy-%offset%))
      (prog ((i 0) (ix 0) (iy 0) (ztemp #C(0.0 0.0)) (zdotu #C(0.0 0.0)))
        (declare (type (complex double-float) zdotu ztemp)
                  (type fixnum iy ix i))
        (setf ztemp (complex 0.0 0.0))
        (setf zdotu (complex 0.0 0.0))
        (if (<= n 0) (go end_label))
        (if (and (= incx 1) (= incy 1)) (go label20))
        (setf ix 1)
        (setf iy 1)
        (if (< incx 0)
            (setf ix
              (f2cl-lib:int-add
                (f2cl-lib:int-mul (f2cl-lib:int-sub 1 n) incx)
                1)))
        (if (< incy 0)
            (setf iy
              (f2cl-lib:int-add
                (f2cl-lib:int-mul (f2cl-lib:int-sub 1 n) incy)
                1)))
        (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                      ((> i n) nil)
          (tagbody
            (setf ztemp
              (+ ztemp
                (* (f2cl-lib:fref zx-%data% (ix) ((1 *)) zx-%offset%)
                  (f2cl-lib:fref zy-%data% (iy) ((1 *)) zy-%offset%))))
            (setf ix (f2cl-lib:int-add ix incx))
            (setf iy (f2cl-lib:int-add iy incy))))
        (setf zdotu ztemp)
        (go end_label)
      label20
      (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                    ((> i n) nil)
        (tagbody
          (setf ztemp
            (+ ztemp
              (* (f2cl-lib:fref zx-%data% (i) ((1 *)) zx-%offset%)
                (f2cl-lib:fref zy-%data% (i) ((1 *)) zy-%offset%))))
          (setf zdotu ztemp)
        )
      )
  )

```

```
end_label  
  (return (values zdotu nil nil nil nil nil))))))
```

## 4.20 zdscal BLAS

```
<zdscal.input>≡  
  )set break resume  
  )sys rm -f zdscal.output  
  )spool zdscal.output  
  )set message test on  
  )set message auto off  
  )clear all  
  
  )spool  
  )lisp (bye)
```

`<zscal.help>`≡

```
=====
zscal examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

ZDSCAL - BLAS level one, Scales a double complex vector

#### SYNOPSIS

```
SUBROUTINE ZDSCAL    ( n, alpha, x, incx )
```

```
    INTEGER          n, incx
```

```
    DOUBLE COMPLEX   x
```

```
    DOUBLE PRECISION alpha
```

#### DESCRIPTION

ZDSCAL scales a double complex vector with a double precision scalar. ZDSCAL scales the vector x of length n and increment incx by the constant alpha.

This routine performs the following vector operation:

$$x \leftarrow \alpha x$$

where alpha is a double precision scalar, and x is a double complex vector.

#### ARGUMENTS

n	INTEGER. (input) Number of elements in the vector. If n <= 0, this routine returns without computation.
alpha	DOUBLE PRECISION. (input) Value used to scale vector
x	DOUBLE COMPLEX. (input and output) Array of dimension (n-1) * abs(incx) + 1. Vector to be scaled.
incx	INTEGER. (input)

Increment between elements of x.  
 If incx = 0, the results will be unpredictable.

## NOTES

When working backward (incx < 0 or incy < 0), each routine starts at the end of the vector and moves backward, as follows:

x(1-incx \* (n-1)), x(1-incx \* (n-2)), ..., x(1)

*(BLAS 1 zdscal)*≡

```
(defun zdscal (n da zx incx)
  (declare (type (simple-array (complex double-float) (*)) zx)
           (type (double-float) da)
           (type fixnum incx n))
  (f2cl-lib:with-multi-array-data
    ((zx (complex double-float) zx-%data% zx-%offset%))
    (prog ((i 0) (ix 0))
      (declare (type fixnum ix i))
      (if (or (<= n 0) (<= incx 0)) (go end_label))
      (if (= incx 1) (go label20))
      (setf ix 1)
      (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                    ((> i n) nil)
        (tagbody
          (setf (f2cl-lib:fref zx-%data% (ix) ((1 *)) zx-%offset%)
                (* (coerce (complex da 0.0) '(complex double-float))
                  (f2cl-lib:fref zx-%data% (ix) ((1 *)) zx-%offset%)))
          (setf ix (f2cl-lib:int-add ix incx))))
      (go end_label)
    label20
      (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                    ((> i n) nil)
        (tagbody
          (setf (f2cl-lib:fref zx-%data% (i) ((1 *)) zx-%offset%)
                (* (coerce (complex da 0.0) '(complex double-float))
                  (f2cl-lib:fref zx-%data% (i) ((1 *)) zx-%offset%))))))
    end_label
    (return (values nil nil nil nil))))
```



## 4.21 zrotg BLAS

```
(zrotg.input)≡  
  )set break resume  
  )sys rm -f zrotg.output  
  )spool zrotg.output  
  )set message test on  
  )set message auto off  
  )clear all  
  
  )spool  
  )lisp (bye)
```

`<zrotg.help>`≡

```
=====
zrotg examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

ZROTG - Extensions to BLAS level one rotation subroutines

#### SYNOPSIS

```
SUBROUTINE ZROTG ( a, b, c, s )
```

```
DOUBLE COMPLEX
```

```
    a, b, s
```

```
DOUBLE PRECISION
```

```
    c
```

#### DESCRIPTION

ZROTG computes the elements of a Givens plane rotation matrix such that:

$$\begin{bmatrix} c & s \\ -\text{conjg}(s) & c \end{bmatrix} * \begin{bmatrix} a \\ b \end{bmatrix} = \begin{bmatrix} r \\ 0 \end{bmatrix}$$

where  $r = (a / \text{sqrt}(\text{conjg}(a)*a)) * \text{sqrt}(\text{conjg}(a)*a + \text{conjg}(b)*b)$ , and the notation  $\text{conjg}(z)$  represents the complex conjugate of  $z$ .

The Givens plane rotation can be used to introduce zero elements into a matrix selectively.

#### ARGUMENTS

a (input and output) DOUBLE COMPLEX

First vector component.

On input, the first component of the vector to be rotated. On output, a is overwritten by the unique complex number r, whose

size in the complex plane is the Euclidean norm of the complex vector  $(a,b)$ , and whose direction in the complex plane is the same as that of the original complex element  $a$ .

```

    if |a| != 0
      r = a / |a| * sqrt( conjg(a)*a + conjg(b)*b )

    if |a| = 0
      r = b

```

b (input) DOUBLE COMPLEX

Second vector component.

The second component of the vector to be rotated.

c (output) DOUBLE PRECISION

Cosine of the angle of rotation.

```

    if |a| != 0
      c = |a| / sqrt( conjg(a)*a + conjg(b)*b )

    if |a| = 0
      c = 0

```

s (output) DOUBLE COMPLEX

Sine of the angle of rotation.

```

    if |a| != 0
      c=a/|a|*conjg(b)/sqrt(conjg(a)*a+conjg(b)*b)

    if |a| = 0
      s = ( 1.0 , 0.0 )

```

(Complex Double-Float). Computes plane rotation. Arguments are:

- da - (complex double-float)
- db - (complex double-float)
- c - double-float
- s - (complex double-float)

Returns multiple values where:

- 1 da - ca
- 2 db - nil
- 3 c - c
- 4 s - s

*(BLAS 1 zrotg)*≡

```
(defun zrotg (ca cb c s)
  (declare (type (double-float) c) (type (complex double-float) s cb ca))
  (prog ((alpha #C(0.0 0.0)) (norm 0.0) (scale 0.0))
    (declare (type (double-float) scale norm)
              (type (complex double-float) alpha))
    (if (/= (f2cl-lib:cdabs ca) 0.0) (go label10))
    (setf c 0.0)
    (setf s (complex 1.0 0.0))
    (setf ca cb)
  (go label20)
label10
  (setf scale
    (coerce (+ (f2cl-lib:cdabs ca) (f2cl-lib:cdabs cb)) 'double-float))
  (setf norm
    (* scale
      (f2cl-lib:dsqrt
        (+ (expt (f2cl-lib:cdabs (/ ca
          (coerce (complex scale 0.0) '(complex double-float)))) 2)
          (expt (f2cl-lib:cdabs (/ cb
            (coerce (complex scale 0.0) '(complex double-float))))
            2))))))
    (setf alpha (/ ca (f2cl-lib:cdabs ca)))
    (setf c (/ (f2cl-lib:cdabs ca) norm))
    (setf s (/ (* alpha (f2cl-lib:dconjg cb)) norm))
    (setf ca (* alpha norm))
  label20
  (return (values ca nil c s))))
```

## 4.22 zscal BLAS

```
(zscal.input)≡  
  )set break resume  
  )sys rm -f zscal.output  
  )spool zscal.output  
  )set message test on  
  )set message auto off  
  )clear all  
  
  )spool  
  )lisp (bye)
```

`<zscal.help>=`

```
=====
zscal examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

ZSCAL - BLAS level one, Scales a double complex vector

#### SYNOPSIS

```
SUBROUTINE ZSCAL    ( n, alpha, x, incx )
```

```
      INTEGER          n, incx
```

```
      DOUBLE COMPLEX   x, alpha
```

#### DESCRIPTION

ZSCAL scales a double complex vector with a double complex scalar. ZSCAL scales the vector x of length n and increment incx by the constant alpha.

This routine performs the following vector operation:

$$x \leftarrow \alpha x$$

where alpha is a double complex scalar, and x is a double complex vector.

#### ARGUMENTS

n	INTEGER. (input) Number of elements in the vector. If n <= 0, this routine returns without computation.
alpha	DOUBLE COMPLEX. (input) Value used to scale vector
x	DOUBLE COMPLEX. (input and output) Array of dimension (n-1) * abs(incx) + 1. Vector to be scaled.
incx	INTEGER. (input) Increment between elements of x. If incx = 0, the results will be unpredictable.

## NOTES

When working backward ( $\text{incx} < 0$  or  $\text{incy} < 0$ ), each routine starts at the end of the vector and moves backward, as follows:

$$x(1-\text{incx} * (n-1)), x(1-\text{incx} * (n-2)), \dots, x(1)$$

```

(BLAS 1 zscal)≡
  (defun zscal (n za zx incx)
    (declare (type (simple-array (complex double-float) (*)) zx)
             (type (complex double-float) za)
             (type fixnum incx n))
    (f2cl-lib:with-multi-array-data
      ((zx (complex double-float) zx-%data% zx-%offset%))
      (prog ((i 0) (ix 0))
        (declare (type fixnum ix i))
        (if (or (<= n 0) (<= incx 0)) (go end_label))
        (if (= incx 1) (go label20))
        (setf ix 1)
        (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                      (> i n) nil)
          (tagbody
            (setf (f2cl-lib:fref zx-%data% (ix) ((1 *)) zx-%offset%)
                  (* za (f2cl-lib:fref zx-%data% (ix) ((1 *)) zx-%offset%)))
            (setf ix (f2cl-lib:int-add ix incx)))
          (go end_label)
        label20
        (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                      (> i n) nil)
          (tagbody
            (setf (f2cl-lib:fref zx-%data% (i) ((1 *)) zx-%offset%)
                  (* za (f2cl-lib:fref zx-%data% (i) ((1 *)) zx-%offset%))))
          end_label
        (return (values nil nil nil nil))))

```

## 4.23 zswap BLAS

```
<zswap.input>≡  
  )set break resume  
  )sys rm -f zswap.output  
  )spool zswap.output  
  )set message test on  
  )set message auto off  
  )clear all  
  
  )spool  
  )lisp (bye)
```



`<zswap.help>`≡

```
=====
zswap examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

ZSWAP - BLAS level one, Swaps two double complex vectors

#### SYNOPSIS

```
SUBROUTINE ZSWAP      ( n, x, incx, y, incy )
```

```
      INTEGER          n, incx, incy
```

```
      DOUBLE COMPLEX   x, y
```

#### DESCRIPTION

ZSWAP swaps two double complex vectors, it interchanges  $n$  values of vector  $x$  and vector  $y$ .  $incx$  and  $incy$  specify the increment between two consecutive elements of respectively vector  $x$  and  $y$ .

This routine performs the following vector operation:

$$x \leftrightarrow y$$

where  $x$  and  $y$  are double complex vectors.

#### ARGUMENTS

$n$	INTEGER. (input) Number of vector elements to be swapped. If $n \leq 0$ , this routine returns without computation.
$x$	DOUBLE COMPLEX, (input and output) Array of dimension $(n-1) *  incx  + 1$ .
$incx$	INTEGER. (input) Increment between elements of $x$ . If $incx = 0$ , the results will be unpredictable.
$y$	DOUBLE COMPLEX, (input and output) array of dimension $(n-1) *  incy  + 1$ . Vector to be swapped.

incy     INTEGER. (input)  
         Increment between elements of y. If incy = 0, the results will  
         be unpredictable.

## NOTES

When working backward ( $\text{incx} < 0$  or  $\text{incy} < 0$ ), each routine starts at the end of the vector and moves backward, as follows:

$x(1-\text{incx} * (n-1)), x(1-\text{incx} * (n-2)), \dots, x(1)$

$y(1-\text{incy} * (n-1)), y(1-\text{incy} * (n-2)), \dots, y(1)$

```

<BLAS 1 zswap>≡
  (defun zswap (n zx incx zy incy)
    (declare (type (simple-array (complex double-float) (*)) zy zx)
      (type fixnum incy incx n))
    (f2cl-lib:with-multi-array-data
      ((zx (complex double-float) zx-%data% zx-%offset%)
        (zy (complex double-float) zy-%data% zy-%offset%))
      (prog ((i 0) (ix 0) (iy 0) (ztemp #C(0.0 0.0)))
        (declare (type (complex double-float) ztemp)
          (type fixnum iy ix i))
        (if (<= n 0) (go end_label))
        (if (and (= incx 1) (= incy 1)) (go label20))
        (setf ix 1)
        (setf iy 1)
        (if (< incx 0)
          (setf ix
            (f2cl-lib:int-add
              (f2cl-lib:int-mul (f2cl-lib:int-sub 1 n) incx)
              1)))
        (if (< incy 0)
          (setf iy
            (f2cl-lib:int-add
              (f2cl-lib:int-mul (f2cl-lib:int-sub 1 n) incy)
              1)))
        (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
          ((> i n) nil)
          (tagbody
            (setf ztemp (f2cl-lib:fref zx-%data% (ix) ((1 *)) zx-%offset%))
            (setf (f2cl-lib:fref zx-%data% (ix) ((1 *)) zx-%offset%)
              (f2cl-lib:fref zy-%data% (iy) ((1 *)) zy-%offset%))
            (setf (f2cl-lib:fref zy-%data% (iy) ((1 *)) zy-%offset%) ztemp)
            (setf ix (f2cl-lib:int-add ix incx))
            (setf iy (f2cl-lib:int-add iy incy))))
        (go end_label)
      label20
      (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
        ((> i n) nil)
        (tagbody
          (setf ztemp (f2cl-lib:fref zx-%data% (i) ((1 *)) zx-%offset%))
          (setf (f2cl-lib:fref zx-%data% (i) ((1 *)) zx-%offset%)
            (f2cl-lib:fref zy-%data% (i) ((1 *)) zy-%offset%))
          (setf (f2cl-lib:fref zy-%data% (i) ((1 *)) zy-%offset%) ztemp)))
      end_label
      (return (values nil nil nil nil nil))))

```

## Chapter 5

# BLAS Level 2

### 5.1 dgbmv BLAS

```
<dgbmv.input>≡  
  )set break resume  
  )sys rm -f dgbmv.output  
  )spool dgbmv.output  
  )set message test on  
  )set message auto off  
  )clear all  
  
  )spool  
  )lisp (bye)
```

`<dgbmv.help>`≡

```
=====
dgbmv examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

DGBMV - perform one of the matrix-vector operations  $y := \alpha * A * x + \beta * y$ , or  $y := \alpha * A' * x + \beta * y$ ,

#### SYNOPSIS

```
SUBROUTINE DGBMV ( TRANS, M, N, KL, KU, ALPHA, A, LDA, X,
                  INCX, BETA, Y, INCY )
```

```
      DOUBLE      PRECISION ALPHA, BETA
```

```
      INTEGER     INCX, INCY, KL, KU, LDA, M, N
```

```
      CHARACTER*1 TRANS
```

```
      DOUBLE      PRECISION A( LDA, * ), X( * ), Y( * )
```

#### PURPOSE

DGBMV performs one of the matrix-vector operations

where alpha and beta are scalars, x and y are vectors and A is an m by n band matrix, with kl sub-diagonals and ku super-diagonals.

#### PARAMETERS

TRANS - CHARACTER\*1.

On entry, TRANS specifies the operation to be performed as follows:

TRANS = 'N' or 'n'  $y := \alpha * A * x + \beta * y$ .

TRANS = 'T' or 't'  $y := \alpha * A' * x + \beta * y$ .

TRANS = 'C' or 'c'  $y := \alpha * A' * x + \beta * y$ .

Unchanged on exit.

M - INTEGER.

On entry, M specifies the number of rows of the matrix A. M must be at least zero. Unchanged on exit.

N - INTEGER.

On entry, N specifies the number of columns of the matrix A. N must be at least zero. Unchanged on exit.

KL - INTEGER.

On entry, KL specifies the number of sub-diagonals of the matrix A. KL must satisfy  $0 \leq KL$ . Unchanged on exit.

KU - INTEGER.

On entry, KU specifies the number of super-diagonals of the matrix A. KU must satisfy  $0 \leq KU$ . Unchanged on exit.

ALPHA - DOUBLE PRECISION.

On entry, ALPHA specifies the scalar alpha. Unchanged on exit.

A - DOUBLE PRECISION array of DIMENSION ( LDA, n ).

Before entry, the leading  $(kl + ku + 1)$  by n part of the array A must contain the matrix of coefficients, supplied column by column, with the leading diagonal of the matrix in row  $(ku + 1)$  of the array, the first super-diagonal starting at position 2 in row ku, the first sub-diagonal starting at position 1 in row  $(ku + 2)$ , and so on. Elements in the array A that do not correspond to elements in the band matrix (such as the top left ku by ku triangle) are not referenced. The following program segment will transfer a band matrix from conventional full matrix storage to band storage:

```
DO 20, J = 1, N
  K = KU + 1 - J
  DO 10, I = MAX( 1, J - KU ), MIN( M, J + KL )
    A( K + I, J ) = matrix( I, J )
  10 CONTINUE
20 CONTINUE
```

Unchanged on exit.

LDA - INTEGER.

On entry, LDA specifies the first dimension of A as declared in the calling (sub) program. LDA must be at

least ( kl + ku + 1 ). Unchanged on exit.

X - DOUBLE PRECISION array of DIMENSION at least  
( 1 + ( n - 1 ) \* abs( INCX ) ) when TRANS = 'N' or 'n'  
and at least ( 1 + ( m - 1 ) \* abs( INCX ) ) otherwise.  
Before entry, the incremented array X must contain  
the vector x. Unchanged on exit.

INCX - INTEGER.  
On entry, INCX specifies the increment for the ele-  
ments of X. INCX must not be zero. Unchanged on  
exit.

BETA - DOUBLE PRECISION.  
On entry, BETA specifies the scalar beta. When BETA  
is supplied as zero then Y need not be set on input.  
Unchanged on exit.

Y - DOUBLE PRECISION array of DIMENSION at least  
( 1 + ( m - 1 ) \* abs( INCY ) ) when TRANS = 'N' or 'n'  
  
and at least ( 1 + ( n - 1 ) \* abs( INCY ) ) otherwise.  
Before entry, the incremented array Y must contain  
the vector y. On exit, Y is overwritten by the  
updated vector y.

INCY - INTEGER.  
On entry, INCY specifies the increment for the ele-  
ments of Y. INCY must not be zero. Unchanged on  
exit.

```

⟨BLAS 2 dgbmv⟩≡
  (let* ((one 1.0) (zero 0.0))
    (declare (type (double-float 1.0 1.0) one)
              (type (double-float 0.0 0.0) zero))
    (defun dgbmv (trans m n kl ku alpha a lda x incx beta y incy)
      (declare (type (simple-array double-float (*)) y x a)
                (type (double-float) beta alpha)
                (type fixnum incx lda ku kl n m)
                (type character trans))
      (f2cl-lib:with-multi-array-data
        ((trans character trans-%data% trans-%offset%)
         (a double-float a-%data% a-%offset%)
         (x double-float x-%data% x-%offset%)
         (y double-float y-%data% y-%offset%))
        (prog ((i 0) (info 0) (ix 0) (iy 0) (j 0) (jx 0) (jy 0) (k 0) (kup1 0)
              (kx 0) (ky 0) (lenx 0) (leny 0) (temp 0.0))
          (declare (type fixnum i info ix iy j jx jy k kup1 kx ky
                        lenx leny)
                    (type (double-float) temp))
          (setf info 0)
          (cond
            ((and (not (char-equal trans #\N))
                  (not (char-equal trans #\T))
                  (not (char-equal trans #\C))))
              (setf info 1))
            ((< m 0)
              (setf info 2))
            ((< n 0)
              (setf info 3))
            ((< kl 0)
              (setf info 4))
            ((< ku 0)
              (setf info 5))
            ((< lda (f2cl-lib:int-add kl ku 1))
              (setf info 8))
            ((= incx 0)
              (setf info 10))
            ((= incy 0)
              (setf info 13)))
          (cond
            ((/= info 0)
              (error
               " ** On entry to ~a parameter number ~a had an illegal value~%"
               "DGBMV" info)
              (go end_label)))
          (if (or (= m 0) (= n 0) (and (= alpha zero) (= beta one))))

```



```

      (go end_label))
(cond
  ((char-equal trans #\N)
   (setf lenx n)
   (setf leny m))
  (t
   (setf lenx m)
   (setf leny n)))
(cond
  ((> incx 0)
   (setf kx 1))
  (t
   (setf kx
    (f2cl-lib:int-sub 1
                      (f2cl-lib:int-mul
                      (f2cl-lib:int-sub lenx 1)
                      incx)))))
(cond
  ((> incy 0)
   (setf ky 1))
  (t
   (setf ky
    (f2cl-lib:int-sub 1
                      (f2cl-lib:int-mul
                      (f2cl-lib:int-sub leny 1)
                      incy)))))
(cond
  ((/= beta one)
   (cond
    ((= incy 1)
     (cond
      ((= beta zero)
       (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                     ((> i leny) nil)
       (tagbody
        (setf (f2cl-lib:fref y-%data% (i) ((1 *)) y-%offset%
                           zero))))
      (t
       (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                     ((> i leny) nil)
       (tagbody
        (setf (f2cl-lib:fref y-%data% (i) ((1 *)) y-%offset%)
              (* beta
               (f2cl-lib:fref y-%data%
                              (i)
                              ((1 *))

```

```

                                                    y-%offset%)))))))))
(t
  (setf iy ky)
  (cond
    ((= beta zero)
      (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
        (> i leny) nil)
      (tagbody
        (setf (f2cl-lib:fref y-%data% (iy) ((1 *)) y-%offset%)
          zero)
        (setf iy (f2cl-lib:int-add iy incy))))))
    (t
      (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
        (> i leny) nil)
      (tagbody
        (setf (f2cl-lib:fref y-%data% (iy) ((1 *)) y-%offset%)
          (* beta
            (f2cl-lib:fref y-%data%
              (iy)
              ((1 *))
              y-%offset%)))
        (setf iy (f2cl-lib:int-add iy incy)))))))))
(if (= alpha zero) (go end_label))
(setf kup1 (f2cl-lib:int-add ku 1))
(cond
  ((char-equal trans #\N)
    (setf jx kx)
    (cond
      ((= incy 1)
        (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
          (> j n) nil)
        (tagbody
          (cond
            ((/= (f2cl-lib:fref x (jx) ((1 *)) zero)
              (setf temp
                (* alpha
                  (f2cl-lib:fref x-%data%
                    (jx)
                    ((1 *))
                    x-%offset%)))
              (setf k (f2cl-lib:int-sub kup1 j))
              (f2cl-lib:fdo (i
                (max (the fixnum 1)
                  (the fixnum
                    (f2cl-lib:int-add j
                      (f2cl-lib:int-sub

```

```

                                ku))))
      (f2cl-lib:int-add i 1))
    (> i
      (min (the fixnum m)
            (the fixnum
              (f2cl-lib:int-add j kl))))
      nil)
  (tagbody
    (setf (f2cl-lib:fref y-%data% (i) ((1 *)) y-%offset%)
          (+
            (f2cl-lib:fref y-%data%
                          (i)
                          ((1 *))
                          y-%offset%)
            (* temp
              (f2cl-lib:fref a-%data%
                            ((f2cl-lib:int-add k i) j)
                            ((1 lda) (1 *))
                            a-%offset%))))))
    (setf jx (f2cl-lib:int-add jx incx))))
  (t
    (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                  (> j n) nil)
    (tagbody
      (cond
        ((/= (f2cl-lib:fref x (jx) ((1 *))) zero)
          (setf temp
            (* alpha
              (f2cl-lib:fref x-%data%
                            (jx)
                            ((1 *))
                            x-%offset%)))
          (setf iy ky)
          (setf k (f2cl-lib:int-sub kup1 j))
          (f2cl-lib:fdo (i
                        (max (the fixnum 1)
                          (the fixnum
                            (f2cl-lib:int-add j
                              (f2cl-lib:int-sub
                                (f2cl-lib:int-add i 1))
                                ku))))
                        (> i
                          (min (the fixnum m)
                                (the fixnum
                                  (f2cl-lib:int-add j kl))))
                          nil)

```

```

(tagbody
  (setf (f2cl-lib:fref y-%data% (iy) ((1 *)) y-%offset%)
    (+
      (f2cl-lib:fref y-%data%
        (iy)
        ((1 *))
        y-%offset%)
      (* temp
        (f2cl-lib:fref a-%data%
          ((f2cl-lib:int-add k i) j)
          ((1 lda) (1 *))
          a-%offset%))))
    (setf iy (f2cl-lib:int-add iy incy))))
  (setf jx (f2cl-lib:int-add jx incx))
  (if (> j ku) (setf ky (f2cl-lib:int-add ky incy))))))
(t
  (setf jy ky)
  (cond
    ((= incx 1)
      (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
        ((> j n) nil)
        (tagbody
          (setf temp zero)
          (setf k (f2cl-lib:int-sub kup1 j))
          (f2cl-lib:fdo (i
            (max (the fixnum 1)
              (the fixnum
                (f2cl-lib:int-add j
                  (f2cl-lib:int-sub
                    ku))))
              (f2cl-lib:int-add i 1))
            ((> i
              (min (the fixnum m)
                (the fixnum
                  (f2cl-lib:int-add j kl))))
              nil)
            (tagbody
              (setf temp
                (+ temp
                  (*
                    (f2cl-lib:fref a-%data%
                      ((f2cl-lib:int-add k i) j)
                      ((1 lda) (1 *))
                      a-%offset%)
                    (f2cl-lib:fref x-%data%
                      (i)

```

```

((1 *))
x-%offset%))))))
(setf (f2cl-lib:fref y-%data% (jy) ((1 *)) y-%offset%)
      (+ (f2cl-lib:fref y-%data% (jy) ((1 *)) y-%offset%)
          (* alpha temp)))
(setf jy (f2cl-lib:int-add jy incy))))
(t
 (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
               (> j n) nil)
 (tagbody
  (setf temp zero)
  (setf ix kx)
  (setf k (f2cl-lib:int-sub kup1 j))
  (f2cl-lib:fdo (i
                 (max (the fixnum 1)
                      (the fixnum
                        (f2cl-lib:int-add j
                                           (f2cl-lib:int-sub
                                            ku))))
                 (f2cl-lib:int-add i 1))
                (> i
                  (min (the fixnum m)
                       (the fixnum
                        (f2cl-lib:int-add j kl))))
                nil)
    (tagbody
     (setf temp
       (+ temp
          (*
           (f2cl-lib:fref a-%data%
                         ((f2cl-lib:int-add k i) j)
                         ((1 lda) (1 *))
                         a-%offset%)
           (f2cl-lib:fref x-%data%
                         (ix)
                         ((1 *))
                         x-%offset%))))
       (setf ix (f2cl-lib:int-add ix incx))))
    (setf (f2cl-lib:fref y-%data% (jy) ((1 *)) y-%offset%)
          (+ (f2cl-lib:fref y-%data% (jy) ((1 *)) y-%offset%)
              (* alpha temp)))
    (setf jy (f2cl-lib:int-add jy incy))
    (if (> j ku) (setf kx (f2cl-lib:int-add kx incx))))))
end_label
(return
 (values nil nil nil nil nil nil nil nil nil nil nil nil))))

```

## 5.2 dgemv BLAS

```
(dgemv.input)≡  
  )set break resume  
  )sys rm -f dgemv.output  
  )spool dgemv.output  
  )set message test on  
  )set message auto off  
  )clear all  
  
  )spool  
  )lisp (bye)
```

`<dgemv.help>=`

```
=====
dgemv examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

DGEMV - perform one of the matrix-vector operations  $y := \alpha * A * x + \beta * y$ , or  $y := \alpha * A' * x + \beta * y$ ,

#### SYNOPSIS

```
SUBROUTINE DGEMV ( TRANS, M, N, ALPHA, A, LDA, X, INCX,
                  BETA, Y, INCY )
```

```
      DOUBLE      PRECISION ALPHA, BETA
```

```
      INTEGER     INCX, INCY, LDA, M, N
```

```
      CHARACTER*1 TRANS
```

```
      DOUBLE      PRECISION A( LDA, * ), X( * ), Y( * )
```

#### PURPOSE

DGEMV performs one of the matrix-vector operations

where alpha and beta are scalars, x and y are vectors and A is an m by n matrix.

#### PARAMETERS

TRANS - CHARACTER\*1.

On entry, TRANS specifies the operation to be performed as follows:

TRANS = 'N' or 'n'  $y := \alpha * A * x + \beta * y$ .

TRANS = 'T' or 't'  $y := \alpha * A' * x + \beta * y$ .

TRANS = 'C' or 'c'  $y := \alpha * A' * x + \beta * y$ .

Unchanged on exit.

M - INTEGER.

On entry, M specifies the number of rows of the

- matrix A. M must be at least zero. Unchanged on exit.
- N - INTEGER.  
On entry, N specifies the number of columns of the matrix A. N must be at least zero. Unchanged on exit.
- ALPHA - DOUBLE PRECISION.  
On entry, ALPHA specifies the scalar alpha. Unchanged on exit.
- A - DOUBLE PRECISION array of DIMENSION ( LDA, n ).  
Before entry, the leading m by n part of the array A must contain the matrix of coefficients. Unchanged on exit.
- LDA - INTEGER.  
On entry, LDA specifies the first dimension of A as declared in the calling (sub) program. LDA must be at least  $\max(1, m)$ . Unchanged on exit.
- X - DOUBLE PRECISION array of DIMENSION at least  $(1 + (n - 1) * \text{abs}(\text{INCX}))$  when TRANS = 'N' or 'n' and at least  $(1 + (m - 1) * \text{abs}(\text{INCX}))$  otherwise. Before entry, the incremented array X must contain the vector x. Unchanged on exit.
- INCX - INTEGER.  
On entry, INCX specifies the increment for the elements of X. INCX must not be zero. Unchanged on exit.
- BETA - DOUBLE PRECISION.  
On entry, BETA specifies the scalar beta. When BETA is supplied as zero then Y need not be set on input. Unchanged on exit.
- Y - DOUBLE PRECISION array of DIMENSION at least  $(1 + (m - 1) * \text{abs}(\text{INCY}))$  when TRANS = 'N' or 'n' and at least  $(1 + (n - 1) * \text{abs}(\text{INCY}))$  otherwise. Before entry with BETA non-zero, the incremented array Y must contain the vector y. On exit, Y is overwritten by the updated vector y.



INCY - INTEGER.

On entry, INCY specifies the increment for the elements of Y. INCY must not be zero. Unchanged on exit.

```

⟨BLAS 2 dgemv⟩≡
  (let* ((one 1.0) (zero 0.0))
    (declare (type (double-float 1.0 1.0) one)
              (type (double-float 0.0 0.0) zero))
    (defun dgemv (trans m n alpha a lda x incx beta y incy)
      (declare (type (simple-array double-float (*)) y x a)
                (type (double-float) beta alpha)
                (type fixnum incy incx lda n m)
                (type character trans))
      (f2cl-lib:with-multi-array-data
        ((trans character trans-%data% trans-%offset%)
         (a double-float a-%data% a-%offset%)
         (x double-float x-%data% x-%offset%)
         (y double-float y-%data% y-%offset%))
        (prog ((i 0) (info 0) (ix 0) (iy 0) (j 0) (jx 0) (jy 0) (kx 0) (ky 0)
              (lenx 0) (leny 0) (temp 0.0))
          (declare (type fixnum i info ix iy j jx jy kx ky lenx
                                leny)
                    (type (double-float) temp))
          (setf info 0)
          (cond
            ((and (not (char-equal trans #\N))
                   (not (char-equal trans #\T))
                   (not (char-equal trans #\C)))
             (setf info 1))
            ((< m 0)
             (setf info 2))
            ((< n 0)
             (setf info 3))
            ((< lda (max (the fixnum 1) (the fixnum m)))
             (setf info 6))
            ((= incx 0)
             (setf info 8))
            ((= incy 0)
             (setf info 11)))
          (cond
            ((/= info 0)
             (error
              " ** On entry to ~a parameter number ~a had an illegal value~%"
              "DGEMV" info)
             (go end_label)))
          (if (or (= m 0) (= n 0) (and (= alpha zero) (= beta one)))
              (go end_label))
          (cond
            ((char-equal trans #\N)
             (setf lenx n)

```

```

      (setf leny m))
    (t
      (setf lenx m)
      (setf leny n)))
  (cond
    ((> incx 0)
      (setf kx 1))
    (t
      (setf kx
        (f2cl-lib:int-sub 1
          (f2cl-lib:int-mul
            (f2cl-lib:int-sub lenx 1)
            incx))))))
  (cond
    ((> incy 0)
      (setf ky 1))
    (t
      (setf ky
        (f2cl-lib:int-sub 1
          (f2cl-lib:int-mul
            (f2cl-lib:int-sub leny 1)
            incy))))))
  (cond
    ((/= beta one)
      (cond
        ((= incy 1)
          (cond
            ((= beta zero)
              (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                ((> i leny) nil)
                (tagbody
                  (setf (f2cl-lib:fref y-%data% (i) ((1 *)) y-%offset%)
                    zero))))
            (t
              (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                ((> i leny) nil)
                (tagbody
                  (setf (f2cl-lib:fref y-%data% (i) ((1 *)) y-%offset%)
                    (* beta
                      (f2cl-lib:fref y-%data%
                        (i)
                        ((1 *))
                        y-%offset%))))))))
          (t
            (setf iy ky)
            (cond

```

```

(= beta zero)
(f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
  (> i leny) nil)
  (tagbody
    (setf (f2cl-lib:fref y-%data% (iy) ((1 *)) y-%offset%)
      zero)
    (setf iy (f2cl-lib:int-add iy incy))))))
(t
  (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
    (> i leny) nil)
  (tagbody
    (setf (f2cl-lib:fref y-%data% (iy) ((1 *)) y-%offset%)
      (* beta
        (f2cl-lib:fref y-%data%
          (iy)
          ((1 *))
          y-%offset%))))
    (setf iy (f2cl-lib:int-add iy incy)))))))))
(if (= alpha zero) (go end_label))
(cond
  ((char-equal trans #\N)
    (setf jx kx)
    (cond
      ((= incy 1)
        (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
          (> j n) nil)
        (tagbody
          (cond
            ((/= (f2cl-lib:fref x (jx) ((1 *)) zero)
              (setf temp
                (* alpha
                  (f2cl-lib:fref x-%data%
                    (jx)
                    ((1 *))
                    x-%offset%)))
              (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                (> i m) nil)
                (tagbody
                  (setf (f2cl-lib:fref y-%data% (i) ((1 *)) y-%offset%)
                    (+
                      (f2cl-lib:fref y-%data%
                        (i)
                        ((1 *))
                        y-%offset%)
                      (* temp
                        (f2cl-lib:fref a-%data%

```

```

                                (i j)
                                ((1 lda) (1 *))
                                a-%offset%)))))))))
    (setf jx (f2cl-lib:int-add jx incx))))))
(t
  (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
    (> j n) nil)
  (tagbody
    (cond
      ((/= (f2cl-lib:fref x (jx) ((1 *))) zero)
        (setf temp
          (* alpha
            (f2cl-lib:fref x-%data%
                          (jx)
                          ((1 *))
                          x-%offset%)))
          (setf iy ky)
          (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
            (> i m) nil)
          (tagbody
            (setf (f2cl-lib:fref y-%data% (iy) ((1 *)) y-%offset%)
              (+
                (f2cl-lib:fref y-%data%
                              (iy)
                              ((1 *))
                              y-%offset%)
                (* temp
                  (f2cl-lib:fref a-%data%
                                (i j)
                                ((1 lda) (1 *))
                                a-%offset%))))
              (setf iy (f2cl-lib:int-add iy incy))))))
            (setf jx (f2cl-lib:int-add jx incx)))))))))
(t
  (setf jy ky)
  (cond
    ((= incx 1)
      (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
        (> j n) nil)
      (tagbody
        (setf temp zero)
        (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
          (> i m) nil)
        (tagbody
          (setf temp
            (+ temp
              (f2cl-lib:fref x-%data%
                            (ix)
                            ((1 *))
                            x-%offset%)
              (f2cl-lib:fref y-%data%
                            (jy)
                            ((1 *))
                            y-%offset%))))
          (setf ix (f2cl-lib:int-add ix incx))))))
        (setf jy (f2cl-lib:int-add jy incy))))))
  )
)

```

```

(*
  (f2cl-lib:fref a-%data%
    (i j)
    ((1 lda) (1 *))
    a-%offset%)
  (f2cl-lib:fref x-%data%
    (i)
    ((1 *))
    x-%offset%))))))
(setf (f2cl-lib:fref y-%data% (jy) ((1 *)) y-%offset%)
  (+ (f2cl-lib:fref y-%data% (jy) ((1 *)) y-%offset%)
    (* alpha temp)))
(setf jy (f2cl-lib:int-add jy incy))))))
(t
  (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
    ((> j n) nil)
    (tagbody
      (setf temp zero)
      (setf ix kx)
      (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
        ((> i m) nil)
        (tagbody
          (setf temp
            (+ temp
              (*
                (f2cl-lib:fref a-%data%
                  (i j)
                  ((1 lda) (1 *))
                  a-%offset%)
                (f2cl-lib:fref x-%data%
                  (ix)
                  ((1 *))
                  x-%offset%))))))
            (setf ix (f2cl-lib:int-add ix incx))))))
      (setf (f2cl-lib:fref y-%data% (jy) ((1 *)) y-%offset%)
        (+ (f2cl-lib:fref y-%data% (jy) ((1 *)) y-%offset%)
          (* alpha temp)))
      (setf jy (f2cl-lib:int-add jy incy)))))))))
end_label
(return (values nil nil nil nil nil nil nil nil nil nil))))))

```

### 5.3 dger BLAS

```
<dger.input>=  
  )set break resume  
  )sys rm -f dger.output  
  )spool dger.output  
  )set message test on  
  )set message auto off  
  )clear all  
  
  )spool  
  )lisp (bye)
```

`<dger.help>`≡

```
=====
dger examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

DGER - perform the rank 1 operation  $A := \alpha x y' + A$ ,

#### SYNOPSIS

```
SUBROUTINE DGER ( M, N, ALPHA, X, INCX, Y, INCY, A, LDA )
```

```
      DOUBLE      PRECISION ALPHA
```

```
      INTEGER      INCX, INCY, LDA, M, N
```

```
      DOUBLE      PRECISION A( LDA, * ), X( * ), Y( * )
```

#### PURPOSE

DGER performs the rank 1 operation

where alpha is a scalar, x is an m element vector, y is an n element vector and A is an m by n matrix.

#### PARAMETERS

M - INTEGER.

On entry, M specifies the number of rows of the matrix A. M must be at least zero. Unchanged on exit.

N - INTEGER.

On entry, N specifies the number of columns of the matrix A. N must be at least zero. Unchanged on exit.

ALPHA - DOUBLE PRECISION.

On entry, ALPHA specifies the scalar alpha. Unchanged on exit.

X - DOUBLE PRECISION array of dimension at least

( 1 + ( m - 1 ) \* abs( INCX ) ). Before entry, the incremented array X must contain the m element vector x. Unchanged on exit.



- INCX - INTEGER.  
On entry, INCX specifies the increment for the elements of X. INCX must not be zero. Unchanged on exit.
- Y - DOUBLE PRECISION array of dimension at least  $(1 + (n - 1) * \text{abs}(\text{INCY}))$ . Before entry, the incremented array Y must contain the n element vector y. Unchanged on exit.
- INCY - INTEGER.  
On entry, INCY specifies the increment for the elements of Y. INCY must not be zero. Unchanged on exit.
- A - DOUBLE PRECISION array of DIMENSION (LDA, n). Before entry, the leading m by n part of the array A must contain the matrix of coefficients. On exit, A is overwritten by the updated matrix.
- LDA - INTEGER.  
On entry, LDA specifies the first dimension of A as declared in the calling (sub) program. LDA must be at least  $\max(1, m)$ . Unchanged on exit.

```

<BLAS 2 dger>=
(let* ((zero 0.0))
  (declare (type (double-float 0.0 0.0) zero))
  (defun dger (m n alpha x incx y incy a lda)
    (declare (type (simple-array double-float (*)) a y x)
              (type (double-float) alpha)
              (type fixnum lda incy incx n m))
    (f2cl-lib:with-multi-array-data
      ((x double-float x-%data% x-%offset%)
       (y double-float y-%data% y-%offset%)
       (a double-float a-%data% a-%offset%))
      (prog ((i 0) (info 0) (ix 0) (j 0) (jy 0) (kx 0) (temp 0.0))
        (declare (type fixnum i info ix j jy kx)
                  (type (double-float) temp))
        (setf info 0)
        (cond
          ((< m 0)
            (setf info 1))
          ((< n 0)
            (setf info 2))
          ((= incx 0)
            (setf info 5))
          ((= incy 0)
            (setf info 7))
          ((< lda (max (the fixnum 1) (the fixnum m)))
            (setf info 9)))
          (cond
            ((/= info 0)
              (error
               " ** On entry to ~a parameter number ~a had an illegal value~%"
               "DYER" info)
              (go end_label)))
            (if (or (= m 0) (= n 0) (= alpha zero)) (go end_label))
            (cond
              ((> incy 0)
                (setf jy 1))
              (t
                (setf jy
                  (f2cl-lib:int-sub 1
                                     (f2cl-lib:int-mul (f2cl-lib:int-sub n 1)
                                                         incy))))))
              (cond
                ((= incx 1)
                  (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                                ((> j n) nil)
                                (tagbody

```

```

(cond
  ((/= (f2cl-lib:fref y (jy) ((1 *))) zero)
    (setf temp
      (* alpha
        (f2cl-lib:fref y-%data% (jy) ((1 *)) y-%offset%)))
    (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
      ((> i m) nil)
      (tagbody
        (setf (f2cl-lib:fref a-%data%
          (i j)
          ((1 lda) (1 *))
          a-%offset%)
          (+
            (f2cl-lib:fref a-%data%
              (i j)
              ((1 lda) (1 *))
              a-%offset%)
            (*
              (f2cl-lib:fref x-%data% (i) ((1 *)) x-%offset%)
              temp))))))
    (setf jy (f2cl-lib:int-add jy incy))))
(t
  (cond
    ((> incx 0)
      (setf kx 1))
    (t
      (setf kx
        (f2cl-lib:int-sub 1
          (f2cl-lib:int-mul
            (f2cl-lib:int-sub m 1)
            incx))))))
  (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
    ((> j n) nil)
    (tagbody
      (cond
        ((/= (f2cl-lib:fref y (jy) ((1 *))) zero)
          (setf temp
            (* alpha
              (f2cl-lib:fref y-%data% (jy) ((1 *)) y-%offset%)))
          (setf ix kx)
          (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
            ((> i m) nil)
            (tagbody
              (setf (f2cl-lib:fref a-%data%
                (i j)
                ((1 lda) (1 *))

```

```

                                a-%offset%)
(+
  (f2cl-lib:fref a-%data%
    (i j)
    ((1 lda) (1 *))
    a-%offset%)
  (*
    (f2cl-lib:fref x-%data%
      (ix)
      ((1 *))
      x-%offset%)
    temp)))
  (setf ix (f2cl-lib:int-add ix incx))))))
(setf jy (f2cl-lib:int-add jy incy))))))
end_label
  (return (values nil nil nil nil nil nil nil nil))))))

```

## 5.4 dsbmV BLAS

```

<dsbmV.input>≡
)set break resume
)sys rm -f dsbmV.output
)spool dsbmV.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)

```

`<dsbmv.help>≡`

```
=====
dsbmv examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

DSBMV - perform the matrix-vector operation  $y := \alpha A x + \beta y$ ,

#### SYNOPSIS

```
SUBROUTINE DSBMV ( UPLO, N, K, ALPHA, A, LDA, X, INCX, BETA,
                  Y, INCY )
```

```
      DOUBLE      PRECISION ALPHA, BETA
```

```
      INTEGER      INCX, INCY, K, LDA, N
```

```
      CHARACTER*1  UPLO
```

```
      DOUBLE      PRECISION A( LDA, * ), X( * ), Y( * )
```

#### PURPOSE

DSBMV performs the matrix-vector operation

where alpha and beta are scalars, x and y are n element vectors and A is an n by n symmetric band matrix, with k super-diagonals.

#### PARAMETERS

UPLO - CHARACTER\*1.

On entry, UPLO specifies whether the upper or lower triangular part of the band matrix A is being supplied as follows:

UPLO = 'U' or 'u' The upper triangular part of A is being supplied.

UPLO = 'L' or 'l' The lower triangular part of A is being supplied.

Unchanged on exit.

- N        - INTEGER.  
On entry, N specifies the order of the matrix A. N must be at least zero. Unchanged on exit.
- K        - INTEGER.  
On entry, K specifies the number of super-diagonals of the matrix A. K must satisfy  $0 \leq K$ . Unchanged on exit.
- ALPHA    - DOUBLE PRECISION.  
On entry, ALPHA specifies the scalar alpha. Unchanged on exit.
- A        - DOUBLE PRECISION array of DIMENSION ( LDA, n ).

Before entry with UPLO = 'U' or 'u', the leading ( k + 1 ) by n part of the array A must contain the upper triangular band part of the symmetric matrix, supplied column by column, with the leading diagonal of the matrix in row ( k + 1 ) of the array, the first super-diagonal starting at position 2 in row k, and so on. The top left k by k triangle of the array A is not referenced. The following program segment will transfer the upper triangular part of a symmetric band matrix from conventional full matrix storage to band storage:

```
DO 20, J = 1, N M = K + 1 - J DO 10, I = MAX( 1, J -
K ), J A( M + I, J ) = matrix( I, J ) 10    CONTINUE
20 CONTINUE
```

Before entry with UPLO = 'L' or 'l', the leading ( k + 1 ) by n part of the array A must contain the lower triangular band part of the symmetric matrix, supplied column by column, with the leading diagonal of the matrix in row 1 of the array, the first sub-diagonal starting at position 1 in row 2, and so on. The bottom right k by k triangle of the array A is not referenced. The following program segment will transfer the lower triangular part of a symmetric band matrix from conventional full matrix storage to band storage:

```
DO 20, J = 1, N M = 1 - J DO 10, I = J, MIN( N, J + K
) A( M + I, J ) = matrix( I, J ) 10    CONTINUE 20
CONTINUE
```

Unchanged on exit.

- LDA - INTEGER.  
On entry, LDA specifies the first dimension of A as declared in the calling (sub) program. LDA must be at least  $(k + 1)$ . Unchanged on exit.
- X - DOUBLE PRECISION array of DIMENSION at least  $(1 + (n - 1) * \text{abs}(\text{INCX}))$ . Before entry, the incremented array X must contain the vector x. Unchanged on exit.
- INCX - INTEGER.  
On entry, INCX specifies the increment for the elements of X. INCX must not be zero. Unchanged on exit.
- BETA - DOUBLE PRECISION.  
On entry, BETA specifies the scalar beta. Unchanged on exit.
- Y - DOUBLE PRECISION array of DIMENSION at least  $(1 + (n - 1) * \text{abs}(\text{INCY}))$ . Before entry, the incremented array Y must contain the vector y. On exit, Y is overwritten by the updated vector y.
- INCY - INTEGER.  
On entry, INCY specifies the increment for the elements of Y. INCY must not be zero. Unchanged on exit.

```

⟨BLAS 2 dsbmv⟩≡
  (let* ((one 1.0) (zero 0.0))
    (declare (type (double-float 1.0 1.0) one)
              (type (double-float 0.0 0.0) zero))
    (defun dsbmv (uplo n k alpha a lda x incx beta y incy)
      (declare (type (simple-array double-float (*)) y x a)
                (type (double-float) beta alpha)
                (type fixnum incy incx lda k n)
                (type character uplo))
      (f2cl-lib:with-multi-array-data
        ((uplo character uplo-%data% uplo-%offset%)
         (a double-float a-%data% a-%offset%)
         (x double-float x-%data% x-%offset%)
         (y double-float y-%data% y-%offset%))
        (prog ((i 0) (info 0) (ix 0) (iy 0) (j 0) (jx 0) (jy 0) (kplus1 0) (kx 0)
              (ky 0) (l 0) (temp1 0.0) (temp2 0.0))
          (declare (type fixnum i info ix iy j jx jy kplus1 kx ky l)
                    (type (double-float) temp1 temp2))
          (setf info 0)
          (cond
            ((and (not (char-equal uplo #\U)) (not (char-equal uplo #\L)))
              (setf info 1))
            ((< n 0)
              (setf info 2))
            ((< k 0)
              (setf info 3))
            ((< lda (f2cl-lib:int-add k 1))
              (setf info 6))
            ((= incx 0)
              (setf info 8))
            ((= incy 0)
              (setf info 11)))
          (cond
            ((/= info 0)
              (error
               " ** On entry to ~a parameter number ~a had an illegal value~%"
               "DSBMV" info)
              (go end_label)))
          (if (or (= n 0) (and (= alpha zero) (= beta one))) (go end_label))
          (cond
            ((> incx 0)
              (setf kx 1))
            (t
              (setf kx
                    (f2cl-lib:int-sub 1
                                       (f2cl-lib:int-mul (f2cl-lib:int-sub n 1)

```



```

incx))))))
(cond
  (> incy 0)
  (setf ky 1))
(t
  (setf ky
    (f2cl-lib:int-sub 1
      (f2cl-lib:int-mul (f2cl-lib:int-sub n 1)
        incy))))))
(cond
  (/= beta one)
  (cond
    (= incy 1)
    (cond
      (= beta zero)
      (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
        (> i n) nil)
      (tagbody
        (setf (f2cl-lib:fref y-%data% (i) ((1 *)) y-%offset%)
          zero))))))
    (t
      (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
        (> i n) nil)
      (tagbody
        (setf (f2cl-lib:fref y-%data% (i) ((1 *)) y-%offset%)
          (* beta
            (f2cl-lib:fref y-%data%
              (i)
              ((1 *))
              y-%offset%))))))))))
    (t
      (setf iy ky)
      (cond
        (= beta zero)
        (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
          (> i n) nil)
        (tagbody
          (setf (f2cl-lib:fref y-%data% (iy) ((1 *)) y-%offset%)
            zero)
          (setf iy (f2cl-lib:int-add iy incy))))))
        (t
          (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
            (> i n) nil)
          (tagbody
            (setf (f2cl-lib:fref y-%data% (iy) ((1 *)) y-%offset%)
              (* beta

```

```

(f2cl-lib:fref y-%data%
  (iy)
  ((1 *))
  y-%offset%)))
(setf iy (f2cl-lib:int-add iy incy)))))))))
(if (= alpha zero) (go end_label))
(cond
  ((char-equal uplo #\U)
   (setf kplus1 (f2cl-lib:int-add k 1))
   (cond
     ((and (= incx 1) (= incy 1))
      (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
        ((> j n) nil)
      (tagbody
        (setf temp1
          (* alpha
            (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%)))
        (setf temp2 zero)
        (setf l (f2cl-lib:int-sub kplus1 j))
        (f2cl-lib:fdo (i
          (max (the fixnum 1)
            (the fixnum
              (f2cl-lib:int-add j
                (f2cl-lib:int-sub
                  (f2cl-lib:int-add i 1))
                  (> i
                    (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
                    nil)
            (tagbody
              (setf (f2cl-lib:fref y-%data% (i) ((1 *)) y-%offset%)
                (+
                  (f2cl-lib:fref y-%data% (i) ((1 *)) y-%offset%)
                  (* temp1
                    (f2cl-lib:fref a-%data%
                      ((f2cl-lib:int-add l i) j)
                      ((1 lda) (1 *))
                      a-%offset%))))
              (setf temp2
                (+ temp2
                  (*
                    (f2cl-lib:fref a-%data%
                      ((f2cl-lib:int-add l i) j)
                      ((1 lda) (1 *))
                      a-%offset%)
                    (f2cl-lib:fref x-%data%

```

```

                                (i)
                                ((1 *))
                                x-%offset%))))))
(setf (f2cl-lib:fref y-%data% (j) ((1 *)) y-%offset%)
      (+ (f2cl-lib:fref y-%data% (j) ((1 *)) y-%offset%)
         (* temp1
            (f2cl-lib:fref a-%data%
                           (kplus1 j)
                           ((1 lda) (1 *))
                           a-%offset%))
          (* alpha temp2))))))
(t
 (setf jx kx)
 (setf jy ky)
 (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
               ((> j n) nil)
  (tagbody
   (setf temp1
          (* alpha
             (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%)))
   (setf temp2 zero)
   (setf ix kx)
   (setf iy ky)
   (setf l (f2cl-lib:int-sub kplus1 j))
   (f2cl-lib:fdo (i
                  (max (the fixnum 1)
                       (the fixnum
                        (f2cl-lib:int-add j
                                           (f2cl-lib:int-sub
                                            k))))
                  (f2cl-lib:int-add i 1))
                 ((> i
                    (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
                  nil)
    (tagbody
     (setf (f2cl-lib:fref y-%data% (iy) ((1 *)) y-%offset%)
           (+
            (f2cl-lib:fref y-%data% (iy) ((1 *)) y-%offset%)
            (* temp1
               (f2cl-lib:fref a-%data%
                              ((f2cl-lib:int-add l i) j)
                              ((1 lda) (1 *))
                              a-%offset%))))
          (setf temp2
                 (+ temp2
                    (*

```

```

(f2cl-lib:fref a-%data%
  ((f2cl-lib:int-add 1 i) j)
  ((1 lda) (1 *))
  a-%offset%)
(f2cl-lib:fref x-%data%
  (ix)
  ((1 *))
  x-%offset%))
(setf ix (f2cl-lib:int-add ix incx))
(setf iy (f2cl-lib:int-add iy incy))
(setf (f2cl-lib:fref y-%data% (jy) ((1 *) y-%offset%)
  (+ (f2cl-lib:fref y-%data% (jy) ((1 *) y-%offset%)
    (* temp1
      (f2cl-lib:fref a-%data%
        (kplus1 j)
        ((1 lda) (1 *))
        a-%offset%))
      (* alpha temp2)))
    (setf jx (f2cl-lib:int-add jx incx))
    (setf jy (f2cl-lib:int-add jy incy))
    (cond
      (> j k)
      (setf kx (f2cl-lib:int-add kx incx))
      (setf ky (f2cl-lib:int-add ky incy))))))
(t
  (cond
    ((and (= incx 1) (= incy 1))
      (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
        (> j n) nil)
      (tagbody
        (setf temp1
          (* alpha
            (f2cl-lib:fref x-%data% (j) ((1 *) x-%offset%)))
          (setf temp2 zero)
          (setf (f2cl-lib:fref y-%data% (j) ((1 *) y-%offset%)
            (+ (f2cl-lib:fref y-%data% (j) ((1 *) y-%offset%)
              (* temp1
                (f2cl-lib:fref a-%data%
                  (1 j)
                  ((1 lda) (1 *))
                  a-%offset%)))
            (setf l (f2cl-lib:int-sub 1 j))
            (f2cl-lib:fdo (i (f2cl-lib:int-add j 1)
              (f2cl-lib:int-add i 1))
                (> i
                  (min (the fixnum n)

```

```

                                (the fixnum
                                (f2cl-lib:int-add j k))))
                                nil)
(tagbody
  (setf (f2cl-lib:fref y-%data% (i) ((1 *)) y-%offset%)
    (+
      (f2cl-lib:fref y-%data% (i) ((1 *)) y-%offset%)
      (* temp1
        (f2cl-lib:fref a-%data%
          ((f2cl-lib:int-add 1 i) j)
          ((1 lda) (1 *))
          a-%offset%))))
    (setf temp2
      (+ temp2
        (*
          (f2cl-lib:fref a-%data%
            ((f2cl-lib:int-add 1 i) j)
            ((1 lda) (1 *))
            a-%offset%)
          (f2cl-lib:fref x-%data%
            (i)
            ((1 *))
            x-%offset%))))))
  (setf (f2cl-lib:fref y-%data% (j) ((1 *)) y-%offset%)
    (+ (f2cl-lib:fref y-%data% (j) ((1 *)) y-%offset%)
      (* alpha temp2))))))
(t
  (setf jx kx)
  (setf jy ky)
  (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
    ((> j n) nil)
    (tagbody
      (setf temp1
        (* alpha
          (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%)))
      (setf temp2 zero)
      (setf (f2cl-lib:fref y-%data% (jy) ((1 *)) y-%offset%)
        (+ (f2cl-lib:fref y-%data% (jy) ((1 *)) y-%offset%)
          (* temp1
            (f2cl-lib:fref a-%data%
              (1 j)
              ((1 lda) (1 *))
              a-%offset%))))))
      (setf l (f2cl-lib:int-sub 1 j))
      (setf ix jx)
      (setf iy jy)

```

```

(f2cl-lib:fdo (i (f2cl-lib:int-add j 1)
                (f2cl-lib:int-add i 1))
              (> i
                (min (the fixnum n)
                     (the fixnum
                      (f2cl-lib:int-add j k))))
              nil)
(tagbody
 (setf ix (f2cl-lib:int-add ix incx))
 (setf iy (f2cl-lib:int-add iy incy))
 (setf (f2cl-lib:fref y-%data% (iy) ((1 *)) y-%offset%)
      (+
       (f2cl-lib:fref y-%data% (iy) ((1 *)) y-%offset%)
       (* temp1
          (f2cl-lib:fref a-%data%
                        ((f2cl-lib:int-add 1 i) j)
                        ((1 lda) (1 *))
                        a-%offset%))))
 (setf temp2
      (+ temp2
         (*
          (f2cl-lib:fref a-%data%
                        ((f2cl-lib:int-add 1 i) j)
                        ((1 lda) (1 *))
                        a-%offset%)
          (f2cl-lib:fref x-%data%
                        (ix)
                        ((1 *))
                        x-%offset%))))))
 (setf (f2cl-lib:fref y-%data% (jy) ((1 *)) y-%offset%)
      (+ (f2cl-lib:fref y-%data% (jy) ((1 *)) y-%offset%)
         (* alpha temp2)))
 (setf jx (f2cl-lib:int-add jx incx))
 (setf jy (f2cl-lib:int-add jy incy))))))
end_label
(return (values nil nil nil nil nil nil nil nil nil nil))))

```

## 5.5 dspmvm BLAS

```
<dspmvm.input>≡  
  )set break resume  
  )sys rm -f dspmvm.output  
  )spool dspmvm.output  
  )set message test on  
  )set message auto off  
  )clear all  
  
  )spool  
  )lisp (bye)
```

`<dspmv.help>=`

```
=====
dspmv examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

DSPMV - perform the matrix-vector operation  $y := \alpha * A * x + \beta * y$ ,

#### SYNOPSIS

```
SUBROUTINE DSPMV ( UPLO, N, ALPHA, AP, X, INCX, BETA, Y,
                  INCY )
```

```
      DOUBLE      PRECISION ALPHA, BETA
```

```
      INTEGER      INCX, INCY, N
```

```
      CHARACTER*1  UPLO
```

```
      DOUBLE      PRECISION AP( * ), X( * ), Y( * )
```

#### PURPOSE

DSPMV performs the matrix-vector operation

where alpha and beta are scalars, x and y are n element vectors and A is an n by n symmetric matrix, supplied in packed form.

#### PARAMETERS

UPLO - CHARACTER\*1.

On entry, UPLO specifies whether the upper or lower triangular part of the matrix A is supplied in the packed array AP as follows:

UPLO = 'U' or 'u' The upper triangular part of A is supplied in AP.

UPLO = 'L' or 'l' The lower triangular part of A is supplied in AP.

Unchanged on exit.



- N** - INTEGER.  
On entry, N specifies the order of the matrix A. N must be at least zero. Unchanged on exit.
- ALPHA** - DOUBLE PRECISION.  
On entry, ALPHA specifies the scalar alpha. Unchanged on exit.
- AP** - DOUBLE PRECISION array of DIMENSION at least  
( ( n\*( n + 1 ) )/2 ). Before entry with UPLO = 'U' or 'u', the array AP must contain the upper triangular part of the symmetric matrix packed sequentially, column by column, so that AP( 1 ) contains a( 1, 1 ), AP( 2 ) and AP( 3 ) contain a( 1, 2 ) and a( 2, 2 ) respectively, and so on. Before entry with UPLO = 'L' or 'l', the array AP must contain the lower triangular part of the symmetric matrix packed sequentially, column by column, so that AP( 1 ) contains a( 1, 1 ), AP( 2 ) and AP( 3 ) contain a( 2, 1 ) and a( 3, 1 ) respectively, and so on. Unchanged on exit.
- X** - DOUBLE PRECISION array of dimension at least  
( 1 + ( n - 1 )\*abs( INCX ) ). Before entry, the incremented array X must contain the n element vector x. Unchanged on exit.
- INCX** - INTEGER.  
On entry, INCX specifies the increment for the elements of X. INCX must not be zero. Unchanged on exit.
- BETA** - DOUBLE PRECISION.  
On entry, BETA specifies the scalar beta. When BETA is supplied as zero then Y need not be set on input. Unchanged on exit.
- Y** - DOUBLE PRECISION array of dimension at least  
( 1 + ( n - 1 )\*abs( INCY ) ). Before entry, the incremented array Y must contain the n element vector y. On exit, Y is overwritten by the updated vector y.
- INCY** - INTEGER.  
On entry, INCY specifies the increment for the elements of Y. INCY must not be zero. Unchanged on exit.



```

<BLAS 2 dspmv>≡
  (let* ((one 1.0) (zero 0.0))
    (declare (type (double-float 1.0 1.0) one)
              (type (double-float 0.0 0.0) zero))
    (defun dspmv (uplo n alpha ap x incx beta y incy)
      (declare (type (simple-array double-float (*)) y x ap)
                (type (double-float) beta alpha)
                (type fixnum incy incx n)
                (type character uplo))
      (f2cl-lib:with-multi-array-data
        ((uplo character uplo-%data% uplo-%offset%)
         (ap double-float ap-%data% ap-%offset%)
         (x double-float x-%data% x-%offset%)
         (y double-float y-%data% y-%offset%))
        (prog ((i 0) (info 0) (ix 0) (iy 0) (j 0) (jx 0) (jy 0) (k 0) (kk 0)
               (kx 0) (ky 0) (temp1 0.0) (temp2 0.0))
          (declare (type fixnum i info ix iy j jx jy k kk kx ky)
                    (type (double-float) temp1 temp2))
          (setf info 0)
          (cond
            ((and (not (char-equal uplo #\U)) (not (char-equal uplo #\L)))
              (setf info 1))
            ((< n 0)
              (setf info 2))
            ((= incx 0)
              (setf info 6))
            ((= incy 0)
              (setf info 9)))
          (cond
            ((/= info 0)
              (error
               " ** On entry to ~a parameter number ~a had an illegal value~%"
               "DSPMV" info)
              (go end_label)))
          (if (or (= n 0) (and (= alpha zero) (= beta one))) (go end_label))
          (cond
            ((> incx 0)
              (setf kx 1))
            (t
              (setf kx
                    (f2cl-lib:int-sub 1
                                       (f2cl-lib:int-mul (f2cl-lib:int-sub n 1)
                                                         incx))))))
          (cond
            ((> incy 0)
              (setf ky 1))

```

```
(t
  (setf ky
    (f2cl-lib:int-sub 1
      (f2cl-lib:int-mul (f2cl-lib:int-sub n 1)
        incy))))))
(cond
  ((/= beta one)
    (cond
      ((= incy 1)
        (cond
          ((= beta zero)
            (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
              (> i n) nil)
            (tagbody
              (setf (f2cl-lib:fref y-%data% (i) ((1 *)) y-%offset%
                zero))))))
          (t
            (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
              (> i n) nil)
            (tagbody
              (setf (f2cl-lib:fref y-%data% (i) ((1 *)) y-%offset%
                (* beta
                  (f2cl-lib:fref y-%data%
                    (i)
                    ((1 *))
                    y-%offset%))))))))))
  (t
    (setf iy ky)
    (cond
      ((= beta zero)
        (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
          (> i n) nil)
        (tagbody
          (setf (f2cl-lib:fref y-%data% (iy) ((1 *)) y-%offset%
            zero)
            (setf iy (f2cl-lib:int-add iy incy))))))
      (t
        (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
          (> i n) nil)
        (tagbody
          (setf (f2cl-lib:fref y-%data% (iy) ((1 *)) y-%offset%
            (* beta
              (f2cl-lib:fref y-%data%
                (iy)
                ((1 *))
                y-%offset%))))))
```

```

                (setf iy (f2cl-lib:int-add iy incy)))))))))
(if (= alpha zero) (go end_label))
(setf kk 1)
(cond
  ((char-equal uplo #\U)
    (cond
      ((and (= incx 1) (= incy 1))
        (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
          ((> j n) nil)
          (tagbody
            (setf temp1
              (* alpha
                (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%)))
            (setf temp2 zero)
            (setf k kk)
            (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
              ((> i
                (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
                nil)
              (tagbody
                (setf (f2cl-lib:fref y-%data% (i) ((1 *)) y-%offset%)
                  (+
                    (f2cl-lib:fref y-%data% (i) ((1 *)) y-%offset%)
                    (* temp1
                      (f2cl-lib:fref ap-%data%
                        (k)
                        ((1 *))
                        ap-%offset%))))
                (setf temp2
                  (+ temp2
                    (*
                      (f2cl-lib:fref ap-%data%
                        (k)
                        ((1 *))
                        ap-%offset%)
                      (f2cl-lib:fref x-%data%
                        (i)
                        ((1 *))
                        x-%offset%))))
                (setf k (f2cl-lib:int-add k 1))))
            (setf (f2cl-lib:fref y-%data% (j) ((1 *)) y-%offset%)
              (+ (f2cl-lib:fref y-%data% (j) ((1 *)) y-%offset%)
                (* temp1
                  (f2cl-lib:fref ap-%data%
                    ((f2cl-lib:int-sub
                      (f2cl-lib:int-add kk j)

```

```

1))
((1 *))
ap-%offset%))

(* alpha temp2)))
(setf kk (f2cl-lib:int-add kk j))))))
(t
  (setf jx kx)
  (setf jy ky)
  (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
    ((> j n) nil)
    (tagbody
      (setf temp1
        (* alpha
          (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%)))
      (setf temp2 zero)
      (setf ix kx)
      (setf iy ky)
      (f2cl-lib:fdo (k kk (f2cl-lib:int-add k 1))
        ((> k
          (f2cl-lib:int-add kk
            j
            (f2cl-lib:int-sub 2))))
          nil)
      (tagbody
        (setf (f2cl-lib:fref y-%data% (iy) ((1 *)) y-%offset%)
          (+
            (f2cl-lib:fref y-%data% (iy) ((1 *)) y-%offset%)
            (* temp1
              (f2cl-lib:fref ap-%data%
                (k)
                ((1 *))
                ap-%offset%))))))
        (setf temp2
          (+ temp2
            (*
              (f2cl-lib:fref ap-%data%
                (k)
                ((1 *))
                ap-%offset%)
              (f2cl-lib:fref x-%data%
                (ix)
                ((1 *))
                x-%offset%))))))
        (setf ix (f2cl-lib:int-add ix incx))
        (setf iy (f2cl-lib:int-add iy incy))))
      (setf (f2cl-lib:fref y-%data% (jy) ((1 *)) y-%offset%)

```

```

(+ (f2cl-lib:fref y-%data% (jy) ((1 *)) y-%offset%)
  (* temp1
    (f2cl-lib:fref ap-%data%
      ((f2cl-lib:int-sub
        (f2cl-lib:int-add kk j)
        1))
      ((1 *))
      ap-%offset%))
    (* alpha temp2)))
(setf jx (f2cl-lib:int-add jx incx))
(setf jy (f2cl-lib:int-add jy incy))
(setf kk (f2cl-lib:int-add kk j))))))
(t
  (cond
    ((and (= incx 1) (= incy 1))
      (f2cl-lib:fd0 (j 1 (f2cl-lib:int-add j 1))
        ((> j n) nil)
        (tagbody
          (setf temp1
            (* alpha
              (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%)))
          (setf temp2 zero)
          (setf (f2cl-lib:fref y-%data% (j) ((1 *)) y-%offset%)
            (+ (f2cl-lib:fref y-%data% (j) ((1 *)) y-%offset%)
              (* temp1
                (f2cl-lib:fref ap-%data%
                  (kk)
                  ((1 *))
                  ap-%offset%))))))
          (setf k (f2cl-lib:int-add kk 1))
          (f2cl-lib:fd0 (i (f2cl-lib:int-add j 1)
            (f2cl-lib:int-add i 1))
              ((> i n) nil)
              (tagbody
                (setf (f2cl-lib:fref y-%data% (i) ((1 *)) y-%offset%)
                  (+
                    (f2cl-lib:fref y-%data% (i) ((1 *)) y-%offset%)
                    (* temp1
                      (f2cl-lib:fref ap-%data%
                        (k)
                        ((1 *))
                        ap-%offset%))))))
                (setf temp2
                  (+ temp2
                    (*
                      (f2cl-lib:fref ap-%data%

```

```

(k)
((1 *))
ap-%offset%)
(f2cl-lib:fref x-%data%
(i)
((1 *))
x-%offset%))))
(setf k (f2cl-lib:int-add k 1)))
(setf (f2cl-lib:fref y-%data% (j) ((1 *)) y-%offset%)
(+ (f2cl-lib:fref y-%data% (j) ((1 *)) y-%offset%)
(* alpha temp2)))
(setf kk
(f2cl-lib:int-add kk
(f2cl-lib:int-add
(f2cl-lib:int-sub n j)
1))))))
(t
(setf jx kx)
(setf jy ky)
(f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
(> j n) nil)
(tagbody
(setf temp1
(* alpha
(f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%)))
(setf temp2 zero)
(setf (f2cl-lib:fref y-%data% (jy) ((1 *)) y-%offset%)
(+ (f2cl-lib:fref y-%data% (jy) ((1 *)) y-%offset%)
(* temp1
(f2cl-lib:fref ap-%data%
(kk)
((1 *))
ap-%offset%))))
(setf ix jx)
(setf iy jy)
(f2cl-lib:fdo (k (f2cl-lib:int-add kk 1)
(f2cl-lib:int-add k 1))
(> k
(f2cl-lib:int-add kk
n
(f2cl-lib:int-sub j)))
nil)
(tagbody
(setf ix (f2cl-lib:int-add ix incx))
(setf iy (f2cl-lib:int-add iy incy))
(setf (f2cl-lib:fref y-%data% (iy) ((1 *)) y-%offset%)

```



```

(+
  (f2cl-lib:fref y-%data% (iy) ((1 *)) y-%offset%)
  (* temp1
    (f2cl-lib:fref ap-%data%
      (k)
      ((1 *))
      ap-%offset%))))
(setf temp2
  (+ temp2
    (*
      (f2cl-lib:fref ap-%data%
        (k)
        ((1 *))
        ap-%offset%)
      (f2cl-lib:fref x-%data%
        (ix)
        ((1 *))
        x-%offset%))))))
(setf (f2cl-lib:fref y-%data% (jy) ((1 *)) y-%offset%)
  (+ (f2cl-lib:fref y-%data% (jy) ((1 *)) y-%offset%)
    (* alpha temp2)))
(setf jx (f2cl-lib:int-add jx incx))
(setf jy (f2cl-lib:int-add jy incy))
(setf kk
  (f2cl-lib:int-add kk
    (f2cl-lib:int-add
      (f2cl-lib:int-sub n j)
      1))))))
end_label
(return (values nil nil nil nil nil nil nil nil))))

```

## 5.6 dspr2 BLAS

```

⟨dspr2.input⟩≡
)set break resume
)sys rm -f dspr2.output
)spool dspr2.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)

```

$\langle dspr2.help \rangle =$

```
=====
dspr2 examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

DSPR2 - perform the symmetric rank 2 operation  $A := \alpha * x * y' + \alpha * y * x' + A$ ,

#### SYNOPSIS

```
SUBROUTINE DSPR2 ( UPLO, N, ALPHA, X, INCX, Y, INCY, AP )
```

```
      DOUBLE      PRECISION ALPHA
```

```
      INTEGER      INCX, INCY, N
```

```
      CHARACTER*1  UPLO
```

```
      DOUBLE      PRECISION AP( * ), X( * ), Y( * )
```

#### PURPOSE

DSPR2 performs the symmetric rank 2 operation

where alpha is a scalar, x and y are n element vectors and A is an n by n symmetric matrix, supplied in packed form.

#### PARAMETERS

UPLO - CHARACTER\*1.

On entry, UPLO specifies whether the upper or lower triangular part of the matrix A is supplied in the packed array AP as follows:

UPLO = 'U' or 'u' The upper triangular part of A is supplied in AP.

UPLO = 'L' or 'l' The lower triangular part of A is supplied in AP.

Unchanged on exit.

N - INTEGER.

On entry, N specifies the order of the matrix A. N

must be at least zero. Unchanged on exit.

ALPHA - DOUBLE PRECISION.

On entry, ALPHA specifies the scalar alpha.  
Unchanged on exit.

X - DOUBLE PRECISION array of dimension at least  
( 1 + ( n - 1 ) \* abs( INCX ) ). Before entry, the  
incremented array X must contain the n element vector  
x. Unchanged on exit.

INCX - INTEGER.

On entry, INCX specifies the increment for the ele-  
ments of X. INCX must not be zero. Unchanged on  
exit.

Y - DOUBLE PRECISION array of dimension at least  
( 1 + ( n - 1 ) \* abs( INCY ) ). Before entry, the  
incremented array Y must contain the n element vector  
y. Unchanged on exit.

INCY - INTEGER.

On entry, INCY specifies the increment for the ele-  
ments of Y. INCY must not be zero. Unchanged on  
exit.

AP - DOUBLE PRECISION array of DIMENSION at least  
( ( n \* ( n + 1 ) ) / 2 ). Before entry with UPLO = 'U'  
or 'u', the array AP must contain the upper triangu-  
lar part of the symmetric matrix packed sequentially,  
column by column, so that AP( 1 ) contains a( 1, 1 ),  
AP( 2 ) and AP( 3 ) contain a( 1, 2 ) and a( 2, 2 )  
respectively, and so on. On exit, the array AP is  
overwritten by the upper triangular part of the  
updated matrix. Before entry with UPLO = 'L' or 'l',  
the array AP must contain the lower triangular part  
of the symmetric matrix packed sequentially, column  
by column, so that AP( 1 ) contains a( 1, 1 ), AP( 2  
) and AP( 3 ) contain a( 2, 1 ) and a( 3, 1 ) respec-  
tively, and so on. On exit, the array AP is overwrit-  
ten by the lower triangular part of the updated  
matrix.

```
(BLAS 2 dspr2)=
(let* ((zero 0.0))
(declare (type (double-float 0.0 0.0) zero))
(defun dspr2 (uplo n alpha x incx y incy ap)
  (declare (type (simple-array double-float (*)) ap y x)
    (type (double-float) alpha)
    (type fixnum incy incx n)
    (type character uplo))
  (f2cl-lib:with-multi-array-data
    ((uplo character uplo-%data% uplo-%offset%)
     (x double-float x-%data% x-%offset%)
     (y double-float y-%data% y-%offset%)
     (ap double-float ap-%data% ap-%offset%))
    (prog ((i 0) (info 0) (ix 0) (iy 0) (j 0) (jx 0) (jy 0) (k 0) (kk 0)
      (kx 0) (ky 0) (temp1 0.0) (temp2 0.0))
      (declare (type fixnum i info ix iy j jx jy k kk kx ky)
        (type (double-float) temp1 temp2))
      (setf info 0)
      (cond
        ((and (not (char-equal uplo #\U)) (not (char-equal uplo #\L)))
         (setf info 1))
        ((< n 0)
         (setf info 2))
        ((= incx 0)
         (setf info 5))
        ((= incy 0)
         (setf info 7)))
      (cond
        ((/= info 0)
         (error
          " ** On entry to ~a parameter number ~a had an illegal value~%"
          "DSPR2" info)
         (go end_label)))
      (if (or (= n 0) (= alpha zero)) (go end_label))
      (cond
        ((or (/= incx 1) (/= incy 1))
         (cond
           ((> incx 0)
            (setf kx 1))
           (t
            (setf kx
              (f2cl-lib:int-sub 1
                (f2cl-lib:int-mul
                  (f2cl-lib:int-sub n 1)
                  incx))))))
          (cond
```

```

(> incy 0)
(setf ky 1))
(t
  (setf ky
    (f2cl-lib:int-sub 1
      (f2cl-lib:int-mul
        (f2cl-lib:int-sub n 1)
        incy))))))

(setf jx kx)
(setf jy ky)))
(setf kk 1)
(cond
  ((char-equal uplo #\U)
    (cond
      ((and (= incx 1) (= incy 1))
        (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
          ((> j n) nil)
          (tagbody
            (cond
              ((or (/= (f2cl-lib:fref x (j) ((1 *))) zero)
                (/= (f2cl-lib:fref y (j) ((1 *))) zero))
                (setf temp1
                  (* alpha
                    (f2cl-lib:fref y-%data%
                      (j)
                      ((1 *))
                      y-%offset%)))
                  (setf temp2
                    (* alpha
                      (f2cl-lib:fref x-%data%
                        (j)
                        ((1 *))
                        x-%offset%)))
                  (setf k kk)
                  (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                    ((> i j) nil)
                    (tagbody
                      (setf (f2cl-lib:fref ap-%data%
                        (k)
                        ((1 *))
                        ap-%offset%)
                        (+
                          (f2cl-lib:fref ap-%data%
                            (k)
                            ((1 *))
                            ap-%offset%)

```

```

(*
  (f2cl-lib:fref x-%data%
    (i)
    ((1 *))
    x-%offset%)

  temp1)
(*
  (f2cl-lib:fref y-%data%
    (i)
    ((1 *))
    y-%offset%)

  temp2)))
(setf k (f2cl-lib:int-add k 1))))))
(setf kk (f2cl-lib:int-add kk j))))))
(t
  (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
    (> j n) nil)
  (tagbody
    (cond
      ((or (/= (f2cl-lib:fref x (jx) ((1 *))) zero)
            (/= (f2cl-lib:fref y (jy) ((1 *))) zero))
        (setf temp1
          (* alpha
            (f2cl-lib:fref y-%data%
              (jy)
              ((1 *))
              y-%offset%)))

        (setf temp2
          (* alpha
            (f2cl-lib:fref x-%data%
              (jx)
              ((1 *))
              x-%offset%)))

        (setf ix kx)
        (setf iy ky)
        (f2cl-lib:fdo (k kk (f2cl-lib:int-add k 1))
          (> k
            (f2cl-lib:int-add kk
              j
              (f2cl-lib:int-sub 1)))

          nil)

        (tagbody
          (setf (f2cl-lib:fref ap-%data%
            (k)
            ((1 *))
            ap-%offset%))

```

```

(+
  (f2cl-lib:fref ap-%data%
    (k)
    ((1 *))
    ap-%offset%)

  (*
    (f2cl-lib:fref x-%data%
      (ix)
      ((1 *))
      x-%offset%)

    temp1)
  (*
    (f2cl-lib:fref y-%data%
      (iy)
      ((1 *))
      y-%offset%)

    temp2)))
  (setf ix (f2cl-lib:int-add ix incx))
  (setf iy (f2cl-lib:int-add iy incy))))))
(setf jx (f2cl-lib:int-add jx incx))
(setf jy (f2cl-lib:int-add jy incy))
(setf kk (f2cl-lib:int-add kk j))))))
(t
  (cond
    ((and (= incx 1) (= incy 1))
      (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
        ((> j n) nil)
        (tagbody
          (cond
            ((or (/= (f2cl-lib:fref x (j) ((1 *))) zero)
              (/= (f2cl-lib:fref y (j) ((1 *))) zero))
              (setf temp1
                (* alpha
                  (f2cl-lib:fref y-%data%
                    (j)
                    ((1 *))
                    y-%offset%)))

                (setf temp2
                  (* alpha
                    (f2cl-lib:fref x-%data%
                      (j)
                      ((1 *))
                      x-%offset%)))

                (setf k kk)
                (f2cl-lib:fdo (i j (f2cl-lib:int-add i 1))
                  ((> i n) nil)

```

```

(tagbody
  (setf (f2cl-lib:fref ap-%data%
    (k)
    ((1 *))
    ap-%offset%)
    (+
      (f2cl-lib:fref ap-%data%
        (k)
        ((1 *))
        ap-%offset%)
      (*
        (f2cl-lib:fref x-%data%
          (i)
          ((1 *))
          x-%offset%)
        temp1)
      (*
        (f2cl-lib:fref y-%data%
          (i)
          ((1 *))
          y-%offset%)
        temp2)))
    (setf k (f2cl-lib:int-add k 1))))))
(setf kk
  (f2cl-lib:int-add
    (f2cl-lib:int-sub (f2cl-lib:int-add kk n) j)
    1))))
(t
  (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
    ((> j n) nil)
    (tagbody
      (cond
        ((or (/= (f2cl-lib:fref x (jx) ((1 *))) zero)
              (/= (f2cl-lib:fref y (jy) ((1 *))) zero))
          (setf temp1
            (* alpha
              (f2cl-lib:fref y-%data%
                (jy)
                ((1 *))
                y-%offset%)))
          (setf temp2
            (* alpha
              (f2cl-lib:fref x-%data%
                (jx)
                ((1 *))
                x-%offset%)))

```



```

(setf ix jx)
(setf iy jy)
(f2cl-lib:fdo (k kk (f2cl-lib:int-add k 1))
  (> k
    (f2cl-lib:int-add kk
      n
      (f2cl-lib:int-sub j)))
    nil)
(tagbody
  (setf (f2cl-lib:fref ap-%data%
    (k)
    ((1 *))
    ap-%offset%)
    (+
      (f2cl-lib:fref ap-%data%
        (k)
        ((1 *))
        ap-%offset%)
      (*
        (f2cl-lib:fref x-%data%
          (ix)
          ((1 *))
          x-%offset%)
        temp1)
      (*
        (f2cl-lib:fref y-%data%
          (iy)
          ((1 *))
          y-%offset%)
        temp2)))
  (setf ix (f2cl-lib:int-add ix incx))
  (setf iy (f2cl-lib:int-add iy incy))))))
(setf jx (f2cl-lib:int-add jx incx))
(setf jy (f2cl-lib:int-add jy incy))
(setf kk
  (f2cl-lib:int-add
    (f2cl-lib:int-sub (f2cl-lib:int-add kk n) j)
    1))))))
end_label
(return (values nil nil nil nil nil nil nil))))

```

## 5.7 dspr BLAS

```
<dspr.input>≡  
  )set break resume  
  )sys rm -f dspr.output  
  )spool dspr.output  
  )set message test on  
  )set message auto off  
  )clear all  
  
  )spool  
  )lisp (bye)
```

`<dspr.help>`≡

```
=====
dspr examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

DSPR - perform the symmetric rank 1 operation  $A := \alpha * x * x' + A$ ,

#### SYNOPSIS

SUBROUTINE DSPR ( UPLO, N, ALPHA, X, INCX, AP )

DOUBLE PRECISION ALPHA

INTEGER INCX, N

CHARACTER\*1 UPLO

DOUBLE PRECISION AP( \* ), X( \* )

#### PURPOSE

DSPR performs the symmetric rank 1 operation

where alpha is a real scalar, x is an n element vector and A is an n by n symmetric matrix, supplied in packed form.

#### PARAMETERS

UPLO - CHARACTER\*1.

On entry, UPLO specifies whether the upper or lower triangular part of the matrix A is supplied in the packed array AP as follows:

UPLO = 'U' or 'u' The upper triangular part of A is supplied in AP.

UPLO = 'L' or 'l' The lower triangular part of A is supplied in AP.

Unchanged on exit.

N - INTEGER.

On entry, N specifies the order of the matrix A. N

must be at least zero. Unchanged on exit.

ALPHA - DOUBLE PRECISION.

On entry, ALPHA specifies the scalar alpha.  
Unchanged on exit.

X - DOUBLE PRECISION array of dimension at least  
( 1 + ( n - 1 ) \* abs( INCX ) ). Before entry, the  
incremented array X must contain the n element vector  
x. Unchanged on exit.

INCX - INTEGER.

On entry, INCX specifies the increment for the ele-  
ments of X. INCX must not be zero. Unchanged on  
exit.

AP - DOUBLE PRECISION array of DIMENSION at least  
( ( n \* ( n + 1 ) ) / 2 ). Before entry with UPLO = 'U'  
or 'u', the array AP must contain the upper triangu-  
lar part of the symmetric matrix packed sequentially,  
column by column, so that AP( 1 ) contains a( 1, 1 ),  
AP( 2 ) and AP( 3 ) contain a( 1, 2 ) and a( 2, 2 )  
respectively, and so on. On exit, the array AP is  
overwritten by the upper triangular part of the  
updated matrix. Before entry with UPLO = 'L' or 'l',  
the array AP must contain the lower triangular part  
of the symmetric matrix packed sequentially, column  
by column, so that AP( 1 ) contains a( 1, 1 ), AP( 2  
) and AP( 3 ) contain a( 2, 1 ) and a( 3, 1 ) respec-  
tively, and so on. On exit, the array AP is overwrit-  
ten by the lower triangular part of the updated  
matrix.

```

<BLAS 2 dspr>≡
  (let* ((zero 0.0))
    (declare (type (double-float 0.0 0.0) zero))
    (defun dspr (uplo n alpha x incx ap)
      (declare (type (simple-array double-float (*)) ap x)
                (type (double-float) alpha)
                (type fixnum incx n)
                (type character uplo))
      (f2cl-lib:with-multi-array-data
        ((uplo character uplo-%data% uplo-%offset%)
         (x double-float x-%data% x-%offset%)
         (ap double-float ap-%data% ap-%offset%))
        (prog ((i 0) (info 0) (ix 0) (j 0) (jx 0) (k 0) (kk 0) (kx 0) (temp 0.0))
          (declare (type fixnum i info ix j jx k kk kx)
                    (type (double-float) temp))
          (setf info 0)
          (cond
            ((and (not (char-equal uplo #\U)) (not (char-equal uplo #\L)))
              (setf info 1))
            ((< n 0)
              (setf info 2))
            ((= incx 0)
              (setf info 5)))
          (cond
            ((/= info 0)
              (error
               " ** On entry to ~a parameter number ~a had an illegal value~%"
               "DSPR" info)
              (go end_label)))
          (if (or (= n 0) (= alpha zero)) (go end_label))
          (cond
            ((<= incx 0)
              (setf kx
                (f2cl-lib:int-sub 1
                  (f2cl-lib:int-mul (f2cl-lib:int-sub n 1)
                                    incx))))
            ((/= incx 1)
              (setf kx 1)))
          (setf kk 1)
          (cond
            ((char-equal uplo #\U)
              (cond
                ((= incx 1)
                  (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                                (> j n) nil)
                  (tagbody

```

```

(cond
  ((/= (f2cl-lib:fref x (j) ((1 *))) zero)
    (setf temp
      (* alpha
        (f2cl-lib:fref x-%data%
          (j)
          ((1 *))
          x-%offset%)))
    (setf k kk)
    (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
      ((> i j) nil)
      (tagbody
        (setf (f2cl-lib:fref ap-%data%
          (k)
          ((1 *))
          ap-%offset%)
          (+
            (f2cl-lib:fref ap-%data%
              (k)
              ((1 *))
              ap-%offset%)
            (*
              (f2cl-lib:fref x-%data%
                (i)
                ((1 *))
                x-%offset%)
              temp))))
        (setf k (f2cl-lib:int-add k 1))))))
    (setf kk (f2cl-lib:int-add kk j))))
(t
  (setf jx kx)
  (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
    ((> j n) nil)
    (tagbody
      (cond
        ((/= (f2cl-lib:fref x (jx) ((1 *))) zero)
          (setf temp
            (* alpha
              (f2cl-lib:fref x-%data%
                (jx)
                ((1 *))
                x-%offset%)))
          (setf ix kx)
          (f2cl-lib:fdo (k kk (f2cl-lib:int-add k 1))
            ((> k
              (f2cl-lib:int-add kk

```

```

                                j
                                (f2cl-lib:int-sub 1)))
                                nil)
(tagbody
  (setf (f2cl-lib:fref ap-%data%
    (k)
    ((1 *))
    ap-%offset%)
    (+
      (f2cl-lib:fref ap-%data%
        (k)
        ((1 *))
        ap-%offset%)
      (*
        (f2cl-lib:fref x-%data%
          (ix)
          ((1 *))
          x-%offset%)
        temp)))
  (setf ix (f2cl-lib:int-add ix incx))))))
(setf jx (f2cl-lib:int-add jx incx))
(setf kk (f2cl-lib:int-add kk j))))))
(t
  (cond
    ((= incx 1)
      (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
        ((> j n) nil)
        (tagbody
          (cond
            ((/= (f2cl-lib:fref x (j) ((1 *))) zero)
              (setf temp
                (* alpha
                  (f2cl-lib:fref x-%data%
                    (j)
                    ((1 *))
                    x-%offset%)))
              (setf k kk)
              (f2cl-lib:fdo (i j (f2cl-lib:int-add i 1))
                ((> i n) nil)
                (tagbody
                  (setf (f2cl-lib:fref ap-%data%
                    (k)
                    ((1 *))
                    ap-%offset%)
                    (+
                      (f2cl-lib:fref ap-%data%

```

```

(k)
((1 *))
ap-%offset%)

(*
(f2cl-lib:fref x-%data%
(i)
((1 *))
x-%offset%)

temp)))
(setf k (f2cl-lib:int-add k 1))))))
(setf kk
(f2cl-lib:int-add
(f2cl-lib:int-sub (f2cl-lib:int-add kk n) j)
1))))))
(t
(setf jx kx)
(f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
(> j n) nil)
(tagbody
(cond
(/= (f2cl-lib:fref x (jx) ((1 *))) zero)
(setf temp
(* alpha
(f2cl-lib:fref x-%data%
(jx)
((1 *))
x-%offset%)))

(setf ix jx)
(f2cl-lib:fdo (k kk (f2cl-lib:int-add k 1))
(> k
(f2cl-lib:int-add kk
n
(f2cl-lib:int-sub j)))

nil)
(tagbody
(setf (f2cl-lib:fref ap-%data%
(k)
((1 *))
ap-%offset%)

(+
(f2cl-lib:fref ap-%data%
(k)
((1 *))
ap-%offset%)

(*
(f2cl-lib:fref x-%data%

```



```

                                (ix)
                                ((1 *))
                                x-%offset%)
                                temp)))
                                (setf ix (f2cl-lib:int-add ix incx))))))
    (setf jx (f2cl-lib:int-add jx incx))
    (setf kk
      (f2cl-lib:int-add
        (f2cl-lib:int-sub (f2cl-lib:int-add kk n) j)
        1))))))
  end_label
  (return (values nil nil nil nil nil nil))))))

```

## 5.8 dsymv BLAS

```

⟨dsymv.input⟩≡
)set break resume
)sys rm -f dsymv.output
)spool dsymv.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)

```

`<dsymv.help>=`

```
=====
dsymv examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

DSYMV - perform the matrix-vector operation  $y := \alpha * A * x + \beta * y$ ,

#### SYNOPSIS

```
SUBROUTINE DSYMV ( UPLO, N, ALPHA, A, LDA, X, INCX, BETA, Y,
                  INCY )
```

```
      DOUBLE      PRECISION ALPHA, BETA
```

```
      INTEGER      INCX, INCY, LDA, N
```

```
      CHARACTER*1  UPLO
```

```
      DOUBLE      PRECISION A( LDA, * ), X( * ), Y( * )
```

#### PURPOSE

DSYMV performs the matrix-vector operation

where alpha and beta are scalars, x and y are n element vectors and A is an n by n symmetric matrix.

#### PARAMETERS

UPLO - CHARACTER\*1.

On entry, UPLO specifies whether the upper or lower triangular part of the array A is to be referenced as follows:

UPLO = 'U' or 'u' Only the upper triangular part of A is to be referenced.

UPLO = 'L' or 'l' Only the lower triangular part of A is to be referenced.

Unchanged on exit.

N - INTEGER.

On entry, N specifies the order of the matrix A. N must be at least zero. Unchanged on exit.

ALPHA - DOUBLE PRECISION.

On entry, ALPHA specifies the scalar alpha. Unchanged on exit.

A - DOUBLE PRECISION array of DIMENSION ( LDA, n ). Before entry with UPLO = 'U' or 'u', the leading n by n upper triangular part of the array A must contain the upper triangular part of the symmetric matrix and the strictly lower triangular part of A is not referenced. Before entry with UPLO = 'L' or 'l', the leading n by n lower triangular part of the array

A must contain the lower triangular part of the symmetric matrix and the strictly upper triangular part of A is not referenced. Unchanged on exit.

LDA - INTEGER.

On entry, LDA specifies the first dimension of A as declared in the calling (sub) program. LDA must be at least  $\max(1, n)$ . Unchanged on exit.

X - DOUBLE PRECISION array of dimension at least  $(1 + (n - 1) * \text{abs}(\text{INCX}))$ . Before entry, the incremented array X must contain the n element vector x. Unchanged on exit.

INCX - INTEGER.

On entry, INCX specifies the increment for the elements of X. INCX must not be zero. Unchanged on exit.

BETA - DOUBLE PRECISION.

On entry, BETA specifies the scalar beta. When BETA is supplied as zero then Y need not be set on input. Unchanged on exit.

Y - DOUBLE PRECISION array of dimension at least  $(1 + (n - 1) * \text{abs}(\text{INCY}))$ . Before entry, the incremented array Y must contain the n element vector y. On exit, Y is overwritten by the updated vector y.

INCY - INTEGER.

On entry, INCY specifies the increment for the ele-

ments of Y. INCY must not be zero. Unchanged on  
exit.

[illegible]

```

(> incy 0)
(setf ky 1))
(t
  (setf ky
    (f2cl-lib:int-sub 1
      (f2cl-lib:int-mul (f2cl-lib:int-sub n 1)
        incy))))))
(cond
  ((/= beta one)
    (cond
      ((= incy 1)
        (cond
          ((= beta zero)
            (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
              (> i n) nil)
            (tagbody
              (setf (f2cl-lib:fref y-%data% (i) ((1 *)) y-%offset%
                zero))))))
          (t
            (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
              (> i n) nil)
            (tagbody
              (setf (f2cl-lib:fref y-%data% (i) ((1 *)) y-%offset%
                (* beta
                  (f2cl-lib:fref y-%data%
                    (i)
                    ((1 *))
                    y-%offset%))))))))))
      (t
        (setf iy ky)
        (cond
          ((= beta zero)
            (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
              (> i n) nil)
            (tagbody
              (setf (f2cl-lib:fref y-%data% (iy) ((1 *)) y-%offset%
                zero)
                (setf iy (f2cl-lib:int-add iy incy))))))
          (t
            (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
              (> i n) nil)
            (tagbody
              (setf (f2cl-lib:fref y-%data% (iy) ((1 *)) y-%offset%
                (* beta
                  (f2cl-lib:fref y-%data%
                    (iy)

```

```

((1 *))
y-%offset%)))
(setf iy (f2cl-lib:int-add iy incy)))))))))
(if (= alpha zero) (go end_label))
(cond
  ((char-equal uplo #\U)
    (cond
      ((and (= incx 1) (= incy 1))
        (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
          ((> j n) nil)
          (tagbody
            (setf temp1
              (* alpha
                (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%)))
            (setf temp2 zero)
            (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
              ((> i
                (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
                nil)
              (tagbody
                (setf (f2cl-lib:fref y-%data% (i) ((1 *)) y-%offset%)
                  (+
                    (f2cl-lib:fref y-%data% (i) ((1 *)) y-%offset%)
                    (* temp1
                      (f2cl-lib:fref a-%data%
                        (i j)
                        ((1 lda) (1 *))
                        a-%offset%))))
                (setf temp2
                  (+ temp2
                    (*
                      (f2cl-lib:fref a-%data%
                        (i j)
                        ((1 lda) (1 *))
                        a-%offset%)
                      (f2cl-lib:fref x-%data%
                        (i)
                        ((1 *))
                        x-%offset%)))))))
            (setf (f2cl-lib:fref y-%data% (j) ((1 *)) y-%offset%)
              (+ (f2cl-lib:fref y-%data% (j) ((1 *)) y-%offset%)
                (* temp1
                  (f2cl-lib:fref a-%data%
                    (j j)
                    ((1 lda) (1 *))
                    a-%offset%)))))

```

```

(* alpha temp2))))))
(t
  (setf jx kx)
  (setf jy ky)
  (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
    (> j n) nil)
  (tagbody
    (setf temp1
      (* alpha
        (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%)))
    (setf temp2 zero)
    (setf ix kx)
    (setf iy ky)
    (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
      (> i
        (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
      nil)
    (tagbody
      (setf (f2cl-lib:fref y-%data% (iy) ((1 *)) y-%offset%)
        (+
          (f2cl-lib:fref y-%data% (iy) ((1 *)) y-%offset%)
          (* temp1
            (f2cl-lib:fref a-%data%
              (i j)
              ((1 lda) (1 *))
              a-%offset%))))
      (setf temp2
        (+ temp2
          (*
            (f2cl-lib:fref a-%data%
              (i j)
              ((1 lda) (1 *))
              a-%offset%)
            (f2cl-lib:fref x-%data%
              (ix)
              ((1 *))
              x-%offset%))))
      (setf ix (f2cl-lib:int-add ix incx))
      (setf iy (f2cl-lib:int-add iy incy))))
  (setf (f2cl-lib:fref y-%data% (jy) ((1 *)) y-%offset%)
    (+ (f2cl-lib:fref y-%data% (jy) ((1 *)) y-%offset%)
      (* temp1
        (f2cl-lib:fref a-%data%
          (j j)
          ((1 lda) (1 *))
          a-%offset%)))

```



```

(* alpha temp2)))
(setf jx (f2cl-lib:int-add jx incx))
(setf jy (f2cl-lib:int-add jy incy))))))
(t
  (cond
    ((and (= incx 1) (= incy 1))
      (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
        ((> j n) nil)
        (tagbody
          (setf temp1
            (* alpha
              (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%)))
          (setf temp2 zero)
          (setf (f2cl-lib:fref y-%data% (j) ((1 *)) y-%offset%)
            (+ (f2cl-lib:fref y-%data% (j) ((1 *)) y-%offset%)
              (* temp1
                (f2cl-lib:fref a-%data%
                  (j j)
                  ((1 lda) (1 *))
                  a-%offset%))))))
          (f2cl-lib:fdo (i (f2cl-lib:int-add j 1)
            (f2cl-lib:int-add i 1))
              ((> i n) nil)
              (tagbody
                (setf (f2cl-lib:fref y-%data% (i) ((1 *)) y-%offset%)
                  (+
                    (f2cl-lib:fref y-%data% (i) ((1 *)) y-%offset%)
                    (* temp1
                      (f2cl-lib:fref a-%data%
                        (i j)
                        ((1 lda) (1 *))
                        a-%offset%))))))
                (setf temp2
                  (+ temp2
                    (*
                      (f2cl-lib:fref a-%data%
                        (i j)
                        ((1 lda) (1 *))
                        a-%offset%)
                      (f2cl-lib:fref x-%data%
                        (i)
                        ((1 *))
                        x-%offset%))))))
                (setf (f2cl-lib:fref y-%data% (j) ((1 *)) y-%offset%)
                  (+ (f2cl-lib:fref y-%data% (j) ((1 *)) y-%offset%)
                    (* alpha temp2))))))

```

```

(t
  (setf jx kx)
  (setf jy ky)
  (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
    ((> j n) nil)
    (tagbody
      (setf temp1
        (* alpha
          (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%)))
      (setf temp2 zero)
      (setf (f2cl-lib:fref y-%data% (jy) ((1 *)) y-%offset%)
        (+ (f2cl-lib:fref y-%data% (jy) ((1 *)) y-%offset%)
          (* temp1
            (f2cl-lib:fref a-%data%
              (j j)
              ((1 lda) (1 *))
              a-%offset%))))
      (setf ix jx)
      (setf iy jy)
      (f2cl-lib:fdo (i (f2cl-lib:int-add j 1)
        (f2cl-lib:int-add i 1))
        ((> i n) nil)
        (tagbody
          (setf ix (f2cl-lib:int-add ix incx))
          (setf iy (f2cl-lib:int-add iy incy))
          (setf (f2cl-lib:fref y-%data% (iy) ((1 *)) y-%offset%)
            (+
              (f2cl-lib:fref y-%data% (iy) ((1 *)) y-%offset%)
              (* temp1
                (f2cl-lib:fref a-%data%
                  (i j)
                  ((1 lda) (1 *))
                  a-%offset%))))
          (setf temp2
            (+ temp2
              (*
                (f2cl-lib:fref a-%data%
                  (i j)
                  ((1 lda) (1 *))
                  a-%offset%)
                (f2cl-lib:fref x-%data%
                  (ix)
                  ((1 *))
                  x-%offset%))))))
      (setf (f2cl-lib:fref y-%data% (jy) ((1 *)) y-%offset%)
        (+ (f2cl-lib:fref y-%data% (jy) ((1 *)) y-%offset%)
          temp2)))

```

```

                                (* alpha temp2)))
      (setf jx (f2cl-lib:int-add jx incx))
      (setf jy (f2cl-lib:int-add jy incy)))))))))
end_label
  (return (values nil nil nil nil nil nil nil nil nil nil))))))

```

## 5.9 dsyr2 BLAS

```

<dsyr2.input>≡
)set break resume
)sys rm -f dsyr2.output
)spool dsyr2.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)

```

`<dsyr2.help>=`

```
=====
dsyr2 examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

DSYR2 - perform the symmetric rank 2 operation  $A := \alpha * x * y' + \alpha * y * x' + A$ ,

#### SYNOPSIS

```
SUBROUTINE DSYR2 ( UPLO, N, ALPHA, X, INCX, Y, INCY, A, LDA
                  )
```

```
      DOUBLE      PRECISION ALPHA
```

```
      INTEGER      INCX, INCY, LDA, N
```

```
      CHARACTER*1  UPLO
```

```
      DOUBLE      PRECISION A( LDA, * ), X( * ), Y( * )
```

#### PURPOSE

DSYR2 performs the symmetric rank 2 operation

where alpha is a scalar, x and y are n element vectors and A is an n by n symmetric matrix.

#### PARAMETERS

UPLO - CHARACTER\*1.

On entry, UPLO specifies whether the upper or lower triangular part of the array A is to be referenced as follows:

UPLO = 'U' or 'u' Only the upper triangular part of A is to be referenced.

UPLO = 'L' or 'l' Only the lower triangular part of A is to be referenced.

Unchanged on exit.

N - INTEGER.

On entry, N specifies the order of the matrix A. N must be at least zero. Unchanged on exit.

ALPHA - DOUBLE PRECISION.

On entry, ALPHA specifies the scalar alpha. Unchanged on exit.

X - DOUBLE PRECISION array of dimension at least  $(1 + (n - 1) * \text{abs}(\text{INCX}))$ . Before entry, the incremented array X must contain the n element vector x. Unchanged on exit.

INCX - INTEGER.

On entry, INCX specifies the increment for the elements of X. INCX must not be zero. Unchanged on exit.

Y - DOUBLE PRECISION array of dimension at least  $(1 + (n - 1) * \text{abs}(\text{INCY}))$ . Before entry, the incremented array Y must contain the n element vector y. Unchanged on exit.

INCY - INTEGER.

On entry, INCY specifies the increment for the elements of Y. INCY must not be zero. Unchanged on exit.

A - DOUBLE PRECISION array of DIMENSION (LDA, n). Before entry with UPLO = 'U' or 'u', the leading n by n upper triangular part of the array A must contain the upper triangular part of the symmetric matrix and the strictly lower triangular part of A is not referenced. On exit, the upper triangular part of the array A is overwritten by the upper triangular part of the updated matrix. Before entry with UPLO = 'L' or 'l', the leading n by n lower triangular part of the array A must contain the lower triangular part of the symmetric matrix and the strictly upper triangular part of A is not referenced. On exit, the lower triangular part of the array A is overwritten by the lower triangular part of the updated matrix.

LDA - INTEGER.

On entry, LDA specifies the first dimension of A as declared in the calling (sub) program. LDA must be at

least `max( 1, n )`. Unchanged on exit.

```

<BLAS 2 dsyr2>≡
  (let* ((zero 0.0))
    (declare (type (double-float 0.0 0.0) zero))
    (defun dsyr2 (uplo n alpha x incx y incy a lda)
      (declare (type (simple-array double-float (*)) a y x)
                (type (double-float) alpha)
                (type fixnum lda incy incx n)
                (type character uplo))
      (f2cl-lib:with-multi-array-data
        ((uplo character uplo-%data% uplo-%offset%)
         (x double-float x-%data% x-%offset%)
         (y double-float y-%data% y-%offset%)
         (a double-float a-%data% a-%offset%))
        (prog ((i 0) (info 0) (ix 0) (iy 0) (j 0) (jx 0) (jy 0) (kx 0) (ky 0)
              (temp1 0.0) (temp2 0.0))
          (declare (type fixnum i info ix iy j jx jy kx ky)
                    (type (double-float) temp1 temp2))
          (setf info 0)
          (cond
            ((and (not (char-equal uplo #\U)) (not (char-equal uplo #\L)))
             (setf info 1))
            ((< n 0)
             (setf info 2))
            ((= incx 0)
             (setf info 5))
            ((= incy 0)
             (setf info 7))
            ((< lda (max (the fixnum 1) (the fixnum n)))
             (setf info 9)))
          (cond
            ((/= info 0)
             (error
              " ** On entry to ~a parameter number ~a had an illegal value~%"
              "DSYR2" info)
             (go end_label)))
          (if (or (= n 0) (= alpha zero)) (go end_label))
          (cond
            ((or (/= incx 1) (/= incy 1))
             (cond
               ((> incx 0)
                (setf kx 1))
               (t
                (setf kx
                  (f2cl-lib:int-sub 1
                    (f2cl-lib:int-mul
                     (f2cl-lib:int-sub n 1)

```

```

incx))))))
(cond
  (> incy 0)
  (setf ky 1))
(t
  (setf ky
    (f2cl-lib:int-sub 1
      (f2cl-lib:int-mul
        (f2cl-lib:int-sub n 1)
        incy))))))
(setf jx kx)
(setf jy ky))
(cond
  ((char-equal uplo #\U)
    (cond
      ((and (= incx 1) (= incy 1))
        (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
          (> j n) nil)
        (tagbody
          (cond
            ((or (/= (f2cl-lib:fref x (j) ((1 *))) zero)
              (/= (f2cl-lib:fref y (j) ((1 *))) zero))
              (setf temp1
                (* alpha
                  (f2cl-lib:fref y-%data%
                    (j)
                    ((1 *))
                    y-%offset%)))
                (setf temp2
                  (* alpha
                    (f2cl-lib:fref x-%data%
                      (j)
                      ((1 *))
                      x-%offset%)))
                (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                  (> i j) nil)
                (tagbody
                  (setf (f2cl-lib:fref a-%data%
                    (i j)
                    ((1 lda) (1 *))
                    a-%offset%)
                    (+
                      (f2cl-lib:fref a-%data%
                        (i j)
                        ((1 lda) (1 *))
                        a-%offset%)

```



```

(*
  (f2cl-lib:fref x-%data%
                (i)
                ((1 *))
                x-%offset%)

  temp1)
(*
  (f2cl-lib:fref y-%data%
                (i)
                ((1 *))
                y-%offset%)

  temp2)))))))))
(t
  (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                (> j n) nil)
  (tagbody
    (cond
      ((or (/= (f2cl-lib:fref x (jx) ((1 *))) zero)
            (/= (f2cl-lib:fref y (jy) ((1 *))) zero))
        (setf temp1
              (* alpha
                (f2cl-lib:fref y-%data%
                              (jy)
                              ((1 *))
                              y-%offset%)))
        (setf temp2
              (* alpha
                (f2cl-lib:fref x-%data%
                              (jx)
                              ((1 *))
                              x-%offset%)))
        (setf ix kx)
        (setf iy ky)
        (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                      (> i j) nil)
        (tagbody
          (setf (f2cl-lib:fref a-%data%
                              (i j)
                              ((1 lda) (1 *))
                              a-%offset%)
                (+
                  (f2cl-lib:fref a-%data%
                              (i j)
                              ((1 lda) (1 *))
                              a-%offset%)

```

```

(f2cl-lib:fref x-%data%
  (ix)
  ((1 *))
  x-%offset%)

temp1)
(*
  (f2cl-lib:fref y-%data%
    (iy)
    ((1 *))
    y-%offset%)
    temp2)))
(setf ix (f2cl-lib:int-add ix incx))
(setf iy (f2cl-lib:int-add iy incy))))))
(setf jx (f2cl-lib:int-add jx incx))
(setf jy (f2cl-lib:int-add jy incy))))))
(t
  (cond
    ((and (= incx 1) (= incy 1))
      (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
        (> j n) nil)
      (tagbody
        (cond
          ((or (/= (f2cl-lib:fref x (j) ((1 *))) zero)
                (/= (f2cl-lib:fref y (j) ((1 *))) zero))
            (setf temp1
              (* alpha
                (f2cl-lib:fref y-%data%
                  (j)
                  ((1 *))
                  y-%offset%)))
            (setf temp2
              (* alpha
                (f2cl-lib:fref x-%data%
                  (j)
                  ((1 *))
                  x-%offset%)))
            (f2cl-lib:fdo (i j (f2cl-lib:int-add i 1))
              (> i n) nil)
            (tagbody
              (setf (f2cl-lib:fref a-%data%
                (i j)
                ((1 lda) (1 *))
                a-%offset%)
                (+
                  (f2cl-lib:fref a-%data%
                    (i j)

```

```

((1 lda) (1 *))
a-%offset%)

(*
(f2cl-lib:fref x-%data%
(i)
((1 *))
x-%offset%)

temp1)
(*
(f2cl-lib:fref y-%data%
(i)
((1 *))
y-%offset%)

temp2))))))))))

(t
(f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
(> j n) nil)

(tagbody
(cond
((or (/= (f2cl-lib:fref x (jx) ((1 *))) zero)
(/= (f2cl-lib:fref y (jy) ((1 *))) zero))
(setf temp1
(* alpha
(f2cl-lib:fref y-%data%
(jy)
((1 *))
y-%offset%)))

(setf temp2
(* alpha
(f2cl-lib:fref x-%data%
(jx)
((1 *))
x-%offset%)))

(setf ix jx)
(setf iy jy)
(f2cl-lib:fdo (i j (f2cl-lib:int-add i 1))
(> i n) nil)

(tagbody
(setf (f2cl-lib:fref a-%data%
(i j)
((1 lda) (1 *))
a-%offset%)

(+
(f2cl-lib:fref a-%data%
(i j)
((1 lda) (1 *))

```

```

                                a-%offset%)
      (*
      (f2cl-lib:fref x-%data%
                    (ix)
                    ((1 *))
                    x-%offset%)

      temp1)
      (*
      (f2cl-lib:fref y-%data%
                    (iy)
                    ((1 *))
                    y-%offset%)

      temp2)))
      (setf ix (f2cl-lib:int-add ix incx))
      (setf iy (f2cl-lib:int-add iy incy))))))
      (setf jx (f2cl-lib:int-add jx incx))
      (setf jy (f2cl-lib:int-add jy incy))))))
end_label
      (return (values nil nil nil nil nil nil nil nil nil))))

```

## 5.10 dsyr BLAS

```

<dsyr.input>≡
)set break resume
)sys rm -f dsyr.output
)spool dsyr.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)

```

`<dsyr.help>`≡

```
=====
dsyr examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

DSYR - perform the symmetric rank 1 operation  $A := \alpha * x * x' + A$ ,

#### SYNOPSIS

SUBROUTINE DSYR ( UPLO, N, ALPHA, X, INCX, A, LDA )

DOUBLE PRECISION ALPHA

INTEGER INCX, LDA, N

CHARACTER\*1 UPLO

DOUBLE PRECISION A( LDA, \* ), X( \* )

#### PURPOSE

DSYR performs the symmetric rank 1 operation

where alpha is a real scalar, x is an n element vector and A is an n by n symmetric matrix.

#### PARAMETERS

UPLO - CHARACTER\*1.

On entry, UPLO specifies whether the upper or lower triangular part of the array A is to be referenced as follows:

UPLO = 'U' or 'u' Only the upper triangular part of A is to be referenced.

UPLO = 'L' or 'l' Only the lower triangular part of A is to be referenced.

Unchanged on exit.

N - INTEGER.

On entry, N specifies the order of the matrix A. N

must be at least zero. Unchanged on exit.

ALPHA - DOUBLE PRECISION.

On entry, ALPHA specifies the scalar alpha.  
Unchanged on exit.

X - DOUBLE PRECISION array of dimension at least  
( 1 + ( n - 1 ) \* abs( INCX ) ). Before entry, the  
incremented array X must contain the n element vector  
x. Unchanged on exit.

INCX - INTEGER.

On entry, INCX specifies the increment for the ele-  
ments of X. INCX must not be zero. Unchanged on  
exit.

A - DOUBLE PRECISION array of DIMENSION ( LDA, n ).  
Before entry with UPLO = 'U' or 'u', the leading n  
by n upper triangular part of the array A must con-  
tain the upper triangular part of the symmetric  
matrix and the strictly lower triangular part of A is  
not referenced. On exit, the upper triangular part of  
the array A is overwritten by the upper triangular  
part of the updated matrix. Before entry with UPLO =  
'L' or 'l', the leading n by n lower triangular part  
of the array A must contain the lower triangular part  
of the symmetric matrix and the strictly upper tri-  
angular part of A is not referenced. On exit, the  
lower triangular part of the array A is overwritten  
by the lower triangular part of the updated matrix.

LDA - INTEGER.

On entry, LDA specifies the first dimension of A as  
declared in the calling (sub) program. LDA must be at  
least max( 1, n ). Unchanged on exit.

```

<BLAS 2 dsyr>≡
  (let* ((zero 0.0))
    (declare (type (double-float 0.0 0.0) zero))
    (defun dsyr (uplo n alpha x incx a lda)
      (declare (type (simple-array double-float (*)) a x)
                (type (double-float) alpha)
                (type fixnum lda incx n)
                (type character uplo))
      (f2cl-lib:with-multi-array-data
        ((uplo character uplo-%data% uplo-%offset%)
         (x double-float x-%data% x-%offset%)
         (a double-float a-%data% a-%offset%))
        (prog ((i 0) (info 0) (ix 0) (j 0) (jx 0) (kx 0) (temp 0.0))
          (declare (type fixnum i info ix j jx kx)
                    (type (double-float) temp))
          (setf info 0)
          (cond
            ((and (not (char-equal uplo #\U)) (not (char-equal uplo #\L)))
              (setf info 1))
            ((< n 0)
              (setf info 2))
            ((= incx 0)
              (setf info 5))
            ((< lda (max (the fixnum 1) (the fixnum n)))
              (setf info 7)))
          (cond
            ((/= info 0)
              (error
               " ** On entry to ~a parameter number ~a had an illegal value~%"
               "DSYR" info)
              (go end_label)))
          (if (or (= n 0) (= alpha zero)) (go end_label))
          (cond
            ((<= incx 0)
              (setf kx
                (f2cl-lib:int-sub 1
                  (f2cl-lib:int-mul (f2cl-lib:int-sub n 1)
                                    incx))))
            ((/= incx 1)
              (setf kx 1)))
          (cond
            ((char-equal uplo #\U)
              (cond
                ((= incx 1)
                  (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                                (> j n) nil)

```

```

(tagbody
  (cond
    ((/= (f2cl-lib:fref x (j) ((1 *))) zero)
      (setf temp
        (* alpha
          (f2cl-lib:fref x-%data%
            (j)
            ((1 *))
            x-%offset%)))
      (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
        ((> i j) nil)
        (tagbody
          (setf (f2cl-lib:fref a-%data%
            (i j)
            ((1 lda) (1 *))
            a-%offset%)
            (+
              (f2cl-lib:fref a-%data%
                (i j)
                ((1 lda) (1 *))
                a-%offset%)
              (*
                (f2cl-lib:fref x-%data%
                  (i)
                  ((1 *))
                  x-%offset%)
                temp)))))))))
(t
  (setf jx kx)
  (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
    ((> j n) nil)
    (tagbody
      (cond
        ((/= (f2cl-lib:fref x (jx) ((1 *))) zero)
          (setf temp
            (* alpha
              (f2cl-lib:fref x-%data%
                (jx)
                ((1 *))
                x-%offset%)))
          (setf ix kx)
          (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
            ((> i j) nil)
            (tagbody
              (setf (f2cl-lib:fref a-%data%
                (i j)
                ((1 lda) (1 *))
                a-%offset%)
                (+
                  (f2cl-lib:fref a-%data%
                    (i j)
                    ((1 lda) (1 *))
                    a-%offset%)
                  (*
                    (f2cl-lib:fref x-%data%
                      (i)
                      ((1 *))
                      x-%offset%)
                    temp)))))))))

```



```

((1 lda) (1 *))
a-%offset%)

(+
  (f2cl-lib:fref a-%data%
    (i j)
    ((1 lda) (1 *))
    a-%offset%)

  (*
    (f2cl-lib:fref x-%data%
      (ix)
      ((1 *))
      x-%offset%)

    temp)))
(setf ix (f2cl-lib:int-add ix incx))))))
(setf jx (f2cl-lib:int-add jx incx))))))

(t
  (cond
    ((= incx 1)
      (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
        ((> j n) nil)
        (tagbody
          (cond
            ((/= (f2cl-lib:fref x (j) ((1 *))) zero)
              (setf temp
                (* alpha
                  (f2cl-lib:fref x-%data%
                    (j)
                    ((1 *))
                    x-%offset%)))
              (f2cl-lib:fdo (i j (f2cl-lib:int-add i 1))
                ((> i n) nil)
                (tagbody
                  (setf (f2cl-lib:fref a-%data%
                    (i j)
                    ((1 lda) (1 *))
                    a-%offset%)

                    (+
                      (f2cl-lib:fref a-%data%
                        (i j)
                        ((1 lda) (1 *))
                        a-%offset%)

                      (*
                        (f2cl-lib:fref x-%data%
                          (i)
                          ((1 *))
                          x-%offset%)

```

```

                                temp))))))))))
(t
  (setf jx kx)
  (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
    ((> j n) nil)
    (tagbody
      (cond
        ((/= (f2cl-lib:fref x (jx) ((1 *))) zero)
          (setf temp
            (* alpha
              (f2cl-lib:fref x-%data%
                            (jx)
                            ((1 *))
                            x-%offset%)))
          (setf ix jx)
          (f2cl-lib:fdo (i j (f2cl-lib:int-add i 1))
            ((> i n) nil)
            (tagbody
              (setf (f2cl-lib:fref a-%data%
                                  (i j)
                                  ((1 lda) (1 *))
                                  a-%offset%)
                (+
                  (f2cl-lib:fref a-%data%
                                  (i j)
                                  ((1 lda) (1 *))
                                  a-%offset%)
                  (*
                    (f2cl-lib:fref x-%data%
                                    (ix)
                                    ((1 *))
                                    x-%offset%)
                    temp))))
              (setf ix (f2cl-lib:int-add ix incx))))))
          (setf jx (f2cl-lib:int-add jx incx))))))
end_label
  (return (values nil nil nil nil nil nil nil))))))

```

## 5.11 dtbmv BLAS

```
<dtbmv.input>≡  
  )set break resume  
  )sys rm -f dtbmv.output  
  )spool dtbmv.output  
  )set message test on  
  )set message auto off  
  )clear all  
  
  )spool  
  )lisp (bye)
```

`<dtbm.v.help>`≡

```
=====
dtbm.v examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

DTBMV - perform one of the matrix-vector operations  $x := A*x$ , or  $x := A'*x$ ,

#### SYNOPSIS

```
SUBROUTINE DTBMV ( UPLO, TRANS, DIAG, N, K, A, LDA, X, INCX
                  )
```

INTEGER INCX, K, LDA, N

CHARACTER\*1 DIAG, TRANS, UPLO

DOUBLE PRECISION A( LDA, \* ), X( \* )

#### PURPOSE

DTBMV performs one of the matrix-vector operations

where  $x$  is an  $n$  element vector and  $A$  is an  $n$  by  $n$  unit, or non-unit, upper or lower triangular band matrix, with  $(k + 1)$  diagonals.

#### PARAMETERS

UPLO - CHARACTER\*1.

On entry, UPLO specifies whether the matrix is an upper or lower triangular matrix as follows:

UPLO = 'U' or 'u' A is an upper triangular matrix.

UPLO = 'L' or 'l' A is a lower triangular matrix.

Unchanged on exit.

TRANS - CHARACTER\*1.

On entry, TRANS specifies the operation to be performed as follows:

TRANS = 'N' or 'n'  $x := A*x$ .

TRANS = 'T' or 't'    x := A'\*x.

TRANS = 'C' or 'c'    x := A'\*x.

Unchanged on exit.

DIAG - CHARACTER\*1.

On entry, DIAG specifies whether or not A is unit triangular as follows:

DIAG = 'U' or 'u'    A is assumed to be unit triangular.

DIAG = 'N' or 'n'    A is not assumed to be unit triangular.

Unchanged on exit.

N - INTEGER.

On entry, N specifies the order of the matrix A. N must be at least zero. Unchanged on exit.

K - INTEGER.

On entry with UPLO = 'U' or 'u', K specifies the number of super-diagonals of the matrix A. On entry with UPLO = 'L' or 'l', K specifies the number of sub-diagonals of the matrix A. K must satisfy 0 .le. K. Unchanged on exit.

A - DOUBLE PRECISION array of DIMENSION ( LDA, n ).  
Before entry with UPLO = 'U' or 'u', the leading ( k + 1 ) by n part of the array A must contain the upper triangular band part of the matrix of coefficients, supplied column by column, with the leading diagonal of the matrix in row ( k + 1 ) of the array, the first super-diagonal starting at position 2 in row k, and so on. The top left k by k triangle of the array A is not referenced. The following program segment will transfer an upper triangular band matrix from conventional full matrix storage to band storage:

```
DO 20, J = 1, N M = K + 1 - J DO 10, I = MAX( 1, J -
K ), J A( M + I, J ) = matrix( I, J ) 10    CONTINUE
20 CONTINUE
```

Before entry with UPLO = 'L' or 'l', the leading ( k + 1 ) by n part of the array A must contain the lower triangular band part of the matrix of coefficients, supplied column by column, with the leading diagonal of the matrix in row 1 of the array, the first sub-diagonal starting at position 1 in row 2, and so on. The bottom right k by k triangle of the array A is not referenced. The following program segment will transfer a lower triangular band matrix from conventional full matrix storage to band storage:

```
DO 20, J = 1, N
  M = 1 - J
  DO 10, I = J, MIN( N, J + K )
    A( M + I, J ) = matrix( I, J )
  10 CONTINUE
20 CONTINUE
```

Note that when DIAG = 'U' or 'u' the elements of the array A corresponding to the diagonal elements of the matrix are not referenced, but are assumed to be unity. Unchanged on exit.

LDA - INTEGER.

On entry, LDA specifies the first dimension of A as declared in the calling (sub) program. LDA must be at least ( k + 1 ). Unchanged on exit.

X - DOUBLE PRECISION array of dimension at least ( 1 + ( n - 1 ) \* abs( INCX ) ). Before entry, the incremented array X must contain the n element vector x. On exit, X is overwritten with the transformed vector x.

INCX - INTEGER.

On entry, INCX specifies the increment for the elements of X. INCX must not be zero. Unchanged on exit.

```

<BLAS 2 dtbm>≡
  (let* ((zero 0.0))
    (declare (type (double-float 0.0 0.0) zero))
    (defun dtbm (uplo trans diag n k a lda x incx)
      (declare (type (simple-array double-float (*)) x a)
        (type fixnum incx lda k n)
        (type character diag trans uplo))
      (f2cl-lib:with-multi-array-data
        ((uplo character uplo-%data% uplo-%offset%)
         (trans character trans-%data% trans-%offset%)
         (diag character diag-%data% diag-%offset%)
         (a double-float a-%data% a-%offset%)
         (x double-float x-%data% x-%offset%))
        (prog ((nunit nil) (i 0) (info 0) (ix 0) (j 0) (jx 0) (kplus1 0) (kx 0)
              (l 0) (temp 0.0))
          (declare (type (member t nil) nunit)
            (type fixnum i info ix j jx kplus1 kx l)
            (type (double-float) temp))
          (setf info 0)
          (cond
            ((and (not (char-equal uplo #\U)) (not (char-equal uplo #\L)))
              (setf info 1))
            ((and (not (char-equal trans #\N))
              (not (char-equal trans #\T))
              (not (char-equal trans #\C)))
              (setf info 2))
            ((and (not (char-equal diag #\U)) (not (char-equal diag #\N)))
              (setf info 3))
            ((< n 0)
              (setf info 4))
            ((< k 0)
              (setf info 5))
            ((< lda (f2cl-lib:int-add k 1))
              (setf info 7))
            ((= incx 0)
              (setf info 9)))
          (cond
            ((/= info 0)
              (error
                " ** On entry to ~a parameter number ~a had an illegal value~%"
                "DTBMV" info)
              (go end_label)))
          (if (= n 0) (go end_label))
          (setf nunit (char-equal diag #\N))
          (cond
            ((<= incx 0)

```

```

(setf kx
  (f2cl-lib:int-sub 1
    (f2cl-lib:int-mul (f2cl-lib:int-sub n 1)
      incx)))

( (/= incx 1)
  (setf kx 1)))
(cond
  ((char-equal trans #\N)
    (cond
      ((char-equal uplo #\U)
        (setf kplus1 (f2cl-lib:int-add k 1))
        (cond
          ((= incx 1)
            (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
              (> j n) nil)
            (tagbody
              (cond
                ((/= (f2cl-lib:fref x (j) ((1 *))) zero)
                  (setf temp
                    (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%))
                  (setf l (f2cl-lib:int-sub kplus1 j))
                  (f2cl-lib:fdo (i
                    (max (the fixnum 1)
                      (the fixnum
                        (f2cl-lib:int-add j
                          (f2cl-lib:int-sub
                            k))))
                      (f2cl-lib:int-add i 1))
                    (> i
                      (f2cl-lib:int-add j
                        (f2cl-lib:int-sub
                          1))))
                    nil)
                (tagbody
                  (setf (f2cl-lib:fref x-%data%
                    (i)
                    ((1 *))
                    x-%offset%)
                      (+
                        (f2cl-lib:fref x-%data%
                          (i)
                          ((1 *))
                          x-%offset%)
                        (* temp
                          (f2cl-lib:fref a-%data%
                            ((f2cl-lib:int-add l i)

```



```

                                j)
                                ((1 lda) (1 *))
                                a-%offset%))))))
(if nunit
  (setf (f2cl-lib:fref x-%data%
    (j)
    ((1 *))
    x-%offset%)
    (*
      (f2cl-lib:fref x-%data%
        (j)
        ((1 *))
        x-%offset%)
      (f2cl-lib:fref a-%data%
        (kplus1 j)
        ((1 lda) (1 *))
        a-%offset%)))))))))
(t
  (setf jx kx)
  (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
    ((> j n) nil)
    (tagbody
      (cond
        ((/= (f2cl-lib:fref x (jx) ((1 *))) zero)
          (setf temp
            (f2cl-lib:fref x-%data%
              (jx)
              ((1 *))
              x-%offset%))
          (setf ix kx)
          (setf l (f2cl-lib:int-sub kplus1 j))
          (f2cl-lib:fdo (i
            (max (the fixnum 1)
              (the fixnum
                (f2cl-lib:int-add j
                  (f2cl-lib:int-
                    (f2cl-lib:int-
                      k))))))
              (f2cl-lib:int-add i 1))
            ((> i
              (f2cl-lib:int-add j
                (f2cl-lib:int-sub
                  1))))
              nil)
          (tagbody
            (setf (f2cl-lib:fref x-%data%
              (ix)

```

```

((1 *))
x-%offset%)
(+
  (f2cl-lib:fref x-%data%
    (ix)
    ((1 *))
    x-%offset%)
  (* temp
    (f2cl-lib:fref a-%data%
      ((f2cl-lib:int-add 1 i)
      j)
      ((1 lda) (1 *))
      a-%offset%))))
  (setf ix (f2cl-lib:int-add ix incx)))
(if nunit
  (setf (f2cl-lib:fref x-%data%
    (jx)
    ((1 *))
    x-%offset%)
    (*
      (f2cl-lib:fref x-%data%
        (jx)
        ((1 *))
        x-%offset%)
      (f2cl-lib:fref a-%data%
        (kplus1 j)
        ((1 lda) (1 *))
        a-%offset%))))))
  (setf jx (f2cl-lib:int-add jx incx))
  (if (> j k) (setf kx (f2cl-lib:int-add kx incx))))))
(t
  (cond
    ((= incx 1)
      (f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
        ((> j 1) nil)
      (tagbody
        (cond
          ((/= (f2cl-lib:fref x (j) ((1 *))) zero)
            (setf temp
              (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%))
            (setf l (f2cl-lib:int-sub 1 j))
            (f2cl-lib:fdo (i
              (min (the fixnum n)
                (the fixnum
                  (f2cl-lib:int-add j k)))
              (f2cl-lib:int-add i

```

```

                                (f2cl-lib:int-sub 1)))
                                ((> i (f2cl-lib:int-add j 1)) nil)
(tagbody
  (setf (f2cl-lib:fref x-%data%
                      (i)
                      ((1 *))
                      x-%offset%)
    (+
      (f2cl-lib:fref x-%data%
                    (i)
                    ((1 *))
                    x-%offset%)
      (* temp
        (f2cl-lib:fref a-%data%
                      ((f2cl-lib:int-add 1 i)
                       j)
                      ((1 lda) (1 *))
                      a-%offset%))))))
(if nunit
  (setf (f2cl-lib:fref x-%data%
                      (j)
                      ((1 *))
                      x-%offset%)
    (*
      (f2cl-lib:fref x-%data%
                    (j)
                    ((1 *))
                    x-%offset%)
      (f2cl-lib:fref a-%data%
                    (1 j)
                    ((1 lda) (1 *))
                    a-%offset%))))))
(t
  (setf kx
    (f2cl-lib:int-add kx
      (f2cl-lib:int-mul
        (f2cl-lib:int-sub n 1)
        incx)))
  (setf jx kx)
  (f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
    ((> j 1) nil)
    (tagbody
      (cond
        ((/= (f2cl-lib:fref x (jx) ((1 *))) zero)
          (setf temp
            (f2cl-lib:fref x-%data%

```

```

                                (jx)
                                ((1 *))
                                x-%offset%)
(setf ix kx)
(setf l (f2cl-lib:int-sub 1 j))
(f2cl-lib:fdo (i
              (min (the fixnum n)
                    (the fixnum
                      (f2cl-lib:int-add j k)))
              (f2cl-lib:int-add i
                                (f2cl-lib:int-sub 1)))
              ((> i (f2cl-lib:int-add j 1)) nil)
  (tagbody
    (setf (f2cl-lib:fref x-%data%
                        (ix)
                        ((1 *))
                        x-%offset%)
          (+
            (f2cl-lib:fref x-%data%
                          (ix)
                          ((1 *))
                          x-%offset%)
            (* temp
              (f2cl-lib:fref a-%data%
                            ((f2cl-lib:int-add 1 i)
                             j)
                            ((1 lda) (1 *))
                            a-%offset%))))
    (setf ix (f2cl-lib:int-sub ix incx)))
  (if nount
    (setf (f2cl-lib:fref x-%data%
                        (jx)
                        ((1 *))
                        x-%offset%)
          (*
            (f2cl-lib:fref x-%data%
                          (jx)
                          ((1 *))
                          x-%offset%)
            (f2cl-lib:fref a-%data%
                          (1 j)
                          ((1 lda) (1 *))
                          a-%offset%))))))
  (setf jx (f2cl-lib:int-sub jx incx))
  (if (>= (f2cl-lib:int-sub n j) k)
    (setf kx (f2cl-lib:int-sub kx incx))))))

```

```

(t
  (cond
    ((char-equal upto #\U)
      (setf kplus1 (f2cl-lib:int-add k 1))
      (cond
        ((= incx 1)
          (f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
            ((> j 1) nil)
            (tagbody
              (setf temp
                (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%))
              (setf l (f2cl-lib:int-sub kplus1 j))
              (if nunit
                (setf temp
                  (* temp
                     (f2cl-lib:fref a-%data%
                                   (kplus1 j)
                                   ((1 lda) (1 *))
                                   a-%offset%))))
                (f2cl-lib:fdo (i (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
                  (f2cl-lib:int-add i (f2cl-lib:int-sub 1)))
                  ((> i
                     (max (the fixnum 1)
                          (the fixnum
                           (f2cl-lib:int-add j
                                                (f2cl-lib:int-
                                                  k))))))
                    nil)
              (tagbody
                (setf temp
                  (+ temp
                     (*
                      (f2cl-lib:fref a-%data%
                                    ((f2cl-lib:int-add 1 i) j)
                                    ((1 lda) (1 *))
                                    a-%offset%)
                      (f2cl-lib:fref x-%data%
                                    (i)
                                    ((1 *))
                                    x-%offset%))))))
                (setf (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%)
                  temp))))
          (t
            (setf kx
              (f2cl-lib:int-add kx
                (f2cl-lib:int-mul

```

```

                                (f2cl-lib:int-sub n 1)
                                incx)))
(setf jx kx)
(f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
              (> j 1) nil)
(tagbody
  (setf temp
    (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%))
  (setf kx (f2cl-lib:int-sub kx incx))
  (setf ix kx)
  (setf l (f2cl-lib:int-sub kplus1 j))
  (if nunit
    (setf temp
      (* temp
        (f2cl-lib:fref a-%data%
                        (kplus1 j)
                        ((1 lda) (1 *))
                        a-%offset%))))
    (f2cl-lib:fdo (i (f2cl-lib:int-add j (f2cl-lib:int-sub 1))
                  (f2cl-lib:int-add i (f2cl-lib:int-sub 1)))
                  (> i
                    (max (the fixnum 1)
                         (the fixnum
                          (f2cl-lib:int-add j
                                                (f2cl-lib:int-sub
                                                  k))))))
                    nil)
    (tagbody
      (setf temp
        (+ temp
          (*
            (f2cl-lib:fref a-%data%
                          ((f2cl-lib:int-add l i) j)
                          ((1 lda) (1 *))
                          a-%offset%)
            (f2cl-lib:fref x-%data%
                          (ix)
                          ((1 *))
                          x-%offset%))))
          (setf ix (f2cl-lib:int-sub ix incx))))
      (setf (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%)
            temp)
      (setf jx (f2cl-lib:int-sub jx incx))))))
(t
  (cond
    ((= incx 1)

```

```

(f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
  (> j n) nil)
(tagbody
  (setf temp
    (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%))
  (setf l (f2cl-lib:int-sub 1 j))
  (if nunit
    (setf temp
      (* temp
        (f2cl-lib:fref a-%data%
          (1 j)
          ((1 lda) (1 *))
          a-%offset%))))
    (f2cl-lib:fdo (i (f2cl-lib:int-add j 1)
      (f2cl-lib:int-add i 1))
      (> i
        (min (the fixnum n)
          (the fixnum
            (f2cl-lib:int-add j k))))
      nil)
    (tagbody
      (setf temp
        (+ temp
          (*
            (f2cl-lib:fref a-%data%
              ((f2cl-lib:int-add 1 i) j)
              ((1 lda) (1 *))
              a-%offset%)
            (f2cl-lib:fref x-%data%
              (i)
              ((1 *))
              x-%offset%))))))
      (setf (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%)
        temp))))
(t
  (setf jx kx)
  (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
    (> j n) nil)
  (tagbody
    (setf temp
      (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%))
    (setf kx (f2cl-lib:int-add kx incx))
    (setf ix kx)
    (setf l (f2cl-lib:int-sub 1 j))
    (if nunit
      (setf temp

```

```

(* temp
  (f2cl-lib:fref a-%data%
    (1 j)
    ((1 lda) (1 *))
    a-%offset%)))
(f2cl-lib:fdo (i (f2cl-lib:int-add j 1)
  (f2cl-lib:int-add i 1))
  (> i
    (min (the fixnum n)
      (the fixnum
        (f2cl-lib:int-add j k))))
    nil)
(tagbody
  (setf temp
    (+ temp
      (*
        (f2cl-lib:fref a-%data%
          ((f2cl-lib:int-add 1 i) j)
          ((1 lda) (1 *))
          a-%offset%)
        (f2cl-lib:fref x-%data%
          (ix)
          ((1 *))
          x-%offset%))))
      (setf ix (f2cl-lib:int-add ix incx))))
  (setf (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%)
    temp)
  (setf jx (f2cl-lib:int-add jx incx))))))
end_label
  (return (values nil nil nil nil nil nil nil nil))))

```

## 5.12 dtbsv BLAS

```

<dtbsv.input>≡
)set break resume
)sys rm -f dtbsv.output
)spool dtbsv.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)

```



`<dtbsv.help>=`

```
=====
dtbsv examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

DTBSV - solve one of the systems of equations  $Ax = b$ , or  $A'x = b$ ,

#### SYNOPSIS

```
SUBROUTINE DTBSV ( UPLO, TRANS, DIAG, N, K, A, LDA, X, INCX
                  )
```

INTEGER INCX, K, LDA, N

CHARACTER\*1 DIAG, TRANS, UPLO

DOUBLE PRECISION A( LDA, \* ), X( \* )

#### PURPOSE

DTBSV solves one of the systems of equations

where b and x are n element vectors and A is an n by n unit, or non-unit, upper or lower triangular band matrix, with ( k + 1 ) diagonals.

No test for singularity or near-singularity is included in this routine. Such tests must be performed before calling this routine.

#### PARAMETERS

UPLO - CHARACTER\*1.

On entry, UPLO specifies whether the matrix is an upper or lower triangular matrix as follows:

UPLO = 'U' or 'u' A is an upper triangular matrix.

UPLO = 'L' or 'l' A is a lower triangular matrix.

Unchanged on exit.

TRANS - CHARACTER\*1.

On entry, TRANS specifies the equations to be solved as follows:

TRANS = 'N' or 'n'     $A*x = b$ .

TRANS = 'T' or 't'     $A'*x = b$ .

TRANS = 'C' or 'c'     $A'*x = b$ .

Unchanged on exit.

DIAG - CHARACTER\*1.

On entry, DIAG specifies whether or not A is unit triangular as follows:

DIAG = 'U' or 'u'    A is assumed to be unit triangular.

DIAG = 'N' or 'n'    A is not assumed to be unit triangular.

Unchanged on exit.

N - INTEGER.

On entry, N specifies the order of the matrix A. N must be at least zero. Unchanged on exit.

K - INTEGER.

On entry with UPLO = 'U' or 'u', K specifies the number of super-diagonals of the matrix A. On entry with UPLO = 'L' or 'l', K specifies the number of sub-diagonals of the matrix A. K must satisfy  $0 \leq K$ . Unchanged on exit.

A - DOUBLE PRECISION array of DIMENSION ( LDA, n ).  
Before entry with UPLO = 'U' or 'u', the leading ( k + 1 ) by n part of the array A must contain the upper triangular band part of the matrix of coefficients, supplied column by column, with the leading diagonal of the matrix in row ( k + 1 ) of the array, the first super-diagonal starting at position 2 in row k, and so on. The top left k by k triangle of the array A is not referenced. The following program segment will transfer an upper triangular band matrix from conventional full matrix storage to band storage:

```

DO 20, J = 1, N M = K + 1 - J DO 10, I = MAX( 1, J -
K ), J A( M + I, J ) = matrix( I, J ) 10    CONTINUE
20 CONTINUE

```

Before entry with UPLO = 'L' or 'l', the leading ( k + 1 ) by n part of the array A must contain the lower triangular band part of the matrix of coefficients, supplied column by column, with the leading diagonal of the matrix in row 1 of the array, the first sub-diagonal starting at position 1 in row 2, and so on. The bottom right k by k triangle of the array A is not referenced. The following program segment will transfer a lower triangular band matrix from conventional full matrix storage to band storage:

```

DO 20, J = 1, N M = 1 - J DO 10, I = J, MIN( N, J + K
) A( M + I, J ) = matrix( I, J ) 10    CONTINUE 20
CONTINUE

```

Note that when DIAG = 'U' or 'u' the elements of the array A corresponding to the diagonal elements of the

matrix are not referenced, but are assumed to be unity. Unchanged on exit.

LDA - INTEGER.

On entry, LDA specifies the first dimension of A as declared in the calling (sub) program. LDA must be at least ( k + 1 ). Unchanged on exit.

X - DOUBLE PRECISION array of dimension at least ( 1 + ( n - 1 ) \* abs( INCX ) ). Before entry, the incremented array X must contain the n element right-hand side vector b. On exit, X is overwritten with the solution vector x.

INCX - INTEGER.

On entry, INCX specifies the increment for the elements of X. INCX must not be zero. Unchanged on exit.

```

⟨BLAS 2 dtbsv⟩≡
  (let* ((zero 0.0))
    (declare (type (double-float 0.0 0.0) zero))
    (defun dtbsv (uplo trans diag n k a lda x incx)
      (declare (type (simple-array double-float (*)) x a)
        (type fixnum incx lda k n)
        (type character diag trans uplo))
      (f2cl-lib:with-multi-array-data
        ((uplo character uplo-%data% uplo-%offset%)
         (trans character trans-%data% trans-%offset%)
         (diag character diag-%data% diag-%offset%)
         (a double-float a-%data% a-%offset%)
         (x double-float x-%data% x-%offset%))
        (prog ((nunit nil) (i 0) (info 0) (ix 0) (j 0) (jx 0) (kplus1 0) (kx 0)
              (l 0) (temp 0.0))
          (declare (type (member t nil) nunit)
            (type fixnum i info ix j jx kplus1 kx l)
            (type (double-float) temp))
          (setf info 0)
          (cond
            ((and (not (char-equal uplo #\U)) (not (char-equal uplo #\L)))
              (setf info 1))
            ((and (not (char-equal trans #\N))
                  (not (char-equal trans #\T))
                  (not (char-equal trans #\C)))
              (setf info 2))
            ((and (not (char-equal diag #\U)) (not (char-equal diag #\N)))
              (setf info 3))
            ((< n 0)
              (setf info 4))
            ((< k 0)
              (setf info 5))
            ((< lda (f2cl-lib:int-add k 1))
              (setf info 7))
            ((= incx 0)
              (setf info 9)))
          (cond
            ((/= info 0)
              (error
               " ** On entry to ~a parameter number ~a had an illegal value~%"
               "DTBSV" info)
              (go end_label)))
          (if (= n 0) (go end_label))
          (setf nunit (char-equal diag #\N))
          (cond
            ((<= incx 0)

```

```

(setf kx
  (f2cl-lib:int-sub 1
    (f2cl-lib:int-mul (f2cl-lib:int-sub n 1)
      incx)))

( (/= incx 1)
  (setf kx 1)))
(cond
  ((char-equal trans #\N)
    (cond
      ((char-equal uplo #\U)
        (setf kplus1 (f2cl-lib:int-add k 1))
        (cond
          ((= incx 1)
            (f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
              ((> j 1) nil)
              (tagbody
                (cond
                  ((/= (f2cl-lib:fref x (j) ((1 *))) zero)
                    (setf l (f2cl-lib:int-sub kplus1 j))
                    (if nunit
                      (setf (f2cl-lib:fref x-%data%
                        (j)
                        ((1 *))
                        x-%offset%)
                        (/
                          (f2cl-lib:fref x-%data%
                            (j)
                            ((1 *))
                            x-%offset%)
                          (f2cl-lib:fref a-%data%
                            (kplus1 j)
                            ((1 lda) (1 *))
                            a-%offset%))))))
                    (setf temp
                      (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%))
                    (f2cl-lib:fdo (i
                      (f2cl-lib:int-add j
                        (f2cl-lib:int-sub 1))
                      (f2cl-lib:int-add i
                        (f2cl-lib:int-sub 1)))
                      ((> i
                        (max (the fixnum 1)
                          (the fixnum
                            (f2cl-lib:int-add j
                              (f2cl-lib:i
                                k))))))

```

```

                                nil)
      (tagbody
        (setf (f2cl-lib:fref x-%data%
                              (i)
                              ((1 *))
                              x-%offset%)
              (-
                (f2cl-lib:fref x-%data%
                              (i)
                              ((1 *))
                              x-%offset%)
                (* temp
                  (f2cl-lib:fref a-%data%
                                ((f2cl-lib:int-add 1 i)
                                 j)
                                ((1 lda) (1 *))
                                a-%offset%))))))))))
(t
  (setf kx
        (f2cl-lib:int-add kx
                          (f2cl-lib:int-mul
                           (f2cl-lib:int-sub n 1)
                           incx)))
  (setf jx kx)
  (f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
                (> j 1) nil)
  (tagbody
    (setf kx (f2cl-lib:int-sub kx incx))
    (cond
      ((/= (f2cl-lib:fref x (jx) ((1 *))) zero)
       (setf ix kx)
       (setf l (f2cl-lib:int-sub kplus1 j))
       (if nounit
          (setf (f2cl-lib:fref x-%data%
                                (jx)
                                ((1 *))
                                x-%offset%)
                (/
                  (f2cl-lib:fref x-%data%
                                (jx)
                                ((1 *))
                                x-%offset%)
                  (f2cl-lib:fref a-%data%
                                (kplus1 j)
                                ((1 lda) (1 *))
                                a-%offset%))))))

```

```

(setf temp
  (f2cl-lib:fref x-%data%
    (jx)
    ((1 *))
    x-%offset%))
(f2cl-lib:fdo (i
  (f2cl-lib:int-add j
    (f2cl-lib:int-sub 1))
  (f2cl-lib:int-add i
    (f2cl-lib:int-sub 1)))
  ((> i
    (max (the fixnum 1)
      (the fixnum
        (f2cl-lib:int-add j
          (f2cl-lib:int-sub 1)
          (f2cl-lib:int-sub i
            (f2cl-lib:int-sub 1)
            k))))))
    nil)
(tagbody
  (setf (f2cl-lib:fref x-%data%
    (ix)
    ((1 *))
    x-%offset%))
  (-
    (f2cl-lib:fref x-%data%
      (ix)
      ((1 *))
      x-%offset%)
    (* temp
      (f2cl-lib:fref a-%data%
        ((f2cl-lib:int-add 1 i)
          j)
        ((1 lda) (1 *))
        a-%offset%))))
  (setf ix (f2cl-lib:int-sub ix incx))))))
(setf jx (f2cl-lib:int-sub jx incx))))))
(t
  (cond
    ((= incx 1)
      (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
        ((> j n) nil)
        (tagbody
          (cond
            ((/= (f2cl-lib:fref x (j) ((1 *))) zero)
              (setf l (f2cl-lib:int-sub 1 j))
              (if nounit
                (setf (f2cl-lib:fref x-%data%

```

```

                                (j)
                                ((1 *))
                                x-%offset%)
(/
  (f2cl-lib:fref x-%data%
    (j)
    ((1 *))
    x-%offset%)
  (f2cl-lib:fref a-%data%
    (1 j)
    ((1 lda) (1 *))
    a-%offset%)))
(setf temp
  (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%))
(f2cl-lib:fdo (i (f2cl-lib:int-add j 1)
  (f2cl-lib:int-add i 1))
  (> i
    (min (the fixnum n)
      (the fixnum
        (f2cl-lib:int-add j k))))
    nil)
(tagbody
  (setf (f2cl-lib:fref x-%data%
    (i)
    ((1 *))
    x-%offset%)
    (-
      (f2cl-lib:fref x-%data%
        (i)
        ((1 *))
        x-%offset%)
      (* temp
        (f2cl-lib:fref a-%data%
          ((f2cl-lib:int-add 1 i)
            j)
          ((1 lda) (1 *))
          a-%offset%))))))
(t
  (setf jx kx)
  (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
    (> j n) nil)
  (tagbody
    (setf kx (f2cl-lib:int-add kx incx))
    (cond
      ((/= (f2cl-lib:fref x (jx) ((1 *))) zero)
        (setf ix kx)

```



```

(setf l (f2cl-lib:int-sub 1 j))
(if nunit
  (setf (f2cl-lib:fref x-%data%
                      (jx)
                      ((1 *))
                      x-%offset%)
    (/
      (f2cl-lib:fref x-%data%
                    (jx)
                    ((1 *))
                    x-%offset%)
      (f2cl-lib:fref a-%data%
                    (1 j)
                    ((1 lda) (1 *))
                    a-%offset%))))
(setf temp
  (f2cl-lib:fref x-%data%
                (jx)
                ((1 *))
                x-%offset%))
(f2cl-lib:fdo (i (f2cl-lib:int-add j 1)
               (f2cl-lib:int-add i 1))
  (> i
    (min (the fixnum n)
          (the fixnum
            (f2cl-lib:int-add j k))))
  nil)
(tagbody
  (setf (f2cl-lib:fref x-%data%
                    (ix)
                    ((1 *))
                    x-%offset%)
    (-
      (f2cl-lib:fref x-%data%
                    (ix)
                    ((1 *))
                    x-%offset%)
      (* temp
        (f2cl-lib:fref a-%data%
                      ((f2cl-lib:int-add 1 i)
                       j)
                      ((1 lda) (1 *))
                      a-%offset%))))
    (setf ix (f2cl-lib:int-add ix incx))))))
(setf jx (f2cl-lib:int-add jx incx))))))
(t

```

```

(cond
  ((char-equal uplo #\U)
   (setf kplus1 (f2cl-lib:int-add k 1))
   (cond
     ((= incx 1)
      (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                     ((> j n) nil)
      (tagbody
        (setf temp
                  (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%))
        (setf l (f2cl-lib:int-sub kplus1 j))
        (f2cl-lib:fdo (i
                      (max (the fixnum 1)
                           (the fixnum
                             (f2cl-lib:int-add j
                               (f2cl-lib:int-sub
                                (f2cl-lib:int-add i 1))
                                (> i
                                  (f2cl-lib:int-add j
                                    (f2cl-lib:int-sub 1))))
                              nil)
                      (tagbody
                        (setf temp
                              (- temp
                                 (*
                                  (f2cl-lib:fref a-%data%
                                                    ((f2cl-lib:int-add l i) j)
                                                    ((1 lda) (1 *))
                                                    a-%offset%)
                                  (f2cl-lib:fref x-%data%
                                                    (i)
                                                    ((1 *))
                                                    x-%offset%))))))
                        (if nunit
                          (setf temp
                                (/ temp
                                   (f2cl-lib:fref a-%data%
                                                    (kplus1 j)
                                                    ((1 lda) (1 *))
                                                    a-%offset%))))
                          (setf (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%)
                                temp))))
        (t
         (setf jx kx)
         (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))

```

```

                                (> j n) nil)
(tagbody
  (setf temp
    (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%))
  (setf ix kx)
  (setf l (f2cl-lib:int-sub kplus1 j))
  (f2cl-lib:fdo (i
    (max (the fixnum 1)
      (the fixnum
        (f2cl-lib:int-add j
          (f2cl-lib:int-sub
            k))))
    (f2cl-lib:int-add i 1))
    (> i
      (f2cl-lib:int-add j
        (f2cl-lib:int-sub 1)))
    nil)
  (tagbody
    (setf temp
      (- temp
        (*
          (f2cl-lib:fref a-%data%
            ((f2cl-lib:int-add 1 i) j)
            ((1 lda) (1 *))
            a-%offset%)
          (f2cl-lib:fref x-%data%
            (ix)
            ((1 *))
            x-%offset%))))
      (setf ix (f2cl-lib:int-add ix incx))))
  (if nunit
    (setf temp
      (/ temp
        (f2cl-lib:fref a-%data%
          (kplus1 j)
          ((1 lda) (1 *))
          a-%offset%)))
    (setf (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%)
      temp)
    (setf jx (f2cl-lib:int-add jx incx))
    (if (> j k) (setf kx (f2cl-lib:int-add kx incx))))))
(t
  (cond
    ((= incx 1)
      (f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
        (> j 1) nil)

```

```

(tagbody
  (setf temp
    (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%))
  (setf l (f2cl-lib:int-sub 1 j))
  (f2cl-lib:fdo (i
    (min (the fixnum n)
      (the fixnum
        (f2cl-lib:int-add j k)))
    (f2cl-lib:int-add i (f2cl-lib:int-sub 1)))
    ((> i (f2cl-lib:int-add j 1)) nil)
    (tagbody
      (setf temp
        (- temp
          (*
            (f2cl-lib:fref a-%data%
              ((f2cl-lib:int-add 1 i) j)
              ((1 lda) (1 *))
              a-%offset%)
            (f2cl-lib:fref x-%data%
              (i)
              ((1 *))
              x-%offset%))))))
    (if nunit
      (setf temp
        (/ temp
          (f2cl-lib:fref a-%data%
            (1 j)
            ((1 lda) (1 *))
            a-%offset%))))
      (setf (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%)
        temp))))
(t
  (setf kx
    (f2cl-lib:int-add kx
      (f2cl-lib:int-mul
        (f2cl-lib:int-sub n 1)
        incx)))
  (setf jx kx)
  (f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
    ((> j 1) nil)
    (tagbody
      (setf temp
        (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%))
      (setf ix kx)
      (setf l (f2cl-lib:int-sub 1 j))
      (f2cl-lib:fdo (i

```

```

(min (the fixnum n)
    (the fixnum
      (f2cl-lib:int-add j k)))
(f2cl-lib:int-add i (f2cl-lib:int-sub 1)))
((> i (f2cl-lib:int-add j 1)) nil)
(tagbody
  (setf temp
    (- temp
      (*
        (f2cl-lib:fref a-%data%
          ((f2cl-lib:int-add 1 i) j)
          ((1 lda) (1 *))
          a-%offset%)
        (f2cl-lib:fref x-%data%
          (ix)
          ((1 *))
          x-%offset%))))))
  (setf ix (f2cl-lib:int-sub ix incx)))
(if nount
  (setf temp
    (/ temp
      (f2cl-lib:fref a-%data%
        (1 j)
        ((1 lda) (1 *))
        a-%offset%))))
  (setf (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%)
    temp)
  (setf jx (f2cl-lib:int-sub jx incx))
  (if (>= (f2cl-lib:int-sub n j) k)
    (setf kx (f2cl-lib:int-sub kx incx))))))
end_label
(return (values nil nil nil nil nil nil nil nil))

```

## 5.13 dtpmv BLAS

```
<dtpmv.input>≡  
  )set break resume  
  )sys rm -f dtpmv.output  
  )spool dtpmv.output  
  )set message test on  
  )set message auto off  
  )clear all  
  
  )spool  
  )lisp (bye)
```

<dtpmv.help>=

```
=====
dtpmv examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

DTPMV - perform one of the matrix-vector operations  $x := A*x$ , or  $x := A'*x$ ,

#### SYNOPSIS

SUBROUTINE DTPMV ( UPLO, TRANS, DIAG, N, AP, X, INCX )

INTEGER INCX, N

CHARACTER\*1 DIAG, TRANS, UPLO

DOUBLE PRECISION AP( \* ), X( \* )

#### PURPOSE

DTPMV performs one of the matrix-vector operations

where  $x$  is an  $n$  element vector and  $A$  is an  $n$  by  $n$  unit, or non-unit, upper or lower triangular matrix, supplied in packed form.

#### PARAMETERS

UPLO - CHARACTER\*1.

On entry, UPLO specifies whether the matrix is an upper or lower triangular matrix as follows:

UPLO = 'U' or 'u' A is an upper triangular matrix.

UPLO = 'L' or 'l' A is a lower triangular matrix.

Unchanged on exit.

TRANS - CHARACTER\*1.

On entry, TRANS specifies the operation to be performed as follows:

TRANS = 'N' or 'n'  $x := A*x$ .

TRANS = 'T' or 't'     $x := A*x$ .

TRANS = 'C' or 'c'     $x := A'*x$ .

Unchanged on exit.

DIAG - CHARACTER\*1.

On entry, DIAG specifies whether or not A is unit triangular as follows:

DIAG = 'U' or 'u'    A is assumed to be unit triangular.

DIAG = 'N' or 'n'    A is not assumed to be unit triangular.

Unchanged on exit.

N - INTEGER.

On entry, N specifies the order of the matrix A. N must be at least zero. Unchanged on exit.

AP - DOUBLE PRECISION array of DIMENSION at least  $((n*(n+1))/2)$ . Before entry with UPLD = 'U' or 'u', the array AP must contain the upper triangular matrix packed sequentially, column by column, so that AP( 1 ) contains a( 1, 1 ), AP( 2 ) and AP( 3 ) contain a( 1, 2 ) and a( 2, 2 ) respectively, and so on. Before entry with UPLD = 'L' or 'l', the array AP must contain the lower triangular matrix packed sequentially, column by column, so that AP( 1 ) contains a( 1, 1 ), AP( 2 ) and AP( 3 ) contain a( 2, 1 ) and a( 3, 1 ) respectively, and so on. Note that when DIAG = 'U' or 'u', the diagonal elements of A are not referenced, but are assumed to be unity. Unchanged on exit.

X - DOUBLE PRECISION array of dimension at least  $(1 + (n-1)*abs( INCX ))$ . Before entry, the incremented array X must contain the n element vector x. On exit, X is overwritten with the transformed vector x.

INCX - INTEGER.

On entry, INCX specifies the increment for the ele-



ments of X. INCX must not be zero. Unchanged on exit.

```

(BLAS 2 dtpmv)≡
(let* ((zero 0.0))
  (declare (type (double-float 0.0 0.0) zero))
  (defun dtpmv (uplo trans diag n ap x incx)
    (declare (type (simple-array double-float (*)) x ap)
              (type fixnum incx n)
              (type character diag trans uplo))
    (f2cl-lib:with-multi-array-data
      ((uplo character uplo-%data% uplo-%offset%)
       (trans character trans-%data% trans-%offset%)
       (diag character diag-%data% diag-%offset%)
       (ap double-float ap-%data% ap-%offset%)
       (x double-float x-%data% x-%offset%))
      (prog ((nounit nil) (i 0) (info 0) (ix 0) (j 0) (jx 0) (k 0) (kk 0)
              (kx 0) (temp 0.0))
        (declare (type (member t nil) nounit)
                  (type fixnum i info ix j jx k kk kx)
                  (type (double-float) temp))
        (setf info 0)
        (cond
          ((and (not (char-equal uplo #\U)) (not (char-equal uplo #\L)))
            (setf info 1))
          ((and (not (char-equal trans #\N))
                 (not (char-equal trans #\T))
                 (not (char-equal trans #\C)))
            (setf info 2))
          ((and (not (char-equal diag #\U)) (not (char-equal diag #\N)))
            (setf info 3))
          ((< n 0)
            (setf info 4))
          ((= incx 0)
            (setf info 7)))
        (cond
          ((/= info 0)
            (error
              " ** On entry to ~a parameter number ~a had an illegal value~%"
              "DTPMV" info)
            (go end_label)))
          (if (= n 0) (go end_label))
          (setf nounit (char-equal diag #\N))
          (cond
            ((<= incx 0)
              (setf kx
                (f2cl-lib:int-sub 1
                  (f2cl-lib:int-mul (f2cl-lib:int-sub n 1)
                    incx))))

```

```

( (/ = incx 1)
  (setf kx 1)))
(cond
  ((char-equal trans #\N)
    (cond
      ((char-equal uplo #\U)
        (setf kk 1)
        (cond
          ((= incx 1)
            (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
              ((> j n) nil)
              (tagbody
                (cond
                  ((/= (f2cl-lib:fref x (j) ((1 *))) zero)
                    (setf temp
                      (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%))
                    (setf k kk)
                    (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                      ((> i
                        (f2cl-lib:int-add j
                          (f2cl-lib:int-sub
                            1)))
                        nil)
                      (tagbody
                        (setf (f2cl-lib:fref x-%data%
                          (i)
                          ((1 *))
                          x-%offset%)
                          (+
                            (f2cl-lib:fref x-%data%
                              (i)
                              ((1 *))
                              x-%offset%)
                            (* temp
                              (f2cl-lib:fref ap-%data%
                                (k)
                                ((1 *))
                                ap-%offset%))))
                        (setf k (f2cl-lib:int-add k 1))))
                    (if nunit
                      (setf (f2cl-lib:fref x-%data%
                        (j)
                        ((1 *))
                        x-%offset%)
                          (*
                            (f2cl-lib:fref x-%data%

```

```

                                (j)
                                ((1 *))
                                x-%offset%)
(f2cl-lib:fref ap-%data%
  ((f2cl-lib:int-sub
    (f2cl-lib:int-add kk j)
    1))
  ((1 *))
  ap-%offset%))))))
(setf kk (f2cl-lib:int-add kk j))))
(t
  (setf jx kx)
  (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
    (> j n) nil)
  (tagbody
    (cond
      ((/= (f2cl-lib:fref x (jx) ((1 *))) zero)
        (setf temp
          (f2cl-lib:fref x-%data%
            (jx)
            ((1 *))
            x-%offset%))
        (setf ix kx)
        (f2cl-lib:fdo (k kk (f2cl-lib:int-add k 1))
          (> k
            (f2cl-lib:int-add kk
              j
              (f2cl-lib:int-sub
                2)))
            nil)
          (tagbody
            (setf (f2cl-lib:fref x-%data%
              (ix)
              ((1 *))
              x-%offset%)
              (+
                (f2cl-lib:fref x-%data%
                  (ix)
                  ((1 *))
                  x-%offset%)
                (* temp
                  (f2cl-lib:fref ap-%data%
                    (k)
                    ((1 *))
                    ap-%offset%))))))
            (setf ix (f2cl-lib:int-add ix incx))))

```

```

(if nunit
  (setf (f2cl-lib:fref x-%data%
    (jx)
    ((1 *))
    x-%offset%)
    (*
      (f2cl-lib:fref x-%data%
        (jx)
        ((1 *))
        x-%offset%)
      (f2cl-lib:fref ap-%data%
        ((f2cl-lib:int-sub
          (f2cl-lib:int-add kk j)
          1))
        ((1 *))
        ap-%offset%))))))
(setf jx (f2cl-lib:int-add jx incx))
(setf kk (f2cl-lib:int-add kk j))))))
(t
  (setf kk (the fixnum (truncate (* n (+ n 1)) 2)))
  (cond
    ((= incx 1)
      (f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
        ((> j 1) nil)
        (tagbody
          (cond
            ((/= (f2cl-lib:fref x (j) ((1 *))) zero)
              (setf temp
                (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%))
              (setf k kk)
              (f2cl-lib:fdo (i n
                (f2cl-lib:int-add i
                  (f2cl-lib:int-sub 1)))
                ((> i (f2cl-lib:int-add j 1)) nil)
                (tagbody
                  (setf (f2cl-lib:fref x-%data%
                    (i)
                    ((1 *))
                    x-%offset%)
                    (+
                      (f2cl-lib:fref x-%data%
                        (i)
                        ((1 *))
                        x-%offset%)
                      (* temp
                        (f2cl-lib:fref ap-%data%

```

```

(k)
((1 *))
ap-%offset%)))
(setf k (f2cl-lib:int-sub k 1)))
(if nunit
  (setf (f2cl-lib:fref x-%data%
                      (j)
                      ((1 *))
                      x-%offset%)
    (*
      (f2cl-lib:fref x-%data%
                    (j)
                    ((1 *))
                    x-%offset%)
      (f2cl-lib:fref ap-%data%
                    ((f2cl-lib:int-add
                     (f2cl-lib:int-sub kk n)
                     j))
                    ((1 *))
                    ap-%offset%))))))
(setf kk
  (f2cl-lib:int-sub kk
    (f2cl-lib:int-add
      (f2cl-lib:int-sub n j)
      1))))
(t
  (setf kx
    (f2cl-lib:int-add kx
      (f2cl-lib:int-mul
        (f2cl-lib:int-sub n 1)
        incx)))
  (setf jx kx)
  (f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
    (> j 1) nil)
  (tagbody
    (cond
      ((/= (f2cl-lib:fref x (jx) ((1 *))) zero)
        (setf temp
          (f2cl-lib:fref x-%data%
                        (jx)
                        ((1 *))
                        x-%offset%))
        (setf ix kx)
        (f2cl-lib:fdo (k kk
          (f2cl-lib:int-add k
            (f2cl-lib:int-sub 1)))

```

```
((> k
      (f2cl-lib:int-add kk
        (f2cl-lib:int-sub
          (f2cl-lib:int-add
            n
            (f2cl-lib:int-sub
              (f2cl-lib:int-add
                j
                1))))))
    nil)
(tagbody
  (setf (f2cl-lib:fref x-%data%
                      (ix)
                      ((1 *))
                      x-%offset%)
    (+
      (f2cl-lib:fref x-%data%
                    (ix)
                    ((1 *))
                    x-%offset%)
      (* temp
         (f2cl-lib:fref ap-%data%
                       (k)
                       ((1 *))
                       ap-%offset%))))
  (setf ix (f2cl-lib:int-sub ix incx)))
(if nounit
  (setf (f2cl-lib:fref x-%data%
                      (jx)
                      ((1 *))
                      x-%offset%)
    (*
      (f2cl-lib:fref x-%data%
                    (jx)
                    ((1 *))
                    x-%offset%)
      (f2cl-lib:fref ap-%data%
                    ((f2cl-lib:int-add
                     (f2cl-lib:int-sub kk n)
                     j))
                    ((1 *))
                    ap-%offset%))))))
(setf jx (f2cl-lib:int-sub jx incx))
(setf kk
  (f2cl-lib:int-sub kk
    (f2cl-lib:int-add
```

```

(f2cl-lib:int-sub n j)
1)))))))))

(t
 (cond
  ((char-equal uplo #\U)
   (setf kk (the fixnum (truncate (* n (+ n 1)) 2)))
   (cond
    ((= incx 1)
     (f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
      (> j 1) nil)
     (tagbody
      (setf temp
        (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%))
      (if nunit
       (setf temp
        (* temp
         (f2cl-lib:fref ap-%data%
          (kk)
          ((1 *))
          ap-%offset%))))
      (setf k (f2cl-lib:int-sub kk 1))
      (f2cl-lib:fdo (i (f2cl-lib:int-add j (f2cl-lib:int-sub 1))
        (f2cl-lib:int-add i (f2cl-lib:int-sub 1)))
       (> i 1) nil)
      (tagbody
       (setf temp
        (+ temp
         (*
          (f2cl-lib:fref ap-%data%
           (k)
           ((1 *))
           ap-%offset%)
          (f2cl-lib:fref x-%data%
           (i)
           ((1 *))
           x-%offset%))))
       (setf k (f2cl-lib:int-sub k 1))))
      (setf (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%)
        temp)
      (setf kk (f2cl-lib:int-sub kk j))))))
  (t
   (setf jx
    (f2cl-lib:int-add kx
     (f2cl-lib:int-mul
      (f2cl-lib:int-sub n 1)
      incx)))

```



```

(f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
  (> j 1) nil)
(tagbody
  (setf temp
    (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%))
  (setf ix jx)
  (if nunit
    (setf temp
      (* temp
        (f2cl-lib:fref ap-%data%
          (kk)
          ((1 *))
          ap-%offset%))))
    (f2cl-lib:fdo (k
      (f2cl-lib:int-add kk (f2cl-lib:int-sub 1))
      (f2cl-lib:int-add k (f2cl-lib:int-sub 1))
      (> k
        (f2cl-lib:int-add kk
          (f2cl-lib:int-sub j)
          1))
      nil)
      (tagbody
        (setf ix (f2cl-lib:int-sub ix incx))
        (setf temp
          (+ temp
            (*
              (f2cl-lib:fref ap-%data%
                (k)
                ((1 *))
                ap-%offset%)
              (f2cl-lib:fref x-%data%
                (ix)
                ((1 *))
                x-%offset%))))))
        (setf (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%)
          temp)
        (setf jx (f2cl-lib:int-sub jx incx))
        (setf kk (f2cl-lib:int-sub kk j))))))
(t
  (setf kk 1)
  (cond
    ((= incx 1)
      (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
        (> j n) nil)
      (tagbody
        (setf temp

```

```

(f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%))
(if nounit
  (setf temp
    (* temp
      (f2cl-lib:fref ap-%data%
        (kk)
        ((1 *))
        ap-%offset%))))
(setf k (f2cl-lib:int-add kk 1))
(f2cl-lib:fdo (i (f2cl-lib:int-add j 1)
  (f2cl-lib:int-add i 1))
  (> i n) nil)
(tagbody
  (setf temp
    (+ temp
      (*
        (f2cl-lib:fref ap-%data%
          (k)
          ((1 *))
          ap-%offset%)
        (f2cl-lib:fref x-%data%
          (i)
          ((1 *))
          x-%offset%))))
    (setf k (f2cl-lib:int-add k 1))))
(setf (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%)
  temp)
(setf kk
  (f2cl-lib:int-add kk
    (f2cl-lib:int-add
      (f2cl-lib:int-sub n j)
      1))))
(t
  (setf jx kx)
  (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
    (> j n) nil)
  (tagbody
    (setf temp
      (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%))
    (setf ix jx)
    (if nounit
      (setf temp
        (* temp
          (f2cl-lib:fref ap-%data%
            (kk)
            ((1 *))
            ap-%offset%))))
      (setf kx
        (f2cl-lib:int-add kx
          (f2cl-lib:int-add
            (f2cl-lib:int-sub n jx)
            1))))))

```

```

                                ap-%offset%))))
(f2cl-lib:fdo (k (f2cl-lib:int-add kk 1)
               (f2cl-lib:int-add k 1))
              (> k
               (f2cl-lib:int-add kk
                                   n
                                   (f2cl-lib:int-sub j)))
              nil)
(tagbody
 (setf ix (f2cl-lib:int-add ix incx))
 (setf temp
  (+ temp
    (*
     (f2cl-lib:fref ap-%data%
                     (k)
                     ((1 *))
                     ap-%offset%)
     (f2cl-lib:fref x-%data%
                     (ix)
                     ((1 *))
                     x-%offset%))))))
(setf (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%)
      temp)
(setf jx (f2cl-lib:int-add jx incx))
(setf kk
  (f2cl-lib:int-add kk
                    (f2cl-lib:int-add
                     (f2cl-lib:int-sub n j)
                     1))))))
end_label
(return (values nil nil nil nil nil nil nil))))

```

## 5.14 dtpsv BLAS

```
<dtpsv.input>=  
  )set break resume  
  )sys rm -f dtpsv.output  
  )spool dtpsv.output  
  )set message test on  
  )set message auto off  
  )clear all  
  
  )spool  
  )lisp (bye)
```

`<dtpsv.help>=`

```
=====
dtpsv examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

DTPSV - solve one of the systems of equations  $Ax = b$ , or  $A'x = b$ ,

#### SYNOPSIS

SUBROUTINE DTPSV ( UPLO, TRANS, DIAG, N, AP, X, INCX )

INTEGER INCX, N

CHARACTER\*1 DIAG, TRANS, UPLO

DOUBLE PRECISION AP( \* ), X( \* )

#### PURPOSE

DTPSV solves one of the systems of equations

where b and x are n element vectors and A is an n by n unit, or non-unit, upper or lower triangular matrix, supplied in packed form.

No test for singularity or near-singularity is included in this routine. Such tests must be performed before calling this routine.

#### PARAMETERS

UPLO - CHARACTER\*1.

On entry, UPLO specifies whether the matrix is an upper or lower triangular matrix as follows:

UPLO = 'U' or 'u' A is an upper triangular matrix.

UPLO = 'L' or 'l' A is a lower triangular matrix.

Unchanged on exit.

TRANS - CHARACTER\*1.

On entry, TRANS specifies the equations to be solved

as follows:

TRANS = 'N' or 'n'     $A*x = b$ .

TRANS = 'T' or 't'     $A'*x = b$ .

TRANS = 'C' or 'c'     $A'*x = b$ .

Unchanged on exit.

DIAG - CHARACTER\*1.

On entry, DIAG specifies whether or not A is unit triangular as follows:

DIAG = 'U' or 'u'    A is assumed to be unit triangular.

DIAG = 'N' or 'n'    A is not assumed to be unit triangular.

Unchanged on exit.

N - INTEGER.

On entry, N specifies the order of the matrix A. N must be at least zero. Unchanged on exit.

AP - DOUBLE PRECISION array of DIMENSION at least  $((n*(n+1))/2)$ . Before entry with UPLD = 'U' or 'u', the array AP must contain the upper triangular matrix packed sequentially, column by column, so that AP( 1 ) contains a( 1, 1 ), AP( 2 ) and AP( 3 ) contain a( 1, 2 ) and a( 2, 2 ) respectively, and so on. Before entry with UPLD = 'L' or 'l', the array AP must contain the lower triangular matrix packed sequentially, column by column, so that AP( 1 ) contains a( 1, 1 ), AP( 2 ) and AP( 3 ) contain a( 2, 1 ) and a( 3, 1 ) respectively, and so on. Note that when DIAG = 'U' or 'u', the diagonal elements of A are not referenced, but are assumed to be unity. Unchanged on exit.

X - DOUBLE PRECISION array of dimension at least  $(1 + (n-1)*abs( INCX ))$ . Before entry, the incremented array X must contain the n element right-hand side vector b. On exit, X is overwritten with the solution vector x.

INCX - INTEGER.

On entry, INCX specifies the increment for the elements of X. INCX must not be zero. Unchanged on exit.

```

<BLAS 2 dtpsv>=
  (let* ((zero 0.0))
    (declare (type (double-float 0.0 0.0) zero))
    (defun dtpsv (uplo trans diag n ap x incx)
      (declare (type (simple-array double-float (*)) x ap)
                (type fixnum incx n)
                (type character diag trans uplo))
      (f2cl-lib:with-multi-array-data
        ((uplo character uplo-%data% uplo-%offset%)
         (trans character trans-%data% trans-%offset%)
         (diag character diag-%data% diag-%offset%)
         (ap double-float ap-%data% ap-%offset%)
         (x double-float x-%data% x-%offset%))
        (prog ((nunit nil) (i 0) (info 0) (ix 0) (j 0) (jx 0) (k 0) (kk 0)
              (kx 0) (temp 0.0))
          (declare (type (member t nil) nunit)
                    (type fixnum i info ix j jx k kk kx)
                    (type (double-float) temp))
          (setf info 0)
          (cond
            ((and (not (char-equal uplo #\U)) (not (char-equal uplo #\L)))
              (setf info 1))
            ((and (not (char-equal trans #\N))
                  (not (char-equal trans #\T))
                  (not (char-equal trans #\C)))
              (setf info 2))
            ((and (not (char-equal diag #\U)) (not (char-equal diag #\N)))
              (setf info 3))
            ((< n 0)
              (setf info 4))
            ((= incx 0)
              (setf info 7)))
          (cond
            ((/= info 0)
              (error
               " ** On entry to ~a parameter number ~a had an illegal value~%"
               "DTPSV" info)
              (go end_label)))
          (if (= n 0) (go end_label))
          (setf nunit (char-equal diag #\N))
          (cond
            ((<= incx 0)
              (setf kx
                (f2cl-lib:int-sub 1
                  (f2cl-lib:int-mul (f2cl-lib:int-sub n 1)
                    incx))))

```



```

( (/= incx 1)
  (setf kx 1)))
(cond
  ((char-equal trans #\N)
    (cond
      ((char-equal uplo #\U)
        (setf kk (the fixnum (truncate (* n (+ n 1)) 2)))
        (cond
          ((= incx 1)
            (f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
              ((> j 1) nil)
              (tagbody
                (cond
                  ((/= (f2cl-lib:fref x (j) ((1 *))) zero)
                    (if nunit
                      (setf (f2cl-lib:fref x-%data%
                                           (j)
                                           ((1 *))
                                           x-%offset%)
                            (/
                              (f2cl-lib:fref x-%data%
                                           (j)
                                           ((1 *))
                                           x-%offset%)
                              (f2cl-lib:fref ap-%data%
                                           (kk)
                                           ((1 *))
                                           ap-%offset%))))))
                    (setf temp
                      (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%))
                    (setf k (f2cl-lib:int-sub kk 1))
                    (f2cl-lib:fdo (i
                      (f2cl-lib:int-add j
                        (f2cl-lib:int-sub 1))
                      (f2cl-lib:int-add i
                        (f2cl-lib:int-sub 1)))
                      ((> i 1) nil)
                      (tagbody
                        (setf (f2cl-lib:fref x-%data%
                                           (i)
                                           ((1 *))
                                           x-%offset%)
                              (-
                                (f2cl-lib:fref x-%data%
                                           (i)
                                           ((1 *))
                                           x-%offset%)
                                (f2cl-lib:fref x-%data%
                                           (i)
                                           ((1 *))
                                           x-%offset%))))))
                    (setf (f2cl-lib:fref x-%data%
                                           (j)
                                           ((1 *))
                                           x-%offset%)
                          (+
                            temp
                            (f2cl-lib:fref x-%data%
                                           (j)
                                           ((1 *))
                                           x-%offset%))))))
                  (t
                    (setf (f2cl-lib:fref x-%data%
                                           (j)
                                           ((1 *))
                                           x-%offset%)
                          (+
                            (f2cl-lib:fref x-%data%
                                           (j)
                                           ((1 *))
                                           x-%offset%)
                            (f2cl-lib:fref ap-%data%
                                           (kk)
                                           ((1 *))
                                           ap-%offset%))))))
                ))
          ((/= incx 1)
            (f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
              ((> j 1) nil)
              (tagbody
                (cond
                  ((/= (f2cl-lib:fref x (j) ((1 *))) zero)
                    (if nunit
                      (setf (f2cl-lib:fref x-%data%
                                           (j)
                                           ((1 *))
                                           x-%offset%)
                            (/
                              (f2cl-lib:fref x-%data%
                                           (j)
                                           ((1 *))
                                           x-%offset%)
                              (f2cl-lib:fref ap-%data%
                                           (kk)
                                           ((1 *))
                                           ap-%offset%))))))
                    (setf temp
                      (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%))
                    (setf k (f2cl-lib:int-sub kk 1))
                    (f2cl-lib:fdo (i
                      (f2cl-lib:int-add j
                        (f2cl-lib:int-sub 1))
                      (f2cl-lib:int-add i
                        (f2cl-lib:int-sub 1)))
                      ((> i 1) nil)
                      (tagbody
                        (setf (f2cl-lib:fref x-%data%
                                           (i)
                                           ((1 *))
                                           x-%offset%)
                              (-
                                (f2cl-lib:fref x-%data%
                                           (i)
                                           ((1 *))
                                           x-%offset%)
                                (f2cl-lib:fref x-%data%
                                           (i)
                                           ((1 *))
                                           x-%offset%))))))
                    (setf (f2cl-lib:fref x-%data%
                                           (j)
                                           ((1 *))
                                           x-%offset%)
                          (+
                            temp
                            (f2cl-lib:fref x-%data%
                                           (j)
                                           ((1 *))
                                           x-%offset%))))))
                  (t
                    (setf (f2cl-lib:fref x-%data%
                                           (j)
                                           ((1 *))
                                           x-%offset%)
                          (+
                            (f2cl-lib:fref x-%data%
                                           (j)
                                           ((1 *))
                                           x-%offset%)
                            (f2cl-lib:fref ap-%data%
                                           (kk)
                                           ((1 *))
                                           ap-%offset%))))))
                ))
          ))
      ))
  ))

```

```

                                x-%offset%)
(* temp
  (f2cl-lib:fref ap-%data%
    (k)
    ((1 *))
    ap-%offset%)))
  (setf k (f2cl-lib:int-sub k 1))))))
(setf kk (f2cl-lib:int-sub kk j))))
(t
  (setf jx
    (f2cl-lib:int-add kx
      (f2cl-lib:int-mul
        (f2cl-lib:int-sub n 1)
        incx)))
    (f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
      (> j 1) nil)
    (tagbody
      (cond
        ((/= (f2cl-lib:fref x (jx) ((1 *))) zero)
          (if nunit
            (setf (f2cl-lib:fref x-%data%
              (jx)
              ((1 *))
              x-%offset%)
              (/
                (f2cl-lib:fref x-%data%
                  (jx)
                  ((1 *))
                  x-%offset%)
                (f2cl-lib:fref ap-%data%
                  (kk)
                  ((1 *))
                  ap-%offset%))))))
          (setf temp
            (f2cl-lib:fref x-%data%
              (jx)
              ((1 *))
              x-%offset%)))
          (setf ix jx)
          (f2cl-lib:fdo (k
            (f2cl-lib:int-add kk
              (f2cl-lib:int-sub 1))
            (f2cl-lib:int-add k
              (f2cl-lib:int-sub 1)))
            (> k
              (f2cl-lib:int-add kk

```

```

                                                    (f2cl-lib:int-sub
                                                    j)
                                                    1))
                                nil)
    (tagbody
      (setf ix (f2cl-lib:int-sub ix incx))
      (setf (f2cl-lib:fref x-%data%
                            (ix)
                            ((1 *))
                            x-%offset%)
            (-
              (f2cl-lib:fref x-%data%
                              (ix)
                              ((1 *))
                              x-%offset%)
              (* temp
                (f2cl-lib:fref ap-%data%
                                (k)
                                ((1 *))
                                ap-%offset%))))))
      (setf jx (f2cl-lib:int-sub jx incx))
      (setf kk (f2cl-lib:int-sub kk j))))))
(t
  (setf kk 1)
  (cond
    ((= incx 1)
     (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                   ((> j n) nil)
     (tagbody
       (cond
         ((/= (f2cl-lib:fref x (j) ((1 *))) zero)
          (if nunit
              (setf (f2cl-lib:fref x-%data%
                                    (j)
                                    ((1 *))
                                    x-%offset%)
                    (/
                     (f2cl-lib:fref x-%data%
                                     (j)
                                     ((1 *))
                                     x-%offset%)
                     (f2cl-lib:fref ap-%data%
                                     (kk)
                                     ((1 *))
                                     ap-%offset%))))
              (setf temp

```

```

      (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%))
    (setf k (f2cl-lib:int-add kk 1))
    (f2cl-lib:fdo (i (f2cl-lib:int-add j 1)
                  (f2cl-lib:int-add i 1))
                  ((> i n) nil)
      (tagbody
        (setf (f2cl-lib:fref x-%data%
                              (i)
                              ((1 *))
                              x-%offset%)
              (-
                (f2cl-lib:fref x-%data%
                              (i)
                              ((1 *))
                              x-%offset%)
                (* temp
                  (f2cl-lib:fref ap-%data%
                                  (k)
                                  ((1 *))
                                  ap-%offset%))))))
        (setf k (f2cl-lib:int-add k 1))))))
    (setf kk
      (f2cl-lib:int-add kk
        (f2cl-lib:int-add
          (f2cl-lib:int-sub n j)
          1))))))
  (t
    (setf jx kx)
    (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                  ((> j n) nil)
      (tagbody
        (cond
          ((/= (f2cl-lib:fref x (jx) ((1 *)) zero)
              (if nunit
                (setf (f2cl-lib:fref x-%data%
                                      (jx)
                                      ((1 *))
                                      x-%offset%)
                      (/
                        (f2cl-lib:fref x-%data%
                                      (jx)
                                      ((1 *))
                                      x-%offset%)
                        (f2cl-lib:fref ap-%data%
                                      (kk)
                                      ((1 *))

```

```

                                ap-%offset%))))))
(setf temp
  (f2cl-lib:fref x-%data%
                 (jx)
                 ((1 *))
                 x-%offset%))
(setf ix jx)
(f2cl-lib:fdo (k (f2cl-lib:int-add kk 1)
               (f2cl-lib:int-add k 1))
              ((> k
                 (f2cl-lib:int-add kk
                                     n
                                     (f2cl-lib:int-sub
                                     j))))
              nil)
(tagbody
  (setf ix (f2cl-lib:int-add ix incx))
  (setf (f2cl-lib:fref x-%data%
                       (ix)
                       ((1 *))
                       x-%offset%)
        (-
          (f2cl-lib:fref x-%data%
                          (ix)
                          ((1 *))
                          x-%offset%)
          (* temp
             (f2cl-lib:fref ap-%data%
                             (k)
                             ((1 *))
                             ap-%offset%))))))
(setf jx (f2cl-lib:int-add jx incx))
(setf kk
  (f2cl-lib:int-add kk
                    (f2cl-lib:int-add
                     (f2cl-lib:int-sub n j)
                     1))))))
(t
 (cond
  ((char-equal uplo #\U)
   (setf kk 1)
   (cond
    ((= incx 1)
     (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                    ((> j n) nil)
                    (tagbody

```

```

(setf temp
  (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%))
(setf k kk)
(f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
  (> i
    (f2cl-lib:int-add j
      (f2cl-lib:int-sub 1)))
    nil)
(tagbody
  (setf temp
    (- temp
      (*
        (f2cl-lib:fref ap-%data%
          (k)
          ((1 *))
          ap-%offset%)
        (f2cl-lib:fref x-%data%
          (i)
          ((1 *))
          x-%offset%))))))
(setf k (f2cl-lib:int-add k 1)))
(if nunit
  (setf temp
    (/ temp
      (f2cl-lib:fref ap-%data%
        ((f2cl-lib:int-sub
          (f2cl-lib:int-add kk j)
          1))
        ((1 *))
        ap-%offset%))))))
(setf (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%)
  temp)
(setf kk (f2cl-lib:int-add kk j))))
(t
  (setf jx kx)
  (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
    (> j n) nil)
  (tagbody
    (setf temp
      (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%))
    (setf ix kx)
    (f2cl-lib:fdo (k kk (f2cl-lib:int-add k 1))
      (> k
        (f2cl-lib:int-add kk
          j
          (f2cl-lib:int-sub 2))))

```

```

                                nil)
      (tagbody
        (setf temp
          (- temp
            (*
              (f2cl-lib:fref ap-%data%
                            (k)
                            ((1 *))
                            ap-%offset%)
              (f2cl-lib:fref x-%data%
                            (ix)
                            ((1 *))
                            x-%offset%))))))
        (setf ix (f2cl-lib:int-add ix incx)))
      (if nounit
        (setf temp
          (/ temp
            (f2cl-lib:fref ap-%data%
                          ((f2cl-lib:int-sub
                            (f2cl-lib:int-add kk j)
                            1))
                          ((1 *))
                          ap-%offset%))))
          (setf (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%)
            temp)
          (setf jx (f2cl-lib:int-add jx incx))
          (setf kk (f2cl-lib:int-add kk j))))))
    (t
      (setf kk (the fixnum (truncate (* n (+ n 1)) 2)))
      (cond
        ((= incx 1)
          (f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
            ((> j 1) nil)
            (tagbody
              (setf temp
                (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%))
              (setf k kk)
              (f2cl-lib:fdo (i n
                            (f2cl-lib:int-add i (f2cl-lib:int-sub 1)))
                ((> i (f2cl-lib:int-add j 1)) nil)
                (tagbody
                  (setf temp
                    (- temp
                      (*
                        (f2cl-lib:fref ap-%data%
                                      (k)
                                      ((1 *))
                                      ap-%offset%)
                        (f2cl-lib:fref x-%data%
                                      (i)
                                      ((1 *))
                                      x-%offset%))))))
                  (setf ix (f2cl-lib:int-add ix incx))
                  (setf kk (f2cl-lib:int-add kk i))))))
              (setf jx (f2cl-lib:int-add jx incx))
              (setf kk (f2cl-lib:int-add kk i))))))
        (t
          (f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
            ((> j 1) nil)
            (tagbody
              (setf temp
                (- temp
                  (*
                    (f2cl-lib:fref ap-%data%
                                    (k)
                                    ((1 *))
                                    ap-%offset%)
                    (f2cl-lib:fref x-%data%
                                    (j)
                                    ((1 *))
                                    x-%offset%))))))
              (setf ix (f2cl-lib:int-add ix incx))
              (setf kk (f2cl-lib:int-add kk j))))))
      (setf jx (f2cl-lib:int-add jx incx))
      (setf kk (f2cl-lib:int-add kk j))))))

```

```

((1 *))
ap-%offset%)
(f2cl-lib:fref x-%data%
(i)
((1 *))
x-%offset%))))
(setf k (f2cl-lib:int-sub k 1)))
(if nunit
  (setf temp
    (/ temp
      (f2cl-lib:fref ap-%data%
        ((f2cl-lib:int-add
          (f2cl-lib:int-sub kk n)
          j))
        ((1 *))
        ap-%offset%))))
    (setf (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%)
      temp)
    (setf kk
      (f2cl-lib:int-sub kk
        (f2cl-lib:int-add
          (f2cl-lib:int-sub n j)
          1)))))
(t
  (setf kx
    (f2cl-lib:int-add kx
      (f2cl-lib:int-mul
        (f2cl-lib:int-sub n 1)
        incx)))
  (setf jx kx)
  (f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
    (> j 1) nil)
  (tagbody
    (setf temp
      (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%))
    (setf ix kx)
    (f2cl-lib:fdo (k kk
      (f2cl-lib:int-add k (f2cl-lib:int-sub 1)))
      (> k
        (f2cl-lib:int-add kk
          (f2cl-lib:int-sub
            (f2cl-lib:int-add n
              (f2cl-lib:int-sub
                (f2cl-lib:int-add
                  j
                  1))))))

```



```

nil)
(tagbody
  (setf temp
    (- temp
      (*
        (f2cl-lib:fref ap-%data%
          (k)
          ((1 *))
          ap-%offset%)
        (f2cl-lib:fref x-%data%
          (ix)
          ((1 *))
          x-%offset%))))))
  (setf ix (f2cl-lib:int-sub ix incx)))
(if nounit
  (setf temp
    (/ temp
      (f2cl-lib:fref ap-%data%
        ((f2cl-lib:int-add
          (f2cl-lib:int-sub kk n)
          j))
        ((1 *))
        ap-%offset%))))))
(setf (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%)
  temp)
(setf jx (f2cl-lib:int-sub jx incx))
(setf kk
  (f2cl-lib:int-sub kk
    (f2cl-lib:int-add
      (f2cl-lib:int-sub n j)
      1))))))
end_label
(return (values nil nil nil nil nil nil nil))))

```

## 5.15 dtrmv BLAS

```
<dtrmv.input>≡  
  )set break resume  
  )sys rm -f dtrmv.output  
  )spool dtrmv.output  
  )set message test on  
  )set message auto off  
  )clear all  
  
  )spool  
  )lisp (bye)
```

`<dtmrv.help>`≡

```
=====
dtmrv examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

DTRMV - perform one of the matrix-vector operations  $x := A*x$ , or  $x := A'*x$ ,

#### SYNOPSIS

SUBROUTINE DTRMV ( UPLO, TRANS, DIAG, N, A, LDA, X, INCX )

INTEGER INCX, LDA, N

CHARACTER\*1 DIAG, TRANS, UPLO

DOUBLE PRECISION A( LDA, \* ), X( \* )

#### PURPOSE

DTRMV performs one of the matrix-vector operations

where  $x$  is an  $n$  element vector and  $A$  is an  $n$  by  $n$  unit, or non-unit, upper or lower triangular matrix.

#### PARAMETERS

UPLO - CHARACTER\*1.

On entry, UPLO specifies whether the matrix is an upper or lower triangular matrix as follows:

UPLO = 'U' or 'u' A is an upper triangular matrix.

UPLO = 'L' or 'l' A is a lower triangular matrix.

Unchanged on exit.

TRANS - CHARACTER\*1.

On entry, TRANS specifies the operation to be performed as follows:

TRANS = 'N' or 'n'  $x := A*x$ .

TRANS = 'T' or 't'  $x := A'*x$ .

TRANS = 'C' or 'c'     $x := A*x$ .

Unchanged on exit.

DIAG    - CHARACTER\*1.

On entry, DIAG specifies whether or not A is unit triangular as follows:

DIAG = 'U' or 'u'    A is assumed to be unit triangular.

DIAG = 'N' or 'n'    A is not assumed to be unit triangular.

Unchanged on exit.

N        - INTEGER.

On entry, N specifies the order of the matrix A. N must be at least zero. Unchanged on exit.

A        - DOUBLE PRECISION array of DIMENSION ( LDA, n ).  
Before entry with UPLO = 'U' or 'u', the leading n by n upper triangular part of the array A must contain the upper triangular matrix and the strictly lower triangular part of A is not referenced. Before entry with UPLO = 'L' or 'l', the leading n by n lower triangular part of the array A must contain the lower triangular matrix and the strictly upper triangular part of A is not referenced. Note that when DIAG = 'U' or 'u', the diagonal elements of A are not referenced either, but are assumed to be unity.  
Unchanged on exit.

LDA      - INTEGER.

On entry, LDA specifies the first dimension of A as declared in the calling (sub) program. LDA must be at least  $\max(1, n)$ . Unchanged on exit.

X        - DOUBLE PRECISION array of dimension at least  $(1 + (n - 1) * \text{abs}(\text{INCX}))$ . Before entry, the incremented array X must contain the n element vector x. On exit, X is overwritten with the transformed vector x.

INCX     - INTEGER.

On entry, INCX specifies the increment for the elements of X. INCX must not be zero. Unchanged on exit.

```

⟨BLAS 2 dtrmv⟩≡
  (let* ((zero 0.0))
    (declare (type (double-float 0.0 0.0) zero))
    (defun dtrmv (uplo trans diag n a lda x incx)
      (declare (type (simple-array double-float (*)) x a)
        (type fixnum incx lda n)
        (type character diag trans uplo))
      (f2cl-lib:with-multi-array-data
        ((uplo character uplo-%data% uplo-%offset%)
         (trans character trans-%data% trans-%offset%)
         (diag character diag-%data% diag-%offset%)
         (a double-float a-%data% a-%offset%)
         (x double-float x-%data% x-%offset%))
        (prog ((nunit nil) (i 0) (info 0) (ix 0) (j 0) (jx 0) (kx 0) (temp 0.0))
          (declare (type (member t nil) nunit)
            (type fixnum i info ix j jx kx)
            (type (double-float) temp))
          (setf info 0)
          (cond
            ((and (not (char-equal uplo #\U)) (not (char-equal uplo #\L)))
              (setf info 1))
            ((and (not (char-equal trans #\N))
              (not (char-equal trans #\T))
              (not (char-equal trans #\C)))
              (setf info 2))
            ((and (not (char-equal diag #\U)) (not (char-equal diag #\N)))
              (setf info 3))
            ((< n 0)
              (setf info 4))
            ((< lda (max (the fixnum 1) (the fixnum n)))
              (setf info 6))
            ((= incx 0)
              (setf info 8)))
          (cond
            ((/= info 0)
              (error
                " ** On entry to ~a parameter number ~a had an illegal value~%"
                "DTRMV" info)
              (go end_label)))
          (if (= n 0) (go end_label))
          (setf nunit (char-equal diag #\N))
          (cond
            ((<= incx 0)
              (setf kx
                (f2cl-lib:int-sub 1
                  (f2cl-lib:int-mul (f2cl-lib:int-sub n 1)

```

```

incx)))
( (/= incx 1)
  (setf kx 1)))
(cond
  ((char-equal trans #\N)
   (cond
     ((char-equal uplo #\U)
      (cond
        ((= incx 1)
         (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                       ((> j n) nil)
         (tagbody
          (cond
            ((/= (f2cl-lib:fref x (j) ((1 *))) zero)
             (setf temp
                   (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%))
             (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                           ((> i
                               (f2cl-lib:int-add j
                                   (f2cl-lib:int-sub
                                      1)))
                             nil)
             (tagbody
              (setf (f2cl-lib:fref x-%data%
                                   (i)
                                   ((1 *))
                                   x-%offset%)
                    (+
                     (f2cl-lib:fref x-%data%
                                     (i)
                                     ((1 *))
                                     x-%offset%)
                     (* temp
                       (f2cl-lib:fref a-%data%
                                       (i j)
                                       ((1 lda) (1 *))
                                       a-%offset%))))))
             (if nunit
                 (setf (f2cl-lib:fref x-%data%
                                     (j)
                                     ((1 *))
                                     x-%offset%)
                       (*
                        (f2cl-lib:fref x-%data%
                                       (j)
                                       ((1 *))

```

```

                                x-%offset%)
(f2cl-lib:fref a-%data%
  (j j)
  ((1 lda) (1 *))
  a-%offset%)))))))))
(t
  (setf jx kx)
  (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
    (> j n) nil)
  (tagbody
    (cond
      ((/= (f2cl-lib:fref x (jx) ((1 *))) zero)
        (setf temp
          (f2cl-lib:fref x-%data%
            (jx)
            ((1 *))
            x-%offset%))
        (setf ix kx)
        (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
          (> i
            (f2cl-lib:int-add j
              (f2cl-lib:int-sub
                1)))
            nil)
          (tagbody
            (setf (f2cl-lib:fref x-%data%
              (ix)
              ((1 *))
              x-%offset%)
              (+
                (f2cl-lib:fref x-%data%
                  (ix)
                  ((1 *))
                  x-%offset%)
                (* temp
                  (f2cl-lib:fref a-%data%
                    (i j)
                    ((1 lda) (1 *))
                    a-%offset%))))))
            (setf ix (f2cl-lib:int-add ix incx))))
        (if nounit
          (setf (f2cl-lib:fref x-%data%
            (jx)
            ((1 *))
            x-%offset%)
            (*

```



```

(f2cl-lib:fref x-%data%
  (jx)
  ((1 *))
  x-%offset%)
(f2cl-lib:fref a-%data%
  (j j)
  ((1 lda) (1 *))
  a-%offset%))))))
(setf jx (f2cl-lib:int-add jx incx))))))
(t
  (cond
    ((= incx 1)
      (f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
        ((> j 1) nil)
        (tagbody
          (cond
            ((/= (f2cl-lib:fref x (j) ((1 *))) zero)
              (setf temp
                (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%))
              (f2cl-lib:fdo (i n
                (f2cl-lib:int-add i
                  (f2cl-lib:int-sub 1)))
                ((> i (f2cl-lib:int-add j 1)) nil)
                (tagbody
                  (setf (f2cl-lib:fref x-%data%
                    (i)
                    ((1 *))
                    x-%offset%)
                    (+
                      (f2cl-lib:fref x-%data%
                        (i)
                        ((1 *))
                        x-%offset%)
                      (* temp
                        (f2cl-lib:fref a-%data%
                          (i j)
                          ((1 lda) (1 *))
                          a-%offset%))))))
                  (if nunit
                    (setf (f2cl-lib:fref x-%data%
                      (j)
                      ((1 *))
                      x-%offset%)
                      (*
                        (f2cl-lib:fref x-%data%
                          (j)

```

```

((1 *))
x-%offset%)
(f2cl-lib:fref a-%data%
(j j)
((1 lda) (1 *))
a-%offset%)))))))))
(t
(setf kx
  (f2cl-lib:int-add kx
    (f2cl-lib:int-mul
      (f2cl-lib:int-sub n 1)
      incx)))
(setf jx kx)
(f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
  (> j 1) nil)
(tagbody
  (cond
    ((/= (f2cl-lib:fref x (jx) ((1 *))) zero)
      (setf temp
        (f2cl-lib:fref x-%data%
          (jx)
          ((1 *))
          x-%offset%))
      (setf ix kx)
      (f2cl-lib:fdo (i n
        (f2cl-lib:int-add i
          (f2cl-lib:int-sub 1)))
        (> i (f2cl-lib:int-add j 1)) nil)
      (tagbody
        (setf (f2cl-lib:fref x-%data%
          (ix)
          ((1 *))
          x-%offset%)
          (+
            (f2cl-lib:fref x-%data%
              (ix)
              ((1 *))
              x-%offset%)
            (* temp
              (f2cl-lib:fref a-%data%
                (i j)
                ((1 lda) (1 *))
                a-%offset%))))
          (setf ix (f2cl-lib:int-sub ix incx))))
      (if nunit
        (setf (f2cl-lib:fref x-%data%

```

```

                                (jx)
                                ((1 *))
                                x-%offset%)
(*
  (f2cl-lib:fref x-%data%
    (jx)
    ((1 *))
    x-%offset%)
  (f2cl-lib:fref a-%data%
    (j j)
    ((1 lda) (1 *))
    a-%offset%))))))
  (setf jx (f2cl-lib:int-sub jx incx)))))))))
(t
  (cond
    ((char-equal uplo #\U)
      (cond
        ((= incx 1)
          (f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
            (> j 1) nil)
          (tagbody
            (setf temp
              (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%))
            (if nount
              (setf temp
                (* temp
                  (f2cl-lib:fref a-%data%
                    (j j)
                    ((1 lda) (1 *))
                    a-%offset%))))
              (f2cl-lib:fdo (i (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
                (f2cl-lib:int-add i (f2cl-lib:int-sub 1)))
                (> i 1) nil)
              (tagbody
                (setf temp
                  (+ temp
                    (*
                      (f2cl-lib:fref a-%data%
                        (i j)
                        ((1 lda) (1 *))
                        a-%offset%)
                      (f2cl-lib:fref x-%data%
                        (i)
                        ((1 *))
                        x-%offset%))))))
                (setf (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%)

```

```

                                temp))))
(t
  (setf jx
    (f2cl-lib:int-add kx
      (f2cl-lib:int-mul
        (f2cl-lib:int-sub n 1)
        incx)))
    (f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
      (> j 1) nil)
    (tagbody
      (setf temp
        (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%))
      (setf ix jx)
      (if nunit
        (setf temp
          (* temp
            (f2cl-lib:fref a-%data%
              (j j)
              ((1 lda) (1 *))
              a-%offset%))))
        (f2cl-lib:fdo (i (f2cl-lib:int-add j (f2cl-lib:int-sub 1))
          (f2cl-lib:int-add i (f2cl-lib:int-sub 1)))
          (> i 1) nil)
          (tagbody
            (setf ix (f2cl-lib:int-sub ix incx))
            (setf temp
              (+ temp
                (*
                  (f2cl-lib:fref a-%data%
                    (i j)
                    ((1 lda) (1 *))
                    a-%offset%)
                  (f2cl-lib:fref x-%data%
                    (ix)
                    ((1 *))
                    x-%offset%))))))
            (setf (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%)
              temp)
            (setf jx (f2cl-lib:int-sub jx incx))))))
(t
  (cond
    ((= incx 1)
      (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
        (> j n) nil)
      (tagbody
        (setf temp

```

```

(f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%))
(if nunit
  (setf temp
    (* temp
      (f2cl-lib:fref a-%data%
        (j j)
        ((1 lda) (1 *))
        a-%offset%))))
(f2cl-lib:fdo (i (f2cl-lib:int-add j 1)
  (f2cl-lib:int-add i 1))
  (> i n) nil)
(tagbody
  (setf temp
    (+ temp
      (*
        (f2cl-lib:fref a-%data%
          (i j)
          ((1 lda) (1 *))
          a-%offset%)
        (f2cl-lib:fref x-%data%
          (i)
          ((1 *))
          x-%offset%))))))
(setf (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%)
  temp)))
(t
  (setf jx kx)
  (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
    (> j n) nil)
  (tagbody
    (setf temp
      (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%))
    (setf ix jx)
    (if nunit
      (setf temp
        (* temp
          (f2cl-lib:fref a-%data%
            (j j)
            ((1 lda) (1 *))
            a-%offset%))))
      (f2cl-lib:fdo (i (f2cl-lib:int-add j 1)
        (f2cl-lib:int-add i 1))
        (> i n) nil)
      (tagbody
        (setf ix (f2cl-lib:int-add ix incx))
        (setf temp

```

```

(+ temp
  (*
    (f2cl-lib:fref a-%data%
      (i j)
      ((1 lda) (1 *))
      a-%offset%)
    (f2cl-lib:fref x-%data%
      (ix)
      ((1 *))
      x-%offset%))))))
(setf (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%)
      temp)
(setf jx (f2cl-lib:int-add jx incx)))))))))
end_label
(return (values nil nil nil nil nil nil nil nil))))))

```

## 5.16 dtrsv BLAS

```

<dtrsv.input>≡
)set break resume
)sys rm -f dtrsv.output
)spool dtrsv.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)

```

`<dtrsv.help>=`

```
=====
dtrsv examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

DTRSV - solve one of the systems of equations  $Ax = b$ , or  $A'x = b$ ,

#### SYNOPSIS

SUBROUTINE DTRSV ( UPLO, TRANS, DIAG, N, A, LDA, X, INCX )

INTEGER INCX, LDA, N

CHARACTER\*1 DIAG, TRANS, UPLO

DOUBLE PRECISION A( LDA, \* ), X( \* )

#### PURPOSE

DTRSV solves one of the systems of equations

where b and x are n element vectors and A is an n by n unit, or non-unit, upper or lower triangular matrix.

No test for singularity or near-singularity is included in this routine. Such tests must be performed before calling this routine.

#### PARAMETERS

UPLO - CHARACTER\*1.

On entry, UPLO specifies whether the matrix is an upper or lower triangular matrix as follows:

UPLO = 'U' or 'u' A is an upper triangular matrix.

UPLO = 'L' or 'l' A is a lower triangular matrix.

Unchanged on exit.

TRANS - CHARACTER\*1.

On entry, TRANS specifies the equations to be solved as follows:

TRANS = 'N' or 'n'     $A*x = b$ .

TRANS = 'T' or 't'     $A'*x = b$ .

TRANS = 'C' or 'c'     $A'*x = b$ .

Unchanged on exit.

DIAG - CHARACTER\*1.

On entry, DIAG specifies whether or not A is unit triangular as follows:

DIAG = 'U' or 'u'    A is assumed to be unit triangular.

DIAG = 'N' or 'n'    A is not assumed to be unit triangular.

Unchanged on exit.

N - INTEGER.

On entry, N specifies the order of the matrix A. N must be at least zero. Unchanged on exit.

A - DOUBLE PRECISION array of DIMENSION ( LDA, n ).  
Before entry with UPLO = 'U' or 'u', the leading n by n upper triangular part of the array A must contain the upper triangular matrix and the strictly lower triangular part of A is not referenced. Before entry with UPLO = 'L' or 'l', the leading n by n lower triangular part of the array A must contain the lower triangular matrix and the strictly upper triangular part of A is not referenced. Note that when DIAG = 'U' or 'u', the diagonal elements of A are not referenced either, but are assumed to be unity.  
Unchanged on exit.

LDA - INTEGER.

On entry, LDA specifies the first dimension of A as declared in the calling (sub) program. LDA must be at least  $\max(1, n)$ . Unchanged on exit.

X - DOUBLE PRECISION array of dimension at least  $(1 + (n - 1) * \text{abs}(\text{INCX}))$ . Before entry, the



incremented array X must contain the n element right-hand side vector b. On exit, X is overwritten with the solution vector x.

INCX - INTEGER.

On entry, INCX specifies the increment for the elements of X. INCX must not be zero. Unchanged on exit.

```

⟨BLAS 2 dtrsv⟩≡
  (let* ((zero 0.0))
    (declare (type (double-float 0.0 0.0) zero))
    (defun dtrsv (uplo trans diag n lda x incx)
      (declare (type (simple-array double-float (*)) x a)
                (type fixnum incx lda n)
                (type character diag trans uplo))
      (f2cl-lib:with-multi-array-data
        ((uplo character uplo-%data% uplo-%offset%)
         (trans character trans-%data% trans-%offset%)
         (diag character diag-%data% diag-%offset%)
         (a double-float a-%data% a-%offset%)
         (x double-float x-%data% x-%offset%))
        (prog ((nunit nil) (i 0) (info 0) (ix 0) (j 0) (jx 0) (kx 0) (temp 0.0))
          (declare (type (member t nil) nunit)
                    (type fixnum i info ix j jx kx)
                    (type (double-float) temp))
          (setf info 0)
          (cond
            ((and (not (char-equal uplo #\U)) (not (char-equal uplo #\L)))
              (setf info 1))
            ((and (not (char-equal trans #\N))
                  (not (char-equal trans #\T))
                  (not (char-equal trans #\C)))
              (setf info 2))
            ((and (not (char-equal diag #\U)) (not (char-equal diag #\N)))
              (setf info 3))
            ((< n 0)
              (setf info 4))
            ((< lda (max (the fixnum 1) (the fixnum n)))
              (setf info 6))
            ((= incx 0)
              (setf info 8)))
          (cond
            ((/= info 0)
              (error
               " ** On entry to ~a parameter number ~a had an illegal value~%"
               "DTRSV" info)
              (go end_label)))
          (if (= n 0) (go end_label))
          (setf nunit (char-equal diag #\N))
          (cond
            ((<= incx 0)
              (setf kx
                    (f2cl-lib:int-sub 1
                                       (f2cl-lib:int-mul (f2cl-lib:int-sub n 1)

```

```

incx)))
( (/= incx 1)
  (setf kx 1)))
(cond
  ((char-equal trans #\N)
    (cond
      ((char-equal uplo #\U)
        (cond
          ((= incx 1)
            (f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
              ((> j 1) nil)
            (tagbody
              (cond
                ((/= (f2cl-lib:fref x-%data%
                                   (j)
                                   ((1 *))
                                   zero)
                  (if nunit
                      (setf (f2cl-lib:fref x-%data%
                                           (j)
                                           ((1 *))
                                           x-%offset%)
                          (f2cl-lib:fref a-%data%
                                           (j j)
                                           ((1 lda) (1 *))
                                           a-%offset%))))
                (/
                  (f2cl-lib:fref x-%data%
                                   (j)
                                   ((1 *))
                                   x-%offset%)
                  (f2cl-lib:fref a-%data%
                                   (j j)
                                   ((1 lda) (1 *))
                                   a-%offset%))))
              (setf temp
                (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%))
              (f2cl-lib:fdo (i
                (f2cl-lib:int-add j
                  (f2cl-lib:int-sub 1))
                (f2cl-lib:int-add i
                  (f2cl-lib:int-sub 1)))
                  ((> i 1) nil)
                (tagbody
                  (setf (f2cl-lib:fref x-%data%
                                       (i)
                                       ((1 *))
                                       x-%offset%)
                      (-
                        (f2cl-lib:fref x-%data%
                                       (i)
                                       ((1 *))
                                       x-%offset%)

```

```

(* temp
  (f2cl-lib:fref a-%data%
    (i j)
    ((1 lda) (1 *))
    a-%offset%)))))))))
(t
  (setf jx
    (f2cl-lib:int-add kx
      (f2cl-lib:int-mul
        (f2cl-lib:int-sub n 1)
        incx)))
  (f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
    (> j 1) nil)
  (tagbody
    (cond
      ((/= (f2cl-lib:fref x (jx) ((1 *))) zero)
        (if nunit
          (setf (f2cl-lib:fref x-%data%
            (jx)
            ((1 *))
            x-%offset%)
            (/
              (f2cl-lib:fref x-%data%
                (jx)
                ((1 *))
                x-%offset%)
              (f2cl-lib:fref a-%data%
                (j j)
                ((1 lda) (1 *))
                a-%offset%))))))
      (setf temp
        (f2cl-lib:fref x-%data%
          (jx)
          ((1 *))
          x-%offset%))
      (setf ix jx)
      (f2cl-lib:fdo (i
        (f2cl-lib:int-add j
          (f2cl-lib:int-sub 1))
        (f2cl-lib:int-add i
          (f2cl-lib:int-sub 1)))
        (> i 1) nil)
      (tagbody
        (setf ix (f2cl-lib:int-sub ix incx))
        (setf (f2cl-lib:fref x-%data%
          (ix)

```

```

                                ((1 *))
                                x-%offset%)
(-
  (f2cl-lib:fref x-%data%
                (ix)
                ((1 *)))
    x-%offset%)
  (* temp
    (f2cl-lib:fref a-%data%
                  (i j)
                  ((1 lda) (1 *)))
      a-%offset%))))))
  (setf jx (f2cl-lib:int-sub jx incx))))))
(t
  (cond
    ((= incx 1)
      (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                    ((> j n) nil)
      (tagbody
        (cond
          ((/= (f2cl-lib:fref x (j) ((1 *))) zero)
            (if nounit
              (setf (f2cl-lib:fref x-%data%
                                   (j)
                                   ((1 *)))
                    x-%offset%)
            (/
              (f2cl-lib:fref x-%data%
                              (j)
                              ((1 *)))
              x-%offset%)
              (f2cl-lib:fref a-%data%
                              (j j)
                              ((1 lda) (1 *)))
              a-%offset%))))
          (setf temp
            (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%))
          (f2cl-lib:fdo (i (f2cl-lib:int-add j 1)
                        (f2cl-lib:int-add i 1))
                        ((> i n) nil)
          (tagbody
            (setf (f2cl-lib:fref x-%data%
                                  (i)
                                  ((1 *)))
                  x-%offset%)
            (-
              (f2cl-lib:fref x-%data%
                              (ix)
                              ((1 *)))
              x-%offset%)
              (* temp
                (f2cl-lib:fref a-%data%
                                (i j)
                                ((1 lda) (1 *)))
                a-%offset%))))))
            (setf jx (f2cl-lib:int-sub jx incx))))))
  )
)

```

```

(f2cl-lib:fref x-%data%
  (i)
  ((1 *))
  x-%offset%)
(* temp
  (f2cl-lib:fref a-%data%
    (i j)
    ((1 lda) (1 *))
    a-%offset%)))))))))
(t
  (setf jx kx)
  (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
    (> j n) nil)
  (tagbody
    (cond
      ((/= (f2cl-lib:fref x (jx) ((1 *))) zero)
        (if nunit
          (setf (f2cl-lib:fref x-%data%
            (jx)
            ((1 *))
            x-%offset%)
            (/
              (f2cl-lib:fref x-%data%
                (jx)
                ((1 *))
                x-%offset%)
              (f2cl-lib:fref a-%data%
                (j j)
                ((1 lda) (1 *))
                a-%offset%))))))
          (setf temp
            (f2cl-lib:fref x-%data%
              (jx)
              ((1 *))
              x-%offset%))
          (setf ix jx)
          (f2cl-lib:fdo (i (f2cl-lib:int-add j 1)
            (f2cl-lib:int-add i 1))
            (> i n) nil)
          (tagbody
            (setf ix (f2cl-lib:int-add ix incx))
            (setf (f2cl-lib:fref x-%data%
              (ix)
              ((1 *))
              x-%offset%)
              (-

```

```

(f2cl-lib:fref x-%data%
  (ix)
  ((1 *))
  x-%offset%)
(* temp
  (f2cl-lib:fref a-%data%
    (i j)
    ((1 lda) (1 *))
    a-%offset%))))))
(setf jx (f2cl-lib:int-add jx incx))))))
(t
  (cond
    ((char-equal uplo #\U)
      (cond
        ((= incx 1)
          (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
            (> j n) nil)
          (tagbody
            (setf temp
              (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%))
            (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
              (> i
                (f2cl-lib:int-add j
                  (f2cl-lib:int-sub 1)))
                nil)
            (tagbody
              (setf temp
                (- temp
                  (*
                    (f2cl-lib:fref a-%data%
                      (i j)
                      ((1 lda) (1 *))
                      a-%offset%)
                    (f2cl-lib:fref x-%data%
                      (i)
                      ((1 *))
                      x-%offset%))))))
              (if nount
                (setf temp
                  (/ temp
                    (f2cl-lib:fref a-%data%
                      (j j)
                      ((1 lda) (1 *))
                      a-%offset%))))
                (setf (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%)
                  temp))))

```

```

(t
  (setf jx kx)
  (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
    (> j n) nil)
  (tagbody
    (setf temp
      (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%))
    (setf ix kx)
    (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
      (> i
        (f2cl-lib:int-add j
          (f2cl-lib:int-sub 1)))
      nil)
    (tagbody
      (setf temp
        (- temp
          (*
            (f2cl-lib:fref a-%data%
              (i j)
              ((1 lda) (1 *))
              a-%offset%)
            (f2cl-lib:fref x-%data%
              (ix)
              ((1 *))
              x-%offset%))))
        (setf ix (f2cl-lib:int-add ix incx))))
    (if nunit
      (setf temp
        (/ temp
          (f2cl-lib:fref a-%data%
            (j j)
            ((1 lda) (1 *))
            a-%offset%)))
        (setf (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%)
          temp)
        (setf jx (f2cl-lib:int-add jx incx))))))
(t
  (cond
    ((= incx 1)
      (f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
        (> j 1) nil)
      (tagbody
        (setf temp
          (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%))
        (f2cl-lib:fdo (i n
          (f2cl-lib:int-add i (f2cl-lib:int-sub 1)))

```



```

                                (> i (f2cl-lib:int-add j 1)) nil)
(tagbody
  (setf temp
    (- temp
      (*
        (f2cl-lib:fref a-%data%
          (i j)
          ((1 lda) (1 *))
          a-%offset%)
        (f2cl-lib:fref x-%data%
          (i)
          ((1 *))
          x-%offset%))))))
(if nounit
  (setf temp
    (/ temp
      (f2cl-lib:fref a-%data%
        (j j)
        ((1 lda) (1 *))
        a-%offset%)))
  (setf (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%)
    temp)))
(t
  (setf kx
    (f2cl-lib:int-add kx
      (f2cl-lib:int-mul
        (f2cl-lib:int-sub n 1)
        incx)))
  (setf jx kx)
  (f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
    (> j 1) nil)
  (tagbody
    (setf temp
      (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%))
    (setf ix kx)
    (f2cl-lib:fdo (i n
      (f2cl-lib:int-add i (f2cl-lib:int-sub 1)))
      (> i (f2cl-lib:int-add j 1)) nil)
    (tagbody
      (setf temp
        (- temp
          (*
            (f2cl-lib:fref a-%data%
              (i j)
              ((1 lda) (1 *))
              a-%offset%)

```

```

                                (f2cl-lib:fref x-%data%
                                (ix)
                                ((1 *))
                                x-%offset%)))
      (setf ix (f2cl-lib:int-sub ix incx)))
    (if nunit
      (setf temp
        (/ temp
          (f2cl-lib:fref a-%data%
            (j j)
            ((1 lda) (1 *))
            a-%offset%)))
      (setf (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%)
        temp)
      (setf jx (f2cl-lib:int-sub jx incx)))))))))
end_label
  (return (values nil nil nil nil nil nil nil nil))))))

```

## 5.17 zgbmv BLAS

```

⟨zgbmv.input⟩≡
)set break resume
)sys rm -f zgbmv.output
)spool zgbmv.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)

```

`<zgbmv.help>=`

```
=====
zgbmv examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

ZGBMV - perform one of the matrix-vector operations  $y := \alpha * A * x + \beta * y$ , or  $y := \alpha * A' * x + \beta * y$ , or  $y := \alpha * \text{conjg}(A') * x + \beta * y$ ,

#### SYNOPSIS

```
SUBROUTINE ZGBMV ( TRANS, M, N, KL, KU, ALPHA, A, LDA, X,
                  INCX, BETA, Y, INCY )
```

```
      COMPLEX*16  ALPHA, BETA
```

```
      INTEGER     INCX, INCY, KL, KU, LDA, M, N
```

```
      CHARACTER*1 TRANS
```

```
      COMPLEX*16  A( LDA, * ), X( * ), Y( * )
```

#### PURPOSE

ZGBMV performs one of the matrix-vector operations

where alpha and beta are scalars, x and y are vectors and A is an m by n band matrix, with kl sub-diagonals and ku super-diagonals.

#### PARAMETERS

TRANS - CHARACTER\*1.

On entry, TRANS specifies the operation to be performed as follows:

TRANS = 'N' or 'n'  $y := \alpha * A * x + \beta * y$ .

TRANS = 'T' or 't'  $y := \alpha * A' * x + \beta * y$ .

TRANS = 'C' or 'c'  $y := \alpha * \text{conjg}(A') * x + \beta * y$ .

Unchanged on exit.

M - INTEGER.  
On entry, M specifies the number of rows of the matrix A. M must be at least zero. Unchanged on exit.

N - INTEGER.  
On entry, N specifies the number of columns of the matrix A. N must be at least zero. Unchanged on exit.

KL - INTEGER.  
On entry, KL specifies the number of sub-diagonals of the matrix A. KL must satisfy  $0 \leq KL$ . Unchanged on exit.

KU - INTEGER.  
On entry, KU specifies the number of super-diagonals of the matrix A. KU must satisfy  $0 \leq KU$ . Unchanged on exit.

ALPHA - COMPLEX\*16 .  
On entry, ALPHA specifies the scalar alpha. Unchanged on exit.

A - COMPLEX\*16 array of DIMENSION ( LDA, n ).  
Before entry, the leading ( kl + ku + 1 ) by n part of the array A must contain the matrix of coefficients, supplied column by column, with the leading diagonal of the matrix in row ( ku + 1 ) of the array, the first super-diagonal starting at position 2 in row ku, the first sub-diagonal starting at position 1 in row ( ku + 2 ), and so on. Elements in the array A that do not correspond to elements in the band matrix (such as the top left ku by ku triangle) are not referenced. The following program segment will transfer a band matrix from conventional full matrix storage to band storage:

```

DO 20, J = 1, N
  K = KU + 1 - J
  DO 10, I = MAX( 1, J - KU ), MIN( M, J + KL )
    A( K + I, J ) = matrix( I, J )
  10 CONTINUE
20 CONTINUE

```

Unchanged on exit.

- LDA - INTEGER.  
On entry, LDA specifies the first dimension of A as declared in the calling (sub) program. LDA must be at least  $(kl + ku + 1)$ . Unchanged on exit.
- X - COMPLEX\*16            array of DIMENSION at least  
 $(1 + (n - 1) * \text{abs}(INCX))$  when TRANS = 'N' or 'n'  
and at least  $(1 + (m - 1) * \text{abs}(INCX))$  otherwise.  
Before entry, the incremented array X must contain the vector x. Unchanged on exit.
- INCX - INTEGER.  
On entry, INCX specifies the increment for the elements of X. INCX must not be zero. Unchanged on exit.
- BETA - COMPLEX\*16            .  
On entry, BETA specifies the scalar beta. When BETA is supplied as zero then Y need not be set on input. Unchanged on exit.
- Y - COMPLEX\*16            array of DIMENSION at least  
 $(1 + (m - 1) * \text{abs}(INCY))$  when TRANS = 'N' or 'n'  
and at least  $(1 + (n - 1) * \text{abs}(INCY))$  otherwise.  
Before entry, the incremented array Y must contain the vector y. On exit, Y is overwritten by the updated vector y.
- INCY - INTEGER.  
On entry, INCY specifies the increment for the elements of Y. INCY must not be zero. Unchanged on exit.

```

<BLAS 2 zgbmv>≡
(let* ((one (complex 1.0 0.0)) (zero (complex 0.0 0.0)))
  (declare (type (complex double-float) one) (type (complex double-float) zero))
  (defun zgbmv (trans m n kl ku alpha a lda x incx beta y incy)
    (declare (type (simple-array (complex double-float) (*)) y x a)
              (type (complex double-float) beta alpha)
              (type fixnum incy incx lda ku kl n m)
              (type character trans))
    (f2cl-lib:with-multi-array-data
      ((trans character trans-%data% trans-%offset%)
       (a (complex double-float) a-%data% a-%offset%)
       (x (complex double-float) x-%data% x-%offset%)
       (y (complex double-float) y-%data% y-%offset%))
      (prog ((noconj nil) (i 0) (info 0) (ix 0) (iy 0) (j 0) (jx 0) (jy 0)
             (k 0) (kup1 0) (kx 0) (ky 0) (lenx 0) (leny 0) (temp #C(0.0 0.0)))
        (declare (type (member t nil) noconj)
                  (type fixnum i info ix iy j jx jy k kup1 kx ky
                               lenx leny)
                  (type (complex double-float) temp))
        (setf info 0)
        (cond
         ((and (not (char-equal trans #\N))
                (not (char-equal trans #\T))
                (not (char-equal trans #\C)))
          (setf info 1))
         ((< m 0)
          (setf info 2))
         ((< n 0)
          (setf info 3))
         ((< kl 0)
          (setf info 4))
         ((< ku 0)
          (setf info 5))
         ((< lda (f2cl-lib:int-add kl ku 1))
          (setf info 8))
         ((= incx 0)
          (setf info 10))
         ((= incy 0)
          (setf info 13)))
        (cond
         ((/= info 0)
          (error
           " ** On entry to ~a parameter number ~a had an illegal value~%"
           "ZGBMV" info)
          (go end_label)))
        (if (or (= m 0) (= n 0) (and (= alpha zero) (= beta one)))

```

```

      (go end_label))
(setf noconj (char-equal trans #\T))
(cond
  ((char-equal trans #\N)
   (setf lenx n)
   (setf leny m))
  (t
   (setf lenx m)
   (setf leny n)))
(cond
  ((> incx 0)
   (setf kx 1))
  (t
   (setf kx
    (f2cl-lib:int-sub 1
                      (f2cl-lib:int-mul
                      (f2cl-lib:int-sub lenx 1)
                      incx)))))
(cond
  ((> incy 0)
   (setf ky 1))
  (t
   (setf ky
    (f2cl-lib:int-sub 1
                      (f2cl-lib:int-mul
                      (f2cl-lib:int-sub leny 1)
                      incy)))))
(cond
  ((/= beta one)
   (cond
    ((= incy 1)
     (cond
      ((= beta zero)
       (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                     ((> i leny) nil)
       (tagbody
        (setf (f2cl-lib:fref y-%data% (i) ((1 *)) y-%offset%)
              zero))))
      (t
       (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                     ((> i leny) nil)
       (tagbody
        (setf (f2cl-lib:fref y-%data% (i) ((1 *)) y-%offset%)
              (* beta
               (f2cl-lib:fref y-%data%
                               (i)

```

```

((1 *))
y-%offset%)))))))))

(t
  (setf iy ky)
  (cond
    ((= beta zero)
      (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
        (> i leny) nil)
      (tagbody
        (setf (f2cl-lib:fref y-%data% (iy) ((1 *)) y-%offset%)
          zero)
        (setf iy (f2cl-lib:int-add iy incy)))))
    (t
      (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
        (> i leny) nil)
      (tagbody
        (setf (f2cl-lib:fref y-%data% (iy) ((1 *)) y-%offset%)
          (* beta
            (f2cl-lib:fref y-%data%
              (iy)
              ((1 *))
              y-%offset%)))
        (setf iy (f2cl-lib:int-add iy incy)))))))))
(if (= alpha zero) (go end_label))
(setf kup1 (f2cl-lib:int-add ku 1))
(cond
  ((char-equal trans #\N)
    (setf jx kx)
    (cond
      ((= incy 1)
        (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
          (> j n) nil)
        (tagbody
          (cond
            ((/= (f2cl-lib:fref x (jx) ((1 *)) zero)
              (setf temp
                (* alpha
                  (f2cl-lib:fref x-%data%
                    (jx)
                    ((1 *))
                    x-%offset%)))
              (setf k (f2cl-lib:int-sub kup1 j))
              (f2cl-lib:fdo (i
                (max (the fixnum 1)
                  (the fixnum
                    (f2cl-lib:int-add j

```



```

(f2cl-lib:int-sub
  ku)))
(f2cl-lib:int-add i 1))
(> i
  (min (the fixnum m)
        (the fixnum
          (f2cl-lib:int-add j kl))))
nil)
(tagbody
  (setf (f2cl-lib:fref y-%data% (i) ((1 *)) y-%offset%)
    (+
      (f2cl-lib:fref y-%data%
        (i)
        ((1 *))
        y-%offset%)
      (* temp
        (f2cl-lib:fref a-%data%
          ((f2cl-lib:int-add k i) j)
          ((1 lda) (1 *))
          a-%offset%))))))
  (setf jx (f2cl-lib:int-add jx incx))))
(t
  (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
    (> j n) nil)
  (tagbody
    (cond
      ((/= (f2cl-lib:fref x (jx) ((1 *))) zero)
        (setf temp
          (* alpha
            (f2cl-lib:fref x-%data%
              (jx)
              ((1 *))
              x-%offset%)))
        (setf iy ky)
        (setf k (f2cl-lib:int-sub kup1 j))
        (f2cl-lib:fdo (i
          (max (the fixnum 1)
              (the fixnum
                (f2cl-lib:int-add j
                  (f2cl-lib:int-sub
                    ku))))
          (f2cl-lib:int-add i 1))
          (> i
            (min (the fixnum m)
                  (the fixnum
                    (f2cl-lib:int-add j kl))))

```

```

nil)
(tagbody
  (setf (f2cl-lib:fref y-%data% (iy) ((1 *)) y-%offset%)
    (+
      (f2cl-lib:fref y-%data%
        (iy)
        ((1 *))
        y-%offset%)
      (* temp
        (f2cl-lib:fref a-%data%
          ((f2cl-lib:int-add k i) j)
          ((1 lda) (1 *))
          a-%offset%))))
    (setf iy (f2cl-lib:int-add iy incy))))))
(setf jx (f2cl-lib:int-add jx incx))
(if (> j ku) (setf ky (f2cl-lib:int-add ky incy))))))
(t
  (setf jy ky)
  (cond
    ((= incx 1)
      (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
        ((> j n) nil)
        (tagbody
          (setf temp zero)
          (setf k (f2cl-lib:int-sub kup1 j))
          (cond
            (noconj
              (f2cl-lib:fdo (i
                (max (the fixnum 1)
                  (the fixnum
                    (f2cl-lib:int-add j
                      (f2cl-lib:int-sub
                        ku))))
                (f2cl-lib:int-add i 1))
                ((> i
                  (min (the fixnum m)
                    (the fixnum
                      (f2cl-lib:int-add j kl))))
                  nil)
                (tagbody
                  (setf temp
                    (+ temp
                      (*
                        (f2cl-lib:fref a-%data%
                          ((f2cl-lib:int-add k i) j)
                          ((1 lda) (1 *))

```

```

                                a-%offset%)
(f2cl-lib:fref x-%data%
  (i)
  ((1 *))
  x-%offset%))))))
(t
  (f2cl-lib:fdo (i
    (max (the fixnum 1)
          (the fixnum
            (f2cl-lib:int-add j
              (f2cl-lib:int-sub
                ku))))
    (f2cl-lib:int-add i 1))
    (> i
      (min (the fixnum m)
            (the fixnum
              (f2cl-lib:int-add j kl))))
    nil)
  (tagbody
    (setf temp
      (+ temp
        (*
          (f2cl-lib:dconjg
            (f2cl-lib:fref a-%data%
              ((f2cl-lib:int-add k i) j)
              ((1 lda) (1 *))
              a-%offset%))
            (f2cl-lib:fref x-%data%
              (i)
              ((1 *))
              x-%offset%))))))
    (setf (f2cl-lib:fref y-%data% (jy) ((1 *)) y-%offset%)
      (+ (f2cl-lib:fref y-%data% (jy) ((1 *)) y-%offset%)
        (* alpha temp)))
    (setf jy (f2cl-lib:int-add jy incy))))
(t
  (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
    (> j n) nil)
  (tagbody
    (setf temp zero)
    (setf ix kx)
    (setf k (f2cl-lib:int-sub kup1 j))
    (cond
      (noconj
        (f2cl-lib:fdo (i
          (max (the fixnum 1)

```

```

        (the fixnum
          (f2cl-lib:int-add j
            (f2cl-lib:int-sub
              ku))))
      (f2cl-lib:int-add i 1))
    ((> i
      (min (the fixnum m)
        (the fixnum
          (f2cl-lib:int-add j kl))))
      nil)
    (tagbody
      (setf temp
        (+ temp
          (*
            (f2cl-lib:fref a-%data%
              ((f2cl-lib:int-add k i) j)
              ((1 lda) (1 *)))
            a-%offset%)
            (f2cl-lib:fref x-%data%
              (ix)
              ((1 *))
              x-%offset%))))
      (setf ix (f2cl-lib:int-add ix incx))))))
(t
  (f2cl-lib:fdo (i
    (max (the fixnum 1)
      (the fixnum
        (f2cl-lib:int-add j
          (f2cl-lib:int-sub
            ku))))
      (f2cl-lib:int-add i 1))
    ((> i
      (min (the fixnum m)
        (the fixnum
          (f2cl-lib:int-add j kl))))
      nil)
    (tagbody
      (setf temp
        (+ temp
          (*
            (f2cl-lib:dconjg
              (f2cl-lib:fref a-%data%
                ((f2cl-lib:int-add k i) j)
                ((1 lda) (1 *)))
                a-%offset%)
            (f2cl-lib:fref x-%data%
              (ix)
              ((1 *))
              x-%offset%))))
      (setf ix (f2cl-lib:int-add ix incx))))))

```

```

                                (ix)
                                ((1 *))
                                x-%offset%))))
      (setf ix (f2cl-lib:int-add ix incx))))))
    (setf (f2cl-lib:fref y-%data% (jy) ((1 *)) y-%offset%)
      (+ (f2cl-lib:fref y-%data% (jy) ((1 *)) y-%offset%)
        (* alpha temp)))
    (setf jy (f2cl-lib:int-add jy incy))
    (if (> j ku) (setf kx (f2cl-lib:int-add kx incx)))))))))
end_label
  (return
    (values nil nil nil nil nil nil nil nil nil nil nil nil)))

```

## 5.18 zgemv BLAS

```

⟨zgemv.input⟩≡
  )set break resume
  )sys rm -f zgemv.output
  )spool zgemv.output
  )set message test on
  )set message auto off
  )clear all

  )spool
  )lisp (bye)

```

`<zgemv.help>`≡

```
=====
zgemv examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

ZGEMV - perform one of the matrix-vector operations  $y := \alpha * A * x + \beta * y$ , or  $y := \alpha * A' * x + \beta * y$ , or  $y := \alpha * \text{conjg}(A') * x + \beta * y$ ,

#### SYNOPSIS

```
SUBROUTINE ZGEMV ( TRANS, M, N, ALPHA, A, LDA, X, INCX,
                  BETA, Y, INCY )
```

```
      COMPLEX*16  ALPHA, BETA
```

```
      INTEGER     INCX, INCY, LDA, M, N
```

```
      CHARACTER*1 TRANS
```

```
      COMPLEX*16  A( LDA, * ), X( * ), Y( * )
```

#### PURPOSE

ZGEMV performs one of the matrix-vector operations

where alpha and beta are scalars, x and y are vectors and A is an m by n matrix.

#### PARAMETERS

TRANS - CHARACTER\*1.

On entry, TRANS specifies the operation to be performed as follows:

TRANS = 'N' or 'n'  $y := \alpha * A * x + \beta * y$ .

TRANS = 'T' or 't'  $y := \alpha * A' * x + \beta * y$ .

TRANS = 'C' or 'c'  $y := \alpha * \text{conjg}(A') * x + \beta * y$ .

Unchanged on exit.

- M - INTEGER.  
On entry, M specifies the number of rows of the matrix A. M must be at least zero. Unchanged on exit.
- N - INTEGER.  
On entry, N specifies the number of columns of the matrix A. N must be at least zero. Unchanged on exit.
- ALPHA - COMPLEX\*16 .  
On entry, ALPHA specifies the scalar alpha. Unchanged on exit.
- A - COMPLEX\*16 array of DIMENSION ( LDA, n ).  
Before entry, the leading m by n part of the array A must contain the matrix of coefficients. Unchanged on exit.
- LDA - INTEGER.  
On entry, LDA specifies the first dimension of A as declared in the calling (sub) program. LDA must be at least  $\max(1, m)$ . Unchanged on exit.
- X - COMPLEX\*16 array of DIMENSION at least  $(1 + (n - 1) * \text{abs}(INCX))$  when TRANS = 'N' or 'n' and at least  $(1 + (m - 1) * \text{abs}(INCX))$  otherwise. Before entry, the incremented array X must contain the vector x. Unchanged on exit.
- INCX - INTEGER.  
On entry, INCX specifies the increment for the elements of X. INCX must not be zero. Unchanged on exit.
- BETA - COMPLEX\*16 .  
On entry, BETA specifies the scalar beta. When BETA is supplied as zero then Y need not be set on input. Unchanged on exit.
- Y - COMPLEX\*16 array of DIMENSION at least  $(1 + (m - 1) * \text{abs}(INCX))$  when TRANS = 'N' or 'n' and at least  $(1 + (n - 1) * \text{abs}(INCX))$  otherwise. Before entry with BETA non-zero, the incremented array Y must contain the vector y. On exit, Y is overwritten by the updated vector y.

INCY    - INTEGER.  
On entry, INCY specifies the increment for the elements of Y. INCY must not be zero. Unchanged on exit.



```

<BLAS 2 zgenv>≡
  (let* ((one (complex 1.0 0.0)) (zero (complex 0.0 0.0)))
    (declare (type (complex double-float) one) (type (complex double-float) zero))
    (defun zgenv (trans m n alpha a lda x incx beta y incy)
      (declare (type (simple-array (complex double-float) (*)) y x a)
        (type (complex double-float) beta alpha)
        (type fixnum incy incx lda n m)
        (type character trans))
      (f2cl-lib:with-multi-array-data
        ((trans character trans-%data% trans-%offset%)
         (a (complex double-float) a-%data% a-%offset%)
         (x (complex double-float) x-%data% x-%offset%)
         (y (complex double-float) y-%data% y-%offset%))
        (prog ((noconj nil) (i 0) (info 0) (ix 0) (iy 0) (j 0) (jx 0) (jy 0)
              (kx 0) (ky 0) (lenx 0) (leny 0) (temp #C(0.0 0.0)))
          (declare (type (member t nil) noconj)
            (type fixnum i info ix iy j jx jy kx ky lenx
              leny)
            (type (complex double-float) temp))
          (setf info 0)
          (cond
            ((and (not (char-equal trans #\N))
                  (not (char-equal trans #\T))
                  (not (char-equal trans #\C)))
             (setf info 1))
            ((< m 0)
             (setf info 2))
            ((< n 0)
             (setf info 3))
            ((< lda (max (the fixnum 1) (the fixnum m)))
             (setf info 6))
            ((= incx 0)
             (setf info 8))
            ((= incy 0)
             (setf info 11)))
          (cond
            ((/= info 0)
             (error
              " ** On entry to ~a parameter number ~a had an illegal value~%"
              "ZGEMV" info)
             (go end_label)))
          (if (or (= m 0) (= n 0) (and (= alpha zero) (= beta one)))
              (go end_label))
          (setf noconj (char-equal trans #\T))
          (cond
            ((char-equal trans #\N)

```

```

      (setf lenx n)
      (setf leny m))
    (t
      (setf lenx m)
      (setf leny n)))
  (cond
    ((> incx 0)
      (setf kx 1))
    (t
      (setf kx
        (f2cl-lib:int-sub 1
          (f2cl-lib:int-mul
            (f2cl-lib:int-sub lenx 1)
            incx))))))
  (cond
    ((> incy 0)
      (setf ky 1))
    (t
      (setf ky
        (f2cl-lib:int-sub 1
          (f2cl-lib:int-mul
            (f2cl-lib:int-sub leny 1)
            incy))))))
  (cond
    ((/= beta one)
      (cond
        ((= incy 1)
          (cond
            ((= beta zero)
              (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                ((> i leny) nil)
              (tagbody
                (setf (f2cl-lib:fref y-%data% (i) ((1 *)) y-%offset%)
                  zero))))
            (t
              (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                ((> i leny) nil)
              (tagbody
                (setf (f2cl-lib:fref y-%data% (i) ((1 *)) y-%offset%)
                  (* beta
                    (f2cl-lib:fref y-%data%
                      (i)
                      ((1 *))
                      y-%offset%))))))))
          (t
            (setf iy ky)

```

```

(cond
  ((= beta zero)
    (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
      ((> i leny) nil)
      (tagbody
        (setf (f2cl-lib:fref y-%data% (iy) ((1 *)) y-%offset%)
          zero)
        (setf iy (f2cl-lib:int-add iy incy))))))
  (t
    (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
      ((> i leny) nil)
      (tagbody
        (setf (f2cl-lib:fref y-%data% (iy) ((1 *)) y-%offset%)
          (* beta
            (f2cl-lib:fref y-%data%
              (iy)
              ((1 *))
              y-%offset%))))
        (setf iy (f2cl-lib:int-add iy incy)))))))))
(if (= alpha zero) (go end_label))
(cond
  ((char-equal trans #\N)
    (setf jx kx)
    (cond
      ((= incy 1)
        (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
          ((> j n) nil)
          (tagbody
            (cond
              ((/= (f2cl-lib:fref x (jx) ((1 *))) zero)
                (setf temp
                  (* alpha
                    (f2cl-lib:fref x-%data%
                      (jx)
                      ((1 *))
                      x-%offset%)))
                (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                  ((> i m) nil)
                  (tagbody
                    (setf (f2cl-lib:fref y-%data% (i) ((1 *)) y-%offset%)
                      (+
                        (f2cl-lib:fref y-%data%
                          (i)
                          ((1 *))
                          y-%offset%)
                        (* temp

```

```

                                (f2cl-lib:fref a-%data%
                                (i j)
                                ((1 lda) (1 *))
                                a-%offset%))))))
    (setf jx (f2cl-lib:int-add jx incx))))
  (t
   (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                 (> j n) nil)
   (tagbody
    (cond
     ((/= (f2cl-lib:fref x (jx) ((1 *)) zero)
          (setf temp
                  (* alpha
                    (f2cl-lib:fref x-%data%
                                     (jx)
                                     ((1 *))
                                     x-%offset%)))
          (setf iy ky)
          (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                        (> i m) nil)
          (tagbody
           (setf (f2cl-lib:fref y-%data% (iy) ((1 *)) y-%offset%)
                 (+
                  (f2cl-lib:fref y-%data%
                                   (iy)
                                   ((1 *))
                                   y-%offset%)
                  (* temp
                    (f2cl-lib:fref a-%data%
                                     (i j)
                                     ((1 lda) (1 *))
                                     a-%offset%))))
                 (setf iy (f2cl-lib:int-add iy incy))))))
           (setf jx (f2cl-lib:int-add jx incx))))))
  (t
   (setf jy ky)
   (cond
    ((= incx 1)
     (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                   (> j n) nil)
     (tagbody
      (setf temp zero)
      (cond
       (noconj
        (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                      (> i m) nil)

```

```

(tagbody
  (setf temp
    (+ temp
      (*
        (f2cl-lib:fref a-%data%
          (i j)
          ((1 lda) (1 *))
          a-%offset%)
        (f2cl-lib:fref x-%data%
          (i)
          ((1 *))
          x-%offset%))))))
(t
  (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
    ((> i m) nil)
    (tagbody
      (setf temp
        (+ temp
          (*
            (f2cl-lib:dconjg
              (f2cl-lib:fref a-%data%
                (i j)
                ((1 lda) (1 *))
                a-%offset%)
              (f2cl-lib:fref x-%data%
                (i)
                ((1 *))
                x-%offset%))))))
      (setf (f2cl-lib:fref y-%data% (jy) ((1 *)) y-%offset%)
        (+ (f2cl-lib:fref y-%data% (jy) ((1 *)) y-%offset%)
          (* alpha temp)))
      (setf jy (f2cl-lib:int-add jy incy))))
(t
  (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
    ((> j n) nil)
    (tagbody
      (setf temp zero)
      (setf ix kx)
      (cond
        (noconj
          (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
            ((> i m) nil)
            (tagbody
              (setf temp
                (+ temp
                  (*

```

```

(f2cl-lib:fref a-%data%
  (i j)
  ((1 lda) (1 *))
  a-%offset%)
(f2cl-lib:fref x-%data%
  (ix)
  ((1 *))
  x-%offset%)))))
(setf ix (f2cl-lib:int-add ix incx))))))
(t
  (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
    (> i m) nil)
  (tagbody
    (setf temp
      (+ temp
        (*
          (f2cl-lib:dconjg
            (f2cl-lib:fref a-%data%
              (i j)
              ((1 lda) (1 *))
              a-%offset%))
            (f2cl-lib:fref x-%data%
              (ix)
              ((1 *))
              x-%offset%)))))
      (setf ix (f2cl-lib:int-add ix incx))))))
  (setf (f2cl-lib:fref y-%data% (jy) ((1 *)) y-%offset%)
    (+ (f2cl-lib:fref y-%data% (jy) ((1 *)) y-%offset%)
      (* alpha temp)))
  (setf jy (f2cl-lib:int-add jy incy))))))
end_label
(return (values nil nil nil nil nil nil nil nil nil nil))))))

```

## 5.19 zgerc BLAS

```
(zgerc.input)=  
  )set break resume  
  )sys rm -f zgerc.output  
  )spool zgerc.output  
  )set message test on  
  )set message auto off  
  )clear all  
  
  )spool  
  )lisp (bye)
```

`<zgerc.help>=`

```
=====
zgerc examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

ZGERC - perform the rank 1 operation  $A := \alpha * x * \text{conjg}(y') + A$ ,

#### SYNOPSIS

```
SUBROUTINE ZGERC ( M, N, ALPHA, X, INCX, Y, INCY, A, LDA )
```

```
      COMPLEX*16    ALPHA
```

```
      INTEGER       INCX, INCY, LDA, M, N
```

```
      COMPLEX*16    A( LDA, * ), X( * ), Y( * )
```

#### PURPOSE

ZGERC performs the rank 1 operation

where alpha is a scalar, x is an m element vector, y is an n element vector and A is an m by n matrix.

#### PARAMETERS

M - INTEGER.

On entry, M specifies the number of rows of the matrix A. M must be at least zero. Unchanged on exit.

N - INTEGER.

On entry, N specifies the number of columns of the matrix A. N must be at least zero. Unchanged on exit.

ALPHA - COMPLEX\*16 .

On entry, ALPHA specifies the scalar alpha. Unchanged on exit.

X - COMPLEX\*16 array of dimension at least

$(1 + (m - 1) * \text{abs}(\text{INCX}))$ . Before entry, the incremented array X must contain the m element vector



- x. Unchanged on exit.
- INCX - INTEGER.  
On entry, INCX specifies the increment for the elements of X. INCX must not be zero. Unchanged on exit.
- Y - COMPLEX\*16 array of dimension at least  $(1 + (n - 1) * \text{abs}(\text{INCY}))$ . Before entry, the incremented array Y must contain the n element vector y. Unchanged on exit.
- INCY - INTEGER.  
On entry, INCY specifies the increment for the elements of Y. INCY must not be zero. Unchanged on exit.
- A - COMPLEX\*16 array of DIMENSION ( LDA, n ). Before entry, the leading m by n part of the array A must contain the matrix of coefficients. On exit, A is overwritten by the updated matrix.
- LDA - INTEGER.  
On entry, LDA specifies the first dimension of A as declared in the calling (sub) program. LDA must be at least  $\max(1, m)$ . Unchanged on exit.

```

<BLAS 2 zgerc>≡
  (let* ((zero (complex 0.0 0.0)))
    (declare (type (complex double-float) zero))
    (defun zgerc (m n alpha x incx y incy a lda)
      (declare (type (simple-array (complex double-float) (*)) a y x)
        (type (complex double-float) alpha)
        (type fixnum lda incy incx n m))
      (f2cl-lib:with-multi-array-data
        ((x (complex double-float) x-%data% x-%offset%)
         (y (complex double-float) y-%data% y-%offset%)
         (a (complex double-float) a-%data% a-%offset%))
        (prog ((i 0) (info 0) (ix 0) (j 0) (jy 0) (kx 0) (temp #C(0.0 0.0)))
          (declare (type fixnum i info ix j jy kx)
            (type (complex double-float) temp))
          (setf info 0)
          (cond
            ((< m 0)
              (setf info 1))
            ((< n 0)
              (setf info 2))
            ((= incx 0)
              (setf info 5))
            ((= incy 0)
              (setf info 7))
            ((< lda (max (the fixnum 1) (the fixnum m)))
              (setf info 9)))
          (cond
            ((/= info 0)
              (error
                " ** On entry to ~a parameter number ~a had an illegal value~%"
                "ZGERC" info)
              (go end_label)))
          (if (or (= m 0) (= n 0) (= alpha zero)) (go end_label))
          (cond
            ((> incy 0)
              (setf jy 1))
            (t
              (setf jy
                (f2cl-lib:int-sub 1
                  (f2cl-lib:int-mul (f2cl-lib:int-sub n 1)
                    incy)))))
          (cond
            ((= incx 1)
              (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                ((> j n) nil)
                (tagbody

```

```

(cond
  ((/= (f2cl-lib:fref y (jy) ((1 *))) zero)
    (setf temp
      (* alpha
        (f2cl-lib:dconjg
          (f2cl-lib:fref y-%data%
            (jy)
            ((1 *))
            y-%offset%))))
      (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
        ((> i m) nil)
        (tagbody
          (setf (f2cl-lib:fref a-%data%
            (i j)
            ((1 lda) (1 *))
            a-%offset%)
            (+
              (f2cl-lib:fref a-%data%
                (i j)
                ((1 lda) (1 *))
                a-%offset%)
              (*
                (f2cl-lib:fref x-%data% (i) ((1 *)) x-%offset%)
                temp))))))
      (setf jy (f2cl-lib:int-add jy incy))))))
(t
  (cond
    ((> incx 0)
      (setf kx 1))
    (t
      (setf kx
        (f2cl-lib:int-sub 1
          (f2cl-lib:int-mul
            (f2cl-lib:int-sub m 1)
            incx))))))
  (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
    ((> j n) nil)
    (tagbody
      (cond
        ((/= (f2cl-lib:fref y (jy) ((1 *))) zero)
          (setf temp
            (* alpha
              (f2cl-lib:dconjg
                (f2cl-lib:fref y-%data%
                  (jy)
                  ((1 *))

```

```

                                y-%offset%))))
(setf ix kx)
(f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
              ((> i m) nil)
  (tagbody
    (setf (f2cl-lib:fref a-%data%
                        (i j)
                        ((1 lda) (1 *))
                        a-%offset%)
      (+
        (f2cl-lib:fref a-%data%
                        (i j)
                        ((1 lda) (1 *))
                        a-%offset%)
        (*
          (f2cl-lib:fref x-%data%
                          (ix)
                          ((1 *))
                          x-%offset%)
          temp)))
      (setf ix (f2cl-lib:int-add ix incx))))))
(setf jy (f2cl-lib:int-add jy incy))))))
end_label
(return (values nil nil nil nil nil nil nil nil nil))))

```

## 5.20 zgeru BLAS

```

⟨zgeru.input⟩≡
)set break resume
)sys rm -f zgeru.output
)spool zgeru.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)

```

`<zgeru.help>=`

```
=====
zgeru examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

ZGERU - perform the rank 1 operation  $A := \alpha x y' + A$ ,

#### SYNOPSIS

SUBROUTINE ZGERU ( M, N, ALPHA, X, INCX, Y, INCY, A, LDA )

COMPLEX\*16 ALPHA

INTEGER INCX, INCY, LDA, M, N

COMPLEX\*16 A( LDA, \* ), X( \* ), Y( \* )

#### PURPOSE

ZGERU performs the rank 1 operation

where alpha is a scalar, x is an m element vector, y is an n element vector and A is an m by n matrix.

#### PARAMETERS

M - INTEGER.

On entry, M specifies the number of rows of the matrix A. M must be at least zero. Unchanged on exit.

N - INTEGER.

On entry, N specifies the number of columns of the matrix A. N must be at least zero. Unchanged on exit.

ALPHA - COMPLEX\*16 .

On entry, ALPHA specifies the scalar alpha. Unchanged on exit.

X - COMPLEX\*16 array of dimension at least  $(1 + (m - 1) * \text{abs}(\text{INCX}))$ . Before entry, the incremented array X must contain the m element vector x. Unchanged on exit.

- INCX - INTEGER.  
On entry, INCX specifies the increment for the elements of X. INCX must not be zero. Unchanged on exit.
- Y - COMPLEX\*16 array of dimension at least  $(1 + (n - 1) * \text{abs}(\text{INCX}))$ . Before entry, the incremented array Y must contain the n element vector y. Unchanged on exit.
- INCY - INTEGER.  
On entry, INCY specifies the increment for the elements of Y. INCY must not be zero. Unchanged on exit.
- A - COMPLEX\*16 array of DIMENSION ( LDA, n ).  
Before entry, the leading m by n part of the array A must contain the matrix of coefficients. On exit, A is overwritten by the updated matrix.
- LDA - INTEGER.  
On entry, LDA specifies the first dimension of A as declared in the calling (sub) program. LDA must be at least  $\max(1, m)$ . Unchanged on exit.

```

<BLAS 2 zgeru>≡
  (let* ((zero (complex 0.0 0.0)))
    (declare (type (complex double-float) zero))
    (defun zgeru (m n alpha x incx y incy a lda)
      (declare (type (simple-array (complex double-float) (*)) a y x)
        (type (complex double-float) alpha)
        (type fixnum lda incy incx n m))
      (f2cl-lib:with-multi-array-data
        ((x (complex double-float) x-%data% x-%offset%)
         (y (complex double-float) y-%data% y-%offset%)
         (a (complex double-float) a-%data% a-%offset%))
        (prog ((i 0) (info 0) (ix 0) (j 0) (jy 0) (kx 0) (temp #C(0.0 0.0)))
          (declare (type fixnum i info ix j jy kx)
            (type (complex double-float) temp))
          (setf info 0)
          (cond
            ((< m 0)
              (setf info 1))
            ((< n 0)
              (setf info 2))
            ((= incx 0)
              (setf info 5))
            ((= incy 0)
              (setf info 7))
            ((< lda (max (the fixnum 1) (the fixnum m)))
              (setf info 9)))
          (cond
            ((/= info 0)
              (error
                " ** On entry to ~a parameter number ~a had an illegal value~%"
                "ZGERU" info)
              (go end_label)))
          (if (or (= m 0) (= n 0) (= alpha zero)) (go end_label))
          (cond
            ((> incy 0)
              (setf jy 1))
            (t
              (setf jy
                (f2cl-lib:int-sub 1
                  (f2cl-lib:int-mul (f2cl-lib:int-sub n 1)
                    incy))))))
          (cond
            ((= incx 1)
              (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                ((> j n) nil)
                (tagbody

```

```

(cond
  ((/= (f2cl-lib:fref y (jy) ((1 *))) zero)
    (setf temp
      (* alpha
        (f2cl-lib:fref y-%data% (jy) ((1 *)) y-%offset%)))
    (f2cl-lib:fd0 (i 1 (f2cl-lib:int-add i 1))
      ((> i m) nil)
      (tagbody
        (setf (f2cl-lib:fref a-%data%
          (i j)
          ((1 lda) (1 *))
          a-%offset%)
          (+
            (f2cl-lib:fref a-%data%
              (i j)
              ((1 lda) (1 *))
              a-%offset%)
            (*
              (f2cl-lib:fref x-%data% (i) ((1 *)) x-%offset%)
              temp))))))
    (setf jy (f2cl-lib:int-add jy incy))))
(t
  (cond
    ((> incx 0)
      (setf kx 1))
    (t
      (setf kx
        (f2cl-lib:int-sub 1
          (f2cl-lib:int-mul
            (f2cl-lib:int-sub m 1)
            incx))))))
  (f2cl-lib:fd0 (j 1 (f2cl-lib:int-add j 1))
    ((> j n) nil)
    (tagbody
      (cond
        ((/= (f2cl-lib:fref y (jy) ((1 *))) zero)
          (setf temp
            (* alpha
              (f2cl-lib:fref y-%data% (jy) ((1 *)) y-%offset%)))
          (setf ix kx)
          (f2cl-lib:fd0 (i 1 (f2cl-lib:int-add i 1))
            ((> i m) nil)
            (tagbody
              (setf (f2cl-lib:fref a-%data%
                (i j)
                ((1 lda) (1 *))

```



```

                                a-%offset%)
(+
  (f2cl-lib:fref a-%data%
    (i j)
    ((1 lda) (1 *))
    a-%offset%)
  (*
    (f2cl-lib:fref x-%data%
      (ix)
      ((1 *))
      x-%offset%)
    temp)))
  (setf ix (f2cl-lib:int-add ix incx))))))
(setf jy (f2cl-lib:int-add jy incy))))))
end_label
(return (values nil nil nil nil nil nil nil nil))))))

```

## 5.21 zhbmv BLAS

```

(zhbmvi.input)≡
)set break resume
)sys rm -f zhbmv.output
)spool zhbmv.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)

```

`<zhbm.v.help>=`

```
=====
zhbm.v examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

ZHBMV - perform the matrix-vector operation  $y := \alpha * A * x + \beta * y$ ,

#### SYNOPSIS

```
SUBROUTINE ZHBMV ( UPLO, N, K, ALPHA, A, LDA, X, INCX, BETA,
                  Y, INCY )
```

```
      COMPLEX*16    ALPHA, BETA
```

```
      INTEGER       INCX, INCY, K, LDA, N
```

```
      CHARACTER*1    UPLO
```

```
      COMPLEX*16    A( LDA, * ), X( * ), Y( * )
```

#### PURPOSE

ZHBMV performs the matrix-vector operation

where alpha and beta are scalars, x and y are n element vectors and A is an n by n hermitian band matrix, with k super-diagonals.

#### PARAMETERS

UPLO - CHARACTER\*1.

On entry, UPLO specifies whether the upper or lower triangular part of the band matrix A is being supplied as follows:

UPLO = 'U' or 'u' The upper triangular part of A is being supplied.

UPLO = 'L' or 'l' The lower triangular part of A is being supplied.

Unchanged on exit.

- N - INTEGER.  
On entry, N specifies the order of the matrix A. N must be at least zero. Unchanged on exit.
- K - INTEGER.  
On entry, K specifies the number of super-diagonals of the matrix A. K must satisfy  $0 \leq K$ . Unchanged on exit.
- ALPHA - COMPLEX\*16 .  
On entry, ALPHA specifies the scalar alpha. Unchanged on exit.
- A - COMPLEX\*16 array of DIMENSION ( LDA, n ).

Before entry with UPLO = 'U' or 'u', the leading ( k + 1 ) by n part of the array A must contain the upper triangular band part of the hermitian matrix, supplied column by column, with the leading diagonal of the matrix in row ( k + 1 ) of the array, the first super-diagonal starting at position 2 in row k, and so on. The top left k by k triangle of the array A is not referenced. The following program segment will transfer the upper triangular part of a hermitian band matrix from conventional full matrix storage to band storage:

```
DO 20, J = 1, N M = K + 1 - J DO 10, I = MAX( 1, J -
K ), J A( M + I, J ) = matrix( I, J ) 10 CONTINUE
20 CONTINUE
```

Before entry with UPLO = 'L' or 'l', the leading ( k + 1 ) by n part of the array A must contain the lower triangular band part of the hermitian matrix, supplied column by column, with the leading diagonal of the matrix in row 1 of the array, the first sub-diagonal starting at position 1 in row 2, and so on. The bottom right k by k triangle of the array A is not referenced. The following program segment will transfer the lower triangular part of a hermitian band matrix from conventional full matrix storage to band storage:

```
DO 20, J = 1, N M = 1 - J DO 10, I = J, MIN( N, J + K
) A( M + I, J ) = matrix( I, J ) 10 CONTINUE 20
CONTINUE
```

Note that the imaginary parts of the diagonal elements need not be set and are assumed to be zero. Unchanged on exit.

- LDA    - INTEGER.  
On entry, LDA specifies the first dimension of A as declared in the calling (sub) program. LDA must be at least  $(k + 1)$ . Unchanged on exit.
- X       - COMPLEX\*16       array of DIMENSION at least  
          $(1 + (n - 1) * \text{abs}(\text{INCX}))$ . Before entry, the  
incremented array X must contain the vector x.  
Unchanged on exit.
- INCX   - INTEGER.  
On entry, INCX specifies the increment for the elements of X. INCX must not be zero. Unchanged on exit.
- BETA   - COMPLEX\*16       .  
  
On entry, BETA specifies the scalar beta. Unchanged on exit.
- Y       - COMPLEX\*16       array of DIMENSION at least  
          $(1 + (n - 1) * \text{abs}(\text{INCY}))$ . Before entry, the  
incremented array Y must contain the vector y. On  
exit, Y is overwritten by the updated vector y.
- INCY   - INTEGER.  
On entry, INCY specifies the increment for the elements of Y. INCY must not be zero. Unchanged on exit.

```

<BLAS 2 zhbmv>≡
  (let* ((one (complex 1.0 0.0)) (zero (complex 0.0 0.0)))
    (declare (type (complex double-float) one) (type (complex double-float) zero))
    (defun zhbmv (uplo n k alpha a lda x incx beta y incy)
      (declare (type (simple-array (complex double-float) (*)) y x a)
        (type (complex double-float) beta alpha)
        (type fixnum incx incy lda k n)
        (type character uplo))
      (f2cl-lib:with-multi-array-data
        ((uplo character uplo-%data% uplo-%offset%)
         (a (complex double-float) a-%data% a-%offset%)
         (x (complex double-float) x-%data% x-%offset%)
         (y (complex double-float) y-%data% y-%offset%))
        (prog ((i 0) (info 0) (ix 0) (iy 0) (j 0) (jx 0) (jy 0) (kplus1 0) (kx 0)
              (ky 0) (l 0) (temp1 #C(0.0 0.0)) (temp2 #C(0.0 0.0)))
          (declare (type fixnum i info ix iy j jx jy kplus1 kx ky l)
            (type (complex double-float) temp1 temp2))
          (setf info 0)
          (cond
            ((and (not (char-equal uplo #\U)) (not (char-equal uplo #\L)))
              (setf info 1))
            ((< n 0)
              (setf info 2))
            ((< k 0)
              (setf info 3))
            ((< lda (f2cl-lib:int-add k 1))
              (setf info 6))
            ((= incx 0)
              (setf info 8))
            ((= incy 0)
              (setf info 11)))
          (cond
            ((/= info 0)
              (error
                " ** On entry to ~a parameter number ~a had an illegal value~%"
                "ZHBMV" info)
              (go end_label)))
          (if (or (= n 0) (and (= alpha zero) (= beta one))) (go end_label))
          (cond
            ((> incx 0)
              (setf kx 1))
            (t
              (setf kx
                (f2cl-lib:int-sub 1
                  (f2cl-lib:int-mul (f2cl-lib:int-sub n 1)
                    incx))))))

```

```

(cond
  (> incy 0)
  (setf ky 1))
(t
  (setf ky
    (f2cl-lib:int-sub 1
      (f2cl-lib:int-mul (f2cl-lib:int-sub n 1)
        incy))))))

(cond
  (/= beta one)
  (cond
    (= incy 1)
    (cond
      (= beta zero)
      (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
        (> i n) nil)
      (tagbody
        (setf (f2cl-lib:fref y-%data% (i) ((1 *)) y-%offset%
          zero))))))
    (t
      (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
        (> i n) nil)
      (tagbody
        (setf (f2cl-lib:fref y-%data% (i) ((1 *)) y-%offset%
          (* beta
            (f2cl-lib:fref y-%data%
              (i)
              ((1 *))
              y-%offset%))))))))))

(t
  (setf iy ky)
  (cond
    (= beta zero)
    (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
      (> i n) nil)
    (tagbody
      (setf (f2cl-lib:fref y-%data% (iy) ((1 *)) y-%offset%
        zero)
        (setf iy (f2cl-lib:int-add iy incy))))))
    (t
      (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
        (> i n) nil)
      (tagbody
        (setf (f2cl-lib:fref y-%data% (iy) ((1 *)) y-%offset%
          (* beta
            (f2cl-lib:fref y-%data%
              (i)
              ((1 *))
              y-%offset%))))))))))

```

```

                                (iy)
                                ((1 *))
                                y-%offset%)))
                                (setf iy (f2cl-lib:int-add iy incy)))))))))
(if (= alpha zero) (go end_label))
(cond
  ((char-equal uplo #\U)
   (setf kplus1 (f2cl-lib:int-add k 1))
   (cond
     ((and (= incx 1) (= incy 1))
      (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                    ((> j n) nil)
      (tagbody
        (setf temp1
          (* alpha
            (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%)))
        (setf temp2 zero)
        (setf l (f2cl-lib:int-sub kplus1 j))
        (f2cl-lib:fdo (i
          (max (the fixnum 1)
              (the fixnum
                (f2cl-lib:int-add j
                  (f2cl-lib:int-sub
                    (f2cl-lib:int-add i 1))
                    (f2cl-lib:int-sub k))))))
          ((> i
            (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
            nil)
        (tagbody
          (setf (f2cl-lib:fref y-%data% (i) ((1 *)) y-%offset%)
            (+
              (f2cl-lib:fref y-%data% (i) ((1 *)) y-%offset%)
              (* temp1
                (f2cl-lib:fref a-%data%
                  ((f2cl-lib:int-add l i) j)
                  ((1 lda) (1 *))
                  a-%offset%))))
          (setf temp2
            (+ temp2
              (*
                (f2cl-lib:dconjg
                  (f2cl-lib:fref a-%data%
                    ((f2cl-lib:int-add l i) j)
                    ((1 lda) (1 *))
                    a-%offset%))
                (f2cl-lib:fref x-%data%

```

```

                                (i)
                                ((1 *))
                                x-%offset%))))))
(setf (f2cl-lib:fref y-%data% (j) ((1 *)) y-%offset%)
      (+ (f2cl-lib:fref y-%data% (j) ((1 *)) y-%offset%)
         (* temp1
            (coerce (realpart
                      (f2cl-lib:fref a-%data%
                                     (kplus1 j)
                                     ((1 lda) (1 *))
                                     a-%offset%)) 'double-float))
          (* alpha temp2))))))
(t
 (setf jx kx)
 (setf jy ky)
 (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
               ((> j n) nil)
 (tagbody
  (setf temp1
        (* alpha
           (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%)))
  (setf temp2 zero)
  (setf ix kx)
  (setf iy ky)
  (setf l (f2cl-lib:int-sub kplus1 j))
  (f2cl-lib:fdo (i
                 (max (the fixnum 1)
                      (the fixnum
                        (f2cl-lib:int-add j
                                           (f2cl-lib:int-sub
                                            k))))
                 (f2cl-lib:int-add i 1))
                ((> i
                    (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
                 nil)
 (tagbody
  (setf (f2cl-lib:fref y-%data% (iy) ((1 *)) y-%offset%)
        (+
         (f2cl-lib:fref y-%data% (iy) ((1 *)) y-%offset%)
         (* temp1
            (f2cl-lib:fref a-%data%
                           ((f2cl-lib:int-add l i) j)
                           ((1 lda) (1 *))
                           a-%offset%))))
  (setf temp2
        (+ temp2

```



```

(*
  (f2cl-lib:dconjg
    (f2cl-lib:fref a-%data%
      ((f2cl-lib:int-add 1 i) j)
      ((1 lda) (1 *))
      a-%offset%))
    (f2cl-lib:fref x-%data%
      (ix)
      ((1 *))
      x-%offset%)))
  (setf ix (f2cl-lib:int-add ix incx))
  (setf iy (f2cl-lib:int-add iy incy)))
(setf (f2cl-lib:fref y-%data% (jy) ((1 *)) y-%offset%)
  (+ (f2cl-lib:fref y-%data% (jy) ((1 *)) y-%offset%)
    (* temp1
      (coerce (realpart
        (f2cl-lib:fref a-%data%
          (kplus1 j)
          ((1 lda) (1 *))
          a-%offset%)) 'double-float))
      (* alpha temp2)))
(setf jx (f2cl-lib:int-add jx incx))
(setf jy (f2cl-lib:int-add jy incy))
(cond
  ((> j k)
    (setf kx (f2cl-lib:int-add kx incx))
    (setf ky (f2cl-lib:int-add ky incy))))))
(t
  (cond
    ((and (= incx 1) (= incy 1))
      (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
        ((> j n) nil)
        (tagbody
          (setf temp1
            (* alpha
              (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%)))
          (setf temp2 zero)
          (setf (f2cl-lib:fref y-%data% (j) ((1 *)) y-%offset%)
            (+ (f2cl-lib:fref y-%data% (j) ((1 *)) y-%offset%)
              (* temp1
                (coerce (realpart
                  (f2cl-lib:fref a-%data%
                    (1 j)
                    ((1 lda) (1 *))
                    a-%offset%)) 'double-float))))
          (setf l (f2cl-lib:int-sub 1 j))

```

```

(f2cl-lib:fdo (i (f2cl-lib:int-add j 1)
               (f2cl-lib:int-add i 1))
  (> i
    (min (the fixnum n)
          (the fixnum
            (f2cl-lib:int-add j k))))
    nil)
(tagbody
  (setf (f2cl-lib:fref y-%data% (i) ((1 *)) y-%offset%)
    (+
      (f2cl-lib:fref y-%data% (i) ((1 *)) y-%offset%)
      (* temp1
        (f2cl-lib:fref a-%data%
          ((f2cl-lib:int-add 1 i) j)
          ((1 lda) (1 *))
          a-%offset%))))
  (setf temp2
    (+ temp2
      (*
        (f2cl-lib:dconjg
          (f2cl-lib:fref a-%data%
            ((f2cl-lib:int-add 1 i) j)
            ((1 lda) (1 *))
            a-%offset%))
        (f2cl-lib:fref x-%data%
          (i)
          ((1 *))
          x-%offset%))))))
  (setf (f2cl-lib:fref y-%data% (j) ((1 *)) y-%offset%)
    (+ (f2cl-lib:fref y-%data% (j) ((1 *)) y-%offset%)
      (* alpha temp2))))))
(t
  (setf jx kx)
  (setf jy ky)
  (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
    (> j n) nil)
  (tagbody
    (setf temp1
      (* alpha
        (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%)))
    (setf temp2 zero)
    (setf (f2cl-lib:fref y-%data% (jy) ((1 *)) y-%offset%)
      (+ (f2cl-lib:fref y-%data% (jy) ((1 *)) y-%offset%)
        (* temp1
          (coerce (realpart
            (f2cl-lib:fref a-%data%

```

```

(1 j)
((1 lda) (1 *))
a-%offset%)) 'double-float))))
(setf l (f2cl-lib:int-sub 1 j))
(setf ix jx)
(setf iy jy)
(f2cl-lib:fdo (i (f2cl-lib:int-add j 1)
                (f2cl-lib:int-add i 1))
              ((> i
                (min (the fixnum n)
                     (the fixnum
                      (f2cl-lib:int-add j k))))
              nil)
(tagbody
 (setf ix (f2cl-lib:int-add ix incx))
 (setf iy (f2cl-lib:int-add iy incy))
 (setf (f2cl-lib:fref y-%data% (iy) ((1 *)) y-%offset%)
      (+
       (f2cl-lib:fref y-%data% (iy) ((1 *)) y-%offset%)
       (* temp1
          (f2cl-lib:fref a-%data%
                        ((f2cl-lib:int-add 1 i) j)
                        ((1 lda) (1 *))
                        a-%offset%))))
 (setf temp2
      (+ temp2
         (*
          (f2cl-lib:dconjg
           (f2cl-lib:fref a-%data%
                         ((f2cl-lib:int-add 1 i) j)
                         ((1 lda) (1 *))
                         a-%offset%))
          (f2cl-lib:fref x-%data%
                        (ix)
                        ((1 *))
                        x-%offset%))))))
 (setf (f2cl-lib:fref y-%data% (jy) ((1 *)) y-%offset%)
      (+ (f2cl-lib:fref y-%data% (jy) ((1 *)) y-%offset%)
         (* alpha temp2)))
 (setf jx (f2cl-lib:int-add jx incx))
 (setf jy (f2cl-lib:int-add jy incy))))))
end_label
(return (values nil nil nil nil nil nil nil nil nil nil))))

```

## 5.22 zhemv BLAS

```
(zhemv.input)≡  
  )set break resume  
  )sys rm -f zhemv.output  
  )spool zhemv.output  
  )set message test on  
  )set message auto off  
  )clear all  
  
  )spool  
  )lisp (bye)
```

`<zhemv.help>`≡

```
=====
zhemv examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

ZHEMV - perform the matrix-vector operation  $y := \alpha A x + \beta y$ ,

#### SYNOPSIS

```
SUBROUTINE ZHEMV ( UPLO, N, ALPHA, A, LDA, X, INCX, BETA, Y,
                  INCY )
```

```
      COMPLEX*16    ALPHA, BETA
```

```
      INTEGER       INCX, INCY, LDA, N
```

```
      CHARACTER*1    UPLO
```

```
      COMPLEX*16    A( LDA, * ), X( * ), Y( * )
```

#### PURPOSE

ZHEMV performs the matrix-vector operation

where alpha and beta are scalars, x and y are n element vectors and A is an n by n hermitian matrix.

#### PARAMETERS

UPLO - CHARACTER\*1.

On entry, UPLO specifies whether the upper or lower triangular part of the array A is to be referenced as follows:

UPLO = 'U' or 'u' Only the upper triangular part of A is to be referenced.

UPLO = 'L' or 'l' Only the lower triangular part of A is to be referenced.

Unchanged on exit.

N - INTEGER.

On entry, N specifies the order of the matrix A. N must be at least zero. Unchanged on exit.

ALPHA - COMPLEX\*16 .  
On entry, ALPHA specifies the scalar alpha.  
Unchanged on exit.

A - COMPLEX\*16 array of DIMENSION ( LDA, n ).  
Before entry with UPLO = 'U' or 'u', the leading n by n upper triangular part of the array A must contain the upper triangular part of the hermitian matrix and the strictly lower triangular part of A is not referenced. Before entry with UPLO = 'L' or 'l', the leading n by n lower triangular part of the array

A must contain the lower triangular part of the hermitian matrix and the strictly upper triangular part of A is not referenced. Note that the imaginary parts of the diagonal elements need not be set and are assumed to be zero. Unchanged on exit.

LDA - INTEGER.  
On entry, LDA specifies the first dimension of A as declared in the calling (sub) program. LDA must be at least max( 1, n ). Unchanged on exit.

X - COMPLEX\*16 array of dimension at least  
( 1 + ( n - 1 ) \* abs( INCX ) ). Before entry, the incremented array X must contain the n element vector x. Unchanged on exit.

INCX - INTEGER.  
On entry, INCX specifies the increment for the elements of X. INCX must not be zero. Unchanged on exit.

BETA - COMPLEX\*16 .  
On entry, BETA specifies the scalar beta. When BETA is supplied as zero then Y need not be set on input. Unchanged on exit.

Y - COMPLEX\*16 array of dimension at least  
( 1 + ( n - 1 ) \* abs( INCY ) ). Before entry, the incremented array Y must contain the n element vector y. On exit, Y is overwritten by the updated vector y.

INCY - INTEGER.

On entry, INCY specifies the increment for the elements of Y. INCY must not be zero. Unchanged on exit.

```

<BLAS 2 zhmv>≡
  (let* ((one (complex 1.0 0.0)) (zero (complex 0.0 0.0)))
    (declare (type (complex double-float) one) (type (complex double-float) zero))
    (defun zhmv (uplo n alpha a lda x incx beta y incy)
      (declare (type (simple-array (complex double-float) (*)) y x a)
        (type (complex double-float) beta alpha)
        (type fixnum incy incx lda n)
        (type character uplo))
      (f2cl-lib:with-multi-array-data
        ((uplo character uplo-%data% uplo-%offset%)
         (a (complex double-float) a-%data% a-%offset%)
         (x (complex double-float) x-%data% x-%offset%)
         (y (complex double-float) y-%data% y-%offset%))
        (prog ((i 0) (info 0) (ix 0) (iy 0) (j 0) (jx 0) (jy 0) (kx 0) (ky 0)
              (temp1 #C(0.0 0.0)) (temp2 #C(0.0 0.0)))
          (declare (type fixnum i info ix iy j jx jy kx ky)
            (type (complex double-float) temp1 temp2))
          (setf info 0)
          (cond
            ((and (not (char-equal uplo #\U)) (not (char-equal uplo #\L)))
              (setf info 1))
            ((< n 0)
              (setf info 2))
            ((< lda (max (the fixnum 1) (the fixnum n)))
              (setf info 5))
            ((= incx 0)
              (setf info 7))
            ((= incy 0)
              (setf info 10)))
          (cond
            ((/= info 0)
              (error
                " ** On entry to ~a parameter number ~a had an illegal value~%"
                "ZHEMV" info)
              (go end_label)))
          (if (or (= n 0) (and (= alpha zero) (= beta one))) (go end_label))
          (cond
            ((> incx 0)
              (setf kx 1))
            (t
              (setf kx
                (f2cl-lib:int-sub 1
                  (f2cl-lib:int-mul (f2cl-lib:int-sub n 1)
                    incx))))
          (cond
            ((> incy 0)

```



```

(setf ky 1))
(t
  (setf ky
    (f2cl-lib:int-sub 1
      (f2cl-lib:int-mul (f2cl-lib:int-sub n 1)
        incy))))))
(cond
  ((/= beta one)
    (cond
      ((= incy 1)
        (cond
          ((= beta zero)
            (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
              (> i n) nil)
            (tagbody
              (setf (f2cl-lib:fref y-%data% (i) ((1 *)) y-%offset%)
                zero))))
          (t
            (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
              (> i n) nil)
            (tagbody
              (setf (f2cl-lib:fref y-%data% (i) ((1 *)) y-%offset%)
                (* beta
                  (f2cl-lib:fref y-%data%
                    (i)
                    ((1 *))
                    y-%offset%))))))))
      (t
        (setf iy ky)
        (cond
          ((= beta zero)
            (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
              (> i n) nil)
            (tagbody
              (setf (f2cl-lib:fref y-%data% (iy) ((1 *)) y-%offset%)
                zero)
              (setf iy (f2cl-lib:int-add iy incy))))))
          (t
            (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
              (> i n) nil)
            (tagbody
              (setf (f2cl-lib:fref y-%data% (iy) ((1 *)) y-%offset%)
                (* beta
                  (f2cl-lib:fref y-%data%
                    (iy)
                    ((1 *))

```

```

                                y-%offset%)))
      (setf iy (f2cl-lib:int-add iy incy)))))))))
(if (= alpha zero) (go end_label))
(cond
  ((char-equal uplo #\U)
    (cond
      ((and (= incx 1) (= incy 1))
        (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
          ((> j n) nil)
          (tagbody
            (setf temp1
              (* alpha
                (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%)))
            (setf temp2 zero)
            (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
              ((> i
                (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
                nil)
              (tagbody
                (setf (f2cl-lib:fref y-%data% (i) ((1 *)) y-%offset%)
                  (+
                    (f2cl-lib:fref y-%data% (i) ((1 *)) y-%offset%)
                    (* temp1
                      (f2cl-lib:fref a-%data%
                        (i j)
                        ((1 lda) (1 *))
                        a-%offset%))))
                (setf temp2
                  (+ temp2
                    (*
                      (f2cl-lib:dconjg
                        (f2cl-lib:fref a-%data%
                          (i j)
                          ((1 lda) (1 *))
                          a-%offset%))
                      (f2cl-lib:fref x-%data%
                        (i)
                        ((1 *))
                        x-%offset%))))))
            (setf (f2cl-lib:fref y-%data% (j) ((1 *)) y-%offset%)
              (+ (f2cl-lib:fref y-%data% (j) ((1 *)) y-%offset%)
                (* temp1
                  (coerce (realpart
                    (f2cl-lib:fref a-%data%
                      (j j)
                      ((1 lda) (1 *))

```

```

                                a-%offset%)) 'double-float))
                                (* alpha temp2))))))
(t
  (setf jx kx)
  (setf jy ky)
  (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
    ((> j n) nil)
    (tagbody
      (setf temp1
        (* alpha
          (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%)))
      (setf temp2 zero)
      (setf ix kx)
      (setf iy ky)
      (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
        ((> i
          (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
          nil)
        (tagbody
          (setf (f2cl-lib:fref y-%data% (iy) ((1 *)) y-%offset%)
            (+
              (f2cl-lib:fref y-%data% (iy) ((1 *)) y-%offset%)
              (* temp1
                (f2cl-lib:fref a-%data%
                  (i j)
                  ((1 lda) (1 *))
                  a-%offset%))))
          (setf temp2
            (+ temp2
              (*
                (f2cl-lib:dconjg
                  (f2cl-lib:fref a-%data%
                    (i j)
                    ((1 lda) (1 *))
                    a-%offset%))
                (f2cl-lib:fref x-%data%
                  (ix)
                  ((1 *))
                  x-%offset%))))
            (setf ix (f2cl-lib:int-add ix incx))
            (setf iy (f2cl-lib:int-add iy incy))))
      (setf (f2cl-lib:fref y-%data% (jy) ((1 *)) y-%offset%)
        (+ (f2cl-lib:fref y-%data% (jy) ((1 *)) y-%offset%)
          (* temp1
            (coerce (realpart
              (f2cl-lib:fref a-%data%

```

```

                                (j j)
                                ((1 lda) (1 *))
                                a-%offset%)) 'double-float))
                                (* alpha temp2)))
    (setf jx (f2cl-lib:int-add jx incx))
    (setf jy (f2cl-lib:int-add jy incy))))))
(t
 (cond
  ((and (= incx 1) (= incy 1))
   (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                  ((> j n) nil)
   (tagbody
    (setf temp1
      (* alpha
        (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%)))
    (setf temp2 zero)
    (setf (f2cl-lib:fref y-%data% (j) ((1 *)) y-%offset%)
      (+ (f2cl-lib:fref y-%data% (j) ((1 *)) y-%offset%)
        (* temp1
          (coerce (realpart
                    (f2cl-lib:fref a-%data%
                                   (j j)
                                   ((1 lda) (1 *))
                                   a-%offset%)) 'double-float))))
    (f2cl-lib:fdo (i (f2cl-lib:int-add j 1)
                    (f2cl-lib:int-add i 1))
                    ((> i n) nil)
    (tagbody
     (setf (f2cl-lib:fref y-%data% (i) ((1 *)) y-%offset%)
       (+
        (f2cl-lib:fref y-%data% (i) ((1 *)) y-%offset%)
        (* temp1
          (f2cl-lib:fref a-%data%
                         (i j)
                         ((1 lda) (1 *))
                         a-%offset%))))
     (setf temp2
       (+ temp2
          (*
            (f2cl-lib:dconjg
              (f2cl-lib:fref a-%data%
                             (i j)
                             ((1 lda) (1 *))
                             a-%offset%))
            (f2cl-lib:fref x-%data%
                           (i)

```

```

((1 *))
x-%offset%))))))
(setf (f2cl-lib:fref y-%data% (j) ((1 *)) y-%offset%)
      (+ (f2cl-lib:fref y-%data% (j) ((1 *)) y-%offset%)
          (* alpha temp2))))))
(t
 (setf jx kx)
 (setf jy ky)
 (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
               ((> j n) nil)
 (tagbody
  (setf temp1
    (* alpha
      (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%)))
  (setf temp2 zero)
  (setf (f2cl-lib:fref y-%data% (jy) ((1 *)) y-%offset%)
        (+ (f2cl-lib:fref y-%data% (jy) ((1 *)) y-%offset%)
            (* temp1
              (coerce (realpart
                (f2cl-lib:fref a-%data%
                              (j j)
                              ((1 lda) (1 *))
                              a-%offset%)) 'double-float))))))
  (setf ix jx)
  (setf iy jy)
  (f2cl-lib:fdo (i (f2cl-lib:int-add j 1)
                (f2cl-lib:int-add i 1))
                ((> i n) nil)
  (tagbody
   (setf ix (f2cl-lib:int-add ix incx))
   (setf iy (f2cl-lib:int-add iy incy))
   (setf (f2cl-lib:fref y-%data% (iy) ((1 *)) y-%offset%)
         (+
          (f2cl-lib:fref y-%data% (iy) ((1 *)) y-%offset%)
          (* temp1
            (f2cl-lib:fref a-%data%
                          (i j)
                          ((1 lda) (1 *))
                          a-%offset%))))))
   (setf temp2
     (+ temp2
       (*
        (f2cl-lib:dconjg
         (f2cl-lib:fref a-%data%
                       (i j)
                       ((1 lda) (1 *))

```

```

                                a-%offset%))
(f2cl-lib:fref x-%data%
  (ix)
  ((1 *))
  x-%offset%))))))
(setf (f2cl-lib:fref y-%data% (jy) ((1 *)) y-%offset%)
      (+ (f2cl-lib:fref y-%data% (jy) ((1 *)) y-%offset%)
          (* alpha temp2)))
(setf jx (f2cl-lib:int-add jx incx))
(setf jy (f2cl-lib:int-add jy incy))))))
end_label
(return (values nil nil nil nil nil nil nil nil nil))))

```

## 5.23 zher2 BLAS

```

⟨zher2.input⟩≡
)set break resume
)sys rm -f zher2.output
)spool zher2.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)

```

`<zher2.help>=`

```
=====
zher2 examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

ZHER2 - perform the hermitian rank 2 operation  $A := \alpha * x * \text{conj}(y') + \text{conj}(\alpha) * y * \text{conj}(x') + A$ ,

#### SYNOPSIS

```
SUBROUTINE ZHER2 ( UPLO, N, ALPHA, X, INCX, Y, INCY, A, LDA
                  )
```

```
      COMPLEX*16    ALPHA
```

```
      INTEGER      INCX, INCY, LDA, N
```

```
      CHARACTER*1   UPLO
```

```
      COMPLEX*16    A( LDA, * ), X( * ), Y( * )
```

#### PURPOSE

ZHER2 performs the hermitian rank 2 operation

where alpha is a scalar, x and y are n element vectors and A is an n by n hermitian matrix.

#### PARAMETERS

UPLO - CHARACTER\*1.

On entry, UPLO specifies whether the upper or lower triangular part of the array A is to be referenced as follows:

UPLO = 'U' or 'u' Only the upper triangular part of A is to be referenced.

UPLO = 'L' or 'l' Only the lower triangular part of A is to be referenced.

Unchanged on exit.

N - INTEGER.

On entry, N specifies the order of the matrix A. N must be at least zero. Unchanged on exit.

ALPHA - COMPLEX\*16 .

On entry, ALPHA specifies the scalar alpha. Unchanged on exit.

X - COMPLEX\*16 array of dimension at least  $(1 + (n - 1) * \text{abs}(\text{INCX}))$ . Before entry, the incremented array X must contain the n element vector x. Unchanged on exit.

INCX - INTEGER.

On entry, INCX specifies the increment for the

elements of X. INCX must not be zero. Unchanged on exit.

Y - COMPLEX\*16 array of dimension at least  $(1 + (n - 1) * \text{abs}(\text{INCY}))$ . Before entry, the incremented array Y must contain the n element vector y. Unchanged on exit.

INCY - INTEGER.

On entry, INCY specifies the increment for the elements of Y. INCY must not be zero. Unchanged on exit.

A - COMPLEX\*16 array of DIMENSION ( LDA, n ). Before entry with UPLO = 'U' or 'u', the leading n by n upper triangular part of the array A must contain the upper triangular part of the hermitian matrix and the strictly lower triangular part of A is not referenced. On exit, the upper triangular part of the array A is overwritten by the upper triangular part of the updated matrix. Before entry with UPLO = 'L' or 'l', the leading n by n lower triangular part of the array A must contain the lower triangular part of the hermitian matrix and the strictly upper triangular part of A is not referenced. On exit, the lower triangular part of the array A is overwritten by the lower triangular part of the updated matrix. Note that the imaginary parts of the diagonal elements need not be set, they are assumed to be zero, and on exit they are set to zero.



LDA - INTEGER.

On entry, LDA specifies the first dimension of A as declared in the calling (sub) program. LDA must be at least  $\max(1, n)$ . Unchanged on exit.

```

⟨BLAS 2 zher2⟩≡
  (let* ((zero (complex 0.0 0.0)))
    (declare (type (complex double-float) zero))
    (defun zher2 (uplo n alpha x incx y incy a lda)
      (declare (type (simple-array (complex double-float) (*)) a y x)
        (type (complex double-float) alpha)
        (type fixnum lda incy incx n)
        (type character uplo))
      (f2cl-lib:with-multi-array-data
        ((uplo character uplo-%data% uplo-%offset%)
         (x (complex double-float) x-%data% x-%offset%)
         (y (complex double-float) y-%data% y-%offset%)
         (a (complex double-float) a-%data% a-%offset%))
        (prog ((i 0) (info 0) (ix 0) (iy 0) (j 0) (jx 0) (jy 0) (kx 0) (ky 0)
          (temp1 #C(0.0 0.0)) (temp2 #C(0.0 0.0)))
          (declare (type fixnum i info ix iy j jx jy kx ky)
            (type (complex double-float) temp1 temp2))
          (setf info 0)
          (cond
            ((and (not (char-equal uplo #\U)) (not (char-equal uplo #\L)))
              (setf info 1))
            ((< n 0)
              (setf info 2))
            ((= incx 0)
              (setf info 5))
            ((= incy 0)
              (setf info 7))
            ((< lda (max (the fixnum 1) (the fixnum n)))
              (setf info 9)))
          (cond
            ((/= info 0)
              (error
                " ** On entry to ~a parameter number ~a had an illegal value~%"
                "ZHER2" info)
              (go end_label)))
          (if (or (= n 0) (= alpha zero)) (go end_label))
          (cond
            ((or (/= incx 1) (/= incy 1))
              (cond
                ((> incx 0)
                  (setf kx 1))
                (t
                  (setf kx
                    (f2cl-lib:int-sub 1
                      (f2cl-lib:int-mul
                        (f2cl-lib:int-sub n 1)

```

```

                                incx))))))
(cond
  (> incy 0)
  (setf ky 1))
(t
  (setf ky
    (f2cl-lib:int-sub 1
      (f2cl-lib:int-mul
        (f2cl-lib:int-sub n 1)
        incy))))))
(setf jx kx)
(setf jy ky))
(cond
  ((char-equal uplo #\U)
    (cond
      ((and (= incx 1) (= incy 1))
        (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
          (> j n) nil)
          (tagbody
            (cond
              ((or (/= (f2cl-lib:fref x (j) ((1 *))) zero)
                (/= (f2cl-lib:fref y (j) ((1 *))) zero))
                (setf temp1
                  (* alpha
                    (f2cl-lib:dconjg
                      (f2cl-lib:fref y-%data%
                        (j)
                        ((1 *))
                        y-%offset%))))))
              (setf temp2
                (coerce
                  (f2cl-lib:dconjg
                    (* alpha
                      (f2cl-lib:fref x-%data%
                        (j)
                        ((1 *))
                        x-%offset%)))
                  '(complex double-float)))
                (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                  (> i
                    (f2cl-lib:int-add j
                      (f2cl-lib:int-sub 1)))
                    nil)
                    (tagbody
                      (setf (f2cl-lib:fref a-%data%
                        (i j)

```

```

((1 lda) (1 *))
a-%offset%)
(+
(f2cl-lib:fref a-%data%
  (i j)
  ((1 lda) (1 *))
  a-%offset%)

(*
(f2cl-lib:fref x-%data%
  (i)
  ((1 *))
  x-%offset%)

temp1)
(*
(f2cl-lib:fref y-%data%
  (i)
  ((1 *))
  y-%offset%)

temp2))))))
(setf (f2cl-lib:fref a-%data%
  (j j)
  ((1 lda) (1 *))
  a-%offset%)

(coerce
(+
(coerce (realpart
(f2cl-lib:fref a-%data%
  (j j)
  ((1 lda) (1 *))
  a-%offset%)) 'double-float)
(coerce (realpart
(+
(*
(f2cl-lib:fref x-%data%
  (j)
  ((1 *))
  x-%offset%)

temp1)
(*
(f2cl-lib:fref y-%data%
  (j)
  ((1 *))
  y-%offset%)

temp2)))) 'double-float))
'(complex double-float))))

```

(t

```

(setf (f2cl-lib:fref a-%data%
                    (j j)
                    ((1 lda) (1 *))
                    a-%offset%))

(coerce
 (coerce (realpart
          (f2cl-lib:fref a-%data%
                        (j j)
                        ((1 lda) (1 *))
                        a-%offset%)) 'double-float)
 '(complex double-float))))))
(t
 (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
               ((> j n) nil)
 (tagbody
  (cond
   ((or (/= (f2cl-lib:fref x (jx) ((1 *))) zero)
        (/= (f2cl-lib:fref y (jy) ((1 *))) zero))
    (setf temp1
      (* alpha
         (f2cl-lib:dconjg
          (f2cl-lib:fref y-%data%
                        (jy)
                        ((1 *))
                        y-%offset%))))
    (setf temp2
      (coerce
       (f2cl-lib:dconjg
        (* alpha
           (f2cl-lib:fref x-%data%
                         (jx)
                         ((1 *))
                         x-%offset%)))
        '(complex double-float)))
    (setf ix kx)
    (setf iy ky)
    (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                  ((> i
                     (f2cl-lib:int-add j
                                   (f2cl-lib:int-sub 1)))
                   nil)
 (tagbody
  (setf (f2cl-lib:fref a-%data%
                      (i j)
                      ((1 lda) (1 *))
                      a-%offset%))

```

```

(+
  (f2cl-lib:fref a-%data%
    (i j)
    ((1 lda) (1 *))
    a-%offset%)

  (*
    (f2cl-lib:fref x-%data%
      (ix)
      ((1 *))
      x-%offset%)

    temp1)
  (*
    (f2cl-lib:fref y-%data%
      (iy)
      ((1 *))
      y-%offset%)

    temp2)))
(setf ix (f2cl-lib:int-add ix incx))
(setf iy (f2cl-lib:int-add iy incy)))
(setf (f2cl-lib:fref a-%data%
  (j j)
  ((1 lda) (1 *))
  a-%offset%)

(coerce
  (+
    (coerce (realpart
      (f2cl-lib:fref a-%data%
        (j j)
        ((1 lda) (1 *))
        a-%offset%)) 'double-float)

    (coerce (realpart
      (+
        (*
          (f2cl-lib:fref x-%data%
            (jx)
            ((1 *))
            x-%offset%)

          temp1)
        (*
          (f2cl-lib:fref y-%data%
            (jy)
            ((1 *))
            y-%offset%)

          temp2))) 'double-float))
    '(complex double-float))))

```

(t

```

(setf (f2cl-lib:fref a-%data%
                    (j j)
                    ((1 lda) (1 *))
                    a-%offset%))

(coerce
 (coerce (realpart
          (f2cl-lib:fref a-%data%
                        (j j)
                        ((1 lda) (1 *))
                        a-%offset%)) 'double-float)
 '(complex double-float))))
(setf jx (f2cl-lib:int-add jx incx))
(setf jy (f2cl-lib:int-add jy incy))))))
(t
 (cond
  ((and (= incx 1) (= incy 1))
   (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                  ((> j n) nil)
   (tagbody
    (cond
     ((or (/= (f2cl-lib:fref x (j) ((1 *))) zero)
           (/= (f2cl-lib:fref y (j) ((1 *))) zero))
      (setf temp1
              (* alpha
                 (f2cl-lib:dconjg
                  (f2cl-lib:fref y-%data%
                                (j)
                                ((1 *))
                                y-%offset%))))
      (setf temp2
              (coerce
               (f2cl-lib:dconjg
                (* alpha
                   (f2cl-lib:fref x-%data%
                                   (j)
                                   ((1 *))
                                   x-%offset%)))
               'complex double-float)))
      (setf (f2cl-lib:fref a-%data%
                          (j j)
                          ((1 lda) (1 *))
                          a-%offset%))
              (+
               (coerce (realpart
                        (f2cl-lib:fref a-%data%

```

```

                                (j j)
                                ((1 lda) (1 *))
                                a-%offset%)) 'double-float)
(coerce (realpart
(+
  (*
    (f2cl-lib:fref x-%data%
                    (j)
                    ((1 *))
                    x-%offset%)

    temp1)
  (*
    (f2cl-lib:fref y-%data%
                    (j)
                    ((1 *))
                    y-%offset%)

    temp2))) 'double-float))
'(complex double-float)))
(f2cl-lib:fdo (i (f2cl-lib:int-add j 1)
                (f2cl-lib:int-add i 1))
              (> i n) nil)
(tagbody
  (setf (f2cl-lib:fref a-%data%
                      (i j)
                      ((1 lda) (1 *))
                      a-%offset%)

    (+
      (f2cl-lib:fref a-%data%
                      (i j)
                      ((1 lda) (1 *))
                      a-%offset%)

      (*
        (f2cl-lib:fref x-%data%
                        (i)
                        ((1 *))
                        x-%offset%)

        temp1)
      (*
        (f2cl-lib:fref y-%data%
                        (i)
                        ((1 *))
                        y-%offset%)

        temp2))))))
(t
  (setf (f2cl-lib:fref a-%data%
                      (j j)

```



```

((1 lda) (1 *))
a-%offset%)
(coerce
  (coerce (realpart
    (f2cl-lib:fref a-%data%
      (j j)
      ((1 lda) (1 *))
      a-%offset%)) 'double-float)
    '(complex double-float))))))
(t
  (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
    ((> j n) nil)
    (tagbody
      (cond
        ((or (/= (f2cl-lib:fref x (jx) ((1 *)) zero)
          (/= (f2cl-lib:fref y (jy) ((1 *)) zero))
          (setf temp1
            (* alpha
              (f2cl-lib:dconjg
                (f2cl-lib:fref y-%data%
                  (jy)
                  ((1 *))
                  y-%offset%))))
            (setf temp2
              (coerce
                (f2cl-lib:dconjg
                  (* alpha
                    (f2cl-lib:fref x-%data%
                      (jx)
                      ((1 *))
                      x-%offset%)))
                  '(complex double-float)))
              (setf (f2cl-lib:fref a-%data%
                (j j)
                ((1 lda) (1 *))
                a-%offset%)
                (coerce
                  (+
                    (coerce (realpart
                      (f2cl-lib:fref a-%data%
                        (j j)
                        ((1 lda) (1 *))
                        a-%offset%)) 'double-float)
                    (coerce (realpart
                      (+
                        (*

```

```

(f2cl-lib:fref x-%data%
  (jx)
  ((1 *))
  x-%offset%)
temp1)
(*
(f2cl-lib:fref y-%data%
  (jy)
  ((1 *))
  y-%offset%)
temp2))) 'double-float))
'(complex double-float))
(setf ix jx)
(setf iy jy)
(f2cl-lib:fdo (i (f2cl-lib:int-add j 1)
  (f2cl-lib:int-add i 1))
  (> i n) nil)
(tagbody
  (setf ix (f2cl-lib:int-add ix incx))
  (setf iy (f2cl-lib:int-add iy incy))
  (setf (f2cl-lib:fref a-%data%
    (i j)
    ((1 lda) (1 *))
    a-%offset%)
    (+
      (f2cl-lib:fref a-%data%
        (i j)
        ((1 lda) (1 *))
        a-%offset%)
      (*
        (f2cl-lib:fref x-%data%
          (ix)
          ((1 *))
          x-%offset%)
        temp1)
      (*
        (f2cl-lib:fref y-%data%
          (iy)
          ((1 *))
          y-%offset%)
        temp2))))))
(t
  (setf (f2cl-lib:fref a-%data%
    (j j)
    ((1 lda) (1 *))
    a-%offset%)

```

```

(coerce
  (coerce (realpart
    (f2cl-lib:fref a-%data%
      (j j)
      ((1 lda) (1 *))
      a-%offset%)) 'double-float)
    '(complex double-float))))
(setf jx (f2cl-lib:int-add jx incx))
(setf jy (f2cl-lib:int-add jy incy))))))
end_label
(return (values nil nil nil nil nil nil nil nil))))

```

## 5.24 zher BLAS

```

<zher.input>≡
)set break resume
)sys rm -f zher.output
)spool zher.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)

```

`<zher.help>`≡

```
=====
zher examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

ZHER - perform the hermitian rank 1 operation     $A :=$   
 $\alpha * x * \text{conjg}(x') + A,$

#### SYNOPSIS

```
SUBROUTINE ZHER ( UPLO, N, ALPHA, X, INCX, A, LDA )
```

```
      DOUBLE      PRECISION ALPHA
```

```
      INTEGER      INCX, LDA, N
```

```
      CHARACTER*1 UPLO
```

```
      COMPLEX*16  A( LDA, * ), X( * )
```

#### PURPOSE

ZHER    performs the hermitian rank 1 operation

where alpha is a real scalar, x is an n element vector and A  
 is an n by n hermitian matrix.

#### PARAMETERS

UPLO    - CHARACTER\*1.

On entry, UPLO specifies whether the upper or lower  
 triangular part of the array A is to be referenced as  
 follows:

UPLO = 'U' or 'u'    Only the upper triangular part of  
 A is to be referenced.

UPLO = 'L' or 'l'    Only the lower triangular part of  
 A is to be referenced.

Unchanged on exit.

N        - INTEGER.

On entry, N specifies the order of the matrix A.    N

must be at least zero. Unchanged on exit.

ALPHA - DOUBLE PRECISION.

On entry, ALPHA specifies the scalar alpha.  
Unchanged on exit.

X - COMPLEX\*16 array of dimension at least  
( 1 + ( n - 1 ) \* abs( INCX ) ). Before entry, the  
incremented array X must contain the n element vector  
x. Unchanged on exit.

INCX - INTEGER.

On entry, INCX specifies the increment for the ele-  
ments of X. INCX must not be zero. Unchanged on  
exit.

A - COMPLEX\*16 array of DIMENSION ( LDA, n ).  
Before entry with UPLO = 'U' or 'u', the leading n  
by n upper triangular part of the array A must con-  
tain the upper triangular part of the hermitian  
matrix and the strictly lower triangular part of A is  
not referenced. On exit, the upper triangular part of  
the array A is overwritten by the upper triangular  
part of the updated matrix. Before entry with UPLO =  
'L' or 'l', the leading n by n lower triangular part  
of the array A must contain the lower triangular part  
of the hermitian matrix and the strictly upper tri-  
angular part of A is not referenced. On exit, the  
lower triangular part of the array A is overwritten  
by the lower triangular part of the updated matrix.  
Note that the imaginary parts of the diagonal ele-  
ments need not be set, they are assumed to be zero,  
and on exit they are set to zero.

LDA - INTEGER.

On entry, LDA specifies the first dimension of A as  
declared in the calling (sub) program. LDA must be at  
least max( 1, n ). Unchanged on exit.

```
(BLAS 2 zher)≡
(let* ((zero (complex 0.0 0.0)))
(declare (type (complex double-float) zero))
(defun zher (uplo n alpha x incx a lda)
  (declare (type (simple-array (complex double-float) (*)) a x)
    (type (double-float) alpha)
    (type fixnum lda incx n)
    (type character uplo))
  (f2cl-lib:with-multi-array-data
    ((uplo character uplo-%data% uplo-%offset%)
     (x (complex double-float) x-%data% x-%offset%)
     (a (complex double-float) a-%data% a-%offset%))
    (prog ((i 0) (info 0) (ix 0) (j 0) (jx 0) (kx 0) (temp #C(0.0 0.0)))
      (declare (type fixnum i info ix j jx kx)
        (type (complex double-float) temp))
      (setf info 0)
      (cond
        ((and (not (char-equal uplo #\U)) (not (char-equal uplo #\L)))
         (setf info 1))
        ((< n 0)
         (setf info 2))
        ((= incx 0)
         (setf info 5))
        ((< lda (max (the fixnum 1) (the fixnum n)))
         (setf info 7)))
      (cond
        ((/= info 0)
         (error
          " ** On entry to ~a parameter number ~a had an illegal value~%"
          "ZHER" info)
         (go end_label)))
      (if (or (= n 0) (= alpha (coerce (realpart zero) 'double-float)))
        (go end_label))
      (cond
        ((<= incx 0)
         (setf kx
          (f2cl-lib:int-sub 1
            (f2cl-lib:int-mul (f2cl-lib:int-sub n 1)
              incx))))
        ((/= incx 1)
         (setf kx 1)))
      (cond
        ((char-equal uplo #\U)
         (cond
           ((= incx 1)
            (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
```

```

                                (> j n) nil)
(tagbody
  (cond
    ((/= (f2cl-lib:fref x (j) ((1 *))) zero)
      (setf temp
        (coerce
          (* alpha
            (f2cl-lib:dconjg
              (f2cl-lib:fref x-%data%
                (j)
                ((1 *))
                x-%offset%)))
          '(complex double-float)))
      (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
        (> i
          (f2cl-lib:int-add j
            (f2cl-lib:int-sub 1)))
          nil)
      (tagbody
        (setf (f2cl-lib:fref a-%data%
          (i j)
          ((1 lda) (1 *))
          a-%offset%)
          (+
            (f2cl-lib:fref a-%data%
              (i j)
              ((1 lda) (1 *))
              a-%offset%)
            (*
              (f2cl-lib:fref x-%data%
                (i)
                ((1 *))
                x-%offset%)
              temp))))))
      (setf (f2cl-lib:fref a-%data%
        (j j)
        ((1 lda) (1 *))
        a-%offset%)
        (coerce
          (+
            (coerce (realpart
              (f2cl-lib:fref a-%data%
                (j j)
                ((1 lda) (1 *))
                a-%offset%)) 'double-float)
            (coerce (realpart

```

```

(*
  (f2cl-lib:fref x-%data%
    (j)
    ((1 *))
    x-%offset%)
  temp)) 'double-float))
'(complex double-float))))
(t
  (setf (f2cl-lib:fref a-%data%
    (j j)
    ((1 lda) (1 *))
    a-%offset%)
    (coerce
      (coerce (realpart
        (f2cl-lib:fref a-%data%
          (j j)
          ((1 lda) (1 *))
          a-%offset%)) 'double-float)
      'double-float))
    'double-float))
  'double-float))))))
(t
  (setf jx kx)
  (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
    ((> j n) nil)
    (tagbody
      (cond
        ((/= (f2cl-lib:fref x (jx) ((1 *))) zero)
          (setf temp
            (coerce
              (* alpha
                (f2cl-lib:dconjg
                  (f2cl-lib:fref x-%data%
                    (jx)
                    ((1 *))
                    x-%offset%)))
              'double-float))
            (setf ix kx)
            (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
              ((> i
                (f2cl-lib:int-add j
                  (f2cl-lib:int-sub 1)))
                nil)
              (tagbody
                (setf (f2cl-lib:fref a-%data%
                  (i j)
                  ((1 lda) (1 *))
                  a-%offset%)

```



```

(+
  (f2cl-lib:fref a-%data%
    (i j)
    ((1 lda) (1 *))
    a-%offset%)

  (*
    (f2cl-lib:fref x-%data%
      (ix)
      ((1 *))
      x-%offset%)

    temp)))
(setf ix (f2cl-lib:int-add ix incx)))
(setf (f2cl-lib:fref a-%data%
  (j j)
  ((1 lda) (1 *))
  a-%offset%)

(coerce
  (+
    (coerce (realpart
      (f2cl-lib:fref a-%data%
        (j j)
        ((1 lda) (1 *))
        a-%offset%)) 'double-float)

    (coerce (realpart
      (*
        (f2cl-lib:fref x-%data%
          (jx)
          ((1 *))
          x-%offset%)

        temp)) 'double-float))
    '(complex double-float))))
(t
  (setf (f2cl-lib:fref a-%data%
    (j j)
    ((1 lda) (1 *))
    a-%offset%)

    (coerce
      (coerce (realpart
        (f2cl-lib:fref a-%data%
          (j j)
          ((1 lda) (1 *))
          a-%offset%)) 'double-float)
      '(complex double-float))))
  (setf jx (f2cl-lib:int-add jx incx))))))
(t
  (cond

```

```
(= incx 1)
(f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
              (> j n) nil)

(tagbody
 (cond
  ((/= (f2cl-lib:fref x (j) ((1 *))) zero)
   (setf temp
        (coerce
         (* alpha
            (f2cl-lib:dconjg
             (f2cl-lib:fref x-%data%
                           (j)
                           ((1 *))
                           x-%offset%)))
          '(complex double-float)))
   (setf (f2cl-lib:fref a-%data%
                       (j j)
                       ((1 lda) (1 *))
                       a-%offset%)
        (coerce
         (+
          (coerce (realpart
                   (f2cl-lib:fref a-%data%
                                   (j j)
                                   ((1 lda) (1 *))
                                   a-%offset%))) 'double-float)
          (coerce (realpart
                   (* temp
                     (f2cl-lib:fref x-%data%
                                     (j)
                                     ((1 *))
                                     x-%offset%))) 'double-float)))
          '(complex double-float)))
  (f2cl-lib:fdo (i (f2cl-lib:int-add j 1)
                  (f2cl-lib:int-add i 1))
                (> i n) nil)
  (tagbody
   (setf (f2cl-lib:fref a-%data%
                       (i j)
                       ((1 lda) (1 *))
                       a-%offset%)
        (+
         (f2cl-lib:fref a-%data%
                         (i j)
                         ((1 lda) (1 *))
                         a-%offset%)
```

```

(*
  (f2cl-lib:fref x-%data%
                (i)
                ((1 *))
                x-%offset%)
temp))))))
(t
  (setf (f2cl-lib:fref a-%data%
                    (j j)
                    ((1 lda) (1 *))
                    a-%offset%)
        (coerce
          (coerce (realpart
                    (f2cl-lib:fref a-%data%
                                    (j j)
                                    ((1 lda) (1 *))
                                    a-%offset%)) 'double-float)
          '(complex double-float))))))
(t
  (setf jx kx)
  (f2cl-lib:fd0 (j 1 (f2cl-lib:int-add j 1))
                ((> j n) nil)
  (tagbody
    (cond
      ((/= (f2cl-lib:fref x (jx) ((1 *))) zero)
        (setf temp
          (coerce
            (* alpha
              (f2cl-lib:dconjg
                (f2cl-lib:fref x-%data%
                                (jx)
                                ((1 *))
                                x-%offset%)))
            '(complex double-float)))
        (setf (f2cl-lib:fref a-%data%
                            (j j)
                            ((1 lda) (1 *))
                            a-%offset%)
              (coerce
                (+
                  (coerce (realpart
                            (f2cl-lib:fref a-%data%
                                            (j j)
                                            ((1 lda) (1 *))
                                            a-%offset%)) 'double-float)
                  (coerce (realpart

```

```

(* temp
  (f2cl-lib:fref x-%data%
    (jx)
    ((1 *))
    x-%offset%))) 'double-float))
  '(complex double-float)))
(setf ix jx)
(f2cl-lib:fdo (i (f2cl-lib:int-add j 1)
  (f2cl-lib:int-add i 1))
  (> i n) nil)
(tagbody
  (setf ix (f2cl-lib:int-add ix incx))
  (setf (f2cl-lib:fref a-%data%
    (i j)
    ((1 lda) (1 *))
    a-%offset%)
    (+
      (f2cl-lib:fref a-%data%
        (i j)
        ((1 lda) (1 *))
        a-%offset%)
      (*
        (f2cl-lib:fref x-%data%
          (ix)
          ((1 *))
          x-%offset%)
        temp))))))
(t
  (setf (f2cl-lib:fref a-%data%
    (j j)
    ((1 lda) (1 *))
    a-%offset%)
    (coerce
      (coerce (realpart
        (f2cl-lib:fref a-%data%
          (j j)
          ((1 lda) (1 *))
          a-%offset%)) 'double-float)
      '(complex double-float))))
  (setf jx (f2cl-lib:int-add jx incx))))))
end_label
  (return (values nil nil nil nil nil nil nil))))))

```

## 5.25 zhpmv BLAS

```
(zhpmv.input)≡  
  )set break resume  
  )sys rm -f zhpmv.output  
  )spool zhpmv.output  
  )set message test on  
  )set message auto off  
  )clear all  
  
  )spool  
  )lisp (bye)
```

`<zhpmv.help>`≡

```
=====
zhpmv examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

ZHPMV - perform the matrix-vector operation  $y := \alpha * A * x + \beta * y$ ,

#### SYNOPSIS

```
SUBROUTINE ZHPMV ( UPLO, N, ALPHA, AP, X, INCX, BETA, Y,
                  INCY )
```

```
      COMPLEX*16    ALPHA, BETA
```

```
      INTEGER       INCX, INCY, N
```

```
      CHARACTER*1    UPLO
```

```
      COMPLEX*16    AP( * ), X( * ), Y( * )
```

#### PURPOSE

ZHPMV performs the matrix-vector operation

where alpha and beta are scalars, x and y are n element vectors and A is an n by n hermitian matrix, supplied in packed form.

#### PARAMETERS

UPLO - CHARACTER\*1.

On entry, UPLO specifies whether the upper or lower triangular part of the matrix A is supplied in the packed array AP as follows:

UPLO = 'U' or 'u'    The upper triangular part of A is supplied in AP.

UPLO = 'L' or 'l'    The lower triangular part of A is supplied in AP.

Unchanged on exit.

- N - INTEGER.  
On entry, N specifies the order of the matrix A. N must be at least zero. Unchanged on exit.
- ALPHA - COMPLEX\*16 .  
On entry, ALPHA specifies the scalar alpha. Unchanged on exit.
- AP - COMPLEX\*16 array of DIMENSION at least  
( ( n\*( n + 1 ) )/2 ). Before entry with UPLO = 'U' or 'u', the array AP must contain the upper triangular part of the hermitian matrix packed sequentially, column by column, so that AP( 1 ) contains a( 1, 1 ), AP( 2 ) and AP( 3 ) contain a( 1, 2 ) and a( 2, 2 ) respectively, and so on. Before entry with UPLO = 'L' or 'l', the array AP must contain the lower triangular part of the hermitian matrix packed sequentially, column by column, so that AP( 1 ) contains a( 1, 1 ), AP( 2 ) and AP( 3 ) contain a( 2, 1 ) and a( 3, 1 ) respectively, and so on. Note that the imaginary parts of the diagonal elements need not be set and are assumed to be zero. Unchanged on exit.
- X - COMPLEX\*16 array of dimension at least  
( 1 + ( n - 1 )\*abs( INCX ) ). Before entry, the incremented array X must contain the n element vector x. Unchanged on exit.
- INCX - INTEGER.  
On entry, INCX specifies the increment for the elements of X. INCX must not be zero. Unchanged on exit.
- BETA - COMPLEX\*16 .  
On entry, BETA specifies the scalar beta. When BETA is supplied as zero then Y need not be set on input. Unchanged on exit.
- Y - COMPLEX\*16 array of dimension at least  
( 1 + ( n - 1 )\*abs( INCY ) ). Before entry, the incremented array Y must contain the n element vector y. On exit, Y is overwritten by the updated vector y.
- INCY - INTEGER.  
On entry, INCY specifies the increment for the ele-

ments of Y. INCY must not be zero. Unchanged on  
exit.



```

(BLAS 2 zhpmv)≡
(let* ((one (complex 1.0 0.0)) (zero (complex 0.0 0.0)))
(declare (type (complex double-float) one) (type (complex double-float) zero))
(defun zhpmv (uplo n alpha ap x incx beta y incy)
  (declare (type (simple-array (complex double-float) (*)) y x ap)
    (type (complex double-float) beta alpha)
    (type fixnum incy incx n)
    (type character uplo))
  (f2cl-lib:with-multi-array-data
    ((uplo character uplo-%data% uplo-%offset%)
     (ap (complex double-float) ap-%data% ap-%offset%)
     (x (complex double-float) x-%data% x-%offset%)
     (y (complex double-float) y-%data% y-%offset%))
    (prog ((i 0) (info 0) (ix 0) (iy 0) (j 0) (jx 0) (jy 0) (k 0) (kk 0)
      (kx 0) (ky 0) (temp1 #C(0.0 0.0)) (temp2 #C(0.0 0.0)))
      (declare (type fixnum i info ix iy j jx jy k kk kx ky)
        (type (complex double-float) temp1 temp2))
      (setf info 0)
      (cond
        ((and (not (char-equal uplo #\U)) (not (char-equal uplo #\L)))
         (setf info 1))
        ((< n 0)
         (setf info 2))
        ((= incx 0)
         (setf info 6))
        ((= incy 0)
         (setf info 9)))
      (cond
        ((/= info 0)
         (error
          " ** On entry to ~a parameter number ~a had an illegal value~%"
          "ZHPMV" info)
         (go end_label)))
      (if (or (= n 0) (and (= alpha zero) (= beta one))) (go end_label))
      (cond
        ((> incx 0)
         (setf kx 1))
        (t
         (setf kx
              (f2cl-lib:int-sub 1
                                (f2cl-lib:int-mul (f2cl-lib:int-sub n 1)
                                                    incx))))))
      (cond
        ((> incy 0)
         (setf ky 1))
        (t

```

```

(setf ky
  (f2cl-lib:int-sub 1
    (f2cl-lib:int-mul (f2cl-lib:int-sub n 1)
      incy))))
(cond
  ((/= beta one)
    (cond
      ((= incy 1)
        (cond
          ((= beta zero)
            (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
              (> i n) nil)
            (tagbody
              (setf (f2cl-lib:fref y-%data% (i) ((1 *)) y-%offset%)
                zero))))
          (t
            (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
              (> i n) nil)
            (tagbody
              (setf (f2cl-lib:fref y-%data% (i) ((1 *)) y-%offset%)
                (* beta
                  (f2cl-lib:fref y-%data%
                    (i)
                    ((1 *))
                    y-%offset%))))))))
      (t
        (setf iy ky)
        (cond
          ((= beta zero)
            (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
              (> i n) nil)
            (tagbody
              (setf (f2cl-lib:fref y-%data% (iy) ((1 *)) y-%offset%)
                zero)
              (setf iy (f2cl-lib:int-add iy incy))))))
          (t
            (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
              (> i n) nil)
            (tagbody
              (setf (f2cl-lib:fref y-%data% (iy) ((1 *)) y-%offset%)
                (* beta
                  (f2cl-lib:fref y-%data%
                    (iy)
                    ((1 *))
                    y-%offset%)))
              (setf iy (f2cl-lib:int-add iy incy))))))))))

```

```

(if (= alpha zero) (go end_label))
(setf kk 1)
(cond
  ((char-equal uplo #\U)
    (cond
      ((and (= incx 1) (= incy 1))
        (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
          ((> j n) nil)
          (tagbody
            (setf temp1
              (* alpha
                (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%)))
            (setf temp2 zero)
            (setf k kk)
            (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
              ((> i
                (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
                nil)
              (tagbody
                (setf (f2cl-lib:fref y-%data% (i) ((1 *)) y-%offset%)
                  (+
                    (f2cl-lib:fref y-%data% (i) ((1 *)) y-%offset%)
                    (* temp1
                      (f2cl-lib:fref ap-%data%
                        (k)
                        ((1 *))
                        ap-%offset%))))
                (setf temp2
                  (+ temp2
                    (*
                      (f2cl-lib:dconjg
                        (f2cl-lib:fref ap-%data%
                          (k)
                          ((1 *))
                          ap-%offset%))
                      (f2cl-lib:fref x-%data%
                        (i)
                        ((1 *))
                        x-%offset%))))
                (setf k (f2cl-lib:int-add k 1))))
              (setf (f2cl-lib:fref y-%data% (j) ((1 *)) y-%offset%)
                (+ (f2cl-lib:fref y-%data% (j) ((1 *)) y-%offset%)
                  (* temp1
                    (coerce (realpart
                      (f2cl-lib:fref ap-%data%
                        ((f2cl-lib:int-sub

```

```

                                (f2cl-lib:int-add kk j)
                                1))
                                ((1 *))
                                ap-%offset%)) 'double-float))
                                (* alpha temp2)))
    (setf kk (f2cl-lib:int-add kk j))))
  (t
   (setf jx kx)
   (setf jy ky)
   (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                  ((> j n) nil)
   (tagbody
    (setf temp1
      (* alpha
        (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%)))
    (setf temp2 zero)
    (setf ix kx)
    (setf iy ky)
    (f2cl-lib:fdo (k kk (f2cl-lib:int-add k 1))
                  ((> k
                    (f2cl-lib:int-add kk
                      j
                      (f2cl-lib:int-sub 2)))
                    nil)
    (tagbody
     (setf (f2cl-lib:fref y-%data% (iy) ((1 *)) y-%offset%)
      (+
       (f2cl-lib:fref y-%data% (iy) ((1 *)) y-%offset%)
       (* temp1
         (f2cl-lib:fref ap-%data%
                          (k)
                          ((1 *))
                          ap-%offset%))))
     (setf temp2
      (+ temp2
        (*
         (f2cl-lib:dconjg
          (f2cl-lib:fref ap-%data%
                          (k)
                          ((1 *))
                          ap-%offset%))
         (f2cl-lib:fref x-%data%
                          (ix)
                          ((1 *))
                          x-%offset%))))
     (setf ix (f2cl-lib:int-add ix incx))

```

```

        (setf iy (f2cl-lib:int-add iy incy))))
    (setf (f2cl-lib:fref y-%data% (jy) ((1 *)) y-%offset%)
        (+ (f2cl-lib:fref y-%data% (jy) ((1 *)) y-%offset%)
            (* temp1
                (coerce (realpart
                    (f2cl-lib:fref ap-%data%
                        ((f2cl-lib:int-sub
                            (f2cl-lib:int-add kk j)
                            1))
                        ((1 *))
                        ap-%offset%)) 'double-float)))
            (* alpha temp2)))
    (setf jx (f2cl-lib:int-add jx incx))
    (setf jy (f2cl-lib:int-add jy incy))
    (setf kk (f2cl-lib:int-add kk j))))))
(t
  (cond
    ((and (= incx 1) (= incy 1))
      (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
        ((> j n) nil)
        (tagbody
          (setf temp1
            (* alpha
              (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%)))
          (setf temp2 zero)
          (setf (f2cl-lib:fref y-%data% (j) ((1 *)) y-%offset%)
              (+ (f2cl-lib:fref y-%data% (j) ((1 *)) y-%offset%)
                  (* temp1
                      (coerce (realpart
                          (f2cl-lib:fref ap-%data%
                              (kk)
                              ((1 *))
                              ap-%offset%)) 'double-float))))
          (setf k (f2cl-lib:int-add kk 1))
          (f2cl-lib:fdo (i (f2cl-lib:int-add j 1)
            (f2cl-lib:int-add i 1))
              ((> i n) nil)
              (tagbody
                (setf (f2cl-lib:fref y-%data% (i) ((1 *)) y-%offset%)
                    (+
                      (f2cl-lib:fref y-%data% (i) ((1 *)) y-%offset%)
                      (* temp1
                          (f2cl-lib:fref ap-%data%
                              (k)
                              ((1 *))
                              ap-%offset%))))))

```

```

      (setf temp2
        (+ temp2
          (*
            (f2cl-lib:dconjg
              (f2cl-lib:fref ap-%data%
                (k)
                ((1 *))
                ap-%offset%)))
            (f2cl-lib:fref x-%data%
              (i)
              ((1 *))
              x-%offset%))))))
      (setf k (f2cl-lib:int-add k 1)))
    (setf (f2cl-lib:fref y-%data% (j) ((1 *)) y-%offset%)
      (+ (f2cl-lib:fref y-%data% (j) ((1 *)) y-%offset%)
        (* alpha temp2)))
    (setf kk
      (f2cl-lib:int-add kk
        (f2cl-lib:int-add
          (f2cl-lib:int-sub n j)
          1))))))
  (t
    (setf jx kx)
    (setf jy ky)
    (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
      ((> j n) nil)
      (tagbody
        (setf temp1
          (* alpha
            (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%)))
        (setf temp2 zero)
        (setf (f2cl-lib:fref y-%data% (jy) ((1 *)) y-%offset%)
          (+ (f2cl-lib:fref y-%data% (jy) ((1 *)) y-%offset%)
            (* temp1
              (coerce (realpart
                (f2cl-lib:fref ap-%data%
                  (kk)
                  ((1 *))
                  ap-%offset%)) 'double-float))))))
        (setf ix jx)
        (setf iy jy)
        (f2cl-lib:fdo (k (f2cl-lib:int-add kk 1)
          (f2cl-lib:int-add k 1))
          ((> k
            (f2cl-lib:int-add kk
              n

```

```

                                (f2cl-lib:int-sub j)))
                                nil)
(tagbody
  (setf ix (f2cl-lib:int-add ix incx))
  (setf iy (f2cl-lib:int-add iy incy))
  (setf (f2cl-lib:fref y-%data% (iy) ((1 *)) y-%offset%)
    (+
      (f2cl-lib:fref y-%data% (iy) ((1 *)) y-%offset%)
      (* temp1
        (f2cl-lib:fref ap-%data%
          (k)
          ((1 *))
          ap-%offset%))))))
  (setf temp2
    (+ temp2
      (*
        (f2cl-lib:dconjg
          (f2cl-lib:fref ap-%data%
            (k)
            ((1 *))
            ap-%offset%))
        (f2cl-lib:fref x-%data%
          (ix)
          ((1 *))
          x-%offset%))))))
  (setf (f2cl-lib:fref y-%data% (jy) ((1 *)) y-%offset%)
    (+ (f2cl-lib:fref y-%data% (jy) ((1 *)) y-%offset%)
      (* alpha temp2)))
  (setf jx (f2cl-lib:int-add jx incx))
  (setf jy (f2cl-lib:int-add jy incy))
  (setf kk
    (f2cl-lib:int-add kk
      (f2cl-lib:int-add
        (f2cl-lib:int-sub n j)
        1))))))
end_label
(return (values nil nil nil nil nil nil nil nil))))

```

## 5.26 zhpr2 BLAS

```
<zhpr2.input>=  
  )set break resume  
  )sys rm -f zhpr2.output  
  )spool zhpr2.output  
  )set message test on  
  )set message auto off  
  )clear all  
  
  )spool  
  )lisp (bye)
```



`<zhpr2.help>=`

```
=====
zhpr2 examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

ZHPR2 - perform the hermitian rank 2 operation  $A := \alpha * x * \text{conjg}(y') + \text{conjg}(\alpha) * y * \text{conjg}(x') + A$ ,

#### SYNOPSIS

SUBROUTINE ZHPR2 ( UPLO, N, ALPHA, X, INCX, Y, INCY, AP )

COMPLEX\*16 ALPHA

INTEGER INCX, INCY, N

CHARACTER\*1 UPLO

COMPLEX\*16 AP( \* ), X( \* ), Y( \* )

#### PURPOSE

ZHPR2 performs the hermitian rank 2 operation

where alpha is a scalar, x and y are n element vectors and A is an n by n hermitian matrix, supplied in packed form.

#### PARAMETERS

UPLO - CHARACTER\*1.

On entry, UPLO specifies whether the upper or lower triangular part of the matrix A is supplied in the packed array AP as follows:

UPLO = 'U' or 'u' The upper triangular part of A is supplied in AP.

UPLO = 'L' or 'l' The lower triangular part of A is supplied in AP.

Unchanged on exit.

N - INTEGER.

On entry, N specifies the order of the matrix A. N

must be at least zero. Unchanged on exit.

- ALPHA - COMPLEX\*16 .  
On entry, ALPHA specifies the scalar alpha.  
Unchanged on exit.
- X - COMPLEX\*16 array of dimension at least  
( 1 + ( n - 1 ) \* abs( INCX ) ). Before entry, the  
incremented array X must contain the n element vector  
x. Unchanged on exit.
- INCX - INTEGER.  
On entry, INCX specifies the increment for the ele-  
ments of X. INCX must not be zero. Unchanged on  
exit.
- Y - COMPLEX\*16 array of dimension at least  
( 1 + ( n - 1 ) \* abs( INCY ) ). Before entry, the  
incremented array Y must contain the n element vector  
y. Unchanged on exit.
- INCY - INTEGER.  
On entry, INCY specifies the increment for the ele-  
ments of Y. INCY must not be zero. Unchanged on  
exit.
- AP - COMPLEX\*16 array of DIMENSION at least  
( ( n \* ( n + 1 ) ) / 2 ). Before entry with UPLO = 'U'  
or 'u', the array AP must contain the upper triangu-  
lar part of the hermitian matrix packed sequentially,  
column by column, so that AP( 1 ) contains a( 1, 1 ),  
AP( 2 ) and AP( 3 ) contain a( 1, 2 ) and a( 2, 2 )  
respectively, and so on. On exit, the array AP is  
overwritten by the upper triangular part of the  
updated matrix. Before entry with UPLO = 'L' or 'l',  
the array AP must contain the lower triangular part  
of the hermitian matrix packed sequentially, column  
by column, so that AP( 1 ) contains a( 1, 1 ), AP( 2  
) and AP( 3 ) contain a( 2, 1 ) and a( 3, 1 ) respec-  
tively, and so on. On exit, the array AP is overwrit-  
ten by the lower triangular part of the updated  
matrix. Note that the imaginary parts of the diago-  
nal elements need not be set, they are assumed to be  
zero, and on exit they are set to zero.

-- Written on 22-October-1986. Jack Dongarra,  
Argonne National Lab. Jeremy Du Croz, Nag Central  
Office. Sven Hammarling, Nag Central Office.  
Richard Hanson, Sandia National Labs.

## SYNOPSIS

```

rou-
time
zrotg(ca,cb,c,s)
sub-
ble
    dou-                                complex
                                         ca,cb,s
ble
    dou-                                precision
                                         c
ble
    dou-                                precision
                                         norm,scale
ble
    dou-                                complex
                                         alpha
    if                                  (cdabs(ca)
                                         .ne.
                                         0.0d0)
                                         go
                                         to
                                         10
    c                                   =
                                         0.0d0
    s                                   =
                                         (1.0d0,0.0d0)
    ca                                  =
                                         cb
    go                                  to
                                         20
    10                                  con-
                                         tinue
    scale                              =
                                         cdabs(ca)
                                         +
                                         cdabs(cb)

```

```

      norm      =
      *          scale*dsqrt((cdabs(ca/dcmplx(scale,0.0d0))**2
      alpha     +
      *          (cdabs(cb/dcmplx(scale,0.0d0))**2)
      =          =
      ca         ca
      /cdabs(ca)
      =          =
      c          cdabs(ca)
      /          /
      norm      norm
      =          =
      s          alpha
      *          *
      *          dconjg(cb)
      /          /
      norm      norm
      =          =
      ca         alpha
      *          *
      *          norm
      *          continue
      20
      return
      end

```

PUR-  
POSE  
NAME

## SYNOPSIS

rou-  
tine  
zscal(n,za,zx,incx)  
sub-  
c

scales  
a  
vec-  
tor  
by  
a  
con-  
stant.  
c jack  
dongarra,  
3/11/78.  
c modified

```

ble
  dou-
    integer
    if(n.le.0)return
    if(incx.eq.1)go
  c
    ix
    if(incx.lt.0)ix
  do
    zx(ix)
    ix
  10
  return
c
to
correct
prob-
lem
with
nega-
tive
incre-
ment,
8/21/90.
complex
za,zx(1)
i,incx,ix,n
to
20
code
for
incre-
ment
not
equal
to
1
=
1
=
(-
n+1)*incx
+
1
10
i
=
1,n
=
za*zx(ix)
=
ix
+
incx
con-
tinue
code

```

```

20
    zx(i)
30
    return
end
PUR-
POSE
    for
    incre-
    ment
    equal
    to
    1
    do
    30
    i
    =
    1,n
    =
    za*zx(i)
    con-
    tinue
```



```

(> incy 0)
(setf ky 1))
(t
  (setf ky
    (f2cl-lib:int-sub 1
      (f2cl-lib:int-mul
        (f2cl-lib:int-sub n 1)
        incy))))))

(setf jx kx)
(setf jy ky)))
(setf kk 1)
(cond
  ((char-equal uplo #\U)
    (cond
      ((and (= incx 1) (= incy 1))
        (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
          ((> j n) nil)
          (tagbody
            (cond
              ((or (/= (f2cl-lib:fref x (j) ((1 *))) zero)
                (/= (f2cl-lib:fref y (j) ((1 *))) zero))
                (setf temp1
                  (* alpha
                    (f2cl-lib:dconjg
                     (f2cl-lib:fref y-%data%
                       (j)
                       ((1 *))
                       y-%offset%))))))

              (setf temp2
                (coerce
                  (f2cl-lib:dconjg
                    (* alpha
                     (f2cl-lib:fref x-%data%
                       (j)
                       ((1 *))
                       x-%offset%)))
                  '(complex double-float)))

              (setf k kk)
              (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                ((> i
                  (f2cl-lib:int-add j
                    (f2cl-lib:int-sub 1)))
                  nil)
                (tagbody
                  (setf (f2cl-lib:fref ap-%data%
                    (k)

```



```

((1 *))
ap-%offset%)
(+
(f2cl-lib:fref ap-%data%
(k)
((1 *))
ap-%offset%)
(*
(f2cl-lib:fref x-%data%
(i)
((1 *))
x-%offset%)
temp1)
(*
(f2cl-lib:fref y-%data%
(i)
((1 *))
y-%offset%)
temp2)))
(setf k (f2cl-lib:int-add k 1)))
(setf (f2cl-lib:fref ap-%data%
((f2cl-lib:int-sub
(f2cl-lib:int-add kk j)
1))
((1 *))
ap-%offset%)
(coerce
(+
(coerce (realpart
(f2cl-lib:fref ap-%data%
((f2cl-lib:int-sub
(f2cl-lib:int-add kk j)
1))
((1 *))
ap-%offset%))) 'double-float)
(coerce (realpart
(+
(*
(f2cl-lib:fref x-%data%
(j)
((1 *))
x-%offset%)
temp1)
(*
(f2cl-lib:fref y-%data%
(j)

```

```

((1 *))
y-%offset%)
temp2))) 'double-float))
'(complex double-float)))
(t
  (setf (f2cl-lib:fref ap-%data%
    ((f2cl-lib:int-sub
      (f2cl-lib:int-add kk j)
      1))
    ((1 *))
    ap-%offset%)
    (coerce
      (coerce (realpart
        (f2cl-lib:fref ap-%data%
          ((f2cl-lib:int-sub
            (f2cl-lib:int-add kk j)
            1))
          ((1 *))
          ap-%offset%)) 'double-float)
        '(complex double-float))))
    (setf kk (f2cl-lib:int-add kk j))))
(t
  (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
    ((> j n) nil)
    (tagbody
      (cond
        ((or (/= (f2cl-lib:fref x (jx) ((1 *))) zero)
          (/= (f2cl-lib:fref y (jy) ((1 *))) zero))
          (setf temp1
            (* alpha
              (f2cl-lib:dconjg
                (f2cl-lib:fref y-%data%
                  (jy)
                  ((1 *))
                  y-%offset%))))
            (setf temp2
              (coerce
                (f2cl-lib:dconjg
                  (* alpha
                    (f2cl-lib:fref x-%data%
                      (jx)
                      ((1 *))
                      x-%offset%)))
                '(complex double-float)))
            (setf ix kx)
            (setf iy ky)

```

```

(f2cl-lib:fdo (k kk (f2cl-lib:int-add k 1))
  (> k
    (f2cl-lib:int-add kk
      j
      (f2cl-lib:int-sub 2)))
  nil)
(tagbody
  (setf (f2cl-lib:fref ap-%data%
    (k)
    ((1 *))
    ap-%offset%)
    (+
      (f2cl-lib:fref ap-%data%
        (k)
        ((1 *))
        ap-%offset%)
      (*
        (f2cl-lib:fref x-%data%
          (ix)
          ((1 *))
          x-%offset%)
        temp1)
      (*
        (f2cl-lib:fref y-%data%
          (iy)
          ((1 *))
          y-%offset%)
        temp2)))
  (setf ix (f2cl-lib:int-add ix incx))
  (setf iy (f2cl-lib:int-add iy incy)))
(setf (f2cl-lib:fref ap-%data%
  ((f2cl-lib:int-sub
    (f2cl-lib:int-add kk j)
    1))
  ((1 *))
  ap-%offset%)
  (coerce
    (+
      (coerce (realpart
        (f2cl-lib:fref ap-%data%
          ((f2cl-lib:int-sub
            (f2cl-lib:int-add kk j)
            1))
          ((1 *))
          ap-%offset%)) 'double-float)
      (coerce (realpart

```

```

(+
  (*
    (f2cl-lib:fref x-%data%
      (jx)
      ((1 *))
      x-%offset%)
    temp1)
  (*
    (f2cl-lib:fref y-%data%
      (jy)
      ((1 *))
      y-%offset%)
    temp2))) 'double-float)))
'(complex double-float))))

(t
  (setf (f2cl-lib:fref ap-%data%
    ((f2cl-lib:int-sub
      (f2cl-lib:int-add kk j)
      1))
    ((1 *))
    ap-%offset%)
    (coerce
      (coerce (realpart
        (f2cl-lib:fref ap-%data%
          ((f2cl-lib:int-sub
            (f2cl-lib:int-add kk j)
            1))
          ((1 *))
          ap-%offset%)) 'double-float)
        '(complex double-float))))))
  (setf jx (f2cl-lib:int-add jx incx))
  (setf jy (f2cl-lib:int-add jy incy))
  (setf kk (f2cl-lib:int-add kk j))))))

(t
  (cond
    ((and (= incx 1) (= incy 1))
      (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
        (> j n) nil)
      (tagbody
        (cond
          ((or (/= (f2cl-lib:fref x (j) ((1 *))) zero)
            (/= (f2cl-lib:fref y (j) ((1 *))) zero))
            (setf temp1
              (* alpha
                (f2cl-lib:dconjg
                  (f2cl-lib:fref y-%data%

```

```

                                (j)
                                ((1 *))
                                y-%offset%))))
(setf temp2
  (coerce
    (f2cl-lib:dconjg
      (* alpha
        (f2cl-lib:fref x-%data%
          (j)
          ((1 *))
          x-%offset%)))
      '(complex double-float)))
(setf (f2cl-lib:fref ap-%data% (kk) ((1 *)) ap-%offset%)
  (coerce
    (+
      (coerce (realpart
        (f2cl-lib:fref ap-%data%
          (kk)
          ((1 *))
          ap-%offset%)) 'double-float)
      (coerce (realpart
        (+
          (*
            (f2cl-lib:fref x-%data%
              (j)
              ((1 *))
              x-%offset%)
            temp1)
          (*
            (f2cl-lib:fref y-%data%
              (j)
              ((1 *))
              y-%offset%)
            temp2)))) 'double-float))
      '(complex double-float)))
(setf k (f2cl-lib:int-add kk 1))
(f2cl-lib:fdo (i (f2cl-lib:int-add j 1)
  (f2cl-lib:int-add i 1))
  ((> i n) nil)
  (tagbody
    (setf (f2cl-lib:fref ap-%data%
      (k)
      ((1 *))
      ap-%offset%)
      (+
        (f2cl-lib:fref ap-%data%

```

```

(k)
((1 *))
ap-%offset%)

(*
(f2cl-lib:fref x-%data%
(i)
((1 *))
x-%offset%)

temp1)
(*
(f2cl-lib:fref y-%data%
(i)
((1 *))
y-%offset%)

temp2)))
(setf k (f2cl-lib:int-add k 1))))))
(t
(setf (f2cl-lib:fref ap-%data% (kk) ((1 *)) ap-%offset%)
(coerce
(coerce (realpart
(f2cl-lib:fref ap-%data%
(kk)
((1 *))
ap-%offset%)) 'double-float)
'(complex double-float))))))
(setf kk
(f2cl-lib:int-add
(f2cl-lib:int-sub (f2cl-lib:int-add kk n) j)
1))))))
(t
(f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
(> j n) nil)
(tagbody
(cond
((or (/= (f2cl-lib:fref x (jx) ((1 *))) zero)
(/= (f2cl-lib:fref y (jy) ((1 *))) zero))
(setf temp1
(* alpha
(f2cl-lib:dconjg
(f2cl-lib:fref y-%data%
(jy)
((1 *))
y-%offset%))))))
(setf temp2
(coerce
(f2cl-lib:dconjg

```

```

(* alpha
  (f2cl-lib:fref x-%data%
    (jx)
    ((1 *))
    x-%offset%)))
'(complex double-float)))
(setf (f2cl-lib:fref ap-%data% (kk) ((1 *)) ap-%offset%)
(coerce
(+
(coerce (realpart
  (f2cl-lib:fref ap-%data%
    (kk)
    ((1 *))
    ap-%offset%)) 'double-float)
(coerce (realpart
(+
(*
  (f2cl-lib:fref x-%data%
    (jx)
    ((1 *))
    x-%offset%)

temp1)
(*
  (f2cl-lib:fref y-%data%
    (jy)
    ((1 *))
    y-%offset%)

temp2))) 'double-float)))
'(complex double-float)))
(setf ix jx)
(setf iy jy)
(f2cl-lib:fdo (k (f2cl-lib:int-add kk 1)
  (f2cl-lib:int-add k 1))
  (> k
    (f2cl-lib:int-add kk
      n
      (f2cl-lib:int-sub j)))

nil)

(tagbody
  (setf ix (f2cl-lib:int-add ix incx))
  (setf iy (f2cl-lib:int-add iy incy))
  (setf (f2cl-lib:fref ap-%data%
    (k)
    ((1 *))
    ap-%offset%)

(+

```

```

(f2cl-lib:fref ap-%data%
  (k)
  ((1 *))
  ap-%offset%)
(*
  (f2cl-lib:fref x-%data%
    (ix)
    ((1 *))
    x-%offset%)
  temp1)
(*
  (f2cl-lib:fref y-%data%
    (iy)
    ((1 *))
    y-%offset%)
  temp2))))))
(t
  (setf (f2cl-lib:fref ap-%data% (kk) ((1 *)) ap-%offset%)
    (coerce
      (coerce (realpart
        (f2cl-lib:fref ap-%data%
          (kk)
          ((1 *))
          ap-%offset%)) 'double-float)
        '(complex double-float))))))
(setf jx (f2cl-lib:int-add jx incx))
(setf jy (f2cl-lib:int-add jy incy))
(setf kk
  (f2cl-lib:int-add
    (f2cl-lib:int-sub (f2cl-lib:int-add kk n) j)
    1))))))
end_label
(return (values nil nil nil nil nil nil nil nil))))))

```



## 5.27 zhpr BLAS

```
<zhpr.input>≡  
  )set break resume  
  )sys rm -f zhpr.output  
  )spool zhpr.output  
  )set message test on  
  )set message auto off  
  )clear all  
  
  )spool  
  )lisp (bye)
```

`<zhpr.help>=`

```
=====
zhpr examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

ZHPR - perform the hermitian rank 1 operation  $A := \alpha * x * \text{conjg}(x') + A$ ,

#### SYNOPSIS

```
SUBROUTINE ZHPR ( UPLO, N, ALPHA, X, INCX, AP )
```

```
      DOUBLE      PRECISION ALPHA
```

```
      INTEGER      INCX, N
```

```
      CHARACTER*1 UPLO
```

```
      COMPLEX*16  AP( * ), X( * )
```

#### PURPOSE

ZHPR performs the hermitian rank 1 operation

where alpha is a real scalar, x is an n element vector and A is an n by n hermitian matrix, supplied in packed form.

#### PARAMETERS

UPLO - CHARACTER\*1.

On entry, UPLO specifies whether the upper or lower triangular part of the matrix A is supplied in the packed array AP as follows:

UPLO = 'U' or 'u' The upper triangular part of A is supplied in AP.

UPLO = 'L' or 'l' The lower triangular part of A is supplied in AP.

Unchanged on exit.

N - INTEGER.

On entry, N specifies the order of the matrix A. N

must be at least zero. Unchanged on exit.

ALPHA - DOUBLE PRECISION.

On entry, ALPHA specifies the scalar alpha.  
Unchanged on exit.

X - COMPLEX\*16 array of dimension at least  
( 1 + ( n - 1 ) \* abs( INCX ) ). Before entry, the  
incremented array X must contain the n element vector  
x. Unchanged on exit.

INCX - INTEGER.

On entry, INCX specifies the increment for the ele-  
ments of X. INCX must not be zero. Unchanged on  
exit.

AP - COMPLEX\*16 array of DIMENSION at least  
( ( n \* ( n + 1 ) ) / 2 ). Before entry with UPLO = 'U'  
or 'u', the array AP must contain the upper triangu-  
lar part of the hermitian matrix packed sequentially,  
column by column, so that AP( 1 ) contains a( 1, 1 ),  
AP( 2 ) and AP( 3 ) contain a( 1, 2 ) and a( 2, 2 )  
respectively, and so on. On exit, the array AP is  
overwritten by the upper triangular part of the  
updated matrix. Before entry with UPLO = 'L' or 'l',  
the array AP must contain the lower triangular part  
of the hermitian matrix packed sequentially, column  
by column, so that AP( 1 ) contains a( 1, 1 ), AP( 2  
) and AP( 3 ) contain a( 2, 1 ) and a( 3, 1 ) respec-  
tively, and so on. On exit, the array AP is overwrit-  
ten by the lower triangular part of the updated  
matrix. Note that the imaginary parts of the diago-  
nal elements need not be set, they are assumed to be  
zero, and on exit they are set to zero.

```

<BLAS 2 zhpr>≡
  (let* ((zero (complex 0.0 0.0)))
    (declare (type (complex double-float) zero))
    (defun zhpr (uplo n alpha x incx ap)
      (declare (type (simple-array (complex double-float) (*)) ap x)
        (type (double-float) alpha)
        (type fixnum incx n)
        (type character uplo))
      (f2cl-lib:with-multi-array-data
        ((uplo character uplo-%data% uplo-%offset%)
         (x (complex double-float) x-%data% x-%offset%)
         (ap (complex double-float) ap-%data% ap-%offset%))
        (prog ((i 0) (info 0) (ix 0) (j 0) (jx 0) (k 0) (kk 0) (kx 0)
              (temp #C(0.0 0.0)))
          (declare (type fixnum i info ix j jx k kk kx)
            (type (complex double-float) temp))
          (setf info 0)
          (cond
            ((and (not (char-equal uplo #\U)) (not (char-equal uplo #\L)))
              (setf info 1))
            ((< n 0)
              (setf info 2))
            ((= incx 0)
              (setf info 5)))
            (cond
              ((/= info 0)
                (error
                  " ** On entry to ~a parameter number ~a had an illegal value~%"
                  "ZHPR" info)
                (go end_label)))
              (if (or (= n 0) (= alpha (coerce (realpart zero) 'double-float)))
                (go end_label)))
            (cond
              ((<= incx 0)
                (setf kx
                  (f2cl-lib:int-sub 1
                    (f2cl-lib:int-mul (f2cl-lib:int-sub n 1)
                    incx))))
                ((/= incx 1)
                  (setf kx 1)))
              (setf kk 1)
              (cond
                ((char-equal uplo #\U)
                  (cond
                    ((= incx 1)
                      (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))

```

```

                                (< j n) nil)
(tagbody
  (cond
    ((/= (f2cl-lib:fref x (j) ((1 *))) zero)
      (setf temp
        (coerce
          (* alpha
            (f2cl-lib:dconjg
              (f2cl-lib:fref x-%data%
                (j)
                ((1 *))
                x-%offset%)))
          '(complex double-float)))
      (setf k kk)
      (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
        (< i
          (f2cl-lib:int-add j
            (f2cl-lib:int-sub 1)))
        nil)
      (tagbody
        (setf (f2cl-lib:fref ap-%data%
          (k)
          ((1 *))
          ap-%offset%)
          (+
            (f2cl-lib:fref ap-%data%
              (k)
              ((1 *))
              ap-%offset%)
            (*
              (f2cl-lib:fref x-%data%
                (i)
                ((1 *))
                x-%offset%)
              temp)))
        (setf k (f2cl-lib:int-add k 1))))
      (setf (f2cl-lib:fref ap-%data%
        ((f2cl-lib:int-sub
          (f2cl-lib:int-add kk j)
          1))
        ((1 *))
        ap-%offset%)
        (coerce
          (+
            (coerce (realpart
              (f2cl-lib:fref ap-%data%

```

```

((f2cl-lib:int-sub
 (f2cl-lib:int-add kk j)
 1))
((1 *))
ap-%offset%)) 'double-float)
(coerce (realpart
 (*
  (f2cl-lib:fref x-%data%
    (j)
    ((1 *))
    x-%offset%)
  temp)) 'double-float))
'(complex double-float))))
(t
 (setf (f2cl-lib:fref ap-%data%
  ((f2cl-lib:int-sub
   (f2cl-lib:int-add kk j)
    1))
  ((1 *))
  ap-%offset%)
  (coerce
   (coerce (realpart
    (f2cl-lib:fref ap-%data%
      ((f2cl-lib:int-sub
       (f2cl-lib:int-add kk j)
        1))
      ((1 *))
      ap-%offset%)) 'double-float)
    '(complex double-float))))))
 (setf kk (f2cl-lib:int-add kk j))))
(t
 (setf jx kx)
 (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
  (> j n) nil)
 (tagbody
  (cond
   ((/= (f2cl-lib:fref x (jx) ((1 *))) zero)
    (setf temp
     (coerce
      (* alpha
       (f2cl-lib:dconjg
        (f2cl-lib:fref x-%data%
          (jx)
          ((1 *))
          x-%offset%)))
      '(complex double-float)))

```

```

(setf ix kx)
(f2cl-lib:fd0 (k kk (f2cl-lib:int-add k 1))
  (> k
    (f2cl-lib:int-add kk
      j
      (f2cl-lib:int-sub 2)))
    nil)
(tagbody
  (setf (f2cl-lib:fref ap-%data%
    (k)
    ((1 *))
    ap-%offset%)
    (+
      (f2cl-lib:fref ap-%data%
        (k)
        ((1 *))
        ap-%offset%)
      (*
        (f2cl-lib:fref x-%data%
          (ix)
          ((1 *))
          x-%offset%)
        temp)))
  (setf ix (f2cl-lib:int-add ix incx)))
(setf (f2cl-lib:fref ap-%data%
  ((f2cl-lib:int-sub
    (f2cl-lib:int-add kk j)
    1))
  ((1 *))
  ap-%offset%)
  (coerce
    (+
      (coerce (realpart
        (f2cl-lib:fref ap-%data%
          ((f2cl-lib:int-sub
            (f2cl-lib:int-add kk j)
            1))
          ((1 *))
          ap-%offset%)) 'double-float)
      (coerce (realpart
        (*
          (f2cl-lib:fref x-%data%
            (jx)
            ((1 *))
            x-%offset%)
          temp)) 'double-float))

```

```

                                '(complex double-float))))
(t
  (setf (f2cl-lib:fref ap-%data%
                      ((f2cl-lib:int-sub
                        (f2cl-lib:int-add kk j)
                        1))
                      ((1 *))
                      ap-%offset%))
        (coerce
          (coerce (realpart
                    (f2cl-lib:fref ap-%data%
                                    ((f2cl-lib:int-sub
                                      (f2cl-lib:int-add kk j)
                                      1))
                                    ((1 *))
                                    ap-%offset%)) 'double-float)
          '(complex double-float))))
  (setf jx (f2cl-lib:int-add jx incx))
  (setf kk (f2cl-lib:int-add kk j))))))
(t
  (cond
    ((= incx 1)
     (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                   ((> j n) nil)
     (tagbody
      (cond
        ((/= (f2cl-lib:fref x (j) ((1 *))) zero)
         (setf temp
              (coerce
                (* alpha
                  (f2cl-lib:dconjg
                    (f2cl-lib:fref x-%data%
                                    (j)
                                    ((1 *))
                                    x-%offset%)))
                '(complex double-float)))
         (setf (f2cl-lib:fref ap-%data% (kk) ((1 *)) ap-%offset%)
              (coerce
                (+
                  (coerce (realpart
                            (f2cl-lib:fref ap-%data%
                                            (kk)
                                            ((1 *))
                                            ap-%offset%)) 'double-float)
                  (coerce (realpart
                            (* temp

```



```

(f2cl-lib:fref x-%data%
  (j)
  ((1 *))
  x-%offset%))) 'double-float))
'(complex double-float)))
(setf k (f2cl-lib:int-add kk 1))
(f2cl-lib:fdo (i (f2cl-lib:int-add j 1)
  (f2cl-lib:int-add i 1))
  (> i n) nil)
(tagbody
  (setf (f2cl-lib:fref ap-%data%
    (k)
    ((1 *))
    ap-%offset%)
    (+
      (f2cl-lib:fref ap-%data%
        (k)
        ((1 *))
        ap-%offset%)
      (*
        (f2cl-lib:fref x-%data%
          (i)
          ((1 *))
          x-%offset%)
        temp)))
    (setf k (f2cl-lib:int-add k 1))))))
(t
  (setf (f2cl-lib:fref ap-%data% (kk) ((1 *)) ap-%offset%)
    (coerce
      (coerce (realpart
        (f2cl-lib:fref ap-%data%
          (kk)
          ((1 *))
          ap-%offset%))) 'double-float)
      '(complex double-float))))))
(setf kk
  (f2cl-lib:int-add
    (f2cl-lib:int-sub (f2cl-lib:int-add kk n) j)
    1))))
(t
  (setf jx kx)
  (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
    (> j n) nil)
  (tagbody
    (cond
      ((/= (f2cl-lib:fref x (jx) ((1 *))) zero)

```

```

(setf temp
  (coerce
    (* alpha
      (f2cl-lib:dconjg
        (f2cl-lib:fref x-%data%
          (jx)
          ((1 *))
          x-%offset%)))
    '(complex double-float)))
(setf (f2cl-lib:fref ap-%data% (kk) ((1 *)) ap-%offset%)
  (coerce
    (+
      (coerce (realpart
        (f2cl-lib:fref ap-%data%
          (kk)
          ((1 *))
          ap-%offset%)) 'double-float)
      (coerce (realpart
        (* temp
          (f2cl-lib:fref x-%data%
            (jx)
            ((1 *))
            x-%offset%))) 'double-float))
    '(complex double-float)))
(setf ix jx)
(f2cl-lib:fdo (k (f2cl-lib:int-add kk 1)
  (f2cl-lib:int-add k 1))
  (> k
    (f2cl-lib:int-add kk
      n
      (f2cl-lib:int-sub j)))
  nil)
(tagbody
  (setf ix (f2cl-lib:int-add ix incx))
  (setf (f2cl-lib:fref ap-%data%
    (k)
    ((1 *))
    ap-%offset%)
    (+
      (f2cl-lib:fref ap-%data%
        (k)
        ((1 *))
        ap-%offset%)
      (*
        (f2cl-lib:fref x-%data%
          (ix)

```

```

((1 *))
x-%offset%)
temp))))))
(t
  (setf (f2cl-lib:fref ap-%data% (kk) ((1 *)) ap-%offset%)
    (coerce
      (coerce (realpart
        (f2cl-lib:fref ap-%data%
          (kk)
            ((1 *))
              ap-%offset%)) 'double-float)
        '(complex double-float))))
  (setf jx (f2cl-lib:int-add jx incx))
  (setf kk
    (f2cl-lib:int-add
      (f2cl-lib:int-sub (f2cl-lib:int-add kk n) j)
      1))))))
end_label
(return (values nil nil nil nil nil nil))))

```

## 5.28 ztbmv BLAS

```

<ztbmv.input>≡
)set break resume
)sys rm -f ztbmv.output
)spool ztbmv.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)

```

`<ztbm.v.help>`≡

```
=====
ztbm.v examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

ZTBMV - perform one of the matrix-vector operations  $x := A*x$ , or  $x := A'*x$ , or  $x := \text{conjg}(A')*x$ ,

#### SYNOPSIS

```
SUBROUTINE ZTBMV ( UPLO, TRANS, DIAG, N, K, A, LDA, X, INCX
                  )
```

```
      INTEGER      INCX, K, LDA, N
```

```
      CHARACTER*1  DIAG, TRANS, UPLO
```

```
      COMPLEX*16   A( LDA, * ), X( * )
```

#### PURPOSE

ZTBMV performs one of the matrix-vector operations

where  $x$  is an  $n$  element vector and  $A$  is an  $n$  by  $n$  unit, or non-unit, upper or lower triangular band matrix, with  $(k + 1)$  diagonals.

#### PARAMETERS

UPLO - CHARACTER\*1.

On entry, UPLO specifies whether the matrix is an upper or lower triangular matrix as follows:

UPLO = 'U' or 'u' A is an upper triangular matrix.

UPLO = 'L' or 'l' A is a lower triangular matrix.

Unchanged on exit.

TRANS - CHARACTER\*1.

On entry, TRANS specifies the operation to be performed as follows:

TRANS = 'N' or 'n'  $x := A*x$ .

TRANS = 'T' or 't'     $x := A' * x$ .

TRANS = 'C' or 'c'     $x := \text{conjg}(A') * x$ .

Unchanged on exit.

DIAG - CHARACTER\*1.

On entry, DIAG specifies whether or not A is unit triangular as follows:

DIAG = 'U' or 'u'    A is assumed to be unit triangular.

DIAG = 'N' or 'n'    A is not assumed to be unit triangular.

Unchanged on exit.

N - INTEGER.

On entry, N specifies the order of the matrix A. N must be at least zero. Unchanged on exit.

K - INTEGER.

On entry with UPLO = 'U' or 'u', K specifies the number of super-diagonals of the matrix A. On entry with UPLO = 'L' or 'l', K specifies the number of sub-diagonals of the matrix A. K must satisfy  $0 \leq K$ . Unchanged on exit.

A - COMPLEX\*16    array of DIMENSION ( LDA, n ).  
Before entry with UPLO = 'U' or 'u', the leading ( k + 1 ) by n part of the array A must contain the upper triangular band part of the matrix of coefficients, supplied column by column, with the leading diagonal of the matrix in row ( k + 1 ) of the array, the first super-diagonal starting at position 2 in row k, and so on. The top left k by k triangle of the array A is not referenced. The following program segment will transfer an upper triangular band matrix from conventional full matrix storage to band storage:

```
DO 20, J = 1, N M = K + 1 - J DO 10, I = MAX( 1, J -
K ), J A( M + I, J ) = matrix( I, J ) 10    CONTINUE
20 CONTINUE
```

Before entry with UPLO = 'L' or 'l', the leading ( k + 1 ) by n part of the array A must contain the lower triangular band part of the matrix of coefficients, supplied column by column, with the leading diagonal of the matrix in row 1 of the array, the first sub-diagonal starting at position 1 in row 2, and so on. The bottom right k by k triangle of the array A is not referenced. The following program segment will transfer a lower triangular band matrix from conventional full matrix storage to band storage:

```
DO 20, J = 1, N
  M = 1 - J
  DO 10, I = J, MIN( N, J + K )
    A( M + I, J ) = matrix( I, J )
  10 CONTINUE
20 CONTINUE
```

Note that when DIAG = 'U' or 'u' the elements of the array A corresponding to the diagonal elements of the matrix are not referenced, but are assumed to be unity. Unchanged on exit.

LDA - INTEGER.

On entry, LDA specifies the first dimension of A as declared in the calling (sub) program. LDA must be at least ( k + 1 ). Unchanged on exit.

X - COMPLEX\*16 array of dimension at least ( 1 + ( n - 1 ) \* abs( INCX ) ). Before entry, the incremented array X must contain the n element vector x. On exit, X is overwritten with the transformed vector x.

INCX - INTEGER.

On entry, INCX specifies the increment for the elements of X. INCX must not be zero. Unchanged on exit.

```

<BLAS 2 ztbmv>≡
  (let* ((zero (complex 0.0 0.0)))
    (declare (type (complex double-float) zero))
    (defun ztbmv (uplo trans diag n k a lda x incx)
      (declare (type (simple-array (complex double-float) (*)) x a)
        (type fixnum incx lda k n)
        (type character diag trans uplo))
      (f2cl-lib:with-multi-array-data
        ((uplo character uplo-%data% uplo-%offset%)
         (trans character trans-%data% trans-%offset%)
         (diag character diag-%data% diag-%offset%)
         (a (complex double-float) a-%data% a-%offset%)
         (x (complex double-float) x-%data% x-%offset%))
        (prog ((noconj nil) (nounit nil) (i 0) (info 0) (ix 0) (j 0) (jx 0)
              (kplus1 0) (kx 0) (l 0) (temp #C(0.0 0.0)))
          (declare (type (member t nil) noconj nounit)
            (type fixnum i info ix j jx kplus1 kx l)
            (type (complex double-float) temp))
          (setf info 0)
          (cond
            ((and (not (char-equal uplo #\U)) (not (char-equal uplo #\L)))
              (setf info 1))
            ((and (not (char-equal trans #\N))
                  (not (char-equal trans #\T))
                  (not (char-equal trans #\C)))
              (setf info 2))
            ((and (not (char-equal diag #\U)) (not (char-equal diag #\N)))
              (setf info 3))
            ((< n 0)
              (setf info 4))
            ((< k 0)
              (setf info 5))
            ((< lda (f2cl-lib:int-add k 1))
              (setf info 7))
            ((= incx 0)
              (setf info 9)))
          (cond
            ((/= info 0)
              (error
               " ** On entry to ~a parameter number ~a had an illegal value~%"
               "ZTBMV" info)
              (go end_label)))
          (if (= n 0) (go end_label))
          (setf noconj (char-equal trans #\T))
          (setf nounit (char-equal diag #\N))
          (cond

```

```

(<= incx 0)
  (setf kx
    (f2cl-lib:int-sub 1
      (f2cl-lib:int-mul (f2cl-lib:int-sub n 1)
        incx))))

(/= incx 1)
  (setf kx 1)))
(cond
  ((char-equal trans #\N)
    (cond
      ((char-equal uplo #\U)
        (setf kplus1 (f2cl-lib:int-add k 1))
        (cond
          ((= incx 1)
            (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
              (> j n) nil)
            (tagbody
              (cond
                ((/= (f2cl-lib:fref x (j) ((1 *))) zero)
                  (setf temp
                    (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%))
                  (setf l (f2cl-lib:int-sub kplus1 j))
                  (f2cl-lib:fdo (i
                    (max (the fixnum 1)
                      (the fixnum
                        (f2cl-lib:int-add j
                          (f2cl-lib:int-sub
                            (f2cl-lib:int-add i 1))
                            (> i
                              (f2cl-lib:int-add j
                                (f2cl-lib:int-sub
                                  (f2cl-lib:int-sub
                                    1))))
                                nil)
                    (tagbody
                      (setf (f2cl-lib:fref x-%data%
                        (i)
                        ((1 *))
                        x-%offset%)
                        (+
                          (f2cl-lib:fref x-%data%
                            (i)
                            ((1 *))
                            x-%offset%)
                          (* temp
                            (f2cl-lib:fref a-%data%

```



```

((f2cl-lib:int-add 1 i)
 j)
((1 lda) (1 *))
a-%offset%))))))
(if nunit
  (setf (f2cl-lib:fref x-%data%
    (j)
    ((1 *))
    x-%offset%)
    (*
      (f2cl-lib:fref x-%data%
        (j)
        ((1 *))
        x-%offset%)
      (f2cl-lib:fref a-%data%
        (kplus1 j)
        ((1 lda) (1 *))
        a-%offset%)))))))))
(t
  (setf jx kx)
  (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
    (> j n) nil)
  (tagbody
    (cond
      ((/= (f2cl-lib:fref x (jx) ((1 *))) zero)
        (setf temp
          (f2cl-lib:fref x-%data%
            (jx)
            ((1 *))
            x-%offset%))
        (setf ix kx)
        (setf l (f2cl-lib:int-sub kplus1 j))
        (f2cl-lib:fdo (i
          (max (the fixnum 1)
            (the fixnum
              (f2cl-lib:int-add j
                (f2cl-lib:int-
                  (f2cl-lib:int-
                    k))))))
          (f2cl-lib:int-add i 1))
          (> i
            (f2cl-lib:int-add j
              (f2cl-lib:int-sub
                1)))
          nil)
        (tagbody
          (setf (f2cl-lib:fref x-%data%

```

```

                                (ix)
                                ((1 *))
                                x-%offset%)
(+
  (f2cl-lib:fref x-%data%
    (ix)
    ((1 *))
    x-%offset%)
  (* temp
    (f2cl-lib:fref a-%data%
      ((f2cl-lib:int-add 1 i)
       j)
      ((1 lda) (1 *))
      a-%offset%))))
  (setf ix (f2cl-lib:int-add ix incx)))
(if nunit
  (setf (f2cl-lib:fref x-%data%
    (jx)
    ((1 *))
    x-%offset%)
    (*
      (f2cl-lib:fref x-%data%
        (jx)
        ((1 *))
        x-%offset%)
      (f2cl-lib:fref a-%data%
        (kplus1 j)
        ((1 lda) (1 *))
        a-%offset%))))))
  (setf jx (f2cl-lib:int-add jx incx))
  (if (> j k) (setf kx (f2cl-lib:int-add kx incx))))))
(t
  (cond
    ((= incx 1)
      (f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
        (> j 1) nil)
      (tagbody
        (cond
          ((/= (f2cl-lib:fref x (j) ((1 *))) zero)
            (setf temp
              (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%))
            (setf l (f2cl-lib:int-sub 1 j))
            (f2cl-lib:fdo (i
              (min (the fixnum n)
                (the fixnum
                  (f2cl-lib:int-add j k)))

```

```

(f2cl-lib:int-add i
  (f2cl-lib:int-sub 1)))
(> i (f2cl-lib:int-add j 1)) nil)
(tagbody
  (setf (f2cl-lib:fref x-%data%
    (i)
    ((1 *))
    x-%offset%)
    (+
      (f2cl-lib:fref x-%data%
        (i)
        ((1 *))
        x-%offset%)
      (* temp
        (f2cl-lib:fref a-%data%
          ((f2cl-lib:int-add 1 i)
           j)
          ((1 lda) (1 *))
          a-%offset%))))))
(if nunit
  (setf (f2cl-lib:fref x-%data%
    (j)
    ((1 *))
    x-%offset%)
    (*
      (f2cl-lib:fref x-%data%
        (j)
        ((1 *))
        x-%offset%)
      (f2cl-lib:fref a-%data%
        (1 j)
        ((1 lda) (1 *))
        a-%offset%))))))
(t
  (setf kx
    (f2cl-lib:int-add kx
      (f2cl-lib:int-mul
        (f2cl-lib:int-sub n 1)
        incx)))
  (setf jx kx)
  (f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
    (> j 1) nil)
  (tagbody
    (cond
      ((/= (f2cl-lib:fref x (jx) ((1 *))) zero)
        (setf temp

```

```

(f2cl-lib:fref x-%data%
  (jx)
  ((1 *))
  x-%offset%)
(setf ix kx)
(setf l (f2cl-lib:int-sub 1 j))
(f2cl-lib:fdo (i
  (min (the fixnum n)
        (the fixnum
          (f2cl-lib:int-add j k)))
  (f2cl-lib:int-add i
    (f2cl-lib:int-sub 1)))
  (> i (f2cl-lib:int-add j 1)) nil)
(tagbody
  (setf (f2cl-lib:fref x-%data%
    (ix)
    ((1 *))
    x-%offset%)
    (+
      (f2cl-lib:fref x-%data%
        (ix)
        ((1 *))
        x-%offset%)
      (* temp
        (f2cl-lib:fref a-%data%
          ((f2cl-lib:int-add 1 i)
           j)
          ((1 lda) (1 *))
          a-%offset%))))
  (setf ix (f2cl-lib:int-sub ix incx)))
(if nunit
  (setf (f2cl-lib:fref x-%data%
    (jx)
    ((1 *))
    x-%offset%)
    (*
      (f2cl-lib:fref x-%data%
        (jx)
        ((1 *))
        x-%offset%)
      (f2cl-lib:fref a-%data%
        (1 j)
        ((1 lda) (1 *))
        a-%offset%))))))
(setf jx (f2cl-lib:int-sub jx incx))
(if (>= (f2cl-lib:int-sub n j) k)

```

```

(setf kx (f2cl-lib:int-sub kx incx)))))))))
(t
  (cond
    ((char-equal uplo #\U)
      (setf kplus1 (f2cl-lib:int-add k 1))
      (cond
        ((= incx 1)
          (f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
            ((> j 1) nil)
            (tagbody
              (setf temp
                (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%))
              (setf l (f2cl-lib:int-sub kplus1 j))
              (cond
                (noconj
                  (if nunit
                    (setf temp
                      (* temp
                        (f2cl-lib:fref a-%data%
                          (kplus1 j)
                          ((1 lda) (1 *))
                          a-%offset%))))
                  (f2cl-lib:fdo (i
                    (f2cl-lib:int-add j
                      (f2cl-lib:int-sub 1))
                    (f2cl-lib:int-add i
                      (f2cl-lib:int-sub 1)))
                      ((> i
                        (max (the fixnum 1)
                          (the fixnum
                            (f2cl-lib:int-add j
                              (f2cl-lib:int-sub 1)
                              k))))))
                      nil)
                    (tagbody
                      (setf temp
                        (+ temp
                          (*
                            (f2cl-lib:fref a-%data%
                              ((f2cl-lib:int-add 1 i)
                                j)
                              ((1 lda) (1 *))
                              a-%offset%)
                            (f2cl-lib:fref x-%data%
                              (i)
                              ((1 *))

```

```

x-%offset%)))))))))
(t
  (if nounit
    (setf temp
      (* temp
        (f2cl-lib:dconjg
          (f2cl-lib:fref a-%data%
            (kplus1 j)
            ((1 lda) (1 *))
            a-%offset%))))))
    (f2cl-lib:fdo (i
      (f2cl-lib:int-add j
        (f2cl-lib:int-sub 1))
      (f2cl-lib:int-add i
        (f2cl-lib:int-sub 1)))
      (> i
        (max (the fixnum 1)
          (the fixnum
            (f2cl-lib:int-add j
              (f2cl-lib:int-sub
                k))))))
      nil)
    (tagbody
      (setf temp
        (+ temp
          (*
            (f2cl-lib:dconjg
              (f2cl-lib:fref a-%data%
                ((f2cl-lib:int-add 1 i)
                  j)
                ((1 lda) (1 *))
                a-%offset%))
            (f2cl-lib:fref x-%data%
              (i)
              ((1 *))
              x-%offset%))))))
      (setf (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%)
        temp))))
(t
  (setf kx
    (f2cl-lib:int-add kx
      (f2cl-lib:int-mul
        (f2cl-lib:int-sub n 1)
        incx)))
  (setf jx kx)
  (f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))

```

```

                                (> j 1) nil)
(tagbody
  (setf temp
    (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%))
  (setf kx (f2cl-lib:int-sub kx incx))
  (setf ix kx)
  (setf l (f2cl-lib:int-sub kplus1 j))
  (cond
    (noconj
      (if nount
        (setf temp
          (* temp
            (f2cl-lib:fref a-%data%
                          (kplus1 j)
                          ((1 lda) (1 *))
                          a-%offset%))))
        (f2cl-lib:fdo (i
          (f2cl-lib:int-add j
            (f2cl-lib:int-sub 1))
          (f2cl-lib:int-add i
            (f2cl-lib:int-sub 1)))
            (> i
              (max (the fixnum 1)
                (the fixnum
                  (f2cl-lib:int-add j
                    (f2cl-lib:int-sub 1)
                    k))))))
          nil)
      (tagbody
        (setf temp
          (+ temp
            (*
              (f2cl-lib:fref a-%data%
                            ((f2cl-lib:int-add 1 i)
                              j)
                            ((1 lda) (1 *))
                            a-%offset%)
              (f2cl-lib:fref x-%data%
                            (ix)
                            ((1 *))
                            x-%offset%))))
            (setf ix (f2cl-lib:int-sub ix incx))))))
  (t
    (if nount
      (setf temp
        (* temp

```

```

(f2cl-lib:dconjg
  (f2cl-lib:fref a-%data%
    (kplus1 j)
    ((1 lda) (1 *))
    a-%offset%))))))
(f2cl-lib:fdo (i
  (f2cl-lib:int-add j
    (f2cl-lib:int-sub 1))
  (f2cl-lib:int-add i
    (f2cl-lib:int-sub 1)))
  ((> i
    (max (the fixnum 1)
      (the fixnum
        (f2cl-lib:int-add j
          (f2cl-lib:int-sub
            k))))))
    nil)
  (tagbody
    (setf temp
      (+ temp
        (*
          (f2cl-lib:dconjg
            (f2cl-lib:fref a-%data%
              ((f2cl-lib:int-add 1 i)
                j)
              ((1 lda) (1 *))
              a-%offset%))
            (f2cl-lib:fref x-%data%
              (ix)
              ((1 *))
              x-%offset%))))
          (setf ix (f2cl-lib:int-sub ix incx))))))
    (setf (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%)
      temp)
    (setf jx (f2cl-lib:int-sub jx incx))))))
(t
  (cond
    ((= incx 1)
      (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
        ((> j n) nil)
        (tagbody
          (setf temp
            (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%))
          (setf l (f2cl-lib:int-sub 1 j))
          (cond
            (noconj

```



```

(if nunit
  (setf temp
    (* temp
      (f2cl-lib:fref a-%data%
        (1 j)
        ((1 lda) (1 *))
        a-%offset%))))
(f2cl-lib:fdo (i (f2cl-lib:int-add j 1)
  (f2cl-lib:int-add i 1))
  (> i
    (min (the fixnum n)
      (the fixnum
        (f2cl-lib:int-add j k))))
    nil)
(tagbody
  (setf temp
    (+ temp
      (*
        (f2cl-lib:fref a-%data%
          ((f2cl-lib:int-add 1 i)
            j)
          ((1 lda) (1 *))
          a-%offset%)
        (f2cl-lib:fref x-%data%
          (i)
          ((1 *))
          x-%offset%))))))
(t
  (if nunit
    (setf temp
      (* temp
        (f2cl-lib:dconjg
          (f2cl-lib:fref a-%data%
            (1 j)
            ((1 lda) (1 *))
            a-%offset%))))
    (f2cl-lib:fdo (i (f2cl-lib:int-add j 1)
      (f2cl-lib:int-add i 1))
      (> i
        (min (the fixnum n)
          (the fixnum
            (f2cl-lib:int-add j k))))
        nil)
    (tagbody
      (setf temp
        (+ temp

```

```

(*
  (f2cl-lib:dconjg
    (f2cl-lib:fref a-%data%
      ((f2cl-lib:int-add 1 i)
        j)
      ((1 lda) (1 *))
      a-%offset%))
    (f2cl-lib:fref x-%data%
      (i)
      ((1 *))
      x-%offset%))))))
  (setf (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%)
    temp)))
(t
  (setf jx kx)
  (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
    (> j n) nil)
  (tagbody
    (setf temp
      (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%))
    (setf kx (f2cl-lib:int-add kx incx))
    (setf ix kx)
    (setf l (f2cl-lib:int-sub 1 j))
    (cond
      (noconj
        (if nunit
          (setf temp
            (* temp
              (f2cl-lib:fref a-%data%
                (1 j)
                ((1 lda) (1 *))
                a-%offset%))))
          (f2cl-lib:fdo (i (f2cl-lib:int-add j 1)
            (f2cl-lib:int-add i 1))
              (> i
                (min (the fixnum n)
                  (the fixnum
                    (f2cl-lib:int-add j k))))
                nil)
            (tagbody
              (setf temp
                (+ temp
                  (*
                    (f2cl-lib:fref a-%data%
                      ((f2cl-lib:int-add 1 i)
                        j)

```

```

((1 lda) (1 *))
a-%offset%)
(f2cl-lib:fref x-%data%
(ix)
((1 *))
x-%offset%))))
(setf ix (f2cl-lib:int-add ix incx))))
(t
  (if nunit
    (setf temp
      (* temp
        (f2cl-lib:dconjg
          (f2cl-lib:fref a-%data%
            (1 j)
            ((1 lda) (1 *))
            a-%offset%))))))
    (f2cl-lib:fdo (i (f2cl-lib:int-add j 1)
      (f2cl-lib:int-add i 1))
      (> i
        (min (the fixnum n)
          (the fixnum
            (f2cl-lib:int-add j k))))
        nil)
      (tagbody
        (setf temp
          (+ temp
            (*
              (f2cl-lib:dconjg
                (f2cl-lib:fref a-%data%
                  ((f2cl-lib:int-add 1 i)
                    j)
                    ((1 lda) (1 *))
                    a-%offset%))
              (f2cl-lib:fref x-%data%
                (ix)
                ((1 *))
                x-%offset%))))
            (setf ix (f2cl-lib:int-add ix incx))))))
      (setf (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%)
        temp)
      (setf jx (f2cl-lib:int-add jx incx))))))
end_label
(return (values nil nil nil nil nil nil nil nil nil))))

```

## 5.29 ztbsv BLAS

```
(ztbsv.input)≡  
  )set break resume  
  )sys rm -f ztbsv.output  
  )spool ztbsv.output  
  )set message test on  
  )set message auto off  
  )clear all  
  
  )spool  
  )lisp (bye)
```

`<ztbsv.help>`≡

```
=====
ztbsv examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

ZTBSV - solve one of the systems of equations  $Ax = b$ , or  $A'^*x = b$ , or  $\text{conjg}(A')x = b$ ,

#### SYNOPSIS

```
SUBROUTINE ZTBSV ( UPLO, TRANS, DIAG, N, K, A, LDA, X, INCX
                  )
```

```
      INTEGER      INCX, K, LDA, N
```

```
      CHARACTER*1  DIAG, TRANS, UPLO
```

```
      COMPLEX*16   A( LDA, * ), X( * )
```

#### PURPOSE

ZTBSV solves one of the systems of equations

where  $b$  and  $x$  are  $n$  element vectors and  $A$  is an  $n$  by  $n$  unit, or non-unit, upper or lower triangular band matrix, with  $(k + 1)$  diagonals.

No test for singularity or near-singularity is included in this routine. Such tests must be performed before calling this routine.

#### PARAMETERS

UPLO - CHARACTER\*1.

On entry, UPLO specifies whether the matrix is an upper or lower triangular matrix as follows:

UPLO = 'U' or 'u' A is an upper triangular matrix.

UPLO = 'L' or 'l' A is a lower triangular matrix.

Unchanged on exit.

TRANS - CHARACTER\*1.

On entry, TRANS specifies the equations to be solved as follows:

TRANS = 'N' or 'n'     $Ax = b$ .

TRANS = 'T' or 't'     $A^T x = b$ .

TRANS = 'C' or 'c'     $\text{conjg}(A)x = b$ .

Unchanged on exit.

DIAG - CHARACTER\*1.

On entry, DIAG specifies whether or not A is unit triangular as follows:

DIAG = 'U' or 'u'    A is assumed to be unit triangular.

DIAG = 'N' or 'n'    A is not assumed to be unit triangular.

Unchanged on exit.

N - INTEGER.

On entry, N specifies the order of the matrix A. N must be at least zero. Unchanged on exit.

K - INTEGER.

On entry with UPLO = 'U' or 'u', K specifies the number of super-diagonals of the matrix A. On entry with UPLO = 'L' or 'l', K specifies the number of sub-diagonals of the matrix A. K must satisfy  $0 \leq K$ . Unchanged on exit.

A - COMPLEX\*16    array of DIMENSION ( LDA, n ).  
Before entry with UPLO = 'U' or 'u', the leading  $(k + 1)$  by n part of the array A must contain the upper triangular band part of the matrix of coefficients, supplied column by column, with the leading diagonal of the matrix in row  $(k + 1)$  of the array, the first super-diagonal starting at position 2 in row k, and so on. The top left k by k triangle of the array A is not referenced. The following program segment will transfer an upper triangular band matrix from conventional full matrix storage to band storage:

```

DO 20, J = 1, N M = K + 1 - J DO 10, I = MAX( 1, J -
K ), J A( M + I, J ) = matrix( I, J ) 10    CONTINUE
20 CONTINUE

```

Before entry with UPLO = 'L' or 'l', the leading ( k + 1 ) by n part of the array A must contain the lower triangular band part of the matrix of coefficients, supplied column by column, with the leading diagonal of the matrix in row 1 of the array, the first sub-diagonal starting at position 1 in row 2, and so on. The bottom right k by k triangle of the array A is not referenced. The following program segment will transfer a lower triangular band matrix from conventional full matrix storage to band storage:

```

DO 20, J = 1, N M = 1 - J DO 10, I = J, MIN( N, J + K
) A( M + I, J ) = matrix( I, J ) 10    CONTINUE 20
CONTINUE

```

Note that when DIAG = 'U' or 'u' the elements of the array A corresponding to the diagonal elements of the

matrix are not referenced, but are assumed to be unity. Unchanged on exit.

LDA - INTEGER.

On entry, LDA specifies the first dimension of A as declared in the calling (sub) program. LDA must be at least ( k + 1 ). Unchanged on exit.

X - COMPLEX\*16 array of dimension at least ( 1 + ( n - 1 ) \* abs( INCX ) ). Before entry, the incremented array X must contain the n element right-hand side vector b. On exit, X is overwritten with the solution vector x.

INCX - INTEGER.

On entry, INCX specifies the increment for the elements of X. INCX must not be zero. Unchanged on exit.

```

<BLAS 2 ztbsv>≡
  (let* ((zero (complex 0.0 0.0)))
    (declare (type (complex double-float) zero))
    (defun ztbsv (uplo trans diag n k a lda x incx)
      (declare (type (simple-array (complex double-float) (*)) x a)
        (type fixnum incx lda k n)
        (type character diag trans uplo))
      (f2cl-lib:with-multi-array-data
        ((uplo character uplo-%data% uplo-%offset%)
         (trans character trans-%data% trans-%offset%)
         (diag character diag-%data% diag-%offset%)
         (a (complex double-float) a-%data% a-%offset%)
         (x (complex double-float) x-%data% x-%offset%))
        (prog ((noconj nil) (nunit nil) (i 0) (info 0) (ix 0) (j 0) (jx 0)
              (kplus1 0) (kx 0) (l 0) (temp #C(0.0 0.0)))
          (declare (type (member t nil) noconj nunit)
            (type fixnum i info ix j jx kplus1 kx l)
            (type (complex double-float) temp))
          (setf info 0)
          (cond
            ((and (not (char-equal uplo #\U)) (not (char-equal uplo #\L)))
              (setf info 1))
            ((and (not (char-equal trans #\N))
              (not (char-equal trans #\T))
              (not (char-equal trans #\C)))
              (setf info 2))
            ((and (not (char-equal diag #\U)) (not (char-equal diag #\N)))
              (setf info 3))
            ((< n 0)
              (setf info 4))
            ((< k 0)
              (setf info 5))
            ((< lda (f2cl-lib:int-add k 1))
              (setf info 7))
            ((= incx 0)
              (setf info 9)))
          (cond
            ((/= info 0)
              (error
                " ** On entry to ~a parameter number ~a had an illegal value~%"
                "ZTBSV" info)
              (go end_label)))
          (if (= n 0) (go end_label))
          (setf noconj (char-equal trans #\T))
          (setf nunit (char-equal diag #\N))
          (cond

```



```

(<= incx 0)
  (setf kx
    (f2cl-lib:int-sub 1
      (f2cl-lib:int-mul (f2cl-lib:int-sub n 1)
        incx))))

(</= incx 1)
  (setf kx 1)))
(cond
  ((char-equal trans #\N)
    (cond
      ((char-equal uplo #\U)
        (setf kplus1 (f2cl-lib:int-add k 1))
        (cond
          ((= incx 1)
            (f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
              (> j 1) nil)
            (tagbody
              (cond
                ((/= (f2cl-lib:fref x (j) ((1 *))) zero)
                  (setf l (f2cl-lib:int-sub kplus1 j))
                  (if nunit
                    (setf (f2cl-lib:fref x-%data%
                                          (j)
                                          ((1 *))
                                          x-%offset%)
                      (/
                        (f2cl-lib:fref x-%data%
                                          (j)
                                          ((1 *))
                                          x-%offset%)
                        (f2cl-lib:fref a-%data%
                                          (kplus1 j)
                                          ((1 lda) (1 *))
                                          a-%offset%))))
                  (setf temp
                    (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%))
                  (f2cl-lib:fdo (i
                    (f2cl-lib:int-add j
                      (f2cl-lib:int-sub 1))
                    (f2cl-lib:int-add i
                      (f2cl-lib:int-sub 1)))
                    (> i
                      (max (the fixnum 1)
                        (the fixnum
                          (f2cl-lib:int-add j
                            (f2cl-lib:i

```

```

k))))))
nil)
(tagbody
  (setf (f2cl-lib:fref x-%data%
    (i)
    ((1 *))
    x-%offset%)
    (-
      (f2cl-lib:fref x-%data%
        (i)
        ((1 *))
        x-%offset%)
      (* temp
        (f2cl-lib:fref a-%data%
          ((f2cl-lib:int-add 1 i)
           j)
          ((1 lda) (1 *))
          a-%offset%))))))))))
(t
  (setf kx
    (f2cl-lib:int-add kx
      (f2cl-lib:int-mul
        (f2cl-lib:int-sub n 1)
        incx)))
  (setf jx kx)
  (f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
    (> j 1) nil)
  (tagbody
    (setf kx (f2cl-lib:int-sub kx incx))
    (cond
      ((/= (f2cl-lib:fref x (jx) ((1 *))) zero)
        (setf ix kx)
        (setf l (f2cl-lib:int-sub kplus1 j))
        (if nounit
          (setf (f2cl-lib:fref x-%data%
            (jx)
            ((1 *))
            x-%offset%)
            (/
              (f2cl-lib:fref x-%data%
                (jx)
                ((1 *))
                x-%offset%)
              (f2cl-lib:fref a-%data%
                (kplus1 j)
                ((1 lda) (1 *))

```

```

                                a-%offset%))))
(setf temp
  (f2cl-lib:fref x-%data%
    (jx)
    ((1 *))
    x-%offset%))
(f2cl-lib:fdo (i
  (f2cl-lib:int-add j
    (f2cl-lib:int-sub 1))
  (f2cl-lib:int-add i
    (f2cl-lib:int-sub 1)))
  ((> i
    (max (the fixnum 1)
      (the fixnum
        (f2cl-lib:int-add j
          (f2cl-lib:int-sub 1)
          (f2cl-lib:int-sub i
            k))))))
    nil)
  (tagbody
    (setf (f2cl-lib:fref x-%data%
      (ix)
      ((1 *))
      x-%offset%))
      (-
        (f2cl-lib:fref x-%data%
          (ix)
          ((1 *))
          x-%offset%)
        (* temp
          (f2cl-lib:fref a-%data%
            ((f2cl-lib:int-add 1 i)
              j)
            ((1 lda) (1 *))
            a-%offset%))))
        (setf ix (f2cl-lib:int-sub ix incx))))))
    (setf jx (f2cl-lib:int-sub jx incx))))))
(t
  (cond
    ((= incx 1)
      (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
        ((> j n) nil)
        (tagbody
          (cond
            ((/= (f2cl-lib:fref x (j) ((1 *))) zero)
              (setf 1 (f2cl-lib:int-sub 1 j))
              (if nunit

```

```

        (setf (f2cl-lib:fref x-%data%
                           (j)
                           ((1 *))
                           x-%offset%)
              (/
                (f2cl-lib:fref x-%data%
                              (j)
                              ((1 *))
                              x-%offset%)
                (f2cl-lib:fref a-%data%
                              (1 j)
                              ((1 lda) (1 *))
                              a-%offset%))))
    (setf temp
      (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%))
    (f2cl-lib:fdo (i (f2cl-lib:int-add j 1)
                  (f2cl-lib:int-add i 1))
      (> i
        (min (the fixnum n)
              (the fixnum
                (f2cl-lib:int-add j k))))
      nil)
    (tagbody
      (setf (f2cl-lib:fref x-%data%
                          (i)
                          ((1 *))
                          x-%offset%)
            (-
              (f2cl-lib:fref x-%data%
                            (i)
                            ((1 *))
                            x-%offset%)
              (* temp
                (f2cl-lib:fref a-%data%
                              ((f2cl-lib:int-add 1 i)
                               j)
                              ((1 lda) (1 *))
                              a-%offset%))))))
  (t
    (setf jx kx)
    (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
      (> j n) nil)
    (tagbody
      (setf kx (f2cl-lib:int-add kx incx))
      (cond
        ((/= (f2cl-lib:fref x (jx) ((1 *))) zero)

```

```

(setf ix kx)
(setf l (f2cl-lib:int-sub 1 j))
(if nunit
  (setf (f2cl-lib:fref x-%data%
                      (jx)
                      ((1 *))
                      x-%offset%)
    (/
      (f2cl-lib:fref x-%data%
                    (jx)
                    ((1 *))
                    x-%offset%)
      (f2cl-lib:fref a-%data%
                    (1 j)
                    ((1 lda) (1 *))
                    a-%offset%))))
(setf temp
  (f2cl-lib:fref x-%data%
                (jx)
                ((1 *))
                x-%offset%))
(f2cl-lib:fdo (i (f2cl-lib:int-add j 1)
               (f2cl-lib:int-add i 1))
  (> i
    (min (the fixnum n)
          (the fixnum
            (f2cl-lib:int-add j k))))
  nil)
(tagbody
  (setf (f2cl-lib:fref x-%data%
                    (ix)
                    ((1 *))
                    x-%offset%)
    (-
      (f2cl-lib:fref x-%data%
                    (ix)
                    ((1 *))
                    x-%offset%)
      (* temp
        (f2cl-lib:fref a-%data%
                      ((f2cl-lib:int-add 1 i)
                       j)
                      ((1 lda) (1 *))
                      a-%offset%))))
    (setf ix (f2cl-lib:int-add ix incx))))))
(setf jx (f2cl-lib:int-add jx incx))))))

```

```
(t
(cond
((char-equal uplo #\U)
(setf kplus1 (f2cl-lib:int-add k 1))
(cond
(= incx 1)
(f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
(> j n) nil)
(tagbody
(setf temp
(f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%))
(setf l (f2cl-lib:int-sub kplus1 j))
(cond
(noconj
(f2cl-lib:fdo (i
(max (the fixnum 1)
(the fixnum
(f2cl-lib:int-add j
(f2cl-lib:int-sub
k))))
(f2cl-lib:int-add i 1))
(> i
(f2cl-lib:int-add j
(f2cl-lib:int-sub
1)))
nil)
(tagbody
(setf temp
(- temp
(*
(f2cl-lib:fref a-%data%
((f2cl-lib:int-add l i)
j)
((1 lda) (1 *))
a-%offset%)
(f2cl-lib:fref x-%data%
(i)
((1 *))
x-%offset%))))))
(if nounit
(setf temp
(/ temp
(f2cl-lib:fref a-%data%
(kplus1 j)
((1 lda) (1 *))
a-%offset%))))))

```

```

(t
  (f2cl-lib:fdo (i
    (max (the fixnum 1)
          (the fixnum
            (f2cl-lib:int-add j
              (f2cl-lib:int-
                k))))))
    (f2cl-lib:int-add i 1))
    (> i
      (f2cl-lib:int-add j
        (f2cl-lib:int-sub
          1)))
    nil)
  (tagbody
    (setf temp
      (- temp
        (*
          (f2cl-lib:dconjg
            (f2cl-lib:fref a-%data%
              ((f2cl-lib:int-add 1 i)
                j)
              ((1 lda) (1 *))
              a-%offset%))
            (f2cl-lib:fref x-%data%
              (i)
              ((1 *))
              x-%offset%))))))
    (if nount
      (setf temp
        (/ temp
          (f2cl-lib:dconjg
            (f2cl-lib:fref a-%data%
              (kplus1 j)
              ((1 lda) (1 *))
              a-%offset%))))))
      (setf (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%)
        temp))))
(t
  (setf jx kx)
  (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
    (> j n) nil)
  (tagbody
    (setf temp
      (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%))
    (setf ix kx)
    (setf l (f2cl-lib:int-sub kplus1 j))

```

```

(cond
  (noconj
    (f2cl-lib:fdo (i
      (max (the fixnum 1)
            (the fixnum
              (f2cl-lib:int-add j
                (f2cl-lib:int-sub
                  k))))))
      (f2cl-lib:int-add i 1))
    (> i
      (f2cl-lib:int-add j
        (f2cl-lib:int-sub
          1)))
    nil)
  (tagbody
    (setf temp
      (- temp
        (*
          (f2cl-lib:fref a-%data%
            ((f2cl-lib:int-add 1 i)
              j)
            ((1 lda) (1 *))
            a-%offset%)
          (f2cl-lib:fref x-%data%
            (ix)
            ((1 *))
            x-%offset%))))))
    (setf ix (f2cl-lib:int-add ix incx)))
  (if nounit
    (setf temp
      (/ temp
        (f2cl-lib:fref a-%data%
          (kplus1 j)
          ((1 lda) (1 *))
          a-%offset%))))))
  (t
    (f2cl-lib:fdo (i
      (max (the fixnum 1)
            (the fixnum
              (f2cl-lib:int-add j
                (f2cl-lib:int-sub
                  k))))))
      (f2cl-lib:int-add i 1))
    (> i
      (f2cl-lib:int-add j
        (f2cl-lib:int-sub
          1)))
    nil)

```



```

1)))
nil)
(tagbody
  (setf temp
    (- temp
      (*
        (f2cl-lib:dconjg
          (f2cl-lib:fref a-%data%
            ((f2cl-lib:int-add 1 i)
              j)
            ((1 lda) (1 *))
            a-%offset%)))
        (f2cl-lib:fref x-%data%
          (ix)
            ((1 *))
            x-%offset%))))))
    (setf ix (f2cl-lib:int-add ix incx))))
(if nunit
  (setf temp
    (/ temp
      (f2cl-lib:dconjg
        (f2cl-lib:fref a-%data%
          (kplus1 j)
            ((1 lda) (1 *))
            a-%offset%))))))
  (setf (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%)
    temp)
  (setf jx (f2cl-lib:int-add jx incx))
  (if (> j k) (setf kx (f2cl-lib:int-add kx incx))))))
(t
  (cond
    ((= incx 1)
      (f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
        ((> j 1) nil)
        (tagbody
          (setf temp
            (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%))
          (setf l (f2cl-lib:int-sub 1 j))
          (cond
            (noconj
              (f2cl-lib:fdo (i
                (min (the fixnum n)
                  (the fixnum
                    (f2cl-lib:int-add j k)))
                (f2cl-lib:int-add i
                  (f2cl-lib:int-sub 1)))

```



```

(f2cl-lib:dconjg
  (f2cl-lib:fref a-%data%
    (1 j)
    ((1 lda) (1 *))
    a-%offset%))))))
(setf (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%)
      temp)))
(t
  (setf kx
    (f2cl-lib:int-add kx
      (f2cl-lib:int-mul
        (f2cl-lib:int-sub n 1)
        incx)))
  (setf jx kx)
  (f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
    ((> j 1) nil)
    (tagbody
      (setf temp
        (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%))
      (setf ix kx)
      (setf l (f2cl-lib:int-sub 1 j))
      (cond
        (noconj
          (f2cl-lib:fdo (i
            (min (the fixnum n)
                  (the fixnum
                    (f2cl-lib:int-add j k)))
            (f2cl-lib:int-add i
              (f2cl-lib:int-sub 1)))
            ((> i (f2cl-lib:int-add j 1)) nil)
            (tagbody
              (setf temp
                (- temp
                  (*
                    (f2cl-lib:fref a-%data%
                      ((f2cl-lib:int-add l i)
                       j)
                      ((1 lda) (1 *))
                      a-%offset%)
                    (f2cl-lib:fref x-%data%
                      (ix)
                      ((1 *))
                      x-%offset%))))
                (setf ix (f2cl-lib:int-sub ix incx))))
          (if nunit
            (setf temp

```

```

                                (/ temp
                                (f2cl-lib:fref a-%data%
                                  (1 j)
                                  ((1 lda) (1 *))
                                  a-%offset%))))
(t
  (f2cl-lib:fdo (i
    (min (the fixnum n)
          (the fixnum
            (f2cl-lib:int-add j k)))
    (f2cl-lib:int-add i
                      (f2cl-lib:int-sub 1)))
    (> i (f2cl-lib:int-add j 1)) nil)
  (tagbody
    (setf temp
      (- temp
        (*
          (f2cl-lib:dconjg
            (f2cl-lib:fref a-%data%
                          ((f2cl-lib:int-add 1 i)
                           j)
                          ((1 lda) (1 *))
                          a-%offset%))
          (f2cl-lib:fref x-%data%
                        (ix)
                        ((1 *))
                        x-%offset%))))
      (setf ix (f2cl-lib:int-sub ix incx))))
  (if nounit
    (setf temp
      (/ temp
        (f2cl-lib:dconjg
          (f2cl-lib:fref a-%data%
                        (1 j)
                        ((1 lda) (1 *))
                        a-%offset%))))))
    (setf (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%)
      temp)
    (setf jx (f2cl-lib:int-sub jx incx))
    (if (>= (f2cl-lib:int-sub n j) k)
      (setf kx (f2cl-lib:int-sub kx incx))))))
end_label
  (return (values nil nil nil nil nil nil nil nil))))

```

### 5.30 ztpmv BLAS

```
<ztpmv.input>≡  
  )set break resume  
  )sys rm -f ztpmv.output  
  )spool ztpmv.output  
  )set message test on  
  )set message auto off  
  )clear all  
  
  )spool  
  )lisp (bye)
```

`<ztpmv.help>`≡

```
=====
ztpmv examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

ZTPMV - perform one of the matrix-vector operations  $x := A*x$ , or  $x := A'*x$ , or  $x := \text{conjg}(A')*x$ ,

#### SYNOPSIS

SUBROUTINE ZTPMV ( UPLO, TRANS, DIAG, N, AP, X, INCX )

INTEGER INCX, N

CHARACTER\*1 DIAG, TRANS, UPLO

COMPLEX\*16 AP( \* ), X( \* )

#### PURPOSE

ZTPMV performs one of the matrix-vector operations

where  $x$  is an  $n$  element vector and  $A$  is an  $n$  by  $n$  unit, or non-unit, upper or lower triangular matrix, supplied in packed form.

#### PARAMETERS

UPLO - CHARACTER\*1.

On entry, UPLO specifies whether the matrix is an upper or lower triangular matrix as follows:

UPLO = 'U' or 'u' A is an upper triangular matrix.

UPLO = 'L' or 'l' A is a lower triangular matrix.

Unchanged on exit.

TRANS - CHARACTER\*1.

On entry, TRANS specifies the operation to be performed as follows:

TRANS = 'N' or 'n'  $x := A*x$ .

TRANS = 'T' or 't'      $x := A * x$ .

TRANS = 'C' or 'c'      $x := \text{conjg}(A) * x$ .

Unchanged on exit.

DIAG - CHARACTER\*1.

On entry, DIAG specifies whether or not A is unit triangular as follows:

DIAG = 'U' or 'u'     A is assumed to be unit triangular.

DIAG = 'N' or 'n'     A is not assumed to be unit triangular.

Unchanged on exit.

N - INTEGER.

On entry, N specifies the order of the matrix A. N must be at least zero. Unchanged on exit.

AP - COMPLEX\*16     array of DIMENSION at least  
 ( (  $n * (n + 1)$  ) ) / 2 ). Before entry with UPLO = 'U' or 'u', the array AP must contain the upper triangular matrix packed sequentially, column by column, so that AP( 1 ) contains a( 1, 1 ), AP( 2 ) and AP( 3 ) contain a( 1, 2 ) and a( 2, 2 ) respectively, and so on. Before entry with UPLO = 'L' or 'l', the array AP must contain the lower triangular matrix packed sequentially, column by column, so that AP( 1 ) contains a( 1, 1 ), AP( 2 ) and AP( 3 ) contain a( 2, 1 ) and a( 3, 1 ) respectively, and so on. Note that when DIAG = 'U' or 'u', the diagonal elements of A are not referenced, but are assumed to be unity.  
 Unchanged on exit.

X - COMPLEX\*16     array of dimension at least  
 ( 1 + (  $n - 1$  ) \* abs( INCX ) ). Before entry, the incremented array X must contain the n element vector x. On exit, X is overwritten with the transformed vector x.

INCX - INTEGER.

On entry, INCX specifies the increment for the ele-

ments of X. INCX must not be zero. Unchanged on exit.



```

<BLAS 2 ztpmv>≡
  (let* ((zero (complex 0.0 0.0)))
    (declare (type (complex double-float) zero))
    (defun ztpmv (uplo trans diag n ap x incx)
      (declare (type (simple-array (complex double-float) (*)) x ap)
        (type fixnum incx n)
        (type character diag trans uplo))
      (f2cl-lib:with-multi-array-data
        ((uplo character uplo-%data% uplo-%offset%)
         (trans character trans-%data% trans-%offset%)
         (diag character diag-%data% diag-%offset%)
         (ap (complex double-float) ap-%data% ap-%offset%)
         (x (complex double-float) x-%data% x-%offset%))
        (prog ((noconj nil) (nunit nil) (i 0) (info 0) (ix 0) (j 0) (jx 0) (k 0)
              (kk 0) (kx 0) (temp #C(0.0 0.0)))
          (declare (type (member t nil) noconj nunit)
            (type fixnum i info ix j jx k kk kx)
            (type (complex double-float) temp))
          (setf info 0)
          (cond
            ((and (not (char-equal uplo #\U)) (not (char-equal uplo #\L)))
              (setf info 1))
            ((and (not (char-equal trans #\N))
              (not (char-equal trans #\T))
              (not (char-equal trans #\C)))
              (setf info 2))
            ((and (not (char-equal diag #\U)) (not (char-equal diag #\N)))
              (setf info 3))
            ((< n 0)
              (setf info 4))
            ((= incx 0)
              (setf info 7)))
          (cond
            ((/= info 0)
              (error
                " ** On entry to ~a parameter number ~a had an illegal value~%"
                "ZTPMV" info)
              (go end_label)))
          (if (= n 0) (go end_label))
          (setf noconj (char-equal trans #\T))
          (setf nunit (char-equal diag #\N))
          (cond
            ((<= incx 0)
              (setf kx
                (f2cl-lib:int-sub 1
                  (f2cl-lib:int-mul (f2cl-lib:int-sub n 1)

```



```

(f2cl-lib:fref x-%data%
  (j)
  ((1 *))
  x-%offset%)
(f2cl-lib:fref ap-%data%
  ((f2cl-lib:int-sub
    (f2cl-lib:int-add kk j)
    1))
  ((1 *))
  ap-%offset%))))))
(setf kk (f2cl-lib:int-add kk j))))
(t
  (setf jx kx)
  (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
    (> j n) nil)
  (tagbody
    (cond
      ((/= (f2cl-lib:fref x (jx) ((1 *))) zero)
        (setf temp
          (f2cl-lib:fref x-%data%
            (jx)
            ((1 *))
            x-%offset%))
        (setf ix kx)
        (f2cl-lib:fdo (k kk (f2cl-lib:int-add k 1))
          (> k
            (f2cl-lib:int-add kk
              j
              (f2cl-lib:int-sub
                2)))
            nil)
          (tagbody
            (setf (f2cl-lib:fref x-%data%
              (ix)
              ((1 *))
              x-%offset%)
              (+
                (f2cl-lib:fref x-%data%
                  (ix)
                  ((1 *))
                  x-%offset%)
                (* temp
                  (f2cl-lib:fref ap-%data%
                    (k)
                    ((1 *))
                    ap-%offset%))))))

```

[illegible]

```

                                (f2cl-lib:fref ap-%data%
                                (k)
                                ((1 *))
                                ap-%offset%))))
    (setf k (f2cl-lib:int-sub k 1)))
(if nunit
  (setf (f2cl-lib:fref x-%data%
                      (j)
                      ((1 *))
                      x-%offset%)
    (*
      (f2cl-lib:fref x-%data%
                    (j)
                    ((1 *))
                    x-%offset%)
      (f2cl-lib:fref ap-%data%
                    ((f2cl-lib:int-add
                     (f2cl-lib:int-sub kk n)
                     j))
                    ((1 *))
                    ap-%offset%))))))
(setf kk
  (f2cl-lib:int-sub kk
    (f2cl-lib:int-add
      (f2cl-lib:int-sub n j)
      1))))
(t
  (setf kx
    (f2cl-lib:int-add kx
      (f2cl-lib:int-mul
        (f2cl-lib:int-sub n 1)
        incx)))
  (setf jx kx)
  (f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
    ((> j 1) nil)
    (tagbody
      (cond
        ((/= (f2cl-lib:fref x (jx) ((1 *))) zero)
          (setf temp
            (f2cl-lib:fref x-%data%
                          (jx)
                          ((1 *))
                          x-%offset%))
          (setf ix kx)
          (f2cl-lib:fdo (k kk
            (f2cl-lib:int-add k

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                                (f2cl-lib:int-sub 1)))
    (> k
      (f2cl-lib:int-add kk
        (f2cl-lib:int-sub
          (f2cl-lib:int-add
            n
            (f2cl-lib:int-sub
              (f2cl-lib:int-add
                j
                1))))))
      nil)
  (tagbody
    (setf (f2cl-lib:fref x-%data%
                        (ix)
                        ((1 *))
                        x-%offset%)
      (+
        (f2cl-lib:fref x-%data%
                        (ix)
                        ((1 *))
                        x-%offset%)
        (* temp
          (f2cl-lib:fref ap-%data%
                        (k)
                        ((1 *))
                        ap-%offset%))))
    (setf ix (f2cl-lib:int-sub ix incx)))
  (if nunit
    (setf (f2cl-lib:fref x-%data%
                        (jx)
                        ((1 *))
                        x-%offset%)
      (*
        (f2cl-lib:fref x-%data%
                        (jx)
                        ((1 *))
                        x-%offset%)
        (f2cl-lib:fref ap-%data%
                        ((f2cl-lib:int-add
                          (f2cl-lib:int-sub kk n)
                          j))
                        ((1 *))
                        ap-%offset%))))))
  (setf jx (f2cl-lib:int-sub jx incx))
  (setf kk
    (f2cl-lib:int-sub kk

```

```

(f2cl-lib:int-add
 (f2cl-lib:int-sub n j)
 1)))))))))
(t
 (cond
  ((char-equal uplo #\U)
   (setf kk (the fixnum (truncate (* n (+ n 1)) 2)))
   (cond
    ((= incx 1)
     (f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
      ((> j 1) nil)
      (tagbody
       (setf temp
        (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%))
       (setf k (f2cl-lib:int-sub kk 1))
       (cond
        (noconj
         (if nounit
          (setf temp
           (* temp
            (f2cl-lib:fref ap-%data%
              (kk)
              ((1 *))
              ap-%offset%))))
          (f2cl-lib:fdo (i
            (f2cl-lib:int-add j
              (f2cl-lib:int-sub 1))
            (f2cl-lib:int-add i
              (f2cl-lib:int-sub 1)))
              ((> i 1) nil)
              (tagbody
               (setf temp
                (+ temp
                 (*
                  (f2cl-lib:fref ap-%data%
                    (k)
                    ((1 *))
                    ap-%offset%)
                  (f2cl-lib:fref x-%data%
                    (i)
                    ((1 *))
                    x-%offset%))))
                (setf k (f2cl-lib:int-sub k 1))))))
        (t
         (if nounit
          (setf temp

```

```

(* temp
  (f2cl-lib:dconjg
    (f2cl-lib:fref ap-%data%
                    (kk)
                    ((1 *))
                    ap-%offset%))))))
(f2cl-lib:fdo (i
              (f2cl-lib:int-add j
                                (f2cl-lib:int-sub 1))
              (f2cl-lib:int-add i
                                (f2cl-lib:int-sub 1)))
              ((> i 1) nil)
  (tagbody
    (setf temp
      (+ temp
        (*
          (f2cl-lib:dconjg
            (f2cl-lib:fref ap-%data%
                            (k)
                            ((1 *))
                            ap-%offset%))
          (f2cl-lib:fref x-%data%
                          (i)
                          ((1 *))
                          x-%offset%))))
        (setf k (f2cl-lib:int-sub k 1))))))
    (setf (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%
                        temp)
      (setf kk (f2cl-lib:int-sub kk j))))))
(t
  (setf jx
    (f2cl-lib:int-add kx
                      (f2cl-lib:int-mul
                        (f2cl-lib:int-sub n 1)
                        incx)))
    (f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
                  ((> j 1) nil)
    (tagbody
      (setf temp
        (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%))
      (setf ix jx)
      (cond
        (noconj
          (if nounit
            (setf temp
              (* temp

```





```

1))
nil)
(tagbody
  (setf ix (f2cl-lib:int-sub ix incx))
  (setf temp
    (+ temp
      (*
        (f2cl-lib:dconjg
          (f2cl-lib:fref ap-%data%
            (k)
            ((1 *))
            ap-%offset%))
        (f2cl-lib:fref x-%data%
          (ix)
          ((1 *))
          x-%offset%))))))
  (setf (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%)
    temp)
  (setf jx (f2cl-lib:int-sub jx incx))
  (setf kk (f2cl-lib:int-sub kk j))))))
(t
  (setf kk 1)
  (cond
    ((= incx 1)
      (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
        (> j n) nil)
      (tagbody
        (setf temp
          (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%))
        (setf k (f2cl-lib:int-add kk 1))
        (cond
          (noconj
            (if nounit
              (setf temp
                (* temp
                  (f2cl-lib:fref ap-%data%
                    (kk)
                    ((1 *))
                    ap-%offset%))))
            (f2cl-lib:fdo (i (f2cl-lib:int-add j 1)
              (f2cl-lib:int-add i 1))
                (> i n) nil)
              (tagbody
                (setf temp
                  (+ temp
                    (*

```

```

        (f2cl-lib:fref ap-%data%
          (k)
          ((1 *))
          ap-%offset%)
        (f2cl-lib:fref x-%data%
          (i)
          ((1 *))
          x-%offset%))))
      (setf k (f2cl-lib:int-add k 1))))
    (t
      (if nunit
        (setf temp
          (* temp
            (f2cl-lib:dconjg
              (f2cl-lib:fref ap-%data%
                (kk)
                ((1 *))
                ap-%offset%))))))
        (f2cl-lib:fdo (i (f2cl-lib:int-add j 1)
          (f2cl-lib:int-add i 1))
          (> i n) nil)
          (tagbody
            (setf temp
              (+ temp
                (*
                  (f2cl-lib:dconjg
                    (f2cl-lib:fref ap-%data%
                      (k)
                      ((1 *))
                      ap-%offset%))
                  (f2cl-lib:fref x-%data%
                    (i)
                    ((1 *))
                    x-%offset%))))))
              (setf k (f2cl-lib:int-add k 1))))))
        (setf (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%)
          temp)
        (setf kk
          (f2cl-lib:int-add kk
            (f2cl-lib:int-add
              (f2cl-lib:int-sub n j)
              1))))))
    (t
      (setf jx kx)
      (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
        (> j n) nil)

```

```
(tagbody
  (setf temp
    (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%))
  (setf ix jx)
  (cond
    (noconj
      (if nounit
        (setf temp
          (* temp
            (f2cl-lib:fref ap-%data%
                          (kk)
                          ((1 *))
                          ap-%offset%))))
        (f2cl-lib:fdo (k (f2cl-lib:int-add kk 1)
                      (f2cl-lib:int-add k 1))
          (> k
            (f2cl-lib:int-add kk
                                n
                                (f2cl-lib:int-sub
                                  j)))
          nil)
        (tagbody
          (setf ix (f2cl-lib:int-add ix incx))
          (setf temp
            (+ temp
              (*
                (f2cl-lib:fref ap-%data%
                              (k)
                              ((1 *))
                              ap-%offset%)
                (f2cl-lib:fref x-%data%
                              (ix)
                              ((1 *))
                              x-%offset%))))))
      t)
    (if nounit
      (setf temp
        (* temp
          (f2cl-lib:dconjg
            (f2cl-lib:fref ap-%data%
                          (kk)
                          ((1 *))
                          ap-%offset%))))
      (f2cl-lib:fdo (k (f2cl-lib:int-add kk 1)
                    (f2cl-lib:int-add k 1))
        (> k
```

```

                                (f2cl-lib:int-add kk
                                n
                                (f2cl-lib:int-sub
                                j)))
                                nil)
(tagbody
  (setf ix (f2cl-lib:int-add ix incx))
  (setf temp
    (+ temp
      (*
        (f2cl-lib:dconjg
          (f2cl-lib:fref ap-%data%
                        (k)
                        ((1 *))
                        ap-%offset%))
        (f2cl-lib:fref x-%data%
                        (ix)
                        ((1 *))
                        x-%offset%))))))
  (setf (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%)
    temp)
  (setf jx (f2cl-lib:int-add jx incx))
  (setf kk
    (f2cl-lib:int-add kk
      (f2cl-lib:int-add
        (f2cl-lib:int-sub n j)
        1))))))
end_label
(return (values nil nil nil nil nil nil nil))

```

### 5.31 ztpsv BLAS

```

<ztpsv.input>≡
)set break resume
)sys rm -f ztpsv.output
)spool ztpsv.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)

```

*<ztpsv.help>*≡

```
=====
ztpsv examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

ZTPSV - solve one of the systems of equations  $A*x = b$ , or  $A'*x = b$ , or  $\text{conj}(A')*x = b$ ,

#### SYNOPSIS

SUBROUTINE ZTPSV ( UPLO, TRANS, DIAG, N, AP, X, INCX )

INTEGER INCX, N

CHARACTER\*1 DIAG, TRANS, UPLO

COMPLEX\*16 AP( \* ), X( \* )

#### PURPOSE

ZTPSV solves one of the systems of equations

where b and x are n element vectors and A is an n by n unit, or non-unit, upper or lower triangular matrix, supplied in packed form.

No test for singularity or near-singularity is included in this routine. Such tests must be performed before calling this routine.

#### PARAMETERS

UPLO - CHARACTER\*1.

On entry, UPLO specifies whether the matrix is an upper or lower triangular matrix as follows:

UPLO = 'U' or 'u' A is an upper triangular matrix.

UPLO = 'L' or 'l' A is a lower triangular matrix.

Unchanged on exit.

TRANS - CHARACTER\*1.

On entry, TRANS specifies the equations to be solved

as follows:

TRANS = 'N' or 'n'     $Ax = b$ .

TRANS = 'T' or 't'     $A^T x = b$ .

TRANS = 'C' or 'c'     $\text{conjg}(A)x = b$ .

Unchanged on exit.

DIAG - CHARACTER\*1.

On entry, DIAG specifies whether or not A is unit triangular as follows:

DIAG = 'U' or 'u'    A is assumed to be unit triangular.

DIAG = 'N' or 'n'    A is not assumed to be unit triangular.

Unchanged on exit.

N - INTEGER.

On entry, N specifies the order of the matrix A. N must be at least zero. Unchanged on exit.

AP - COMPLEX\*16    array of DIMENSION at least  
 ( (  $n*(n+1)$  ) )/2 ). Before entry with UPL0 = 'U' or 'u', the array AP must contain the upper triangular matrix packed sequentially, column by column, so that AP( 1 ) contains a( 1, 1 ), AP( 2 ) and AP( 3 ) contain a( 1, 2 ) and a( 2, 2 ) respectively, and so on. Before entry with UPL0 = 'L' or 'l', the array AP must contain the lower triangular matrix packed sequentially, column by column, so that AP( 1 ) contains a( 1, 1 ), AP( 2 ) and AP( 3 ) contain a( 2, 1 ) and a( 3, 1 ) respectively, and so on. Note that when DIAG = 'U' or 'u', the diagonal elements of A are not referenced, but are assumed to be unity.  
 Unchanged on exit.

X - COMPLEX\*16    array of dimension at least  
 ( 1 + (  $n-1$  ) \*abs( INCX ) ). Before entry, the incremented array X must contain the n element right-hand side vector b. On exit, X is overwritten with the solution vector x.

INCX    - INTEGER.  
On entry, INCX specifies the increment for the elements of X. INCX must not be zero. Unchanged on exit.



```

<BLAS 2 ztpsv>=
  (let* ((zero (complex 0.0 0.0)))
    (declare (type (complex double-float) zero))
    (defun ztpsv (uplo trans diag n ap x incx)
      (declare (type (simple-array (complex double-float) (*)) x ap)
        (type fixnum incx n)
        (type character diag trans uplo))
      (f2cl-lib:with-multi-array-data
        ((uplo character uplo-%data% uplo-%offset%)
         (trans character trans-%data% trans-%offset%)
         (diag character diag-%data% diag-%offset%)
         (ap (complex double-float) ap-%data% ap-%offset%)
         (x (complex double-float) x-%data% x-%offset%))
        (prog ((noconj nil) (nunit nil) (i 0) (info 0) (ix 0) (j 0) (jx 0) (k 0)
              (kk 0) (kx 0) (temp #C(0.0 0.0)))
          (declare (type (member t nil) noconj nunit)
            (type fixnum i info ix j jx k kk kx)
            (type (complex double-float) temp))
          (setf info 0)
          (cond
            ((and (not (char-equal uplo #\U)) (not (char-equal uplo #\L)))
              (setf info 1))
            ((and (not (char-equal trans #\N))
                  (not (char-equal trans #\T))
                  (not (char-equal trans #\C)))
              (setf info 2))
            ((and (not (char-equal diag #\U)) (not (char-equal diag #\N)))
              (setf info 3))
            ((< n 0)
              (setf info 4))
            ((= incx 0)
              (setf info 7)))
          (cond
            ((/= info 0)
              (error
                " ** On entry to ~a parameter number ~a had an illegal value~%"
                "ZTPSV" info)
              (go end_label)))
          (if (= n 0) (go end_label))
          (setf noconj (char-equal trans #\T))
          (setf nunit (char-equal diag #\N))
          (cond
            ((<= incx 0)
              (setf kx
                (f2cl-lib:int-sub 1
                  (f2cl-lib:int-mul (f2cl-lib:int-sub n 1)

```

```

                                incx))))
( (/ = incx 1)
  (setf kx 1)))
(cond
  ((char-equal trans #\N)
    (cond
      ((char-equal uplo #\U)
        (setf kk (the fixnum (truncate (* n (+ n 1)) 2)))
        (cond
          ((= incx 1)
            (f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
                          ((> j 1) nil)
              (tagbody
                (cond
                  ((/= (f2cl-lib:fref x (j) ((1 *))) zero)
                    (if nounit
                      (setf (f2cl-lib:fref x-%data%
                                             (j)
                                             ((1 *))
                                             x-%offset%)
                            (/
                             (f2cl-lib:fref x-%data%
                                             (j)
                                             ((1 *))
                                             x-%offset%)
                             (f2cl-lib:fref ap-%data%
                                             (kk)
                                             ((1 *))
                                             ap-%offset%))))))
                    (setf temp
                      (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%))
                    (setf k (f2cl-lib:int-sub kk 1))
                    (f2cl-lib:fdo (i
                                   (f2cl-lib:int-add j
                                                         (f2cl-lib:int-sub 1))
                                   (f2cl-lib:int-add i
                                                         (f2cl-lib:int-sub 1)))
                                  ((> i 1) nil)
                        (tagbody
                          (setf (f2cl-lib:fref x-%data%
                                                  (i)
                                                  ((1 *))
                                                  x-%offset%)
                                (-
                                 (f2cl-lib:fref x-%data%
                                                  (i)
                                                  (i)
                                                  x-%offset%)
                                 (f2cl-lib:fref x-%data%
                                                  (i)
                                                  ((1 *))
                                                  x-%offset%))))))
                    (setf kx 1)
                    (return))))
          (t
            (return))))))
  (t
    (return)))

```

```

                                ((1 *))
                                x-%offset%)
(* temp
  (f2cl-lib:fref ap-%data%
    (k)
    ((1 *))
    ap-%offset%))))
  (setf k (f2cl-lib:int-sub k 1))))))
(setf kk (f2cl-lib:int-sub kk j))))
(t
  (setf jx
    (f2cl-lib:int-add kx
      (f2cl-lib:int-mul
        (f2cl-lib:int-sub n 1)
        incx)))
    (f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
      ((> j 1) nil)
      (tagbody
        (cond
          ((/= (f2cl-lib:fref x (jx) ((1 *))) zero)
            (if nunit
              (setf (f2cl-lib:fref x-%data%
                (jx)
                ((1 *))
                x-%offset%)
                (/
                  (f2cl-lib:fref x-%data%
                    (jx)
                    ((1 *))
                    x-%offset%)
                  (f2cl-lib:fref ap-%data%
                    (kk)
                    ((1 *))
                    ap-%offset%))))
              (setf temp
                (f2cl-lib:fref x-%data%
                  (jx)
                  ((1 *))
                  x-%offset%)))
            (setf ix jx)
            (f2cl-lib:fdo (k
              (f2cl-lib:int-add kk
                (f2cl-lib:int-sub 1))
              (f2cl-lib:int-add k
                (f2cl-lib:int-sub 1)))
              ((> k

```

```

                                (f2cl-lib:int-add kk
                                (f2cl-lib:int-sub
                                  j)
                                1))
                                nil)
  (tagbody
    (setf ix (f2cl-lib:int-sub ix incx))
    (setf (f2cl-lib:fref x-%data%
                        (ix)
                        ((1 *))
                        x-%offset%)
      (-
        (f2cl-lib:fref x-%data%
                      (ix)
                      ((1 *))
                      x-%offset%)
        (* temp
          (f2cl-lib:fref ap-%data%
                        (k)
                        ((1 *))
                        ap-%offset%))))))
    (setf jx (f2cl-lib:int-sub jx incx))
    (setf kk (f2cl-lib:int-sub kk j))))))
(t
  (setf kk 1)
  (cond
    ((= incx 1)
      (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                    (> j n) nil)
      (tagbody
        (cond
          ((/= (f2cl-lib:fref x (j) ((1 *))) zero)
            (if nounit
              (setf (f2cl-lib:fref x-%data%
                                (j)
                                ((1 *))
                                x-%offset%)
                (/
                  (f2cl-lib:fref x-%data%
                                (j)
                                ((1 *))
                                x-%offset%)
                  (f2cl-lib:fref ap-%data%
                                (kk)
                                ((1 *))
                                ap-%offset%))))))

```

```

(setf temp
  (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%))
(setf k (f2cl-lib:int-add kk 1))
(f2cl-lib:fdo (i (f2cl-lib:int-add j 1)
              (f2cl-lib:int-add i 1))
              (> i n) nil)
  (tagbody
    (setf (f2cl-lib:fref x-%data%
                        (i)
                        ((1 *))
                        x-%offset%)
          (-
            (f2cl-lib:fref x-%data%
                          (i)
                          ((1 *))
                          x-%offset%)
            (* temp
              (f2cl-lib:fref ap-%data%
                            (k)
                            ((1 *))
                            ap-%offset%))))))
    (setf k (f2cl-lib:int-add k 1))))))
(setf kk
  (f2cl-lib:int-add kk
    (f2cl-lib:int-add
      (f2cl-lib:int-sub n j)
      1))))))
(t
  (setf jx kx)
  (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                (> j n) nil)
    (tagbody
      (cond
        ((/= (f2cl-lib:fref x (jx) ((1 *))) zero)
          (if nunit
              (setf (f2cl-lib:fref x-%data%
                                  (jx)
                                  ((1 *))
                                  x-%offset%)
                    (/
                      (f2cl-lib:fref x-%data%
                                    (jx)
                                    ((1 *))
                                    x-%offset%)
                      (f2cl-lib:fref ap-%data%
                                    (kk)

```

```

((1 *))
ap-%offset%))))
(setf temp
  (f2cl-lib:fref x-%data%
    (jx)
    ((1 *))
    x-%offset%))
(setf ix jx)
(f2cl-lib:fdo (k (f2cl-lib:int-add kk 1)
  (f2cl-lib:int-add k 1))
  (> k
    (f2cl-lib:int-add kk
      n
      (f2cl-lib:int-sub
        j)))
    nil)
(tagbody
  (setf ix (f2cl-lib:int-add ix incx))
  (setf (f2cl-lib:fref x-%data%
    (ix)
    ((1 *))
    x-%offset%)
    (-
      (f2cl-lib:fref x-%data%
        (ix)
        ((1 *))
        x-%offset%)
      (* temp
        (f2cl-lib:fref ap-%data%
          (k)
          ((1 *))
          ap-%offset%))))))
(setf jx (f2cl-lib:int-add jx incx))
(setf kk
  (f2cl-lib:int-add kk
    (f2cl-lib:int-add
      (f2cl-lib:int-sub n j)
      1))))))
(t
  (cond
    ((char-equal uplo #\U)
      (setf kk 1)
      (cond
        ((= incx 1)
          (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
            (> j n) nil)

```

```

(tagbody
  (setf temp
    (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%))
  (setf k kk)
  (cond
    (noconj
      (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
        ((> i
          (f2cl-lib:int-add j
            (f2cl-lib:int-sub
              1)))
          nil)
      (tagbody
        (setf temp
          (- temp
            (*
              (f2cl-lib:fref ap-%data%
                (k)
                ((1 *))
                ap-%offset%)
              (f2cl-lib:fref x-%data%
                (i)
                ((1 *))
                x-%offset%))))
          (setf k (f2cl-lib:int-add k 1))))
    (if nount
      (setf temp
        (/ temp
          (f2cl-lib:fref ap-%data%
            ((f2cl-lib:int-sub
              (f2cl-lib:int-add kk j)
              1))
            ((1 *))
            ap-%offset%))))
      (t
        (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
          ((> i
            (f2cl-lib:int-add j
              (f2cl-lib:int-sub
                1)))
            nil)
          (tagbody
            (setf temp
              (- temp
                (*
                  (f2cl-lib:dconjg

```

```

(f2cl-lib:fref ap-%data%
  (k)
  ((1 *))
  ap-%offset%))
(f2cl-lib:fref x-%data%
  (i)
  ((1 *))
  x-%offset%)))))
(setf k (f2cl-lib:int-add k 1)))
(if nunit
  (setf temp
    (/ temp
      (f2cl-lib:dconjg
        (f2cl-lib:fref ap-%data%
          ((f2cl-lib:int-sub
            (f2cl-lib:int-add kk
              j)
            1))
          ((1 *))
          ap-%offset%))))))
(setf (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%)
  temp)
(setf kk (f2cl-lib:int-add kk j))))
(t
  (setf jx kx)
  (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
    (> j n) nil)
  (tagbody
    (setf temp
      (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%))
    (setf ix kx)
    (cond
      (noconj
        (f2cl-lib:fdo (k kk (f2cl-lib:int-add k 1))
          (> k
            (f2cl-lib:int-add kk
              j
              (f2cl-lib:int-sub
                2))))
          nil)
        (tagbody
          (setf temp
            (- temp
              (*
                (f2cl-lib:fref ap-%data%
                  (k)

```



```

((1 *))
ap-%offset%)
(f2cl-lib:fref x-%data%
(ix)
((1 *))
x-%offset%))))
(setf ix (f2cl-lib:int-add ix incx)))
(if nunit
  (setf temp
    (/ temp
      (f2cl-lib:fref ap-%data%
        ((f2cl-lib:int-sub
          (f2cl-lib:int-add kk j)
          1))
        ((1 *))
        ap-%offset%))))))
(t
  (f2cl-lib:fdo (k kk (f2cl-lib:int-add k 1))
    (> k
      (f2cl-lib:int-add kk
        j
        (f2cl-lib:int-sub
          2)))
    nil)
  (tagbody
    (setf temp
      (- temp
        (*
          (f2cl-lib:dconjg
            (f2cl-lib:fref ap-%data%
              (k)
              ((1 *))
              ap-%offset%))
            (f2cl-lib:fref x-%data%
              (ix)
              ((1 *))
              x-%offset%))))))
    (setf ix (f2cl-lib:int-add ix incx)))
  (if nunit
    (setf temp
      (/ temp
        (f2cl-lib:dconjg
          (f2cl-lib:fref ap-%data%
            ((f2cl-lib:int-sub
              (f2cl-lib:int-add kk
                j)

```

```

1))
((1 *))
ap-%offset%))))))
(setf (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%)
temp)
(setf jx (f2cl-lib:int-add jx incx))
(setf kk (f2cl-lib:int-add kk j))))))
(t
(setf kk (the fixnum (truncate (* n (+ n 1)) 2)))
(cond
(= incx 1)
(f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
(> j 1) nil)
(tagbody
(setf temp
(f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%))
(setf k kk)
(cond
(noconj
(f2cl-lib:fdo (i n
(f2cl-lib:int-add i
(f2cl-lib:int-sub 1)))
(> i (f2cl-lib:int-add j 1)) nil)
(tagbody
(setf temp
(- temp
(*
(f2cl-lib:fref ap-%data%
(k)
((1 *))
ap-%offset%)
(f2cl-lib:fref x-%data%
(i)
((1 *))
x-%offset%))))
(setf k (f2cl-lib:int-sub k 1))))
(if nounit
(setf temp
(/ temp
(f2cl-lib:fref ap-%data%
((f2cl-lib:int-add
(f2cl-lib:int-sub kk n)
j))
((1 *))
ap-%offset%))))))
(t

```

```

(f2cl-lib:fdo (i n
              (f2cl-lib:int-add i
                                (f2cl-lib:int-sub 1)))
              ((> i (f2cl-lib:int-add j 1)) nil)
  (tagbody
    (setf temp
      (- temp
        (*
          (f2cl-lib:dconjg
            (f2cl-lib:fref ap-%data%
                          (k)
                          ((1 *))
                          ap-%offset%))
          (f2cl-lib:fref x-%data%
                        (i)
                        ((1 *))
                        x-%offset%))))
      (setf k (f2cl-lib:int-sub k 1))))
  (if nunit
    (setf temp
      (/ temp
        (f2cl-lib:dconjg
          (f2cl-lib:fref ap-%data%
                        ((f2cl-lib:int-add
                          (f2cl-lib:int-sub kk
                            n)
                          j))
                        ((1 *))
                        ap-%offset%))))))
    (setf (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%)
      temp)
    (setf kk
      (f2cl-lib:int-sub kk
        (f2cl-lib:int-add
          (f2cl-lib:int-sub n j)
          1))))))
  (t
    (setf kx
      (f2cl-lib:int-add kx
        (f2cl-lib:int-mul
          (f2cl-lib:int-sub n 1)
          incx)))
    (setf jx kx)
    (f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
      ((> j 1) nil)
    (tagbody

```

```

(setf temp
  (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%))
(setf ix kx)
(cond
  (noconj
    (f2cl-lib:fdo (k kk
      (f2cl-lib:int-add k
        (f2cl-lib:int-sub 1)))
      ((> k
        (f2cl-lib:int-add kk
          (f2cl-lib:int-sub
            (f2cl-lib:int-add
              n
              (f2cl-lib:int-sub
                (f2cl-lib:int-add
                  j
                  1))))))
        nil)
    (tagbody
      (setf temp
        (- temp
          (*
            (f2cl-lib:fref ap-%data%
              (k)
              ((1 *))
              ap-%offset%)
            (f2cl-lib:fref x-%data%
              (ix)
              ((1 *))
              x-%offset%))))
      (setf ix (f2cl-lib:int-sub ix incx)))
    (if nunit
      (setf temp
        (/ temp
          (f2cl-lib:fref ap-%data%
            ((f2cl-lib:int-add
              (f2cl-lib:int-sub kk n)
              j))
            ((1 *))
            ap-%offset%))))
      (t
        (f2cl-lib:fdo (k kk
          (f2cl-lib:int-add k
            (f2cl-lib:int-sub 1)))
          ((> k
            (f2cl-lib:int-add kk

```

```

(f2cl-lib:int-sub
(f2cl-lib:int-add
  n
  (f2cl-lib:int-sub
    (f2cl-lib:int-add
      j
      1))))))
nil)
(tagbody
  (setf temp
    (- temp
      (*
        (f2cl-lib:dconjg
          (f2cl-lib:fref ap-%data%
            (k)
            ((1 *))
            ap-%offset%))
        (f2cl-lib:fref x-%data%
          (ix)
          ((1 *))
          x-%offset%))))
    (setf ix (f2cl-lib:int-sub ix incx))))
(if nunit
  (setf temp
    (/ temp
      (f2cl-lib:dconjg
        (f2cl-lib:fref ap-%data%
          ((f2cl-lib:int-add
            (f2cl-lib:int-sub kk
              n)
            j))
          ((1 *))
          ap-%offset%))))))
  (setf (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%)
    temp)
  (setf jx (f2cl-lib:int-sub jx incx))
  (setf kk
    (f2cl-lib:int-sub kk
      (f2cl-lib:int-add
        (f2cl-lib:int-sub n j)
        1))))))
end_label
(return (values nil nil nil nil nil nil nil))))

```

## 5.32 ztrmv BLAS

```
<ztrmv.input>=  
  )set break resume  
  )sys rm -f ztrmv.output  
  )spool ztrmv.output  
  )set message test on  
  )set message auto off  
  )clear all  
  
  )spool  
  )lisp (bye)
```

`<ztrmv.help>`≡

```
=====
ztrmv examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

ZTRMV - perform one of the matrix-vector operations  $x := A*x$ , or  $x := A'*x$ , or  $x := \text{conjg}(A')*x$ ,

#### SYNOPSIS

SUBROUTINE ZTRMV ( UPLO, TRANS, DIAG, N, A, LDA, X, INCX )

INTEGER INCX, LDA, N

CHARACTER\*1 DIAG, TRANS, UPLO

COMPLEX\*16 A( LDA, \* ), X( \* )

#### PURPOSE

ZTRMV performs one of the matrix-vector operations

where  $x$  is an  $n$  element vector and  $A$  is an  $n$  by  $n$  unit, or non-unit, upper or lower triangular matrix.

#### PARAMETERS

UPLO - CHARACTER\*1.

On entry, UPLO specifies whether the matrix is an upper or lower triangular matrix as follows:

UPLO = 'U' or 'u' A is an upper triangular matrix.

UPLO = 'L' or 'l' A is a lower triangular matrix.

Unchanged on exit.

TRANS - CHARACTER\*1.

On entry, TRANS specifies the operation to be performed as follows:

TRANS = 'N' or 'n'  $x := A*x$ .

TRANS = 'T' or 't'  $x := A'*x$ .

TRANS = 'C' or 'c'     $x := \text{conjg}(A) * x$ .

Unchanged on exit.

DIAG - CHARACTER\*1.

On entry, DIAG specifies whether or not A is unit triangular as follows:

DIAG = 'U' or 'u'    A is assumed to be unit triangular.

DIAG = 'N' or 'n'    A is not assumed to be unit triangular.

Unchanged on exit.

N - INTEGER.

On entry, N specifies the order of the matrix A. N must be at least zero. Unchanged on exit.

A - COMPLEX\*16        array of DIMENSION ( LDA, n ).  
Before entry with UPLO = 'U' or 'u', the leading n by n upper triangular part of the array A must contain the upper triangular matrix and the strictly lower triangular part of A is not referenced. Before entry with UPLO = 'L' or 'l', the leading n by n lower triangular part of the array A must contain the lower triangular matrix and the strictly upper triangular part of A is not referenced. Note that when DIAG = 'U' or 'u', the diagonal elements of A are not referenced either, but are assumed to be unity.  
Unchanged on exit.

LDA - INTEGER.

On entry, LDA specifies the first dimension of A as declared in the calling (sub) program. LDA must be at least  $\max(1, n)$ . Unchanged on exit.

X - COMPLEX\*16        array of dimension at least  $(1 + (n - 1) * \text{abs}(\text{INCX}))$ . Before entry, the incremented array X must contain the n element vector x. On exit, X is overwritten with the transformed vector x.

INCX - INTEGER.



On entry, INCX specifies the increment for the elements of X. INCX must not be zero. Unchanged on exit.

```

<BLAS 2 ztrmv>≡
  (let* ((zero (complex 0.0 0.0)))
    (declare (type (complex double-float) zero))
    (defun ztrmv (uplo trans diag n a lda x incx)
      (declare (type (simple-array (complex double-float) (*)) x a)
        (type fixnum incx lda n)
        (type character diag trans uplo))
      (f2cl-lib:with-multi-array-data
        ((uplo character uplo-%data% uplo-%offset%)
         (trans character trans-%data% trans-%offset%)
         (diag character diag-%data% diag-%offset%)
         (a (complex double-float) a-%data% a-%offset%)
         (x (complex double-float) x-%data% x-%offset%))
        (prog ((noconj nil) (nunit nil) (i 0) (info 0) (ix 0) (j 0) (jx 0)
              (kx 0) (temp #C(0.0 0.0)))
          (declare (type (member t nil) noconj nunit)
            (type fixnum i info ix j jx kx)
            (type (complex double-float) temp))
          (setf info 0)
          (cond
            ((and (not (char-equal uplo #\U)) (not (char-equal uplo #\L)))
              (setf info 1))
            ((and (not (char-equal trans #\N))
              (not (char-equal trans #\T))
              (not (char-equal trans #\C)))
              (setf info 2))
            ((and (not (char-equal diag #\U)) (not (char-equal diag #\N)))
              (setf info 3))
            ((< n 0)
              (setf info 4))
            ((< lda (max (the fixnum 1) (the fixnum n)))
              (setf info 6))
            ((= incx 0)
              (setf info 8)))
          (cond
            ((/= info 0)
              (error
                " ** On entry to ~a parameter number ~a had an illegal value~%"
                "ZTRMV" info)
              (go end_label)))
          (if (= n 0) (go end_label))
          (setf noconj (char-equal trans #\T))
          (setf nunit (char-equal diag #\N))
          (cond
            ((<= incx 0)
              (setf kx

```

```

(f2cl-lib:int-sub 1
  (f2cl-lib:int-mul (f2cl-lib:int-sub n 1)
    incx)))

( (/= incx 1)
  (setf kx 1)))
(cond
  ((char-equal trans #\N)
    (cond
      ((char-equal uplo #\U)
        (cond
          ((= incx 1)
            (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
              (> j n) nil)
            (tagbody
              (cond
                ((/= (f2cl-lib:fref x (j) ((1 *))) zero)
                  (setf temp
                    (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%))
                  (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                    (> i
                      (f2cl-lib:int-add j
                        (f2cl-lib:int-sub
                          1)))
                    nil)
                  (tagbody
                    (setf (f2cl-lib:fref x-%data%
                      (i)
                      ((1 *))
                      x-%offset%)
                      (+
                        (f2cl-lib:fref x-%data%
                          (i)
                          ((1 *))
                          x-%offset%)
                        (* temp
                          (f2cl-lib:fref a-%data%
                            (i j)
                            ((1 lda) (1 *))
                            a-%offset%))))))
                    (if nunit
                      (setf (f2cl-lib:fref x-%data%
                        (j)
                        ((1 *))
                        x-%offset%)
                          (*
                            (f2cl-lib:fref x-%data%

```

```

                                (j)
                                ((1 *))
                                x-%offset%)
(f2cl-lib:fref a-%data%
  (j j)
  ((1 lda) (1 *))
  a-%offset%)))))))))
(t
  (setf jx kx)
  (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
    (> j n) nil)
  (tagbody
    (cond
      ((/= (f2cl-lib:fref x (jx) ((1 *))) zero)
        (setf temp
          (f2cl-lib:fref x-%data%
            (jx)
            ((1 *))
            x-%offset%))
        (setf ix kx)
        (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
          (> i
            (f2cl-lib:int-add j
              (f2cl-lib:int-sub
                1)))
            nil)
          (tagbody
            (setf (f2cl-lib:fref x-%data%
              (ix)
              ((1 *))
              x-%offset%)
              (+
                (f2cl-lib:fref x-%data%
                  (ix)
                  ((1 *))
                  x-%offset%)
                (* temp
                  (f2cl-lib:fref a-%data%
                    (i j)
                    ((1 lda) (1 *))
                    a-%offset%))))))
            (setf ix (f2cl-lib:int-add ix incx))))
        (if nounit
          (setf (f2cl-lib:fref x-%data%
            (jx)
            ((1 *))

```

```
(t
  (*
    (f2cl-lib:fref x-%data%
      (jx)
      ((1 *))
      x-%offset%)
    (f2cl-lib:fref a-%data%
      (j j)
      ((1 lda) (1 *))
      a-%offset%))))))
  (setf jx (f2cl-lib:int-add jx incx))))))
(cond
  (= incx 1)
  (f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
    (> j 1) nil)
  (tagbody
    (cond
      (/= (f2cl-lib:fref x (j) ((1 *))) zero)
      (setf temp
        (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%))
      (f2cl-lib:fdo (i n
        (f2cl-lib:int-add i
          (f2cl-lib:int-sub 1)))
        (> i (f2cl-lib:int-add j 1)) nil)
      (tagbody
        (setf (f2cl-lib:fref x-%data%
          (i)
          ((1 *))
          x-%offset%)
          (+
            (f2cl-lib:fref x-%data%
              (i)
              ((1 *))
              x-%offset%)
            (* temp
              (f2cl-lib:fref a-%data%
                (i j)
                ((1 lda) (1 *))
                a-%offset%))))))
      (if nounit
        (setf (f2cl-lib:fref x-%data%
          (j)
          ((1 *))
          x-%offset%)
          (*
```

```

(f2cl-lib:fref x-%data%
  (j)
  ((1 *))
  x-%offset%)
(f2cl-lib:fref a-%data%
  (j j)
  ((1 lda) (1 *))
  a-%offset%)))))))))
(t
  (setf kx
    (f2cl-lib:int-add kx
      (f2cl-lib:int-mul
        (f2cl-lib:int-sub n 1)
        incx)))
  (setf jx kx)
  (f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
    (> j 1) nil)
  (tagbody
    (cond
      ((/= (f2cl-lib:fref x (jx) ((1 *))) zero)
        (setf temp
          (f2cl-lib:fref x-%data%
            (jx)
            ((1 *))
            x-%offset%))
        (setf ix kx)
        (f2cl-lib:fdo (i n
          (f2cl-lib:int-add i
            (f2cl-lib:int-sub 1)))
          (> i (f2cl-lib:int-add j 1)) nil)
          (tagbody
            (setf (f2cl-lib:fref x-%data%
              (ix)
              ((1 *))
              x-%offset%)
              (+
                (f2cl-lib:fref x-%data%
                  (ix)
                  ((1 *))
                  x-%offset%)
                (* temp
                  (f2cl-lib:fref a-%data%
                    (i j)
                    ((1 lda) (1 *))
                    a-%offset%))))
              (setf ix (f2cl-lib:int-sub ix incx))))

```

```

      (if nunit
        (setf (f2cl-lib:fref x-%data%
                           (jx)
                           ((1 *))
                           x-%offset%)
              (*
               (f2cl-lib:fref x-%data%
                           (jx)
                           ((1 *))
                           x-%offset%)
               (f2cl-lib:fref a-%data%
                           (j j)
                           ((1 lda) (1 *))
                           a-%offset%))))))
      (setf jx (f2cl-lib:int-sub jx incx)))))))))
(t
 (cond
  ((char-equal uplo #\U)
   (cond
    ((= incx 1)
     (f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
                   ((> j 1) nil)
     (tagbody
      (setf temp
              (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%))
      (cond
       (noconj
        (if nunit
         (setf temp
                 (* temp
                    (f2cl-lib:fref a-%data%
                                    (j j)
                                    ((1 lda) (1 *))
                                    a-%offset%))))
        (f2cl-lib:fdo (i
                      (f2cl-lib:int-add j
                                         (f2cl-lib:int-sub 1))
                      (f2cl-lib:int-add i
                                         (f2cl-lib:int-sub 1)))
                      ((> i 1) nil)
          (tagbody
           (setf temp
                   (+ temp
                      (*
                     (f2cl-lib:fref a-%data%
                                     (i j)

```

```

                                ((1 lda) (1 *))
                                a-%offset%)
(f2cl-lib:fref x-%data%
(i)
((1 *))
x-%offset%)))))))))
(t
  (if nounit
    (setf temp
      (* temp
        (f2cl-lib:dconjg
          (f2cl-lib:fref a-%data%
            (j j)
            ((1 lda) (1 *))
            a-%offset%))))))
    (f2cl-lib:fdo (i
      (f2cl-lib:int-add j
        (f2cl-lib:int-sub 1))
      (f2cl-lib:int-add i
        (f2cl-lib:int-sub 1)))
      (> i 1) nil)
    (tagbody
      (setf temp
        (+ temp
          (*
            (f2cl-lib:dconjg
              (f2cl-lib:fref a-%data%
                (i j)
                ((1 lda) (1 *))
                a-%offset%))
            (f2cl-lib:fref x-%data%
              (i)
              ((1 *))
              x-%offset%))))))
      (setf (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%)
        temp))))
(t
  (setf jx
    (f2cl-lib:int-add kx
      (f2cl-lib:int-mul
        (f2cl-lib:int-sub n 1)
        incx)))
  (f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
    (> j 1) nil)
  (tagbody
    (setf temp

```



```
(f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%))
(setf ix jx)
(cond
  (noconj
    (if nounit
      (setf temp
        (* temp
          (f2cl-lib:fref a-%data%
                        (j j)
                        ((1 lda) (1 *)))
          a-%offset%))))
    (f2cl-lib:fdo (i
      (f2cl-lib:int-add j
        (f2cl-lib:int-sub 1))
      (f2cl-lib:int-add i
        (f2cl-lib:int-sub 1)))
      ((> i 1) nil)
      (tagbody
        (setf ix (f2cl-lib:int-sub ix incx))
        (setf temp
          (+ temp
            (*
              (f2cl-lib:fref a-%data%
                            (i j)
                            ((1 lda) (1 *)))
              a-%offset%)
            (f2cl-lib:fref x-%data%
                          (ix)
                          ((1 *)))
            x-%offset%))))))
(t
  (if nounit
    (setf temp
      (* temp
        (f2cl-lib:dconjg
          (f2cl-lib:fref a-%data%
                        (j j)
                        ((1 lda) (1 *)))
          a-%offset%))))
    (f2cl-lib:fdo (i
      (f2cl-lib:int-add j
        (f2cl-lib:int-sub 1))
      (f2cl-lib:int-add i
        (f2cl-lib:int-sub 1)))
      ((> i 1) nil)
      (tagbody
```

```

        (setf ix (f2cl-lib:int-sub ix incx))
        (setf temp
          (+ temp
            (*
              (f2cl-lib:dconjg
                (f2cl-lib:fref a-%data%
                              (i j)
                              ((1 lda) (1 *))
                              a-%offset%))
              (f2cl-lib:fref x-%data%
                              (ix)
                              ((1 *))
                              x-%offset%))))))
        (setf (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%)
              temp)
        (setf jx (f2cl-lib:int-sub jx incx))))))
(t
 (cond
  ((= incx 1)
   (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                 ((> j n) nil)
   (tagbody
    (setf temp
      (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%))
    (cond
     (noconj
      (if nunit
         (setf temp
           (* temp
              (f2cl-lib:fref a-%data%
                              (j j)
                              ((1 lda) (1 *))
                              a-%offset%))))
      (f2cl-lib:fdo (i (f2cl-lib:int-add j 1)
                      (f2cl-lib:int-add i 1))
                    ((> i n) nil)
      (tagbody
       (setf temp
         (+ temp
           (*
              (f2cl-lib:fref a-%data%
                              (i j)
                              ((1 lda) (1 *))
                              a-%offset%)
              (f2cl-lib:fref x-%data%
                              (i)

```

```

((1 *))
x-%offset%)))))))))

(t
  (if nunit
    (setf temp
      (* temp
        (f2cl-lib:dconjg
          (f2cl-lib:fref a-%data%
            (j j)
            ((1 lda) (1 *))
            a-%offset%))))))
    (f2cl-lib:fdo (i (f2cl-lib:int-add j 1)
      (f2cl-lib:int-add i 1))
      (> i n) nil)
    (tagbody
      (setf temp
        (+ temp
          (*
            (f2cl-lib:dconjg
              (f2cl-lib:fref a-%data%
                (i j)
                ((1 lda) (1 *))
                a-%offset%))
            (f2cl-lib:fref x-%data%
              (i)
              ((1 *))
              x-%offset%))))))
      (setf (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%)
        temp))))
(t
  (setf jx kx)
  (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
    (> j n) nil)
  (tagbody
    (setf temp
      (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%))
    (setf ix jx)
    (cond
      (noconj
        (if nunit
          (setf temp
            (* temp
              (f2cl-lib:fref a-%data%
                (j j)
                ((1 lda) (1 *))
                a-%offset%))))

```

```

(f2cl-lib:fdo (i (f2cl-lib:int-add j 1)
                (f2cl-lib:int-add i 1))
              (> i n) nil)
(tagbody
  (setf ix (f2cl-lib:int-add ix incx))
  (setf temp
    (+ temp
      (*
        (f2cl-lib:fref a-%data%
          (i j)
          ((1 lda) (1 *))
          a-%offset%)
        (f2cl-lib:fref x-%data%
          (ix)
          ((1 *))
          x-%offset%))))))
(t
  (if nounit
    (setf temp
      (* temp
        (f2cl-lib:dconjg
          (f2cl-lib:fref a-%data%
            (j j)
            ((1 lda) (1 *))
            a-%offset%))))
    (f2cl-lib:fdo (i (f2cl-lib:int-add j 1)
                    (f2cl-lib:int-add i 1))
                  (> i n) nil)
    (tagbody
      (setf ix (f2cl-lib:int-add ix incx))
      (setf temp
        (+ temp
          (*
            (f2cl-lib:dconjg
              (f2cl-lib:fref a-%data%
                (i j)
                ((1 lda) (1 *))
                a-%offset%)
              (f2cl-lib:fref x-%data%
                (ix)
                ((1 *))
                x-%offset%))))))
      (setf (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%)
            temp)
      (setf jx (f2cl-lib:int-add jx incx))))))

```

end\_label

```
(return (values nil nil nil nil nil nil nil nil)))))
```

### 5.33 ztrsv BLAS

```
<ztrsv.input>≡  
  )set break resume  
  )sys rm -f ztrsv.output  
  )spool ztrsv.output  
  )set message test on  
  )set message auto off  
  )clear all  
  
  )spool  
  )lisp (bye)
```

`<ztrsv.help>=`

```
=====
ztrsv examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

ZTRSV - solve one of the systems of equations  $A*x = b$ , or  $A'*x = b$ , or  $\text{conjg}(A')*x = b$ ,

#### SYNOPSIS

SUBROUTINE ZTRSV ( UPLO, TRANS, DIAG, N, A, LDA, X, INCX )

INTEGER INCX, LDA, N

CHARACTER\*1 DIAG, TRANS, UPLO

COMPLEX\*16 A( LDA, \* ), X( \* )

#### PURPOSE

ZTRSV solves one of the systems of equations

where  $b$  and  $x$  are  $n$  element vectors and  $A$  is an  $n$  by  $n$  unit, or non-unit, upper or lower triangular matrix.

No test for singularity or near-singularity is included in this routine. Such tests must be performed before calling this routine.

#### PARAMETERS

UPLO - CHARACTER\*1.

On entry, UPLO specifies whether the matrix is an upper or lower triangular matrix as follows:

UPLO = 'U' or 'u' A is an upper triangular matrix.

UPLO = 'L' or 'l' A is a lower triangular matrix.

Unchanged on exit.

TRANS - CHARACTER\*1.

On entry, TRANS specifies the equations to be solved as follows:

TRANS = 'N' or 'n'     $A*x = b$ .

TRANS = 'T' or 't'     $A'*x = b$ .

TRANS = 'C' or 'c'     $\text{conjg}(A)*x = b$ .

Unchanged on exit.

DIAG - CHARACTER\*1.

On entry, DIAG specifies whether or not A is unit triangular as follows:

DIAG = 'U' or 'u'    A is assumed to be unit triangular.

DIAG = 'N' or 'n'    A is not assumed to be unit triangular.

Unchanged on exit.

N - INTEGER.

On entry, N specifies the order of the matrix A. N must be at least zero. Unchanged on exit.

A - COMPLEX\*16    array of DIMENSION ( LDA, n ).  
Before entry with UPLO = 'U' or 'u', the leading n by n upper triangular part of the array A must contain the upper triangular matrix and the strictly lower triangular part of A is not referenced. Before entry with UPLO = 'L' or 'l', the leading n by n lower triangular part of the array A must contain the lower triangular matrix and the strictly upper triangular part of A is not referenced. Note that when DIAG = 'U' or 'u', the diagonal elements of A are not referenced either, but are assumed to be unity.  
Unchanged on exit.

LDA - INTEGER.

On entry, LDA specifies the first dimension of A as declared in the calling (sub) program. LDA must be at least  $\max(1, n)$ . Unchanged on exit.

X - COMPLEX\*16    array of dimension at least  $(1 + (n - 1) * \text{abs}(\text{INCX}))$ . Before entry, the

incremented array X must contain the n element right-hand side vector b. On exit, X is overwritten with the solution vector x.

INCX - INTEGER.  
On entry, INCX specifies the increment for the elements of X. INCX must not be zero. Unchanged on exit.



```

<BLAS 2 ztrsv>≡
  (let* ((zero (complex 0.0 0.0)))
    (declare (type (complex double-float) zero))
    (defun ztrsv (uplo trans diag n a lda x incx)
      (declare (type (simple-array (complex double-float) (*)) x a)
        (type fixnum incx lda n)
        (type character diag trans uplo))
      (f2cl-lib:with-multi-array-data
        ((uplo character uplo-%data% uplo-%offset%)
         (trans character trans-%data% trans-%offset%)
         (diag character diag-%data% diag-%offset%)
         (a (complex double-float) a-%data% a-%offset%)
         (x (complex double-float) x-%data% x-%offset%))
        (prog ((noconj nil) (nunit nil) (i 0) (info 0) (ix 0) (j 0) (jx 0)
              (kx 0) (temp #C(0.0 0.0)))
          (declare (type (member t nil) noconj nunit)
            (type fixnum i info ix j jx kx)
            (type (complex double-float) temp))
          (setf info 0)
          (cond
            ((and (not (char-equal uplo #\U)) (not (char-equal uplo #\L)))
              (setf info 1))
            ((and (not (char-equal trans #\N))
              (not (char-equal trans #\T))
              (not (char-equal trans #\C)))
              (setf info 2))
            ((and (not (char-equal diag #\U)) (not (char-equal diag #\N)))
              (setf info 3))
            ((< n 0)
              (setf info 4))
            ((< lda (max (the fixnum 1) (the fixnum n)))
              (setf info 6))
            ((= incx 0)
              (setf info 8)))
          (cond
            ((/= info 0)
              (error
                "** On entry to ~a parameter number ~a had an illegal value~%"
                "ZTRSV" info)
              (go end_label)))
          (if (= n 0) (go end_label))
          (setf noconj (char-equal trans #\T))
          (setf nunit (char-equal diag #\N))
          (cond
            ((<= incx 0)
              (setf kx

```

```

(f2cl-lib:int-sub 1
  (f2cl-lib:int-mul (f2cl-lib:int-sub n 1)
    incx)))

( (/= incx 1)
  (setf kx 1)))
(cond
  ((char-equal trans #\N)
    (cond
      ((char-equal uplo #\U)
        (cond
          ((= incx 1)
            (f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
              (> j 1) nil)
            (tagbody
              (cond
                ((/= (f2cl-lib:fref x (j) ((1 *))) zero)
                  (if nunit
                    (setf (f2cl-lib:fref x-%data%
                      (j)
                      ((1 *))
                      x-%offset%)
                      (/
                        (f2cl-lib:fref x-%data%
                          (j)
                          ((1 *))
                          x-%offset%)
                        (f2cl-lib:fref a-%data%
                          (j j)
                          ((1 lda) (1 *))
                          a-%offset%))))
                  (setf temp
                    (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%))
                  (f2cl-lib:fdo (i
                    (f2cl-lib:int-add j
                      (f2cl-lib:int-sub 1))
                    (f2cl-lib:int-add i
                      (f2cl-lib:int-sub 1)))
                      (> i 1) nil)
                    (tagbody
                      (setf (f2cl-lib:fref x-%data%
                        (i)
                        ((1 *))
                        x-%offset%)
                        (-
                          (f2cl-lib:fref x-%data%
                            (i)

```

```

((1 *))
x-%offset%)
(* temp
  (f2cl-lib:fref a-%data%
    (i j)
    ((1 lda) (1 *))
    a-%offset%)))))))))
(t
  (setf jx
    (f2cl-lib:int-add kx
      (f2cl-lib:int-mul
        (f2cl-lib:int-sub n 1)
        incx)))
  (f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
    ((> j 1) nil)
    (tagbody
      (cond
        ((/= (f2cl-lib:fref x (jx) ((1 *))) zero)
          (if nunit
            (setf (f2cl-lib:fref x-%data%
              (jx)
              ((1 *))
              x-%offset%)
              (/
                (f2cl-lib:fref x-%data%
                  (jx)
                  ((1 *))
                  x-%offset%)
                (f2cl-lib:fref a-%data%
                  (j j)
                  ((1 lda) (1 *))
                  a-%offset%))))))
            (setf temp
              (f2cl-lib:fref x-%data%
                (jx)
                ((1 *))
                x-%offset%)))
            (setf ix jx)
            (f2cl-lib:fdo (i
              (f2cl-lib:int-add j
                (f2cl-lib:int-sub 1))
              (f2cl-lib:int-add i
                (f2cl-lib:int-sub 1)))
              ((> i 1) nil)
              (tagbody
                (setf ix (f2cl-lib:int-sub ix incx))

```

```

        (setf (f2cl-lib:fref x-%data%
                           (ix)
                           ((1 *))
                           x-%offset%)
              (-
                (f2cl-lib:fref x-%data%
                              (ix)
                              ((1 *))
                              x-%offset%)
                (* temp
                  (f2cl-lib:fref a-%data%
                                (i j)
                                ((1 lda) (1 *))
                                a-%offset%))))))
        (setf jx (f2cl-lib:int-sub jx incx))))))
(t
 (cond
  ((= incx 1)
   (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                  ((> j n) nil)
   (tagbody
    (cond
     ((/= (f2cl-lib:fref x (j) ((1 *))) zero)
      (if nunit
          (setf (f2cl-lib:fref x-%data%
                              (j)
                              ((1 *))
                              x-%offset%)
                (/
                  (f2cl-lib:fref x-%data%
                                (j)
                                ((1 *))
                                x-%offset%)
                  (f2cl-lib:fref a-%data%
                                (j j)
                                ((1 lda) (1 *))
                                a-%offset%))))
          (setf temp
                (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%))
          (f2cl-lib:fdo (i (f2cl-lib:int-add j 1)
                        (f2cl-lib:int-add i 1))
                        ((> i n) nil)
          (tagbody
           (setf (f2cl-lib:fref x-%data%
                               (i)
                               ((1 *))

```

```

                                x-%offset%)
(-
  (f2cl-lib:fref x-%data%
    (i)
    ((1 *))
    x-%offset%)
  (* temp
    (f2cl-lib:fref a-%data%
      (i j)
      ((1 lda) (1 *))
      a-%offset%)))))))))
(t
  (setf jx kx)
  (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
    ((> j n) nil)
    (tagbody
      (cond
        ((/= (f2cl-lib:fref x (jx) ((1 *))) zero)
          (if nunit
            (setf (f2cl-lib:fref x-%data%
              (jx)
              ((1 *))
              x-%offset%)
              (/
                (f2cl-lib:fref x-%data%
                  (jx)
                  ((1 *))
                  x-%offset%)
                (f2cl-lib:fref a-%data%
                  (j j)
                  ((1 lda) (1 *))
                  a-%offset%))))))
            (setf temp
              (f2cl-lib:fref x-%data%
                (jx)
                ((1 *))
                x-%offset%)))
          (setf ix jx)
          (f2cl-lib:fdo (i (f2cl-lib:int-add j 1)
            (f2cl-lib:int-add i 1))
            ((> i n) nil)
            (tagbody
              (setf ix (f2cl-lib:int-add ix incx))
              (setf (f2cl-lib:fref x-%data%
                (ix)
                ((1 *))

```

```

                                x-%offset%)
(-
  (f2cl-lib:fref x-%data%
    (ix)
    ((1 *))
    x-%offset%)
  (* temp
    (f2cl-lib:fref a-%data%
      (i j)
      ((1 lda) (1 *))
      a-%offset%))))))
  (setf jx (f2cl-lib:int-add jx incx))))))
(t
  (cond
    ((char-equal uplo #\U)
      (cond
        ((= incx 1)
          (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
            (> j n) nil)
          (tagbody
            (setf temp
              (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%))
            (cond
              (noconj
                (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                  (> i
                    (f2cl-lib:int-add j
                      (f2cl-lib:int-sub
                        1)))
                    nil)
                (tagbody
                  (setf temp
                    (- temp
                      (*
                        (f2cl-lib:fref a-%data%
                          (i j)
                          ((1 lda) (1 *))
                          a-%offset%)
                        (f2cl-lib:fref x-%data%
                          (i)
                          ((1 *))
                          x-%offset%))))))
                  (if nounit
                    (setf temp
                      (/ temp
                        (f2cl-lib:fref a-%data%

```

```

                                (j j)
                                ((1 lda) (1 *))
                                a-%offset%))))))
(t
  (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
    ((> i
      (f2cl-lib:int-add j
        (f2cl-lib:int-sub
          1)))
      nil)
    (tagbody
      (setf temp
        (- temp
          (*
            (f2cl-lib:dconjg
              (f2cl-lib:fref a-%data%
                (i j)
                ((1 lda) (1 *))
                a-%offset%))
            (f2cl-lib:fref x-%data%
              (i)
              ((1 *))
              x-%offset%))))))
      (if nount
        (setf temp
          (/ temp
            (f2cl-lib:dconjg
              (f2cl-lib:fref a-%data%
                (j j)
                ((1 lda) (1 *))
                a-%offset%))))))
        (setf (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%)
          temp))))
(t
  (setf jx kx)
  (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
    ((> j n) nil)
    (tagbody
      (setf ix kx)
      (setf temp
        (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%))
      (cond
        (noconj
          (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
            ((> i
              (f2cl-lib:int-add j

```

```

(f2cl-lib:int-sub
1)))

nil)

(tagbody
  (setf temp
    (- temp
      (*
        (f2cl-lib:fref a-%data%
          (i j)
          ((1 lda) (1 *))
          a-%offset%)
        (f2cl-lib:fref x-%data%
          (ix)
          ((1 *))
          x-%offset%))))))
  (setf ix (f2cl-lib:int-add ix incx)))
(if nunit
  (setf temp
    (/ temp
      (f2cl-lib:fref a-%data%
        (j j)
        ((1 lda) (1 *))
        a-%offset%))))))
(t
  (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
    (> i
      (f2cl-lib:int-add j
        (f2cl-lib:int-sub
          1)))

    nil)

  (tagbody
    (setf temp
      (- temp
        (*
          (f2cl-lib:dconjg
            (f2cl-lib:fref a-%data%
              (i j)
              ((1 lda) (1 *))
              a-%offset%)
            (f2cl-lib:fref x-%data%
              (ix)
              ((1 *))
              x-%offset%))))))
      (setf ix (f2cl-lib:int-add ix incx)))
    (if nunit
      (setf temp

```



```

(/ temp
  (f2cl-lib:dconjg
    (f2cl-lib:fref a-%data%
      (j j)
      ((1 lda) (1 *))
      a-%offset%))))))
(setf (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%)
  temp)
(setf jx (f2cl-lib:int-add jx incx))))))
(t
  (cond
    ((= incx 1)
      (f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
        ((> j 1) nil)
        (tagbody
          (setf temp
            (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%))
          (cond
            (noconj
              (f2cl-lib:fdo (i n
                (f2cl-lib:int-add i
                  (f2cl-lib:int-sub 1)))
                ((> i (f2cl-lib:int-add j 1)) nil)
                (tagbody
                  (setf temp
                    (- temp
                      (*
                        (f2cl-lib:fref a-%data%
                          (i j)
                          ((1 lda) (1 *))
                          a-%offset%)
                        (f2cl-lib:fref x-%data%
                          (i)
                          ((1 *))
                          x-%offset%))))))
                  (if nunit
                    (setf temp
                      (/ temp
                        (f2cl-lib:fref a-%data%
                          (j j)
                          ((1 lda) (1 *))
                          a-%offset%))))))
                  (t
                    (f2cl-lib:fdo (i n
                      (f2cl-lib:int-add i
                        (f2cl-lib:int-sub 1)))

```

```

                                (> i (f2cl-lib:int-add j 1)) nil)
(tagbody
  (setf temp
    (- temp
      (*
        (f2cl-lib:dconjg
          (f2cl-lib:fref a-%data%
            (i j)
            ((1 lda) (1 *))
            a-%offset%))
        (f2cl-lib:fref x-%data%
          (i)
          ((1 *))
          x-%offset%))))))
(if nounit
  (setf temp
    (/ temp
      (f2cl-lib:dconjg
        (f2cl-lib:fref a-%data%
          (j j)
          ((1 lda) (1 *))
          a-%offset%))))))
(setf (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%
  temp)))
(t
  (setf kx
    (f2cl-lib:int-add kx
      (f2cl-lib:int-mul
        (f2cl-lib:int-sub n 1)
        incx)))
  (setf jx kx)
  (f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
    (> j 1) nil)
  (tagbody
    (setf ix kx)
    (setf temp
      (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%))
    (cond
      (noconj
        (f2cl-lib:fdo (i n
          (f2cl-lib:int-add i
            (f2cl-lib:int-sub 1)))
          (> i (f2cl-lib:int-add j 1)) nil)
        (tagbody
          (setf temp
            (- temp
              (*
                (f2cl-lib:dconjg
                  (f2cl-lib:fref a-%data%
                    (i j)
                    ((1 lda) (1 *))
                    a-%offset%))
                (f2cl-lib:fref x-%data%
                  (i)
                  ((1 *))
                  x-%offset%))))))
          (setf temp
            (/ temp
              (f2cl-lib:dconjg
                (f2cl-lib:fref a-%data%
                  (j j)
                  ((1 lda) (1 *))
                  a-%offset%))))))
        (setf (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%
          temp)))
      (conj
        (f2cl-lib:fdo (i n
          (f2cl-lib:int-add i
            (f2cl-lib:int-sub 1)))
          (> i (f2cl-lib:int-add j 1)) nil)
        (tagbody
          (setf temp
            (- temp
              (*
                (f2cl-lib:dconjg
                  (f2cl-lib:fref a-%data%
                    (i j)
                    ((1 lda) (1 *))
                    a-%offset%))
                (f2cl-lib:fref x-%data%
                  (i)
                  ((1 *))
                  x-%offset%))))))
          (setf temp
            (/ temp
              (f2cl-lib:dconjg
                (f2cl-lib:fref a-%data%
                  (j j)
                  ((1 lda) (1 *))
                  a-%offset%))))))
        (setf (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%
          temp)))
    )
  )

```

```

(*
  (f2cl-lib:fref a-%data%
    (i j)
    ((1 lda) (1 *))
    a-%offset%)
  (f2cl-lib:fref x-%data%
    (ix)
    ((1 *))
    x-%offset%))))
  (setf ix (f2cl-lib:int-sub ix incx))))
(if nunit
  (setf temp
    (/ temp
      (f2cl-lib:fref a-%data%
        (j j)
        ((1 lda) (1 *))
        a-%offset%))))))
(t
  (f2cl-lib:fdo (i n
    (f2cl-lib:int-add i
      (f2cl-lib:int-sub 1)))
    ((> i (f2cl-lib:int-add j 1)) nil)
    (tagbody
      (setf temp
        (- temp
          (*
            (f2cl-lib:dconjg
              (f2cl-lib:fref a-%data%
                (i j)
                ((1 lda) (1 *))
                a-%offset%))
            (f2cl-lib:fref x-%data%
              (ix)
              ((1 *))
              x-%offset%))))))
        (setf ix (f2cl-lib:int-sub ix incx))))
    (if nunit
      (setf temp
        (/ temp
          (f2cl-lib:dconjg
            (f2cl-lib:fref a-%data%
              (j j)
              ((1 lda) (1 *))
              a-%offset%))))))
      (setf (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%)
        temp)

```

```
                                (setf jx (f2cl-lib:int-sub jx incx)))))))))  
end_label  
    (return (values nil nil nil nil nil nil nil nil)))))
```



## Chapter 6

# BLAS Level 3

### 6.1 dgemm BLAS

```
<dgemm.input>≡  
  )set break resume  
  )sys rm -f dgemm.output  
  )spool dgemm.output  
  )set message test on  
  )set message auto off  
  )clear all  
  
  )spool  
  )lisp (bye)
```

`<dgemm.help>`≡

```
=====
dgemm examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

DGEMM - perform one of the matrix-matrix operations  $C := \alpha * \text{op}(A) * \text{op}(B) + \beta * C$ ,

#### SYNOPSIS

```
SUBROUTINE DGEMM ( TRANSA, TRANSB, M, N, K, ALPHA, A, LDA,
                  B, LDB, BETA, C, LDC )
```

```
      CHARACTER*1  TRANSA, TRANSB
```

```
      INTEGER      M, N, K, LDA, LDB, LDC
```

```
      DOUBLE       PRECISION ALPHA, BETA
```

```
      DOUBLE       PRECISION A( LDA, * ), B( LDB, * ), C( LDC,
      * )
```

#### PURPOSE

DGEMM performs one of the matrix-matrix operations

where  $\text{op}(X)$  is one of

$\text{op}(X) = X$  or  $\text{op}(X) = X'$ ,

alpha and beta are scalars, and A, B and C are matrices, with  $\text{op}(A)$  an m by k matrix,  $\text{op}(B)$  a k by n matrix and C an m by n matrix.

#### PARAMETERS

TRANSA - CHARACTER\*1. On entry, TRANSA specifies the form of  $\text{op}(A)$  to be used in the matrix multiplication as follows:

TRANSA = 'N' or 'n',  $\text{op}(A) = A$ .

TRANSA = 'T' or 't',  $\text{op}(A) = A'$ .

TRANSA = 'C' or 'c', op( A ) = A'.

Unchanged on exit.

TRANSB - CHARACTER\*1. On entry, TRANSB specifies the form of op( B ) to be used in the matrix multiplication as follows:

TRANSB = 'N' or 'n', op( B ) = B.

TRANSB = 'T' or 't', op( B ) = B'.

TRANSB = 'C' or 'c', op( B ) = B'.

Unchanged on exit.

M - INTEGER.

On entry, M specifies the number of rows of the matrix op( A ) and of the matrix C. M must be at least zero. Unchanged on exit.

N - INTEGER.

On entry, N specifies the number of columns of the matrix op( B ) and the number of columns of the matrix C. N must be at least zero. Unchanged on exit.

K - INTEGER.

On entry, K specifies the number of columns of the matrix op( A ) and the number of rows of the matrix op( B ). K must be at least zero. Unchanged on exit.

ALPHA - DOUBLE PRECISION.

On entry, ALPHA specifies the scalar alpha. Unchanged on exit.

ka is

A -

DOUBLE PRECISION array of DIMENSION ( LDA, ka ), where k when TRANSA = 'N' or 'n', and is m otherwise. Before entry with TRANSA = 'N' or 'n', the leading m by k part of the array A must contain the matrix A, otherwise the leading k by m part of the array A must contain the matrix A. Unchanged on exit.



LDA - INTEGER.  
 On entry, LDA specifies the first dimension of A as declared in the calling (sub) program. When TRANSA = 'N' or 'n' then LDA must be at least  $\max(1, m)$ , otherwise LDA must be at least  $\max(1, k)$ . Unchanged on exit.

kb is  
 B -  
 DOUBLE PRECISION array of DIMENSION ( LDB, kb ), where n when TRANSB = 'N' or 'n', and is k otherwise. Before entry with TRANSB = 'N' or 'n', the leading k by n part of the array B must contain the matrix B, otherwise the leading n by k part of the array B must contain the matrix B. Unchanged on exit.

LDB - INTEGER.  
 On entry, LDB specifies the first dimension of B as declared in the calling (sub) program. When TRANSB = 'N' or 'n' then LDB must be at least  $\max(1, k)$ , otherwise LDB must be at least  $\max(1, n)$ . Unchanged on exit.

BETA - DOUBLE PRECISION.  
 On entry, BETA specifies the scalar beta. When BETA is supplied as zero then C need not be set on input. Unchanged on exit.

C - DOUBLE PRECISION array of DIMENSION ( LDC, n ).  
 Before entry, the leading m by n part of the array C must contain the matrix C, except when beta is zero, in which case C need not be set on entry. On exit, the array C is overwritten by the m by n matrix (  $\alpha * \text{op}(A) * \text{op}(B) + \text{beta} * C$  ).

LDC - INTEGER.  
 On entry, LDC specifies the first dimension of C as declared in the calling (sub) program. LDC must be at least  $\max(1, m)$ . Unchanged on exit.

```

⟨BLAS 3 dgemm⟩≡
  (let* ((one 1.0) (zero 0.0))
    (declare (type (double-float 1.0 1.0) one)
              (type (double-float 0.0 0.0) zero))
    (defun dgemm (transa transb m n k alpha a lda b ldb$ beta c ldc)
      (declare (type (simple-array double-float (*)) c b a)
                (type (double-float) beta alpha)
                (type fixnum ldc ldb$ lda k n m)
                (type character transb transa))
      (f2cl-lib:with-multi-array-data
        ((transa character transa-%data% transa-%offset%)
         (transb character transb-%data% transb-%offset%)
         (a double-float a-%data% a-%offset%)
         (b double-float b-%data% b-%offset%)
         (c double-float c-%data% c-%offset%))
        (prog ((temp 0.0) (i 0) (info 0) (j 0) (l 0) (ncola 0) (nrowa 0)
               (nrowb 0) (nota nil) (notb nil))
          (declare (type (double-float) temp)
                    (type fixnum i info j l ncola nrowa nrowb)
                    (type (member t nil) nota notb))
          (setf nota (char-equal transa #\N))
          (setf notb (char-equal transb #\N))
          (cond
            (nota
             (setf nrowa m)
             (setf ncola k))
            (t
             (setf nrowa k)
             (setf ncola m)))
          (cond
            (notb
             (setf nrowb k))
            (t
             (setf nrowb n)))
          (setf info 0)
          (cond
            ((and (not nota) (not (char-equal transa #\C)) (not (char-equal transa #\T)))
             (setf info 1))
            ((and (not notb) (not (char-equal transb #\C)) (not (char-equal transb #\T)))
             (setf info 2))
            ((< m 0)
             (setf info 3))
            ((< n 0)
             (setf info 4))
            ((< k 0)
             (setf info 5))

```

```

((< lda (max (the fixnum 1) (the fixnum nrowa)))
 (setf info 8))
((< ldb$
  (max (the fixnum 1) (the fixnum nrowb)))
 (setf info 10))
((< ldc (max (the fixnum 1) (the fixnum m)))
 (setf info 13)))
(cond
  ((/= info 0)
   (error
    (error
     " ** On entry to ~a parameter number ~a had an illegal value~%"
     "DGEMM" info)
    (go end_label)))
  (if (or (= m 0) (= n 0) (and (or (= alpha zero) (= k 0)) (= beta one)))
      (go end_label)))
(cond
  ((= alpha zero)
   (cond
    ((= beta zero)
     (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                   ((> j n) nil)
     (tagbody
      (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                    ((> i m) nil)
      (tagbody
       (setf (f2cl-lib:fref c-%data%
                           (i j)
                           ((1 ldc) (1 *))
                           c-%offset%)
              zero))))))
    (t
     (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                   ((> j n) nil)
     (tagbody
      (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                    ((> i m) nil)
      (tagbody
       (setf (f2cl-lib:fref c-%data%
                           (i j)
                           ((1 ldc) (1 *))
                           c-%offset%)
              (* beta
               (f2cl-lib:fref c-%data%
                             (i j)
                             ((1 ldc) (1 *))
                             c-%offset%))))))))))

```

```

      (go end_label)))
    (cond
      (notb
        (cond
          (nota
            (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
              ((> j n) nil)
            (tagbody
              (cond
                ((= beta zero)
                  (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                    ((> i m) nil)
                  (tagbody
                    (setf (f2cl-lib:fref c-%data%
                                          (i j)
                                          ((1 ldc) (1 *))
                                          c-%offset%)
                      zero))))
                ((/= beta one)
                  (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                    ((> i m) nil)
                  (tagbody
                    (setf (f2cl-lib:fref c-%data%
                                          (i j)
                                          ((1 ldc) (1 *))
                                          c-%offset%)
                      (* beta
                        (f2cl-lib:fref c-%data%
                                          (i j)
                                          ((1 ldc) (1 *))
                                          c-%offset%)))))))
            (f2cl-lib:fdo (l 1 (f2cl-lib:int-add l 1))
              ((> l k) nil)
            (tagbody
              (cond
                ((/= (f2cl-lib:fref b (l j) ((1 ldb$) (1 *))) zero)
                  (setf temp
                    (* alpha
                      (f2cl-lib:fref b-%data%
                                        (l j)
                                        ((1 ldb$) (1 *))
                                        b-%offset%)))
                  (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                    ((> i m) nil)
                  (tagbody
                    (setf (f2cl-lib:fref c-%data%

```

```

                                (i j)
                                ((1 ldc) (1 *))
                                c-%offset%)
(+
  (f2cl-lib:fref c-%data%
    (i j)
    ((1 ldc) (1 *))
    c-%offset%)
  (* temp
    (f2cl-lib:fref a-%data%
      (i 1)
      ((1 lda) (1 *))
      a-%offset%)))))))))
(t
  (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
    ((> j n) nil)
  (tagbody
    (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
      ((> i m) nil)
    (tagbody
      (setf temp zero)
      (f2cl-lib:fdo (l 1 (f2cl-lib:int-add l 1))
        ((> l k) nil)
      (tagbody
        (setf temp
          (+ temp
            (*
              (f2cl-lib:fref a-%data%
                (l i)
                ((1 lda) (1 *))
                a-%offset%)
              (f2cl-lib:fref b-%data%
                (l j)
                ((1 ldb$) (1 *))
                b-%offset%))))))
        (cond
          ((= beta zero)
            (setf (f2cl-lib:fref c-%data%
              (i j)
              ((1 ldc) (1 *))
              c-%offset%)
              (* alpha temp)))
          (t
            (setf (f2cl-lib:fref c-%data%
              (i j)
              ((1 ldc) (1 *))

```

```

                                c-%offset%)
                                (+ (* alpha temp)
                                (* beta
                                (f2cl-lib:fref c-%data%
                                                (i j)
                                                ((1 ldc) (1 *)))
                                c-%offset%))))))))))))))
(t
  (cond
    (nota
      (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                    ((> j n) nil)
      (tagbody
        (cond
          ((= beta zero)
            (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                          ((> i m) nil)
            (tagbody
              (setf (f2cl-lib:fref c-%data%
                                  (i j)
                                  ((1 ldc) (1 *)))
                    c-%offset%)
              zero))))
          ( /= beta one)
            (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                          ((> i m) nil)
            (tagbody
              (setf (f2cl-lib:fref c-%data%
                                  (i j)
                                  ((1 ldc) (1 *)))
                    c-%offset%)
              (* beta
                (f2cl-lib:fref c-%data%
                                (i j)
                                ((1 ldc) (1 *)))
                c-%offset%))))))
      (f2cl-lib:fdo (l 1 (f2cl-lib:int-add l 1))
                    ((> l k) nil)
      (tagbody
        (cond
          ( /= (f2cl-lib:fref b (j 1) ((1 ldb$) (1 *))) zero)
            (setf temp
              (* alpha
                (f2cl-lib:fref b-%data%
                                (j 1)
                                ((1 ldb$) (1 *)))

```

```

                                b-%offset%)))
(f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
              ((> i m) nil)
  (tagbody
    (setf (f2cl-lib:fref c-%data%
                        (i j)
                        ((1 ldc) (1 *)))
          c-%offset%)
      (+
        (f2cl-lib:fref c-%data%
                        (i j)
                        ((1 ldc) (1 *)))
        c-%offset%)
      (* temp
        (f2cl-lib:fref a-%data%
                        (i l)
                        ((1 lda) (1 *)))
        a-%offset%)))))))))
(t
 (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
               ((> j n) nil)
  (tagbody
    (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                  ((> i m) nil)
      (tagbody
        (setf temp zero)
        (f2cl-lib:fdo (l 1 (f2cl-lib:int-add l 1))
                      ((> l k) nil)
          (tagbody
            (setf temp
              (+ temp
                (*
                  (f2cl-lib:fref a-%data%
                                  (l i)
                                  ((1 lda) (1 *)))
                  a-%offset%)
                  (f2cl-lib:fref b-%data%
                                  (j l)
                                  ((1 ldb$) (1 *)))
                  b-%offset%))))))
      (cond
        ((= beta zero)
         (setf (f2cl-lib:fref c-%data%
                              (i j)
                              ((1 ldc) (1 *)))
               c-%offset%)
          (setf (f2cl-lib:fref a-%data%
                              (i l)
                              ((1 lda) (1 *)))
                a-%offset%)
          (setf (f2cl-lib:fref b-%data%
                              (j l)
                              ((1 ldb$) (1 *)))
                b-%offset%))))))

```

```

                                (* alpha temp)))
(t
  (setf (f2cl-lib:fref c-%data%
                      (i j)
                      ((1 ldc) (1 *))
                      c-%offset%)
    (+ (* alpha temp)
      (* beta
        (f2cl-lib:fref c-%data%
                      (i j)
                      ((1 ldc) (1 *))
                      c-%offset%)))))))))
end_label
(return
 (values nil nil nil nil nil nil nil nil nil nil nil nil nil)))

```

## 6.2 dsymm BLAS

```

<dsymm.input>≡
)set break resume
)sys rm -f dsymm.output
)spool dsymm.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)

```



`<dsymm.help>`≡

```
=====
dsymm examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

DSYMM - perform one of the matrix-matrix operations  $C := \alpha * A * B + \beta * C$ ,

#### SYNOPSIS

```
SUBROUTINE DSYMM ( SIDE, UPLO, M, N, ALPHA, A, LDA, B, LDB,
                  BETA, C, LDC )
```

```
CHARACTER*1 SIDE, UPLO
```

```
INTEGER      M, N, LDA, LDB, LDC
```

```
DOUBLE       PRECISION ALPHA, BETA
```

```
DOUBLE       PRECISION A( LDA, * ), B( LDB, * ), C( LDC,
* )
```

#### PURPOSE

DSYMM performs one of the matrix-matrix operations

or

$$C := \alpha * B * A + \beta * C,$$

where alpha and beta are scalars, A is a symmetric matrix and B and C are m by n matrices.

#### PARAMETERS

SIDE - CHARACTER\*1.

On entry, SIDE specifies whether the symmetric matrix A appears on the left or right in the operation as follows:

SIDE = 'L' or 'l'  $C := \alpha * A * B + \beta * C$ ,

SIDE = 'R' or 'r'  $C := \alpha * B * A + \beta * C$ ,

Unchanged on exit.

UPLO - CHARACTER\*1.

On entry, UPLO specifies whether the upper or lower triangular part of the symmetric matrix A is to be referenced as follows:

UPLO = 'U' or 'u' Only the upper triangular part of the symmetric matrix is to be referenced.

UPLO = 'L' or 'l' Only the lower triangular part of the symmetric matrix is to be referenced.

Unchanged on exit.

M - INTEGER.

On entry, M specifies the number of rows of the matrix C. M must be at least zero. Unchanged on exit.

N - INTEGER.

On entry, N specifies the number of columns of the matrix C. N must be at least zero. Unchanged on exit.

ALPHA - DOUBLE PRECISION.

On entry, ALPHA specifies the scalar alpha.  
Unchanged on exit.

ka is

A -

DOUBLE PRECISION array of DIMENSION ( LDA, ka ), where m when SIDE = 'L' or 'l' and is n otherwise. Before entry with SIDE = 'L' or 'l', the m by m part of the array A must contain the symmetric matrix, such that when UPLO = 'U' or 'u', the leading m by m upper triangular part of the array A must contain the upper triangular part of the symmetric matrix and the strictly lower triangular part of A is not referenced, and when UPLO = 'L' or 'l', the leading m by m lower triangular part of the array A must contain the lower triangular part of the symmetric matrix and the strictly upper triangular part of A is not referenced. Before entry with SIDE = 'R' or 'r', the n by n part of the array A must contain the symmetric

matrix, such that when `UPLO = 'U'` or `'u'`, the leading  $n$  by  $n$  upper triangular part of the array `A` must contain the upper triangular part of the symmetric matrix and the strictly lower triangular part of `A` is not referenced, and when `UPLO = 'L'` or `'l'`, the leading  $n$  by  $n$  lower triangular part of the array `A` must contain the lower triangular part of the symmetric matrix and the strictly upper triangular part of `A` is not referenced. Unchanged on exit.

`LDA` - INTEGER.

On entry, `LDA` specifies the first dimension of `A` as declared in the calling (sub) program. When `SIDE = 'L'` or `'l'` then `LDA` must be at least  $\max(1, m)$ , otherwise `LDA` must be at least  $\max(1, n)$ . Unchanged on exit.

`B` - DOUBLE PRECISION array of DIMENSION ( `LDB`,  $n$  ). Before entry, the leading  $m$  by  $n$  part of the array `B` must contain the matrix `B`. Unchanged on exit.

`LDB` - INTEGER.

On entry, `LDB` specifies the first dimension of `B` as declared in the calling (sub) program. `LDB` must be at least  $\max(1, m)$ . Unchanged on exit.

`BETA` - DOUBLE PRECISION.

On entry, `BETA` specifies the scalar `beta`. When `BETA` is supplied as zero then `C` need not be set on input. Unchanged on exit.

`C` - DOUBLE PRECISION array of DIMENSION ( `LDC`,  $n$  ). Before entry, the leading  $m$  by  $n$  part of the array `C` must contain the matrix `C`, except when `beta` is zero, in which case `C` need not be set on entry. On exit, the array `C` is overwritten by the  $m$  by  $n$  updated matrix.

`LDC` - INTEGER.

On entry, `LDC` specifies the first dimension of `C` as declared in the calling (sub) program. `LDC` must be at least  $\max(1, m)$ . Unchanged on exit.

Level 3 Blas routine.

```

⟨BLAS 3 dsymm⟩≡
  (let* ((one 1.0) (zero 0.0))
    (declare (type (double-float 1.0 1.0) one)
              (type (double-float 0.0 0.0) zero))
    (defun dsymm (side uplo m n alpha a lda b ldb$ beta c ldc)
      (declare (type (simple-array double-float (*)) c b a)
                (type (double-float) beta alpha)
                (type fixnum ldc ldb$ lda n m)
                (type character uplo side))
      (f2cl-lib:with-multi-array-data
        ((side character side-%data% side-%offset%)
         (uplo character uplo-%data% uplo-%offset%)
         (a double-float a-%data% a-%offset%)
         (b double-float b-%data% b-%offset%)
         (c double-float c-%data% c-%offset%))
        (prog ((temp1 0.0) (temp2 0.0) (i 0) (info 0) (j 0) (k 0) (nrowa 0)
              (upper nil))
          (declare (type (double-float) temp1 temp2)
                    (type fixnum i info j k nrowa)
                    (type (member t nil) upper))
          (cond
            ((char-equal side #\L)
              (setf nrowa m))
            (t
              (setf nrowa n)))
          (setf upper (char-equal uplo #\U))
          (setf info 0)
          (cond
            ((and (not (char-equal side #\L)) (not (char-equal side #\R)))
              (setf info 1))
            ((and (not upper) (not (char-equal uplo #\L)))
              (setf info 2))
            ((< m 0)
              (setf info 3))
            ((< n 0)
              (setf info 4))
            ((< lda (max (the fixnum 1) (the fixnum nrowa)))
              (setf info 7))
            ((< ldb$ (max (the fixnum 1) (the fixnum m)))
              (setf info 9))
            ((< ldc (max (the fixnum 1) (the fixnum m)))
              (setf info 12)))
          (cond
            ((/= info 0)
              (error
               " ** On entry to ~a parameter number ~a had an illegal value~%"

```

```

"DSYMM" info)
(go end_label)))
(if (or (= m 0) (= n 0) (and (= alpha zero) (= beta one)))
    (go end_label))
(cond
  ((= alpha zero)
   (cond
     ((= beta zero)
      (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                    (> j n) nil)
      (tagbody
        (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                      (> i m) nil)
        (tagbody
          (setf (f2cl-lib:fref c-%data%
                               (i j)
                               ((1 ldc) (1 *))
                               c-%offset%)
                zero))))))
    (t
     (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                   (> j n) nil)
     (tagbody
       (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                     (> i m) nil)
       (tagbody
         (setf (f2cl-lib:fref c-%data%
                              (i j)
                              ((1 ldc) (1 *))
                              c-%offset%)
              (* beta
               (f2cl-lib:fref c-%data%
                              (i j)
                              ((1 ldc) (1 *))
                              c-%offset%))))))
     (go end_label)))
(cond
  ((char-equal side #\L)
   (cond
     (upper
      (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                    (> j n) nil)
      (tagbody
        (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                      (> i m) nil)
        (tagbody
```

```

(setf temp1
  (* alpha
    (f2cl-lib:fref b-%data%
      (i j)
      ((1 ldb$) (1 *))
      b-%offset%)))

(setf temp2 zero)
(f2cl-lib:fd0 (k 1 (f2cl-lib:int-add k 1))
  (> k
    (f2cl-lib:int-add i
      (f2cl-lib:int-sub
        1)))
    nil)

(tagbody
  (setf (f2cl-lib:fref c-%data%
    (k j)
    ((1 ldc) (1 *))
    c-%offset%)

    (+
      (f2cl-lib:fref c-%data%
        (k j)
        ((1 ldc) (1 *))
        c-%offset%)

      (* temp1
        (f2cl-lib:fref a-%data%
          (k i)
          ((1 lda) (1 *))
          a-%offset%))))

  (setf temp2
    (+ temp2
      (*
        (f2cl-lib:fref b-%data%
          (k j)
          ((1 ldb$) (1 *))
          b-%offset%)
        (f2cl-lib:fref a-%data%
          (k i)
          ((1 lda) (1 *))
          a-%offset%))))))

(cond
  ((= beta zero)
    (setf (f2cl-lib:fref c-%data%
      (i j)
      ((1 ldc) (1 *))
      c-%offset%)

      (+

```

```

(* temp1
  (f2cl-lib:fref a-%data%
    (i i)
    ((1 lda) (1 *))
    a-%offset%))
(* alpha temp2))))
(t
  (setf (f2cl-lib:fref c-%data%
    (i j)
    ((1 ldc) (1 *))
    c-%offset%))
  (+
    (* beta
      (f2cl-lib:fref c-%data%
        (i j)
        ((1 ldc) (1 *))
        c-%offset%))
    (* temp1
      (f2cl-lib:fref a-%data%
        (i i)
        ((1 lda) (1 *))
        a-%offset%))
    (* alpha temp2)))))))))
(t
  (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
    (> j n) nil)
  (tagbody
    (f2cl-lib:fdo (i m (f2cl-lib:int-add i (f2cl-lib:int-sub 1)))
      (> i 1) nil)
    (tagbody
      (setf temp1
        (* alpha
          (f2cl-lib:fref b-%data%
            (i j)
            ((1 ldb$) (1 *))
            b-%offset%)))
      (setf temp2 zero)
      (f2cl-lib:fdo (k (f2cl-lib:int-add i 1)
        (f2cl-lib:int-add k 1))
        (> k m) nil)
      (tagbody
        (setf (f2cl-lib:fref c-%data%
          (k j)
          ((1 ldc) (1 *))
          c-%offset%))
          (+

```

```

(f2cl-lib:fref c-%data%
  (k j)
  ((1 ldc) (1 *))
  c-%offset%)

(* temp1
  (f2cl-lib:fref a-%data%
    (k i)
    ((1 lda) (1 *))
    a-%offset%)))

(setf temp2
  (+ temp2
    (*
      (f2cl-lib:fref b-%data%
        (k j)
        ((1 ldb$) (1 *))
        b-%offset%)
      (f2cl-lib:fref a-%data%
        (k i)
        ((1 lda) (1 *))
        a-%offset%))))))

(cond
  ((= beta zero)
    (setf (f2cl-lib:fref c-%data%
      (i j)
      ((1 ldc) (1 *))
      c-%offset%)
      (+
        (* temp1
          (f2cl-lib:fref a-%data%
            (i i)
            ((1 lda) (1 *))
            a-%offset%))
        (* alpha temp2))))))

(t
  (setf (f2cl-lib:fref c-%data%
    (i j)
    ((1 ldc) (1 *))
    c-%offset%)
    (+
      (* beta
        (f2cl-lib:fref c-%data%
          (i j)
          ((1 ldc) (1 *))
          c-%offset%))
      (* temp1
        (f2cl-lib:fref a-%data%

```



```

                                (i i)
                                ((1 lda) (1 *))
                                a-%offset%)
                                (* alpha temp2))))))))))
(t
  (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
    (> j n) nil)
  (tagbody
    (setf temp1
      (* alpha
        (f2cl-lib:fref a-%data%
          (j j)
          ((1 lda) (1 *))
          a-%offset%)))
    (cond
      ((= beta zero)
        (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
          (> i m) nil)
        (tagbody
          (setf (f2cl-lib:fref c-%data%
            (i j)
            ((1 ldc) (1 *))
            c-%offset%)
            (* temp1
              (f2cl-lib:fref b-%data%
                (i j)
                ((1 ldb$) (1 *))
                b-%offset%))))))
      (t
        (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
          (> i m) nil)
        (tagbody
          (setf (f2cl-lib:fref c-%data%
            (i j)
            ((1 ldc) (1 *))
            c-%offset%)
            (+
              (* beta
                (f2cl-lib:fref c-%data%
                  (i j)
                  ((1 ldc) (1 *))
                  c-%offset%))
              (* temp1
                (f2cl-lib:fref b-%data%
                  (i j)
                  ((1 ldb$) (1 *))

```

```

                                b-%offset%)))))))))
(f2cl-lib:fdo (k 1 (f2cl-lib:int-add k 1))
              ((> k (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
               nil)
(tagbody
 (cond
  (upper
   (setf temp1
          (* alpha
             (f2cl-lib:fref a-%data%
                             (k j)
                             ((1 lda) (1 *))
                             a-%offset%))))

   (t
    (setf temp1
           (* alpha
              (f2cl-lib:fref a-%data%
                              (j k)
                              ((1 lda) (1 *))
                              a-%offset%))))))
(f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
              ((> i m) nil)
(tagbody
 (setf (f2cl-lib:fref c-%data%
                      (i j)
                      ((1 ldc) (1 *))
                      c-%offset%)

        (+
         (f2cl-lib:fref c-%data%
                         (i j)
                         ((1 ldc) (1 *))
                         c-%offset%)

         (* temp1
            (f2cl-lib:fref b-%data%
                            (i k)
                            ((1 ldb) (1 *))
                            b-%offset%))))))
(f2cl-lib:fdo (k (f2cl-lib:int-add j 1) (f2cl-lib:int-add k 1))
              ((> k n) nil)
(tagbody
 (cond
  (upper
   (setf temp1
          (* alpha
             (f2cl-lib:fref a-%data%
                             (j k)

```

```

((1 lda) (1 *))
a-%offset%)))

(t
  (setf temp1
    (* alpha
      (f2cl-lib:fref a-%data%
        (k j)
        ((1 lda) (1 *))
        a-%offset%))))
  (f2cl-lib:fd0 (i 1 (f2cl-lib:int-add i 1))
    (> i m) nil)
  (tagbody
    (setf (f2cl-lib:fref c-%data%
      (i j)
      ((1 ldc) (1 *))
      c-%offset%)
      (+
        (f2cl-lib:fref c-%data%
          (i j)
          ((1 ldc) (1 *))
          c-%offset%)
        (* temp1
          (f2cl-lib:fref b-%data%
            (i k)
            ((1 ldb$) (1 *))
            b-%offset%))))))
  end_label
  (return (values nil nil nil nil nil nil nil nil nil nil nil)))

```

### 6.3 dsyr2k BLAS

```

⟨dsyr2k.input⟩≡
)set break resume
)sys rm -f dsyr2k.output
)spool dsyr2k.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)

```

$\langle dsyr2k.help \rangle =$

```
=====
dsyr2k examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

DSYR2K - perform one of the symmetric rank 2k operations    C  
 $C := \alpha A B' + \alpha B A' + \beta C,$

#### SYNOPSIS

```
SUBROUTINE DSYR2K( UPLO, TRANS, N, K, ALPHA, A, LDA, B, LDB,
                   BETA, C, LDC )
```

```
      CHARACTER*1    UPLO, TRANS
```

```
      INTEGER        N, K, LDA, LDB, LDC
```

```
      DOUBLE         PRECISION ALPHA, BETA
```

```
      DOUBLE         PRECISION A( LDA, * ), B( LDB, * ), C(
                        LDC, * )
```

#### PURPOSE

DSYR2K performs one of the symmetric rank 2k operations

or

$$C := \alpha A' B + \alpha B' A + \beta C,$$

where alpha and beta are scalars, C is an n by n symmetric matrix and A and B are n by k matrices in the first case and k by n matrices in the second case.

#### PARAMETERS

UPLO - CHARACTER\*1.

On entry, UPLO specifies whether the upper or lower triangular part of the array C is to be referenced as follows:

UPLO = 'U' or 'u' Only the upper triangular part of C is to be referenced.

UPLO = 'L' or 'l' Only the lower triangular part of C is to be referenced.

Unchanged on exit.

TRANS - CHARACTER\*1.

On entry, TRANS specifies the operation to be performed as follows:

TRANS = 'N' or 'n'  $C := \alpha * A * B' + \alpha * B * A' + \beta * C$ .

TRANS = 'T' or 't'  $C := \alpha * A' * B + \alpha * B' * A + \beta * C$ .

TRANS = 'C' or 'c'  $C := \alpha * A' * B + \alpha * B' * A + \beta * C$ .

Unchanged on exit.

N - INTEGER.

On entry, N specifies the order of the matrix C. N must be at least zero. Unchanged on exit.

K - INTEGER.

On entry with TRANS = 'N' or 'n', K specifies the number of columns of the matrices A and B, and on entry with TRANS = 'T' or 't' or 'C' or 'c', K specifies the number of rows of the matrices A and B. K must be at least zero. Unchanged on exit.

ALPHA - DOUBLE PRECISION.

On entry, ALPHA specifies the scalar alpha. Unchanged on exit.

ka is

A -

DOUBLE PRECISION array of DIMENSION ( LDA, ka ), where k when TRANS = 'N' or 'n', and is n otherwise. Before entry with TRANS = 'N' or 'n', the leading n by k part of the array A must contain the matrix A, otherwise the leading k by n part of the array A must contain the matrix A. Unchanged on exit.

LDA - INTEGER.

On entry, LDA specifies the first dimension of A as

declared in the calling (sub) program. When  $\text{TRANS} = 'N'$  or  $'n'$  then LDA must be at least  $\max(1, n)$ , otherwise LDA must be at least  $\max(1, k)$ . Unchanged on exit.

kb is

B -  
DOUBLE PRECISION array of DIMENSION ( LDB, kb ), where k when  $\text{TRANS} = 'N'$  or  $'n'$ , and is n otherwise. Before entry with  $\text{TRANS} = 'N'$  or  $'n'$ , the leading n by k part of the array B must contain the matrix B, otherwise the leading k by n part of the array B must contain the matrix B. Unchanged on exit.

LDB - INTEGER.  
On entry, LDB specifies the first dimension of B as declared in the calling (sub) program. When  $\text{TRANS} = 'N'$  or  $'n'$  then LDB must be at least  $\max(1, n)$ , otherwise LDB must be at least  $\max(1, k)$ . Unchanged on exit.

BETA - DOUBLE PRECISION.  
On entry, BETA specifies the scalar beta. Unchanged on exit.

C - DOUBLE PRECISION array of DIMENSION ( LDC, n ).  
Before entry with  $\text{UPLO} = 'U'$  or  $'u'$ , the leading n by n upper triangular part of the array C must contain the upper triangular part of the symmetric matrix and the strictly lower triangular part of C is not referenced. On exit, the upper triangular part of the array C is overwritten by the upper triangular part of the updated matrix. Before entry with  $\text{UPLO} = 'L'$  or  $'l'$ , the leading n by n lower triangular part of the array C must contain the lower triangular part of the symmetric matrix and the strictly upper triangular part of C is not referenced. On exit, the lower triangular part of the array C is overwritten by the lower triangular part of the updated matrix.

LDC - INTEGER.  
On entry, LDC specifies the first dimension of C as declared in the calling (sub) program. LDC must be at least  $\max(1, n)$ . Unchanged on exit.

```

<BLAS 3 dsyr2k>=
  (let* ((one 1.0) (zero 0.0))
    (declare (type (double-float 1.0 1.0) one)
              (type (double-float 0.0 0.0) zero))
    (defun dsyr2k (uplo trans n k alpha a lda b ldb$ beta c ldc)
      (declare (type (simple-array double-float (*)) c b a)
                (type (double-float) beta alpha)
                (type fixnum ldc ldb$ lda k n)
                (type character trans uplo))
      (f2cl-lib:with-multi-array-data
        ((uplo character uplo-%data% uplo-%offset%)
         (trans character trans-%data% trans-%offset%)
         (a double-float a-%data% a-%offset%)
         (b double-float b-%data% b-%offset%)
         (c double-float c-%data% c-%offset%))
        (prog ((temp1 0.0) (temp2 0.0) (i 0) (info 0) (j 0) (l 0) (nrowa 0)
              (upper nil))
          (declare (type (double-float) temp1 temp2)
                    (type fixnum i info j l nrowa)
                    (type (member t nil) upper))
          (cond
            ((char-equal trans #\N)
             (setf nrowa n))
            (t
             (setf nrowa k)))
          (setf upper (char-equal uplo #\U))
          (setf info 0)
          (cond
            ((and (not upper) (not (char-equal uplo #\L)))
             (setf info 1))
            ((and (not (char-equal trans #\N))
                  (not (char-equal trans #\T))
                  (not (char-equal trans #\C)))
             (setf info 2))
            ((< n 0)
             (setf info 3))
            ((< k 0)
             (setf info 4))
            ((< lda (max (the fixnum 1) (the fixnum nrowa)))
             (setf info 7))
            ((< ldb$
              (max (the fixnum 1) (the fixnum nrowa)))
             (setf info 9))
            ((< ldc (max (the fixnum 1) (the fixnum n)))
             (setf info 12)))
          (cond

```

```
((/= info 0)
(error
 " ** On entry to ~a parameter number ~a had an illegal value~%"
 "DSYR2K" info)
(go end_label)))
(if (or (= n 0) (and (or (= alpha zero) (= k 0)) (= beta one)))
    (go end_label))
(cond
 ((= alpha zero)
  (cond
   (upper
    (cond
     ((= beta zero)
      (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                    (> j n) nil)
      (tagbody
       (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                     (> i j) nil)
       (tagbody
        (setf (f2cl-lib:fref c-%data%
                             (i j)
                             ((1 ldc) (1 *)))
              c-%offset%)
              zero))))))
    (t
     (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                   (> j n) nil)
     (tagbody
      (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                    (> i j) nil)
      (tagbody
       (setf (f2cl-lib:fref c-%data%
                           (i j)
                           ((1 ldc) (1 *)))
             c-%offset%)
             (* beta
              (f2cl-lib:fref c-%data%
                              (i j)
                              ((1 ldc) (1 *)))
              c-%offset%))))))))))
(t
 (cond
  ((= beta zero)
   (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                 (> j n) nil)
   (tagbody
```



```

(f2cl-lib:fdo (i j (f2cl-lib:int-add i 1))
  (> i n) nil)
  (tagbody
    (setf (f2cl-lib:fref c-%data%
      (i j)
      ((1 ldc) (1 *))
      c-%offset%)
      zero))))))
(t
  (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
    (> j n) nil)
  (tagbody
    (f2cl-lib:fdo (i j (f2cl-lib:int-add i 1))
      (> i n) nil)
      (tagbody
        (setf (f2cl-lib:fref c-%data%
          (i j)
          ((1 ldc) (1 *))
          c-%offset%)
          (* beta
            (f2cl-lib:fref c-%data%
              (i j)
              ((1 ldc) (1 *))
              c-%offset%))))))))))
  (go end_label)))
(cond
  ((char-equal trans #\N)
    (cond
      (upper
        (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
          (> j n) nil)
        (tagbody
          (cond
            ((= beta zero)
              (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                (> i j) nil)
              (tagbody
                (setf (f2cl-lib:fref c-%data%
                  (i j)
                  ((1 ldc) (1 *))
                  c-%offset%)
                  zero))))))
            ((/= beta one)
              (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                (> i j) nil)
              (tagbody

```

```

(setf (f2cl-lib:fref c-%data%
                    (i j)
                    ((1 ldc) (1 *))
                    c-%offset%))

(* beta
  (f2cl-lib:fref c-%data%
                (i j)
                ((1 ldc) (1 *))
                c-%offset%))))))
(f2cl-lib:fdo (1 1 (f2cl-lib:int-add 1 1))
              ((> 1 k) nil)
(tagbody
 (cond
  ((or (/= (f2cl-lib:fref a (j 1) ((1 lda) (1 *))) zero)
        (/= (f2cl-lib:fref b (j 1) ((1 ldb$) (1 *))) zero))
   (setf temp1
          (* alpha
             (f2cl-lib:fref b-%data%
                             (j 1)
                             ((1 ldb$) (1 *))
                             b-%offset%)))

   (setf temp2
          (* alpha
             (f2cl-lib:fref a-%data%
                             (j 1)
                             ((1 lda) (1 *))
                             a-%offset%)))
   (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                 ((> i j) nil)
   (tagbody
    (setf (f2cl-lib:fref c-%data%
                        (i j)
                        ((1 ldc) (1 *))
                        c-%offset%)

          (+
            (f2cl-lib:fref c-%data%
                            (i j)
                            ((1 ldc) (1 *))
                            c-%offset%)

            (*
              (f2cl-lib:fref a-%data%
                              (i 1)
                              ((1 lda) (1 *))
                              a-%offset%)

              temp1)

          (*

```

```

                                (f2cl-lib:fref b-%data%
                                (i 1)
                                ((1 ldb$) (1 *)))
                                b-%offset%)
                                temp2))))))))))
(t
(f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
              (> j n) nil)
(tagbody
(cond
  ((= beta zero)
   (f2cl-lib:fdo (i j (f2cl-lib:int-add i 1))
                 (> i n) nil)
   (tagbody
    (setf (f2cl-lib:fref c-%data%
                        (i j)
                        ((1 ldc) (1 *)))
          c-%offset%)
          zero))))
  ((/= beta one)
   (f2cl-lib:fdo (i j (f2cl-lib:int-add i 1))
                 (> i n) nil)
   (tagbody
    (setf (f2cl-lib:fref c-%data%
                        (i j)
                        ((1 ldc) (1 *)))
          c-%offset%)
          (* beta
           (f2cl-lib:fref c-%data%
                           (i j)
                           ((1 ldc) (1 *)))
           c-%offset%))))))
(f2cl-lib:fdo (l 1 (f2cl-lib:int-add l 1))
              (> l k) nil)
(tagbody
(cond
  ((or (/= (f2cl-lib:fref a (j 1) ((1 lda) (1 *))) zero)
        (/= (f2cl-lib:fref b (j 1) ((1 ldb$) (1 *))) zero))
   (setf temp1
          (* alpha
             (f2cl-lib:fref b-%data%
                             (j 1)
                             ((1 ldb$) (1 *)))
             b-%offset%)))
  (setf temp2
         (* alpha
            (f2cl-lib:fref c-%data%
                            (i j)
                            ((1 ldc) (1 *)))
            c-%offset%))))))

```

```

(f2cl-lib:fref a-%data%
  (j 1)
  ((1 lda) (1 *))
  a-%offset%))
(f2cl-lib:fdo (i j (f2cl-lib:int-add i 1))
  ((> i n) nil)
  (tagbody
    (setf (f2cl-lib:fref c-%data%
      (i j)
      ((1 ldc) (1 *))
      c-%offset%)
      (+
        (f2cl-lib:fref c-%data%
          (i j)
          ((1 ldc) (1 *))
          c-%offset%)
        (*
          (f2cl-lib:fref a-%data%
            (i 1)
            ((1 lda) (1 *))
            a-%offset%)
          temp1)
        (*
          (f2cl-lib:fref b-%data%
            (i 1)
            ((1 ldb$) (1 *))
            b-%offset%)
          temp2))))))))))
(t
  (cond
    (upper
      (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
        ((> j n) nil)
        (tagbody
          (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
            ((> i j) nil)
            (tagbody
              (setf temp1 zero)
              (setf temp2 zero)
              (f2cl-lib:fdo (l 1 (f2cl-lib:int-add l 1))
                ((> l k) nil)
                (tagbody
                  (setf temp1
                    (+ temp1
                      (*
                        (f2cl-lib:fref a-%data%

```

```

                                (1 i)
                                ((1 lda) (1 *))
                                a-%offset%)
(f2cl-lib:fref b-%data%
  (1 j)
  ((1 ldb$) (1 *))
  b-%offset%)))
(setf temp2
  (+ temp2
    (*
      (f2cl-lib:fref b-%data%
        (1 i)
        ((1 ldb$) (1 *))
        b-%offset%)
      (f2cl-lib:fref a-%data%
        (1 j)
        ((1 lda) (1 *))
        a-%offset%))))))
(cond
  ((= beta zero)
    (setf (f2cl-lib:fref c-%data%
      (i j)
      ((1 ldc) (1 *))
      c-%offset%)
      (+ (* alpha temp1) (* alpha temp2))))
  (t
    (setf (f2cl-lib:fref c-%data%
      (i j)
      ((1 ldc) (1 *))
      c-%offset%)
      (+
        (* beta
          (f2cl-lib:fref c-%data%
            (i j)
            ((1 ldc) (1 *))
            c-%offset%))
        (* alpha temp1)
        (* alpha temp2))))))
(t
  (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
    ((> j n) nil)
    (tagbody
      (f2cl-lib:fdo (i j (f2cl-lib:int-add i 1))
        ((> i n) nil)
        (tagbody
          (setf temp1 zero)

```

```

(setf temp2 zero)
(f2cl-lib:fdo (1 1 (f2cl-lib:int-add 1 1))
  ((> 1 k) nil)
  (tagbody
    (setf temp1
      (+ temp1
        (*
          (f2cl-lib:fref a-%data%
            (1 i)
            ((1 lda) (1 *))
            a-%offset%)
          (f2cl-lib:fref b-%data%
            (1 j)
            ((1 ldb$) (1 *))
            b-%offset%))))))
    (setf temp2
      (+ temp2
        (*
          (f2cl-lib:fref b-%data%
            (1 i)
            ((1 ldb$) (1 *))
            b-%offset%)
          (f2cl-lib:fref a-%data%
            (1 j)
            ((1 lda) (1 *))
            a-%offset%))))))
  (cond
    ((= beta zero)
      (setf (f2cl-lib:fref c-%data%
        (i j)
        ((1 ldc) (1 *))
        c-%offset%)
        (+ (* alpha temp1) (* alpha temp2))))
    (t
      (setf (f2cl-lib:fref c-%data%
        (i j)
        ((1 ldc) (1 *))
        c-%offset%)
        (+
          (* beta
            (f2cl-lib:fref c-%data%
              (i j)
              ((1 ldc) (1 *))
              c-%offset%))
          (* alpha temp1)
          (* alpha temp2)))))))))

```

```
end_label  
  (return (values nil nil nil nil nil nil nil nil nil nil nil nil)))))
```

## 6.4 dsyrk BLAS

```
<dsyrk.input>≡  
  )set break resume  
  )sys rm -f dsyrk.output  
  )spool dsyrk.output  
  )set message test on  
  )set message auto off  
  )clear all  
  
  )spool  
  )lisp (bye)
```

`<dsyrk.help>=`

```
=====
dsyrk examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

DSYRK - perform one of the symmetric rank k operations    C  
 $C := \alpha * A * A' + \beta * C,$

#### SYNOPSIS

```
SUBROUTINE DSYRK ( UPLO, TRANS, N, K, ALPHA, A, LDA, BETA,
                  C, LDC )
```

```
CHARACTER*1  UPLO, TRANS
```

```
INTEGER      N, K, LDA, LDC
```

```
DOUBLE       PRECISION ALPHA, BETA
```

```
DOUBLE       PRECISION A( LDA, * ), C( LDC, * )
```

#### PURPOSE

DSYRK performs one of the symmetric rank k operations

or

$$C := \alpha * A' * A + \beta * C,$$

where  $\alpha$  and  $\beta$  are scalars, C is an n by n symmetric matrix and A is an n by k matrix in the first case and a k by n matrix in the second case.

#### PARAMETERS

UPLO - CHARACTER\*1.

On entry, UPLO specifies whether the upper or lower triangular part of the array C is to be referenced as follows:

UPLO = 'U' or 'u' Only the upper triangular part of C is to be referenced.

UPLO = 'L' or 'l' Only the lower triangular part



of  $C$  is to be referenced.

Unchanged on exit.

TRANS - CHARACTER\*1.

On entry, TRANS specifies the operation to be performed as follows:

TRANS = 'N' or 'n'  $C := \alpha * A * A' + \beta * C$ .

TRANS = 'T' or 't'  $C := \alpha * A' * A + \beta * C$ .

TRANS = 'C' or 'c'  $C := \alpha * A' * A + \beta * C$ .

Unchanged on exit.

N - INTEGER.

On entry, N specifies the order of the matrix  $C$ . N must be at least zero. Unchanged on exit.

K - INTEGER.

On entry with TRANS = 'N' or 'n', K specifies the number of columns of the matrix  $A$ , and on entry with TRANS = 'T' or 't' or 'C' or 'c', K specifies the number of rows of the matrix  $A$ . K must be at least zero. Unchanged on exit.

ALPHA - DOUBLE PRECISION.

On entry, ALPHA specifies the scalar  $\alpha$ .  
Unchanged on exit.

ka is

A -

DOUBLE PRECISION array of DIMENSION ( LDA, ka ), where  $k$  when TRANS = 'N' or 'n', and is  $n$  otherwise. Before entry with TRANS = 'N' or 'n', the leading  $n$  by  $k$  part of the array  $A$  must contain the matrix  $A$ , otherwise the leading  $k$  by  $n$  part of the array  $A$  must contain the matrix  $A$ . Unchanged on exit.

LDA - INTEGER.

On entry, LDA specifies the first dimension of  $A$  as declared in the calling (sub) program. When TRANS = 'N' or 'n' then LDA must be at least  $\max(1, n)$ , otherwise LDA must be at least  $\max(1, k)$ . Unchanged on exit.

- BETA    - DOUBLE PRECISION.  
On entry, BETA specifies the scalar beta. Unchanged on exit.
- C        - DOUBLE PRECISION array of DIMENSION ( LDC, n ).  
Before entry with UPLO = 'U' or 'u', the leading n by n upper triangular part of the array C must contain the upper triangular part of the symmetric matrix and the strictly lower triangular part of C is not referenced. On exit, the upper triangular part of the array C is overwritten by the upper triangular part of the updated matrix. Before entry with UPLO = 'L' or 'l', the leading n by n lower triangular part of the array C must contain the lower triangular part of the symmetric matrix and the strictly upper triangular part of C is not referenced. On exit, the lower triangular part of the array C is overwritten by the lower triangular part of the updated matrix.
- LDC      - INTEGER.  
On entry, LDC specifies the first dimension of C as declared in the calling (sub) program. LDC must be at least  $\max(1, n)$ . Unchanged on exit.

```

<BLAS 3 dsyrk>≡
  (let* ((one 1.0) (zero 0.0))
    (declare (type (double-float 1.0 1.0) one)
              (type (double-float 0.0 0.0) zero))
    (defun dsyrk (uplo trans n k alpha a lda beta c ldc)
      (declare (type (simple-array double-float (*)) c a)
                (type (double-float) beta alpha)
                (type fixnum ldc lda k n)
                (type character trans uplo))
      (f2cl-lib:with-multi-array-data
        ((uplo character uplo-%data% uplo-%offset%)
         (trans character trans-%data% trans-%offset%)
         (a double-float a-%data% a-%offset%)
         (c double-float c-%data% c-%offset%))
        (prog ((temp 0.0) (i 0) (info 0) (j 0) (l 0) (nrowa 0) (upper nil))
          (declare (type (double-float) temp)
                    (type fixnum i info j l nrowa)
                    (type (member t nil) upper))

          (cond
            ((char-equal trans #\N)
              (setf nrowa n))
            (t
              (setf nrowa k)))
          (setf upper (char-equal uplo #\U))
          (setf info 0)
          (cond
            ((and (not upper) (not (char-equal uplo #\L)))
              (setf info 1))
            ((and (not (char-equal trans #\N))
                  (not (char-equal trans #\T))
                  (not (char-equal trans #\C)))
              (setf info 2))
            ((< n 0)
              (setf info 3))
            ((< k 0)
              (setf info 4))
            ((< lda (max (the fixnum 1) (the fixnum nrowa)))
              (setf info 7))
            ((< ldc (max (the fixnum 1) (the fixnum n)))
              (setf info 10)))
          (cond
            ((/= info 0)
              (error
               " ** On entry to ~a parameter number ~a had an illegal value~%"
               "DSYRK" info)
              (go end_label))))

```

```

(if (or (= n 0) (and (or (= alpha zero) (= k 0)) (= beta one)))
  (go end_label))
(cond
  ((= alpha zero)
   (cond
     (upper
      (cond
        ((= beta zero)
         (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                       ((> j n) nil)
         (tagbody
          (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                        ((> i j) nil)
          (tagbody
           (setf (f2cl-lib:fref c-%data%
                               (i j)
                               ((1 ldc) (1 *))
                               c-%offset%)
                 zero))))))
        (t
         (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                       ((> j n) nil)
         (tagbody
          (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                        ((> i j) nil)
          (tagbody
           (setf (f2cl-lib:fref c-%data%
                               (i j)
                               ((1 ldc) (1 *))
                               c-%offset%)
                 (* beta
                  (f2cl-lib:fref c-%data%
                                (i j)
                                ((1 ldc) (1 *))
                                c-%offset%))))))))))
     (t
      (cond
        ((= beta zero)
         (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                       ((> j n) nil)
         (tagbody
          (f2cl-lib:fdo (i j (f2cl-lib:int-add i 1))
                        ((> i n) nil)
          (tagbody
           (setf (f2cl-lib:fref c-%data%
                               (i j)

```



```

(f2cl-lib:fref c-%data%
  (i j)
  ((1 ldc) (1 *))
  c-%offset%))))))
(f2cl-lib:fdo (1 1 (f2cl-lib:int-add 1 1))
  (> 1 k) nil)
(tagbody
  (cond
    ((/= (f2cl-lib:fref a (j 1) ((1 lda) (1 *))) zero)
      (setf temp
        (* alpha
          (f2cl-lib:fref a-%data%
            (j 1)
            ((1 lda) (1 *))
            a-%offset%)))
        (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
          (> i j) nil)
        (tagbody
          (setf (f2cl-lib:fref c-%data%
            (i j)
            ((1 ldc) (1 *))
            c-%offset%)
            (+
              (f2cl-lib:fref c-%data%
                (i j)
                ((1 ldc) (1 *))
                c-%offset%)
              (* temp
                (f2cl-lib:fref a-%data%
                  (i 1)
                  ((1 lda) (1 *))
                  a-%offset%))))))))))
(t
  (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
    (> j n) nil)
  (tagbody
    (cond
      ((= beta zero)
        (f2cl-lib:fdo (i j (f2cl-lib:int-add i 1))
          (> i n) nil)
        (tagbody
          (setf (f2cl-lib:fref c-%data%
            (i j)
            ((1 ldc) (1 *))
            c-%offset%)
            zero))))

```

```

( (/ = beta one)
  (f2cl-lib:fdo (i j (f2cl-lib:int-add i 1))
    ((> i n) nil)
    (tagbody
      (setf (f2cl-lib:fref c-%data%
        (i j)
        ((1 ldc) (1 *))
        c-%offset%)
        (* beta
          (f2cl-lib:fref c-%data%
            (i j)
            ((1 ldc) (1 *))
            c-%offset%))))))
(f2cl-lib:fdo (l 1 (f2cl-lib:int-add 1 1))
  ((> l k) nil)
  (tagbody
    (cond
      ((/= (f2cl-lib:fref a (j 1) ((1 lda) (1 *))) zero)
        (setf temp
          (* alpha
            (f2cl-lib:fref a-%data%
              (j 1)
              ((1 lda) (1 *))
              a-%offset%)))
        (f2cl-lib:fdo (i j (f2cl-lib:int-add i 1))
          ((> i n) nil)
          (tagbody
            (setf (f2cl-lib:fref c-%data%
              (i j)
              ((1 ldc) (1 *))
              c-%offset%)
              (+
                (f2cl-lib:fref c-%data%
                  (i j)
                  ((1 ldc) (1 *))
                  c-%offset%)
                (* temp
                  (f2cl-lib:fref a-%data%
                    (i 1)
                    ((1 lda) (1 *))
                    a-%offset%))))))))))
(t
  (cond
    (upper
      (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
        ((> j n) nil)

```

```

(tagbody
  (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
    ((> i j) nil)
  (tagbody
    (setf temp zero)
    (f2cl-lib:fdo (l 1 (f2cl-lib:int-add l 1))
      ((> l k) nil)
    (tagbody
      (setf temp
        (+ temp
          (*
            (f2cl-lib:fref a-%data%
              (l i)
              ((1 lda) (1 *))
              a-%offset%)
            (f2cl-lib:fref a-%data%
              (l j)
              ((1 lda) (1 *))
              a-%offset%))))))
    (cond
      ((= beta zero)
        (setf (f2cl-lib:fref c-%data%
          (i j)
          ((1 ldc) (1 *))
          c-%offset%)
          (* alpha temp)))
      (t
        (setf (f2cl-lib:fref c-%data%
          (i j)
          ((1 ldc) (1 *))
          c-%offset%)
          (+ (* alpha temp)
            (* beta
              (f2cl-lib:fref c-%data%
                (i j)
                ((1 ldc) (1 *))
                c-%offset%))))))))))
(t
  (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
    ((> j n) nil)
  (tagbody
    (f2cl-lib:fdo (i j (f2cl-lib:int-add i 1))
      ((> i n) nil)
    (tagbody
      (setf temp zero)
      (f2cl-lib:fdo (l 1 (f2cl-lib:int-add l 1))

```



```

                                (> 1 k) nil)
(tagbody
  (setf temp
    (+ temp
      (*
        (f2cl-lib:fref a-%data%
          (1 i)
          ((1 lda) (1 *))
          a-%offset%)
        (f2cl-lib:fref a-%data%
          (1 j)
          ((1 lda) (1 *))
          a-%offset%))))))
(cond
  ((= beta zero)
    (setf (f2cl-lib:fref c-%data%
      (i j)
      ((1 ldc) (1 *))
      c-%offset%)
      (* alpha temp)))
  (t
    (setf (f2cl-lib:fref c-%data%
      (i j)
      ((1 ldc) (1 *))
      c-%offset%)
      (+ (* alpha temp)
        (* beta
          (f2cl-lib:fref c-%data%
            (i j)
            ((1 ldc) (1 *))
            c-%offset%))))))))))
end_label
(return (values nil nil nil nil nil nil nil nil nil))

```

## 6.5 dtrmm BLAS

```
<dtrmm.input>=  
  )set break resume  
  )sys rm -f dtrmm.output  
  )spool dtrmm.output  
  )set message test on  
  )set message auto off  
  )clear all  
  
  )spool  
  )lisp (bye)
```

`<dtrmm.help>=`

```
=====
dtrmm examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

DTRMM - perform one of the matrix-matrix operations  $B := \alpha * \text{op}(A) * B$ , or  $B := \alpha * B * \text{op}(A)$ ,

#### SYNOPSIS

```
SUBROUTINE DTRMM ( SIDE, UPLO, TRANSA, DIAG, M, N, ALPHA, A,
                  LDA, B, LDB )
```

CHARACTER\*1 SIDE, UPLO, TRANSA, DIAG

INTEGER M, N, LDA, LDB

DOUBLE PRECISION ALPHA

DOUBLE PRECISION A( LDA, \* ), B( LDB, \* )

#### PURPOSE

DTRMM performs one of the matrix-matrix operations

where  $\alpha$  is a scalar,  $B$  is an  $m$  by  $n$  matrix,  $A$  is a unit, or non-unit, upper or lower triangular matrix and  $\text{op}(A)$  is one of

$\text{op}(A) = A$  or  $\text{op}(A) = A'$ .

#### PARAMETERS

SIDE - CHARACTER\*1.

On entry, SIDE specifies whether  $\text{op}(A)$  multiplies  $B$  from the left or right as follows:

SIDE = 'L' or 'l'  $B := \alpha * \text{op}(A) * B$ .

SIDE = 'R' or 'r'  $B := \alpha * B * \text{op}(A)$ .

Unchanged on exit.

UPLO - CHARACTER\*1.

On entry, UPLO specifies whether the matrix A is an upper or lower triangular matrix as follows:

UPLO = 'U' or 'u'    A is an upper triangular matrix.

UPLO = 'L' or 'l'    A is a lower triangular matrix.

Unchanged on exit.

TRANSA - CHARACTER\*1. On entry, TRANSA specifies the form of  $op(A)$  to be used in the matrix multiplication as follows:

TRANSA = 'N' or 'n'     $op(A) = A$ .

TRANSA = 'T' or 't'     $op(A) = A'$ .

TRANSA = 'C' or 'c'     $op(A) = A'$ .

Unchanged on exit.

DIAG - CHARACTER\*1.

On entry, DIAG specifies whether or not A is unit triangular as follows:

DIAG = 'U' or 'u'    A is assumed to be unit triangular.

DIAG = 'N' or 'n'    A is not assumed to be unit triangular.

Unchanged on exit.

M - INTEGER.

On entry, M specifies the number of rows of B. M must be at least zero. Unchanged on exit.

N - INTEGER.

On entry, N specifies the number of columns of B. N must be at least zero. Unchanged on exit.

ALPHA - DOUBLE PRECISION.

On entry, ALPHA specifies the scalar alpha. When alpha is zero then A is not referenced and B need not be set before entry. Unchanged on exit.

is m

A

-

DOUBLE PRECISION array of DIMENSION ( LDA, k ), where k when SIDE = 'L' or 'l' and is n when SIDE = 'R' or 'r'. Before entry with UPLO = 'U' or 'u', the leading k by k upper triangular part of the array A must contain the upper triangular matrix and the strictly lower triangular part of A is not referenced. Before entry with UPLO = 'L' or 'l', the leading k by k lower triangular part of the array A must contain the lower triangular matrix and the strictly upper triangular part of A is not referenced. Note that when DIAG = 'U' or 'u', the diagonal elements of A are not referenced either, but are assumed to be unity. Unchanged on exit.

LDA

- INTEGER.

On entry, LDA specifies the first dimension of A as declared in the calling (sub) program. When SIDE = 'L' or 'l' then LDA must be at least max( 1, m ), when SIDE = 'R' or 'r' then LDA must be at least

max( 1, n ). Unchanged on exit.

B

- DOUBLE PRECISION array of DIMENSION ( LDB, n ).

Before entry, the leading m by n part of the array B must contain the matrix B, and on exit is overwritten by the transformed matrix.

LDB

- INTEGER.

On entry, LDB specifies the first dimension of B as declared in the calling (sub) program. LDB must be at least max( 1, m ). Unchanged on exit.

```

<BLAS 3 dtrmm>≡
(let* ((one 1.0) (zero 0.0))
  (declare (type (double-float 1.0 1.0) one)
            (type (double-float 0.0 0.0) zero))
  (defun dtrmm (side uplo transa diag m n alpha a lda b ldb$)
    (declare (type (simple-array double-float (*)) b a)
              (type (double-float) alpha)
              (type fixnum ldb$ lda n m)
              (type character diag transa uplo side))
    (f2cl-lib:with-multi-array-data
      ((side character side-%data% side-%offset%)
       (uplo character uplo-%data% uplo-%offset%)
       (transa character transa-%data% transa-%offset%)
       (diag character diag-%data% diag-%offset%)
       (a double-float a-%data% a-%offset%)
       (b double-float b-%data% b-%offset%))
      (prog ((temp 0.0) (i 0) (info 0) (j 0) (k 0) (nrowa 0) (lside nil)
              (nunit nil) (upper nil))
        (declare (type (double-float) temp)
                  (type fixnum i info j k nrowa)
                  (type (member t nil) lside nunit upper))
        (setf lside (char-equal side #\L))
        (cond
          (lside
           (setf nrowa m))
          (t
           (setf nrowa n)))
        (setf nunit (char-equal diag #\N))
        (setf upper (char-equal uplo #\U))
        (setf info 0)
        (cond
          ((and (not lside) (not (char-equal side #\R)))
           (setf info 1))
          ((and (not upper) (not (char-equal uplo #\L)))
           (setf info 2))
          ((and (not (char-equal transa #\N))
                 (not (char-equal transa #\T))
                 (not (char-equal transa #\C)))
           (setf info 3))
          ((and (not (char-equal diag #\U)) (not (char-equal diag #\N)))
           (setf info 4))
          ((< m 0)
           (setf info 5))
          ((< n 0)
           (setf info 6))
          ((< lda (max (the fixnum 1) (the fixnum nrowa)))

```

```

      (setf info 9))
      ((< ldb$ (max (the fixnum 1) (the fixnum m)))
       (setf info 11)))
    (cond
      ((/= info 0)
       (error
        " ** On entry to ~a parameter number ~a had an illegal value~%"
        "DTRMM" info)
       (go end_label)))
    (if (= n 0) (go end_label))
    (cond
      ((= alpha zero)
       (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                     (> j n) nil)
       (tagbody
        (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                      (> i m) nil)
        (tagbody
         (setf (f2cl-lib:fref b-%data%
                              (i j)
                              ((1 ldb$) (1 *))
                              b-%offset%)
                zero))))))
      (go end_label)))
    (cond
      (lside
       (cond
         ((char-equal transa #\N)
          (cond
            (upper
             (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                           (> j n) nil)
             (tagbody
              (f2cl-lib:fdo (k 1 (f2cl-lib:int-add k 1))
                            (> k m) nil)
              (tagbody
               (cond
                 ((/= (f2cl-lib:fref b (k j) ((1 ldb$) (1 *))) zero)
                  (setf temp
                       (* alpha
                          (f2cl-lib:fref b-%data%
                                           (k j)
                                           ((1 ldb$) (1 *))
                                           b-%offset%)))
                 (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                               (> i

```

```

                                (f2cl-lib:int-add k
                                (f2cl-lib:int-sub
                                1)))
                                nil)
    (tagbody
      (setf (f2cl-lib:fref b-%data%
                          (i j)
                          ((1 ldb$) (1 *)))
            b-%offset%)
      (+
        (f2cl-lib:fref b-%data%
                      (i j)
                      ((1 ldb$) (1 *)))
        b-%offset%)
      (* temp
        (f2cl-lib:fref a-%data%
                      (i k)
                      ((1 lda) (1 *)))
        a-%offset%))))))
    (if nounit
      (setf temp
        (* temp
          (f2cl-lib:fref a-%data%
                        (k k)
                        ((1 lda) (1 *)))
          a-%offset%))))
    (setf (f2cl-lib:fref b-%data%
                      (k j)
                      ((1 ldb$) (1 *)))
          b-%offset%)
      temp))))))
  (t
    (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
      (> j n) nil)
    (tagbody
      (f2cl-lib:fdo (k m
                    (f2cl-lib:int-add k (f2cl-lib:int-sub 1)))
        (> k 1) nil)
      (tagbody
        (cond
          ((/= (f2cl-lib:fref b (k j) ((1 ldb$) (1 *))) zero)
            (setf temp
              (* alpha
                (f2cl-lib:fref b-%data%
                              (k j)
                              ((1 ldb$) (1 *)))

```



```

                                b-%offset%)))
(setf (f2cl-lib:fref b-%data%
                    (k j)
                    ((1 ldb$) (1 *))
                    b-%offset%))

    temp)
(if nounit
  (setf (f2cl-lib:fref b-%data%
                    (k j)
                    ((1 ldb$) (1 *))
                    b-%offset%))

    (*
      (f2cl-lib:fref b-%data%
                    (k j)
                    ((1 ldb$) (1 *))
                    b-%offset%)
      (f2cl-lib:fref a-%data%
                    (k k)
                    ((1 lda) (1 *))
                    a-%offset%))))
(f2cl-lib:fdo (i (f2cl-lib:int-add k 1)
              (f2cl-lib:int-add i 1))
              ((> i m) nil)
  (tagbody
    (setf (f2cl-lib:fref b-%data%
                    (i j)
                    ((1 ldb$) (1 *))
                    b-%offset%))

        (+
          (f2cl-lib:fref b-%data%
                    (i j)
                    ((1 ldb$) (1 *))
                    b-%offset%)

          (* temp
            (f2cl-lib:fref a-%data%
                    (i k)
                    ((1 lda) (1 *))
                    a-%offset%)))))))))

(t
  (cond
    (upper
      (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                    ((> j n) nil)
        (tagbody
          (f2cl-lib:fdo (i m
                        (f2cl-lib:int-add i (f2cl-lib:int-sub 1)))

```

```

                                (> i 1) nil)
(tagbody
  (setf temp
    (f2cl-lib:fref b-%data%
      (i j)
      ((1 ldb$) (1 *))
      b-%offset%))

  (if nunit
    (setf temp
      (* temp
        (f2cl-lib:fref a-%data%
          (i i)
          ((1 lda) (1 *))
          a-%offset%))))
    (f2cl-lib:fdo (k 1 (f2cl-lib:int-add k 1))
      (> k
        (f2cl-lib:int-add i
          (f2cl-lib:int-sub
            1)))

      nil)
    (tagbody
      (setf temp
        (+ temp
          (*
            (f2cl-lib:fref a-%data%
              (k i)
              ((1 lda) (1 *))
              a-%offset%)
            (f2cl-lib:fref b-%data%
              (k j)
              ((1 ldb$) (1 *))
              b-%offset%))))))
      (setf (f2cl-lib:fref b-%data%
        (i j)
        ((1 ldb$) (1 *))
        b-%offset%)
        (* alpha temp))))))
(t
  (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
    (> j n) nil)
  (tagbody
    (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
      (> i m) nil)
    (tagbody
      (setf temp
        (f2cl-lib:fref b-%data%
          (i j)
          ((1 ldb$) (1 *))
          b-%offset%)
          (* alpha temp))))))

```

```

                                (i j)
                                ((1 ldb$) (1 *))
                                b-%offset%)
(if nunit
  (setf temp
    (* temp
      (f2cl-lib:fref a-%data%
        (i i)
        ((1 lda) (1 *))
        a-%offset%))))
(f2cl-lib:fdo (k (f2cl-lib:int-add i 1)
  (f2cl-lib:int-add k 1))
  (> k m) nil)
(tagbody
  (setf temp
    (+ temp
      (*
        (f2cl-lib:fref a-%data%
          (k i)
          ((1 lda) (1 *))
          a-%offset%)
        (f2cl-lib:fref b-%data%
          (k j)
          ((1 ldb$) (1 *))
          b-%offset%))))))
(setf (f2cl-lib:fref b-%data%
  (i j)
  ((1 ldb$) (1 *))
  b-%offset%)
  (* alpha temp))))))
(t
  (cond
    ((char-equal transa #\N)
      (cond
        (upper
          (f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
            (> j 1) nil)
          (tagbody
            (setf temp alpha)
            (if nunit
              (setf temp
                (* temp
                  (f2cl-lib:fref a-%data%
                    (j j)
                    ((1 lda) (1 *))
                    a-%offset%))))

```

```

(f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
  (> i m) nil)
(tagbody
  (setf (f2cl-lib:fref b-%data%
    (i j)
    ((1 ldb$) (1 *)))
    b-%offset%)
    (* temp
      (f2cl-lib:fref b-%data%
        (i j)
        ((1 ldb$) (1 *)))
        b-%offset%))))
(f2cl-lib:fdo (k 1 (f2cl-lib:int-add k 1))
  (> k
    (f2cl-lib:int-add j
      (f2cl-lib:int-sub 1)))
  nil)
(tagbody
  (cond
    ((/= (f2cl-lib:fref a (k j) ((1 lda) (1 *))) zero)
      (setf temp
        (* alpha
          (f2cl-lib:fref a-%data%
            (k j)
            ((1 lda) (1 *)))
            a-%offset%)))
    (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
      (> i m) nil)
    (tagbody
      (setf (f2cl-lib:fref b-%data%
        (i j)
        ((1 ldb$) (1 *)))
        b-%offset%)
        (+
          (f2cl-lib:fref b-%data%
            (i j)
            ((1 ldb$) (1 *)))
            b-%offset%)
          (* temp
            (f2cl-lib:fref b-%data%
              (i k)
              ((1 ldb$) (1 *)))
              b-%offset%))))))))))
(t
  (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
    (> j n) nil)

```

```

(tagbody
  (setf temp alpha)
  (if nunit
    (setf temp
      (* temp
        (f2cl-lib:fref a-%data%
          (j j)
          ((1 lda) (1 *))
          a-%offset%))))
    (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
      (> i m) nil)
    (tagbody
      (setf (f2cl-lib:fref b-%data%
        (i j)
        ((1 ldb$) (1 *))
        b-%offset%)
        (* temp
          (f2cl-lib:fref b-%data%
            (i j)
            ((1 ldb$) (1 *))
            b-%offset%))))
      (f2cl-lib:fdo (k (f2cl-lib:int-add j 1)
        (f2cl-lib:int-add k 1))
        (> k n) nil)
      (tagbody
        (cond
          ((/= (f2cl-lib:fref a (k j) ((1 lda) (1 *))) zero)
            (setf temp
              (* alpha
                (f2cl-lib:fref a-%data%
                  (k j)
                  ((1 lda) (1 *))
                  a-%offset%))))
            (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
              (> i m) nil)
            (tagbody
              (setf (f2cl-lib:fref b-%data%
                (i j)
                ((1 ldb$) (1 *))
                b-%offset%)
                (+
                  (f2cl-lib:fref b-%data%
                    (i j)
                    ((1 ldb$) (1 *))
                    b-%offset%)
                  (* temp

```

```

(f2cl-lib:fref b-%data%
  (i k)
  ((1 ldb$) (1 *))
  b-%offset%)))))))))))))

(t
  (cond
    (upper
      (f2cl-lib:fdo (k 1 (f2cl-lib:int-add k 1))
        (> k n) nil)
      (tagbody
        (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
          (> j
            (f2cl-lib:int-add k
              (f2cl-lib:int-sub 1)))
          nil)
        (tagbody
          (cond
            ((/= (f2cl-lib:fref a (j k) ((1 lda) (1 *))) zero)
              (setf temp
                (* alpha
                  (f2cl-lib:fref a-%data%
                    (j k)
                    ((1 lda) (1 *))
                    a-%offset%)))
              (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                (> i m) nil)
              (tagbody
                (setf (f2cl-lib:fref b-%data%
                  (i j)
                  ((1 ldb$) (1 *))
                  b-%offset%)
                  (+
                    (f2cl-lib:fref b-%data%
                      (i j)
                      ((1 ldb$) (1 *))
                      b-%offset%)
                    (* temp
                      (f2cl-lib:fref b-%data%
                        (i k)
                        ((1 ldb$) (1 *))
                        b-%offset%))))))))))
              (setf temp alpha)
            (if nunit
              (setf temp
                (* temp
                  (f2cl-lib:fref a-%data%
                    (i k)
                    ((1 lda) (1 *))
                    a-%offset%))))))))))

```

```

(k k)
((1 lda) (1 *))
a-%offset%)))
(cond
  (/= temp one)
  (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
    (> i m) nil)
  (tagbody
    (setf (f2cl-lib:fref b-%data%
      (i k)
      ((1 ldb$) (1 *))
      b-%offset%))
      (* temp
        (f2cl-lib:fref b-%data%
          (i k)
          ((1 ldb$) (1 *))
          b-%offset%))))))
(t
  (f2cl-lib:fdo (k n (f2cl-lib:int-add k (f2cl-lib:int-sub 1)))
    (> k 1) nil)
  (tagbody
    (f2cl-lib:fdo (j (f2cl-lib:int-add k 1)
      (f2cl-lib:int-add j 1))
      (> j n) nil)
    (tagbody
      (cond
        (/= (f2cl-lib:fref a (j k) ((1 lda) (1 *))) zero)
        (setf temp
          (* alpha
            (f2cl-lib:fref a-%data%
              (j k)
              ((1 lda) (1 *))
              a-%offset%)))
          (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
            (> i m) nil)
            (tagbody
              (setf (f2cl-lib:fref b-%data%
                (i j)
                ((1 ldb$) (1 *))
                b-%offset%))
                (+
                  (f2cl-lib:fref b-%data%
                    (i j)
                    ((1 ldb$) (1 *))
                    b-%offset%))
                  (* temp

```

```

                                (f2cl-lib:fref b-%data%
                                (i k)
                                ((1 ldb$) (1 *))
                                b-%offset%)))))))))
(setf temp alpha)
(if nunit
  (setf temp
    (* temp
      (f2cl-lib:fref a-%data%
        (k k)
        ((1 lda) (1 *))
        a-%offset%))))))
(cond
  ((/= temp one)
    (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
      (> i m) nil)
    (tagbody
      (setf (f2cl-lib:fref b-%data%
        (i k)
        ((1 ldb$) (1 *))
        b-%offset%)
        (* temp
          (f2cl-lib:fref b-%data%
            (i k)
            ((1 ldb$) (1 *))
            b-%offset%)))))))))
end_label
(return (values nil nil nil nil nil nil nil nil nil nil))

```

## 6.6 dtrsm BLAS

```

<dtrsm.input>≡
)set break resume
)sys rm -f dtrsm.output
)spool dtrsm.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)

```



`<dtrsm.help>`≡

```
=====
dtrsm examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

DTRSM - solve one of the matrix equations  $\text{op}(A) * X = \alpha * B$ , or  $X * \text{op}(A) = \alpha * B$ ,

#### SYNOPSIS

```
SUBROUTINE DTRSM ( SIDE, UPLO, TRANSA, DIAG, M, N, ALPHA, A,
                  LDA, B, LDB )
```

```
CHARACTER*1 SIDE, UPLO, TRANSA, DIAG
```

```
INTEGER      M, N, LDA, LDB
```

```
DOUBLE       PRECISION ALPHA
```

```
DOUBLE       PRECISION A( LDA, * ), B( LDB, * )
```

#### PURPOSE

DTRSM solves one of the matrix equations

where alpha is a scalar, X and B are m by n matrices, A is a unit, or non-unit, upper or lower triangular matrix and  $\text{op}(A)$  is one of

$\text{op}(A) = A$  or  $\text{op}(A) = A'$ .

The matrix X is overwritten on B.

#### PARAMETERS

SIDE - CHARACTER\*1.

On entry, SIDE specifies whether  $\text{op}(A)$  appears on the left or right of X as follows:

SIDE = 'L' or 'l'  $\text{op}(A) * X = \alpha * B$ .

SIDE = 'R' or 'r'  $X * \text{op}(A) = \alpha * B$ .

Unchanged on exit.

UPLO - CHARACTER\*1.

On entry, UPLO specifies whether the matrix A is an upper or lower triangular matrix as follows:

UPLO = 'U' or 'u' A is an upper triangular matrix.

UPLO = 'L' or 'l' A is a lower triangular matrix.

Unchanged on exit.

TRANSA - CHARACTER\*1. On entry, TRANSA specifies the form of  $op(A)$  to be used in the matrix multiplication as follows:

TRANSA = 'N' or 'n'  $op(A) = A$ .

TRANSA = 'T' or 't'  $op(A) = A'$ .

TRANSA = 'C' or 'c'  $op(A) = A'$ .

Unchanged on exit.

DIAG - CHARACTER\*1.

On entry, DIAG specifies whether or not A is unit triangular as follows:

DIAG = 'U' or 'u' A is assumed to be unit triangular.

DIAG = 'N' or 'n' A is not assumed to be unit triangular.

Unchanged on exit.

M - INTEGER.

On entry, M specifies the number of rows of B. M must be at least zero. Unchanged on exit.

N - INTEGER.

On entry, N specifies the number of columns of B. N must be at least zero. Unchanged on exit.

ALPHA - DOUBLE PRECISION.

On entry, ALPHA specifies the scalar alpha. When alpha is zero then A is not referenced and B need

not be set before entry. Unchanged on exit.

is m

A

-

DOUBLE PRECISION array of DIMENSION ( LDA, k ), where k when SIDE = 'L' or 'l' and is n when SIDE = 'R' or 'r'. Before entry with UPLO = 'U' or 'u', the leading k by k upper triangular part of the array A must contain the upper triangular matrix and the strictly lower triangular part of A is not referenced. Before entry with UPLO = 'L' or 'l', the leading k by k lower triangular part of the array A must contain the lower triangular matrix and the strictly upper triangular part of A is not referenced. Note that when DIAG = 'U' or 'u', the diagonal elements of A are not referenced either, but are assumed to be unity. Unchanged on exit.

LDA

- INTEGER.

On entry, LDA specifies the first dimension of A as declared in the calling (sub) program. When SIDE =

'L' or 'l' then LDA must be at least  $\max(1, m)$ , when SIDE = 'R' or 'r' then LDA must be at least  $\max(1, n)$ . Unchanged on exit.

B

- DOUBLE PRECISION array of DIMENSION ( LDB, n ).

Before entry, the leading m by n part of the array B must contain the right-hand side matrix B, and on exit is overwritten by the solution matrix X.

LDB

- INTEGER.

On entry, LDB specifies the first dimension of B as declared in the calling (sub) program. LDB must be at least  $\max(1, m)$ . Unchanged on exit.

```

(BLAS 3 dtrsm)≡
(let* ((one 1.0) (zero 0.0))
  (declare (type (double-float 1.0 1.0) one)
            (type (double-float 0.0 0.0) zero))
  (defun dtrsm (side uplo transa diag m n alpha a lda b ldb$)
    (declare (type (simple-array double-float (*)) b a)
              (type (double-float) alpha)
              (type fixnum ldb$ lda n m)
              (type character diag transa uplo side))
    (f2cl-lib:with-multi-array-data
      ((side character side-%data% side-%offset%)
       (uplo character uplo-%data% uplo-%offset%)
       (transa character transa-%data% transa-%offset%)
       (diag character diag-%data% diag-%offset%)
       (a double-float a-%data% a-%offset%)
       (b double-float b-%data% b-%offset%))
      (prog ((temp 0.0) (i 0) (info 0) (j 0) (k 0) (nrowa 0) (lside nil)
             (nunit nil) (upper nil))
        (declare (type (double-float) temp)
                  (type fixnum i info j k nrowa)
                  (type (member t nil) lside nunit upper))
        (setf lside (char-equal side #\L))
        (cond
          (lside
           (setf nrowa m))
          (t
           (setf nrowa n)))
        (setf nunit (char-equal diag #\N))
        (setf upper (char-equal uplo #\U))
        (setf info 0)
        (cond
          ((and (not lside) (not (char-equal side #\R)))
           (setf info 1))
          ((and (not upper) (not (char-equal uplo #\L)))
           (setf info 2))
          ((and (not (char-equal transa #\N))
                 (not (char-equal transa #\T))
                 (not (char-equal transa #\C)))
           (setf info 3))
          ((and (not (char-equal diag #\U)) (not (char-equal diag #\N)))
           (setf info 4))
          ((< m 0)
           (setf info 5))
          ((< n 0)
           (setf info 6))
          ((< lda (max (the fixnum 1) (the fixnum nrowa)))

```

```

(setf info 9))
((< ldb$ (max (the fixnum 1) (the fixnum m)))
 (setf info 11)))
(cond
  ((/= info 0)
   (error
    " ** On entry to ~a parameter number ~a had an illegal value~%"
    "DTRSM" info)
   (go end_label)))
(if (= n 0) (go end_label))
(cond
  ((= alpha zero)
   (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                  (> j n) nil)
   (tagbody
    (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                  (> i m) nil)
    (tagbody
     (setf (f2cl-lib:fref b-%data%
                          (i j)
                          ((1 ldb$) (1 *))
                          b-%offset%)
            zero))))))
   (go end_label)))
(cond
  (lside
   (cond
    ((char-equal transa #\N)
     (cond
      (upper
       (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                      (> j n) nil)
       (tagbody
        (cond
         ((/= alpha one)
          (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                        (> i m) nil)
          (tagbody
           (setf (f2cl-lib:fref b-%data%
                                (i j)
                                ((1 ldb$) (1 *))
                                b-%offset%)
                  (* alpha
                    (f2cl-lib:fref b-%data%
                                    (i j)
                                    ((1 ldb$) (1 *))

```

```

                                b-%offset%))))))
(f2cl-lib:fdo (k m
              (f2cl-lib:int-add k (f2cl-lib:int-sub 1)))
              (> k 1) nil)
(tagbody
 (cond
  ((/= (f2cl-lib:fref b (k j) ((1 ldb$) (1 *))) zero)
   (if nunit
      (setf (f2cl-lib:fref b-%data%
                          (k j)
                          ((1 ldb$) (1 *))
                          b-%offset%)
            (/
             (f2cl-lib:fref b-%data%
                           (k j)
                           ((1 ldb$) (1 *))
                           b-%offset%)
             (f2cl-lib:fref a-%data%
                           (k k)
                           ((1 lda) (1 *))
                           a-%offset%))))
      (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                    (> i
                     (f2cl-lib:int-add k
                                     (f2cl-lib:int-sub
                                      1)))
                    nil)
      (tagbody
       (setf (f2cl-lib:fref b-%data%
                           (i j)
                           ((1 ldb$) (1 *))
                           b-%offset%)
             (-
              (f2cl-lib:fref b-%data%
                            (i j)
                            ((1 ldb$) (1 *))
                            b-%offset%)
              (*
               (f2cl-lib:fref b-%data%
                             (k j)
                             ((1 ldb$) (1 *))
                             b-%offset%)
               (f2cl-lib:fref a-%data%
                             (i k)
                             ((1 lda) (1 *))
                             a-%offset%))))))))))

```

```
(t
(f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
  (> j n) nil)
(tagbody
  (cond
    ((/= alpha one)
      (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
        (> i m) nil)
      (tagbody
        (setf (f2cl-lib:fref b-%data%
                              (i j)
                              ((1 ldb$) (1 *)))
              b-%offset%)
          (* alpha
            (f2cl-lib:fref b-%data%
                          (i j)
                          ((1 ldb$) (1 *)))
              b-%offset%))))))
(f2cl-lib:fdo (k 1 (f2cl-lib:int-add k 1))
  (> k m) nil)
(tagbody
  (cond
    ((/= (f2cl-lib:fref b (k j) ((1 ldb$) (1 *))) zero)
      (if nunit
        (setf (f2cl-lib:fref b-%data%
                              (k j)
                              ((1 ldb$) (1 *)))
              b-%offset%)
          (/
            (f2cl-lib:fref b-%data%
                          (k j)
                          ((1 ldb$) (1 *)))
              b-%offset%)
            (f2cl-lib:fref a-%data%
                          (k k)
                          ((1 lda) (1 *)))
              a-%offset%))))
    (f2cl-lib:fdo (i (f2cl-lib:int-add k 1)
                    (f2cl-lib:int-add i 1))
      (> i m) nil)
    (tagbody
      (setf (f2cl-lib:fref b-%data%
                          (i j)
                          ((1 ldb$) (1 *)))
          b-%offset%)
          (-
```

```

(f2cl-lib:fref b-%data%
  (i j)
  ((1 ldb$) (1 *)))
b-%offset%)

(*
  (f2cl-lib:fref b-%data%
    (k j)
    ((1 ldb$) (1 *)))
    b-%offset%)
  (f2cl-lib:fref a-%data%
    (i k)
    ((1 lda) (1 *)))
    a-%offset%)))))))))))))

(t
  (cond
    (upper
      (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
        (> j n) nil)
      (tagbody
        (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
          (> i m) nil)
          (tagbody
            (setf temp
              (* alpha
                (f2cl-lib:fref b-%data%
                  (i j)
                  ((1 ldb$) (1 *)))
                  b-%offset%)))
              (f2cl-lib:fdo (k 1 (f2cl-lib:int-add k 1))
                (> k
                  (f2cl-lib:int-add i
                    (f2cl-lib:int-sub
                      1)))
                  nil)
                (tagbody
                  (setf temp
                    (- temp
                      (*
                        (f2cl-lib:fref a-%data%
                          (k i)
                          ((1 lda) (1 *)))
                          a-%offset%)
                        (f2cl-lib:fref b-%data%
                          (k j)
                          ((1 ldb$) (1 *)))
                          b-%offset%))))))

```



```

      (if nounit
        (setf temp
          (/ temp
            (f2cl-lib:fref a-%data%
              (i i)
              ((1 lda) (1 *))
              a-%offset%))))
        (setf (f2cl-lib:fref b-%data%
          (i j)
          ((1 ldb$) (1 *))
          b-%offset%)
          temp))))))
(t
 (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
  ((> j n) nil)
  (tagbody
   (f2cl-lib:fdo (i m
     (f2cl-lib:int-add i (f2cl-lib:int-sub 1)))
    ((> i 1) nil)
    (tagbody
     (setf temp
       (* alpha
         (f2cl-lib:fref b-%data%
           (i j)
           ((1 ldb$) (1 *))
           b-%offset%)))
      (f2cl-lib:fdo (k (f2cl-lib:int-add i 1)
        (f2cl-lib:int-add k 1))
        ((> k m) nil)
        (tagbody
         (setf temp
           (- temp
             (*
              (f2cl-lib:fref a-%data%
                (k i)
                ((1 lda) (1 *))
                a-%offset%)
              (f2cl-lib:fref b-%data%
                (k j)
                ((1 ldb$) (1 *))
                b-%offset%))))))
      (if nounit
        (setf temp
          (/ temp
            (f2cl-lib:fref a-%data%
              (i i)

```

```

((1 lda) (1 *))
a-%offset%)))
(setf (f2cl-lib:fref b-%data%
                    (i j)
                    ((1 ldb$) (1 *))
                    b-%offset%)
      temp)))))))))
(t
 (cond
  ((char-equal transa #\N)
   (cond
    (upper
     (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                   ((> j n) nil)
     (tagbody
      (cond
       ((/= alpha one)
        (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                      ((> i m) nil)
        (tagbody
         (setf (f2cl-lib:fref b-%data%
                             (i j)
                             ((1 ldb$) (1 *))
                             b-%offset%)
               (* alpha
                 (f2cl-lib:fref b-%data%
                             (i j)
                             ((1 ldb$) (1 *))
                             b-%offset%))))))
        (f2cl-lib:fdo (k 1 (f2cl-lib:int-add k 1))
                      ((> k
                        (f2cl-lib:int-add j
                          (f2cl-lib:int-sub 1)))
                      nil)
        (tagbody
         (cond
          ((/= (f2cl-lib:fref a (k j) ((1 lda) (1 *))) zero)
           (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                         ((> i m) nil)
           (tagbody
            (setf (f2cl-lib:fref b-%data%
                                (i j)
                                ((1 ldb$) (1 *))
                                b-%offset%)
                  (-
                   (f2cl-lib:fref b-%data%

```

```

                                (i j)
                                ((1 ldb$) (1 *))
                                b-%offset%)
(*
  (f2cl-lib:fref a-%data%
    (k j)
    ((1 lda) (1 *))
    a-%offset%)
  (f2cl-lib:fref b-%data%
    (i k)
    ((1 ldb$) (1 *))
    b-%offset%)))))))))
(cond
  (nunit
    (setf temp
      (/ one
        (f2cl-lib:fref a-%data%
          (j j)
          ((1 lda) (1 *))
          a-%offset%)))
      (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
        (> i m) nil)
      (tagbody
        (setf (f2cl-lib:fref b-%data%
          (i j)
          ((1 ldb$) (1 *))
          b-%offset%)
          (* temp
            (f2cl-lib:fref b-%data%
              (i j)
              ((1 ldb$) (1 *))
              b-%offset%)))))))))
(t
  (f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
    (> j 1) nil)
  (tagbody
    (cond
      ((/= alpha one)
        (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
          (> i m) nil)
        (tagbody
          (setf (f2cl-lib:fref b-%data%
            (i j)
            ((1 ldb$) (1 *))
            b-%offset%)
            (* alpha

```

```

(f2cl-lib:fref b-%data%
  (i j)
  ((1 ldb$) (1 *))
  b-%offset%))))))
(f2cl-lib:fdo (k (f2cl-lib:int-add j 1)
  (f2cl-lib:int-add k 1))
  (> k n) nil)
(tagbody
  (cond
    ((/= (f2cl-lib:fref a (k j) ((1 lda) (1 *))) zero)
      (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
        (> i m) nil)
      (tagbody
        (setf (f2cl-lib:fref b-%data%
          (i j)
          ((1 ldb$) (1 *))
          b-%offset%)
          (-
            (f2cl-lib:fref b-%data%
              (i j)
              ((1 ldb$) (1 *))
              b-%offset%)
            (*
              (f2cl-lib:fref a-%data%
                (k j)
                ((1 lda) (1 *))
                a-%offset%)
              (f2cl-lib:fref b-%data%
                (i k)
                ((1 ldb$) (1 *))
                b-%offset%))))))))))
(cond
  (nounit
    (setf temp
      (/ one
        (f2cl-lib:fref a-%data%
          (j j)
          ((1 lda) (1 *))
          a-%offset%)))
    (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
      (> i m) nil)
    (tagbody
      (setf (f2cl-lib:fref b-%data%
        (i j)
        ((1 ldb$) (1 *))
        b-%offset%)

```

```

(* temp
  (f2cl-lib:fref b-%data%
    (i j)
    ((1 ldb$) (1 *)))
  b-%offset%))))))))))

(t
  (cond
    (upper
      (f2cl-lib:fdo (k n (f2cl-lib:int-add k (f2cl-lib:int-sub 1)))
        ((> k 1) nil)
        (tagbody
          (cond
            (nunit
              (setf temp
                (/ one
                  (f2cl-lib:fref a-%data%
                    (k k)
                    ((1 lda) (1 *)))
                    a-%offset%)))
              (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                ((> i m) nil)
                (tagbody
                  (setf (f2cl-lib:fref b-%data%
                    (i k)
                    ((1 ldb$) (1 *)))
                    b-%offset%)
                    (* temp
                      (f2cl-lib:fref b-%data%
                        (i k)
                        ((1 ldb$) (1 *)))
                        b-%offset%))))))
              (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                ((> j
                  (f2cl-lib:int-add k
                    (f2cl-lib:int-sub 1)))
                  nil)
                (tagbody
                  (cond
                    ((/= (f2cl-lib:fref a (j k) ((1 lda) (1 *))) zero)
                     (setf temp
                       (f2cl-lib:fref a-%data%
                        (j k)
                        ((1 lda) (1 *)))
                        a-%offset%)))
                    (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                      ((> i m) nil)

```

```

        (tagbody
          (setf (f2cl-lib:fref b-%data%
                               (i j)
                               ((1 ldb$) (1 *))
                               b-%offset%))
            (-
              (f2cl-lib:fref b-%data%
                             (i j)
                             ((1 ldb$) (1 *))
                             b-%offset%)
              (* temp
                (f2cl-lib:fref b-%data%
                               (i k)
                               ((1 ldb$) (1 *))
                               b-%offset%)))))))))
    (cond
      ((/= alpha one)
       (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                     (> i m) nil)
       (tagbody
         (setf (f2cl-lib:fref b-%data%
                              (i k)
                              ((1 ldb$) (1 *))
                              b-%offset%))
           (* alpha
             (f2cl-lib:fref b-%data%
                            (i k)
                            ((1 ldb$) (1 *))
                            b-%offset%)))))))))
  (t
   (f2cl-lib:fdo (k 1 (f2cl-lib:int-add k 1))
                 (> k n) nil)
   (tagbody
     (cond
       (nunit
        (setf temp
              (/ one
                 (f2cl-lib:fref a-%data%
                                (k k)
                                ((1 lda) (1 *))
                                a-%offset%)))
         (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                       (> i m) nil)
         (tagbody
           (setf (f2cl-lib:fref b-%data%
                               (i k)
                               ((1 ldb$) (1 *))
                               b-%offset%))
             (* alpha
               (f2cl-lib:fref a-%data%
                              (k k)
                              ((1 lda) (1 *))
                              a-%offset%)))))))))

```

```

((1 ldb$) (1 *))
b-%offset%)

(* temp
  (f2cl-lib:fref b-%data%
    (i k)
    ((1 ldb$) (1 *))
    b-%offset%))))))
(f2cl-lib:fdo (j (f2cl-lib:int-add k 1)
  (f2cl-lib:int-add j 1))
  (> j n) nil)

(tagbody
  (cond
    ((/= (f2cl-lib:fref a (j k) ((1 lda) (1 *))) zero)
      (setf temp
        (f2cl-lib:fref a-%data%
          (j k)
          ((1 lda) (1 *))
          a-%offset%))
        (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
          (> i m) nil)
        (tagbody
          (setf (f2cl-lib:fref b-%data%
            (i j)
            ((1 ldb$) (1 *))
            b-%offset%)
              (-
                (f2cl-lib:fref b-%data%
                  (i j)
                  ((1 ldb$) (1 *))
                  b-%offset%)
                (* temp
                  (f2cl-lib:fref b-%data%
                    (i k)
                    ((1 ldb$) (1 *))
                    b-%offset%))))))))))
    (cond
      ((/= alpha one)
        (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
          (> i m) nil)
        (tagbody
          (setf (f2cl-lib:fref b-%data%
            (i k)
            ((1 ldb$) (1 *))
            b-%offset%)
              (* alpha
                (f2cl-lib:fref b-%data%
                  (i j)
                  ((1 ldb$) (1 *))
                  b-%offset%))))))))))
  )
)

```

```

                                (i k)
                                ((1 ldb$) (1 *))
                                b-%offset%)))))))))))))
end_label
      (return (values nil nil nil nil nil nil nil nil nil nil nil)))))

```

## 6.7 zgemm BLAS

```

⟨zgemm.input⟩≡
)set break resume
)sys rm -f zgemm.output
)spool zgemm.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)

```



`<zgemm.help>`≡

```
=====
zgemm examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

ZGEMM - perform one of the matrix-matrix operations  $C := \alpha * \text{op}(A) * \text{op}(B) + \beta * C$ ,

#### SYNOPSIS

SUBROUTINE ZGEMM ( TRANSA, TRANSB, M, N, K, ALPHA, A, LDA,  
B, LDB, BETA, C, LDC )

CHARACTER\*1 TRANSA, TRANSB

INTEGER M, N, K, LDA, LDB, LDC

COMPLEX\*16 ALPHA, BETA

COMPLEX\*16 A( LDA, \* ), B( LDB, \* ), C( LDC, \* )

#### PURPOSE

ZGEMM performs one of the matrix-matrix operations

where  $\text{op}(X)$  is one of

$\text{op}(X) = X$  or  $\text{op}(X) = X'$  or  $\text{op}(X) = \text{conjg}(X')$ ,

alpha and beta are scalars, and A, B and C are matrices,  
with  $\text{op}(A)$  an m by k matrix,  $\text{op}(B)$  a k by n matrix  
and C an m by n matrix.

#### PARAMETERS

TRANSA - CHARACTER\*1. On entry, TRANSA specifies the form  
of  $\text{op}(A)$  to be used in the matrix multiplication as fol-  
lows:

TRANSA = 'N' or 'n',  $\text{op}(A) = A$ .

TRANSA = 'T' or 't',  $\text{op}(A) = A'$ .

TRANSA = 'C' or 'c', op( A ) = conjg( A' ).

Unchanged on exit.

TRANSB - CHARACTER\*1. On entry, TRANSB specifies the form of op( B ) to be used in the matrix multiplication as follows:

TRANSB = 'N' or 'n', op( B ) = B.

TRANSB = 'T' or 't', op( B ) = B'.

TRANSB = 'C' or 'c', op( B ) = conjg( B' ).

Unchanged on exit.

M - INTEGER.  
On entry, M specifies the number of rows of the matrix op( A ) and of the matrix C. M must be at least zero. Unchanged on exit.

N - INTEGER.  
On entry, N specifies the number of columns of the matrix op( B ) and the number of columns of the matrix C. N must be at least zero. Unchanged on exit.

K - INTEGER.  
On entry, K specifies the number of columns of the matrix op( A ) and the number of rows of the matrix op( B ). K must be at least zero. Unchanged on exit.

ALPHA - COMPLEX\*16 .  
On entry, ALPHA specifies the scalar alpha.  
Unchanged on exit.

ka is

A -  
COMPLEX\*16 array of DIMENSION ( LDA, ka ), where k when TRANSA = 'N' or 'n', and is m otherwise. Before entry with TRANSA = 'N' or 'n', the leading m by k part of the array A must contain the matrix A, otherwise the leading k by m part of the array A must contain the matrix A. Unchanged on exit.

LDA - INTEGER.  
 On entry, LDA specifies the first dimension of A as declared in the calling (sub) program. When TRANSA = 'N' or 'n' then LDA must be at least  $\max(1, m)$ , otherwise LDA must be at least  $\max(1, k)$ . Unchanged on exit.

kb is  
 B -  
 COMPLEX\*16 array of DIMENSION ( LDB, kb ), where n when TRANSB = 'N' or 'n', and is k otherwise. Before entry with TRANSB = 'N' or 'n', the leading k by n part of the array B must contain the matrix B, otherwise the leading n by k part of the array B must contain the matrix B. Unchanged on exit.

LDB - INTEGER.  
 On entry, LDB specifies the first dimension of B as declared in the calling (sub) program. When TRANSB = 'N' or 'n' then LDB must be at least  $\max(1, k)$ , otherwise LDB must be at least  $\max(1, n)$ . Unchanged on exit.

BETA - COMPLEX\*16 .  
 On entry, BETA specifies the scalar beta. When BETA is supplied as zero then C need not be set on input. Unchanged on exit.

C - COMPLEX\*16 array of DIMENSION ( LDC, n ).  
 Before entry, the leading m by n part of the array C must contain the matrix C, except when beta is zero, in which case C need not be set on entry. On exit, the array C is overwritten by the m by n matrix (  $\alpha * \text{op}(A) * \text{op}(B) + \text{beta} * C$  ).

LDC - INTEGER.  
 On entry, LDC specifies the first dimension of C as declared in the calling (sub) program. LDC must be at least  $\max(1, m)$ . Unchanged on exit.

```

<BLAS 3 zgemm>≡
  (let* ((one (complex 1.0 0.0)) (zero (complex 0.0 0.0)))
    (declare (type (complex double-float) one) (type (complex double-float) zero))
    (defun zgemm (transa transb m n k alpha a lda b ldb$ beta c ldc)
      (declare (type (simple-array (complex double-float) (*)) c b a)
        (type (complex double-float) beta alpha)
        (type fixnum ldc ldb$ lda k n m)
        (type character transb transa))
      (f2cl-lib:with-multi-array-data
        ((transa character transa-%data% transa-%offset%)
         (transb character transb-%data% transb-%offset%)
         (a (complex double-float) a-%data% a-%offset%)
         (b (complex double-float) b-%data% b-%offset%)
         (c (complex double-float) c-%data% c-%offset%))
        (prog ((temp #C(0.0 0.0)) (i 0) (info 0) (j 0) (l 0) (ncola 0) (nrowa 0)
              (nrowb 0) (conja nil) (conjb nil) (nota nil) (notb nil))
          (declare (type (complex double-float) temp)
            (type fixnum i info j l ncola nrowa nrowb)
            (type (member t nil) conja conjb nota notb))
          (setf nota (char-equal transa #\N))
          (setf notb (char-equal transb #\N))
          (setf conja (char-equal transa #\C))
          (setf conjb (char-equal transb #\C))
          (cond
            (nota
              (setf nrowa m)
              (setf ncola k))
            (t
              (setf nrowa k)
              (setf ncola m)))
          (cond
            (notb
              (setf nrowb k))
            (t
              (setf nrowb n)))
          (setf info 0)
          (cond
            ((and (not nota) (not conja) (not (char-equal transa #\T))))
              (setf info 1))
            ((and (not notb) (not conjb) (not (char-equal transb #\T))))
              (setf info 2))
            ((< m 0)
              (setf info 3))
            ((< n 0)
              (setf info 4))
            ((< k 0)

```

```

(setf info 5))
((< lda (max (the fixnum 1) (the fixnum nrowa)))
 (setf info 8))
((< ldb$
  (max (the fixnum 1) (the fixnum nrowb)))
 (setf info 10))
((< ldc (max (the fixnum 1) (the fixnum m)))
 (setf info 13)))
(cond
  ((/= info 0)
   (error
    (error
     " ** On entry to ~a parameter number ~a had an illegal value~%"
     "ZGEMM" info)
    (go end_label)))
  (if (or (= m 0) (= n 0) (and (or (= alpha zero) (= k 0)) (= beta one)))
      (go end_label)))
(cond
  ((= alpha zero)
   (cond
    ((= beta zero)
     (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                   ((> j n) nil)
     (tagbody
      (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                    ((> i m) nil)
      (tagbody
       (setf (f2cl-lib:fref c-%data%
                           (i j)
                           ((1 ldc) (1 *))
                           c-%offset%)
              zero))))))
    (t
     (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                   ((> j n) nil)
     (tagbody
      (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                    ((> i m) nil)
      (tagbody
       (setf (f2cl-lib:fref c-%data%
                           (i j)
                           ((1 ldc) (1 *))
                           c-%offset%)
              (* beta
               (f2cl-lib:fref c-%data%
                             (i j)
                             ((1 ldc) (1 *))

```

```

c-%offset%)))))))))
  (go end_label)))
(cond
  (notb
    (cond
      (nota
        (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
          (> j n) nil)
        (tagbody
          (cond
            (= beta zero)
            (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
              (> i m) nil)
            (tagbody
              (setf (f2cl-lib:fref c-%data%
                (i j)
                ((1 ldc) (1 *))
                c-%offset%)
                zero))))
            (/= beta one)
            (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
              (> i m) nil)
            (tagbody
              (setf (f2cl-lib:fref c-%data%
                (i j)
                ((1 ldc) (1 *))
                c-%offset%)
                (* beta
                  (f2cl-lib:fref c-%data%
                    (i j)
                    ((1 ldc) (1 *))
                    c-%offset%)))))))
            (f2cl-lib:fdo (l 1 (f2cl-lib:int-add l 1))
              (> l k) nil)
            (tagbody
              (cond
                (/= (f2cl-lib:fref b (l j) ((1 ldb$) (1 *))) zero)
                (setf temp
                  (* alpha
                    (f2cl-lib:fref b-%data%
                      (l j)
                      ((1 ldb$) (1 *))
                      b-%offset%)))
                (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                  (> i m) nil)
                (tagbody

```

```

(setf (f2cl-lib:fref c-%data%
  (i j)
  ((1 ldc) (1 *))
  c-%offset%))

(+
  (f2cl-lib:fref c-%data%
    (i j)
    ((1 ldc) (1 *))
    c-%offset%))
  (* temp
    (f2cl-lib:fref a-%data%
      (i 1)
      ((1 lda) (1 *))
      a-%offset%)))))))))

(conja
  (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
    ((> j n) nil)
    (tagbody
      (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
        ((> i m) nil)
        (tagbody
          (setf temp zero)
          (f2cl-lib:fdo (l 1 (f2cl-lib:int-add l 1))
            ((> l k) nil)
            (tagbody
              (setf temp
                (+ temp
                  (*
                     (f2cl-lib:dconjg
                       (f2cl-lib:fref a-%data%
                         (l i)
                         ((1 lda) (1 *))
                         a-%offset%))
                     (f2cl-lib:fref b-%data%
                       (l j)
                       ((1 ldb$) (1 *))
                       b-%offset%))))))
              (cond
                ((= beta zero)
                  (setf (f2cl-lib:fref c-%data%
                    (i j)
                    ((1 ldc) (1 *))
                    c-%offset%))
                    (* alpha temp)))
                (t
                  (setf (f2cl-lib:fref c-%data%

```

```

                (i j)
                ((1 ldc) (1 *))
                c-%offset%)
        (+ (* alpha temp)
          (* beta
            (f2cl-lib:fref c-%data%
                           (i j)
                           ((1 ldc) (1 *))
                           c-%offset%)))))))))
(t
 (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
  (> j n) nil)
(tagbody
 (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
  (> i m) nil)
(tagbody
 (setf temp zero)
 (f2cl-lib:fdo (l 1 (f2cl-lib:int-add l 1))
  (> l k) nil)
(tagbody
 (setf temp
  (+ temp
    (*
     (f2cl-lib:fref a-%data%
                     (l i)
                     ((1 lda) (1 *))
                     a-%offset%)
     (f2cl-lib:fref b-%data%
                     (l j)
                     ((1 ldb$) (1 *))
                     b-%offset%))))))
(cond
 ((= beta zero)
  (setf (f2cl-lib:fref c-%data%
                       (i j)
                       ((1 ldc) (1 *))
                       c-%offset%)
    (* alpha temp)))
(t
 (setf (f2cl-lib:fref c-%data%
                       (i j)
                       ((1 ldc) (1 *))
                       c-%offset%)
  (+ (* alpha temp)
    (* beta
      (f2cl-lib:fref c-%data%

```



```

(i j)
((1 ldc) (1 *))
c-%offset%)))))))))))))

(nota
(cond
(conjb
(f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
  (> j n) nil)
(tagbody
(cond
(= beta zero)
(f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
  (> i m) nil)
(tagbody
(setf (f2cl-lib:fref c-%data%
  (i j)
  ((1 ldc) (1 *))
  c-%offset%)
  zero))))
(/= beta one)
(f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
  (> i m) nil)
(tagbody
(setf (f2cl-lib:fref c-%data%
  (i j)
  ((1 ldc) (1 *))
  c-%offset%)
  (* beta
    (f2cl-lib:fref c-%data%
      (i j)
      ((1 ldc) (1 *))
      c-%offset%))))))
(f2cl-lib:fdo (l 1 (f2cl-lib:int-add l 1))
  (> l k) nil)
(tagbody
(cond
(/= (f2cl-lib:fref b (j 1) ((1 ldb$) (1 *))) zero)
(setf temp
  (* alpha
    (f2cl-lib:dconjg
      (f2cl-lib:fref b-%data%
        (j 1)
        ((1 ldb$) (1 *))
        b-%offset%))))
(f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
  (> i m) nil)

```

```

      (tagbody
        (setf (f2cl-lib:fref c-%data%
                          (i j)
                          ((1 ldc) (1 *))
                          c-%offset%)
              (+
                (f2cl-lib:fref c-%data%
                          (i j)
                          ((1 ldc) (1 *))
                          c-%offset%)
                (* temp
                  (f2cl-lib:fref a-%data%
                          (i 1)
                          ((1 lda) (1 *))
                          a-%offset%))))))
(t
 (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
  (> j n) nil)
 (tagbody
  (cond
   ((= beta zero)
    (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
      (> i m) nil)
    (tagbody
      (setf (f2cl-lib:fref c-%data%
                        (i j)
                        ((1 ldc) (1 *))
                        c-%offset%)
              zero))))
   ((/= beta one)
    (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
      (> i m) nil)
    (tagbody
      (setf (f2cl-lib:fref c-%data%
                        (i j)
                        ((1 ldc) (1 *))
                        c-%offset%)
              (* beta
                (f2cl-lib:fref c-%data%
                          (i j)
                          ((1 ldc) (1 *))
                          c-%offset%))))))
 (f2cl-lib:fdo (l 1 (f2cl-lib:int-add l 1))
  (> l k) nil)
 (tagbody
  (cond

```

```

( (/ = (f2cl-lib:fref b (j 1) ((1 ldb$) (1 *))) zero)
  (setf temp
    (* alpha
      (f2cl-lib:fref b-%data%
        (j 1)
        ((1 ldb$) (1 *))
        b-%offset%)))
    (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
      (> i m) nil)
    (tagbody
      (setf (f2cl-lib:fref c-%data%
        (i j)
        ((1 ldc) (1 *))
        c-%offset%))
        (+
          (f2cl-lib:fref c-%data%
            (i j)
            ((1 ldc) (1 *))
            c-%offset%)
          (* temp
            (f2cl-lib:fref a-%data%
              (i 1)
              ((1 lda) (1 *))
              a-%offset%)))))))))
(conja
  (cond
    (conjb
      (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
        (> j n) nil)
      (tagbody
        (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
          (> i m) nil)
        (tagbody
          (setf temp zero)
          (f2cl-lib:fdo (l 1 (f2cl-lib:int-add l 1))
            (> l k) nil)
          (tagbody
            (setf temp
              (+ temp
                (*
                  (f2cl-lib:dconjg
                    (f2cl-lib:fref a-%data%
                      (l i)
                      ((1 lda) (1 *))
                      a-%offset%))
                  (f2cl-lib:dconjg

```

```

(f2cl-lib:fref b-%data%
  (j 1)
  ((1 ldb$) (1 *))
  b-%offset%))))))
(cond
  ((= beta zero)
    (setf (f2cl-lib:fref c-%data%
      (i j)
      ((1 ldc) (1 *))
      c-%offset%)
      (* alpha temp)))
  (t
    (setf (f2cl-lib:fref c-%data%
      (i j)
      ((1 ldc) (1 *))
      c-%offset%)
      (+ (* alpha temp)
        (* beta
          (f2cl-lib:fref c-%data%
            (i j)
            ((1 ldc) (1 *))
            c-%offset%))))))))))
(t
  (f2cl-lib:fd0 (j 1 (f2cl-lib:int-add j 1))
    ((> j n) nil)
  (tagbody
    (f2cl-lib:fd0 (i 1 (f2cl-lib:int-add i 1))
      ((> i m) nil)
    (tagbody
      (setf temp zero)
      (f2cl-lib:fd0 (l 1 (f2cl-lib:int-add l 1))
        ((> l k) nil)
      (tagbody
        (setf temp
          (+ temp
            (*
              (f2cl-lib:dconjg
                (f2cl-lib:fref a-%data%
                  (l i)
                  ((1 lda) (1 *))
                  a-%offset%))
              (f2cl-lib:fref b-%data%
                (j 1)
                ((1 ldb$) (1 *))
                b-%offset%))))))
        (cond

```

```

( (= beta zero)
  (setf (f2cl-lib:fref c-%data%
                     (i j)
                     ((1 ldc) (1 *))
                     c-%offset%)
        (* alpha temp)))
(t
  (setf (f2cl-lib:fref c-%data%
                     (i j)
                     ((1 ldc) (1 *))
                     c-%offset%)
        (+ (* alpha temp)
            (* beta
              (f2cl-lib:fref c-%data%
                             (i j)
                             ((1 ldc) (1 *))
                             c-%offset%)))))))))
(t
  (cond
    (conjb
      (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                    ((> j n) nil)
      (tagbody
        (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                      ((> i m) nil)
        (tagbody
          (setf temp zero)
          (f2cl-lib:fdo (l 1 (f2cl-lib:int-add l 1))
                        ((> l k) nil)
          (tagbody
            (setf temp
                  (+ temp
                    (*
                     (f2cl-lib:fref a-%data%
                                     (l i)
                                     ((1 lda) (1 *))
                                     a-%offset%)
                     (f2cl-lib:dconjg
                      (f2cl-lib:fref b-%data%
                                     (j l)
                                     ((1 ldb$) (1 *))
                                     b-%offset%)))))))))
          (cond
            ((= beta zero)
              (setf (f2cl-lib:fref c-%data%
                                  (i j)

```

```

                                ((1 ldc) (1 *))
                                c-%offset%)
                                (* alpha temp)))
(t
  (setf (f2cl-lib:fref c-%data%
                      (i j)
                      ((1 ldc) (1 *))
                      c-%offset%)
        (+ (* alpha temp)
           (* beta
             (f2cl-lib:fref c-%data%
                           (i j)
                           ((1 ldc) (1 *))
                           c-%offset%)))))))))
(t
  (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                ((> j n) nil)
    (tagbody
      (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                    ((> i m) nil)
        (tagbody
          (setf temp zero)
          (f2cl-lib:fdo (l 1 (f2cl-lib:int-add l 1))
                        ((> l k) nil)
            (tagbody
              (setf temp
                (+ temp
                  (*
                     (f2cl-lib:fref a-%data%
                                     (l i)
                                     ((1 lda) (1 *))
                                     a-%offset%)
                     (f2cl-lib:fref b-%data%
                                     (j l)
                                     ((1 ldb$) (1 *))
                                     b-%offset%))))))
              (cond
                ((= beta zero)
                 (setf (f2cl-lib:fref c-%data%
                                     (i j)
                                     ((1 ldc) (1 *))
                                     c-%offset%)
                       (* alpha temp)))
                (t
                 (setf (f2cl-lib:fref c-%data%
                                     (i j)

```

```

((1 ldc) (1 *))
c-%offset%)
(+ (* alpha temp)
  (* beta
    (f2cl-lib:fref c-%data%
      (i j)
      ((1 ldc) (1 *))
      c-%offset%)))))))))
end_label
(return
  (values nil nil nil nil nil nil nil nil nil nil nil nil nil)))

```

## 6.8 zhemm BLAS

```

⟨zhemm.input⟩≡
)set break resume
)sys rm -f zhemm.output
)spool zhemm.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)

```

`<zhemm.help>`≡

```
=====
zhemm examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

ZHEMM - perform one of the matrix-matrix operations  $C := \alpha * A * B + \beta * C$ ,

#### SYNOPSIS

```
SUBROUTINE ZHEMM ( SIDE, UPLO, M, N, ALPHA, A, LDA, B, LDB,
                  BETA, C, LDC )
```

```
CHARACTER*1  SIDE, UPLO
```

```
INTEGER      M, N, LDA, LDB, LDC
```

```
COMPLEX*16   ALPHA, BETA
```

```
COMPLEX*16   A( LDA, * ), B( LDB, * ), C( LDC, * )
```

#### PURPOSE

ZHEMM performs one of the matrix-matrix operations

or

$C := \alpha * B * A + \beta * C$ ,

where alpha and beta are scalars, A is an hermitian matrix and B and C are m by n matrices.

#### PARAMETERS

SIDE - CHARACTER\*1.

On entry, SIDE specifies whether the hermitian matrix A appears on the left or right in the operation as follows:

SIDE = 'L' or 'l'  $C := \alpha * A * B + \beta * C$ ,

SIDE = 'R' or 'r'  $C := \alpha * B * A + \beta * C$ ,

Unchanged on exit.



UPLO - CHARACTER\*1.

On entry, UPLO specifies whether the upper or lower triangular part of the hermitian matrix A is to be referenced as follows:

UPLO = 'U' or 'u' Only the upper triangular part of the hermitian matrix is to be referenced.

UPLO = 'L' or 'l' Only the lower triangular part of the hermitian matrix is to be referenced.

Unchanged on exit.

M - INTEGER.

On entry, M specifies the number of rows of the matrix C. M must be at least zero. Unchanged on exit.

N - INTEGER.

On entry, N specifies the number of columns of the matrix C. N must be at least zero. Unchanged on exit.

ALPHA - COMPLEX\*16 .

On entry, ALPHA specifies the scalar alpha. Unchanged on exit.

ka is

A -

COMPLEX\*16 array of DIMENSION ( LDA, ka ), where m when SIDE = 'L' or 'l' and is n otherwise. Before entry with SIDE = 'L' or 'l', the m by m part of the array A must contain the hermitian matrix, such that when UPLO = 'U' or 'u', the leading m by m upper triangular part of the array A must contain the upper triangular part of the hermitian matrix and the strictly lower triangular part of A is not referenced, and when UPLO = 'L' or 'l', the leading m by m lower triangular part of the array A must contain the lower triangular part of the hermitian matrix and the strictly upper triangular part of A is not referenced. Before entry with SIDE = 'R' or 'r', the n by n part of the array A must contain the hermitian matrix, such that when UPLO = 'U' or 'u', the lead-

ing  $n$  by  $n$  upper triangular part of the array  $A$  must contain the upper triangular part of the hermitian matrix and the strictly lower triangular part of  $A$  is not referenced, and when  $UPLO = 'L'$  or  $'l'$ , the leading  $n$  by  $n$  lower triangular part of the array  $A$  must contain the lower triangular part of the hermitian matrix and the strictly upper triangular part of  $A$  is not referenced. Note that the imaginary parts of the diagonal elements need not be set, they are assumed to be zero. Unchanged on exit.

LDA - INTEGER.

On entry, LDA specifies the first dimension of  $A$  as declared in the calling (sub) program. When  $SIDE = 'L'$  or  $'l'$  then LDA must be at least  $\max(1, m)$ , otherwise LDA must be at least  $\max(1, n)$ . Unchanged on exit.

B - COMPLEX\*16 array of DIMENSION ( LDB,  $n$  ).

Before entry, the leading  $m$  by  $n$  part of the array  $B$  must contain the matrix  $B$ . Unchanged on exit.

LDB - INTEGER.

On entry, LDB specifies the first dimension of  $B$  as declared in the calling (sub) program. LDB must be at least  $\max(1, m)$ . Unchanged on exit.

BETA - COMPLEX\*16 .

On entry, BETA specifies the scalar  $\beta$ . When BETA is supplied as zero then  $C$  need not be set on input. Unchanged on exit.

C - COMPLEX\*16 array of DIMENSION ( LDC,  $n$  ).

Before entry, the leading  $m$  by  $n$  part of the array  $C$  must contain the matrix  $C$ , except when  $\beta$  is zero, in which case  $C$  need not be set on entry. On exit, the array  $C$  is overwritten by the  $m$  by  $n$  updated matrix.

LDC - INTEGER.

On entry, LDC specifies the first dimension of  $C$  as declared in the calling (sub) program. LDC must be at least  $\max(1, m)$ . Unchanged on exit.

```

<BLAS 3 zhemm>≡
  (let* ((one (complex 1.0 0.0)) (zero (complex 0.0 0.0)))
    (declare (type (complex double-float) one) (type (complex double-float) zero))
    (defun zhemm (side uplo m n alpha a lda b ldb$ beta c ldc)
      (declare (type (simple-array (complex double-float) (*)) c b a)
        (type (complex double-float) beta alpha)
        (type fixnum ldc ldb$ lda n m)
        (type character uplo side))
      (f2cl-lib:with-multi-array-data
        ((side character side-%data% side-%offset%)
         (uplo character uplo-%data% uplo-%offset%)
         (a (complex double-float) a-%data% a-%offset%)
         (b (complex double-float) b-%data% b-%offset%)
         (c (complex double-float) c-%data% c-%offset%))
        (prog ((temp1 #C(0.0 0.0)) (temp2 #C(0.0 0.0)) (i 0) (info 0) (j 0) (k 0)
              (nrowa 0) (upper nil))
          (declare (type (complex double-float) temp1 temp2)
            (type fixnum i info j k nrowa)
            (type (member t nil) upper))
          (cond
            ((char-equal side #\L)
              (setf nrowa m))
            (t
              (setf nrowa n)))
          (setf upper (char-equal uplo #\U))
          (setf info 0)
          (cond
            ((and (not (char-equal side #\L)) (not (char-equal side #\R)))
              (setf info 1))
            ((and (not upper) (not (char-equal uplo #\L)))
              (setf info 2))
            ((< m 0)
              (setf info 3))
            ((< n 0)
              (setf info 4))
            ((< lda (max (the fixnum 1) (the fixnum nrowa)))
              (setf info 7))
            ((< ldb$ (max (the fixnum 1) (the fixnum m)))
              (setf info 9))
            ((< ldc (max (the fixnum 1) (the fixnum m)))
              (setf info 12)))
          (cond
            ((/= info 0)
              (error
                " ** On entry to ~a parameter number ~a had an illegal value~%"
                "ZHEMM" info))

```

```

      (go end_label)))
    (if (or (= m 0) (= n 0) (and (= alpha zero) (= beta one)))
        (go end_label))
    (cond
      ((= alpha zero)
       (cond
         ((= beta zero)
          (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                        (> j n) nil)
          (tagbody
            (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                          (> i m) nil)
            (tagbody
              (setf (f2cl-lib:fref c-%data%
                                  (i j)
                                  ((1 ldc) (1 *))
                                  c-%offset%)
                    zero))))))
          (t
           (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                         (> j n) nil)
           (tagbody
            (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                          (> i m) nil)
            (tagbody
              (setf (f2cl-lib:fref c-%data%
                                  (i j)
                                  ((1 ldc) (1 *))
                                  c-%offset%)
                    (* beta
                     (f2cl-lib:fref c-%data%
                                     (i j)
                                     ((1 ldc) (1 *))
                                     c-%offset%))))))
            (go end_label))))
      (cond
        ((char-equal side #\L)
         (cond
           (upper
            (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                          (> j n) nil)
            (tagbody
              (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                            (> i m) nil)
              (tagbody
                (setf temp1

```

```

(* alpha
  (f2cl-lib:fref b-%data%
    (i j)
    ((1 ldb$) (1 *))
    b-%offset%)))
(setf temp2 zero)
(f2cl-lib:fdo (k 1 (f2cl-lib:int-add k 1))
  (> k
    (f2cl-lib:int-add i
      (f2cl-lib:int-sub
        1)))
    nil)
(tagbody
  (setf (f2cl-lib:fref c-%data%
    (k j)
    ((1 ldc) (1 *))
    c-%offset%)
    (+
      (f2cl-lib:fref c-%data%
        (k j)
        ((1 ldc) (1 *))
        c-%offset%)
      (* temp1
        (f2cl-lib:fref a-%data%
          (k i)
          ((1 lda) (1 *))
          a-%offset%))))))
(setf temp2
  (+ temp2
    (*
      (f2cl-lib:fref b-%data%
        (k j)
        ((1 ldb$) (1 *))
        b-%offset%)
      (f2cl-lib:dconjg
        (f2cl-lib:fref a-%data%
          (k i)
          ((1 lda) (1 *))
          a-%offset%)))))))
(cond
  ((= beta zero)
    (setf
      (f2cl-lib:fref c-%data% (i j) ((1 ldc) (1 *))
        c-%offset%)
      (+
        (* temp1

```

```

        (coerce (realpart
          (f2cl-lib:fref a-%data% (i i) ((1 lda) (1 *))
                        a-%offset%))
          'double-float))
      (* alpha temp2))))
(t
  (setf (f2cl-lib:fref c-%data%
    (i j)
    ((1 ldc) (1 *))
    c-%offset%)
    (+
      (* beta
        (f2cl-lib:fref c-%data%
          (i j)
          ((1 ldc) (1 *))
          c-%offset%))
      (* temp1
        (coerce (realpart
          (f2cl-lib:fref a-%data%
            (i i)
            ((1 lda) (1 *))
            a-%offset%)) 'double-float))
      (* alpha temp2)))))))))
(t
  (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
    ((> j n) nil)
    (tagbody
      (f2cl-lib:fdo (i m (f2cl-lib:int-add i (f2cl-lib:int-sub 1)))
        ((> i 1) nil)
        (tagbody
          (setf temp1
            (* alpha
              (f2cl-lib:fref b-%data%
                (i j)
                ((1 ldb) (1 *))
                b-%offset%)))
            (setf temp2 zero)
            (f2cl-lib:fdo (k (f2cl-lib:int-add i 1)
              (f2cl-lib:int-add k 1))
              ((> k m) nil)
              (tagbody
                (setf (f2cl-lib:fref c-%data%
                  (k j)
                  ((1 ldc) (1 *))
                  c-%offset%)

```

```

(+
  (f2cl-lib:fref c-%data%
                 (k j)
                 ((1 ldc) (1 *)))
  c-%offset%)

(* temp1
  (f2cl-lib:fref a-%data%
                 (k i)
                 ((1 lda) (1 *)))
  a-%offset%)))

(setf temp2
  (+ temp2
    (*
      (f2cl-lib:fref b-%data%
                     (k j)
                     ((1 ldb$) (1 *)))
      b-%offset%)
      (f2cl-lib:dconjg
        (f2cl-lib:fref a-%data%
                       (k i)
                       ((1 lda) (1 *)))
        a-%offset%))))))

(cond
  ((= beta zero)
    (setf (f2cl-lib:fref c-%data%
                        (i j)
                        ((1 ldc) (1 *)))
          c-%offset%)

    (+
      (* temp1
        (coerce (realpart
                  (f2cl-lib:fref a-%data%
                                (i i)
                                ((1 lda) (1 *)))
                  a-%offset%)) 'double-float))
      (* alpha temp2))))

(t
  (setf (f2cl-lib:fref c-%data%
                      (i j)
                      ((1 ldc) (1 *)))
        c-%offset%)

    (+
      (* beta
        (f2cl-lib:fref c-%data%
                      (i j)
                      ((1 ldc) (1 *)))

```

```

                                c-%offset%))
    (* temp1
      (coerce (realpart
                (f2cl-lib:fref a-%data%
                              (i i)
                              ((1 lda) (1 *))
                              a-%offset%)) 'double-float))
      (* alpha temp2))))))))))
(t
  (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
    (> j n) nil)
  (tagbody
    (setf temp1
      (* alpha
        (coerce (realpart
                  (f2cl-lib:fref a-%data%
                                (j j)
                                ((1 lda) (1 *))
                                a-%offset%)) 'double-float)))
    (cond
      ((= beta zero)
        (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
          (> i m) nil)
        (tagbody
          (setf (f2cl-lib:fref c-%data%
                              (i j)
                              ((1 ldc) (1 *))
                              c-%offset%))
            (* temp1
              (f2cl-lib:fref b-%data%
                            (i j)
                            ((1 ldb) (1 *))
                            b-%offset%))))))
    (t
      (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
        (> i m) nil)
      (tagbody
        (setf (f2cl-lib:fref c-%data%
                              (i j)
                              ((1 ldc) (1 *))
                              c-%offset%))
          (+
            (* beta
              (f2cl-lib:fref c-%data%
                            (i j)
                            ((1 ldc) (1 *))

```



```

                                c-%offset%))
      (* temp1
        (f2cl-lib:fref b-%data%
          (i j)
          ((1 ldb$) (1 *))
          b-%offset%)))))))))
(f2cl-lib:fdo (k 1 (f2cl-lib:int-add k 1))
  ((> k (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
   nil)
(tagbody
  (cond
    (upper
      (setf temp1
        (* alpha
          (f2cl-lib:fref a-%data%
            (k j)
            ((1 lda) (1 *))
            a-%offset%))))

    (t
      (setf temp1
        (* alpha
          (f2cl-lib:dconjg
            (f2cl-lib:fref a-%data%
              (j k)
              ((1 lda) (1 *))
              a-%offset%))))))
(f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
  ((> i m) nil)
  (tagbody
    (setf (f2cl-lib:fref c-%data%
      (i j)
      ((1 ldc) (1 *))
      c-%offset%)

      (+
        (f2cl-lib:fref c-%data%
          (i j)
          ((1 ldc) (1 *))
          c-%offset%)

        (* temp1
          (f2cl-lib:fref b-%data%
            (i k)
            ((1 ldb$) (1 *))
            b-%offset%)))))))))
(f2cl-lib:fdo (k (f2cl-lib:int-add j 1) (f2cl-lib:int-add k 1))
  ((> k n) nil)
  (tagbody

```

```

(cond
  (upper
    (setf temp1
      (* alpha
        (f2cl-lib:dconjg
          (f2cl-lib:fref a-%data%
            (j k)
            ((1 lda) (1 *))
            a-%offset%))))))
  (t
    (setf temp1
      (* alpha
        (f2cl-lib:fref a-%data%
          (k j)
          ((1 lda) (1 *))
          a-%offset%))))))
(f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
  (> i m) nil)
(tagbody
  (setf (f2cl-lib:fref c-%data%
    (i j)
    ((1 ldc) (1 *))
    c-%offset%)
    (+
      (f2cl-lib:fref c-%data%
        (i j)
        ((1 ldc) (1 *))
        c-%offset%)
      (* temp1
        (f2cl-lib:fref b-%data%
          (i k)
          ((1 ldb$) (1 *))
          b-%offset%))))))
end_label
(return (values nil nil nil nil nil nil nil nil nil nil nil)))

```

## 6.9 zher2k BLAS

```
(zher2k.input)=  
  )set break resume  
  )sys rm -f zher2k.output  
  )spool zher2k.output  
  )set message test on  
  )set message auto off  
  )clear all  
  
  )spool  
  )lisp (bye)
```

`<zher2k.help>=`

```
=====
zher2k examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

ZHER2K - perform one of the hermitian rank 2k operations    C  
 $C := \alpha A \text{conjg}(B') + \text{conjg}(\alpha) B \text{conjg}(A') +$   
 $\beta C,$

#### SYNOPSIS

```
SUBROUTINE ZHER2K( UPLO, TRANS, N, K, ALPHA, A, LDA, B, LDB,
                  BETA, C, LDC )
```

```
      CHARACTER*1  UPLO, TRANS
```

```
      INTEGER      N, K, LDA, LDB, LDC
```

```
      DOUBLE       PRECISION BETA
```

```
      COMPLEX*16   ALPHA
```

```
      COMPLEX*16   A( LDA, * ), B( LDB, * ), C( LDC, * )
```

#### PURPOSE

ZHER2K performs one of the hermitian rank 2k operations

or

$C := \alpha \text{conjg}(A') B + \text{conjg}(\alpha) \text{conjg}(B') A +$   
 $\beta C,$

where  $\alpha$  and  $\beta$  are scalars with  $\beta$  real,  $C$  is  
 an  $n$  by  $n$  hermitian matrix and  $A$  and  $B$  are  $n$  by  $k$   
 matrices in the first case and  $k$  by  $n$  matrices in the  
 second case.

#### PARAMETERS

UPLO - CHARACTER\*1.

On entry, UPLO specifies whether the upper or  
 lower triangular part of the array C is to be  
 referenced as follows:

UPLO = 'U' or 'u' Only the upper triangular part of C is to be referenced.

UPLO = 'L' or 'l' Only the lower triangular part of C is to be referenced.

Unchanged on exit.

TRANS - CHARACTER\*1.

On entry, TRANS specifies the operation to be performed as follows:

TRANS = 'N' or 'n'  $C := \alpha * A * \text{conjg}(B) + \text{conjg}(\alpha) * B * \text{conjg}(A) + \beta * C$ .

TRANS = 'C' or 'c'  $C := \alpha * \text{conjg}(A) * B + \text{conjg}(\alpha) * \text{conjg}(B) * A + \beta * C$ .

Unchanged on exit.

N - INTEGER.

On entry, N specifies the order of the matrix C. N must be at least zero. Unchanged on exit.

K - INTEGER.

On entry with TRANS = 'N' or 'n', K specifies the number of columns of the matrices A and B, and on entry with TRANS = 'C' or 'c', K specifies the number of rows of the matrices A and B. K must be at least zero. Unchanged on exit.

ALPHA - COMPLEX\*16 .

On entry, ALPHA specifies the scalar alpha. Unchanged on exit.

ka is

A -

COMPLEX\*16 array of DIMENSION ( LDA, ka ), where k when TRANS = 'N' or 'n', and is n otherwise. Before entry with TRANS = 'N' or 'n', the leading n by k part of the array A must contain the matrix A, otherwise the leading k by n part of the array A must contain the matrix A. Unchanged on exit.

LDA - INTEGER.

On entry, LDA specifies the first dimension of A as declared in the calling (sub) program. When TRANS = 'N' or 'n' then LDA must be at least  $\max(1, n)$ , otherwise LDA must be at least  $\max(1, k)$ . Unchanged on exit.

kb is

B -

COMPLEX\*16 array of DIMENSION ( LDB, kb ), where k when TRANS = 'N' or 'n', and is n otherwise. Before entry with TRANS = 'N' or 'n', the leading n by k part of the array B must contain the matrix B, otherwise the leading k by n part of the array B must contain the matrix B. Unchanged on exit.

LDB - INTEGER.

On entry, LDB specifies the first dimension of B as declared in the calling (sub) program. When TRANS = 'N' or 'n' then LDB must be at least  $\max(1, n)$ , otherwise LDB must be at least  $\max(1, k)$ .

Unchanged on exit.

BETA - DOUBLE PRECISION.

On entry, BETA specifies the scalar beta. Unchanged on exit.

C - COMPLEX\*16 array of DIMENSION ( LDC, n ).

Before entry with UPLO = 'U' or 'u', the leading n by n upper triangular part of the array C must contain the upper triangular part of the hermitian matrix and the strictly lower triangular part of C is not referenced. On exit, the upper triangular part of the array C is overwritten by the upper triangular part of the updated matrix. Before entry with UPLO = 'L' or 'l', the leading n by n lower triangular part of the array C must contain the lower triangular part of the hermitian matrix and the strictly upper triangular part of C is not referenced. On exit, the lower triangular part of the array C is overwritten by the lower triangular part of the updated matrix. Note that the imaginary parts of the diagonal elements need not be set, they are assumed to be zero, and on exit they are set to zero.

LDC     - INTEGER.

On entry, LDC specifies the first dimension of C as declared in the calling (sub) program. LDC must be at least  $\max(1, n)$ . Unchanged on exit.

```

<BLAS 3 zher2k>=
  (let* ((one 1.0) (zero (complex 0.0 0.0)))
    (declare (type (double-float 1.0 1.0) one) (type (complex double-float) zero))
    (defun zher2k (uplo trans n k alpha a lda b ldb$ beta c ldc)
      (declare (type (double-float) beta)
        (type (simple-array (complex double-float) (*)) c b a)
        (type (complex double-float) alpha)
        (type fixnum ldc ldb$ lda k n)
        (type character trans uplo))
      (f2cl-lib:with-multi-array-data
        ((uplo character uplo-%data% uplo-%offset%)
         (trans character trans-%data% trans-%offset%)
         (a (complex double-float) a-%data% a-%offset%)
         (b (complex double-float) b-%data% b-%offset%)
         (c (complex double-float) c-%data% c-%offset%))
        (prog ((temp1 #C(0.0 0.0)) (temp2 #C(0.0 0.0)) (i 0) (info 0) (j 0) (l 0)
              (nrowa 0) (upper nil))
          (declare (type (complex double-float) temp1 temp2)
            (type fixnum i info j l nrowa)
            (type (member t nil) upper))
          (cond
            ((char-equal trans #\N)
              (setf nrowa n))
            (t
              (setf nrowa k)))
          (setf upper (char-equal uplo #\U))
          (setf info 0)
          (cond
            ((and (not upper) (not (char-equal uplo #\L)))
              (setf info 1))
            ((and (not (char-equal trans #\N)) (not (char-equal trans #\C)))
              (setf info 2))
            ((< n 0)
              (setf info 3))
            ((< k 0)
              (setf info 4))
            ((< lda (max (the fixnum 1) (the fixnum nrowa)))
              (setf info 7))
            ((< ldb$
              (max (the fixnum 1) (the fixnum nrowa)))
              (setf info 9))
            ((< ldc (max (the fixnum 1) (the fixnum n)))
              (setf info 12)))
          (cond
            ((/= info 0)
              (error

```





```

(* beta
  (coerce (realpart
    (f2cl-lib:fref c-%data%
      (j j)
      ((1 ldc) (1 *))
      c-%offset%)) 'double-float))
'(complex double-float))))))
(t
  (cond
    ((= beta (coerce (realpart zero) 'double-float))
      (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
        (> j n) nil)
      (tagbody
        (f2cl-lib:fdo (i j (f2cl-lib:int-add i 1))
          (> i n) nil)
          (tagbody
            (setf (f2cl-lib:fref c-%data%
              (i j)
              ((1 ldc) (1 *))
              c-%offset%)
              zero))))))
  (t
    (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
      (> j n) nil)
      (tagbody
        (setf (f2cl-lib:fref c-%data%
          (j j)
          ((1 ldc) (1 *))
          c-%offset%)
          (coerce
            (* beta
              (coerce (realpart
                (f2cl-lib:fref c-%data%
                  (j j)
                  ((1 ldc) (1 *))
                  c-%offset%)) 'double-float))
            '(complex double-float)))
          (f2cl-lib:fdo (i (f2cl-lib:int-add j 1)
            (f2cl-lib:int-add i 1))
              (> i n) nil)
              (tagbody
                (setf (f2cl-lib:fref c-%data%
                  (i j)
                  ((1 ldc) (1 *))
                  c-%offset%)
                  (* beta

```

```

(f2cl-lib:fref c-%data%
  (i j)
  ((1 ldc) (1 *))
  c-%offset%)))))))))

(go end_label)))
(cond
  ((char-equal trans #\N)
    (cond
      (upper
        (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
          (> j n) nil)
        (tagbody
          (cond
            ((= beta (coerce (realpart zero) 'double-float))
              (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                (> i j) nil)
              (tagbody
                (setf (f2cl-lib:fref c-%data%
                  (i j)
                  ((1 ldc) (1 *))
                  c-%offset%)
                  zero))))
            ((/= beta one)
              (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                (> i
                  (f2cl-lib:int-add j
                    (f2cl-lib:int-sub 1)))
                nil)
              (tagbody
                (setf (f2cl-lib:fref c-%data%
                  (i j)
                  ((1 ldc) (1 *))
                  c-%offset%)
                  (* beta
                    (f2cl-lib:fref c-%data%
                      (i j)
                      ((1 ldc) (1 *))
                      c-%offset%))))))
              (setf (f2cl-lib:fref c-%data%
                (j j)
                ((1 ldc) (1 *))
                c-%offset%)
                (coerce
                  (* beta
                    (coerce (realpart
                      (f2cl-lib:fref c-%data%

```

```

                                (j j)
                                ((1 ldc) (1 *))
                                c-%offset%)) 'double-float))
                                '(complex double-float)))
(t
  (setf (f2cl-lib:fref c-%data%
                    (j j)
                    ((1 ldc) (1 *))
                    c-%offset%)
        (coerce
          (coerce (realpart
                    (f2cl-lib:fref c-%data%
                    (j j)
                    ((1 ldc) (1 *))
                    c-%offset%)) 'double-float)
          '(complex double-float))))
  (f2cl-lib:fdo (1 1 (f2cl-lib:int-add 1 1))
    ((> 1 k) nil)
    (tagbody
      (cond
        ((or (/= (f2cl-lib:fref a (j 1) ((1 lda) (1 *))) zero)
              (/= (f2cl-lib:fref b (j 1) ((1 ldb$) (1 *))) zero))
          (setf temp1
            (* alpha
              (f2cl-lib:dconjg
                (f2cl-lib:fref b-%data%
                (j 1)
                ((1 ldb$) (1 *))
                b-%offset%))))
          (setf temp2
            (coerce
              (f2cl-lib:dconjg
                (* alpha
                  (f2cl-lib:fref a-%data%
                  (j 1)
                  ((1 lda) (1 *))
                  a-%offset%)))
              '(complex double-float)))
          (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
            ((> i
              (f2cl-lib:int-add j
                (f2cl-lib:int-sub
                  1)))
              nil)
            (tagbody
              (setf (f2cl-lib:fref c-%data%

```

```

                                (i j)
                                ((1 ldc) (1 *))
                                c-%offset%)
(+
  (f2cl-lib:fref c-%data%
    (i j)
    ((1 ldc) (1 *))
    c-%offset%)

  (*
    (f2cl-lib:fref a-%data%
      (i 1)
      ((1 lda) (1 *))
      a-%offset%)

    temp1)
  (*
    (f2cl-lib:fref b-%data%
      (i 1)
      ((1 ldb$) (1 *))
      b-%offset%)

    temp2))))))
(setf (f2cl-lib:fref c-%data%
  (j j)
  ((1 ldc) (1 *))
  c-%offset%)

(coerce
  (+
    (coerce (realpart
      (f2cl-lib:fref c-%data%
        (j j)
        ((1 ldc) (1 *))
        c-%offset%)) 'double-float)

    (coerce (realpart
      (+
        (*
          (f2cl-lib:fref a-%data%
            (j 1)
            ((1 lda) (1 *))
            a-%offset%)

          temp1)
        (*
          (f2cl-lib:fref b-%data%
            (j 1)
            ((1 ldb$) (1 *))
            b-%offset%)

          temp2))) 'double-float))
    'complex double-float)))))))))

```

```

(t
  (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
    ((> j n) nil)
    (tagbody
      (cond
        ((= beta (coerce (realpart zero) 'double-float))
          (f2cl-lib:fdo (i j (f2cl-lib:int-add i 1))
            ((> i n) nil)
            (tagbody
              (setf (f2cl-lib:fref c-%data%
                                (i j)
                                ((1 ldc) (1 *))
                                c-%offset%)
                    zero))))
          ((/= beta one)
            (f2cl-lib:fdo (i (f2cl-lib:int-add j 1)
                          (f2cl-lib:int-add i 1))
              ((> i n) nil)
              (tagbody
                (setf (f2cl-lib:fref c-%data%
                                  (i j)
                                  ((1 ldc) (1 *))
                                  c-%offset%)
                    (* beta
                     (f2cl-lib:fref c-%data%
                                   (i j)
                                   ((1 ldc) (1 *))
                                   c-%offset%))))))
            (setf (f2cl-lib:fref c-%data%
                              (j j)
                              ((1 ldc) (1 *))
                              c-%offset%)
                  (coerce
                    (* beta
                     (coerce (realpart
                              (f2cl-lib:fref c-%data%
                                              (j j)
                                              ((1 ldc) (1 *))
                                              c-%offset%))
                              'double-float))
                    '(complex double-float))))))
    (t
      (setf (f2cl-lib:fref c-%data%
                          (j j)
                          ((1 ldc) (1 *))
                          c-%offset%)
            (coerce
              (* beta
               (coerce (realpart
                        (f2cl-lib:fref c-%data%
                                      (j j)
                                      ((1 ldc) (1 *))
                                      c-%offset%)
                        'double-float))
               '(complex double-float))))))

```

```

(coerce (realpart
  (f2cl-lib:fref c-%data%
    (j j)
    ((1 ldc) (1 *))
    c-%offset%)) 'double-float)
'(complex double-float))))
(f2cl-lib:fdo (1 1 (f2cl-lib:int-add 1 1))
  (> 1 k) nil)
(tagbody
  (cond
    ((or (/= (f2cl-lib:fref a (j 1) ((1 lda) (1 *))) zero)
      (/= (f2cl-lib:fref b (j 1) ((1 ldb$) (1 *))) zero))
      (setf temp1
        (* alpha
          (f2cl-lib:dconjg
            (f2cl-lib:fref b-%data%
              (j 1)
              ((1 ldb$) (1 *))
              b-%offset%))))
        (setf temp2
          (coerce
            (f2cl-lib:dconjg
              (* alpha
                (f2cl-lib:fref a-%data%
                  (j 1)
                  ((1 lda) (1 *))
                  a-%offset%)))
            'complex double-float)))
        (f2cl-lib:fdo (i (f2cl-lib:int-add j 1)
          (f2cl-lib:int-add i 1))
            (> i n) nil)
        (tagbody
          (setf (f2cl-lib:fref c-%data%
            (i j)
            ((1 ldc) (1 *))
            c-%offset%))
            (+
              (f2cl-lib:fref c-%data%
                (i j)
                ((1 ldc) (1 *))
                c-%offset%)
              (*
                (f2cl-lib:fref a-%data%
                  (i 1)
                  ((1 lda) (1 *))
                  a-%offset%)

```

```

temp1)
(*
  (f2cl-lib:fref b-%data%
    (i 1)
    ((1 ldb$) (1 *)))
    b-%offset%)
temp2))))))
(setf (f2cl-lib:fref c-%data%
  (j j)
  ((1 ldc) (1 *)))
  c-%offset%)
(coerce
  (+
    (coerce (realpart
      (f2cl-lib:fref c-%data%
        (j j)
        ((1 ldc) (1 *)))
        c-%offset%)) 'double-float)
    (coerce (realpart
      (+
        (*
          (f2cl-lib:fref a-%data%
            (j 1)
            ((1 lda) (1 *)))
            a-%offset%)
          temp1)
        (*
          (f2cl-lib:fref b-%data%
            (j 1)
            ((1 ldb$) (1 *)))
            b-%offset%)
          temp2))) 'double-float))
    '(complex double-float)))))))))
(t
  (cond
    (upper
      (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
        ((> j n) nil)
      (tagbody
        (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
          ((> i j) nil)
        (tagbody
          (setf temp1 zero)
          (setf temp2 zero)
          (f2cl-lib:fdo (l 1 (f2cl-lib:int-add l 1))
            ((> l k) nil)

```



```

(tagbody
  (setf temp1
    (+ temp1
      (*
        (f2cl-lib:dconjg
          (f2cl-lib:fref a-%data%
            (1 i)
            ((1 lda) (1 *))
            a-%offset%))
        (f2cl-lib:fref b-%data%
          (1 j)
          ((1 ldb$) (1 *))
          b-%offset%))))
    (setf temp2
      (+ temp2
        (*
          (f2cl-lib:dconjg
            (f2cl-lib:fref b-%data%
              (1 i)
              ((1 ldb$) (1 *))
              b-%offset%))
          (f2cl-lib:fref a-%data%
            (1 j)
            ((1 lda) (1 *))
            a-%offset%))))))
  (cond
    ((= i j)
      (cond
        ((= beta (coerce (realpart zero) 'double-float))
          (setf (f2cl-lib:fref c-%data%
            (j j)
            ((1 ldc) (1 *))
            c-%offset%))
            (coerce
              (coerce (realpart
                (+ (* alpha temp1)
                  (* (f2cl-lib:dconjg alpha) temp2)))
                'double-float)
              '(complex double-float))))
        (t
          (setf (f2cl-lib:fref c-%data%
            (j j)
            ((1 ldc) (1 *))
            c-%offset%))
            (coerce
              (+

```

```

(* beta
  (coerce (realpart
    (f2cl-lib:fref c-%data%
      (j j)
      ((1 ldc) (1 *))
      c-%offset%))
    'double-float))
  (coerce (realpart
    (+ (* alpha temp1)
      (* (f2cl-lib:dconjg alpha) temp2)))
    'double-float))
  '(complex double-float))))))
(t
  (cond
    ((= beta (coerce (realpart zero) 'double-float))
      (setf (f2cl-lib:fref c-%data%
        (i j)
        ((1 ldc) (1 *))
        c-%offset%))
        (+ (* alpha temp1)
          (* (f2cl-lib:dconjg alpha) temp2))))
    (t
      (setf (f2cl-lib:fref c-%data%
        (i j)
        ((1 ldc) (1 *))
        c-%offset%))
        (+
          (* beta
            (f2cl-lib:fref c-%data%
              (i j)
              ((1 ldc) (1 *))
              c-%offset%))
            (* alpha temp1)
            (* (f2cl-lib:dconjg alpha) temp2))))))))))
(t
  (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
    (> j n) nil)
  (tagbody
    (f2cl-lib:fdo (i j (f2cl-lib:int-add i 1))
      (> i n) nil)
    (tagbody
      (setf temp1 zero)
      (setf temp2 zero)
      (f2cl-lib:fdo (l 1 (f2cl-lib:int-add l 1))
        (> l k) nil)
      (tagbody

```

```

(setf temp1
  (+ temp1
    (*
      (f2cl-lib:dconjg
        (f2cl-lib:fref a-%data%
          (1 i)
          ((1 lda) (1 *))
          a-%offset%))
      (f2cl-lib:fref b-%data%
        (1 j)
        ((1 ldb$) (1 *))
        b-%offset%))))
(setf temp2
  (+ temp2
    (*
      (f2cl-lib:dconjg
        (f2cl-lib:fref b-%data%
          (1 i)
          ((1 ldb$) (1 *))
          b-%offset%))
      (f2cl-lib:fref a-%data%
        (1 j)
        ((1 lda) (1 *))
        a-%offset%))))))
(cond
  ((= i j)
    (cond
      ((= beta (coerce (realpart zero) 'double-float))
        (setf (f2cl-lib:fref c-%data%
          (j j)
          ((1 ldc) (1 *))
          c-%offset%))
          (coerce
            (coerce (realpart
              (+ (* alpha temp1)
                (* (f2cl-lib:dconjg alpha) temp2)))
              'double-float)
            '(complex double-float))))
      (t
        (setf (f2cl-lib:fref c-%data%
          (j j)
          ((1 ldc) (1 *))
          c-%offset%))
          (coerce
            (+
              (* beta

```

```

        (coerce (realpart
                  (f2cl-lib:fref c-%data%
                                (j j)
                                ((1 ldc) (1 *))
                                c-%offset%))
                  'double-float))
        (coerce (realpart
                  (+ (* alpha temp1)
                     (* (f2cl-lib:dconjg alpha) temp2)))
                  'double-float))
        '(complex double-float))))))
(t
 (cond
  ((= beta (coerce (realpart zero) 'double-float))
   (setf (f2cl-lib:fref c-%data%
                       (i j)
                       ((1 ldc) (1 *))
                       c-%offset%)
          (+ (* alpha temp1)
              (* (f2cl-lib:dconjg alpha) temp2))))
  (t
   (setf (f2cl-lib:fref c-%data%
                       (i j)
                       ((1 ldc) (1 *))
                       c-%offset%)
          (+
            (* beta
              (f2cl-lib:fref c-%data%
                            (i j)
                            ((1 ldc) (1 *))
                            c-%offset%))
            (* alpha temp1)
            (* (f2cl-lib:dconjg alpha) temp2))))))))))
end_label
(return (values nil nil nil nil nil nil nil nil nil nil nil nil nil nil))

```

## 6.10 zherk BLAS

```
<zherk.input>=  
  )set break resume  
  )sys rm -f zherk.output  
  )spool zherk.output  
  )set message test on  
  )set message auto off  
  )clear all  
  
  )spool  
  )lisp (bye)
```

*<zherk.help>*≡

=====

zherk examples

=====

=====

Man Page Details

=====

#### NAME

ZHERK - perform one of the hermitian rank k operations    C  
 := alpha\*A\*conjg( A' ) + beta\*C,

#### SYNOPSIS

SUBROUTINE ZHERK ( UPLO, TRANS, N, K, ALPHA, A, LDA, BETA,  
                   C, LDC )

CHARACTER\*1  UPLO, TRANS

INTEGER      N, K, LDA, LDC

DOUBLE       PRECISION ALPHA, BETA

COMPLEX\*16   A( LDA, \* ), C( LDC, \* )

#### PURPOSE

ZHERK performs one of the hermitian rank k operations

or

C := alpha\*conjg( A' )\*A + beta\*C,

where alpha and beta are real scalars, C is an n by n  
 hermitian matrix and A is an n by k matrix in the first  
 case and a k by n matrix in the second case.

#### PARAMETERS

UPLO - CHARACTER\*1.

On entry, UPLO specifies whether the upper or  
 lower triangular part of the array C is to be  
 referenced as follows:

UPLO = 'U' or 'u' Only the upper triangular part  
 of C is to be referenced.

UPLO = 'L' or 'l' Only the lower triangular part

of C is to be referenced.

Unchanged on exit.

TRANS - CHARACTER\*1.

On entry, TRANS specifies the operation to be performed as follows:

TRANS = 'N' or 'n'     $C := \alpha * A * \text{conjg}(A') + \beta * C.$

TRANS = 'C' or 'c'     $C := \alpha * \text{conjg}(A') * A + \beta * C.$

Unchanged on exit.

N - INTEGER.

On entry, N specifies the order of the matrix C. N must be at least zero. Unchanged on exit.

K - INTEGER.

On entry with TRANS = 'N' or 'n', K specifies the number of columns of the matrix A, and on entry with TRANS = 'C' or 'c', K specifies the number of rows of the matrix A. K must be at least zero. Unchanged on exit.

ALPHA - DOUBLE PRECISION.

On entry, ALPHA specifies the scalar alpha. Unchanged on exit.

ka is

A -

COMPLEX\*16    array of DIMENSION ( LDA, ka ), where k when TRANS = 'N' or 'n', and is n otherwise. Before entry with TRANS = 'N' or 'n', the leading n by k part of the array A must contain the matrix A, otherwise the leading k by n part of the array A must contain the matrix A. Unchanged on exit.

LDA - INTEGER.

On entry, LDA specifies the first dimension of A as declared in the calling (sub) program. When TRANS = 'N' or 'n' then LDA must be at least  $\max(1, n)$ , otherwise LDA must be at least  $\max(1, k)$ . Unchanged on exit.

- BETA    - DOUBLE PRECISION.  
On entry, BETA specifies the scalar beta. Unchanged on exit.
- C        - COMPLEX\*16        array of DIMENSION ( LDC, n ).  
Before entry with UPLO = 'U' or 'u', the leading n by n upper triangular part of the array C must contain the upper triangular part of the hermitian matrix and the strictly lower triangular part of C is not referenced. On exit, the upper triangular part of the array C is overwritten by the upper triangular part of the updated matrix. Before entry with UPLO = 'L' or 'l', the leading n by n lower triangular part of the array C must contain the lower triangular part of the hermitian matrix and the strictly upper triangular part of C is not referenced. On exit, the lower triangular part of the array C is overwritten by the lower triangular part of the updated matrix. Note that the imaginary parts of the diagonal elements need not be set, they are assumed to be zero, and on exit they are set to zero.
- LDC     - INTEGER.  
On entry, LDC specifies the first dimension of C as declared in the calling (sub) program. LDC must be at least  $\max(1, n)$ . Unchanged on exit.



```

<BLAS 3 zherk>≡
  (let* ((one 1.0) (zero 0.0))
    (declare (type (double-float 1.0 1.0) one)
              (type (double-float 0.0 0.0) zero))
    (defun zherk (uplo trans n k alpha a lda beta c ldc)
      (declare (type (simple-array (complex double-float) (*)) c a)
                (type (double-float) beta alpha)
                (type fixnum ldc lda k n)
                (type character trans uplo))
      (f2cl-lib:with-multi-array-data
        ((uplo character uplo-%data% uplo-%offset%)
         (trans character trans-%data% trans-%offset%)
         (a (complex double-float) a-%data% a-%offset%)
         (c (complex double-float) c-%data% c-%offset%))
        (prog ((temp #C(0.0 0.0)) (rtemp 0.0) (i 0) (info 0) (j 0) (l 0)
              (nrowa 0) (upper nil))
          (declare (type (complex double-float) temp)
                    (type (double-float) rtemp)
                    (type fixnum i info j l nrowa)
                    (type (member t nil) upper))
          (cond
            ((char-equal trans #\N)
             (setf nrowa n))
            (t
             (setf nrowa k)))
          (setf upper (char-equal uplo #\U))
          (setf info 0)
          (cond
            ((and (not upper) (not (char-equal uplo #\L)))
             (setf info 1))
            ((and (not (char-equal trans #\N)) (not (char-equal trans #\C)))
             (setf info 2))
            ((< n 0)
             (setf info 3))
            ((< k 0)
             (setf info 4))
            ((< lda (max (the fixnum 1) (the fixnum nrowa)))
             (setf info 7))
            ((< ldc (max (the fixnum 1) (the fixnum n)))
             (setf info 10)))
          (cond
            ((/= info 0)
             (error
              " ** On entry to ~a parameter number ~a had an illegal value~%"
              "ZHERK" info)
             (go end_label))))

```

```

(if (or (= n 0) (and (or (= alpha zero) (= k 0)) (= beta one)))
  (go end_label))
(cond
  ((= alpha zero)
   (cond
     (upper
      (cond
        ((= beta zero)
         (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                       ((> j n) nil)
         (tagbody
          (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                        ((> i j) nil)
          (tagbody
           (setf (f2cl-lib:fref c-%data%
                               (i j)
                               ((1 ldc) (1 *))
                               c-%offset%)
                 (coerce zero '(complex double-float))))))))))
     (t
      (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                    ((> j n) nil)
      (tagbody
       (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                     ((> i
                       (f2cl-lib:int-add j
                         (f2cl-lib:int-sub 1)))
                      nil)
       (tagbody
        (setf (f2cl-lib:fref c-%data%
                            (i j)
                            ((1 ldc) (1 *))
                            c-%offset%)
              (* beta
                (f2cl-lib:fref c-%data%
                              (i j)
                              ((1 ldc) (1 *))
                              c-%offset%))))))
        (setf (f2cl-lib:fref c-%data%
                            (j j)
                            ((1 ldc) (1 *))
                            c-%offset%)
              (coerce
                (* beta
                  (coerce (realpart
                           (f2cl-lib:fref c-%data%

```

```

                                (j j)
                                ((1 ldc) (1 *))
                                c-%offset%) 'double-float))
                                '(complex double-float))))))
(t
  (cond
    ((= beta zero)
      (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
        ((> j n) nil)
        (tagbody
          (f2cl-lib:fdo (i j (f2cl-lib:int-add i 1))
            ((> i n) nil)
            (tagbody
              (setf (f2cl-lib:fref c-%data%
                                (i j)
                                ((1 ldc) (1 *))
                                c-%offset%)
                (coerce zero '(complex double-float)))))))
      (t
        (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
          ((> j n) nil)
          (tagbody
            (setf (f2cl-lib:fref c-%data%
                                (j j)
                                ((1 ldc) (1 *))
                                c-%offset%)
              (coerce
                (* beta
                  (coerce (realpart
                    (f2cl-lib:fref c-%data%
                                (j j)
                                ((1 ldc) (1 *))
                                c-%offset%) 'double-float))
                    '(complex double-float)))
                (f2cl-lib:fdo (i (f2cl-lib:int-add j 1)
                  (f2cl-lib:int-add i 1))
                    ((> i n) nil)
                    (tagbody
                      (setf (f2cl-lib:fref c-%data%
                                (i j)
                                ((1 ldc) (1 *))
                                c-%offset%)
                        (* beta
                          (f2cl-lib:fref c-%data%
                                (i j)
                                ((1 ldc) (1 *))
                                c-%offset%)
                        )
                      )
                    )
                )
            )
          )
        )
      )
    )
  )

```

```

c-%offset%))))))))))

(go end_label)))
(cond
  ((char-equal trans #\N)
    (cond
      (upper
        (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
          ((> j n) nil)
          (tagbody
            (cond
              ((= beta zero)
                (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                  ((> i j) nil)
                  (tagbody
                    (setf (f2cl-lib:fref c-%data%
                                      (i j)
                                      ((1 ldc) (1 *))
                                      c-%offset%)
                      (coerce zero '(complex double-float))))))
              ((/= beta one)
                (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                  ((> i
                    (f2cl-lib:int-add j
                      (f2cl-lib:int-sub 1)))
                    nil)
                  (tagbody
                    (setf (f2cl-lib:fref c-%data%
                                      (i j)
                                      ((1 ldc) (1 *))
                                      c-%offset%)
                      (* beta
                        (f2cl-lib:fref c-%data%
                                      (i j)
                                      ((1 ldc) (1 *))
                                      c-%offset%))))))
                (setf (f2cl-lib:fref c-%data%
                                      (j j)
                                      ((1 ldc) (1 *))
                                      c-%offset%)
                    (coerce
                      (* beta
                        (coerce (realpart
                          (f2cl-lib:fref c-%data%
                                      (j j)
                                      ((1 ldc) (1 *))
                                      c-%offset%)) 'double-float))
                    ))))
            ))))
      ))))
  ))))

```

```

      '(complex double-float))))
(t
  (setf (f2cl-lib:fref c-%data%
                      (j j)
                      ((1 ldc) (1 *)))
        c-%offset%)

    (coerce
      (coerce (realpart
                (f2cl-lib:fref c-%data%
                              (j j)
                              ((1 ldc) (1 *)))
                c-%offset%)) 'double-float)
      '(complex double-float))))))
(f2cl-lib:fdo (l 1 (f2cl-lib:int-add 1 1))
  ((> l k) nil)

(tagbody
  (cond
    ((/= (f2cl-lib:fref a (j 1) ((1 lda) (1 *)))
          (coerce (complex zero) '(complex double-float)))
      (setf temp
        (coerce
          (* alpha
            (f2cl-lib:dconjg
              (f2cl-lib:fref a-%data%
                            (j 1)
                            ((1 lda) (1 *)))
              a-%offset%)))
          '(complex double-float)))
      (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
        ((> i
          (f2cl-lib:int-add j
            (f2cl-lib:int-sub
              1)))
          nil)
      (tagbody
        (setf (f2cl-lib:fref c-%data%
                            (i j)
                            ((1 ldc) (1 *)))
              c-%offset%)

          (+
            (f2cl-lib:fref c-%data%
                          (i j)
                          ((1 ldc) (1 *)))
              c-%offset%)

          (* temp
            (f2cl-lib:fref a-%data%
                          (i j)
                          ((1 lda) (1 *)))
              a-%offset%)))

```

```

                                (i 1)
                                ((1 lda) (1 *))
                                a-%offset%))))))
(setf (f2cl-lib:fref c-%data%
                    (j j)
                    ((1 ldc) (1 *))
                    c-%offset%)
      (coerce
        (+
          (coerce (realpart
                    (f2cl-lib:fref c-%data%
                                    (j j)
                                    ((1 ldc) (1 *))
                                    c-%offset%)) 'double-float)
          (coerce (realpart
                    (* temp
                      (f2cl-lib:fref a-%data%
                                    (i 1)
                                    ((1 lda) (1 *))
                                    a-%offset%))
                    'double-float))
          '(complex double-float)))))))))
(t
 (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
               ((> j n) nil)
  (tagbody
   (cond
    ((= beta zero)
     (f2cl-lib:fdo (i j (f2cl-lib:int-add i 1))
                   ((> i n) nil)
      (tagbody
       (setf (f2cl-lib:fref c-%data%
                           (i j)
                           ((1 ldc) (1 *))
                           c-%offset%)
              (coerce zero '(complex double-float)))))
     ((/= beta one)
      (setf (f2cl-lib:fref c-%data%
                          (j j)
                          ((1 ldc) (1 *))
                          c-%offset%)
            (coerce
              (* beta
                (coerce (realpart
                          (f2cl-lib:fref c-%data%
                                          (j j)
                                          ((1 ldc) (1 *))
                                          c-%offset%)
                        'double-float)
                  (coerce (realpart
                          (f2cl-lib:fref c-%data%
                                          (j j)
                                          ((1 ldc) (1 *))
                                          c-%offset%)
                        'double-float)
                    'double-float))
              'double-float))
            '(complex double-float))))))

```

```

((1 ldc) (1 *))
c-%offset%)) 'double-float))
'(complex double-float)))
(f2cl-lib:fdo (i (f2cl-lib:int-add j 1)
                (f2cl-lib:int-add i 1))
              (> i n) nil)
(tagbody
  (setf (f2cl-lib:fref c-%data%
                    (i j)
                    ((1 ldc) (1 *))
                    c-%offset%)
        (* beta
          (f2cl-lib:fref c-%data%
                        (i j)
                        ((1 ldc) (1 *))
                        c-%offset%))))))
(t
  (setf (f2cl-lib:fref c-%data%
                    (j j)
                    ((1 ldc) (1 *))
                    c-%offset%)
        (coerce
          (coerce (realpart
                    (f2cl-lib:fref c-%data%
                                  (j j)
                                  ((1 ldc) (1 *))
                                  c-%offset%)) 'double-float)
          '(complex double-float))))))
(f2cl-lib:fdo (l 1 (f2cl-lib:int-add 1 1))
              (> l k) nil)
(tagbody
  (cond
    ((/= (f2cl-lib:fref a (j 1) ((1 lda) (1 *)))
         (coerce (complex zero) 'complex double-float)))
    (setf temp
      (coerce
        (* alpha
          (f2cl-lib:dconjg
            (f2cl-lib:fref a-%data%
                          (j 1)
                          ((1 lda) (1 *))
                          a-%offset%)))
        '(complex double-float)))
    (setf (f2cl-lib:fref c-%data%
                      (j j)
                      ((1 ldc) (1 *))

```

```

                                c-%offset%)
(coerce
(+
  (coerce (realpart
    (f2cl-lib:fref c-%data%
      (j j)
      ((1 ldc) (1 *))
      c-%offset%)) 'double-float)
  (coerce (realpart
    (* temp
      (f2cl-lib:fref a-%data%
        (j 1)
        ((1 lda) (1 *))
        a-%offset%)))
    'double-float))
  '(complex double-float)))
(f2cl-lib:fdo (i (f2cl-lib:int-add j 1)
  (f2cl-lib:int-add i 1))
  (> i n) nil)
(tagbody
  (setf (f2cl-lib:fref c-%data%
    (i j)
    ((1 ldc) (1 *))
    c-%offset%)
    (+
      (f2cl-lib:fref c-%data%
        (i j)
        ((1 ldc) (1 *))
        c-%offset%)
      (* temp
        (f2cl-lib:fref a-%data%
          (i 1)
          ((1 lda) (1 *))
          a-%offset%)))))))))
(t
(cond
  (upper
    (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
      (> j n) nil)
    (tagbody
      (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
        (> i
          (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
          nil)
      (tagbody
        (setf temp (coerce zero '(complex double-float)))

```



```

(f2cl-lib:fdo (1 1 (f2cl-lib:int-add 1 1))
  (> 1 k) nil)
(tagbody
  (setf temp
    (+ temp
      (*
        (f2cl-lib:dconjg
          (f2cl-lib:fref a-%data%
            (1 i)
            ((1 lda) (1 *))
            a-%offset%))
        (f2cl-lib:fref a-%data%
          (1 j)
          ((1 lda) (1 *))
          a-%offset%))))))
(cond
  ((= beta zero)
    (setf (f2cl-lib:fref c-%data%
      (i j)
      ((1 ldc) (1 *))
      c-%offset%)
      (* alpha temp)))
  (t
    (setf (f2cl-lib:fref c-%data%
      (i j)
      ((1 ldc) (1 *))
      c-%offset%)
      (+ (* alpha temp)
        (* beta
          (f2cl-lib:fref c-%data%
            (i j)
            ((1 ldc) (1 *))
            c-%offset%)))))))
(setf rtemp zero)
(f2cl-lib:fdo (1 1 (f2cl-lib:int-add 1 1))
  (> 1 k) nil)
(tagbody
  (setf rtemp
    (coerce
      (realpart
        (+ rtemp
          (*
            (f2cl-lib:dconjg
              (f2cl-lib:fref a-%data%
                (1 j)
                ((1 lda) (1 *))

```

```

                                a-%offset%))
(f2cl-lib:fref a-%data%
  (1 j)
  ((1 lda) (1 *))
  a-%offset%)))
'double-float)))
(cond
  ((= beta zero)
    (setf (f2cl-lib:fref c-%data%
      (j j)
      ((1 ldc) (1 *))
      c-%offset%)
      (coerce (* alpha rtemp) '(complex double-float))))
  (t
    (setf (f2cl-lib:fref c-%data%
      (j j)
      ((1 ldc) (1 *))
      c-%offset%)
      (coerce
        (+ (* alpha rtemp)
          (* beta
            (coerce (realpart
              (f2cl-lib:fref c-%data%
                (j j)
                ((1 ldc) (1 *))
                c-%offset%)
              'double-float)))
          '(complex double-float))))))
    (t
      (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
        ((> j n) nil)
        (tagbody
          (setf rtemp zero)
          (f2cl-lib:fdo (l 1 (f2cl-lib:int-add l 1))
            ((> l k) nil)
            (tagbody
              (setf rtemp
                (coerce
                  (realpart
                    (+ rtemp
                      (*
                        (f2cl-lib:dconjg
                          (f2cl-lib:fref a-%data%
                            (1 j)
                            ((1 lda) (1 *))
                            a-%offset%))

```

```

(f2cl-lib:fref a-%data%
  (1 j)
  ((1 lda) (1 *))
  a-%offset%)))
'double-float))))
(cond
  (= beta zero)
  (setf (f2cl-lib:fref c-%data%
    (j j)
    ((1 ldc) (1 *))
    c-%offset%)
    (coerce (* alpha rtemp) '(complex double-float))))
(t
  (setf (f2cl-lib:fref c-%data%
    (j j)
    ((1 ldc) (1 *))
    c-%offset%)
    (coerce
      (+ (* alpha rtemp)
        (* beta
          (coerce (realpart
            (f2cl-lib:fref c-%data%
              (j j)
              ((1 ldc) (1 *))
              c-%offset%))
            'double-float)))
        '(complex double-float))))))
(f2cl-lib:fdo (i (f2cl-lib:int-add j 1)
  (f2cl-lib:int-add i 1))
  (> i n) nil)
(tagbody
  (setf temp (coerce zero '(complex double-float)))
  (f2cl-lib:fdo (l 1 (f2cl-lib:int-add 1 1))
    (> l k) nil)
  (tagbody
    (setf temp
      (+ temp
        (*
          (f2cl-lib:dconjg
            (f2cl-lib:fref a-%data%
              (1 i)
              ((1 lda) (1 *))
              a-%offset%))
          (f2cl-lib:fref a-%data%
            (1 j)
            ((1 lda) (1 *))

```

```

a-%offset%))))))
(cond
  ((= beta zero)
    (setf (f2cl-lib:fref c-%data%
                        (i j)
                        ((1 ldc) (1 *))
                        c-%offset%)
          (* alpha temp)))
  (t
    (setf (f2cl-lib:fref c-%data%
                        (i j)
                        ((1 ldc) (1 *))
                        c-%offset%)
          (+ (* alpha temp)
             (* beta
              (f2cl-lib:fref c-%data%
                              (i j)
                              ((1 ldc) (1 *))
                              c-%offset%))))))))))
end_label
(return (values nil nil nil nil nil nil nil nil nil))))))

```

## 6.11 zsymm BLAS

```

⟨zsymm.input⟩≡
)set break resume
)sys rm -f zsymm.output
)spool zsymm.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)

```

`<zsymm.help>=`

```
=====
zsymm examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

ZSYMM - perform one of the matrix-matrix operations  $C := \alpha * A * B + \beta * C$ ,

#### SYNOPSIS

SUBROUTINE ZSYMM ( SIDE, UPLO, M, N, ALPHA, A, LDA, B, LDB,  
BETA, C, LDC )

CHARACTER\*1 SIDE, UPLO

INTEGER M, N, LDA, LDB, LDC

COMPLEX\*16 ALPHA, BETA

COMPLEX\*16 A( LDA, \* ), B( LDB, \* ), C( LDC, \* )

#### PURPOSE

ZSYMM performs one of the matrix-matrix operations

or

$C := \alpha * B * A + \beta * C$ ,

where alpha and beta are scalars, A is a symmetric matrix  
and B and C are m by n matrices.

#### PARAMETERS

SIDE - CHARACTER\*1.

On entry, SIDE specifies whether the symmetric  
matrix A appears on the left or right in the  
operation as follows:

SIDE = 'L' or 'l'  $C := \alpha * A * B + \beta * C$ ,

SIDE = 'R' or 'r'  $C := \alpha * B * A + \beta * C$ ,

Unchanged on exit.

UPLO - CHARACTER\*1.

On entry, UPLO specifies whether the upper or lower triangular part of the symmetric matrix A is to be referenced as follows:

UPLO = 'U' or 'u' Only the upper triangular part of the symmetric matrix is to be referenced.

UPLO = 'L' or 'l' Only the lower triangular part of the symmetric matrix is to be referenced.

Unchanged on exit.

M - INTEGER.

On entry, M specifies the number of rows of the matrix C. M must be at least zero. Unchanged on exit.

N - INTEGER.

On entry, N specifies the number of columns of the matrix C. N must be at least zero. Unchanged on exit.

ALPHA - COMPLEX\*16 .

On entry, ALPHA specifies the scalar alpha. Unchanged on exit.

ka is

A -  
COMPLEX\*16 array of DIMENSION ( LDA, ka ), where m when SIDE = 'L' or 'l' and is n otherwise. Before entry with SIDE = 'L' or 'l', the m by m part of the array A must contain the symmetric matrix, such that when UPLO = 'U' or 'u', the leading m by m upper triangular part of the array A must contain the upper triangular part of the symmetric matrix and the strictly lower triangular part of A is not referenced, and when UPLO = 'L' or 'l', the leading m by m lower triangular part of the array A must contain the lower triangular part of the symmetric matrix and the strictly upper triangular part of A is not referenced. Before entry with SIDE = 'R' or 'r', the n by n part of the array A must contain the symmetric matrix, such that when UPLO = 'U' or 'u', the lead-

ing  $n$  by  $n$  upper triangular part of the array  $A$  must contain the upper triangular part of the symmetric matrix and the strictly lower triangular part of  $A$  is not referenced, and when  $UPLO = 'L'$  or  $'l'$ , the leading  $n$  by  $n$  lower triangular part of the array  $A$  must contain the lower triangular part of the symmetric matrix and the strictly upper triangular part of  $A$  is not referenced. Unchanged on exit.

- LDA - INTEGER.  
On entry, LDA specifies the first dimension of  $A$  as declared in the calling (sub) program. When  $SIDE = 'L'$  or  $'l'$  then LDA must be at least  $\max(1, m)$ , otherwise LDA must be at least  $\max(1, n)$ . Unchanged on exit.
- B - COMPLEX\*16 array of DIMENSION ( LDB,  $n$  ).  
Before entry, the leading  $m$  by  $n$  part of the array  $B$  must contain the matrix  $B$ . Unchanged on exit.
- LDB - INTEGER.  
On entry, LDB specifies the first dimension of  $B$  as declared in the calling (sub) program. LDB must be at least  $\max(1, m)$ . Unchanged on exit.
- BETA - COMPLEX\*16 .  
On entry, BETA specifies the scalar  $\beta$ . When BETA is supplied as zero then  $C$  need not be set on input. Unchanged on exit.
- C - COMPLEX\*16 array of DIMENSION ( LDC,  $n$  ).  
Before entry, the leading  $m$  by  $n$  part of the array  $C$  must contain the matrix  $C$ , except when  $\beta$  is zero, in which case  $C$  need not be set on entry. On exit, the array  $C$  is overwritten by the  $m$  by  $n$  updated matrix.
- LDC - INTEGER.  
On entry, LDC specifies the first dimension of  $C$  as declared in the calling (sub) program. LDC must be at least  $\max(1, m)$ . Unchanged on exit.

```

⟨BLAS 3 zsymm⟩≡
  (let* ((one (complex 1.0 0.0)) (zero (complex 0.0 0.0)))
    (declare (type (complex double-float) one) (type (complex double-float) zero))
    (defun zsymm (side uplo m n alpha a lda b ldb$ beta c ldc)
      (declare (type (simple-array (complex double-float) (*)) c b a)
        (type (complex double-float) beta alpha)
        (type fixnum ldc ldb$ lda n m)
        (type character uplo side))
      (f2cl-lib:with-multi-array-data
        ((side character side-%data% side-%offset%)
         (uplo character uplo-%data% uplo-%offset%)
         (a (complex double-float) a-%data% a-%offset%)
         (b (complex double-float) b-%data% b-%offset%)
         (c (complex double-float) c-%data% c-%offset%))
        (prog ((temp1 #C(0.0 0.0)) (temp2 #C(0.0 0.0)) (i 0) (info 0) (j 0) (k 0)
              (nrowa 0) (upper nil))
          (declare (type (complex double-float) temp1 temp2)
            (type fixnum i info j k nrowa)
            (type (member t nil) upper))
          (cond
            ((char-equal side #\L)
              (setf nrowa m))
            (t
              (setf nrowa n)))
          (setf upper (char-equal uplo #\U))
          (setf info 0)
          (cond
            ((and (not (char-equal side #\L)) (not (char-equal side #\R)))
              (setf info 1))
            ((and (not upper) (not (char-equal uplo #\L)))
              (setf info 2))
            ((< m 0)
              (setf info 3))
            ((< n 0)
              (setf info 4))
            ((< lda (max (the fixnum 1) (the fixnum nrowa)))
              (setf info 7))
            ((< ldb$ (max (the fixnum 1) (the fixnum m)))
              (setf info 9))
            ((< ldc (max (the fixnum 1) (the fixnum m)))
              (setf info 12)))
          (cond
            ((/= info 0)
              (error
                " ** On entry to ~a parameter number ~a had an illegal value~%"
                "ZSYMM" info))

```



```

      (go end_label)))
    (if (or (= m 0) (= n 0) (and (= alpha zero) (= beta one)))
        (go end_label))
    (cond
      ((= alpha zero)
        (cond
          ((= beta zero)
            (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                          ((> j n) nil)
            (tagbody
              (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                            ((> i m) nil)
              (tagbody
                (setf (f2cl-lib:fref c-%data%
                                     (i j)
                                     ((1 ldc) (1 *))
                                     c-%offset%)
                      zero))))))
          (t
            (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                          ((> j n) nil)
            (tagbody
              (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                            ((> i m) nil)
              (tagbody
                (setf (f2cl-lib:fref c-%data%
                                     (i j)
                                     ((1 ldc) (1 *))
                                     c-%offset%)
                      (* beta
                        (f2cl-lib:fref c-%data%
                                       (i j)
                                       ((1 ldc) (1 *))
                                       c-%offset%))))))))
            (go end_label)))
      (cond
        ((char-equal side #\L)
          (cond
            (upper
              (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                            ((> j n) nil)
              (tagbody
                (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                              ((> i m) nil)
                (tagbody
                  (setf temp1

```

```

(* alpha
  (f2cl-lib:fref b-%data%
    (i j)
    ((1 ldb$) (1 *))
    b-%offset%)))
(setf temp2 zero)
(f2cl-lib:fdo (k 1 (f2cl-lib:int-add k 1))
  (> k
    (f2cl-lib:int-add i
      (f2cl-lib:int-sub
        1))))
  nil)
(tagbody
  (setf (f2cl-lib:fref c-%data%
    (k j)
    ((1 ldc) (1 *))
    c-%offset%)
    (+
      (f2cl-lib:fref c-%data%
        (k j)
        ((1 ldc) (1 *))
        c-%offset%)
      (* temp1
        (f2cl-lib:fref a-%data%
          (k i)
          ((1 lda) (1 *))
          a-%offset%))))))
(setf temp2
  (+ temp2
    (*
      (f2cl-lib:fref b-%data%
        (k j)
        ((1 ldb$) (1 *))
        b-%offset%)
      (f2cl-lib:fref a-%data%
        (k i)
        ((1 lda) (1 *))
        a-%offset%))))))
(cond
  ((= beta zero)
    (setf (f2cl-lib:fref c-%data%
      (i j)
      ((1 ldc) (1 *))
      c-%offset%)
      (+
        (* temp1
          (f2cl-lib:fref a-%data%
            (k i)
            ((1 lda) (1 *))
            a-%offset%))))))

```

```

(f2cl-lib:fref a-%data%
  (i i)
  ((1 lda) (1 *))
  a-%offset%))
(* alpha temp2))))
(t
  (setf (f2cl-lib:fref c-%data%
    (i j)
    ((1 ldc) (1 *))
    c-%offset%))
    (+
      (* beta
        (f2cl-lib:fref c-%data%
          (i j)
          ((1 ldc) (1 *))
          c-%offset%))
        (* temp1
          (f2cl-lib:fref a-%data%
            (i i)
            ((1 lda) (1 *))
            a-%offset%))
          (* alpha temp2)))))))))
(t
  (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
    (> j n) nil)
  (tagbody
    (f2cl-lib:fdo (i m (f2cl-lib:int-add i (f2cl-lib:int-sub 1)))
      (> i 1) nil)
    (tagbody
      (setf temp1
        (* alpha
          (f2cl-lib:fref b-%data%
            (i j)
            ((1 ldb) (1 *))
            b-%offset%)))
        (setf temp2 zero)
        (f2cl-lib:fdo (k (f2cl-lib:int-add i 1)
          (f2cl-lib:int-add k 1))
          (> k m) nil)
        (tagbody
          (setf (f2cl-lib:fref c-%data%
            (k j)
            ((1 ldc) (1 *))
            c-%offset%))
            (+
              (f2cl-lib:fref c-%data%

```

```

(k j)
((1 ldc) (1 *))
c-%offset%)

(* temp1
  (f2cl-lib:fref a-%data%
    (k i)
    ((1 lda) (1 *))
    a-%offset%)))

(setf temp2
  (+ temp2
    (*
      (f2cl-lib:fref b-%data%
        (k j)
        ((1 ldb$) (1 *))
        b-%offset%)
      (f2cl-lib:fref a-%data%
        (k i)
        ((1 lda) (1 *))
        a-%offset%))))))

(cond
  ((= beta zero)
    (setf (f2cl-lib:fref c-%data%
      (i j)
      ((1 ldc) (1 *))
      c-%offset%)
      (+
        (* temp1
          (f2cl-lib:fref a-%data%
            (i i)
            ((1 lda) (1 *))
            a-%offset%))
        (* alpha temp2))))))

(t
  (setf (f2cl-lib:fref c-%data%
    (i j)
    ((1 ldc) (1 *))
    c-%offset%)
    (+
      (* beta
        (f2cl-lib:fref c-%data%
          (i j)
          ((1 ldc) (1 *))
          c-%offset%)
        (* temp1
          (f2cl-lib:fref a-%data%
            (i i)
            ((1 lda) (1 *))
            a-%offset%))
          ))))

```

```

((1 lda) (1 *))
a-%offset%))
(* alpha temp2))))))))))
(t
(f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
  (> j n) nil)
(tagbody
  (setf temp1
    (* alpha
      (f2cl-lib:fref a-%data%
        (j j)
        ((1 lda) (1 *))
        a-%offset%)))
(cond
  ((= beta zero)
    (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
      (> i m) nil)
    (tagbody
      (setf (f2cl-lib:fref c-%data%
        (i j)
        ((1 ldc) (1 *))
        c-%offset%))
        (* temp1
          (f2cl-lib:fref b-%data%
            (i j)
            ((1 ldb$) (1 *))
            b-%offset%))))))
(t
(f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
  (> i m) nil)
(tagbody
  (setf (f2cl-lib:fref c-%data%
    (i j)
    ((1 ldc) (1 *))
    c-%offset%))
    (+
      (* beta
        (f2cl-lib:fref c-%data%
          (i j)
          ((1 ldc) (1 *))
          c-%offset%))
      (* temp1
        (f2cl-lib:fref b-%data%
          (i j)
          ((1 ldb$) (1 *))
          b-%offset%))))))

```

```

(f2cl-lib:fdo (k 1 (f2cl-lib:int-add k 1))
  (> k (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
  nil)

(tagbody
  (cond
    (upper
      (setf temp1
        (* alpha
          (f2cl-lib:fref a-%data%
            (k j)
            ((1 lda) (1 *))
            a-%offset%))))

    (t
      (setf temp1
        (* alpha
          (f2cl-lib:fref a-%data%
            (j k)
            ((1 lda) (1 *))
            a-%offset%))))))

(f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
  (> i m) nil)

(tagbody
  (setf (f2cl-lib:fref c-%data%
    (i j)
    ((1 ldc) (1 *))
    c-%offset%)

    (+
      (f2cl-lib:fref c-%data%
        (i j)
        ((1 ldc) (1 *))
        c-%offset%)

      (* temp1
        (f2cl-lib:fref b-%data%
          (i k)
          ((1 ldb) (1 *))
          b-%offset%))))))

(f2cl-lib:fdo (k (f2cl-lib:int-add j 1) (f2cl-lib:int-add k 1))
  (> k n) nil)

(tagbody
  (cond
    (upper
      (setf temp1
        (* alpha
          (f2cl-lib:fref a-%data%
            (j k)
            ((1 lda) (1 *))

```

```

a-%offset%))))
(t
  (setf temp1
    (* alpha
      (f2cl-lib:fref a-%data%
        (k j)
        ((1 lda) (1 *))
        a-%offset%))))
(f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
  (> i m) nil)
(tagbody
  (setf (f2cl-lib:fref c-%data%
    (i j)
    ((1 ldc) (1 *))
    c-%offset%)
    (+
      (f2cl-lib:fref c-%data%
        (i j)
        ((1 ldc) (1 *))
        c-%offset%)
      (* temp1
        (f2cl-lib:fref b-%data%
          (i k)
          ((1 ldb$) (1 *))
          b-%offset%))))))
end_label
(return (values nil nil nil nil nil nil nil nil nil nil nil))

```

## 6.12 zsyr2k BLAS

```

⟨zsyr2k.input⟩≡
)set break resume
)sys rm -f zsyr2k.output
)spool zsyr2k.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)

```

`<zsy2k.help>≡`

```
=====
zsy2k examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

ZSYR2K - perform one of the symmetric rank 2k operations    C  
 $C := \alpha A B' + \alpha B A' + \beta C,$

#### SYNOPSIS

```
SUBROUTINE ZSYR2K( UPLO, TRANS, N, K, ALPHA, A, LDA, B, LDB,
                  BETA, C, LDC )
```

```
      CHARACTER*1    UPLO, TRANS
```

```
      INTEGER        N, K, LDA, LDB, LDC
```

```
      COMPLEX*16     ALPHA, BETA
```

```
      COMPLEX*16     A( LDA, * ), B( LDB, * ), C( LDC, * )
```

#### PURPOSE

ZSYR2K performs one of the symmetric rank 2k operations

or

$$C := \alpha A' B + \alpha B' A + \beta C,$$

where alpha and beta are scalars, C is an n by n symmetric matrix and A and B are n by k matrices in the first case and k by n matrices in the second case.

#### PARAMETERS

UPLO - CHARACTER\*1.

On entry, UPLO specifies whether the upper or lower triangular part of the array C is to be referenced as follows:

UPLO = 'U' or 'u' Only the upper triangular part of C is to be referenced.

UPLO = 'L' or 'l' Only the lower triangular part



of C is to be referenced.

Unchanged on exit.

TRANS - CHARACTER\*1.

On entry, TRANS specifies the operation to be performed as follows:

TRANS = 'N' or 'n'      $C := \alpha * A * B + \alpha * B * A + \beta * C$ .

TRANS = 'T' or 't'      $C := \alpha * A' * B + \alpha * B' * A + \beta * C$ .

Unchanged on exit.

N - INTEGER.

On entry, N specifies the order of the matrix C. N must be at least zero. Unchanged on exit.

K - INTEGER.

On entry with TRANS = 'N' or 'n', K specifies the number of columns of the matrices A and B, and on entry with TRANS = 'T' or 't', K specifies the number of rows of the matrices A and B. K must be at least zero. Unchanged on exit.

ALPHA - COMPLEX\*16 .

On entry, ALPHA specifies the scalar alpha. Unchanged on exit.

ka is

A -

COMPLEX\*16 array of DIMENSION ( LDA, ka ), where k when TRANS = 'N' or 'n', and is n otherwise. Before entry with TRANS = 'N' or 'n', the leading n by k part of the array A must contain the matrix A, otherwise the leading k by n part of the array A must contain the matrix A. Unchanged on exit.

LDA - INTEGER.

On entry, LDA specifies the first dimension of A as declared in the calling (sub) program. When TRANS = 'N' or 'n' then LDA must be at least max( 1, n ), otherwise LDA must be at least max( 1, k ). Unchanged on exit.

`kb` is  
`B`     -     COMPLEX\*16         array of DIMENSION ( `LDB`, `kb` ), where  
           `k` when `TRANS` = 'N' or 'n', and is `n` otherwise.  
           Before entry with `TRANS` = 'N' or 'n', the leading  
           `n` by `k` part of the array `B` must contain the matrix  
           `B`, otherwise the leading `k` by `n` part of the array  
           `B` must contain the matrix `B`. Unchanged on exit.

`LDB`   - INTEGER.  
           On entry, `LDB` specifies the first dimension of `B` as  
           declared in the calling (sub) program. When  
           `TRANS` = 'N' or 'n' then `LDB` must be at least `max(`  
           `1, n )`, otherwise `LDB` must be at least `max( 1, k )`.  
           Unchanged on exit.

`BETA`   - COMPLEX\*16         .  
           On entry, `BETA` specifies the scalar beta. Unchanged  
           on exit.

`C`       - COMPLEX\*16         array of DIMENSION ( `LDC`, `n` ).  
           Before entry with `UPLO` = 'U' or 'u', the leading  
           `n` by `n` upper triangular part of the array `C` must con-  
           tain the upper triangular part of the symmetric  
           matrix and the strictly lower triangular part of `C`  
           is not referenced. On exit, the upper triangular  
           part of the array `C` is overwritten by the upper tri-  
           angular part of the updated matrix. Before entry  
           with `UPLO` = 'L' or 'l', the leading `n` by `n` lower  
           triangular part of the array `C` must contain the lower  
           triangular part of the symmetric matrix and the  
           strictly upper triangular part of `C` is not refer-  
           enced. On exit, the lower triangular part of the  
           array `C` is overwritten by the lower triangular part  
           of the updated matrix.

`LDC`    - INTEGER.  
           On entry, `LDC` specifies the first dimension of `C` as  
           declared in the calling (sub) program. `LDC`  
           must be at least `max( 1, n )`. Unchanged on exit.

```

<BLAS 3 zsyr2k>≡
  (let* ((one (complex 1.0 0.0)) (zero (complex 0.0 0.0)))
    (declare (type (complex double-float) one) (type (complex double-float) zero))
    (defun zsyr2k (uplo trans n k alpha a lda b ldb$ beta c ldc)
      (declare (type (simple-array (complex double-float) (*)) c b a)
        (type (complex double-float) beta alpha)
        (type fixnum ldc ldb$ lda k n)
        (type character trans uplo))
      (f2cl-lib:with-multi-array-data
        ((uplo character uplo-%data% uplo-%offset%)
         (trans character trans-%data% trans-%offset%)
         (a (complex double-float) a-%data% a-%offset%)
         (b (complex double-float) b-%data% b-%offset%)
         (c (complex double-float) c-%data% c-%offset%))
        (prog ((temp1 #C(0.0 0.0)) (temp2 #C(0.0 0.0)) (i 0) (info 0) (j 0) (l 0)
              (nrowa 0) (upper nil))
          (declare (type (complex double-float) temp1 temp2)
            (type fixnum i info j l nrowa)
            (type (member t nil) upper))
          (cond
            ((char-equal trans #\N)
              (setf nrowa n))
            (t
              (setf nrowa k)))
          (setf upper (char-equal uplo #\U))
          (setf info 0)
          (cond
            ((and (not upper) (not (char-equal uplo #\L)))
              (setf info 1))
            ((and (not (char-equal trans #\N)) (not (char-equal trans #\T)))
              (setf info 2))
            ((< n 0)
              (setf info 3))
            ((< k 0)
              (setf info 4))
            ((< lda (max (the fixnum 1) (the fixnum nrowa)))
              (setf info 7))
            ((< ldb$
              (max (the fixnum 1) (the fixnum nrowa)))
              (setf info 9))
            ((< ldc (max (the fixnum 1) (the fixnum n)))
              (setf info 12)))
          (cond
            ((/= info 0)
              (error
                " ** On entry to ~a parameter number ~a had an illegal value~%"

```

[illegible]

```

        (setf (f2cl-lib:fref c-%data%
                           (i j)
                           ((1 ldc) (1 *))
                           c-%offset%)
              zero))))))
(t
 (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
               ((> j n) nil)
 (tagbody
  (f2cl-lib:fdo (i j (f2cl-lib:int-add i 1))
                ((> i n) nil)
  (tagbody
   (setf (f2cl-lib:fref c-%data%
                        (i j)
                        ((1 ldc) (1 *))
                        c-%offset%)
         (* beta
            (f2cl-lib:fref c-%data%
                           (i j)
                           ((1 ldc) (1 *))
                           c-%offset%))))))))))
(go end_label)))
(cond
 ((char-equal trans #\N)
  (cond
   (upper
    (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                  ((> j n) nil)
    (tagbody
     (cond
      ((= beta zero)
       (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                     ((> i j) nil)
       (tagbody
        (setf (f2cl-lib:fref c-%data%
                             (i j)
                             ((1 ldc) (1 *))
                             c-%offset%)
              zero))))
      ((/= beta one)
       (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                     ((> i j) nil)
       (tagbody
        (setf (f2cl-lib:fref c-%data%
                             (i j)
                             ((1 ldc) (1 *))

```

```

                                c-%offset%)
(* beta
  (f2cl-lib:fref c-%data%
    (i j)
    ((1 ldc) (1 *))
    c-%offset%))))))
(f2cl-lib:fdo (1 1 (f2cl-lib:int-add 1 1))
  (> 1 k) nil)
(tagbody
  (cond
    ((or (/= (f2cl-lib:fref a (j 1) ((1 lda) (1 *))) zero)
      (/= (f2cl-lib:fref b (j 1) ((1 ldb$) (1 *))) zero))
      (setf temp1
        (* alpha
          (f2cl-lib:fref b-%data%
            (j 1)
            ((1 ldb$) (1 *))
            b-%offset%)))
        (setf temp2
          (* alpha
            (f2cl-lib:fref a-%data%
              (j 1)
              ((1 lda) (1 *))
              a-%offset%)))
          (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
            (> i j) nil)
            (tagbody
              (setf (f2cl-lib:fref c-%data%
                (i j)
                ((1 ldc) (1 *))
                c-%offset%)
                (+
                  (f2cl-lib:fref c-%data%
                    (i j)
                    ((1 ldc) (1 *))
                    c-%offset%)
                  (*
                    (f2cl-lib:fref a-%data%
                      (i 1)
                      ((1 lda) (1 *))
                      a-%offset%)
                    temp1)
                  (*
                    (f2cl-lib:fref b-%data%
                      (i 1)
                      ((1 ldb$) (1 *))

```

```

                                b-%offset%)
                                temp2)))))))))))))
(t
(f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
              ((> j n) nil)
(tagbody
(cond
  ((= beta zero)
   (f2cl-lib:fdo (i j (f2cl-lib:int-add i 1))
                 ((> i n) nil)
   (tagbody
    (setf (f2cl-lib:fref c-%data%
                        (i j)
                        ((1 ldc) (1 *))
                        c-%offset%)
          zero))))
  ((/= beta one)
   (f2cl-lib:fdo (i j (f2cl-lib:int-add i 1))
                 ((> i n) nil)
   (tagbody
    (setf (f2cl-lib:fref c-%data%
                        (i j)
                        ((1 ldc) (1 *))
                        c-%offset%)
          (* beta
            (f2cl-lib:fref c-%data%
                          (i j)
                          ((1 ldc) (1 *))
                          c-%offset%)))))))
(f2cl-lib:fdo (l 1 (f2cl-lib:int-add l 1))
              ((> l k) nil)
(tagbody
(cond
  ((or (/= (f2cl-lib:fref a (j 1) ((1 lda) (1 *))) zero)
        (/= (f2cl-lib:fref b (j 1) ((1 ldb$) (1 *))) zero))
   (setf temp1
          (* alpha
            (f2cl-lib:fref b-%data%
                          (j 1)
                          ((1 ldb$) (1 *))
                          b-%offset%)))
   (setf temp2
          (* alpha
            (f2cl-lib:fref a-%data%
                          (j 1)
                          ((1 lda) (1 *))

```

```

                                a-%offset%)))
(f2cl-lib:fdo (i j (f2cl-lib:int-add i 1))
  ((> i n) nil)
  (tagbody
    (setf (f2cl-lib:fref c-%data%
                        (i j)
                        ((1 ldc) (1 *))
                        c-%offset%)
      (+
        (f2cl-lib:fref c-%data%
                      (i j)
                      ((1 ldc) (1 *))
                      c-%offset%)
        (*
          (f2cl-lib:fref a-%data%
                        (i 1)
                        ((1 lda) (1 *))
                        a-%offset%)
          temp1)
        (*
          (f2cl-lib:fref b-%data%
                        (i 1)
                        ((1 ldb$) (1 *))
                        b-%offset%)
          temp2)))))))))))))
(t
  (cond
    (upper
      (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
        ((> j n) nil)
        (tagbody
          (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
            ((> i j) nil)
            (tagbody
              (setf temp1 zero)
              (setf temp2 zero)
              (f2cl-lib:fdo (l 1 (f2cl-lib:int-add l 1))
                ((> l k) nil)
                (tagbody
                  (setf temp1
                    (+ temp1
                      (*
                        (f2cl-lib:fref a-%data%
                                      (l i)
                                      ((1 lda) (1 *))
                                      a-%offset%)

```



```

(f2cl-lib:fref b-%data%
  (1 j)
  ((1 ldb$) (1 *))
  b-%offset%)))
(setf temp2
  (+ temp2
    (*
      (f2cl-lib:fref b-%data%
        (1 i)
        ((1 ldb$) (1 *))
        b-%offset%)
      (f2cl-lib:fref a-%data%
        (1 j)
        ((1 lda) (1 *))
        a-%offset%))))))
(cond
  ((= beta zero)
    (setf (f2cl-lib:fref c-%data%
      (i j)
      ((1 ldc) (1 *))
      c-%offset%)
      (+ (* alpha temp1) (* alpha temp2))))
  (t
    (setf (f2cl-lib:fref c-%data%
      (i j)
      ((1 ldc) (1 *))
      c-%offset%)
      (+
        (* beta
          (f2cl-lib:fref c-%data%
            (i j)
            ((1 ldc) (1 *))
            c-%offset%))
        (* alpha temp1)
        (* alpha temp2))))))
(t
  (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
    (> j n) nil)
  (tagbody
    (f2cl-lib:fdo (i j (f2cl-lib:int-add i 1))
      (> i n) nil)
    (tagbody
      (setf temp1 zero)
      (setf temp2 zero)
      (f2cl-lib:fdo (l 1 (f2cl-lib:int-add l 1))
        (> l k) nil)

```

```

(tagbody
  (setf temp1
    (+ temp1
      (*
        (f2cl-lib:fref a-%data%
          (1 i)
          ((1 lda) (1 *))
          a-%offset%)
        (f2cl-lib:fref b-%data%
          (1 j)
          ((1 ldb$) (1 *))
          b-%offset%))))
    (setf temp2
      (+ temp2
        (*
          (f2cl-lib:fref b-%data%
            (1 i)
            ((1 ldb$) (1 *))
            b-%offset%)
          (f2cl-lib:fref a-%data%
            (1 j)
            ((1 lda) (1 *))
            a-%offset%))))))
(cond
  ((= beta zero)
    (setf (f2cl-lib:fref c-%data%
      (i j)
      ((1 ldc) (1 *))
      c-%offset%)
      (+ (* alpha temp1) (* alpha temp2))))
  (t
    (setf (f2cl-lib:fref c-%data%
      (i j)
      ((1 ldc) (1 *))
      c-%offset%)
      (+
        (* beta
          (f2cl-lib:fref c-%data%
            (i j)
            ((1 ldc) (1 *))
            c-%offset%))
        (* alpha temp1)
        (* alpha temp2))))))
end_label
(return (values nil nil nil nil nil nil nil nil nil nil nil)))

```

### 6.13 zsyrrk BLAS

```
<zsyrrk.input>=  
  )set break resume  
  )sys rm -f zsyrrk.output  
  )spool zsyrrk.output  
  )set message test on  
  )set message auto off  
  )clear all  
  
  )spool  
  )lisp (bye)
```

`<zsyrok.help>=`

```
=====
zsyrok examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

ZSYRK - perform one of the symmetric rank k operations    C  
 $C := \alpha * A * A' + \beta * C,$

#### SYNOPSIS

```
SUBROUTINE ZSYRK ( UPLO, TRANS, N, K, ALPHA, A, LDA, BETA,
                  C, LDC )
```

```
CHARACTER*1  UPLO, TRANS
```

```
INTEGER      N, K, LDA, LDC
```

```
COMPLEX*16   ALPHA, BETA
```

```
COMPLEX*16   A( LDA, * ), C( LDC, * )
```

#### PURPOSE

ZSYRK performs one of the symmetric rank k operations

or

$$C := \alpha * A' * A + \beta * C,$$

where  $\alpha$  and  $\beta$  are scalars, C is an n by n symmetric matrix and A is an n by k matrix in the first case and a k by n matrix in the second case.

#### PARAMETERS

UPLO - CHARACTER\*1.

On entry, UPLO specifies whether the upper or lower triangular part of the array C is to be referenced as follows:

UPLO = 'U' or 'u' Only the upper triangular part of C is to be referenced.

UPLO = 'L' or 'l' Only the lower triangular part

of C is to be referenced.

Unchanged on exit.

TRANS - CHARACTER\*1.

On entry, TRANS specifies the operation to be performed as follows:

TRANS = 'N' or 'n'    C := alpha\*A\*A' + beta\*C.

TRANS = 'T' or 't'    C := alpha\*A'\*A + beta\*C.

Unchanged on exit.

N - INTEGER.

On entry, N specifies the order of the matrix C. N must be at least zero. Unchanged on exit.

K - INTEGER.

On entry with TRANS = 'N' or 'n', K specifies the number of columns of the matrix A, and on entry with TRANS = 'T' or 't', K specifies the number of rows of the matrix A. K must be at least zero. Unchanged on exit.

ALPHA - COMPLEX\*16 .

On entry, ALPHA specifies the scalar alpha. Unchanged on exit.

ka is

A -

COMPLEX\*16 array of DIMENSION ( LDA, ka ), where k when TRANS = 'N' or 'n', and is n otherwise. Before entry with TRANS = 'N' or 'n', the leading n by k part of the array A must contain the matrix A, otherwise the leading k by n part of the array A must contain the matrix A. Unchanged on exit.

LDA - INTEGER.

On entry, LDA specifies the first dimension of A as declared in the calling (sub) program. When TRANS = 'N' or 'n' then LDA must be at least max( 1, n ), otherwise LDA must be at least max( 1, k ). Unchanged on exit.

BETA - COMPLEX\*16 .

On entry, BETA specifies the scalar beta. Unchanged on exit.

C    - COMPLEX\*16        array of DIMENSION ( LDC, n ).  
Before entry with UPLO = 'U' or 'u', the leading n by n upper triangular part of the array C must contain the upper triangular part of the symmetric matrix and the strictly lower triangular part of C is not referenced. On exit, the upper triangular part of the array C is overwritten by the upper triangular part of the updated matrix. Before entry with UPLO = 'L' or 'l', the leading n by n lower triangular part of the array C must contain the lower triangular part of the symmetric matrix and the strictly upper triangular part of C is not referenced. On exit, the lower triangular part of the array C is overwritten by the lower triangular part of the updated matrix.

LDC    - INTEGER.

On entry, LDC specifies the first dimension of C as declared in the calling (sub) program. LDC must be at least  $\max(1, n)$ . Unchanged on exit.

```

<BLAS 3 zsyrrk>=
  (let* ((one (complex 1.0 0.0)) (zero (complex 0.0 0.0)))
    (declare (type (complex double-float) one) (type (complex double-float) zero))
    (defun zsyrrk (uplo trans n k alpha a lda beta c ldc)
      (declare (type (simple-array (complex double-float) (*)) c a)
        (type (complex double-float) beta alpha)
        (type fixnum ldc lda k n)
        (type character trans uplo))
      (f2cl-lib:with-multi-array-data
        ((uplo character uplo-%data% uplo-%offset%)
         (trans character trans-%data% trans-%offset%)
         (a (complex double-float) a-%data% a-%offset%)
         (c (complex double-float) c-%data% c-%offset%))
        (prog ((temp #C(0.0 0.0)) (i 0) (info 0) (j 0) (l 0) (nrowa 0)
              (upper nil))
          (declare (type (complex double-float) temp)
            (type fixnum i info j l nrowa)
            (type (member t nil) upper))
          (cond
            ((char-equal trans #\N)
              (setf nrowa n))
            (t
              (setf nrowa k)))
          (setf upper (char-equal uplo #\U))
          (setf info 0)
          (cond
            ((and (not upper) (not (char-equal uplo #\L)))
              (setf info 1))
            ((and (not (char-equal trans #\N)) (not (char-equal trans #\T)))
              (setf info 2))
            ((< n 0)
              (setf info 3))
            ((< k 0)
              (setf info 4))
            ((< lda (max (the fixnum 1) (the fixnum nrowa)))
              (setf info 7))
            ((< ldc (max (the fixnum 1) (the fixnum n)))
              (setf info 10)))
          (cond
            ((/= info 0)
              (error
                " ** On entry to ~a parameter number ~a had an illegal value~%"
                "ZSYRK" info)
              (go end_label)))
          (if (or (= n 0) (and (or (= alpha zero) (= k 0)) (= beta one)))
            (go end_label)))
    )
  )

```

```

(cond
  ((= alpha zero)
    (cond
      (upper
        (cond
          ((= beta zero)
            (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                          ((> j n) nil)
            (tagbody
              (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                            ((> i j) nil)
              (tagbody
                (setf (f2cl-lib:fref c-%data%
                                   (i j)
                                   ((1 ldc) (1 *))
                                   c-%offset%)
                      zero))))))
          (t
            (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                          ((> j n) nil)
            (tagbody
              (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                            ((> i j) nil)
              (tagbody
                (setf (f2cl-lib:fref c-%data%
                                   (i j)
                                   ((1 ldc) (1 *))
                                   c-%offset%)
                      (* beta
                        (f2cl-lib:fref c-%data%
                                       (i j)
                                       ((1 ldc) (1 *))
                                       c-%offset%))))))))))
      (t
        (cond
          ((= beta zero)
            (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                          ((> j n) nil)
            (tagbody
              (f2cl-lib:fdo (i j (f2cl-lib:int-add i 1))
                            ((> i n) nil)
              (tagbody
                (setf (f2cl-lib:fref c-%data%
                                   (i j)
                                   ((1 ldc) (1 *))
                                   c-%offset%)
                      zero))))))
          (t
            (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                          ((> j n) nil)
            (tagbody
              (f2cl-lib:fdo (i j (f2cl-lib:int-add i 1))
                            ((> i n) nil)
              (tagbody
                (setf (f2cl-lib:fref c-%data%
                                   (i j)
                                   ((1 ldc) (1 *))
                                   c-%offset%)
                      (* beta
                        (f2cl-lib:fref c-%data%
                                       (i j)
                                       ((1 ldc) (1 *))
                                       c-%offset%))))))))))
        ))
    ))
  ))

```



```

                                zero))))))
(t
  (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
    ((> j n) nil)
    (tagbody
      (f2cl-lib:fdo (i j (f2cl-lib:int-add i 1))
        ((> i n) nil)
        (tagbody
          (setf (f2cl-lib:fref c-%data%
                               (i j)
                               ((1 ldc) (1 *))
                               c-%offset%)
            (* beta
              (f2cl-lib:fref c-%data%
                             (i j)
                             ((1 ldc) (1 *))
                             c-%offset%))))))))))
  (go end_label)))
(cond
  ((char-equal trans #\N)
    (cond
      (upper
        (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
          ((> j n) nil)
          (tagbody
            (cond
              ((= beta zero)
                (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                  ((> i j) nil)
                  (tagbody
                    (setf (f2cl-lib:fref c-%data%
                                         (i j)
                                         ((1 ldc) (1 *))
                                         c-%offset%)
                      zero))))
                ((/= beta one)
                  (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                    ((> i j) nil)
                    (tagbody
                      (setf (f2cl-lib:fref c-%data%
                                           (i j)
                                           ((1 ldc) (1 *))
                                           c-%offset%)
                        (* beta
                          (f2cl-lib:fref c-%data%
                                           (i j)

```

```

((1 ldc) (1 *))
c-%offset%)))))))))
(f2cl-lib:fdo (1 1 (f2cl-lib:int-add 1 1))
  (> 1 k) nil)
(tagbody
  (cond
    ((/= (f2cl-lib:fref a (j 1) ((1 lda) (1 *))) zero)
      (setf temp
        (* alpha
          (f2cl-lib:fref a-%data%
            (j 1)
            ((1 lda) (1 *))
            a-%offset%)))
        (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
          (> i j) nil)
        (tagbody
          (setf (f2cl-lib:fref c-%data%
            (i j)
            ((1 ldc) (1 *))
            c-%offset%)
            (+
              (f2cl-lib:fref c-%data%
                (i j)
                ((1 ldc) (1 *))
                c-%offset%)
              (* temp
                (f2cl-lib:fref a-%data%
                  (i 1)
                  ((1 lda) (1 *))
                  a-%offset%)))))))))))))
(t
  (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
    (> j n) nil)
  (tagbody
    (cond
      ((= beta zero)
        (f2cl-lib:fdo (i j (f2cl-lib:int-add i 1))
          (> i n) nil)
        (tagbody
          (setf (f2cl-lib:fref c-%data%
            (i j)
            ((1 ldc) (1 *))
            c-%offset%)
            zero))))
      ((/= beta one)
        (f2cl-lib:fdo (i j (f2cl-lib:int-add i 1))

```

```

                                (> i n) nil)
(tagbody
  (setf (f2cl-lib:fref c-%data%
                     (i j)
                     ((1 ldc) (1 *))
                     c-%offset%))
    (* beta
      (f2cl-lib:fref c-%data%
                     (i j)
                     ((1 ldc) (1 *))
                     c-%offset%))))))
(f2cl-lib:fdo (1 1 (f2cl-lib:int-add 1 1))
  (> 1 k) nil)
(tagbody
  (cond
    ((/= (f2cl-lib:fref a (j 1) ((1 lda) (1 *))) zero)
      (setf temp
        (* alpha
          (f2cl-lib:fref a-%data%
                         (j 1)
                         ((1 lda) (1 *))
                         a-%offset%)))
        (f2cl-lib:fdo (i j (f2cl-lib:int-add i 1))
          (> i n) nil)
          (tagbody
            (setf (f2cl-lib:fref c-%data%
                               (i j)
                               ((1 ldc) (1 *))
                               c-%offset%))
              (+
                (f2cl-lib:fref c-%data%
                               (i j)
                               ((1 ldc) (1 *))
                               c-%offset%)
                (* temp
                  (f2cl-lib:fref a-%data%
                                 (i 1)
                                 ((1 lda) (1 *))
                                 a-%offset%))))))))))
(t
  (cond
    (upper
      (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
        (> j n) nil)
      (tagbody
        (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))

```



```

(setf temp
  (+ temp
    (*
      (f2cl-lib:fref a-%data%
        (1 i)
        ((1 lda) (1 *))
        a-%offset%)
      (f2cl-lib:fref a-%data%
        (1 j)
        ((1 lda) (1 *))
        a-%offset%))))))
(cond
  ((= beta zero)
    (setf (f2cl-lib:fref c-%data%
      (i j)
      ((1 ldc) (1 *))
      c-%offset%)
      (* alpha temp)))
  (t
    (setf (f2cl-lib:fref c-%data%
      (i j)
      ((1 ldc) (1 *))
      c-%offset%)
      (+ (* alpha temp)
        (* beta
          (f2cl-lib:fref c-%data%
            (i j)
            ((1 ldc) (1 *))
            c-%offset%))))))))))
end_label
(return (values nil nil nil nil nil nil nil nil nil))

```

## 6.14 ztrmm BLAS

```
<ztrmm.input>=  
  )set break resume  
  )sys rm -f ztrmm.output  
  )spool ztrmm.output  
  )set message test on  
  )set message auto off  
  )clear all  
  
  )spool  
  )lisp (bye)
```

`<ztrmm.help>=`

```
=====
ztrmm examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

ZTRMM - perform one of the matrix-matrix operations  $B := \alpha * \text{op}(A) * B$ , or  $B := \alpha * B * \text{op}(A)$  where  $\alpha$  is a scalar,  $B$  is an  $m$  by  $n$  matrix,  $A$  is a unit, or non-unit, upper or lower triangular matrix and  $\text{op}(A)$  is one of  $\text{op}(A) = A$  or  $\text{op}(A) = A'$  or  $\text{op}(A) = \text{conjg}(A')$

#### SYNOPSIS

```
SUBROUTINE ZTRMM ( SIDE, UPLO, TRANSA, DIAG, M, N, ALPHA, A,
                  LDA, B, LDB )
```

```
CHARACTER*1 SIDE, UPLO, TRANSA, DIAG
```

```
INTEGER      M, N, LDA, LDB
```

```
COMPLEX*16   ALPHA
```

```
COMPLEX*16   A( LDA, * ), B( LDB, * )
```

#### PURPOSE

ZTRMM performs one of the matrix-matrix operations

#### PARAMETERS

SIDE - CHARACTER\*1.

On entry, SIDE specifies whether  $\text{op}(A)$  multiplies  $B$  from the left or right as follows:

SIDE = 'L' or 'l'  $B := \alpha * \text{op}(A) * B$ .

SIDE = 'R' or 'r'  $B := \alpha * B * \text{op}(A)$ .

Unchanged on exit.

UPLO - CHARACTER\*1.

On entry, UPLO specifies whether the matrix  $A$  is an upper or lower triangular matrix as follows:

UPLO = 'U' or 'u'    A is an upper triangular matrix.

UPLO = 'L' or 'l'    A is a lower triangular matrix.

Unchanged on exit.

TRANSA - CHARACTER\*1. On entry, TRANSA specifies the form of op( A ) to be used in the matrix multiplication as follows:

TRANSA = 'N' or 'n'    op( A ) = A.

TRANSA = 'T' or 't'    op( A ) = A'.

TRANSA = 'C' or 'c'    op( A ) = conjg( A' ).

Unchanged on exit.

DIAG - CHARACTER\*1.

On entry, DIAG specifies whether or not A is unit triangular as follows:

DIAG = 'U' or 'u'    A is assumed to be unit triangular.

DIAG = 'N' or 'n'    A is not assumed to be unit triangular.

Unchanged on exit.

M - INTEGER.

On entry, M specifies the number of rows of B. M must be at least zero. Unchanged on exit.

N - INTEGER.

On entry, N specifies the number of columns of B. N must be at least zero. Unchanged on exit.

ALPHA - COMPLEX\*16 .

On entry, ALPHA specifies the scalar alpha. When alpha is zero then A is not referenced and B need not be set before entry. Unchanged on exit.

is m

A -

COMPLEX\*16            array of DIMENSION ( LDA, k ), where k



when `SIDE = 'L'` or `'l'` and is `n` when `SIDE = 'R'` or `'r'`. Before entry with `UPLO = 'U'` or `'u'`, the leading `k` by `k` upper triangular part of the array `A` must contain the upper triangular matrix and the strictly lower triangular part of `A` is not referenced. Before entry with `UPLO = 'L'` or `'l'`, the leading `k` by `k` lower triangular part of the array `A` must contain the lower triangular matrix and the strictly upper triangular part of `A` is not referenced. Note that when `DIAG = 'U'` or `'u'`, the diagonal elements of `A` are not referenced either, but are assumed to be unity. Unchanged on exit.

LDA - INTEGER.

On entry, LDA specifies the first dimension of `A` as declared in the calling (sub) program. When `SIDE = 'L'` or `'l'` then LDA must be at least `max( 1, m )`, when `SIDE = 'R'` or `'r'` then LDA must be at least `max( 1, n )`. Unchanged on exit.

B - COMPLEX\*16 array of DIMENSION ( LDB, n ).  
Before entry, the leading `m` by `n` part of the array `B` must contain the matrix `B`, and on exit is overwritten by the transformed matrix.

LDB - INTEGER.

On entry, LDB specifies the first dimension of `B` as declared in the calling (sub) program. LDB must be at least `max( 1, m )`. Unchanged on exit.

```

<BLAS 3 ztrmm>=
  (let* ((one (complex 1.0 0.0)) (zero (complex 0.0 0.0)))
    (declare (type (complex double-float) one) (type (complex double-float) zero))
    (defun ztrmm (side uplo transa diag m n alpha a lda b ldb$)
      (declare (type (simple-array (complex double-float) (*)) b a)
        (type (complex double-float) alpha)
        (type fixnum ldb$ lda n m)
        (type character diag transa uplo side))
      (f2cl-lib:with-multi-array-data
        ((side character side-%data% side-%offset%)
         (uplo character uplo-%data% uplo-%offset%)
         (transa character transa-%data% transa-%offset%)
         (diag character diag-%data% diag-%offset%)
         (a (complex double-float) a-%data% a-%offset%)
         (b (complex double-float) b-%data% b-%offset%))
        (prog ((temp #C(0.0 0.0)) (i 0) (info 0) (j 0) (k 0) (nrowa 0)
              (lside nil) (noconj nil) (nounit nil) (upper nil))
          (declare (type (complex double-float) temp)
            (type fixnum i info j k nrowa)
            (type (member t nil) lside noconj nounit upper))
          (setf lside (char-equal side #\L))
          (cond
            (lside
              (setf nrowa m))
            (t
              (setf nrowa n)))
          (setf noconj (char-equal transa #\T))
          (setf nounit (char-equal diag #\N))
          (setf upper (char-equal uplo #\U))
          (setf info 0)
          (cond
            ((and (not lside) (not (char-equal side #\R)))
              (setf info 1))
            ((and (not upper) (not (char-equal uplo #\L)))
              (setf info 2))
            ((and (not (char-equal transa #\N))
                  (not (char-equal transa #\T))
                  (not (char-equal transa #\C)))
              (setf info 3))
            ((and (not (char-equal diag #\U)) (not (char-equal diag #\N)))
              (setf info 4))
            ((< m 0)
              (setf info 5))
            ((< n 0)
              (setf info 6))
            ((< lda (max (the fixnum 1) (the fixnum nrowa))))

```

```

      (setf info 9))
      ((< ldb$ (max (the fixnum 1) (the fixnum m)))
       (setf info 11)))
    (cond
      ((/= info 0)
       (error
        " ** On entry to ~a parameter number ~a had an illegal value~%"
        "ZTRMM" info)
       (go end_label)))
    (if (= n 0) (go end_label))
    (cond
      ((= alpha zero)
       (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                     ((> j n) nil)
       (tagbody
        (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                      ((> i m) nil)
        (tagbody
         (setf (f2cl-lib:fref b-%data%
                              (i j)
                              ((1 ldb$) (1 *))
                              b-%offset%)
                zero))))))
       (go end_label)))
    (cond
      (lside
       (cond
         ((char-equal transa #\N)
          (cond
            (upper
             (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                           ((> j n) nil)
             (tagbody
              (f2cl-lib:fdo (k 1 (f2cl-lib:int-add k 1))
                            ((> k m) nil)
              (tagbody
               (cond
                 ((/= (f2cl-lib:fref b (k j) ((1 ldb$) (1 *))) zero)
                  (setf temp
                       (* alpha
                          (f2cl-lib:fref b-%data%
                                           (k j)
                                           ((1 ldb$) (1 *))
                                           b-%offset%)))
                  (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                                ((> i

```

```

                                (f2cl-lib:int-add k
                                (f2cl-lib:int-sub
                                1)))
                                nil)
    (tagbody
      (setf (f2cl-lib:fref b-%data%
                          (i j)
                          ((1 ldb$) (1 *)))
            b-%offset%)
        (+
          (f2cl-lib:fref b-%data%
                        (i j)
                        ((1 ldb$) (1 *)))
            b-%offset%)
          (* temp
            (f2cl-lib:fref a-%data%
                          (i k)
                          ((1 lda) (1 *)))
            a-%offset%))))))
    (if nunit
      (setf temp
        (* temp
          (f2cl-lib:fref a-%data%
                        (k k)
                        ((1 lda) (1 *)))
            a-%offset%))))
      (setf (f2cl-lib:fref b-%data%
                          (k j)
                          ((1 ldb$) (1 *)))
            b-%offset%)
        temp))))))
  (t
    (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
      (> j n) nil)
    (tagbody
      (f2cl-lib:fdo (k m
                    (f2cl-lib:int-add k (f2cl-lib:int-sub 1)))
        (> k 1) nil)
      (tagbody
        (cond
          ((/= (f2cl-lib:fref b (k j) ((1 ldb$) (1 *))) zero)
            (setf temp
              (* alpha
                (f2cl-lib:fref b-%data%
                              (k j)
                              ((1 ldb$) (1 *)))

```

```

                                b-%offset%)))
(setf (f2cl-lib:fref b-%data%
                    (k j)
                    ((1 ldb$) (1 *))
                    b-%offset%))

    temp)
(if nounit
    (setf (f2cl-lib:fref b-%data%
                        (k j)
                        ((1 ldb$) (1 *))
                        b-%offset%))

        (*
          (f2cl-lib:fref b-%data%
                        (k j)
                        ((1 ldb$) (1 *))
                        b-%offset%)
          (f2cl-lib:fref a-%data%
                        (k k)
                        ((1 lda) (1 *))
                        a-%offset%))))
(f2cl-lib:fd0 (i (f2cl-lib:int-add k 1)
                (f2cl-lib:int-add i 1))
              ((> i m) nil))
(tagbody
  (setf (f2cl-lib:fref b-%data%
                      (i j)
                      ((1 ldb$) (1 *))
                      b-%offset%))

      (+
        (f2cl-lib:fref b-%data%
                      (i j)
                      ((1 ldb$) (1 *))
                      b-%offset%)

        (* temp
          (f2cl-lib:fref a-%data%
                      (i k)
                      ((1 lda) (1 *))
                      a-%offset%)))))))))
(t
  (cond
    (upper
      (f2cl-lib:fd0 (j 1 (f2cl-lib:int-add j 1))
                    ((> j n) nil))
      (tagbody
        (f2cl-lib:fd0 (i m
                      (f2cl-lib:int-add i (f2cl-lib:int-sub 1)))

```

```

        (<> i 1) nil)
(tagbody
  (setf temp
    (f2cl-lib:fref b-%data%
      (i j)
      ((1 ldb$) (1 *))
      b-%offset%))
  (cond
    (noconj
      (if nunit
        (setf temp
          (* temp
            (f2cl-lib:fref a-%data%
              (i i)
              ((1 lda) (1 *))
              a-%offset%))))
        (f2cl-lib:fdo (k 1 (f2cl-lib:int-add k 1))
          (<> k
            (f2cl-lib:int-add i
              (f2cl-lib:int-sub
                1))))
          nil)
      (tagbody
        (setf temp
          (+ temp
            (*
              (f2cl-lib:fref a-%data%
                (k i)
                ((1 lda) (1 *))
                a-%offset%)
              (f2cl-lib:fref b-%data%
                (k j)
                ((1 ldb$) (1 *))
                b-%offset%)))))))
    (t
      (if nunit
        (setf temp
          (* temp
            (f2cl-lib:dconjg
              (f2cl-lib:fref a-%data%
                (i i)
                ((1 lda) (1 *))
                a-%offset%))))
        (f2cl-lib:fdo (k 1 (f2cl-lib:int-add k 1))
          (<> k
            (f2cl-lib:int-add i

```

```

(f2cl-lib:int-sub
1)))

nil)

(tagbody
  (setf temp
    (+ temp
      (*
        (f2cl-lib:dconjg
          (f2cl-lib:fref a-%data%
            (k i)
            ((1 lda) (1 *))
            a-%offset%))
        (f2cl-lib:fref b-%data%
          (k j)
          ((1 ldb$) (1 *))
          b-%offset%))))))
  (setf (f2cl-lib:fref b-%data%
    (i j)
    ((1 ldb$) (1 *))
    b-%offset%)
    (* alpha temp))))))
(t
  (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
    ((> j n) nil)
    (tagbody
      (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
        ((> i m) nil)
        (tagbody
          (setf temp
            (f2cl-lib:fref b-%data%
              (i j)
              ((1 ldb$) (1 *))
              b-%offset%))

          (cond
            (noconj
              (if nounit
                (setf temp
                  (* temp
                    (f2cl-lib:fref a-%data%
                      (i i)
                      ((1 lda) (1 *))
                      a-%offset%))))
                (f2cl-lib:fdo (k (f2cl-lib:int-add i 1)
                  (f2cl-lib:int-add k 1))
                    ((> k m) nil)
                    (tagbody

```

```

      (setf temp
        (+ temp
          (*
            (f2cl-lib:fref a-%data%
                          (k i)
                          ((1 lda) (1 *))
                          a-%offset%)
            (f2cl-lib:fref b-%data%
                          (k j)
                          ((1 ldb$) (1 *))
                          b-%offset%))))))
(t
  (if nounit
    (setf temp
      (* temp
        (f2cl-lib:dconjg
          (f2cl-lib:fref a-%data%
                        (i i)
                        ((1 lda) (1 *))
                        a-%offset%))))))
    (f2cl-lib:fdo (k (f2cl-lib:int-add i 1)
                  (f2cl-lib:int-add k 1))
      (> k m) nil)
    (tagbody
      (setf temp
        (+ temp
          (*
            (f2cl-lib:dconjg
              (f2cl-lib:fref a-%data%
                            (k i)
                            ((1 lda) (1 *))
                            a-%offset%)
              (f2cl-lib:fref b-%data%
                            (k j)
                            ((1 ldb$) (1 *))
                            b-%offset%))))))
          (setf (f2cl-lib:fref b-%data%
                            (i j)
                            ((1 ldb$) (1 *))
                            b-%offset%)
            (* alpha temp))))))
(t
  (cond
    ((char-equal transa #\N)
      (cond
        (upper

```



```

(f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
  (> j 1) nil)
(tagbody
  (setf temp alpha)
  (if nunit
    (setf temp
      (* temp
        (f2cl-lib:fref a-%data%
          (j j)
          ((1 lda) (1 *))
          a-%offset%))))
  (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
    (> i m) nil)
  (tagbody
    (setf (f2cl-lib:fref b-%data%
      (i j)
      ((1 ldb$) (1 *))
      b-%offset%)
      (* temp
        (f2cl-lib:fref b-%data%
          (i j)
          ((1 ldb$) (1 *))
          b-%offset%))))
  (f2cl-lib:fdo (k 1 (f2cl-lib:int-add k 1))
    (> k
      (f2cl-lib:int-add j
        (f2cl-lib:int-sub 1)))
    nil)
  (tagbody
    (cond
      ((/= (f2cl-lib:fref a (k j) ((1 lda) (1 *))) zero)
        (setf temp
          (* alpha
            (f2cl-lib:fref a-%data%
              (k j)
              ((1 lda) (1 *))
              a-%offset%)))
        (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
          (> i m) nil)
        (tagbody
          (setf (f2cl-lib:fref b-%data%
            (i j)
            ((1 ldb$) (1 *))
            b-%offset%)
            (+
              (f2cl-lib:fref b-%data%

```

```

                                (i j)
                                ((1 ldb$) (1 *))
                                b-%offset%)
                                (* temp
                                (f2cl-lib:fref b-%data%
                                (i k)
                                ((1 ldb$) (1 *))
                                b-%offset%)))))))))))))
(t
(f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
              (> j n) nil)
(tagbody
(setf temp alpha)
(if nunit
  (setf temp
    (* temp
      (f2cl-lib:fref a-%data%
                      (j j)
                      ((1 lda) (1 *))
                      a-%offset%))))
(f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
              (> i m) nil)
(tagbody
  (setf (f2cl-lib:fref b-%data%
                      (i j)
                      ((1 ldb$) (1 *))
                      b-%offset%)
    (* temp
      (f2cl-lib:fref b-%data%
                      (i j)
                      ((1 ldb$) (1 *))
                      b-%offset%))))
(f2cl-lib:fdo (k (f2cl-lib:int-add j 1)
              (f2cl-lib:int-add k 1))
              (> k n) nil)
(tagbody
  (cond
    ((/= (f2cl-lib:fref a (k j) ((1 lda) (1 *))) zero)
      (setf temp
        (* alpha
          (f2cl-lib:fref a-%data%
                          (k j)
                          ((1 lda) (1 *))
                          a-%offset%))))
    (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                  (> i m) nil)

```

```

(tagbody
  (setf (f2cl-lib:fref b-%data%
                     (i j)
                     ((1 ldb$) (1 *))
                     b-%offset%))
    (+
      (f2cl-lib:fref b-%data%
                     (i j)
                     ((1 ldb$) (1 *))
                     b-%offset%))
      (* temp
        (f2cl-lib:fref b-%data%
                       (i k)
                       ((1 ldb$) (1 *))
                       b-%offset%)))))))))
(t
  (cond
    (upper
      (f2cl-lib:fdo (k 1 (f2cl-lib:int-add k 1))
                    ((> k n) nil)
      (tagbody
        (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                      ((> j
                        (f2cl-lib:int-add k
                          (f2cl-lib:int-sub 1)))
                        nil)
        (tagbody
          (cond
            ((/= (f2cl-lib:fref a (j k) ((1 lda) (1 *))) zero)
              (cond
                (noconj
                  (setf temp
                        (* alpha
                          (f2cl-lib:fref a-%data%
                                          (j k)
                                          ((1 lda) (1 *))
                                          a-%offset%))))
                (t
                  (setf temp
                        (* alpha
                          (f2cl-lib:dconjg
                            (f2cl-lib:fref a-%data%
                                          (j k)
                                          ((1 lda) (1 *))
                                          a-%offset%))))))
              (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))

```

```

                                (> i m) nil)
(tagbody
  (setf (f2cl-lib:fref b-%data%
                      (i j)
                      ((1 ldb$) (1 *)))
        b-%offset%)
    (+
      (f2cl-lib:fref b-%data%
                    (i j)
                    ((1 ldb$) (1 *)))
        b-%offset%)
      (* temp
        (f2cl-lib:fref b-%data%
                      (i k)
                      ((1 ldb$) (1 *)))
        b-%offset%)))))))))
(setf temp alpha)
(cond
  (nunit
    (cond
      (noconj
        (setf temp
          (* temp
            (f2cl-lib:fref a-%data%
                          (k k)
                          ((1 lda) (1 *)))
            a-%offset%))))
      (t
        (setf temp
          (* temp
            (f2cl-lib:dconjg
              (f2cl-lib:fref a-%data%
                            (k k)
                            ((1 lda) (1 *)))
              a-%offset%)))))))))
(cond
  ((/= temp one)
    (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
      (> i m) nil)
    (tagbody
      (setf (f2cl-lib:fref b-%data%
                        (i k)
                        ((1 ldb$) (1 *)))
            b-%offset%)
        (* temp
          (f2cl-lib:fref b-%data%
                        (i k)
                        ((1 ldb$) (1 *)))
            b-%offset%))))))

```

```

                                (i k)
                                ((1 ldb$) (1 *))
                                b-%offset%))))))))))
(t
  (f2cl-lib:fdo (k n (f2cl-lib:int-add k (f2cl-lib:int-sub 1)))
    ((> k 1) nil)
    (tagbody
      (f2cl-lib:fdo (j (f2cl-lib:int-add k 1)
        (f2cl-lib:int-add j 1))
        ((> j n) nil)
        (tagbody
          (cond
            ((/= (f2cl-lib:fref a (j k) ((1 lda) (1 *))) zero)
              (cond
                (noconj
                  (setf temp
                    (* alpha
                      (f2cl-lib:fref a-%data%
                        (j k)
                        ((1 lda) (1 *))
                        a-%offset%))))
                  (t
                    (setf temp
                      (* alpha
                        (f2cl-lib:dconjg
                          (f2cl-lib:fref a-%data%
                            (j k)
                            ((1 lda) (1 *))
                            a-%offset%)))))))
                (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                  ((> i m) nil)
                  (tagbody
                    (setf (f2cl-lib:fref b-%data%
                      (i j)
                      ((1 ldb$) (1 *))
                      b-%offset%)
                      (+
                        (f2cl-lib:fref b-%data%
                          (i j)
                          ((1 ldb$) (1 *))
                          b-%offset%)
                        (* temp
                          (f2cl-lib:fref b-%data%
                            (i k)
                            ((1 ldb$) (1 *))
                            b-%offset%))))))))))

```

```

(setf temp alpha)
(cond
  (nounit
    (cond
      (noconj
        (setf temp
          (* temp
            (f2cl-lib:fref a-%data%
              (k k)
              ((1 lda) (1 *))
              a-%offset%))))
        (t
          (setf temp
            (* temp
              (f2cl-lib:dconjg
                (f2cl-lib:fref a-%data%
                  (k k)
                  ((1 lda) (1 *))
                  a-%offset%))))))))))
    (cond
      ((/= temp one)
        (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
          (> i m) nil)
        (tagbody
          (setf (f2cl-lib:fref b-%data%
            (i k)
            ((1 ldb$) (1 *))
            b-%offset%)
            (* temp
              (f2cl-lib:fref b-%data%
                (i k)
                ((1 ldb$) (1 *))
                b-%offset%))))))))))
end_label
(return (values nil nil nil nil nil nil nil nil nil nil))

```

## 6.15 ztrsm BLAS

```
<ztrsm.input>≡  
  )set break resume  
  )sys rm -f ztrsm.output  
  )spool ztrsm.output  
  )set message test on  
  )set message auto off  
  )clear all  
  
  )spool  
  )lisp (bye)
```

`<ztrsm.help>=`

```
=====
ztrsm examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

ZTRSM - solve one of the matrix equations  $\text{op}(A) * X = \alpha * B$ , or  $X * \text{op}(A) = \alpha * B$ ,

#### SYNOPSIS

```
SUBROUTINE ZTRSM ( SIDE, UPLO, TRANSA, DIAG, M, N, ALPHA, A,
                  LDA, B, LDB )
```

```
CHARACTER*1  SIDE, UPLO, TRANSA, DIAG
```

```
INTEGER      M, N, LDA, LDB
```

```
COMPLEX*16   ALPHA
```

```
COMPLEX*16   A( LDA, * ), B( LDB, * )
```

#### PURPOSE

ZTRSM solves one of the matrix equations

where alpha is a scalar, X and B are m by n matrices, A is a unit, or non-unit, upper or lower triangular matrix and  $\text{op}(A)$  is one of

$\text{op}(A) = A$  or  $\text{op}(A) = A'$  or  $\text{op}(A) = \text{conjg}(A')$ .

The matrix X is overwritten on B.

#### PARAMETERS

SIDE - CHARACTER\*1.

On entry, SIDE specifies whether  $\text{op}(A)$  appears on the left or right of X as follows:

SIDE = 'L' or 'l'  $\text{op}(A) * X = \alpha * B$ .

SIDE = 'R' or 'r'  $X * \text{op}(A) = \alpha * B$ .



Unchanged on exit.

UPLO - CHARACTER\*1.

On entry, UPLO specifies whether the matrix A is an upper or lower triangular matrix as follows:

UPLO = 'U' or 'u'    A is an upper triangular matrix.

UPLO = 'L' or 'l'    A is a lower triangular matrix.

Unchanged on exit.

TRANSA - CHARACTER\*1. On entry, TRANSA specifies the form of  $op(A)$  to be used in the matrix

multiplication as follows:

TRANSA = 'N' or 'n'     $op(A) = A$ .

TRANSA = 'T' or 't'     $op(A) = A'$ .

TRANSA = 'C' or 'c'     $op(A) = \text{conjg}(A')$ .

Unchanged on exit.

DIAG - CHARACTER\*1.

On entry, DIAG specifies whether or not A is unit triangular as follows:

DIAG = 'U' or 'u'    A is assumed to be unit triangular.

DIAG = 'N' or 'n'    A is not assumed to be unit triangular.

Unchanged on exit.

M - INTEGER.

On entry, M specifies the number of rows of B. M must be at least zero. Unchanged on exit.

N - INTEGER.

On entry, N specifies the number of columns of B. N must be at least zero. Unchanged on exit.

ALPHA - COMPLEX\*16    .

On entry, ALPHA specifies the scalar alpha. When alpha is zero then A is not referenced and B need not be set before entry. Unchanged on exit.

is m

A

-

COMPLEX\*16 array of DIMENSION ( LDA, k ), where k when SIDE = 'L' or 'l' and is n when SIDE = 'R' or 'r'. Before entry with UPLO = 'U' or 'u', the leading k by k upper triangular part of the array A must contain the upper triangular matrix and the strictly lower triangular part of A is not referenced. Before entry with UPLO = 'L' or 'l', the leading k by k lower triangular part of the array A must contain the lower triangular matrix and the strictly upper triangular part of A is not referenced. Note that when DIAG = 'U' or 'u', the diagonal elements of A are not referenced either, but are assumed to be unity. Unchanged on exit.

LDA - INTEGER.

On entry, LDA specifies the first dimension of A as declared in the calling (sub) program. When SIDE = 'L' or 'l' then LDA must be at least  $\max(1, m)$ , when SIDE = 'R' or 'r' then LDA must be at least  $\max(1, n)$ . Unchanged on exit.

B

- COMPLEX\*16 array of DIMENSION ( LDB, n ). Before entry, the leading m by n part of the array B must contain the right-hand side matrix B, and on exit is overwritten by the solution matrix X.

LDB - INTEGER.

On entry, LDB specifies the first dimension of B as declared in the calling (sub) program. LDB must be at least  $\max(1, m)$ . Unchanged on exit.

```

<BLAS 3 ztrsm>≡
  (let* ((one (complex 1.0 0.0)) (zero (complex 0.0 0.0)))
    (declare (type (complex double-float) one) (type (complex double-float) zero))
    (defun ztrsm (side uplo transa diag m n alpha a lda b ldb$)
      (declare (type (simple-array (complex double-float) (*)) b a)
        (type (complex double-float) alpha)
        (type fixnum ldb$ lda n m)
        (type character diag transa uplo side))
      (f2cl-lib:with-multi-array-data
        ((side character side-%data% side-%offset%)
         (uplo character uplo-%data% uplo-%offset%)
         (transa character transa-%data% transa-%offset%)
         (diag character diag-%data% diag-%offset%)
         (a (complex double-float) a-%data% a-%offset%)
         (b (complex double-float) b-%data% b-%offset%))
        (prog ((temp #C(0.0 0.0)) (i 0) (info 0) (j 0) (k 0) (nrowa 0)
              (lside nil) (noconj nil) (nounit nil) (upper nil))
          (declare (type (complex double-float) temp)
            (type fixnum i info j k nrowa)
            (type (member t nil) lside noconj nounit upper))
          (setf lside (char-equal side #\L))
          (cond
            (lside
              (setf nrowa m))
            (t
              (setf nrowa n)))
          (setf noconj (char-equal transa #\T))
          (setf nounit (char-equal diag #\N))
          (setf upper (char-equal uplo #\U))
          (setf info 0)
          (cond
            ((and (not lside) (not (char-equal side #\R)))
              (setf info 1))
            ((and (not upper) (not (char-equal uplo #\L)))
              (setf info 2))
            ((and (not (char-equal transa #\N))
                  (not (char-equal transa #\T))
                  (not (char-equal transa #\C)))
              (setf info 3))
            ((and (not (char-equal diag #\U)) (not (char-equal diag #\N)))
              (setf info 4))
            ((< m 0)
              (setf info 5))
            ((< n 0)
              (setf info 6))
            ((< lda (max (the fixnum 1) (the fixnum nrowa)))

```

```

      (setf info 9))
      ((< ldb$ (max (the fixnum 1) (the fixnum m)))
       (setf info 11)))
    (cond
      ((/= info 0)
       (error
        " ** On entry to ~a parameter number ~a had an illegal value~%"
        "ZTRSM" info)
       (go end_label)))
    (if (= n 0) (go end_label))
    (cond
      ((= alpha zero)
       (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                     (> j n) nil)
       (tagbody
        (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                      (> i m) nil)
        (tagbody
         (setf (f2cl-lib:fref b-%data%
                              (i j)
                              ((1 ldb$) (1 *)))
               b-%offset%)
         zero))))))
      (go end_label)))
    (cond
      (lside
       (cond
         ((char-equal transa #\N)
          (cond
            (upper
             (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                           (> j n) nil)
             (tagbody
              (cond
                ((/= alpha one)
                 (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                               (> i m) nil)
                 (tagbody
                  (setf (f2cl-lib:fref b-%data%
                                       (i j)
                                       ((1 ldb$) (1 *)))
                        b-%offset%)
                  (* alpha
                   (f2cl-lib:fref b-%data%
                                   (i j)
                                   ((1 ldb$) (1 *)))

```

```

b-%offset%)))))))))
(f2cl-lib:fdo (k m
               (f2cl-lib:int-add k (f2cl-lib:int-sub 1)))
               (> k 1) nil)
(tagbody
 (cond
  ((/= (f2cl-lib:fref b (k j) ((1 ldb$) (1 *))) zero)
   (if nunit
        (setf (f2cl-lib:fref b-%data%
                              (k j)
                              ((1 ldb$) (1 *)))
                b-%offset%)
         (/
          (f2cl-lib:fref b-%data%
                        (k j)
                        ((1 ldb$) (1 *)))
          b-%offset%)
        (f2cl-lib:fref a-%data%
                        (k k)
                        ((1 lda) (1 *)))
        a-%offset%))))
(f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
               (> i
                 (f2cl-lib:int-add k
                                     (f2cl-lib:int-sub
                                      1)))
               nil)
(tagbody
 (setf (f2cl-lib:fref b-%data%
                      (i j)
                      ((1 ldb$) (1 *)))
        b-%offset%)
 (-
  (f2cl-lib:fref b-%data%
                  (i j)
                  ((1 ldb$) (1 *)))
  b-%offset%)
 (*
  (f2cl-lib:fref b-%data%
                  (k j)
                  ((1 ldb$) (1 *)))
  b-%offset%)
  (f2cl-lib:fref a-%data%
                  (i k)
                  ((1 lda) (1 *)))
  a-%offset%)))))))))

```

```

(t
  (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
    (> j n) nil)
  (tagbody
    (cond
      ((/= alpha one)
        (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
          (> i m) nil)
        (tagbody
          (setf (f2cl-lib:fref b-%data%
                                (i j)
                                ((1 ldb$) (1 *)))
                b-%offset%)
            (* alpha
              (f2cl-lib:fref b-%data%
                              (i j)
                              ((1 ldb$) (1 *)))
              b-%offset%))))))
    (f2cl-lib:fdo (k 1 (f2cl-lib:int-add k 1))
      (> k m) nil)
    (tagbody
      (cond
        ((/= (f2cl-lib:fref b (k j) ((1 ldb$) (1 *))) zero)
          (if nounit
            (setf (f2cl-lib:fref b-%data%
                                  (k j)
                                  ((1 ldb$) (1 *)))
                  b-%offset%)
              (/
                (f2cl-lib:fref b-%data%
                                (k j)
                                ((1 ldb$) (1 *)))
                b-%offset%)
                (f2cl-lib:fref a-%data%
                                (k k)
                                ((1 lda) (1 *)))
                a-%offset%))))))
      (f2cl-lib:fdo (i (f2cl-lib:int-add k 1)
                    (f2cl-lib:int-add i 1))
        (> i m) nil)
      (tagbody
        (setf (f2cl-lib:fref b-%data%
                              (i j)
                              ((1 ldb$) (1 *)))
              b-%offset%)
          (-

```

```

(f2cl-lib:fref b-%data%
  (i j)
  ((1 ldb$) (1 *))
  b-%offset%)
(*
(f2cl-lib:fref b-%data%
  (k j)
  ((1 ldb$) (1 *))
  b-%offset%)
(f2cl-lib:fref a-%data%
  (i k)
  ((1 lda) (1 *))
  a-%offset%)))))))))))))
(t
  (cond
    (upper
      (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
        ((> j n) nil)
        (tagbody
          (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
            ((> i m) nil)
            (tagbody
              (setf temp
                (* alpha
                  (f2cl-lib:fref b-%data%
                    (i j)
                    ((1 ldb$) (1 *))
                    b-%offset%)))
                (cond
                  (noconj
                    (f2cl-lib:fdo (k 1 (f2cl-lib:int-add k 1))
                      ((> k
                        (f2cl-lib:int-add i
                          (f2cl-lib:int-sub
                            1)))
                        nil)
                    (tagbody
                      (setf temp
                        (- temp
                          (*
                            (f2cl-lib:fref a-%data%
                              (k i)
                              ((1 lda) (1 *))
                              a-%offset%)
                            (f2cl-lib:fref b-%data%
                              (k j)

```

```

((1 ldb$) (1 *))
b-%offset%))))))

(if nunit
  (setf temp
    (/ temp
      (f2cl-lib:fref a-%data%
        (i i)
        ((1 lda) (1 *))
        a-%offset%))))))

(t
  (f2cl-lib:fdo (k 1 (f2cl-lib:int-add k 1))
    (> k
      (f2cl-lib:int-add i
        (f2cl-lib:int-sub
          1)))
    nil)
  (tagbody
    (setf temp
      (- temp
        (*
          (f2cl-lib:dconjg
            (f2cl-lib:fref a-%data%
              (k i)
              ((1 lda) (1 *))
              a-%offset%))
          (f2cl-lib:fref b-%data%
            (k j)
            ((1 ldb$) (1 *))
            b-%offset%))))))

  (if nunit
    (setf temp
      (/ temp
        (f2cl-lib:dconjg
          (f2cl-lib:fref a-%data%
            (i i)
            ((1 lda) (1 *))
            a-%offset%))))))

  (setf (f2cl-lib:fref b-%data%
    (i j)
    ((1 ldb$) (1 *))
    b-%offset%)
    temp))))))

(t
  (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
    (> j n) nil)
  (tagbody

```



```

(f2cl-lib:fdo (i m
              (f2cl-lib:int-add i (f2cl-lib:int-sub 1)))
              (> i 1) nil)
(tagbody
  (setf temp
    (* alpha
      (f2cl-lib:fref b-%data%
                     (i j)
                     ((1 ldb$) (1 *))
                     b-%offset%)))
  (cond
    (noconj
      (f2cl-lib:fdo (k (f2cl-lib:int-add i 1)
                       (f2cl-lib:int-add k 1))
                     (> k m) nil)
      (tagbody
        (setf temp
          (- temp
            (*
              (f2cl-lib:fref a-%data%
                             (k i)
                             ((1 lda) (1 *))
                             a-%offset%)
              (f2cl-lib:fref b-%data%
                             (k j)
                             ((1 ldb$) (1 *))
                             b-%offset%))))))
      (if nounit
        (setf temp
          (/ temp
            (f2cl-lib:fref a-%data%
                           (i i)
                           ((1 lda) (1 *))
                           a-%offset%))))))
    (t
      (f2cl-lib:fdo (k (f2cl-lib:int-add i 1)
                       (f2cl-lib:int-add k 1))
                     (> k m) nil)
      (tagbody
        (setf temp
          (- temp
            (*
              (f2cl-lib:dconjg
                (f2cl-lib:fref a-%data%
                               (k i)
                               ((1 lda) (1 *))

```

```

                                a-%offset%))
                                (f2cl-lib:fref b-%data%
                                (k j)
                                ((1 ldb$) (1 *))
                                b-%offset%))))))
    (if nunit
      (setf temp
        (/ temp
          (f2cl-lib:dconjg
            (f2cl-lib:fref a-%data%
              (i i)
              ((1 lda) (1 *))
              a-%offset%))))))
    (setf (f2cl-lib:fref b-%data%
      (i j)
      ((1 ldb$) (1 *))
      b-%offset%)
      temp)))))))))
(t
  (cond
    ((char-equal transa #\N)
      (cond
        (upper
          (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
            (> j n) nil)
          (tagbody
            (cond
              ((/= alpha one)
                (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                  (> i m) nil)
                (tagbody
                  (setf (f2cl-lib:fref b-%data%
                    (i j)
                    ((1 ldb$) (1 *))
                    b-%offset%)
                    (* alpha
                      (f2cl-lib:fref b-%data%
                        (i j)
                        ((1 ldb$) (1 *))
                        b-%offset%))))))
                (f2cl-lib:fdo (k 1 (f2cl-lib:int-add k 1))
                  (> k
                    (f2cl-lib:int-add j
                      (f2cl-lib:int-sub 1)))
                    nil)
                (tagbody

```

```

(cond
  ((/= (f2cl-lib:fref a (k j) ((1 lda) (1 *))) zero)
    (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
      ((> i m) nil)
      (tagbody
        (setf (f2cl-lib:fref b-%data%
          (i j)
          ((1 ldb$) (1 *))
          b-%offset%))
          (-
            (f2cl-lib:fref b-%data%
              (i j)
              ((1 ldb$) (1 *))
              b-%offset%)
            (*
              (f2cl-lib:fref a-%data%
                (k j)
                ((1 lda) (1 *))
                a-%offset%)
              (f2cl-lib:fref b-%data%
                (i k)
                ((1 ldb$) (1 *))
                b-%offset%))))))))))
(cond
  (nunit
    (setf temp
      (/ one
        (f2cl-lib:fref a-%data%
          (j j)
          ((1 lda) (1 *))
          a-%offset%)))
    (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
      ((> i m) nil)
      (tagbody
        (setf (f2cl-lib:fref b-%data%
          (i j)
          ((1 ldb$) (1 *))
          b-%offset%))
          (* temp
            (f2cl-lib:fref b-%data%
              (i j)
              ((1 ldb$) (1 *))
              b-%offset%))))))))))
(t
  (f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
    ((> j 1) nil)

```

```

(tagbody
  (cond
    ((/= alpha one)
      (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
        (> i m) nil)
      (tagbody
        (setf (f2cl-lib:fref b-%data%
          (i j)
          ((1 ldb$) (1 *))
          b-%offset%)
          (* alpha
            (f2cl-lib:fref b-%data%
              (i j)
              ((1 ldb$) (1 *))
              b-%offset%))))))
      (f2cl-lib:fdo (k (f2cl-lib:int-add j 1)
        (f2cl-lib:int-add k 1))
          (> k n) nil)
      (tagbody
        (cond
          ((/= (f2cl-lib:fref a (k j) ((1 lda) (1 *))) zero)
            (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
              (> i m) nil)
            (tagbody
              (setf (f2cl-lib:fref b-%data%
                (i j)
                ((1 ldb$) (1 *))
                b-%offset%)
                (-
                  (f2cl-lib:fref b-%data%
                    (i j)
                    ((1 ldb$) (1 *))
                    b-%offset%)
                  (*
                    (f2cl-lib:fref a-%data%
                      (k j)
                      ((1 lda) (1 *))
                      a-%offset%)
                    (f2cl-lib:fref b-%data%
                      (i k)
                      ((1 ldb$) (1 *))
                      b-%offset%))))))))))
          (t nil)))
        (cond
          (nunit
            (setf temp
              (/ one

```

```

(f2cl-lib:fref a-%data%
  (j j)
  ((1 lda) (1 *))
  a-%offset%)))
(f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
  (> i m) nil)
(tagbody
  (setf (f2cl-lib:fref b-%data%
    (i j)
    ((1 ldb$) (1 *))
    b-%offset%)
    (* temp
      (f2cl-lib:fref b-%data%
        (i j)
        ((1 ldb$) (1 *))
        b-%offset%)))))))))
(t
  (cond
    (upper
      (f2cl-lib:fdo (k n (f2cl-lib:int-add k (f2cl-lib:int-sub 1)))
        (> k 1) nil)
      (tagbody
        (cond
          (nunit
            (cond
              (noconj
                (setf temp
                  (/ one
                    (f2cl-lib:fref a-%data%
                      (k k)
                      ((1 lda) (1 *))
                      a-%offset%))))))
                (t
                  (setf temp
                    (/ one
                      (f2cl-lib:dconjg
                        (f2cl-lib:fref a-%data%
                          (k k)
                          ((1 lda) (1 *))
                          a-%offset%)))))))))
          (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
            (> i m) nil)
          (tagbody
            (setf (f2cl-lib:fref b-%data%
              (i k)
              ((1 ldb$) (1 *))

```

```

                                b-%offset%)
(* temp
  (f2cl-lib:fref b-%data%
    (i k)
    ((1 ldb$) (1 *))
    b-%offset%))))))
(f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
  (> j
    (f2cl-lib:int-add k
      (f2cl-lib:int-sub 1)))
  nil)
(tagbody
  (cond
    ((/= (f2cl-lib:fref a (j k) ((1 lda) (1 *))) zero)
      (cond
        (noconj
          (setf temp
            (f2cl-lib:fref a-%data%
              (j k)
              ((1 lda) (1 *))
              a-%offset%)))
          (t
            (setf temp
              (coerce
                (f2cl-lib:dconjg
                  (f2cl-lib:fref a-%data%
                    (j k)
                    ((1 lda) (1 *))
                    a-%offset%))
                '(complex double-float))))))
        (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
          (> i m) nil)
        (tagbody
          (setf (f2cl-lib:fref b-%data%
            (i j)
            ((1 ldb$) (1 *))
            b-%offset%)
            (-
              (f2cl-lib:fref b-%data%
                (i j)
                ((1 ldb$) (1 *))
                b-%offset%)
              (* temp
                (f2cl-lib:fref b-%data%
                  (i k)
                  ((1 ldb$) (1 *))

```

```
(cond
  ((/= alpha one)
    (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
      (> i m) nil)
    (tagbody
      (setf (f2cl-lib:fref b-%data%
                          (i k)
                          ((1 ldb$) (1 *)))
        b-%offset%)
      (* alpha
        (f2cl-lib:fref b-%data%
                      (i k)
                      ((1 ldb$) (1 *)))
        b-%offset%)))))))))
(t
  (f2cl-lib:fdo (k 1 (f2cl-lib:int-add k 1))
    (> k n) nil)
  (tagbody
    (cond
      (nounit
        (cond
          (noconj
            (setf temp
              (/ one
                (f2cl-lib:fref a-%data%
                              (k k)
                              ((1 lda) (1 *)))
                a-%offset%)))
            (t
              (setf temp
                (/ one
                  (f2cl-lib:dconjg
                    (f2cl-lib:fref a-%data%
                                  (k k)
                                  ((1 lda) (1 *)))
                    a-%offset%))))))
          (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
            (> i m) nil)
            (tagbody
              (setf (f2cl-lib:fref b-%data%
                                (i k)
                                ((1 ldb$) (1 *)))
                b-%offset%)
              (* temp
                (f2cl-lib:fref b-%data%
```

```

                                (i k)
                                ((1 ldb$) (1 *))
                                b-%offset%))))))
(f2cl-lib:fdo (j (f2cl-lib:int-add k 1)
                (f2cl-lib:int-add j 1))
              (> j n) nil)
(tagbody
 (cond
  ( (/= (f2cl-lib:fref a (j k) ((1 lda) (1 *))) zero)
    (cond
     (noconj
      (setf temp
               (f2cl-lib:fref a-%data%
                               (j k)
                               ((1 lda) (1 *))
                               a-%offset%)))

      (t
       (setf temp
                (coerce
                 (f2cl-lib:dconjg
                  (f2cl-lib:fref a-%data%
                                  (j k)
                                  ((1 lda) (1 *))
                                  a-%offset%))
                  '(complex double-float))))))
    (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                  (> i m) nil)
    (tagbody
     (setf (f2cl-lib:fref b-%data%
                           (i j)
                           ((1 ldb$) (1 *))
                           b-%offset%)
            (-
             (f2cl-lib:fref b-%data%
                             (i j)
                             ((1 ldb$) (1 *))
                             b-%offset%)
             (* temp
              (f2cl-lib:fref b-%data%
                              (i k)
                              ((1 ldb$) (1 *))
                              b-%offset%))))))
    (cond
     ( (/= alpha one)
      (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                    (> i m) nil)

```



```

(tagbody
  (setf (f2cl-lib:fref b-%data%
    (i k)
    ((1 ldb$) (1 *))
    b-%offset%)
    (* alpha
      (f2cl-lib:fref b-%data%
        (i k)
        ((1 ldb$) (1 *))
        b-%offset%)))))))))
end_label
(return (values nil nil nil nil nil nil nil nil nil nil nil)))

```

## Chapter 7

# LAPACK

### 7.1 dbdsdc LAPACK

```
<dbdsdc.input>≡  
  )set break resume  
  )sys rm -f dbdsdc.output  
  )spool dbdsdc.output  
  )set message test on  
  )set message auto off  
  )clear all  
  
  )spool  
  )lisp (bye)
```

`<dbdsdc.help>=`

```
=====
dbdsdc examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

DBDSDC - the singular value decomposition (SVD) of a real N-by-N (upper or lower) bidiagonal matrix B

#### SYNOPSIS

```
SUBROUTINE DBDSDC( UPLO, COMPQ, N, D, E, U, LDU, VT, LDVT, Q, IQ, WORK,
                  IWORK, INFO )
```

CHARACTER        COMPQ, UPLO

INTEGER         INFO, LDU, LDVT, N

INTEGER         IQ( \* ), IWORK( \* )

DOUBLE          PRECISION D( \* ), E( \* ), Q( \* ), U( LDU, \* ), VT( LDVT, \* ), WORK( \* )

#### PURPOSE

DBDSDC computes the singular value decomposition (SVD) of a real N-by-N (upper or lower) bidiagonal matrix B:  $B = U * S * VT$ , using a divide and conquer method, where S is a diagonal matrix with non-negative diagonal elements (the singular values of B), and U and VT are orthogonal matrices of left and right singular vectors, respectively. DBDSDC can be used to compute all singular values, and optionally, singular vectors or singular vectors in compact form.

This code makes very mild assumptions about floating point arithmetic. It will work on machines with a guard digit in add/subtract, or on those binary machines without guard digits which subtract like the Cray X-MP, Cray Y-MP, Cray C-90, or Cray-2. It could conceivably fail on hexadecimal or decimal machines without guard digits, but we know of none. See DLASD3 for details.

The code currently calls DLASDQ if singular values only are desired. However, it can be slightly modified to compute singular values using the divide and conquer method.

## ARGUMENTS

- UPLO (input) CHARACTER\*1  
 = 'U': B is upper bidiagonal.  
 = 'L': B is lower bidiagonal.
- COMPQ (input) CHARACTER\*1  
 Specifies whether singular vectors are to be computed as follows:  
 = 'N': Compute singular values only;  
 = 'P': Compute singular values and compute singular vectors in compact form; = 'I': Compute singular values and singular vectors.
- N (input) INTEGER  
 The order of the matrix B.  $N \geq 0$ .
- D (input/output) DOUBLE PRECISION array, dimension (N)  
 On entry, the n diagonal elements of the bidiagonal matrix B.  
 On exit, if INFO=0, the singular values of B.
- E (input/output) DOUBLE PRECISION array, dimension (N-1)  
 On entry, the elements of E contain the offdiagonal elements of the bidiagonal matrix whose SVD is desired. On exit, E has been destroyed.
- U (output) DOUBLE PRECISION array, dimension (LDU,N)  
 If COMPQ = 'I', then: On exit, if INFO = 0, U contains the left singular vectors of the bidiagonal matrix. For other values of COMPQ, U is not referenced.
- LDU (input) INTEGER  
 The leading dimension of the array U.  $LDU \geq 1$ . If singular vectors are desired, then  $LDU \geq \max(1, N)$ .
- VT (output) DOUBLE PRECISION array, dimension (LDVT,N)  
 If COMPQ = 'I', then: On exit, if INFO = 0, VT contains the right singular vectors of the bidiagonal matrix. For other values of COMPQ, VT is not referenced.
- LDVT (input) INTEGER  
 The leading dimension of the array VT.  $LDVT \geq 1$ . If singular vectors are desired, then  $LDVT \geq \max(1, N)$ .
- Q (output) DOUBLE PRECISION array, dimension (LDQ)  
 If COMPQ = 'P', then: On exit, if INFO = 0, Q and IQ contain

the left and right singular vectors in a compact form, requiring  $O(N \log N)$  space instead of  $2N^2$ . In particular,  $Q$  contains all the DOUBLE PRECISION data in  $LDQ \geq N(11 + 2 \text{SMLSIZ} + 8 \text{INT}(\text{LOG}_2(N/(\text{SMLSIZ}+1))))$  words of memory, where  $\text{SMLSIZ}$  is returned by `ILAENV` and is equal to the maximum size of the subproblems at the bottom of the computation tree (usually about 25). For other values of `COMPQ`,  $Q$  is not referenced.

- IQ** (output) INTEGER array, dimension (`LDIQ`)  
 If `COMPQ = 'P'`, then: On exit, if `INFO = 0`,  $Q$  and  $IQ$  contain the left and right singular vectors in a compact form, requiring  $O(N \log N)$  space instead of  $2N^2$ . In particular,  $IQ$  contains all INTEGER data in  $LDIQ \geq N(3 + 3 \text{INT}(\text{LOG}_2(N/(\text{SMLSIZ}+1))))$  words of memory, where  $\text{SMLSIZ}$  is returned by `ILAENV` and is equal to the maximum size of the subproblems at the bottom of the computation tree (usually about 25). For other values of `COMPQ`,  $IQ$  is not referenced.
- WORK** (workspace) DOUBLE PRECISION array, dimension (`MAX(1,LWORK)`)  
 If `COMPQ = 'N'` then  $\text{LWORK} \geq (4 * N)$ . If `COMPQ = 'P'` then  $\text{LWORK} \geq (6 * N)$ . If `COMPQ = 'I'` then  $\text{LWORK} \geq (3 * N^2 + 4 * N)$ .
- IWORK** (workspace) INTEGER array, dimension ( $8 * N$ )
- INFO** (output) INTEGER  
 = 0: successful exit.  
 < 0: if `INFO = -i`, the  $i$ -th argument had an illegal value.  
 > 0: The algorithm failed to compute an singular value. The update process of divide and conquer failed.

The input arguments are:

- *uplo* - simple-array character (1)
- *compq* - (simple-array character (1)
- *n* - fixnum
- *d* - array doublefloat
- *e* - array doublefloat
- *u* - array doublefloat
- *ldu* - fixnum
- *vt* - doublefloat
- *ldvt* - fixnum
- *q* - array doublefloat
- *iq* - array fixnum
- *work* - array doublefloat
- *iwork* - array fixnum
- *info* - fixnum

The return values are:

- *uplo* - nil
- *compq* - nil
- *n* - nil
- *d* - nil
- *e* - nil
- *u* - nil
- *ldu* - nil
- *vt* - nil
- *ldvt* - nil
- *q* - nil
- *iq* - nil

- work - nil
- iwork - nil
- info - info

```
[dlasr p??]
[dswap p??]
[dlasda p??]
[dlasd0 p??]
[dlamch p??]
[dlascl p??]
[dlanst p??]
[dlaset p??]
[dlasdq p??]
[dlartg p??]
[dcopy p??]
[ilaenv p??]
[xerbla p??]
[char-equal p??]
```

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```
(let* ((zero 0.0) (one 1.0) (two 2.0))
  (declare (type (double-float 0.0 0.0) zero)
            (type (double-float 1.0 1.0) one)
            (type (double-float 2.0 2.0) two))
  (defun dbdsdc (uplo compq n d e u ldu vt ldvt q iq work iwork info)
    (declare (type (simple-array fixnum (*)) iwork iq)
              (type (simple-array double-float (*)) work q vt u e d)
              (type fixnum info ldvt ldu n)
              (type character compq uplo))
    (f2cl-lib:with-multi-array-data
      ((uplo character uplo-%data% uplo-%offset%)
       (compq character compq-%data% compq-%offset%)
       (d double-float d-%data% d-%offset%)
       (e double-float e-%data% e-%offset%)
       (u double-float u-%data% u-%offset%)
       (vt double-float vt-%data% vt-%offset%)
       (q double-float q-%data% q-%offset%)
       (work double-float work-%data% work-%offset%)
       (iq fixnum iq-%data% iq-%offset%)
       (iwork fixnum iwork-%data% iwork-%offset%))
      (prog ((cs 0.0) (eps 0.0) (orgnrm 0.0) (p 0.0) (r 0.0) (sn 0.0) (difl 0)
             (difr 0) (givcol 0) (givnum 0) (givptr 0) (i 0) (ic 0) (icompq 0)
             (ierr 0) (ii 0) (is 0) (iu 0) (iuplo 0) (ivt 0) (j 0) (k 0) (kk 0)
             (mlvl 0) (nm1 0) (nsize 0) (perm 0) (poles 0) (qstart 0)
```

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(smlsiz 0) (smlszp 0) (sqre 0) (start 0) (wstart 0) (z 0))
(declare (type (double-float) cs eps orgnrm p r sn)
  (type fixnum difl difr givcol givnum givptr i ic
    icompq ierr ii is iu iuplo ivt j k
    kk mlvl nm1 nsize perm poles qstart
    smlsiz smlszp sqre start wstart z))

(setf info 0)
(setf iuplo 0)
(if (char-equal uplo #\U) (setf iuplo 1))
(if (char-equal uplo #\L) (setf iuplo 2))
(cond
  ((char-equal compq #\N) (setf icompq 0))
  ((char-equal compq #\P) (setf icompq 1))
  ((char-equal compq #\I) (setf icompq 2))
  (t (setf icompq -1)))
(cond
  ((= iuplo 0) (setf info -1))
  ((< icompq 0) (setf info -2))
  ((< n 0) (setf info -3))
  ((or (< ldu 1) (and (= icompq 2) (< ldu n))) (setf info -7))
  ((or (< ldvt 1) (and (= icompq 2) (< ldvt n))) (setf info -9)))
(cond
  ((/= info 0)
    (error
      " ** On entry to ~a parameter number ~a had an illegal value~%"
      "DBDSDC" (f2cl-lib:int-sub info))
    (go end_label)))
(if (= n 0) (go end_label))
(setf smlsiz (ilaenv 9 "DBDSDC" " " 0 0 0 0))
(cond
  ((= n 1)
    (cond
      ((= icompq 1)
        (setf
          (f2cl-lib:fref q-%data% (1) ((1 *)) q-%offset%)
          (f2cl-lib:sign one
            (f2cl-lib:fref d-%data% (1) ((1 *)) d-%offset%)))
        (setf
          (f2cl-lib:fref q-%data%
            ((f2cl-lib:int-add 1
              (f2cl-lib:int-mul smlsiz n))) ((1 *)) q-%offset%)
          one))
      ((= icompq 2)
        (setf
          (f2cl-lib:fref u-%data% (1 1) ((1 ldu) (1 *)) u-%offset%)
          (f2cl-lib:sign one (f2cl-lib:fref d-%data% (1) ((1 *)) d-%offset%)))))

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(setf
  (f2cl-lib:fref vt-%data% (1 1) ((1 ldvt) (1 *)) vt-%offset%
    one)))
(setf (f2cl-lib:fref d-%data% (1) ((1 *)) d-%offset%)
  (abs (f2cl-lib:fref d-%data% (1) ((1 *)) d-%offset%)))
(go end_label)))
(setf nm1 (f2cl-lib:int-sub n 1))
(setf wstart 1)
(setf qstart 3)
(cond
  ((= icompq 1)
    (dcopy n d 1 (f2cl-lib:array-slice q double-float (1) ((1 *))) 1)
    (dcopy (f2cl-lib:int-sub n 1) e 1
      (f2cl-lib:array-slice q double-float ((+ n 1)) ((1 *))) 1)))
  (cond
    ((= iuplo 2)
      (setf qstart 5)
      (setf wstart (f2cl-lib:int-sub (f2cl-lib:int-mul 2 n) 1))
      (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
        ((> i (f2cl-lib:int-add n (f2cl-lib:int-sub 1))) nil)
        (tagbody
          (multiple-value-bind (var-0 var-1 var-2 var-3 var-4)
            (dlartg (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%)
              (f2cl-lib:fref e-%data% (i) ((1 *)) e-%offset%) cs sn r)
            (declare (ignore var-0 var-1))
            (setf cs var-2)
            (setf sn var-3)
            (setf r var-4)
            (setf (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%) r)
            (setf
              (f2cl-lib:fref e-%data% (i) ((1 *)) e-%offset%)
              (* sn (f2cl-lib:fref
                d-%data% ((f2cl-lib:int-add i 1)) ((1 *)) d-%offset%)))
            (setf
              (f2cl-lib:fref d-%data%
                ((f2cl-lib:int-add i 1)) ((1 *)) d-%offset%)
              (* cs (f2cl-lib:fref
                d-%data% ((f2cl-lib:int-add i 1)) ((1 *)) d-%offset%)))
            (cond
              ((= icompq 1)
                (setf
                  (f2cl-lib:fref q-%data%
                    ((f2cl-lib:int-add i (f2cl-lib:int-mul 2 n)))
                    ((1 *)) q-%offset%)
                  cs)
                (setf

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      (f2cl-lib:fref q-%data%
        ((f2cl-lib:int-add i (f2cl-lib:int-mul 3 n)))
        ((1 *)) q-%offset%)
      sn))
    (= icompq 2)
    (setf (f2cl-lib:fref work-%data% (i) ((1 *)) work-%offset%) cs)
    (setf
      (f2cl-lib:fref work-%data%
        ((f2cl-lib:int-add nm1 i)) ((1 *)) work-%offset%)
      (- sn))))))
(cond
  (= icompq 0)
  (multiple-value-bind
    (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9
     var-10 var-11 var-12 var-13 var-14 var-15)
    (dlasdq "U" 0 n 0 0 0 d e vt ldvt u ldu u ldu
      (f2cl-lib:array-slice work double-float (wstart) ((1 *))) info)
    (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
      var-8 var-9 var-10 var-11 var-12 var-13 var-14))
    (setf info var-15))
  (go label40)))
(cond
  (<= n smlsiz)
  (cond
    (= icompq 2)
    (dlaset "A" n n zero one u ldu)
    (dlaset "A" n n zero one vt ldvt)
    (multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
       var-9 var-10 var-11 var-12 var-13 var-14 var-15)
      (dlasdq "U" 0 n n n 0 d e vt ldvt u ldu u ldu
        (f2cl-lib:array-slice work double-float (wstart) ((1 *)))
        info)
      (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
        var-7 var-8 var-9 var-10 var-11 var-12 var-13 var-14))
      (setf info var-15)))
    (= icompq 1)
    (setf iu 1)
    (setf ivt (f2cl-lib:int-add iu n))
    (dlaset "A" n n zero one
      (f2cl-lib:array-slice q double-float
        ((+ iu
          (f2cl-lib:int-mul
            (f2cl-lib:int-add qstart (f2cl-lib:int-sub 1)) n)))
        ((1 *)))
      n)

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```

(dlaset "A" n n zero one
(f2cl-lib:array-slice q double-float
  ((+ ivt
    (f2cl-lib:int-mul
      (f2cl-lib:int-add qstart (f2cl-lib:int-sub 1)) n)))
    ((1 *)))
n)
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
   var-9 var-10 var-11 var-12 var-13 var-14 var-15)
  (dlasdq "U" 0 n n n 0 d e
   (f2cl-lib:array-slice q double-float
    ((+ ivt
      (f2cl-lib:int-mul
        (f2cl-lib:int-add qstart (f2cl-lib:int-sub 1))
        n)))
    ((1 *)))
    n
   (f2cl-lib:array-slice q double-float
    ((+ iu
      (f2cl-lib:int-mul
        (f2cl-lib:int-add qstart (f2cl-lib:int-sub 1))
        n)))
    ((1 *)))
    n
   (f2cl-lib:array-slice q double-float
    ((+ iu
      (f2cl-lib:int-mul
        (f2cl-lib:int-add qstart (f2cl-lib:int-sub 1))
        n)))
    ((1 *)))
    n
   (f2cl-lib:array-slice work double-float (wstart) ((1 *)))
   info)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
    var-7 var-8 var-9 var-10 var-11 var-12 var-13 var-14))
  (setf info var-15)))
  (go label40)))
(cond
  ((= icompq 2)
   (dlaset "A" n n zero one u ldu)
   (dlaset "A" n n zero one vt ldvt)))
(setf orgnrm (dlanst "M" n d e))
(if (= orgnrm zero) (go end_label))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9)

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(dlascl "G" 0 0 orgnrm one n 1 d n ierr)
(declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
            var-8))
(setf ierr var-9))
(multiple-value-bind
 (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9)
 (dlascl "G" 0 0 orgnrm one nm1 1 e nm1 ierr)
 (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
            var-8))
 (setf ierr var-9))
(setf eps (dlamch "Epsilon"))
(setf mlvl
 (f2cl-lib:int-add
  (f2cl-lib:int
   (/
    (f2cl-lib:flog
     (/ (coerce (realpart n) 'double-float)
         (coerce (realpart (f2cl-lib:int-add smlsiz 1)) 'double-float)))
    (f2cl-lib:flog two)))
  1))
(setf smlszp (f2cl-lib:int-add smlsiz 1))
(cond
 ((= icompq 1)
  (setf iu 1)
  (setf ivt (f2cl-lib:int-add 1 smlsiz))
  (setf difl (f2cl-lib:int-add ivt smlszp))
  (setf difr (f2cl-lib:int-add difl mlvl))
  (setf z (f2cl-lib:int-add difr (f2cl-lib:int-mul mlvl 2)))
  (setf ic (f2cl-lib:int-add z mlvl))
  (setf is (f2cl-lib:int-add ic 1))
  (setf poles (f2cl-lib:int-add is 1))
  (setf givnum (f2cl-lib:int-add poles (f2cl-lib:int-mul 2 mlvl)))
  (setf k 1)
  (setf givptr 2)
  (setf perm 3)
  (setf givcol (f2cl-lib:int-add perm mlvl))))
(f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
              (> i n) nil)
(tagbody
 (cond
  ((< (abs (f2cl-lib:fref d (i) ((1 *)))) eps)
   (setf
    (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%)
    (f2cl-lib:sign eps
     (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%))))))
(setf start 1)

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(setf sqre 0)
(f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
              ((> i nm1) nil)
(tagbody
 (cond
  ((or (< (abs (f2cl-lib:fref e (i) ((1 *)))) eps) (= i nm1))
   (cond
    ((< i nm1)
     (setf nsize (f2cl-lib:int-add (f2cl-lib:int-sub i start) 1)))
    ((>= (abs (f2cl-lib:fref e (i) ((1 *)))) eps)
     (setf nsize (f2cl-lib:int-add (f2cl-lib:int-sub n start) 1)))
    (t
     (setf nsize (f2cl-lib:int-add (f2cl-lib:int-sub i start) 1))
     (cond
      ((= icompq 2)
       (setf
        (f2cl-lib:fref u-%data% (n n) ((1 ldu) (1 *)) u-%offset%)
        (f2cl-lib:sign one
         (f2cl-lib:fref d-%data% (n) ((1 *)) d-%offset%)))
       (setf
        (f2cl-lib:fref vt-%data% (n n) ((1 ldvt) (1 *)) vt-%offset%)
        one))
      ((= icompq 1)
       (setf
        (f2cl-lib:fref q-%data%
         ((f2cl-lib:int-add n
          (f2cl-lib:int-mul (f2cl-lib:int-sub qstart 1) n)))
         ((1 *)) q-%offset%)
        (f2cl-lib:sign one
         (f2cl-lib:fref d-%data% (n) ((1 *)) d-%offset%)))
       (setf
        (f2cl-lib:fref q-%data%
         ((f2cl-lib:int-add n
          (f2cl-lib:int-mul
           (f2cl-lib:int-sub
            (f2cl-lib:int-add smlsiz qstart) 1) n)))
         ((1 *)) q-%offset%)
        one)))
      (setf
       (f2cl-lib:fref d-%data% (n) ((1 *)) d-%offset%)
       (abs (f2cl-lib:fref d-%data% (n) ((1 *)) d-%offset%))))))
   (cond
    ((= icompq 2)
     (multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
       var-9 var-10 var-11)

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(dlasd0 nsize sqre
  (f2cl-lib:array-slice d double-float (start) ((1 *)))
  (f2cl-lib:array-slice e double-float (start) ((1 *)))
  (f2cl-lib:array-slice u double-float
    (start start) ((1 ldu) (1 *)))
  ldu
  (f2cl-lib:array-slice vt double-float
    (start start) ((1 ldvt) (1 *)))
  ldvt
  smlsiz
  iwork
  (f2cl-lib:array-slice work double-float (wstart) ((1 *))) info)
(declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
  var-7 var-8 var-9 var-10))
(setf info var-11))
(t
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
   var-9 var-10 var-11 var-12 var-13 var-14 var-15 var-16
   var-17 var-18 var-19 var-20 var-21 var-22 var-23)
  (dlasda icomq smlsiz nsize sqre
    (f2cl-lib:array-slice d double-float (start) ((1 *)))
    (f2cl-lib:array-slice e double-float (start) ((1 *)))
    (f2cl-lib:array-slice q double-float
      ((+ start (f2cl-lib:int-mul (f2cl-lib:int-add iu qstart
        (f2cl-lib:int-sub 2)) n))) ((1 *)))
    n
    (f2cl-lib:array-slice q double-float
      ((+ start (f2cl-lib:int-mul (f2cl-lib:int-add ivt qstart
        (f2cl-lib:int-sub 2)) n))) ((1 *)))
    (f2cl-lib:array-slice iq fixnum
      ((+ start (f2cl-lib:int-mul k n))) ((1 *)))
    (f2cl-lib:array-slice q double-float
      ((+ start (f2cl-lib:int-mul (f2cl-lib:int-add difl qstart
        (f2cl-lib:int-sub 2)) n))) ((1 *)))
    (f2cl-lib:array-slice q double-float
      ((+ start (f2cl-lib:int-mul (f2cl-lib:int-add difr qstart
        (f2cl-lib:int-sub 2)) n))) ((1 *)))
    (f2cl-lib:array-slice q double-float
      ((+ start (f2cl-lib:int-mul (f2cl-lib:int-add z qstart
        (f2cl-lib:int-sub 2)) n))) ((1 *)))
    (f2cl-lib:array-slice q double-float
      ((+ start (f2cl-lib:int-mul (f2cl-lib:int-add poles qstart
        (f2cl-lib:int-sub 2)) n))) ((1 *)))
    (f2cl-lib:array-slice iq fixnum
      ((+ start (f2cl-lib:int-mul givptr n))) ((1 *)))

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(f2cl-lib:array-slice iq fixnum
  ((+ start (f2cl-lib:int-mul givcol n))) ((1 *)))
n
(f2cl-lib:array-slice iq fixnum
  ((+ start (f2cl-lib:int-mul perm n))) ((1 *)))
(f2cl-lib:array-slice q double-float
  ((+ start (f2cl-lib:int-mul (f2cl-lib:int-add givnum qstart
    (f2cl-lib:int-sub 2)) n))) ((1 *)))
(f2cl-lib:array-slice q double-float
  ((+ start (f2cl-lib:int-mul (f2cl-lib:int-add ic qstart
    (f2cl-lib:int-sub 2)) n))) ((1 *)))
(f2cl-lib:array-slice q double-float
  ((+ start (f2cl-lib:int-mul (f2cl-lib:int-add is qstart
    (f2cl-lib:int-sub 2)) n))) ((1 *)))
(f2cl-lib:array-slice work double-float (wstart) ((1 *)))
iwork
info)
(declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
  var-7 var-8 var-9 var-10 var-11 var-12
  var-13 var-14 var-15 var-16 var-17 var-18
  var-19 var-20 var-21 var-22))
  (setf info var-23))
(cond
  ((/= info 0) (go end_label))))
(setf start (f2cl-lib:int-add i 1))))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9)
  (dlascl "G" 0 0 one orgnrm n 1 d n ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8))
  (setf ierr var-9))
label40
(f2cl-lib:fdo (ii 2 (f2cl-lib:int-add ii 1))
  (> ii n) nil)
(tagbody
  (setf i (f2cl-lib:int-sub ii 1))
  (setf kk i)
  (setf p (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%))
  (f2cl-lib:fdo (j ii (f2cl-lib:int-add j 1))
    (> j n) nil)
  (tagbody
    (cond
      (> (f2cl-lib:fref d (j) ((1 *)) p)
        (setf kk j)
        (setf p (f2cl-lib:fref d-%data% (j) ((1 *)) d-%offset%))))))
  (cond
    ((/= kk i)

```

```

      (setf (f2cl-lib:fref d-%data% (kk) ((1 *)) d-%offset%)
            (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%))
      (setf (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%) p)
      (cond
        ((= icompq 1)
         (setf (f2cl-lib:fref iq-%data% (i) ((1 *)) iq-%offset%) kk))
        ((= icompq 2)
         (dswap n
          (f2cl-lib:array-slice u double-float (1 i) ((1 ldu) (1 *)))
          1
          (f2cl-lib:array-slice u double-float (1 kk) ((1 ldu) (1 *)))
          1)
         (dswap n
          (f2cl-lib:array-slice vt double-float (i 1) ((1 ldvt) (1 *)))
          ldvt
          (f2cl-lib:array-slice vt double-float (kk 1) ((1 ldvt) (1 *)))
          ldvt))))
      ((= icompq 1)
       (setf (f2cl-lib:fref iq-%data% (i) ((1 *)) iq-%offset%) i))))
      (cond
        ((= icompq 1)
         (cond
           ((= iuplo 1)
            (setf (f2cl-lib:fref iq-%data% (n) ((1 *)) iq-%offset%) 1))
           (t
            (setf (f2cl-lib:fref iq-%data% (n) ((1 *)) iq-%offset%) 0))))
        (if (and (= iuplo 2) (= icompq 2))
            (dlasr "L" "V" "B" n n
             (f2cl-lib:array-slice work double-float (1) ((1 *)))
             (f2cl-lib:array-slice work double-float (n) ((1 *))) u ldu))
            end_label
        (return
         (values nil nil nil nil nil nil nil nil nil nil nil nil info))))))

```



## 7.2 dbdsqr LAPACK

```
<dbdsqr.input>≡  
  )set break resume  
  )sys rm -f dbdsqr.output  
  )spool dbdsqr.output  
  )set message test on  
  )set message auto off  
  )clear all  
  
  )spool  
  )lisp (bye)
```

`<dbdsqr.help>`≡

```
=====
dbdsqr examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

DBDSQR - the singular values and, optionally, the right and/or left singular vectors from the singular value decomposition (SVD) of a real N-by-N (upper or lower) bidiagonal matrix B using the implicit zero-shift QR algorithm

#### SYNOPSIS

```
SUBROUTINE DBDSQR( UPLO, N, NCVT, NRU, NCC, D, E, VT, LDVT, U, LDU, C,
                  LDC, WORK, INFO )
```

```
CHARACTER        UPLO
```

```
INTEGER          INFO, LDC, LDU, LDVT, N, NCC, NCVT, NRU
```

```
DOUBLE           PRECISION  C( LDC, * ), D( * ), E( * ), U( LDU, * ),
                  VT( LDVT, * ), WORK( * )
```

#### PURPOSE

DBDSQR computes the singular values and, optionally, the right and/or left singular vectors from the singular value decomposition (SVD) of a real N-by-N (upper or lower) bidiagonal matrix B using the implicit zero-shift QR algorithm. The SVD of B has the form

$$B = Q * S * P^{**T}$$

where S is the diagonal matrix of singular values, Q is an orthogonal matrix of left singular vectors, and P is an orthogonal matrix of right singular vectors. If left singular vectors are requested, this subroutine actually returns U\*Q instead of Q, and, if right singular vectors are requested, this subroutine returns P\*\*T\*VT instead of P\*\*T, for given real input matrices U and VT. When U and VT are the orthogonal matrices that reduce a general matrix A to bidiagonal form:  $A = U*B*VT$ , as computed by DGEBRD, then

$$A = (U*Q) * S * (P^{**T}*VT)$$

is the SVD of A. Optionally, the subroutine may also compute  $Q^{**T}*C$

for a given real input matrix C.

See "Computing Small Singular Values of Bidiagonal Matrices With Guaranteed High Relative Accuracy," by J. Demmel and W. Kahan, LAPACK Working Note #3 (or SIAM J. Sci. Statist. Comput. vol. 11, no. 5, pp. 873-912, Sept 1990) and

"Accurate singular values and differential qd algorithms," by B. Parlett and V. Fernando, Technical Report CPAM-554, Mathematics Department, University of California at Berkeley, July 1992 for a detailed description of the algorithm.

#### ARGUMENTS

- UPLD      (input) CHARACTER\*1  
           = 'U': B is upper bidiagonal;  
           = 'L': B is lower bidiagonal.
- N          (input) INTEGER  
           The order of the matrix B.  $N \geq 0$ .
- NCVT      (input) INTEGER  
           The number of columns of the matrix VT.  $NCVT \geq 0$ .
- NRU      (input) INTEGER  
           The number of rows of the matrix U.  $NRU \geq 0$ .
- NCC      (input) INTEGER  
           The number of columns of the matrix C.  $NCC \geq 0$ .
- D          (input/output) DOUBLE PRECISION array, dimension (N)  
           On entry, the n diagonal elements of the bidiagonal matrix B.  
           On exit, if INFO=0, the singular values of B in decreasing order.
- E          (input/output) DOUBLE PRECISION array, dimension (N-1)  
           On entry, the N-1 offdiagonal elements of the bidiagonal matrix B. On exit, if INFO = 0, E is destroyed; if INFO > 0, D and E will contain the diagonal and superdiagonal elements of a bidiagonal matrix orthogonally equivalent to the one given as input.
- VT        (input/output) DOUBLE PRECISION array, dimension (LDVT, NCVT)  
           On entry, an N-by-NCVT matrix VT. On exit, VT is overwritten by  $P^*T * VT$ . Not referenced if  $NCVT = 0$ .
- LDVT      (input) INTEGER

The leading dimension of the array VT. LDVT  $\geq \max(1, N)$  if NCVT  $> 0$ ; LDVT  $\geq 1$  if NCVT = 0.

U (input/output) DOUBLE PRECISION array, dimension (LDU, N)  
On entry, an NRU-by-N matrix U. On exit, U is overwritten by  $U * Q$ . Not referenced if NRU = 0.

LDU (input) INTEGER  
The leading dimension of the array U. LDU  $\geq \max(1, \text{NRU})$ .

C (input/output) DOUBLE PRECISION array, dimension (LDC, NCC)  
On entry, an N-by-NCC matrix C. On exit, C is overwritten by  $Q^{**T} * C$ . Not referenced if NCC = 0.

LDC (input) INTEGER  
The leading dimension of the array C. LDC  $\geq \max(1, N)$  if NCC  $> 0$ ; LDC  $\geq 1$  if NCC = 0.

WORK (workspace) DOUBLE PRECISION array, dimension (2\*N)  
if NCVT = NRU = NCC = 0, ( $\max(1, 4*N)$ ) otherwise

INFO (output) INTEGER  
= 0: successful exit  
< 0: If INFO = -i, the i-th argument had an illegal value  
> 0: the algorithm did not converge; D and E contain the elements of a bidiagonal matrix which is orthogonally similar to the input matrix B; if INFO = i, i elements of E have not converged to zero.

#### PARAMETERS

TOLMUL DOUBLE PRECISION, default =  $\max(10, \min(100, \text{EPS}^{**(-1/8)}))$   
TOLMUL controls the convergence criterion of the QR loop. If it is positive, TOLMUL\*EPS is the desired relative precision in the computed singular values. If it is negative,  $\text{abs}(\text{TOLMUL} * \text{EPS} * \text{sigma\_max})$  is the desired absolute accuracy in the computed singular values (corresponds to relative accuracy  $\text{abs}(\text{TOLMUL} * \text{EPS})$  in the largest singular value.  $\text{abs}(\text{TOLMUL})$  should be between 1 and  $1/\text{EPS}$ , and preferably between 10 (for fast convergence) and  $.1/\text{EPS}$  (for there to be some accuracy in the results). Default is to lose at either one eighth or 2 of the available decimal digits in each computed singular value (whichever is smaller).

MAXITR INTEGER, default = 6  
MAXITR controls the maximum number of passes of the algorithm through its inner loop. The algorithm stops (and so fails to

converge) if the number of passes through the inner loop exceeds  $\text{MAXITR} \times N^2$ .

```

(LAPACK dbdsqr)=
  (let* ((zero 0.0)
        (one 1.0)
        (negone (- 1.0))
        (hndrth 0.01)
        (ten 10.0)
        (hndrd 100.0)
        (meigth (- 0.125))
        (maxitr 6))
    (declare (type (double-float 0.0 0.0) zero)
              (type (double-float 1.0 1.0) one)
              (type (double-float) negone)
              (type (double-float 0.01 0.01) hndrth)
              (type (double-float 10.0 10.0) ten)
              (type (double-float 100.0 100.0) hndrd)
              (type (double-float) meigth)
              (type (fixnum 6 6) maxitr))
    (defun dbdsqr (uplo n ncvr nru ncc d e vt ldvt u ldu c ldc work info)
      (declare (type (simple-array double-float (*)) work c u vt e d)
                (type fixnum info ldc ldu ldvt ncc nru ncvr n)
                (type character uplo))
      (f2cl-lib:with-multi-array-data
        ((uplo character uplo-%data% uplo-%offset%)
         (d double-float d-%data% d-%offset%)
         (e double-float e-%data% e-%offset%)
         (vt double-float vt-%data% vt-%offset%)
         (u double-float u-%data% u-%offset%)
         (c double-float c-%data% c-%offset%)
         (work double-float work-%data% work-%offset%))
        (prog ((abse 0.0) (abss 0.0) (cosl 0.0) (cosr 0.0) (cs 0.0) (eps 0.0)
              (f 0.0) (g 0.0) (h 0.0) (mu 0.0) (oldcs 0.0) (oldsn 0.0) (r 0.0)
              (shift 0.0) (sigmn 0.0) (sigmx 0.0) (sinl 0.0) (sinr 0.0)
              (sll 0.0) (smax 0.0) (smin 0.0) (sminl 0.0) (sminlo 0.0)
              (sminoa 0.0) (sn 0.0) (thresh 0.0) (tol 0.0) (tolmul 0.0)
              (unfl 0.0) (i 0) (idir 0) (isub 0) (iter 0) (j 0) (ll 0) (lll 0)
              (m 0) (maxit 0) (nm1 0) (nm12 0) (nm13 0) (oldll 0) (oldm 0)
              (lower nil) (rotate nil))
              (declare (type (double-float) abse abss cosl cosr cs eps f g h mu oldcs
                                oldsn r shift sigmn sigmx sinl sinr sll
                                smax smin sminl sminlo sminoa sn thresh
                                tol tolmul unfl)
                        (type fixnum i idir isub iter j ll lll m maxit
                                nm1 nm12 nm13 oldll oldm)
                        (type (member t nil) lower rotate))
              (setf info 0)
              (setf lower (char-equal uplo #\L)))

```

```

(cond
  ((and (not (char-equal uplo #\U)) (not lower))
    (setf info -1))
  ((< n 0)
    (setf info -2))
  ((< ncv 0)
    (setf info -3))
  ((< nru 0)
    (setf info -4))
  ((< ncc 0)
    (setf info -5))
  ((or (and (= ncv 0) (< ldvt 1))
    (and (> ncv 0)
      (< ldvt
        (max (the fixnum 1)
              (the fixnum n))))))
    (setf info -9))
  ((< ldu (max (the fixnum 1) (the fixnum nru)))
    (setf info -11))
  ((or (and (= ncc 0) (< ldc 1))
    (and (> ncc 0)
      (< ldc
        (max (the fixnum 1)
              (the fixnum n))))))
    (setf info -13)))
(cond
  ((/= info 0)
    (error
      " ** On entry to ~a parameter number ~a had an illegal value~%"
      "DBDSQR" (f2cl-lib:int-sub info))
    (go end_label)))
(if (= n 0) (go end_label))
(if (= n 1) (go label160))
(setf rotate (or (> ncv 0) (> nru 0) (> ncc 0)))
(cond
  ((not rotate)
    (multiple-value-bind (var-0 var-1 var-2 var-3 var-4)
      (dlasq1 n d e work info)
      (declare (ignore var-0 var-1 var-2 var-3))
      (setf info var-4))
    (go end_label)))
(setf nm1 (f2cl-lib:int-sub n 1))
(setf nm12 (f2cl-lib:int-add nm1 nm1))
(setf nm13 (f2cl-lib:int-add nm12 nm1))
(setf idir 0)
(setf eps (dlamch "Epsilon"))

```

```

(setf unfl (dlamch "Safe minimum"))
(cond
  (lower
    (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
      ((> i (f2cl-lib:int-add n (f2cl-lib:int-sub 1))) nil)
    (tagbody
      (multiple-value-bind (var-0 var-1 var-2 var-3 var-4)
        (dlartg (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%)
          (f2cl-lib:fref e-%data% (i) ((1 *)) e-%offset%) cs sn r)
        (declare (ignore var-0 var-1))
        (setf cs var-2)
        (setf sn var-3)
        (setf r var-4))
      (setf (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%) r)
      (setf (f2cl-lib:fref e-%data% (i) ((1 *)) e-%offset%)
        (* sn
          (f2cl-lib:fref d-%data%
            ((f2cl-lib:int-add i 1))
            ((1 *))
            d-%offset%)))
      (setf (f2cl-lib:fref d-%data%
        ((f2cl-lib:int-add i 1))
        ((1 *))
        d-%offset%)
        (* cs
          (f2cl-lib:fref d-%data%
            ((f2cl-lib:int-add i 1))
            ((1 *))
            d-%offset%)))
      (setf (f2cl-lib:fref work-%data% (i) ((1 *)) work-%offset%) cs)
      (setf (f2cl-lib:fref work-%data%
        ((f2cl-lib:int-add nm1 i))
        ((1 *))
        work-%offset%)
        sn)))
    (if (> nru 0)
      (dlasr "R" "V" "F" nru n
        (f2cl-lib:array-slice work double-float (1) ((1 *)))
        (f2cl-lib:array-slice work double-float (n) ((1 *))) u ldu))
    (if (> ncc 0)
      (dlasr "L" "V" "F" n ncc
        (f2cl-lib:array-slice work double-float (1) ((1 *)))
        (f2cl-lib:array-slice work double-float (n) ((1 *))) c ldc))))
(setf tolmul (max ten (min hndrd (expt eps meigth))))
(setf tol (* tolmul eps))
(setf smax zero)

```



```

(f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
  ((> i n) nil)
  (tagbody
    (setf smax
      (max smax
        (abs
          (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%))))))
(f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
  ((> i (f2cl-lib:int-add n (f2cl-lib:int-sub 1))) nil)
  (tagbody
    (setf smax
      (max smax
        (abs
          (f2cl-lib:fref e-%data% (i) ((1 *)) e-%offset%))))))
(setf sminl zero)
(cond
  ((>= tol zero)
    (tagbody
      (setf sminoa
        (abs (f2cl-lib:fref d-%data% (1) ((1 *)) d-%offset%)))
      (if (= sminoa zero) (go label50))
      (setf mu sminoa)
      (f2cl-lib:fdo (i 2 (f2cl-lib:int-add i 1))
        ((> i n) nil)
        (tagbody
          (setf mu
            (*
              (abs (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%))
              (/ mu
                (+ mu
                  (abs
                    (f2cl-lib:fref e-%data%
                      ((f2cl-lib:int-sub i 1))
                      ((1 *))
                      e-%offset%))))))
            (setf sminoa (min sminoa mu))
            (if (= sminoa zero) (go label50))))))
    label50
    (setf sminoa
      (/ sminoa (f2cl-lib:fsqrt (coerce (realpart n) 'double-float))))
    (setf thresh (max (* tol sminoa) (* maxitr n n unfl))))
  (t
    (setf thresh (max (* (abs tol) smax) (* maxitr n n unfl))))
  (setf maxit (f2cl-lib:int-mul maxitr n n))
  (setf iter 0)
  (setf oldl1 -1)

```

```

(setf oldm -1)
(setf m n)

label60
(if (<= m 1) (go label160))
(if (> iter maxit) (go label200))
(if
  (and (< tol zero)
    (<= (abs (f2cl-lib:fref d-%data% (m) ((1 *)) d-%offset%)
      thresh)))
  (setf (f2cl-lib:fref d-%data% (m) ((1 *)) d-%offset%) zero))
(setf smax (abs (f2cl-lib:fref d-%data% (m) ((1 *)) d-%offset%)))
(setf smin smax)
(f2cl-lib:fdo (l1 1 (f2cl-lib:int-add l1 1))
  ((> l1 (f2cl-lib:int-add m (f2cl-lib:int-sub 1))) nil)
  (tagbody
    (setf l1 (f2cl-lib:int-sub m l1))
    (setf abss (abs (f2cl-lib:fref d-%data% (l1) ((1 *)) d-%offset%)))
    (setf abse (abs (f2cl-lib:fref e-%data% (l1) ((1 *)) e-%offset%)))
    (if (and (< tol zero) (<= abss thresh))
      (setf (f2cl-lib:fref d-%data% (l1) ((1 *)) d-%offset%) zero))
    (if (<= abse thresh) (go label80))
    (setf smin (min smin abss))
    (setf smax (max smax abss abse)))
  (setf l1 0)
  (go label90))

label80
(setf (f2cl-lib:fref e-%data% (l1) ((1 *)) e-%offset%) zero)
(cond
  ((= l1 (f2cl-lib:int-add m (f2cl-lib:int-sub 1)))
    (setf m (f2cl-lib:int-sub m 1))
    (go label60)))

label90
(setf l1 (f2cl-lib:int-add l1 1))
(cond
  ((= l1 (f2cl-lib:int-add m (f2cl-lib:int-sub 1)))
    (multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8)
      (dlasv2
        (f2cl-lib:fref d-%data%
          ((f2cl-lib:int-sub m 1))
          ((1 *))
          d-%offset%)
        (f2cl-lib:fref e-%data%
          ((f2cl-lib:int-sub m 1))
          ((1 *))
          e-%offset%)

```

```

(f2cl-lib:fref d-%data% (m) ((1 *)) d-%offset%) sigmn sigmx
sinr cosr sinl cosl)
(declare (ignore var-0 var-1 var-2))
(setf sigmn var-3)
(setf sigmx var-4)
(setf sinr var-5)
(setf cosr var-6)
(setf sinl var-7)
(setf cosl var-8))
(setf (f2cl-lib:fref d-%data%
                    ((f2cl-lib:int-sub m 1))
                    ((1 *))
                    d-%offset%)
      sigmx)
(setf (f2cl-lib:fref e-%data%
                    ((f2cl-lib:int-sub m 1))
                    ((1 *))
                    e-%offset%)
      zero)
(setf (f2cl-lib:fref d-%data% (m) ((1 *)) d-%offset%) sigmn)
(if (> ncv 0)
    (drot ncv
      (f2cl-lib:array-slice vt
                            double-float
                            ((+ m (f2cl-lib:int-sub 1)) 1)
                            ((1 ldvt) (1 *)))
      ldvt
      (f2cl-lib:array-slice vt double-float (m 1) ((1 ldvt) (1 *)))
      ldvt cosr sinr))
(if (> nru 0)
    (drot nru
      (f2cl-lib:array-slice u
                            double-float
                            (1 (f2cl-lib:int-sub m 1))
                            ((1 ldu) (1 *)))
      1 (f2cl-lib:array-slice u double-float (1 m) ((1 ldu) (1 *))) 1
      cosl sinl))
(if (> ncc 0)
    (drot ncc
      (f2cl-lib:array-slice c
                            double-float
                            ((+ m (f2cl-lib:int-sub 1)) 1)
                            ((1 ldc) (1 *)))
      ldc (f2cl-lib:array-slice c double-float (m 1) ((1 ldc) (1 *)))
      ldc cosl sinl))
(setf m (f2cl-lib:int-sub m 2))

```

```

      (go label60)))
    (cond
      ((or (> ll oldm) (< m oldl1))
        (cond
          ((>= (abs (f2cl-lib:fref d (ll) ((1 *))))
                (abs (f2cl-lib:fref d (m) ((1 *))))))
            (setf idir 1))
          (t
            (setf idir 2))))))
    (cond
      ((= idir 1)
        (cond
          ((or
            (<=
              (abs
                (f2cl-lib:fref e
                  ((f2cl-lib:int-add m (f2cl-lib:int-sub 1)))
                  ((1 *))))
                (* (abs tol) (abs (f2cl-lib:fref d (m) ((1 *)))))))
            (and (< tol zero)
              (<=
                (abs
                  (f2cl-lib:fref e
                    ((f2cl-lib:int-add m
                      (f2cl-lib:int-sub 1)))
                    ((1 *))))
                  thresh))))
            (setf (f2cl-lib:fref e-%data%
              ((f2cl-lib:int-sub m 1))
              ((1 *))
              e-%offset%)
              zero)
            (go label60)))
          (t
            (cond
              ((>= tol zero)
                (setf mu (abs (f2cl-lib:fref d-%data% (ll) ((1 *)) d-%offset%)))
                (setf sminl mu)
                (f2cl-lib:fdo (l1l ll (f2cl-lib:int-add l1l 1))
                  ((> l1l (f2cl-lib:int-add m (f2cl-lib:int-sub 1)))
                    nil)
                (tagbody
                  (cond
                    ((<= (abs (f2cl-lib:fref e (l1l) ((1 *)))) (* tol mu))
                      (setf (f2cl-lib:fref e-%data% (l1l) ((1 *)) e-%offset%)
                        zero)
                      (go label60))))
                  (t
                    (go label60))))
              (t
                (go label60))))))

```

```

      (setf sminlo sminl)
      (setf mu
        (*
          (abs
            (f2cl-lib:fref d-%data%
                          ((f2cl-lib:int-add l1l 1))
                          ((1 *))
                          d-%offset%))
          (/ mu
            (+ mu
              (abs
                (f2cl-lib:fref e-%data%
                              (l1l)
                              ((1 *))
                              e-%offset%))))))
        (setf sminl (min sminl mu))))))
(t
  (cond
    ((or
      (<= (abs (f2cl-lib:fref e (l1) ((1 *))))
        (* (abs tol) (abs (f2cl-lib:fref d (l1) ((1 *))))))
      (and (< tol zero)
        (<= (abs (f2cl-lib:fref e (l1) ((1 *)))) thresh)))
      (setf (f2cl-lib:fref e-%data% (l1) ((1 *)) e-%offset%) zero)
      (go label60)))
    (cond
      ((>= tol zero)
        (setf mu (abs (f2cl-lib:fref d-%data% (m) ((1 *)) d-%offset%)))
        (setf sminl mu)
        (f2cl-lib:fdo (l1l (f2cl-lib:int-add m (f2cl-lib:int-sub 1))
                      (f2cl-lib:int-add l1l (f2cl-lib:int-sub 1)))
          ((> l1l l1) nil)
          (tagbody
            (cond
              ((<= (abs (f2cl-lib:fref e (l1l) ((1 *)))) (* tol mu))
                (setf (f2cl-lib:fref e-%data% (l1l) ((1 *)) e-%offset%)
                  zero)
                (go label60)))
            (setf sminlo sminl)
            (setf mu
              (*
                (abs
                  (f2cl-lib:fref d-%data% (l1l) ((1 *)) d-%offset%))
                (/ mu
                  (+ mu
                    (abs

```

```

(f2cl-lib:fref e-%data%
  (111)
  ((1 *))
  e-%offset%))))))
  (setf sminl (min sminl mu)))))))))
(setf oldl1 l1)
(setf oldm m)
(cond
  ((and (>= tol zero)
    (<= (* n tol (f2cl-lib:f2cl/ sminl smax))
      (max eps (* hndrth tol))))
    (setf shift zero))
  (t
    (cond
      ((= idir 1)
        (setf s11 (abs (f2cl-lib:fref d-%data% (11) ((1 *)) d-%offset%)))
        (multiple-value-bind (var-0 var-1 var-2 var-3 var-4)
          (dlas2
            (f2cl-lib:fref d-%data%
              ((f2cl-lib:int-sub m 1))
              ((1 *))
              d-%offset%)
            (f2cl-lib:fref e-%data%
              ((f2cl-lib:int-sub m 1))
              ((1 *))
              e-%offset%)
            (f2cl-lib:fref d-%data% (m) ((1 *)) d-%offset%) shift r)
          (declare (ignore var-0 var-1 var-2))
          (setf shift var-3)
          (setf r var-4)))
        (t
          (setf s11 (abs (f2cl-lib:fref d-%data% (m) ((1 *)) d-%offset%)))
          (multiple-value-bind (var-0 var-1 var-2 var-3 var-4)
            (dlas2 (f2cl-lib:fref d-%data% (11) ((1 *)) d-%offset%)
              (f2cl-lib:fref e-%data% (11) ((1 *)) e-%offset%)
              (f2cl-lib:fref d-%data%
                ((f2cl-lib:int-add 11 1))
                ((1 *))
                d-%offset%)
              shift r)
            (declare (ignore var-0 var-1 var-2))
            (setf shift var-3)
            (setf r var-4))))
        (cond
          ((> s11 zero)
            (if (< (expt (/ shift s11) 2) eps) (setf shift zero))))))
    ))

```

```

(setf iter (f2cl-lib:int-sub (f2cl-lib:int-add iter m) 1))
(cond
  ((= shift zero)
    (cond
      ((= idir 1)
        (setf cs one)
        (setf oldcs one)
        (f2cl-lib:fdo (i 1) (f2cl-lib:int-add i 1))
          ((> i (f2cl-lib:int-add m (f2cl-lib:int-sub 1)))
            nil)
        (tagbody
          (multiple-value-bind (var-0 var-1 var-2 var-3 var-4)
            (dlartg
              (* (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%) cs)
              (f2cl-lib:fref e-%data% (i) ((1 *)) e-%offset%) cs sn r)
            (declare (ignore var-0 var-1))
            (setf cs var-2)
            (setf sn var-3)
            (setf r var-4))
          (if (> i 1)
            (setf (f2cl-lib:fref e-%data%
                                ((f2cl-lib:int-sub i 1))
                                ((1 *))
                                e-%offset%)
                  (* oldsn r)))
          (multiple-value-bind (var-0 var-1 var-2 var-3 var-4)
            (dlartg (* oldcs r)
              (*
                (f2cl-lib:fref d-%data%
                              ((f2cl-lib:int-add i 1))
                              ((1 *))
                              d-%offset%)
                sn)
              oldcs oldsn
              (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%))
            (declare (ignore var-0 var-1))
            (setf oldcs var-2)
            (setf oldsn var-3)
            (setf (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%)
                  var-4))
            (setf (f2cl-lib:fref work-%data%
                                ((f2cl-lib:int-add
                                  (f2cl-lib:int-sub i 1)
                                  1))
                                ((1 *))
                                work-%offset%)
                  (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%))
          )
        )
      )
    )
  )

```

```

      cs)
      (setf (f2cl-lib:fref work-%data%
                          ((f2cl-lib:int-add
                           (f2cl-lib:int-sub i 11)
                           1
                           nm1))
                          ((1 *))
                          work-%offset%))

      sn)
      (setf (f2cl-lib:fref work-%data%
                          ((f2cl-lib:int-add
                           (f2cl-lib:int-sub i 11)
                           1
                           nm12))
                          ((1 *))
                          work-%offset%))

      oldcs)
      (setf (f2cl-lib:fref work-%data%
                          ((f2cl-lib:int-add
                           (f2cl-lib:int-sub i 11)
                           1
                           nm13))
                          ((1 *))
                          work-%offset%))

      oldsn)))
      (setf h (* (f2cl-lib:fref d-%data% (m) ((1 *)) d-%offset%) cs))
      (setf (f2cl-lib:fref d-%data% (m) ((1 *)) d-%offset%) (* h oldcs))
      (setf (f2cl-lib:fref e-%data%
                          ((f2cl-lib:int-sub m 1))
                          ((1 *))
                          e-%offset%)
            (* h oldsn))
      (if (> ncvt 0)
          (dlsr "L" "V" "F"
               (f2cl-lib:int-add (f2cl-lib:int-sub m 11) 1) ncvt
               (f2cl-lib:array-slice work double-float (1) ((1 *)))
               (f2cl-lib:array-slice work double-float (n) ((1 *)))
               (f2cl-lib:array-slice vt
                                       double-float
                                       (11 1)
                                       ((1 ldvt) (1 *)))
               ldvt))
      (if (> nru 0)
          (dlsr "R" "V" "F" nru
               (f2cl-lib:int-add (f2cl-lib:int-sub m 11) 1)
               (f2cl-lib:array-slice work

```



```

double-float
((+ nm12 1))
((1 *)))
(f2cl-lib:array-slice work
double-float
((+ nm13 1))
((1 *)))
(f2cl-lib:array-slice u double-float (1 ll) ((1 ldu) (1 *)))
ldu))
(if (> ncc 0)
(dlasr "L" "V" "F"
(f2cl-lib:int-add (f2cl-lib:int-sub m ll) 1) ncc
(f2cl-lib:array-slice work
double-float
((+ nm12 1))
((1 *)))
(f2cl-lib:array-slice work
double-float
((+ nm13 1))
((1 *)))
(f2cl-lib:array-slice c double-float (ll 1) ((1 ldc) (1 *)))
ldc))
(if
(<=
(abs
(f2cl-lib:fref e-%data%
((f2cl-lib:int-sub m 1))
((1 *))
e-%offset%))
thresh)
(setf (f2cl-lib:fref e-%data%
((f2cl-lib:int-sub m 1))
((1 *))
e-%offset%)
zero)))
(t
(setf cs one)
(setf oldcs one)
(f2cl-lib:fdo (i m (f2cl-lib:int-add i (f2cl-lib:int-sub 1)))
(> i (f2cl-lib:int-add ll 1)) nil)
(tagbody
(multiple-value-bind (var-0 var-1 var-2 var-3 var-4)
(dlartg
(* (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%) cs)
(f2cl-lib:fref e-%data%
((f2cl-lib:int-sub i 1))

```

```

((1 *))
e-%offset%)

cs sn r)
(declare (ignore var-0 var-1))
(setf cs var-2)
(setf sn var-3)
(setf r var-4))
(if (< i m)
  (setf (f2cl-lib:fref e-%data% (i) ((1 *)) e-%offset%)
        (* oldsn r)))
(multiple-value-bind (var-0 var-1 var-2 var-3 var-4)
  (dlartg (* oldcs r)
    (*
      (f2cl-lib:fref d-%data%
        ((f2cl-lib:int-sub i 1))
        ((1 *))
        d-%offset%)
      sn)
    oldcs oldsn
    (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%)))
(declare (ignore var-0 var-1))
(setf oldcs var-2)
(setf oldsn var-3)
(setf (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%)
      var-4))
(setf (f2cl-lib:fref work-%data%
  ((f2cl-lib:int-sub i 11))
  ((1 *))
  work-%offset%)
  cs)
(setf (f2cl-lib:fref work-%data%
  ((f2cl-lib:int-add
    (f2cl-lib:int-sub i 11)
    nm1))
  ((1 *))
  work-%offset%)
  (- sn))
(setf (f2cl-lib:fref work-%data%
  ((f2cl-lib:int-add
    (f2cl-lib:int-sub i 11)
    nm12))
  ((1 *))
  work-%offset%)
  oldcs)
(setf (f2cl-lib:fref work-%data%
  ((f2cl-lib:int-add

```

```

(f2cl-lib:int-sub i 11)
nm13))
((1 *))
work-%offset%)
(- oldsn)))
(setf h (* (f2cl-lib:fref d-%data% (11) ((1 *)) d-%offset%) cs))
(setf (f2cl-lib:fref d-%data% (11) ((1 *)) d-%offset%)
(* h oldcs))
(setf (f2cl-lib:fref e-%data% (11) ((1 *)) e-%offset%)
(* h oldsn))
(if (> ncv 0)
  (dlasr "L" "V" "B"
    (f2cl-lib:int-add (f2cl-lib:int-sub m 11) 1) ncv
    (f2cl-lib:array-slice work
      double-float
      ((+ nm12 1))
      ((1 *)))
    (f2cl-lib:array-slice work
      double-float
      ((+ nm13 1))
      ((1 *)))
    (f2cl-lib:array-slice vt
      double-float
      (11 1)
      ((1 ldvt) (1 *)))
    ldvt))
(if (> nru 0)
  (dlasr "R" "V" "B" nru
    (f2cl-lib:int-add (f2cl-lib:int-sub m 11) 1)
    (f2cl-lib:array-slice work double-float (1) ((1 *)))
    (f2cl-lib:array-slice work double-float (n) ((1 *)))
    (f2cl-lib:array-slice u double-float (1 11) ((1 ldu) (1 *)))
    ldu))
(if (> ncc 0)
  (dlasr "L" "V" "B"
    (f2cl-lib:int-add (f2cl-lib:int-sub m 11) 1) ncc
    (f2cl-lib:array-slice work double-float (1) ((1 *)))
    (f2cl-lib:array-slice work double-float (n) ((1 *)))
    (f2cl-lib:array-slice c double-float (11 1) ((1 ldc) (1 *)))
    ldc))
(if
  (<= (abs (f2cl-lib:fref e-%data% (11) ((1 *)) e-%offset%))
    thresh)
  (setf (f2cl-lib:fref e-%data% (11) ((1 *)) e-%offset%) zero))))
(t
  (cond

```

```

(= idir 1)
(setf f
  (*
    (-
      (abs (f2cl-lib:fref d-%data% (ll) ((1 *)) d-%offset%))
      shift)
    (+
      (f2cl-lib:sign one
        (f2cl-lib:fref d-%data%
          (ll)
          ((1 *))
          d-%offset%))
      (/ shift
        (f2cl-lib:fref d-%data% (ll) ((1 *)) d-%offset%))))))
(setf g (f2cl-lib:fref e-%data% (ll) ((1 *)) e-%offset%))
(f2cl-lib:fdo (i ll (f2cl-lib:int-add i 1))
  ((> i (f2cl-lib:int-add m (f2cl-lib:int-sub 1)))
   nil)
  (tagbody
    (multiple-value-bind (var-0 var-1 var-2 var-3 var-4)
      (dlartg f g cosr sinr r)
      (declare (ignore var-0 var-1))
      (setf cosr var-2)
      (setf sinr var-3)
      (setf r var-4))
    (if (> i ll)
      (setf (f2cl-lib:fref e-%data%
        ((f2cl-lib:int-sub i 1))
        ((1 *))
        e-%offset%)
        r))
    (setf f
      (+
        (* cosr
          (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%))
        (* sinr
          (f2cl-lib:fref e-%data%
            (i)
            ((1 *))
            e-%offset%))))))
(setf (f2cl-lib:fref e-%data% (i) ((1 *)) e-%offset%)
  (-
    (* cosr
      (f2cl-lib:fref e-%data% (i) ((1 *)) e-%offset%))
    (* sinr
      (f2cl-lib:fref d-%data%

```

```

                                (i)
                                ((1 *))
                                d-%offset%))))
(setf g
  (* sinr
    (f2cl-lib:fref d-%data%
      ((f2cl-lib:int-add i 1))
      ((1 *))
      d-%offset%)))
(setf (f2cl-lib:fref d-%data%
  ((f2cl-lib:int-add i 1))
  ((1 *))
  d-%offset%)
  (* cosr
    (f2cl-lib:fref d-%data%
      ((f2cl-lib:int-add i 1))
      ((1 *))
      d-%offset%)))
(multiple-value-bind (var-0 var-1 var-2 var-3 var-4)
  (dlartg f g cosl sinl r)
  (declare (ignore var-0 var-1))
  (setf cosl var-2)
  (setf sinl var-3)
  (setf r var-4))
(setf (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%) r)
(setf f
  (+
    (* cosl
      (f2cl-lib:fref e-%data% (i) ((1 *)) e-%offset%))
    (* sinl
      (f2cl-lib:fref d-%data%
        ((f2cl-lib:int-add i 1))
        ((1 *))
        d-%offset%))))
(setf (f2cl-lib:fref d-%data%
  ((f2cl-lib:int-add i 1))
  ((1 *))
  d-%offset%)
  (-
    (* cosl
      (f2cl-lib:fref d-%data%
        ((f2cl-lib:int-add i 1))
        ((1 *))
        d-%offset%))
    (* sinl
      (f2cl-lib:fref e-%data%

```

```

                                (i)
                                ((1 *))
                                e-%offset%))))
(cond
  ((< i (f2cl-lib:int-add m (f2cl-lib:int-sub 1)))
   (setf g
         (* sinl
            (f2cl-lib:fref e-%data%
                           ((f2cl-lib:int-add i 1))
                           ((1 *))
                           e-%offset%)))
        (setf (f2cl-lib:fref e-%data%
                           ((f2cl-lib:int-add i 1))
                           ((1 *))
                           e-%offset%)
              (* cosl
                 (f2cl-lib:fref e-%data%
                                ((f2cl-lib:int-add i 1))
                                ((1 *))
                                e-%offset%))))))
  (setf (f2cl-lib:fref work-%data%
                      ((f2cl-lib:int-add
                        (f2cl-lib:int-sub i 11)
                        1))
                      ((1 *))
                      work-%offset%)
        cosr)
  (setf (f2cl-lib:fref work-%data%
                      ((f2cl-lib:int-add
                        (f2cl-lib:int-sub i 11)
                        1
                        nm1))
                      ((1 *))
                      work-%offset%)
        sinr)
  (setf (f2cl-lib:fref work-%data%
                      ((f2cl-lib:int-add
                        (f2cl-lib:int-sub i 11)
                        1
                        nm12))
                      ((1 *))
                      work-%offset%)
        cosl)
  (setf (f2cl-lib:fref work-%data%
                      ((f2cl-lib:int-add
                        (f2cl-lib:int-sub i 11)

```

```

1
nm13))
((1 *))
work-%offset%)
sinl)))
(setf (f2cl-lib:fref e-%data%
              ((f2cl-lib:int-sub m 1))
              ((1 *))
              e-%offset%)
      f)
(if (> ncv 0)
    (dlasr "L" "V" "F"
      (f2cl-lib:int-add (f2cl-lib:int-sub m 1) 1) ncv
      (f2cl-lib:array-slice work double-float (1) ((1 *)))
      (f2cl-lib:array-slice work double-float (n) ((1 *)))
      (f2cl-lib:array-slice vt
        double-float
        (1 1)
        ((1 ldvt) (1 *)))
      ldvt))
(if (> nru 0)
    (dlasr "R" "V" "F" nru
      (f2cl-lib:int-add (f2cl-lib:int-sub m 1) 1)
      (f2cl-lib:array-slice work
        double-float
        ((+ nm12 1))
        ((1 *)))
      (f2cl-lib:array-slice work
        double-float
        ((+ nm13 1))
        ((1 *)))
      (f2cl-lib:array-slice u double-float (1 1) ((1 ldu) (1 *)))
      ldu))
(if (> ncc 0)
    (dlasr "L" "V" "F"
      (f2cl-lib:int-add (f2cl-lib:int-sub m 1) 1) ncc
      (f2cl-lib:array-slice work
        double-float
        ((+ nm12 1))
        ((1 *)))
      (f2cl-lib:array-slice work
        double-float
        ((+ nm13 1))
        ((1 *)))
      (f2cl-lib:array-slice c double-float (1 1) ((1 ldc) (1 *)))
      ldc))

```

```

(if
  (<=
    (abs
      (f2cl-lib:fref e-%data%
        ((f2cl-lib:int-sub m 1))
        ((1 *))
        e-%offset%))
    thresh)
  (setf (f2cl-lib:fref e-%data%
    ((f2cl-lib:int-sub m 1))
    ((1 *))
    e-%offset%)
    zero)))
(t
  (setf f
    (*
      (- (abs (f2cl-lib:fref d-%data% (m) ((1 *)) d-%offset%))
        shift)
      (+
        (f2cl-lib:sign one
          (f2cl-lib:fref d-%data%
            (m)
            ((1 *))
            d-%offset%))
        (/ shift
          (f2cl-lib:fref d-%data% (m) ((1 *)) d-%offset%))))))
  (setf g
    (f2cl-lib:fref e-%data%
      ((f2cl-lib:int-sub m 1))
      ((1 *))
      e-%offset%))
  (f2cl-lib:fdo (i m (f2cl-lib:int-add i (f2cl-lib:int-sub 1)))
    ((> i (f2cl-lib:int-add ll 1)) nil)
    (tagbody
      (multiple-value-bind (var-0 var-1 var-2 var-3 var-4)
        (dlartg f g cosr sinr r)
        (declare (ignore var-0 var-1))
        (setf cosr var-2)
        (setf sinr var-3)
        (setf r var-4))
      (if (< i m)
        (setf (f2cl-lib:fref e-%data% (i) ((1 *)) e-%offset%) r))
      (setf f
        (+
          (* cosr
            (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%))

```



```

(* sinr
  (f2cl-lib:fref e-%data%
    ((f2cl-lib:int-sub i 1))
    ((1 *))
    e-%offset%)))
(setf (f2cl-lib:fref e-%data%
  ((f2cl-lib:int-sub i 1))
  ((1 *))
  e-%offset%)

(-
  (* cosr
    (f2cl-lib:fref e-%data%
      ((f2cl-lib:int-sub i 1))
      ((1 *))
      e-%offset%))

  (* sinr
    (f2cl-lib:fref d-%data%
      (i)
      ((1 *))
      d-%offset%)))

(setf g
  (* sinr
    (f2cl-lib:fref d-%data%
      ((f2cl-lib:int-sub i 1))
      ((1 *))
      d-%offset%)))

(setf (f2cl-lib:fref d-%data%
  ((f2cl-lib:int-sub i 1))
  ((1 *))
  d-%offset%)

  (* cosr
    (f2cl-lib:fref d-%data%
      ((f2cl-lib:int-sub i 1))
      ((1 *))
      d-%offset%)))

(multiple-value-bind (var-0 var-1 var-2 var-3 var-4)
  (dlartg f g cosl sinl r)
  (declare (ignore var-0 var-1))
  (setf cosl var-2)
  (setf sinl var-3)
  (setf r var-4))
(setf (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%) r)
(setf f
  (+
    (* cosl
      (f2cl-lib:fref e-%data%

```

```

((f2cl-lib:int-sub i 1))
((1 *))
e-%offset%))
(* sinl
  (f2cl-lib:fref d-%data%
    ((f2cl-lib:int-sub i 1))
    ((1 *))
    d-%offset%)))
(setf (f2cl-lib:fref d-%data%
  ((f2cl-lib:int-sub i 1))
  ((1 *))
  d-%offset%)
(-
  (* cosl
    (f2cl-lib:fref d-%data%
      ((f2cl-lib:int-sub i 1))
      ((1 *))
      d-%offset%))
    (* sinl
      (f2cl-lib:fref e-%data%
        ((f2cl-lib:int-sub i 1))
        ((1 *))
        e-%offset%)))
(cond
  (> i (f2cl-lib:int-add 11 1))
  (setf g
    (* sinl
      (f2cl-lib:fref e-%data%
        ((f2cl-lib:int-sub i 2))
        ((1 *))
        e-%offset%)))
    (setf (f2cl-lib:fref e-%data%
      ((f2cl-lib:int-sub i 2))
      ((1 *))
      e-%offset%)
      (* cosl
        (f2cl-lib:fref e-%data%
          ((f2cl-lib:int-sub i 2))
          ((1 *))
          e-%offset%))))))
(setf (f2cl-lib:fref work-%data%
  ((f2cl-lib:int-sub i 11))
  ((1 *))
  work-%offset%)
  cosr)
(setf (f2cl-lib:fref work-%data%

```

```

((f2cl-lib:int-add
  (f2cl-lib:int-sub i 11)
  nm1))
((1 *))
work-%offset%)

(- sinr))
(setf (f2cl-lib:fref work-%data%
  ((f2cl-lib:int-add
    (f2cl-lib:int-sub i 11)
    nm12))
  ((1 *))
  work-%offset%)

  cosl)
(setf (f2cl-lib:fref work-%data%
  ((f2cl-lib:int-add
    (f2cl-lib:int-sub i 11)
    nm13))
  ((1 *))
  work-%offset%)

  (- sinl))))
(setf (f2cl-lib:fref e-%data% (11) ((1 *)) e-%offset%) f)
(if
  (<= (abs (f2cl-lib:fref e-%data% (11) ((1 *)) e-%offset%))
    thresh)
  (setf (f2cl-lib:fref e-%data% (11) ((1 *)) e-%offset%) zero))
(if (> ncv 0)
  (dlasr "L" "V" "B"
    (f2cl-lib:int-add (f2cl-lib:int-sub m 11) 1) ncv
    (f2cl-lib:array-slice work
      double-float
      ((+ nm12 1))
      ((1 *)))
    (f2cl-lib:array-slice work
      double-float
      ((+ nm13 1))
      ((1 *)))
    (f2cl-lib:array-slice vt
      double-float
      (11 1)
      ((1 ldvt) (1 *)))
    ldvt))
(if (> nru 0)
  (dlasr "R" "V" "B" nru
    (f2cl-lib:int-add (f2cl-lib:int-sub m 11) 1)
    (f2cl-lib:array-slice work double-float (1) ((1 *)))
    (f2cl-lib:array-slice work double-float (n) ((1 *)))

```

```

(f2cl-lib:array-slice u double-float (1 ll) ((1 ldu) (1 *)))
ldu))
(if (> ncc 0)
  (dlasr "L" "V" "B"
    (f2cl-lib:int-add (f2cl-lib:int-sub m ll) 1) ncc
    (f2cl-lib:array-slice work double-float (1) ((1 *)))
    (f2cl-lib:array-slice work double-float (n) ((1 *)))
    (f2cl-lib:array-slice c double-float (ll 1) ((1 ldc) (1 *)))
    ldc))))))
(go label60)
label160
(f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
  (> i n) nil)
(tagbody
  (cond
    ((< (f2cl-lib:fref d (i) ((1 *))) zero)
      (setf (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%)
        (- (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%)))
      (if (> ncvt 0)
        (dscal ncvt negone
          (f2cl-lib:array-slice vt
                                double-float
                                (i 1)
                                ((1 ldvt) (1 *)))
          ldvt))))))
(f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
  (> i (f2cl-lib:int-add n (f2cl-lib:int-sub 1))) nil)
(tagbody
  (setf isub 1)
  (setf smin (f2cl-lib:fref d-%data% (1) ((1 *)) d-%offset%))
  (f2cl-lib:fdo (j 2 (f2cl-lib:int-add j 1))
    (> j (f2cl-lib:int-add n 1 (f2cl-lib:int-sub i)))
    nil)
  (tagbody
    (cond
      ((<= (f2cl-lib:fref d (j) ((1 *))) smin)
        (setf isub j)
        (setf smin
          (f2cl-lib:fref d-%data% (j) ((1 *)) d-%offset%))))))
  (cond
    ((/= isub (f2cl-lib:int-add n 1 (f2cl-lib:int-sub i)))
      (setf (f2cl-lib:fref d-%data% (isub) ((1 *)) d-%offset%)
        (f2cl-lib:fref d-%data%
          ((f2cl-lib:int-sub (f2cl-lib:int-add n 1)
            i))
          ((1 *)))

```



```

      (go end_label)
label200
  (setf info 0)
  (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
    ((> i (f2cl-lib:int-add n (f2cl-lib:int-sub 1))) nil)
    (tagbody
      (if (/= (f2cl-lib:fref e-%data% (i) ((1 *)) e-%offset%) zero)
        (setf info (f2cl-lib:int-add info 1))))))
end_label
  (return
    (values nil
      nil
      nil
      nil
      nil
      nil
      nil
      nil
      nil
      nil
      nil
      nil
      nil
      nil
      nil
      nil
      nil
      info))))))

```

### 7.3 ddisna LAPACK

```

<ddisna.input>≡
)set break resume
)sys rm -f ddisna.output
)spool ddisna.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)

```

`<ddisna.help>=`

```
=====
ddisna examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

DDISNA - the reciprocal condition numbers for the eigenvectors of a real symmetric or complex Hermitian matrix or for the left or right singular vectors of a general m-by-n matrix

#### SYNOPSIS

```
SUBROUTINE DDISNA( JOB, M, N, D, SEP, INFO )
```

```
      CHARACTER      JOB
```

```
      INTEGER        INFO, M, N
```

```
      DOUBLE         PRECISION D( * ), SEP( * )
```

#### PURPOSE

DDISNA computes the reciprocal condition numbers for the eigenvectors of a real symmetric or complex Hermitian matrix or for the left or right singular vectors of a general m-by-n matrix. The reciprocal condition number is the 'gap' between the corresponding eigenvalue or singular value and the nearest other one.

The bound on the error, measured by angle in radians, in the I-th computed vector is given by

$$\text{DLAMCH}( 'E' ) * ( \text{ANORM} / \text{SEP}( I ) )$$

where  $\text{ANORM} = 2\text{-norm}(A) = \max( \text{abs}( D(j) ) )$ .  $\text{SEP}(I)$  is not allowed to be smaller than  $\text{DLAMCH}( 'E' ) * \text{ANORM}$  in order to limit the size of the error bound.

DDISNA may also be used to compute error bounds for eigenvectors of the generalized symmetric definite eigenproblem.

#### ARGUMENTS

JOB (input) CHARACTER\*1

Specifies for which problem the reciprocal condition numbers

should be computed:  
= 'E': the eigenvectors of a symmetric/Hermitian matrix;  
= 'L': the left singular vectors of a general matrix;  
= 'R': the right singular vectors of a general matrix.

M (input) INTEGER  
The number of rows of the matrix.  $M \geq 0$ .

N (input) INTEGER  
If JOB = 'L' or 'R', the number of columns of the matrix, in which case  $N \geq 0$ . Ignored if JOB = 'E'.

D (input) DOUBLE PRECISION array, dimension (M) if JOB = 'E'  
dimension (min(M,N)) if JOB = 'L' or 'R' The eigenvalues (if JOB = 'E') or singular values (if JOB = 'L' or 'R') of the matrix, in either increasing or decreasing order. If singular values, they must be non-negative.

SEP (output) DOUBLE PRECISION array, dimension (M) if JOB = 'E'  
dimension (min(M,N)) if JOB = 'L' or 'R' The reciprocal condition numbers of the vectors.

INFO (output) INTEGER  
= 0: successful exit.  
< 0: if INFO = -i, the i-th argument had an illegal value.



```

(LAPACK ddisna)≡
  (let* ((zero 0.0))
    (declare (type (double-float 0.0 0.0) zero))
    (defun ddisna (job m n d sep info)
      (declare (type (simple-array double-float (*)) sep d)
                (type fixnum info n m)
                (type character job))
      (f2cl-lib:with-multi-array-data
        ((job character job-%data% job-%offset%)
         (d double-float d-%data% d-%offset%)
         (sep double-float sep-%data% sep-%offset%))
        (prog ((anorm 0.0) (eps 0.0) (newgap 0.0) (oldgap 0.0) (safmin 0.0)
              (thresh 0.0) (i 0) (k 0) (decr nil) (eigen nil) (incr nil)
              (left nil) (right nil) (sing nil))
              (declare (type (double-float) anorm eps newgap oldgap safmin thresh)
                        (type fixnum i k)
                        (type (member t nil) decr eigen incr left right sing))
              (setf info 0)
              (setf eigen (char-equal job #\E))
              (setf left (char-equal job #\L))
              (setf right (char-equal job #\R))
              (setf sing (or left right))
              (cond
                (eigen
                 (setf k m))
                (sing
                 (setf k (min (the fixnum m) (the fixnum n)))))
              (cond
                ((and (not eigen) (not sing))
                 (setf info -1))
                ((< m 0)
                 (setf info -2))
                ((< k 0)
                 (setf info -3))
                (t
                 (setf incr t)
                 (setf decr t)
                 (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                               ((> i (f2cl-lib:int-add k (f2cl-lib:int-sub 1))) nil)
                 (tagbody
                  (if incr
                     (setf incr
                      (and incr
                           (<=
                            (f2cl-lib:fref d-%data%
                                              (i)

```

```

                                ((1 *))
                                d-%offset%)
(f2cl-lib:fref d-%data%
                                ((f2cl-lib:int-add i 1))
                                ((1 *))
                                d-%offset%))))))
(if decr
  (setf decr
    (and decr
      (>=
        (f2cl-lib:fref d-%data%
          (i)
          ((1 *))
          d-%offset%)
        (f2cl-lib:fref d-%data%
          ((f2cl-lib:int-add i 1))
          ((1 *))
          d-%offset%)))))))
(cond
  ((and sing (> k 0))
    (if incr
      (setf incr
        (and incr
          (<= zero
            (f2cl-lib:fref d-%data%
              (1)
              ((1 *))
              d-%offset%))))))
    (if decr
      (setf decr
        (and decr
          (>=
            (f2cl-lib:fref d-%data% (k) ((1 *)) d-%offset%)
            zero))))))
    (if (not (or incr decr)) (setf info -4))))
(cond
  ((/= info 0)
    (error
      " ** On entry to ~a parameter number ~a had an illegal value~%"
      "DDISNA" (f2cl-lib:int-sub info))
    (go end_label)))
(if (= k 0) (go end_label))
(cond
  ((= k 1)
    (setf (f2cl-lib:fref sep-%data% (1) ((1 *)) sep-%offset%)
      (dlamch "0"))))

```

```

(t
  (setf oldgap
    (abs
      (- (f2cl-lib:fref d-%data% (2) ((1 *)) d-%offset%)
        (f2cl-lib:fref d-%data% (1) ((1 *)) d-%offset%))))
    (setf (f2cl-lib:fref sep-%data% (1) ((1 *)) sep-%offset%) oldgap)
    (f2cl-lib:fdo (i 2 (f2cl-lib:int-add i 1))
      ((> i (f2cl-lib:int-add k (f2cl-lib:int-sub 1))) nil)
      (tagbody
        (setf newgap
          (abs
            (-
              (f2cl-lib:fref d-%data%
                ((f2cl-lib:int-add i 1))
                ((1 *))
                d-%offset%)
              (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%))))
          (setf (f2cl-lib:fref sep-%data% (i) ((1 *)) sep-%offset%)
            (min oldgap newgap))
          (setf oldgap newgap)))
        (setf (f2cl-lib:fref sep-%data% (k) ((1 *)) sep-%offset%) oldgap)))
  (cond
    (sing
      (cond
        ((or (and left (> m n)) (and right (< m n)))
          (if incr
            (setf (f2cl-lib:fref sep-%data% (1) ((1 *)) sep-%offset%)
              (min
                (f2cl-lib:fref sep-%data% (1) ((1 *)) sep-%offset%)
                (f2cl-lib:fref d-%data% (1) ((1 *)) d-%offset%)))
            (if decr
              (setf (f2cl-lib:fref sep-%data% (k) ((1 *)) sep-%offset%)
                (min
                  (f2cl-lib:fref sep-%data% (k) ((1 *)) sep-%offset%)
                  (f2cl-lib:fref d-%data%
                    (k)
                    ((1 *))
                    d-%offset%))))))))
          (setf eps (dlamch "E"))
          (setf safmin (dlamch "S"))
          (setf anorm
            (max (abs (f2cl-lib:fref d-%data% (1) ((1 *)) d-%offset%))
              (abs (f2cl-lib:fref d-%data% (k) ((1 *)) d-%offset%))))
          (cond
            ((= anorm zero)
              (setf thresh eps))

```

```

      (t
        (setf thresh (max (* eps anorm) safmin))))
      (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
        ((> i k) nil)
        (tagbody
          (setf (f2cl-lib:fref sep-%data% (i) ((1 *)) sep-%offset%)
            (max (f2cl-lib:fref sep-%data% (i) ((1 *)) sep-%offset%)
              thresh))))
      end_label
      (return (values nil nil nil nil nil info))))))

```

## 7.4 dgebak LAPACK

```

⟨dgebak.input⟩≡
)set break resume
)sys rm -f dgebak.output
)spool dgebak.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)

```

*<dgebak.help>*≡

```
=====
dgebak examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

DGEBAK - the right or left eigenvectors of a real general matrix by backward transformation on the computed eigenvectors of the balanced matrix output by DGEBAL

#### SYNOPSIS

```
SUBROUTINE DGEBAK( JOB, SIDE, N, ILO, IHI, SCALE, M, V, LDV, INFO )
```

```
      CHARACTER      JOB, SIDE
```

```
      INTEGER        IHI, ILO, INFO, LDV, M, N
```

```
      DOUBLE         PRECISION SCALE( * ), V( LDV, * )
```

#### PURPOSE

DGEBAK forms the right or left eigenvectors of a real general matrix by backward transformation on the computed eigenvectors of the balanced matrix output by DGEBAL.

#### ARGUMENTS

**JOB** (input) CHARACTER\*1  
Specifies the type of backward transformation required: = 'N', do nothing, return immediately; = 'P', do backward transformation for permutation only; = 'S', do backward transformation for scaling only; = 'B', do backward transformations for both permutation and scaling. JOB must be the same as the argument JOB supplied to DGEBAL.

**SIDE** (input) CHARACTER\*1  
= 'R': V contains right eigenvectors;  
= 'L': V contains left eigenvectors.

**N** (input) INTEGER  
The number of rows of the matrix V. N >= 0.

**ILO** (input) INTEGER

IHI (input) INTEGER The integers ILO and IHI determined by DGEBAL.  $1 \leq ILO \leq IHI \leq N$ , if  $N > 0$ ;  $ILO=1$  and  $IHI=0$ , if  $N=0$ .

SCALE (input) DOUBLE PRECISION array, dimension (N)  
Details of the permutation and scaling factors, as returned by DGEBAL.

M (input) INTEGER  
The number of columns of the matrix V.  $M \geq 0$ .

V (input/output) DOUBLE PRECISION array, dimension (LDV,M)  
On entry, the matrix of right or left eigenvectors to be transformed, as returned by DHSEIN or DTREVC. On exit, V is overwritten by the transformed eigenvectors.

LDV (input) INTEGER  
The leading dimension of the array V.  $LDV \geq \max(1,N)$ .

INFO (output) INTEGER  
= 0: successful exit  
< 0: if  $INFO = -i$ , the i-th argument had an illegal value.

```

(LAPACK dgebak)≡
  (let* ((one 1.0))
    (declare (type (double-float 1.0 1.0) one))
    (defun dgebak (job side n ilo ihi scale m v ldv info)
      (declare (type (simple-array double-float (*)) v scale)
        (type fixnum info ldv m ihi ilo n)
        (type character side job))
      (f2cl-lib:with-multi-array-data
        ((job character job-%data% job-%offset%)
         (side character side-%data% side-%offset%)
         (scale double-float scale-%data% scale-%offset%)
         (v double-float v-%data% v-%offset%))
        (prog ((s 0.0) (i 0) (ii 0) (k 0) (leftv nil) (rightv nil))
          (declare (type (double-float) s)
            (type fixnum i ii k)
            (type (member t nil) leftv rightv))
          (setf rightv (char-equal side #\R))
          (setf leftv (char-equal side #\L))
          (setf info 0)
          (cond
            ((and (not (char-equal job #\N))
                  (not (char-equal job #\P))
                  (not (char-equal job #\S))
                  (not (char-equal job #\B)))
              (setf info -1))
            ((and (not rightv) (not leftv))
              (setf info -2))
            ((< n 0)
              (setf info -3))
            ((or (< ilo 1)
                  (> ilo
                    (max (the fixnum 1) (the fixnum n))))
              (setf info -4))
            ((or
              (< ihi (min (the fixnum ilo) (the fixnum n)))
              (> ihi n))
              (setf info -5))
            ((< m 0)
              (setf info -7))
            ((< ldv (max (the fixnum 1) (the fixnum n)))
              (setf info -9)))
          (cond
            ((/= info 0)
              (error
                " ** On entry to ~a parameter number ~a had an illegal value~%"
                "DGEBAK" (f2cl-lib:int-sub info))

```

```

        (go end_label)))
    (if (= n 0) (go end_label))
    (if (= m 0) (go end_label))
    (if (char-equal job #\N) (go end_label))
    (if (= ilo ihi) (go label30))
    (cond
      ((or (char-equal job #\S) (char-equal job #\B))
        (cond
          (rightv
            (f2cl-lib:fdo (i ilo (f2cl-lib:int-add i 1))
                          (> i ihi) nil)
            (tagbody
              (setf s
                    (f2cl-lib:fref scale-%data%
                                   (i)
                                   ((1 *))
                                   scale-%offset%))
              (dscal m s
                (f2cl-lib:array-slice v double-float (i 1) ((1 ldv) (1 *)))
                ldv))))))
      (cond
        (leftv
          (f2cl-lib:fdo (i ilo (f2cl-lib:int-add i 1))
                        (> i ihi) nil)
          (tagbody
            (setf s
                  (/ one
                    (f2cl-lib:fref scale-%data%
                                   (i)
                                   ((1 *))
                                   scale-%offset%)))
            (dscal m s
              (f2cl-lib:array-slice v double-float (i 1) ((1 ldv) (1 *)))
              ldv))))))
      label30
      (cond
        ((or (char-equal job #\P) (char-equal job #\B))
          (cond
            (rightv
              (f2cl-lib:fdo (ii 1 (f2cl-lib:int-add ii 1))
                            (> ii n) nil)
              (tagbody
                (setf i ii)
                (if (and (>= i ilo) (<= i ihi)) (go label40))
                (if (< i ilo) (setf i (f2cl-lib:int-sub ilo ii)))
                (setf k

```



```

(f2cl-lib:int
  (f2cl-lib:fref scale-%data%
    (i)
    ((1 *))
    scale-%offset%)))
(if (= k i) (go label40))
(dswap m
  (f2cl-lib:array-slice v double-float (i 1) ((1 ldv) (1 *)))
  ldv
  (f2cl-lib:array-slice v double-float (k 1) ((1 ldv) (1 *)))
  ldv)
label40)))
(cond
  (leftv
    (f2cl-lib:fdo (ii 1 (f2cl-lib:int-add ii 1))
      (> ii n) nil)
    (tagbody
      (setf i ii)
      (if (and (>= i ilo) (<= i ihi)) (go label50))
      (if (< i ilo) (setf i (f2cl-lib:int-sub ilo ii)))
      (setf k
        (f2cl-lib:int
          (f2cl-lib:fref scale-%data%
            (i)
            ((1 *))
            scale-%offset%)))
      (if (= k i) (go label50))
      (dswap m
        (f2cl-lib:array-slice v double-float (i 1) ((1 ldv) (1 *)))
        ldv
        (f2cl-lib:array-slice v double-float (k 1) ((1 ldv) (1 *)))
        ldv)
      label50))))))
end_label
(return (values nil nil nil nil nil nil nil nil nil info))))))

```

## 7.5 dgebal LAPACK

```
<dgebal.input>≡  
  )set break resume  
  )sys rm -f dgebal.output  
  )spool dgebal.output  
  )set message test on  
  )set message auto off  
  )clear all  
  
  )spool  
  )lisp (bye)
```

`<dgebal.help>=`

```
=====
dgebal examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

DGEBAL - a general real matrix A

#### SYNOPSIS

```
SUBROUTINE DGEBAL( JOB, N, A, LDA, ILO, IHI, SCALE, INFO )
```

```
      CHARACTER      JOB
```

```
      INTEGER        IHI, ILO, INFO, LDA, N
```

```
      DOUBLE         PRECISION A( LDA, * ), SCALE( * )
```

#### PURPOSE

DGEBAL balances a general real matrix A. This involves, first, permuting A by a similarity transformation to isolate eigenvalues in the first 1 to ILO-1 and last IHI+1 to N elements on the diagonal; and second, applying a diagonal similarity transformation to rows and columns ILO to IHI to make the rows and columns as close in norm as possible. Both steps are optional.

Balancing may reduce the 1-norm of the matrix, and improve the accuracy of the computed eigenvalues and/or eigenvectors.

#### ARGUMENTS

**JOB** (input) CHARACTER\*1

Specifies the operations to be performed on A:

= 'N': none: simply set ILO = 1, IHI = N, SCALE(I) = 1.0 for  
i = 1,...,N; = 'P': permute only;  
= 'S': scale only;  
= 'B': both permute and scale.

**N** (input) INTEGER

The order of the matrix A. N >= 0.

**A** (input/output) DOUBLE PRECISION array, dimension (LDA,N)

On entry, the input matrix A. On exit, A is overwritten by

the balanced matrix. If JOB = 'N', A is not referenced. See Further Details. LDA (input) INTEGER The leading dimension of the array A. LDA  $\geq \max(1, N)$ .

ILO (output) INTEGER  
 IHI (output) INTEGER ILO and IHI are set to integers such that on exit  $A(i, j) = 0$  if  $i > j$  and  $j = 1, \dots, ILO-1$  or  $i = IHI+1, \dots, N$ . If JOB = 'N' or 'S', ILO = 1 and IHI = N.

SCALE (output) DOUBLE PRECISION array, dimension (N)  
 Details of the permutations and scaling factors applied to A. If P(j) is the index of the row and column interchanged with row and column j and D(j) is the scaling factor applied to row and column j, then  $SCALE(j) = P(j)$  for  $j = 1, \dots, ILO-1$  and  $SCALE(j) = IHI+1-P(j)$  for  $j = ILO, \dots, N$ . The order in which the interchanges are made is N to IHI+1, then 1 to ILO-1.

INFO (output) INTEGER  
 = 0: successful exit.  
 < 0: if INFO = -i, the i-th argument had an illegal value.

#### FURTHER DETAILS

The permutations consist of row and column interchanges which put the matrix in the form

$$P A P = \begin{pmatrix} T1 & X & Y \\ 0 & B & Z \\ 0 & 0 & T2 \end{pmatrix}$$

where T1 and T2 are upper triangular matrices whose eigenvalues lie along the diagonal. The column indices ILO and IHI mark the starting and ending columns of the submatrix B. Balancing consists of applying a diagonal similarity transformation  $\text{inv}(D) * B * D$  to make the 1-norms of each row of B and its corresponding column nearly equal. The output matrix is

$$\begin{pmatrix} T1 & X*D & Y \\ 0 & \text{inv}(D)*B*D & \text{inv}(D)*Z \\ 0 & 0 & T2 \end{pmatrix}.$$

Information about the permutations P and the diagonal matrix D is returned in the vector SCALE.

This subroutine is based on the EISPACK routine BALANC.

```

(LAPACK dgebal)≡
  (let* ((zero 0.0) (one 1.0) (sclfac 8.0) (factor 0.95))
    (declare (type (double-float 0.0 0.0) zero)
              (type (double-float 1.0 1.0) one)
              (type (double-float 8.0 8.0) sclfac)
              (type (double-float 0.95 0.95) factor))
    (defun dgebal (job n a lda ilo ihi scale info)
      (declare (type (simple-array double-float (*)) scale a)
                (type fixnum info ihi ilo lda n)
                (type character job))
      (f2cl-lib:with-multi-array-data
        ((job character job-%data% job-%offset%)
         (a double-float a-%data% a-%offset%)
         (scale double-float scale-%data% scale-%offset%))
        (prog ((c 0.0) (ca 0.0) (f 0.0) (g 0.0) (r 0.0) (ra 0.0) (s 0.0)
               (sfmax1 0.0) (sfmax2 0.0) (sfmin1 0.0) (sfmin2 0.0) (i 0) (ica 0)
               (iexc 0) (ira 0) (j 0) (k 0) (l 0) (m 0) (noconv nil))
          (declare (type (double-float) c ca f g r ra s sfmax1 sfmax2 sfmin1
                           sfmin2)
                    (type fixnum i ica iexc ira j k l m)
                    (type (member t nil) noconv))
            (setf info 0)
            (cond
              ((and (not (char-equal job #\N))
                     (not (char-equal job #\P))
                     (not (char-equal job #\S))
                     (not (char-equal job #\B))))
                (setf info -1))
              ((< n 0)
                (setf info -2))
              ((< lda (max (the fixnum 1) (the fixnum n)))
                (setf info -4)))
            (cond
              ((/= info 0)
                (error
                 " ** On entry to ~a parameter number ~a had an illegal value~%"
                 "DGEBAL" (f2cl-lib:int-sub info))
                (go end_label)))
              (t
                (setf k 1)
                (setf l n)
                (if (= n 0) (go label210))
                (cond
                  ((char-equal job #\N)
                    (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                                   (> i n) nil)
                    (tagbody

```

```

        (setf (f2cl-lib:fref scale-%data% (i) ((1 *)) scale-%offset%)
              one)))
      (go label210)))
    (if (char-equal job #\S) (go label120))
    (go label150)
label120
  (setf (f2cl-lib:fref scale-%data% (m) ((1 *)) scale-%offset%)
        (coerce (the fixnum j) 'double-float))
  (if (= j m) (go label130))
  (dswap 1 (f2cl-lib:array-slice a double-float (1 j) ((1 lda) (1 *))) 1
        (f2cl-lib:array-slice a double-float (1 m) ((1 lda) (1 *))) 1)
  (dswap (f2cl-lib:int-add (f2cl-lib:int-sub n k) 1)
        (f2cl-lib:array-slice a double-float (j k) ((1 lda) (1 *))) lda
        (f2cl-lib:array-slice a double-float (m k) ((1 lda) (1 *))) lda)
label130
  (f2cl-lib:computed-goto (label140 label180) iexc)
label140
  (if (= 1 1) (go label210))
  (setf 1 (f2cl-lib:int-sub 1 1))
label150
  (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
                (> j 1) nil)
    (tagbody
      (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                    (> i 1) nil)
      (tagbody
        (if (= i j) (go label160))
        (if
          (/= (f2cl-lib:fref a-%data% (j i) ((1 lda) (1 *)) a-%offset%)
              zero)
          (go label170))
        label160))
      (setf m 1)
      (setf iexc 1)
      (go label120)
label170))
  (go label190)
label180
  (setf k (f2cl-lib:int-add k 1))
label190
  (f2cl-lib:fdo (j k (f2cl-lib:int-add j 1))
                (> j 1) nil)
    (tagbody
      (f2cl-lib:fdo (i k (f2cl-lib:int-add i 1))
                    (> i 1) nil)
      (tagbody

```

```

        (if (= i j) (go label100))
        (if
          (/= (f2cl-lib:fref a-%data% (i j) ((1 lda) (1 *)) a-%offset%)
             zero)
            (go label110))
label100))
        (setf m k)
        (setf iexc 2)
        (go label20)
label110))
label120
        (f2cl-lib:fdo (i k (f2cl-lib:int-add i 1))
                      ((> i l) nil)
          (tagbody
            (setf (f2cl-lib:fref scale-%data% (i) ((1 *)) scale-%offset%) one)))
        (if (char-equal job #\P) (go label210))
        (setf sfmin1 (/ (dlamch "S") (dlamch "P")))
        (setf sfmax1 (/ one sfmin1))
        (setf sfmin2 (* sfmin1 sclfac))
        (setf sfmax2 (/ one sfmin2))
label140
        (setf noconv nil)
        (f2cl-lib:fdo (i k (f2cl-lib:int-add i 1))
                      ((> i l) nil)
          (tagbody
            (setf c zero)
            (setf r zero)
            (f2cl-lib:fdo (j k (f2cl-lib:int-add j 1))
                          ((> j l) nil)
              (tagbody
                (if (= j i) (go label150))
                (setf c
                  (+ c
                    (abs
                     (f2cl-lib:fref a-%data%
                                     (j i)
                                     ((1 lda) (1 *))
                                     a-%offset%))))
                  (setf r
                    (+ r
                      (abs
                       (f2cl-lib:fref a-%data%
                                       (i j)
                                       ((1 lda) (1 *))
                                       a-%offset%)))))))
            (go label150))
label150))

```

```

      (setf ica
        (idamax 1
          (f2cl-lib:array-slice a
                                double-float
                                (1 i)
                                ((1 lda) (1 *)))
          1))
      (setf ca
        (abs
          (f2cl-lib:fref a-%data%
                        (ica i)
                        ((1 lda) (1 *))
                        a-%offset%)))
      (setf ira
        (idamax (f2cl-lib:int-add (f2cl-lib:int-sub n k) 1)
          (f2cl-lib:array-slice a
                                double-float
                                (i k)
                                ((1 lda) (1 *)))
          lda))
      (setf ra
        (abs
          (f2cl-lib:fref a-%data%
                        (i
                          (f2cl-lib:int-sub (f2cl-lib:int-add ira k)
                                              1))
                        ((1 lda) (1 *))
                        a-%offset%)))
      (if (or (= c zero) (= r zero)) (go label200))
      (setf g (/ r sclfac))
      (setf f one)
      (setf s (+ c r))
label160
      (if (or (>= c g) (>= (max f c ca) sfmax2) (<= (min r g ra) sfmin2))
        (go label170))
      (setf f (* f sclfac))
      (setf c (* c sclfac))
      (setf ca (* ca sclfac))
      (setf r (/ r sclfac))
      (setf g (/ g sclfac))
      (setf ra (/ ra sclfac))
      (go label160)
label170
      (setf g (/ c sclfac))
label180
      (if (or (< g r) (>= (max r ra) sfmax2) (<= (min f c g ca) sfmin2))

```



```

        (go label190))
      (setf f (/ f sclfac))
      (setf c (/ c sclfac))
      (setf g (/ g sclfac))
      (setf ca (/ ca sclfac))
      (setf r (* r sclfac))
      (setf ra (* ra sclfac))
      (go label180)
label190
      (if (>= (+ c r) (* factor s)) (go label200))
      (cond
        ((and (< f one) (< (f2cl-lib:fref scale (i) ((1 *))) one))
          (if
            (<=
              (* f (f2cl-lib:fref scale-%data% (i) ((1 *)) scale-%offset%)
                sfmin1)
              (go label200))))
        ((and (> f one) (> (f2cl-lib:fref scale (i) ((1 *))) one))
          (if
            (>= (f2cl-lib:fref scale-%data% (i) ((1 *)) scale-%offset%)
              (/ sfmax1 f))
            (go label200))))
      (setf g (/ one f))
      (setf (f2cl-lib:fref scale-%data% (i) ((1 *)) scale-%offset%)
        (* (f2cl-lib:fref scale-%data% (i) ((1 *)) scale-%offset%)
          f))
      (setf noconv t)
      (dscal (f2cl-lib:int-add (f2cl-lib:int-sub n k) 1) g
        (f2cl-lib:array-slice a double-float (i k) ((1 lda) (1 *))) lda)
      (dscal 1 f
        (f2cl-lib:array-slice a double-float (1 i) ((1 lda) (1 *))) 1)
label200))
      (if noconv (go label140))
label210
      (setf ilo k)
      (setf ihi l)
end_label
      (return (values nil nil nil nil ilo ihi nil info))))))

```

## 7.6 dgebd2 LAPACK

```
<dgebd2.input>=  
  )set break resume  
  )sys rm -f dgebd2.output  
  )spool dgebd2.output  
  )set message test on  
  )set message auto off  
  )clear all  
  
  )spool  
  )lisp (bye)
```

`<dgebd2.help>=`

```
=====
dgebd2 examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

DGEBD2 - a real general m by n matrix A to upper or lower bidiagonal form B by an orthogonal transformation

#### SYNOPSIS

```
SUBROUTINE DGEBD2( M, N, A, LDA, D, E, TAUQ, TAUP, WORK, INFO )
```

```
      INTEGER          INFO, LDA, M, N
```

```
      DOUBLE           PRECISION A( LDA, * ), D( * ), E( * ),  TAUP( * ),
                        TAUQ( * ), WORK( * )
```

#### PURPOSE

DGEBD2 reduces a real general m by n matrix A to upper or lower bidiagonal form B by an orthogonal transformation:  $Q' * A * P = B$ .

If  $m \geq n$ , B is upper bidiagonal; if  $m < n$ , B is lower bidiagonal.

#### ARGUMENTS

M (input) INTEGER  
The number of rows in the matrix A.  $M \geq 0$ .

N (input) INTEGER  
The number of columns in the matrix A.  $N \geq 0$ .

A (input/output) DOUBLE PRECISION array, dimension (LDA,N)  
On entry, the m by n general matrix to be reduced. On exit, if  $m \geq n$ , the diagonal and the first superdiagonal are overwritten with the upper bidiagonal matrix B; the elements below the diagonal, with the array TAUQ, represent the orthogonal matrix Q as a product of elementary reflectors, and the elements above the first superdiagonal, with the array TAUP, represent the orthogonal matrix P as a product of elementary reflectors; if  $m < n$ , the diagonal and the first subdiagonal are overwritten with the lower bidiagonal matrix B; the elements below the first subdiagonal, with the array TAUQ, represent the orthogo-

nal matrix  $Q$  as a product of elementary reflectors, and the elements above the diagonal, with the array  $TAUP$ , represent the orthogonal matrix  $P$  as a product of elementary reflectors. See Further Details.  $LDA$  (input) INTEGER The leading dimension of the array  $A$ .  $LDA \geq \max(1, M)$ .

- D** (output) DOUBLE PRECISION array, dimension  $(\min(M, N))$   
The diagonal elements of the bidiagonal matrix  $B$ :  $D(i) = A(i, i)$ .
- E** (output) DOUBLE PRECISION array, dimension  $(\min(M, N)-1)$   
The off-diagonal elements of the bidiagonal matrix  $B$ : if  $m \geq n$ ,  $E(i) = A(i, i+1)$  for  $i = 1, 2, \dots, n-1$ ; if  $m < n$ ,  $E(i) = A(i+1, i)$  for  $i = 1, 2, \dots, m-1$ .
- TAUQ** (output) DOUBLE PRECISION array dimension  $(\min(M, N))$   
The scalar factors of the elementary reflectors which represent the orthogonal matrix  $Q$ . See Further Details. **TAUP** (output) DOUBLE PRECISION array, dimension  $(\min(M, N))$  The scalar factors of the elementary reflectors which represent the orthogonal matrix  $P$ . See Further Details. **WORK** (workspace) DOUBLE PRECISION array, dimension  $(\max(M, N))$
- INFO** (output) INTEGER  
= 0: successful exit.  
< 0: if  $INFO = -i$ , the  $i$ -th argument had an illegal value.

#### FURTHER DETAILS

The matrices  $Q$  and  $P$  are represented as products of elementary reflectors:

If  $m \geq n$ ,

$$Q = H(1) H(2) \dots H(n) \quad \text{and} \quad P = G(1) G(2) \dots G(n-1)$$

Each  $H(i)$  and  $G(i)$  has the form:

$$H(i) = I - \tau_q * v * v' \quad \text{and} \quad G(i) = I - \tau_p * u * u'$$

where  $\tau_q$  and  $\tau_p$  are real scalars, and  $v$  and  $u$  are real vectors;  $v(1:i-1) = 0$ ,  $v(i) = 1$ , and  $v(i+1:m)$  is stored on exit in  $A(i+1:m, i)$ ;  $u(1:i) = 0$ ,  $u(i+1) = 1$ , and  $u(i+2:n)$  is stored on exit in  $A(i, i+2:n)$ ;  $\tau_q$  is stored in  $TAUQ(i)$  and  $\tau_p$  in  $TAUP(i)$ .

If  $m < n$ ,

$$Q = H(1) H(2) \dots H(m-1) \quad \text{and} \quad P = G(1) G(2) \dots G(m)$$

Each  $H(i)$  and  $G(i)$  has the form:

$$H(i) = I - \tau_q * v * v' \quad \text{and} \quad G(i) = I - \tau_p * u * u'$$

where  $\tau_q$  and  $\tau_p$  are real scalars, and  $v$  and  $u$  are real vectors;  $v(1:i) = 0$ ,  $v(i+1) = 1$ , and  $v(i+2:m)$  is stored on exit in  $A(i+2:m,i)$ ;  $u(1:i-1) = 0$ ,  $u(i) = 1$ , and  $u(i+1:n)$  is stored on exit in  $A(i,i+1:n)$ ;  $\tau_q$  is stored in  $TAUQ(i)$  and  $\tau_p$  in  $TAUP(i)$ .

The contents of  $A$  on exit are illustrated by the following examples:

$m = 6$  and  $n = 5$  ( $m > n$ ):

```
( d  e  u1 u1 u1 )
( v1 d  e  u2 u2 )
( v1 v2 d  e  u3 )
( v1 v2 v3 d  e  )
( v1 v2 v3 v4 d  )
( v1 v2 v3 v4 v5 )
```

$m = 5$  and  $n = 6$  ( $m < n$ ):

```
( d  u1 u1 u1 u1 u1 )
( e  d  u2 u2 u2 u2 )
( v1 e  d  u3 u3 u3 )
( v1 v2 e  d  u4 u4 )
( v1 v2 v3 e  d  u5 )
```

where  $d$  and  $e$  denote diagonal and off-diagonal elements of  $B$ ,  $v_i$  denotes an element of the vector defining  $H(i)$ , and  $u_i$  an element of the vector defining  $G(i)$ .

```

(LAPACK dgebd2)≡
  (let* ((zero 0.0) (one 1.0))
    (declare (type (double-float 0.0 0.0) zero)
              (type (double-float 1.0 1.0) one))
    (defun dgebd2 (m n a lda d e tauq taup work info)
      (declare (type (simple-array double-float (*)) work tauq tauq e d a)
                (type fixnum info lda n m))
      (f2cl-lib:with-multi-array-data
        ((a double-float a-%data% a-%offset%)
         (d double-float d-%data% d-%offset%)
         (e double-float e-%data% e-%offset%)
         (tauq double-float tauq-%data% tauq-%offset%)
         (taup double-float taup-%data% taup-%offset%)
         (work double-float work-%data% work-%offset%))
        (prog ((i 0))
          (declare (type fixnum i))
          (setf info 0)
          (cond
            ((< m 0)
              (setf info -1))
            ((< n 0)
              (setf info -2))
            ((< lda (max (the fixnum 1) (the fixnum m)))
              (setf info -4)))
          (cond
            ((< info 0)
              (error
               " ** On entry to ~a parameter number ~a had an illegal value~%"
               "DGEBD2" (f2cl-lib:int-sub info))
              (go end_label)))
          (cond
            ((>= m n)
              (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                            ((> i n) nil)
              (tagbody
                (multiple-value-bind (var-0 var-1 var-2 var-3 var-4)
                  (dlarfg (f2cl-lib:int-add (f2cl-lib:int-sub m i) 1)
                        (f2cl-lib:fref a-%data% (i i) ((1 lda) (1 *)) a-%offset%)
                        (f2cl-lib:array-slice a
                                              double-float
                                              ((min (f2cl-lib:int-add i 1) m) i)
                                              ((1 lda) (1 *))))
                  1 (f2cl-lib:fref tauq-%data% (i i) ((1 *)) tauq-%offset%))
                (declare (ignore var-0 var-2 var-3))
                (setf (f2cl-lib:fref a-%data%
                                     (i i)

```

```

((1 lda) (1 *))
a-%offset%)

var-1)
(setf (f2cl-lib:fref tauq-%data% (i) ((1 *)) tauq-%offset%)
var-4))
(setf (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%)
(f2cl-lib:fref a-%data%
(i i)
((1 lda) (1 *))
a-%offset%))
(setf (f2cl-lib:fref a-%data% (i i) ((1 lda) (1 *)) a-%offset%)
one)
(dlarf "Left" (f2cl-lib:int-add (f2cl-lib:int-sub m i) 1)
(f2cl-lib:int-sub n i)
(f2cl-lib:array-slice a double-float (i i) ((1 lda) (1 *))) 1
(f2cl-lib:fref tauq-%data% (i) ((1 *)) tauq-%offset%)
(f2cl-lib:array-slice a
double-float
(i (f2cl-lib:int-add i 1))
((1 lda) (1 *)))

lda work)
(setf (f2cl-lib:fref a-%data% (i i) ((1 lda) (1 *)) a-%offset%)
(f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%))
(cond
((< i n)
(multiple-value-bind (var-0 var-1 var-2 var-3 var-4)
(dlarfg (f2cl-lib:int-sub n i)
(f2cl-lib:fref a-%data%
(i (f2cl-lib:int-add i 1))
((1 lda) (1 *))
a-%offset%)
(f2cl-lib:array-slice a
double-float
(i
(min
(the fixnum
(f2cl-lib:int-add i 2))
(the fixnum n))))
((1 lda) (1 *)))

lda
(f2cl-lib:fref taup-%data% (i) ((1 *)) taup-%offset%))
(declare (ignore var-0 var-2 var-3))
(setf (f2cl-lib:fref a-%data%
(i (f2cl-lib:int-add i 1))
((1 lda) (1 *))
a-%offset%)

```

```

        var-1)
      (setf (f2cl-lib:fref taup-%data% (i) ((1 *)) taup-%offset%)
            var-4))
    (setf (f2cl-lib:fref e-%data% (i) ((1 *)) e-%offset%)
          (f2cl-lib:fref a-%data%
                          (i (f2cl-lib:int-add i 1))
                          ((1 lda) (1 *)))
          a-%offset%))
    (setf (f2cl-lib:fref a-%data%
                        (i (f2cl-lib:int-add i 1))
                        ((1 lda) (1 *)))
          a-%offset%)

    one)
  (dlarf "Right" (f2cl-lib:int-sub m i) (f2cl-lib:int-sub n i)
        (f2cl-lib:array-slice a
                                double-float
                                (i (f2cl-lib:int-add i 1))
                                ((1 lda) (1 *))))
  lda (f2cl-lib:fref taup-%data% (i) ((1 *)) taup-%offset%)
  (f2cl-lib:array-slice a
                        double-float
                        ((+ i 1) (f2cl-lib:int-add i 1))
                        ((1 lda) (1 *)))

  lda work)
  (setf (f2cl-lib:fref a-%data%
                      (i (f2cl-lib:int-add i 1))
                      ((1 lda) (1 *)))
        a-%offset%)
    (f2cl-lib:fref e-%data% (i) ((1 *)) e-%offset%)))
(t
  (setf (f2cl-lib:fref taup-%data% (i) ((1 *)) taup-%offset%)
        zero))))))
(t
  (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                ((> i m) nil))

  (tagbody
    (multiple-value-bind (var-0 var-1 var-2 var-3 var-4)
      (dlarfg (f2cl-lib:int-add (f2cl-lib:int-sub n i) 1)
              (f2cl-lib:fref a-%data% (i i) ((1 lda) (1 *))) a-%offset%)
      (f2cl-lib:array-slice a
                            double-float
                            (i
                             (min
                              (the fixnum
                               (f2cl-lib:int-add i 1))
                              (the fixnum n))))

```



```

((1 lda) (1 *)))
lda (f2cl-lib:fref taup-%data% (i) ((1 *)) taup-%offset%))
(declare (ignore var-0 var-2 var-3))
(setf (f2cl-lib:fref a-%data%
      (i i)
      ((1 lda) (1 *))
      a-%offset%)
      var-1)
(setf (f2cl-lib:fref taup-%data% (i) ((1 *)) taup-%offset%)
      var-4))
(setf (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%)
      (f2cl-lib:fref a-%data%
        (i i)
        ((1 lda) (1 *))
        a-%offset%))
(setf (f2cl-lib:fref a-%data% (i i) ((1 lda) (1 *)) a-%offset%)
      one)
(dlarf "Right" (f2cl-lib:int-sub m i)
      (f2cl-lib:int-add (f2cl-lib:int-sub n i) 1)
      (f2cl-lib:array-slice a double-float (i i) ((1 lda) (1 *))) lda
      (f2cl-lib:fref taup-%data% (i) ((1 *)) taup-%offset%)
      (f2cl-lib:array-slice a
        double-float
        ((min (f2cl-lib:int-add i 1) m) i)
        ((1 lda) (1 *)))
lda work)
(setf (f2cl-lib:fref a-%data% (i i) ((1 lda) (1 *)) a-%offset%)
      (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%))
(cond
  ((< i m)
    (multiple-value-bind (var-0 var-1 var-2 var-3 var-4)
      (dlarf (f2cl-lib:int-sub m i)
        (f2cl-lib:fref a-%data%
          ((f2cl-lib:int-add i 1) i)
          ((1 lda) (1 *))
          a-%offset%)
        (f2cl-lib:array-slice a
          double-float
          ((min (f2cl-lib:int-add i 2) m) i)
          ((1 lda) (1 *)))
          1 (f2cl-lib:fref tauq-%data% (i) ((1 *)) tauq-%offset%))
      (declare (ignore var-0 var-2 var-3))
      (setf (f2cl-lib:fref a-%data%
        ((f2cl-lib:int-add i 1) i)
        ((1 lda) (1 *))
        a-%offset%)

```

```

        var-1)
      (setf (f2cl-lib:fref tauq-%data% (i) ((1 *)) tauq-%offset%)
        var-4))
    (setf (f2cl-lib:fref e-%data% (i) ((1 *)) e-%offset%)
      (f2cl-lib:fref a-%data%
        ((f2cl-lib:int-add i 1) i)
        ((1 lda) (1 *))
        a-%offset%))
    (setf (f2cl-lib:fref a-%data%
      ((f2cl-lib:int-add i 1) i)
      ((1 lda) (1 *))
      a-%offset%)
      one)
    (dlarf "Left" (f2cl-lib:int-sub m i) (f2cl-lib:int-sub n i)
      (f2cl-lib:array-slice a
        double-float
        ((+ i 1) i)
        ((1 lda) (1 *)))
      1 (f2cl-lib:fref tauq-%data% (i) ((1 *)) tauq-%offset%)
      (f2cl-lib:array-slice a
        double-float
        ((+ i 1) (f2cl-lib:int-add i 1))
        ((1 lda) (1 *)))

    lda work)
    (setf (f2cl-lib:fref a-%data%
      ((f2cl-lib:int-add i 1) i)
      ((1 lda) (1 *))
      a-%offset%)
      (f2cl-lib:fref e-%data% (i) ((1 *)) e-%offset%)))
  (t
    (setf (f2cl-lib:fref tauq-%data% (i) ((1 *)) tauq-%offset%)
      zero))))))
end_label
(return (values nil nil nil nil nil nil nil nil info))))))

```

## 7.7 dgebrd LAPACK

```
<dgebrd.input>=  
  )set break resume  
  )sys rm -f dgebrd.output  
  )spool dgebrd.output  
  )set message test on  
  )set message auto off  
  )clear all  
  
  )spool  
  )lisp (bye)
```

`<dgebrd.help>`≡

```
=====
dgebrd examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

DGEBRD - a general real M-by-N matrix A to upper or lower bidiagonal form B by an orthogonal transformation

#### SYNOPSIS

```
SUBROUTINE DGEBRD( M, N, A, LDA, D, E, TAUQ, TAUP, WORK, LWORK, INFO )
```

```
      INTEGER          INFO, LDA, LWORK, M, N
```

```
      DOUBLE           PRECISION A( LDA, * ), D( * ), E( * ),  TAUP( * ),
      TAUQ( * ), WORK( * )
```

#### PURPOSE

DGEBRD reduces a general real M-by-N matrix A to upper or lower bidiagonal form B by an orthogonal transformation:  $Q^*T * A * P = B$ .

If  $m \geq n$ , B is upper bidiagonal; if  $m < n$ , B is lower bidiagonal.

#### ARGUMENTS

M (input) INTEGER

The number of rows in the matrix A.  $M \geq 0$ .

N (input) INTEGER

The number of columns in the matrix A.  $N \geq 0$ .

A (input/output) DOUBLE PRECISION array, dimension (LDA,N)

On entry, the M-by-N general matrix to be reduced. On exit, if  $m \geq n$ , the diagonal and the first superdiagonal are overwritten with the upper bidiagonal matrix B; the elements below the diagonal, with the array TAUQ, represent the orthogonal matrix Q as a product of elementary reflectors, and the elements above the first superdiagonal, with the array TAUP, represent the orthogonal matrix P as a product of elementary reflectors; if  $m < n$ , the diagonal and the first subdiagonal are overwritten with the lower bidiagonal matrix B; the elements below the first subdiagonal, with the array TAUQ, represent the orthogo-

nal matrix  $Q$  as a product of elementary reflectors, and the elements above the diagonal, with the array  $TAUP$ , represent the orthogonal matrix  $P$  as a product of elementary reflectors. See Further Details.  $LDA$  (input) INTEGER The leading dimension of the array  $A$ .  $LDA \geq \max(1, M)$ .

**D** (output) DOUBLE PRECISION array, dimension  $(\min(M, N))$   
The diagonal elements of the bidiagonal matrix  $B$ :  $D(i) = A(i, i)$ .

**E** (output) DOUBLE PRECISION array, dimension  $(\min(M, N)-1)$   
The off-diagonal elements of the bidiagonal matrix  $B$ : if  $m \geq n$ ,  $E(i) = A(i, i+1)$  for  $i = 1, 2, \dots, n-1$ ; if  $m < n$ ,  $E(i) = A(i+1, i)$  for  $i = 1, 2, \dots, m-1$ .

**TAUQ** (output) DOUBLE PRECISION array dimension  $(\min(M, N))$   
The scalar factors of the elementary reflectors which represent the orthogonal matrix  $Q$ . See Further Details. **TAUP** (output) DOUBLE PRECISION array, dimension  $(\min(M, N))$  The scalar factors of the elementary reflectors which represent the orthogonal matrix  $P$ . See Further Details. **WORK** (workspace/output) DOUBLE PRECISION array, dimension  $(\max(1, LWORK))$  On exit, if  $INFO = 0$ ,  $WORK(1)$  returns the optimal  $LWORK$ .

**LWORK** (input) INTEGER  
The length of the array  $WORK$ .  $LWORK \geq \max(1, M, N)$ . For optimum performance  $LWORK \geq (M+N)*NB$ , where  $NB$  is the optimal blocksize.

If  $LWORK = -1$ , then a workspace query is assumed; the routine only calculates the optimal size of the  $WORK$  array, returns this value as the first entry of the  $WORK$  array, and no error message related to  $LWORK$  is issued by XERBLA.

**INFO** (output) INTEGER  
= 0: successful exit  
< 0: if  $INFO = -i$ , the  $i$ -th argument had an illegal value.

#### FURTHER DETAILS

The matrices  $Q$  and  $P$  are represented as products of elementary reflectors:

If  $m \geq n$ ,

$$Q = H(1) H(2) \dots H(n) \quad \text{and} \quad P = G(1) G(2) \dots G(n-1)$$

Each  $H(i)$  and  $G(i)$  has the form:

$$H(i) = I - \tau_{uq} * v * v' \quad \text{and} \quad G(i) = I - \tau_{up} * u * u'$$

where  $\tau_{uq}$  and  $\tau_{up}$  are real scalars, and  $v$  and  $u$  are real vectors;  $v(1:i-1) = 0$ ,  $v(i) = 1$ , and  $v(i+1:m)$  is stored on exit in  $A(i+1:m,i)$ ;  $u(1:i) = 0$ ,  $u(i+1) = 1$ , and  $u(i+2:n)$  is stored on exit in  $A(i,i+2:n)$ ;  $\tau_{uq}$  is stored in  $\text{TAUQ}(i)$  and  $\tau_{up}$  in  $\text{TAUP}(i)$ .

If  $m < n$ ,

$$Q = H(1) H(2) \dots H(m-1) \quad \text{and} \quad P = G(1) G(2) \dots G(m)$$

Each  $H(i)$  and  $G(i)$  has the form:

$$H(i) = I - \tau_{uq} * v * v' \quad \text{and} \quad G(i) = I - \tau_{up} * u * u'$$

where  $\tau_{uq}$  and  $\tau_{up}$  are real scalars, and  $v$  and  $u$  are real vectors;  $v(1:i) = 0$ ,  $v(i+1) = 1$ , and  $v(i+2:m)$  is stored on exit in  $A(i+2:m,i)$ ;  $u(1:i-1) = 0$ ,  $u(i) = 1$ , and  $u(i+1:n)$  is stored on exit in  $A(i,i+1:n)$ ;  $\tau_{uq}$  is stored in  $\text{TAUQ}(i)$  and  $\tau_{up}$  in  $\text{TAUP}(i)$ .

The contents of  $A$  on exit are illustrated by the following examples:

$m = 6$  and  $n = 5$  ( $m > n$ ):

```
( d   e   u1  u1  u1 )
( v1  d   e   u2  u2 )
( v1  v2  d   e   u3 )
( v1  v2  v3  d   e )
( v1  v2  v3  v4  d )
( v1  v2  v3  v4  v5 )
```

$m = 5$  and  $n = 6$  ( $m < n$ ):

```
( d   u1  u1  u1  u1  u1 )
( e   d   u2  u2  u2  u2 )
( v1  e   d   u3  u3  u3 )
( v1  v2  e   d   u4  u4 )
( v1  v2  v3  e   d   u5 )
```

where  $d$  and  $e$  denote diagonal and off-diagonal elements of  $B$ ,  $v_i$  denotes an element of the vector defining  $H(i)$ , and  $u_i$  an element of the vector defining  $G(i)$ .

```

(LAPACK dgebrd)≡
  (let* ((one 1.0))
    (declare (type (double-float 1.0 1.0) one))
    (defun dgebrd (m n a lda d e tauq taup work lwork info)
      (declare (type (simple-array double-float (*)) work taup tauq e d a)
        (type fixnum info lwork lda n m))
      (f2cl-lib:with-multi-array-data
        ((a double-float a-%data% a-%offset%)
         (d double-float d-%data% d-%offset%)
         (e double-float e-%data% e-%offset%)
         (tauq double-float tauq-%data% tauq-%offset%)
         (taup double-float taup-%data% taup-%offset%)
         (work double-float work-%data% work-%offset%))
        (prog ((ws 0.0) (i 0) (iinfo 0) (j 0) (ldwrkx 0) (ldwrky 0) (lwkopt 0)
              (minmn 0) (nb 0) (nbmin 0) (nx 0) (lquery nil))
          (declare (type (double-float) ws)
            (type fixnum i iinfo j ldwrkx ldwrky lwkopt minmn
              nb nbmin nx)
            (type (member t nil) lquery))
          (setf info 0)
          (setf nb
            (max (the fixnum 1)
              (the fixnum
                (ilaenv 1 "DGEBRD" " " m n -1 -1))))
          (setf lwkopt (f2cl-lib:int-mul (f2cl-lib:int-add m n) nb))
          (setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)
            (coerce (realpart lwkopt) 'double-float))
          (setf lquery (coerce (= lwork -1) '(member t nil)))
          (cond
            ((< m 0)
              (setf info -1))
            ((< n 0)
              (setf info -2))
            ((< lda (max (the fixnum 1) (the fixnum m)))
              (setf info -4))
            ((and
              (< lwork
                (max (the fixnum 1)
                  (the fixnum m)
                  (the fixnum n)))
              (not lquery))
              (setf info -10)))
          (cond
            ((< info 0)
              (error
                " ** On entry to ~a parameter number ~a had an illegal value~%"

```

```

        "DGEHRD" (f2cl-lib:int-sub info))
      (go end_label))
    (lquery
      (go end_label)))
  (setf minmn (min (the fixnum m) (the fixnum n)))
  (cond
    ((= minmn 0)
      (setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)
        (coerce (the fixnum 1) 'double-float))
      (go end_label)))
  (setf ws
    (coerce
      (the fixnum
        (max (the fixnum m)
              (the fixnum n)))
      'double-float))
  (setf ldwrkx m)
  (setf ldwrky n)
  (cond
    ((and (> nb 1) (< nb minmn))
      (setf nx
        (max (the fixnum nb)
              (the fixnum
                (ilaenv 3 "DGEHRD" " " m n -1 -1))))
      (cond
        ((< nx minmn)
          (setf ws
            (coerce
              (the fixnum
                (f2cl-lib:int-mul (f2cl-lib:int-add m n) nb))
              'double-float))
          (cond
            ((< lwork ws)
              (setf nbmin (ilaenv 2 "DGEHRD" " " m n -1 -1))
              (cond
                ((>= lwork (f2cl-lib:int-mul (f2cl-lib:int-add m n) nbmin))
                  (setf nb (the fixnum (truncate lwork (+ m n)))))
                (t
                  (setf nb 1)
                  (setf nx minmn))))))
            (t
              (setf nx minmn)))
          (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i nb))
            ((> i (f2cl-lib:int-add minmn (f2cl-lib:int-sub nx))) nil)
            (tagbody
              (dlabrd (f2cl-lib:int-add (f2cl-lib:int-sub m i) 1)

```



```

(f2cl-lib:int-add (f2cl-lib:int-sub n i) 1) nb
(f2cl-lib:array-slice a double-float (i i) ((1 lda) (1 *))) lda
(f2cl-lib:array-slice d double-float (i) ((1 *)))
(f2cl-lib:array-slice e double-float (i) ((1 *)))
(f2cl-lib:array-slice tauq double-float (i) ((1 *)))
(f2cl-lib:array-slice taup double-float (i) ((1 *))) work ldwrkx
(f2cl-lib:array-slice work
  double-float
  ((+ (f2cl-lib:int-mul ldwrkx nb) 1))
  ((1 *)))
ldwrky)
(dgemm "No transpose" "Transpose"
  (f2cl-lib:int-add (f2cl-lib:int-sub m i nb) 1)
  (f2cl-lib:int-add (f2cl-lib:int-sub n i nb) 1) nb (- one)
  (f2cl-lib:array-slice a double-float ((+ i nb) i) ((1 lda) (1 *)))
  lda
  (f2cl-lib:array-slice work
    double-float
    ((+ (f2cl-lib:int-mul ldwrkx nb) nb 1))
    ((1 *)))
  ldwrky one
  (f2cl-lib:array-slice a
    double-float
    ((+ i nb) (f2cl-lib:int-add i nb))
    ((1 lda) (1 *)))
  lda)
(dgemm "No transpose" "No transpose"
  (f2cl-lib:int-add (f2cl-lib:int-sub m i nb) 1)
  (f2cl-lib:int-add (f2cl-lib:int-sub n i nb) 1) nb (- one)
  (f2cl-lib:array-slice work double-float ((+ nb 1)) ((1 *))) ldwrkx
  (f2cl-lib:array-slice a
    double-float
    (i (f2cl-lib:int-add i nb))
    ((1 lda) (1 *)))
  lda one
  (f2cl-lib:array-slice a
    double-float
    ((+ i nb) (f2cl-lib:int-add i nb))
    ((1 lda) (1 *)))
  lda)
(cond
  ((>= m n)
    (f2cl-lib:fdo (j i (f2cl-lib:int-add j 1))
      (> j
        (f2cl-lib:int-add i nb (f2cl-lib:int-sub 1)))
      nil)

```

```

      (tagbody
        (setf (f2cl-lib:fref a-%data%
          (j j)
          ((1 lda) (1 *))
          a-%offset%)
          (f2cl-lib:fref d-%data% (j) ((1 *)) d-%offset%))
        (setf (f2cl-lib:fref a-%data%
          (j (f2cl-lib:int-add j 1))
          ((1 lda) (1 *))
          a-%offset%)
          (f2cl-lib:fref e-%data% (j) ((1 *)) e-%offset%))))))
    (t
      (f2cl-lib:fdo (j i (f2cl-lib:int-add j 1))
        (> j
          (f2cl-lib:int-add i nb (f2cl-lib:int-sub 1)))
        nil)
      (tagbody
        (setf (f2cl-lib:fref a-%data%
          (j j)
          ((1 lda) (1 *))
          a-%offset%)
          (f2cl-lib:fref d-%data% (j) ((1 *)) d-%offset%))
        (setf (f2cl-lib:fref a-%data%
          ((f2cl-lib:int-add j 1) j)
          ((1 lda) (1 *))
          a-%offset%)
          (f2cl-lib:fref e-%data% (j) ((1 *)) e-%offset%))))))
    (multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9)
      (dgebd2 (f2cl-lib:int-add (f2cl-lib:int-sub m i) 1)
        (f2cl-lib:int-add (f2cl-lib:int-sub n i) 1)
        (f2cl-lib:array-slice a double-float (i i) ((1 lda) (1 *))) lda
        (f2cl-lib:array-slice d double-float (i) ((1 *)))
        (f2cl-lib:array-slice e double-float (i) ((1 *)))
        (f2cl-lib:array-slice tauq double-float (i) ((1 *)))
        (f2cl-lib:array-slice taup double-float (i) ((1 *))) work iinfo)
      (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
        var-8))
      (setf iinfo var-9))
    (setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%) ws)
  end_label
  (return (values nil nil nil nil nil nil nil nil nil info))))))

```

## 7.8 dgeev LAPACK

```
<dgeev.input>=  
  )set break resume  
  )sys rm -f dgeev.output  
  )spool dgeev.output  
  )set message test on  
  )set message auto off  
  )clear all  
  
  )spool  
  )lisp (bye)
```

`<dgeev.help>=`

```
=====
dgeev examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

DGEEV - for an N-by-N real nonsymmetric matrix A, the eigenvalues and, optionally, the left and/or right eigenvectors

#### SYNOPSIS

```
SUBROUTINE DGEEV( JOBVL, JOBVR, N, A, LDA, WR, WI, VL, LDVL, VR, LDVR,
                  WORK, LWORK, INFO )
```

```
      CHARACTER    JOBVL, JOBVR
```

```
      INTEGER      INFO, LDA, LDVL, LDVR, LWORK, N
```

```
      DOUBLE       PRECISION  A( LDA, * ), VL( LDVL, * ), VR( LDVR, * ),
                        WI( * ), WORK( * ), WR( * )
```

#### PURPOSE

DGEEV computes for an N-by-N real nonsymmetric matrix A, the eigenvalues and, optionally, the left and/or right eigenvectors.

The right eigenvector  $v(j)$  of A satisfies

$$A * v(j) = \lambda(j) * v(j)$$

where  $\lambda(j)$  is its eigenvalue.

The left eigenvector  $u(j)$  of A satisfies

$$u(j)^*H * A = \lambda(j) * u(j)^*H$$

where  $u(j)^*H$  denotes the conjugate transpose of  $u(j)$ .

The computed eigenvectors are normalized to have Euclidean norm equal to 1 and largest component real.

#### ARGUMENTS

```
      JOBVL  (input) CHARACTER*1
              = 'N': left eigenvectors of A are not computed;
              = 'V': left eigenvectors of A are computed.
```

```
      JOBVR  (input) CHARACTER*1
              = 'N': right eigenvectors of A are not computed;
```

= 'V': right eigenvectors of A are computed.

N        (input) INTEGER  
The order of the matrix A.  $N \geq 0$ .

A        (input/output) DOUBLE PRECISION array, dimension (LDA,N)  
On entry, the N-by-N matrix A. On exit, A has been overwritten.

LDA      (input) INTEGER  
The leading dimension of the array A.  $LDA \geq \max(1,N)$ .

WR      (output) DOUBLE PRECISION array, dimension (N)  
WI      (output) DOUBLE PRECISION array, dimension (N) WR and WI contain the real and imaginary parts, respectively, of the computed eigenvalues. Complex conjugate pairs of eigenvalues appear consecutively with the eigenvalue having the positive imaginary part first.

VL      (output) DOUBLE PRECISION array, dimension (LDVL,N)  
If  $JOBVL = 'V'$ , the left eigenvectors  $u(j)$  are stored one after another in the columns of VL, in the same order as their eigenvalues. If  $JOBVL = 'N'$ , VL is not referenced. If the j-th eigenvalue is real, then  $u(j) = VL(:,j)$ , the j-th column of VL. If the j-th and (j+1)-st eigenvalues form a complex conjugate pair, then  $u(j) = VL(:,j) + i*VL(:,j+1)$  and  $u(j+1) = VL(:,j) - i*VL(:,j+1)$ .

LDVL    (input) INTEGER  
The leading dimension of the array VL.  $LDVL \geq 1$ ; if  $JOBVL = 'V'$ ,  $LDVL \geq N$ .

VR      (output) DOUBLE PRECISION array, dimension (LDVR,N)  
If  $JOBVR = 'V'$ , the right eigenvectors  $v(j)$  are stored one after another in the columns of VR, in the same order as their eigenvalues. If  $JOBVR = 'N'$ , VR is not referenced. If the j-th eigenvalue is real, then  $v(j) = VR(:,j)$ , the j-th column of VR. If the j-th and (j+1)-st eigenvalues form a complex conjugate pair, then  $v(j) = VR(:,j) + i*VR(:,j+1)$  and  $v(j+1) = VR(:,j) - i*VR(:,j+1)$ .

LDVR    (input) INTEGER  
The leading dimension of the array VR.  $LDVR \geq 1$ ; if  $JOBVR = 'V'$ ,  $LDVR \geq N$ .

WORK    (workspace/output) DOUBLE PRECISION array, dimension

(MAX(1,LWORK))

On exit, if INFO = 0, WORK(1) returns the optimal LWORK.

LWORK (input) INTEGER

The dimension of the array WORK. LWORK  $\geq \max(1, 3*N)$ , and if JOBVL = 'V' or JOBVR = 'V', LWORK  $\geq 4*N$ . For good performance, LWORK must generally be larger.

If LWORK = -1, then a workspace query is assumed; the routine only calculates the optimal size of the WORK array, returns this value as the first entry of the WORK array, and no error message related to LWORK is issued by XERBLA.

INFO (output) INTEGER

= 0: successful exit

< 0: if INFO = -i, the i-th argument had an illegal value.

> 0: if INFO = i, the QR algorithm failed to compute all the eigenvalues, and no eigenvectors have been computed; elements i+1:N of WR and WI contain eigenvalues which have converged.

```

(LAPACK dgeev)≡
  (let* ((zero 0.0) (one 1.0))
    (declare (type (double-float 0.0 0.0) zero)
              (type (double-float 1.0 1.0) one))
    (defun dgeev (jobvl jobvr n a lda wr wi vl ldvl vr ldvr work lwork info)
      (declare (type (simple-array double-float (*)) work vr vl wi wr a)
                (type fixnum info lwork ldvr ldvl lda n)
                (type character jobvr jobvl))
      (f2cl-lib:with-multi-array-data
        ((jobvl character jobvl-%data% jobvl-%offset%)
         (jobvr character jobvr-%data% jobvr-%offset%)
         (a double-float a-%data% a-%offset%)
         (wr double-float wr-%data% wr-%offset%)
         (wi double-float wi-%data% wi-%offset%)
         (vl double-float vl-%data% vl-%offset%)
         (vr double-float vr-%data% vr-%offset%)
         (work double-float work-%data% work-%offset%))
        (prog ((dum (make-array 1 :element-type 'double-float))
              (select (make-array 1 :element-type 't)) (anrm 0.0) (bignum 0.0)
              (cs 0.0) (cscale 0.0) (eps 0.0) (r 0.0) (scl 0.0) (smlnum 0.0)
              (sn 0.0) (hswork 0) (i 0) (ibal 0) (ierr 0) (ihi 0) (ilo 0)
              (itau 0) (iwrk 0) (k 0) (maxb 0) (maxwrk 0) (minwrk 0) (nout 0)
              (side
                (make-array '(1) :element-type 'character :initial-element #\ ))
              (lquery nil) (scalea nil) (wantvl nil) (wantvr nil))
              (declare (type (simple-array double-float (1)) dum)
                        (type (simple-array (member t nil) (1)) select)
                        (type (double-float) anrm bignum cs cscale eps r scl smlnum
                               sn)
                        (type fixnum hswork i ibal ierr ihi ilo itau iwrk
                               k maxb maxwrk minwrk nout)
                        (type (simple-array character (1)) side)
                        (type (member t nil) lquery scalea wantvl wantvr))
              (setf info 0)
              (setf lquery (coerce (= lwork -1) '(member t nil)))
              (setf wantvl (char-equal jobvl #\V))
              (setf wantvr (char-equal jobvr #\V))
              (cond
                ((and (not wantvl) (not (char-equal jobvl #\N)))
                 (setf info -1))
                ((and (not wantvr) (not (char-equal jobvr #\N)))
                 (setf info -2))
                ((< n 0)
                 (setf info -3))
                ((< lda (max (the fixnum 1) (the fixnum n)))
                 (setf info -5)))
              )
      )
    )

```

```

((or (< ldvl 1) (and wantvl (< ldvl n)))
 (setf info -9))
((or (< ldvr 1) (and wantvr (< ldvr n)))
 (setf info -11)))
(setf minwrk 1)
(cond
 ((and (= info 0) (or (>= lwork 1) lquery))
  (setf maxwrk
    (f2cl-lib:int-add (f2cl-lib:int-mul 2 n)
      (f2cl-lib:int-mul n
        (ilaenv 1 "DGEHRD" " " " n
          1 n 0))))))
 (cond
  ((and (not wantvl) (not wantvr))
   (setf minwrk
     (max (the fixnum 1)
       (the fixnum (f2cl-lib:int-mul 3 n))))
   (setf maxb
     (max
      (the fixnum
        (ilaenv 8 "DHSEQR" "EN" n 1 n -1))
      (the fixnum 2)))
   (setf k
     (min (the fixnum maxb)
       (the fixnum n)
       (the fixnum
        (max (the fixnum 2)
          (the fixnum
            (ilaenv 4 "DHSEQR" "EN" n 1 n -1)))))))
   (setf hswork
     (max
      (the fixnum
        (f2cl-lib:int-mul k (f2cl-lib:int-add k 2)))
      (the fixnum (f2cl-lib:int-mul 2 n))))
   (setf maxwrk
     (max (the fixnum maxwrk)
       (the fixnum (f2cl-lib:int-add n 1))
       (the fixnum
        (f2cl-lib:int-add n hswork)))))
  (t
   (setf minwrk
     (max (the fixnum 1)
       (the fixnum (f2cl-lib:int-mul 4 n))))
   (setf maxwrk
     (max (the fixnum maxwrk)
       (the fixnum

```



```

(f2cl-lib:int-add (f2cl-lib:int-mul 2 n)
  (f2cl-lib:int-mul
    (f2cl-lib:int-sub n 1)
    (ilaenv 1 "DORGHR" " " n 1 n
      -1))))))
(setf maxb
  (max
    (the fixnum
      (ilaenv 8 "DHSEQR" "SV" n 1 n -1))
    (the fixnum 2)))
(setf k
  (min (the fixnum maxb)
    (the fixnum n)
    (the fixnum
      (max (the fixnum 2)
        (the fixnum
          (ilaenv 4 "DHSEQR" "SV" n 1 n -1)))))))
(setf hswrk
  (max
    (the fixnum
      (f2cl-lib:int-mul k (f2cl-lib:int-add k 2)))
    (the fixnum (f2cl-lib:int-mul 2 n))))
(setf maxwrk
  (max (the fixnum maxwrk)
    (the fixnum (f2cl-lib:int-add n 1))
    (the fixnum (f2cl-lib:int-add n hswrk))))
(setf maxwrk
  (max (the fixnum maxwrk)
    (the fixnum (f2cl-lib:int-mul 4 n))))))
(setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)
  (coerce (the fixnum maxwrk) 'double-float)))
(cond
  ((and (< lwork minwrk) (not lquery))
    (setf info -13)))
(cond
  ((/= info 0)
    (error
      "** On entry to ~a parameter number ~a had an illegal value~%"
      "DGEEV " (f2cl-lib:int-sub info))
    (go end_label))
  (lquery
    (go end_label)))
(if (= n 0) (go end_label))
(setf eps (dlamch "P"))
(setf smlnum (dlamch "S"))
(setf bignum (/ one smlnum))

```

```

(multiple-value-bind (var-0 var-1)
  (dlabad smlnum bignum)
  (declare (ignore))
  (setf smlnum var-0)
  (setf bignum var-1))
(setf smlnum (/ (f2cl-lib:fsqrt smlnum) eps))
(setf bignum (/ one smlnum))
(setf anrm (dlange "M" n n a lda dum))
(setf scalea nil)
(cond
  ((and (> anrm zero) (< anrm smlnum))
   (setf scalea t)
   (setf cscale smlnum))
  ((> anrm bignum)
   (setf scalea t)
   (setf cscale bignum)))
(if scalea
  (multiple-value-bind
    (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9)
    (dlascl "G" 0 0 anrm cscale n n a lda ierr)
    (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
      var-8))
    (setf ierr var-9)))
(setf ibal 1)
(multiple-value-bind (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7)
  (dgebal "B" n a lda ilo ihi
    (f2cl-lib:array-slice work double-float (ibal) ((1 *))) ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-6))
  (setf ilo var-4)
  (setf ihi var-5)
  (setf ierr var-7))
(setf itau (f2cl-lib:int-add ibal n))
(setf iwrk (f2cl-lib:int-add itau n))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8)
  (dgehrd n ilo ihi a lda
    (f2cl-lib:array-slice work double-float (itau) ((1 *)))
    (f2cl-lib:array-slice work double-float (iwrk) ((1 *)))
    (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwrk) 1) ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7))
  (setf ierr var-8))
(cond
  (wantvl
   (f2cl-lib:f2cl-set-string side "L" (string 1))
   (dlacpy "L" n n a lda vl ldvl)
   (multiple-value-bind

```

```

    (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8)
(dorghr n ilo ihi vl ldvl
  (f2cl-lib:array-slice work double-float (itau) ((1 *)))
  (f2cl-lib:array-slice work double-float (iwrk) ((1 *)))
  (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwrk) 1) ierr)
(declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7))
(setf ierr var-8))
(setf iwrk itau)
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9
   var-10 var-11 var-12 var-13)
  (dhseqr "S" "V" n ilo ihi a lda wr wi vl ldvl
    (f2cl-lib:array-slice work double-float (iwrk) ((1 *)))
    (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwrk) 1) info)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
    var-8 var-9 var-10 var-11 var-12))
  (setf info var-13))
(cond
  (wantvr
    (f2cl-lib:f2cl-set-string side "B" (string 1))
    (dlacpy "F" n n vl ldvl vr ldvr)))
(wantvr
  (f2cl-lib:f2cl-set-string side "R" (string 1))
  (dlacpy "L" n n a lda vr ldvr)
  (multiple-value-bind
    (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8)
    (dorghr n ilo ihi vr ldvr
      (f2cl-lib:array-slice work double-float (itau) ((1 *)))
      (f2cl-lib:array-slice work double-float (iwrk) ((1 *)))
      (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwrk) 1) ierr)
    (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7))
    (setf ierr var-8))
  (setf iwrk itau)
  (multiple-value-bind
    (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9
     var-10 var-11 var-12 var-13)
    (dhseqr "S" "V" n ilo ihi a lda wr wi vr ldvr
      (f2cl-lib:array-slice work double-float (iwrk) ((1 *)))
      (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwrk) 1) info)
    (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
      var-8 var-9 var-10 var-11 var-12))
    (setf info var-13)))
(t
  (setf iwrk itau)
  (multiple-value-bind
    (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9

```

```

var-10 var-11 var-12 var-13)
(dhseqr "E" "N" n ilo ihi a lda wr wi vr ldvr
(f2cl-lib:array-slice work double-float (iwrk) ((1 *)))
(f2cl-lib:int-add (f2cl-lib:int-sub lwork iwrk) 1) info)
(declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
var-8 var-9 var-10 var-11 var-12))
(setf info var-13)))
(if (> info 0) (go label50))
(cond
((or wantvl wantvr)
(multiple-value-bind
(var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9
var-10 var-11 var-12 var-13)
(dtrevc side "B" select n a lda vl ldvl vr ldvr n nout
(f2cl-lib:array-slice work double-float (iwrk) ((1 *))) ierr)
(declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
var-8 var-9 var-10 var-12))
(setf nout var-11)
(setf ierr var-13))))
(cond
(wantvl
(multiple-value-bind
(var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9)
(dgebak "B" "L" n ilo ihi
(f2cl-lib:array-slice work double-float (ibal) ((1 *))) n vl
ldvl ierr)
(declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
var-8))
(setf ierr var-9))
(f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
(> i n) nil)
(tagbody
(cond
((= (f2cl-lib:fref wi (i) ((1 *))) zero)
(setf scl
(/ one
(dnrm2 n
(f2cl-lib:array-slice vl
double-float
(1 i)
((1 ldvl) (1 *)))
1)))
(dscal n scl
(f2cl-lib:array-slice vl
double-float
(1 i)

```

```

((1 ldvl) (1 *)))
1))
(> (f2cl-lib:fref wi (i) ((1 *))) zero)
(setf scl
  (/ one
    (dlapy2
      (dnrm2 n
        (f2cl-lib:array-slice vl
          double-float
          (1 i)
          ((1 ldvl) (1 *)))
        1)
      (dnrm2 n
        (f2cl-lib:array-slice vl
          double-float
          (1 (f2cl-lib:int-add i 1))
          ((1 ldvl) (1 *)))
        1))))
(dscal n scl
  (f2cl-lib:array-slice vl
    double-float
    (1 i)
    ((1 ldvl) (1 *)))
  1)
(dscal n scl
  (f2cl-lib:array-slice vl
    double-float
    (1 (f2cl-lib:int-add i 1))
    ((1 ldvl) (1 *)))
  1)
(f2cl-lib:fdo (k 1 (f2cl-lib:int-add k 1))
  (> k n) nil)
(tagbody
  (setf (f2cl-lib:fref work-%data%
    ((f2cl-lib:int-sub
      (f2cl-lib:int-add iwrk k)
      1))
    ((1 *))
    work-%offset%))
    (+
      (expt
        (f2cl-lib:fref vl-%data%
          (k i)
          ((1 ldvl) (1 *))
          vl-%offset%))
        2)

```

```

                                (expt
                                  (f2cl-lib:fref vl-%data%
                                                    (k (f2cl-lib:int-add i 1))
                                                    ((1 ldvl) (1 *)))
                                  vl-%offset%)
                                2))))))
(setf k
      (idamax n
              (f2cl-lib:array-slice work
                                      double-float
                                      (iwrk)
                                      ((1 *)))
              1))
(multiple-value-bind (var-0 var-1 var-2 var-3 var-4)
  (dlartg
   (f2cl-lib:fref vl-%data%
                   (k i)
                   ((1 ldvl) (1 *)))
   vl-%offset%)
  (f2cl-lib:fref vl-%data%
                 (k (f2cl-lib:int-add i 1))
                 ((1 ldvl) (1 *)))
  vl-%offset%)
  (cs sn r)
  (declare (ignore var-0 var-1))
  (setf cs var-2)
  (setf sn var-3)
  (setf r var-4))
(drot n
  (f2cl-lib:array-slice vl
                        double-float
                        (1 i)
                        ((1 ldvl) (1 *)))
  1
  (f2cl-lib:array-slice vl
                        double-float
                        (1 (f2cl-lib:int-add i 1))
                        ((1 ldvl) (1 *)))
  1 cs sn)
(setf (f2cl-lib:fref vl-%data%
                     (k (f2cl-lib:int-add i 1))
                     ((1 ldvl) (1 *)))
      vl-%offset%)
      zero))))))
(cond
  (wantvr

```

```

(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9)
  (dgebak "B" "R" n ilo ihi
    (f2cl-lib:array-slice work double-float (ibal) ((1 *))) n vr
    ldvr ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
    var-8))
  (setf ierr var-9))
(f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
  ((> i n) nil)
  (tagbody
    (cond
      ((= (f2cl-lib:fref wi (i) ((1 *))) zero)
        (setf scl
          (/ one
            (dnrm2 n
              (f2cl-lib:array-slice vr
                double-float
                (1 i)
                ((1 ldvr) (1 *)))
              1)))
        (dscal n scl
          (f2cl-lib:array-slice vr
            double-float
            (1 i)
            ((1 ldvr) (1 *)))
          1))
      ((> (f2cl-lib:fref wi (i) ((1 *))) zero)
        (setf scl
          (/ one
            (dlapy2
              (dnrm2 n
                (f2cl-lib:array-slice vr
                  double-float
                  (1 i)
                  ((1 ldvr) (1 *)))
                1)
              (dnrm2 n
                (f2cl-lib:array-slice vr
                  double-float
                  (1 (f2cl-lib:int-add i 1))
                  ((1 ldvr) (1 *)))
                1))))
        (dscal n scl
          (f2cl-lib:array-slice vr
            double-float

```

```

                                (1 i)
                                ((1 ldvr) (1 *)))
1)
(dscal n scl
 (f2cl-lib:array-slice vr
  double-float
  (1 (f2cl-lib:int-add i 1))
  ((1 ldvr) (1 *)))
1)
(f2cl-lib:fdo (k 1 (f2cl-lib:int-add k 1))
  (> k n) nil)
(tagbody
  (setf (f2cl-lib:fref work-%data%
    ((f2cl-lib:int-sub
      (f2cl-lib:int-add iwrk k)
      1))
    ((1 *))
    work-%offset%)
    (+
      (expt
        (f2cl-lib:fref vr-%data%
          (k i)
          ((1 ldvr) (1 *))
          vr-%offset%)
        2)
      (expt
        (f2cl-lib:fref vr-%data%
          (k (f2cl-lib:int-add i 1))
          ((1 ldvr) (1 *))
          vr-%offset%)
        2))))))
(setf k
  (idamax n
    (f2cl-lib:array-slice work
      double-float
      (iwrk)
      ((1 *)))
    1))
(multiple-value-bind (var-0 var-1 var-2 var-3 var-4)
  (dlartg
    (f2cl-lib:fref vr-%data%
      (k i)
      ((1 ldvr) (1 *))
      vr-%offset%)
    (f2cl-lib:fref vr-%data%
      (k (f2cl-lib:int-add i 1))

```



```

((1 ldvr) (1 *))
vr-%offset%)

cs sn r)
(declare (ignore var-0 var-1))
(setf cs var-2)
(setf sn var-3)
(setf r var-4))
(drot n
 (f2cl-lib:array-slice vr
  double-float
  (1 i)
  ((1 ldvr) (1 *)))

1
 (f2cl-lib:array-slice vr
  double-float
  (1 (f2cl-lib:int-add i 1))
  ((1 ldvr) (1 *)))

1 cs sn)
(setf (f2cl-lib:fref vr-%data%
  (k (f2cl-lib:int-add i 1))
  ((1 ldvr) (1 *))
  vr-%offset%)
 zero))))))

label50
(cond
 (scalea
  (multiple-value-bind
   (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9)
   (dlascl "G" 0 0 cscale anrm (f2cl-lib:int-sub n info) 1
    (f2cl-lib:array-slice wr double-float ((+ info 1)) ((1 *)))
    (max (the fixnum (f2cl-lib:int-sub n info))
      (the fixnum 1))
    ierr)
   (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
    var-8))
   (setf ierr var-9))
  (multiple-value-bind
   (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9)
   (dlascl "G" 0 0 cscale anrm (f2cl-lib:int-sub n info) 1
    (f2cl-lib:array-slice wi double-float ((+ info 1)) ((1 *)))
    (max (the fixnum (f2cl-lib:int-sub n info))
      (the fixnum 1))
    ierr)
   (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
    var-8))
   (setf ierr var-9))

```

```

(cond
  (> info 0)
  (multiple-value-bind
    (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
     var-9)
    (dlascl "G" 0 0 cscale anrm (f2cl-lib:int-sub ilo 1) 1 wr n
      ierr)
    (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
      var-7 var-8))
    (setf ierr var-9))
  (multiple-value-bind
    (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
     var-9)
    (dlascl "G" 0 0 cscale anrm (f2cl-lib:int-sub ilo 1) 1 wi n
      ierr)
    (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
      var-7 var-8))
    (setf ierr var-9))))))
(setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)
  (coerce (the fixnum maxwrk) 'double-float))
end_label
(return
  (values nil nil nil nil nil nil nil nil nil nil nil nil info))))))

```

## 7.9 dgeevx LAPACK

```

⟨dgeevx.input⟩≡
)set break resume
)sys rm -f dgeevx.output
)spool dgeevx.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)

```

`<dgeevx.help>=`

```
=====
dgeevx examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

DGEEVX - for an N-by-N real nonsymmetric matrix A, the eigenvalues and, optionally, the left and/or right eigenvectors

#### SYNOPSIS

```
SUBROUTINE DGEEVX( BALANC, JOBVL, JOBVR, SENSE, N, A, LDA, WR, WI, VL,
                  LDVL, VR, LDVR, ILO, IHI, SCALE, ABNRM, RCONDE,
                  RCONDV, WORK, LWORK, IWORK, INFO )
```

CHARACTER BALANC, JOBVL, JOBVR, SENSE

INTEGER IHI, ILO, INFO, LDA, LDVL, LDVR, LWORK, N

DOUBLE PRECISION ABNRM

INTEGER IWORK( \* )

DOUBLE PRECISION A( LDA, \* ), RCONDE( \* ), RCONDV( \* ),  
SCALE( \* ), VL( LDVL, \* ), VR( LDVR, \* ), WI( \* ),  
WORK( \* ), WR( \* )

#### PURPOSE

DGEEVX computes for an N-by-N real nonsymmetric matrix A, the eigenvalues and, optionally, the left and/or right eigenvectors.

Optionally also, it computes a balancing transformation to improve the conditioning of the eigenvalues and eigenvectors (ILO, IHI, SCALE, and ABNRM), reciprocal condition numbers for the eigenvalues (RCONDE), and reciprocal condition numbers for the right eigenvectors (RCONDV).

The right eigenvector  $v(j)$  of A satisfies

$$A * v(j) = \text{lambda}(j) * v(j)$$

where  $\text{lambda}(j)$  is its eigenvalue.

The left eigenvector  $u(j)$  of A satisfies

$$u(j)**H * A = \text{lambda}(j) * u(j)**H$$

where  $u(j)**H$  denotes the conjugate transpose of  $u(j)$ .

The computed eigenvectors are normalized to have Euclidean norm equal to 1 and largest component real.

Balancing a matrix means permuting the rows and columns to make it more nearly upper triangular, and applying a diagonal similarity transformation  $D * A * D^{**(-1)}$ , where  $D$  is a diagonal matrix, to make its rows and columns closer in norm and the condition numbers of its eigenvalues and eigenvectors smaller. The computed reciprocal condition numbers correspond to the balanced matrix. Permuting rows and columns will not change the condition numbers (in exact arithmetic) but diagonal scaling will. For further explanation of balancing, see section 4.10.2 of the LAPACK Users' Guide.

#### ARGUMENTS

**BALANC** (input) CHARACTER\*1  
 Indicates how the input matrix should be diagonally scaled and/or permuted to improve the conditioning of its eigenvalues.  
 = 'N': Do not diagonally scale or permute;  
 = 'P': Perform permutations to make the matrix more nearly upper triangular. Do not diagonally scale;  
 = 'S': Diagonally scale the matrix, i.e. replace  $A$  by  $D * A * D^{**(-1)}$ , where  $D$  is a diagonal matrix chosen to make the rows and columns of  $A$  more equal in norm. Do not permute;  
 = 'B': Both diagonally scale and permute  $A$ .

Computed reciprocal condition numbers will be for the matrix after balancing and/or permuting. Permuting does not change condition numbers (in exact arithmetic), but balancing does.

**JOBVL** (input) CHARACTER\*1  
 = 'N': left eigenvectors of  $A$  are not computed;  
 = 'V': left eigenvectors of  $A$  are computed. If **SENSE** = 'E' or 'B', **JOBVL** must = 'V'.

**JOBVR** (input) CHARACTER\*1  
 = 'N': right eigenvectors of  $A$  are not computed;  
 = 'V': right eigenvectors of  $A$  are computed. If **SENSE** = 'E' or 'B', **JOBVR** must = 'V'.

**SENSE** (input) CHARACTER\*1  
 Determines which reciprocal condition numbers are computed.  
 = 'N': None are computed;  
 = 'E': Computed for eigenvalues only;  
 = 'V': Computed for right eigenvectors only;

= 'B': Computed for eigenvalues and right eigenvectors.

If SENSE = 'E' or 'B', both left and right eigenvectors must also be computed (JOBVL = 'V' and JOBVR = 'V').

- N (input) INTEGER  
The order of the matrix A.  $N \geq 0$ .
- A (input/output) DOUBLE PRECISION array, dimension (LDA,N)  
On entry, the N-by-N matrix A. On exit, A has been overwritten. If JOBVL = 'V' or JOBVR = 'V', A contains the real Schur form of the balanced version of the input matrix A.
- LDA (input) INTEGER  
The leading dimension of the array A.  $LDA \geq \max(1, N)$ .
- WR (output) DOUBLE PRECISION array, dimension (N)  
WI (output) DOUBLE PRECISION array, dimension (N) WR and WI contain the real and imaginary parts, respectively, of the computed eigenvalues. Complex conjugate pairs of eigenvalues will appear consecutively with the eigenvalue having the positive imaginary part first.
- VL (output) DOUBLE PRECISION array, dimension (LDVL,N)  
If JOBVL = 'V', the left eigenvectors  $u(j)$  are stored one after another in the columns of VL, in the same order as their eigenvalues. If JOBVL = 'N', VL is not referenced. If the j-th eigenvalue is real, then  $u(j) = VL(:, j)$ , the j-th column of VL. If the j-th and (j+1)-st eigenvalues form a complex conjugate pair, then  $u(j) = VL(:, j) + i*VL(:, j+1)$  and  $u(j+1) = VL(:, j) - i*VL(:, j+1)$ .
- LDVL (input) INTEGER  
The leading dimension of the array VL.  $LDVL \geq 1$ ; if JOBVL = 'V',  $LDVL \geq N$ .
- VR (output) DOUBLE PRECISION array, dimension (LDVR,N)  
If JOBVR = 'V', the right eigenvectors  $v(j)$  are stored one after another in the columns of VR, in the same order as their eigenvalues. If JOBVR = 'N', VR is not referenced. If the j-th eigenvalue is real, then  $v(j) = VR(:, j)$ , the j-th column of VR. If the j-th and (j+1)-st eigenvalues form a complex conjugate pair, then  $v(j) = VR(:, j) + i*VR(:, j+1)$  and  $v(j+1) = VR(:, j) - i*VR(:, j+1)$ .
- LDVR (input) INTEGER

The leading dimension of the array VR. LDVR  $\geq 1$ , and if JOBVR = 'V', LDVR  $\geq N$ .

ILO (output) INTEGER

IHI (output) INTEGER ILO and IHI are integer values determined when A was balanced. The balanced  $A(i,j) = 0$  if  $I > J$  and  $J = 1, \dots, ILO-1$  or  $I = IHI+1, \dots, N$ .

SCALE (output) DOUBLE PRECISION array, dimension (N)

Details of the permutations and scaling factors applied when balancing A. If P(j) is the index of the row and column interchanged with row and column j, and D(j) is the scaling factor applied to row and column j, then SCALE(J) = P(J), for J = 1, ..., ILO-1 = D(J), for J = ILO, ..., IHI = P(J) for J = IHI+1, ..., N. The order in which the interchanges are made is N to IHI+1, then 1 to ILO-1.

ABNRM (output) DOUBLE PRECISION

The one-norm of the balanced matrix (the maximum of the sum of absolute values of elements of any column).

RCONDE (output) DOUBLE PRECISION array, dimension (N)

RCONDE(j) is the reciprocal condition number of the j-th eigenvalue.

RCONDV (output) DOUBLE PRECISION array, dimension (N)

RCONDV(j) is the reciprocal condition number of the j-th right eigenvector.

WORK (workspace/output) DOUBLE PRECISION array, dimension (MAX(1,LWORK))

On exit, if INFO = 0, WORK(1) returns the optimal LWORK.

LWORK (input) INTEGER

The dimension of the array WORK. If SENSE = 'N' or 'E', LWORK  $\geq \max(1, 2*N)$ , and if JOBVL = 'V' or JOBVR = 'V', LWORK  $\geq 3*N$ . If SENSE = 'V' or 'B', LWORK  $\geq N*(N+6)$ . For good performance, LWORK must generally be larger.

If LWORK = -1, then a workspace query is assumed; the routine only calculates the optimal size of the WORK array, returns this value as the first entry of the WORK array, and no error message related to LWORK is issued by XERBLA.

IWORK (workspace) INTEGER array, dimension (2\*N-2)

If SENSE = 'N' or 'E', not referenced.

INFO      (output) INTEGER  
= 0:    successful exit  
< 0:    if INFO = -i, the i-th argument had an illegal value.  
> 0:    if INFO = i, the QR algorithm failed to compute all the  
eigenvalues, and no eigenvectors or condition numbers have been  
computed; elements 1:ILO-1 and i+1:N of WR and WI contain  
eigenvalues which have converged.

```

(LAPACK dgeevx)=
  (let* ((zero 0.0) (one 1.0))
    (declare (type (double-float 0.0 0.0) zero)
              (type (double-float 1.0 1.0) one))
    (defun dgeevx
      (balanc jobvl jobvr sense n a lda wr wi vl ldvl vr ldvr ilo ihi scale
        abnrm rconde rcondv work lwork iwork info)
      (declare (type (simple-array fixnum (*)) iwork)
                (type (double-float) abnrm)
                (type (simple-array double-float (*)) work rcondv rconde scale vr vl wi
                      wr a)
                (type fixnum info lwork ihi ilo ldvr ldvl lda n)
                (type character sense jobvr jobvl balanc))
      (f2cl-lib:with-multi-array-data
        ((balanc character balanc-%data% balanc-%offset%)
         (jobvl character jobvl-%data% jobvl-%offset%)
         (jobvr character jobvr-%data% jobvr-%offset%)
         (sense character sense-%data% sense-%offset%)
         (a double-float a-%data% a-%offset%)
         (wr double-float wr-%data% wr-%offset%)
         (wi double-float wi-%data% wi-%offset%)
         (vl double-float vl-%data% vl-%offset%)
         (vr double-float vr-%data% vr-%offset%)
         (scale double-float scale-%data% scale-%offset%)
         (rconde double-float rconde-%data% rconde-%offset%)
         (rcondv double-float rcondv-%data% rcondv-%offset%)
         (work double-float work-%data% work-%offset%)
         (iwork fixnum iwork-%data% iwork-%offset%))
      (prog ((dum (make-array 1 :element-type 'double-float))
              (select (make-array 1 :element-type 't)) (anrm 0.0) (bignum 0.0)
              (cs 0.0) (cscale 0.0) (eps 0.0) (r 0.0) (scl 0.0) (smlnum 0.0)
              (sn 0.0) (hswork 0) (i 0) (icond 0) (ierr 0) (itau 0) (iwrk 0)
              (k 0) (maxb 0) (maxwrk 0) (minwrk 0) (nout 0)
              (job
               (make-array '(1) :element-type 'character :initial-element #\ ))
              (side
               (make-array '(1) :element-type 'character :initial-element #\ ))
              (lquery nil) (scalea nil) (wantvl nil) (wantvr nil) (wntsnb nil)
              (wntsne nil) (wntsnr nil) (wntsnv nil))
      (declare (type (simple-array double-float (1)) dum)
                (type (simple-array (member t nil) (1)) select)
                (type (double-float) anrm bignum cs cscale eps r scl smlnum
                      sn)
                (type fixnum hswork i icond ierr itau iwrk k maxb
                      maxwrk minwrk nout)
                (type (simple-array character (1)) job side)

```



```

      (type (member t nil) lquery scalea wantvl wantvr wntsnb
            wntsne wntsnv))

(setf info 0)
(setf lquery (coerce (= lwork -1) '(member t nil)))
(setf wantvl (char-equal jobvl #\V))
(setf wantvr (char-equal jobvr #\V))
(setf wntsnv (char-equal sense #\N))
(setf wntsne (char-equal sense #\E))
(setf wntsnb (char-equal sense #\B))
(cond
  ((not
    (or (char-equal balanc #\N)
        (char-equal balanc #\S)
        (char-equal balanc #\P)
        (char-equal balanc #\B)))
    (setf info -1))
  ((and (not wantvl) (not (char-equal jobvl #\N)))
    (setf info -2))
  ((and (not wantvr) (not (char-equal jobvr #\N)))
    (setf info -3))
  ((or (not (or wntsnv wntsne wntsnb wntsnv))
        (and (or wntsne wntsnb) (not (and wantvl wantvr))))
    (setf info -4))
  ((< n 0)
    (setf info -5))
  ((< lda (max (the fixnum 1) (the fixnum n)))
    (setf info -7))
  ((or (< ldvl 1) (and wantvl (< ldvl n)))
    (setf info -11))
  ((or (< ldvr 1) (and wantvr (< ldvr n)))
    (setf info -13)))
(setf minwrk 1)
(cond
  ((and (= info 0) (or (>= lwork 1) lquery))
    (setf maxwrk
      (f2cl-lib:int-add n
        (f2cl-lib:int-mul n
          (ilaenv 1 "DGEHRD" " " " n
            1 n 0))))))

(cond
  ((and (not wantvl) (not wantvr))
    (setf minwrk
      (max (the fixnum 1)
        (the fixnum (f2cl-lib:int-mul 2 n))))
    (if (not wntsnv)

```



```
(t
  (setf minwrk
    (max (the fixnum 1)
          (the fixnum (f2cl-lib:int-mul 3 n))))
  (if (and (not wntsn) (not wntsne))
      (setf minwrk
        (max (the fixnum minwrk)
              (the fixnum
                (f2cl-lib:int-add (f2cl-lib:int-mul n n)
                                   (f2cl-lib:int-mul 6
                                                         n))))))
  (setf maxb
    (max
     (the fixnum
      (ilaenv 8 "DHSEQR" "SN" n 1 n -1))
     (the fixnum 2)))
  (setf k
    (min (the fixnum maxb)
         (the fixnum n)
         (the fixnum
          (max (the fixnum 2)
                (the fixnum
                 (ilaenv 4 "DHSEQR" "EN" n 1 n -1))))))
  (setf hswrk
    (max
     (the fixnum
      (f2cl-lib:int-mul k (f2cl-lib:int-add k 2)))
     (the fixnum (f2cl-lib:int-mul 2 n))))
  (setf maxwrk
    (max (the fixnum maxwrk)
          (the fixnum 1)
          (the fixnum hswrk)))
  (setf maxwrk
    (max (the fixnum maxwrk)
          (the fixnum
            (f2cl-lib:int-add n
                               (f2cl-lib:int-mul
                                (f2cl-lib:int-sub n 1)
                                (ilaenv 1 "DORGHR" " " n 1 n
                                           -1))))))
  (if (and (not wntsn) (not wntsne))
      (setf maxwrk
        (max (the fixnum maxwrk)
              (the fixnum
                (f2cl-lib:int-add (f2cl-lib:int-mul n n)
                                   (f2cl-lib:int-mul 6
```

```

n))))))

      (setf maxwrk
        (max (the fixnum maxwrk)
              (the fixnum (f2cl-lib:int-mul 3 n))
              (the fixnum 1))))
      (setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)
        (coerce (the fixnum maxwrk) 'double-float)))
(cond
  ((and (< lwork minwrk) (not lquery))
   (setf info -21)))
(cond
  ((/= info 0)
   (error
    " ** On entry to ~a parameter number ~a had an illegal value~%"
    "DGEEVX" (f2cl-lib:int-sub info))
   (go end_label))
  (lquery
   (go end_label)))
(if (= n 0) (go end_label))
(setf eps (dlamch "P"))
(setf smlnum (dlamch "S"))
(setf bignum (/ one smlnum))
(multiple-value-bind (var-0 var-1)
  (dlabad smlnum bignum)
  (declare (ignore))
  (setf smlnum var-0)
  (setf bignum var-1))
(setf smlnum (/ (f2cl-lib:fsqrt smlnum) eps))
(setf bignum (/ one smlnum))
(setf icond 0)
(setf anrm (dlange "M" n n a lda dum))
(setf scalea nil)
(cond
  ((and (> anrm zero) (< anrm smlnum))
   (setf scalea t)
   (setf cscale smlnum))
  ((> anrm bignum)
   (setf scalea t)
   (setf cscale bignum)))
(if scalea
  (multiple-value-bind
    (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9)
    (dlascl "G" 0 0 anrm cscale n n a lda ierr)
    (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
                    var-8))
    (setf ierr var-9)))

```

```

(multiple-value-bind (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7)
  (dgebal balanc n a lda ilo ihi scale ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-6))
  (setf ilo var-4)
  (setf ihi var-5)
  (setf ierr var-7))
(setf abnrm (dlange "1" n n a lda dum))
(cond
  (scalea
    (setf (f2cl-lib:fref dum (1) ((1 1))) abnrm)
    (multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9)
      (dlascl "G" 0 0 cscale anrm 1 1 dum 1 ierr)
      (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
        var-8))
      (setf ierr var-9))
    (setf abnrm (f2cl-lib:fref dum (1) ((1 1))))))
(setf itau 1)
(setf iwrk (f2cl-lib:int-add itau n))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8)
  (dgehrd n ilo ihi a lda
    (f2cl-lib:array-slice work double-float (itau) ((1 *)))
    (f2cl-lib:array-slice work double-float (iwrk) ((1 *)))
    (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwrk) 1) ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7))
  (setf ierr var-8))
(cond
  (wantvl
    (f2cl-lib:f2cl-set-string side "L" (string 1))
    (dlacpy "L" n n a lda vl ldvl)
    (multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8)
      (dorghr n ilo ihi vl ldvl
        (f2cl-lib:array-slice work double-float (itau) ((1 *)))
        (f2cl-lib:array-slice work double-float (iwrk) ((1 *)))
        (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwrk) 1) ierr)
      (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7))
      (setf ierr var-8))
    (setf iwrk itau)
    (multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9
        var-10 var-11 var-12 var-13)
      (dhseqr "S" "V" n ilo ihi a lda wr wi vl ldvl
        (f2cl-lib:array-slice work double-float (iwrk) ((1 *)))
        (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwrk) 1) info)

```

```

      (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
                    var-8 var-9 var-10 var-11 var-12))
      (setf info var-13))
    (cond
      (wantvr
        (f2cl-lib:f2cl-set-string side "B" (string 1))
        (dlacpy "F" n n vl ldvl vr ldvr))))
    (wantvr
      (f2cl-lib:f2cl-set-string side "R" (string 1))
      (dlacpy "L" n n a lda vr ldvr)
      (multiple-value-bind
        (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8)
        (dorghr n ilo ihi vr ldvr
          (f2cl-lib:array-slice work double-float (itau) ((1 *)))
          (f2cl-lib:array-slice work double-float (iwrk) ((1 *)))
          (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwrk) 1) ierr)
        (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7))
        (setf ierr var-8))
      (setf iwrk itau)
      (multiple-value-bind
        (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9
          var-10 var-11 var-12 var-13)
        (dhseqr "S" "V" n ilo ihi a lda wr wi vr ldvr
          (f2cl-lib:array-slice work double-float (iwrk) ((1 *)))
          (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwrk) 1) info)
        (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
                          var-8 var-9 var-10 var-11 var-12))
        (setf info var-13)))
    (t
      (cond
        (wntsnn
          (f2cl-lib:f2cl-set-string job "E" (string 1)))
        (t
          (f2cl-lib:f2cl-set-string job "S" (string 1))))
      (setf iwrk itau)
      (multiple-value-bind
        (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9
          var-10 var-11 var-12 var-13)
        (dhseqr job "N" n ilo ihi a lda wr wi vr ldvr
          (f2cl-lib:array-slice work double-float (iwrk) ((1 *)))
          (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwrk) 1) info)
        (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
                          var-8 var-9 var-10 var-11 var-12))
        (setf info var-13))))
    (if (> info 0) (go label50))
  (cond

```

```

((or wantvl wantvr)
  (multiple-value-bind
    (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9
     var-10 var-11 var-12 var-13)
    (dtrevc side "B" select n a lda vl ldvl vr ldvr n nout
      (f2cl-lib:array-slice work double-float (iwrk) ((1 *))) ierr)
    (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
      var-8 var-9 var-10 var-12))
    (setf nout var-11)
    (setf ierr var-13))))
(cond
  ((not wntsn)
    (multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9
       var-10 var-11 var-12 var-13 var-14 var-15 var-16 var-17)
      (dtrsna sense "A" select n a lda vl ldvl vr ldvr rconde rcondv n
        nout (f2cl-lib:array-slice work double-float (iwrk) ((1 *))) n
        iwork icond)
      (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
        var-8 var-9 var-10 var-11 var-12 var-14 var-15
        var-16))
      (setf nout var-13)
      (setf icond var-17))))
  (cond
    (wantvl
      (multiple-value-bind
        (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9)
        (dgebak balanc "L" n ilo ihi scale n vl ldvl ierr)
        (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
          var-8))
        (setf ierr var-9))
      (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
        ((> i n) nil)
      (tagbody
        (cond
          ((= (f2cl-lib:fref wi (i) ((1 *))) zero)
            (setf scl
              (/ one
                (dnrm2 n
                  (f2cl-lib:array-slice vl
                    double-float
                    (1 i)
                    ((1 ldvl) (1 *)))
                  1))))
          (dscal n scl
            (f2cl-lib:array-slice vl

```

```

double-float
(1 i)
((1 ldvl) (1 *)))
1))
(> (f2cl-lib:fref wi (i) ((1 *))) zero)
(setf scl
  (/ one
    (dlapy2
      (dnrm2 n
        (f2cl-lib:array-slice vl
          double-float
          (1 i)
          ((1 ldvl) (1 *)))
        1)
      (dnrm2 n
        (f2cl-lib:array-slice vl
          double-float
          (1 (f2cl-lib:int-add i 1))
          ((1 ldvl) (1 *)))
        1))))
(dscal n scl
  (f2cl-lib:array-slice vl
    double-float
    (1 i)
    ((1 ldvl) (1 *)))
  1)
(dscal n scl
  (f2cl-lib:array-slice vl
    double-float
    (1 (f2cl-lib:int-add i 1))
    ((1 ldvl) (1 *)))
  1)
(f2cl-lib:fdo (k 1 (f2cl-lib:int-add k 1))
  (> k n) nil)
(tagbody
  (setf (f2cl-lib:fref work-%data%
    (k)
    ((1 *))
    work-%offset%)
    (+
      (expt
        (f2cl-lib:fref vl-%data%
          (k i)
          ((1 ldvl) (1 *))
          vl-%offset%)
        2)

```



```

(expt
  (f2cl-lib:fref vl-%data%
    (k (f2cl-lib:int-add i 1))
    ((1 ldvl) (1 *)))
    vl-%offset%)
  2))))))
(setf k (idamax n work 1))
(multiple-value-bind (var-0 var-1 var-2 var-3 var-4)
  (dlartg
    (f2cl-lib:fref vl-%data%
      (k i)
      ((1 ldvl) (1 *)))
      vl-%offset%)
    (f2cl-lib:fref vl-%data%
      (k (f2cl-lib:int-add i 1))
      ((1 ldvl) (1 *)))
      vl-%offset%)
    cs sn r)
(declare (ignore var-0 var-1))
(setf cs var-2)
(setf sn var-3)
(setf r var-4)
(drot n
  (f2cl-lib:array-slice vl
    double-float
    (1 i)
    ((1 ldvl) (1 *)))
  1
  (f2cl-lib:array-slice vl
    double-float
    (1 (f2cl-lib:int-add i 1))
    ((1 ldvl) (1 *)))
  1 cs sn)
(setf (f2cl-lib:fref vl-%data%
  (k (f2cl-lib:int-add i 1))
  ((1 ldvl) (1 *)))
  vl-%offset%)
  zero))))))
(cond
  (wantvr
    (multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9)
      (dgebak balanc "R" n ilo ihi scale n vr ldvr ierr)
      (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
        var-8))
      (setf ierr var-9))

```

```

(f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
  (> i n) nil)
(tagbody
  (cond
    ((= (f2cl-lib:fref wi (i) ((1 *))) zero)
      (setf scl
        (/ one
          (dnrm2 n
            (f2cl-lib:array-slice vr
              double-float
              (1 i)
              ((1 ldvr) (1 *)))
            1)))
      (dscal n scl
        (f2cl-lib:array-slice vr
          double-float
          (1 i)
          ((1 ldvr) (1 *)))
        1))
    (> (f2cl-lib:fref wi (i) ((1 *))) zero)
      (setf scl
        (/ one
          (dlapy2
            (dnrm2 n
              (f2cl-lib:array-slice vr
                double-float
                (1 i)
                ((1 ldvr) (1 *)))
              1)
            (dnrm2 n
              (f2cl-lib:array-slice vr
                double-float
                (1 (f2cl-lib:int-add i 1))
                ((1 ldvr) (1 *)))
              1))))
      (dscal n scl
        (f2cl-lib:array-slice vr
          double-float
          (1 i)
          ((1 ldvr) (1 *)))
        1)
      (dscal n scl
        (f2cl-lib:array-slice vr
          double-float
          (1 (f2cl-lib:int-add i 1))
          ((1 ldvr) (1 *)))
        1))))

```

```

1)
(f2cl-lib:fdo (k 1 (f2cl-lib:int-add k 1))
              ((> k n) nil)
  (tagbody
    (setf (f2cl-lib:fref work-%data%
                        (k)
                        ((1 *))
                        work-%offset%)
          (+
            (expt
              (f2cl-lib:fref vr-%data%
                            (k i)
                            ((1 ldvr) (1 *))
                            vr-%offset%)
              2)
            (expt
              (f2cl-lib:fref vr-%data%
                            (k (f2cl-lib:int-add i 1))
                            ((1 ldvr) (1 *))
                            vr-%offset%)
              2))))))
(setf k (idamax n work 1))
(multiple-value-bind (var-0 var-1 var-2 var-3 var-4)
  (dlartg
   (f2cl-lib:fref vr-%data%
                 (k i)
                 ((1 ldvr) (1 *))
                 vr-%offset%)
   (f2cl-lib:fref vr-%data%
                 (k (f2cl-lib:int-add i 1))
                 ((1 ldvr) (1 *))
                 vr-%offset%)
   cs sn r)
  (declare (ignore var-0 var-1))
  (setf cs var-2)
  (setf sn var-3)
  (setf r var-4))
(drot n
  (f2cl-lib:array-slice vr
                        double-float
                        (1 i)
                        ((1 ldvr) (1 *)))
  1
  (f2cl-lib:array-slice vr
                        double-float
                        (1 (f2cl-lib:int-add i 1))

```

```

                                ((1 ldvr) (1 *)))
      1 cs sn
      (setf (f2cl-lib:fref vr-%data%
                            (k (f2cl-lib:int-add i 1))
                            ((1 ldvr) (1 *)))
            vr-%offset%)
      zero))))))
label50
  (cond
    (scalea
      (multiple-value-bind
        (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9)
        (dlascl "G" 0 0 cscale anrm (f2cl-lib:int-sub n info) 1
          (f2cl-lib:array-slice wr double-float ((+ info 1)) ((1 *)))
          (max (the fixnum (f2cl-lib:int-sub n info))
              (the fixnum 1))
          ierr)
        (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
          var-8))
        (setf ierr var-9))
      (multiple-value-bind
        (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9)
        (dlascl "G" 0 0 cscale anrm (f2cl-lib:int-sub n info) 1
          (f2cl-lib:array-slice wi double-float ((+ info 1)) ((1 *)))
          (max (the fixnum (f2cl-lib:int-sub n info))
              (the fixnum 1))
          ierr)
        (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
          var-8))
        (setf ierr var-9))
      (cond
        ((= info 0)
          (if (and (or wntsnv wntsnb) (= icond 0))
            (multiple-value-bind
              (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
              var-9)
              (dlascl "G" 0 0 cscale anrm n 1 rcondv n ierr)
              (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
              var-7 var-8))
              (setf ierr var-9))))
          (t
            (multiple-value-bind
              (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
              var-9)
              (dlascl "G" 0 0 cscale anrm (f2cl-lib:int-sub ilo 1) 1 wr n
              ierr)

```

```

      (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                    var-7 var-8))
      (setf ierr var-9))
    (multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
       var-9)
      (dlascl "G" 0 0 cscale anrm (f2cl-lib:int-sub ilo 1) 1 wi n
              ierr)
      (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                    var-7 var-8))
      (setf ierr var-9))))))
    (setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)
          (coerce (the fixnum maxwrk) 'double-float))
  end_label
  (return
   (values nil
           nil
           nil
           nil
           nil
           nil
           nil
           nil
           nil
           nil
           nil
           nil
           nil
           ilo
           ihi
           nil
           abnrm
           nil
           nil
           nil
           nil
           nil
           info))))))

```

## 7.10 dgehd2 LAPACK

```
<dgehd2.input>=  
  )set break resume  
  )sys rm -f dgehd2.output  
  )spool dgehd2.output  
  )set message test on  
  )set message auto off  
  )clear all  
  
  )spool  
  )lisp (bye)
```

`<dgehd2.help>=`

```
=====
dgehd2 examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

DGEHD2 - a real general matrix A to upper Hessenberg form H by an orthogonal similarity transformation

#### SYNOPSIS

```
SUBROUTINE DGEHD2( N, ILO, IHI, A, LDA, TAU, WORK, INFO )
```

```
      INTEGER      IHI, ILO, INFO, LDA, N
```

```
      DOUBLE      PRECISION A( LDA, * ), TAU( * ), WORK( * )
```

#### PURPOSE

DGEHD2 reduces a real general matrix A to upper Hessenberg form H by an orthogonal similarity transformation:  $Q' * A * Q = H$ .

#### ARGUMENTS

N (input) INTEGER

The order of the matrix A.  $N \geq 0$ .

ILO (input) INTEGER

IHI (input) INTEGER It is assumed that A is already upper triangular in rows and columns 1:ILO-1 and IHI+1:N. ILO and IHI are normally set by a previous call to DGEBAL; otherwise they should be set to 1 and N respectively. See Further Details.

A (input/output) DOUBLE PRECISION array, dimension (LDA,N)

On entry, the n by n general matrix to be reduced. On exit, the upper triangle and the first subdiagonal of A are overwritten with the upper Hessenberg matrix H, and the elements below the first subdiagonal, with the array TAU, represent the orthogonal matrix Q as a product of elementary reflectors. See Further Details. LDA (input) INTEGER The leading dimension of the array A.  $LDA \geq \max(1,N)$ .

TAU (output) DOUBLE PRECISION array, dimension (N-1)

The scalar factors of the elementary reflectors (see Further

Details).

WORK (workspace) DOUBLE PRECISION array, dimension (N)

INFO (output) INTEGER

= 0: successful exit.

< 0: if INFO = -i, the i-th argument had an illegal value.

#### FURTHER DETAILS

The matrix  $Q$  is represented as a product of (ihi-ilo) elementary reflectors

$$Q = H(\text{ilo}) H(\text{ilo}+1) \dots H(\text{ihi}-1).$$

Each  $H(i)$  has the form

$$H(i) = I - \tau * v * v'$$

where  $\tau$  is a real scalar, and  $v$  is a real vector with  $v(1:i) = 0$ ,  $v(i+1) = 1$  and  $v(\text{ihi}+1:n) = 0$ ;  $v(i+2:\text{ihi})$  is stored on exit in  $A(i+2:\text{ihi}, i)$ , and  $\tau$  in  $\text{TAU}(i)$ .

The contents of  $A$  are illustrated by the following example, with  $n = 7$ ,  $\text{ilo} = 2$  and  $\text{ihi} = 6$ :

on entry,

on exit,

```
( a  a  a  a  a  a  a ) ( a  a  h  h  h  h  a ) ( a
a  a  a  a  a  a ) ( a  h  h  h  h  a ) ( a  a  a
a  a  a ) ( h  h  h  h  h  h ) ( a  a  a  a  a
a ) ( v2  h  h  h  h  h ) ( a  a  a  a  a  a )
( v2  v3  h  h  h  h ) ( a  a  a  a  a  a ) (
v2  v3  v4  h  h  h ) ( a ) (
a )
```

where  $a$  denotes an element of the original matrix  $A$ ,  $h$  denotes a modified element of the upper Hessenberg matrix  $H$ , and  $v_i$  denotes an element of the vector defining  $H(i)$ .



```

(LAPACK dgehd2)≡
  (let* ((one 1.0))
    (declare (type (double-float 1.0 1.0) one))
    (defun dgehd2 (n ilo ihi a lda tau work info)
      (declare (type (simple-array double-float (*)) work tau a)
        (type fixnum info lda ihi ilo n))
      (f2cl-lib:with-multi-array-data
        ((a double-float a-%data% a-%offset%)
         (tau double-float tau-%data% tau-%offset%)
         (work double-float work-%data% work-%offset%))
        (prog ((a1i 0.0) (i 0))
          (declare (type (double-float) a1i) (type fixnum i))
          (setf info 0)
          (cond
            ((< n 0)
              (setf info -1))
            ((or (< ilo 1)
                  (> ilo
                    (max (the fixnum 1) (the fixnum n))))
              (setf info -2))
            ((or
              (< ihi (min (the fixnum ilo) (the fixnum n)))
              (> ihi n))
              (setf info -3))
            ((< lda (max (the fixnum 1) (the fixnum n)))
              (setf info -5)))
          (cond
            ((/= info 0)
              (error
                " ** On entry to ~a parameter number ~a had an illegal value~%"
                "DGEHD2" (f2cl-lib:int-sub info))
              (go end_label)))
          (f2cl-lib:fdo (i ilo (f2cl-lib:int-add i 1))
            ((> i (f2cl-lib:int-add ihi (f2cl-lib:int-sub 1))) nil)
            (tagbody
              (multiple-value-bind (var-0 var-1 var-2 var-3 var-4)
                (dlarf (f2cl-lib:int-sub ihi i)
                  (f2cl-lib:fref a-%data%
                                ((f2cl-lib:int-add i 1) i)
                                ((1 lda) (1 *))
                                a-%offset%)
                  (f2cl-lib:array-slice a
                                        double-float
                                        ((min (f2cl-lib:int-add i 2) n) i)
                                        ((1 lda) (1 *)))
                    1 (f2cl-lib:fref tau-%data% (i) ((1 *)) tau-%offset%))

```

```

      (declare (ignore var-0 var-2 var-3))
      (setf (f2cl-lib:fref a-%data%
                          ((f2cl-lib:int-add i 1) i)
                          ((1 lda) (1 *)))
            a-%offset%)

      var-1)
      (setf (f2cl-lib:fref tau-%data% (i) ((1 *)) tau-%offset%) var-4))
      (setf aii
            (f2cl-lib:fref a-%data%
                          ((f2cl-lib:int-add i 1) i)
                          ((1 lda) (1 *)))
            a-%offset%))
      (setf (f2cl-lib:fref a-%data%
                          ((f2cl-lib:int-add i 1) i)
                          ((1 lda) (1 *)))
            a-%offset%)

      one)
      (dlarf "Right" ihi (f2cl-lib:int-sub ihi i)
            (f2cl-lib:array-slice a double-float ((+ i 1) i) ((1 lda) (1 *)))
            1 (f2cl-lib:fref tau-%data% (i) ((1 *)) tau-%offset%)
            (f2cl-lib:array-slice a
                                  double-float
                                  (1 (f2cl-lib:int-add i 1))
                                  ((1 lda) (1 *))))

      lda work)
      (dlarf "Left" (f2cl-lib:int-sub ihi i) (f2cl-lib:int-sub n i)
            (f2cl-lib:array-slice a double-float ((+ i 1) i) ((1 lda) (1 *)))
            1 (f2cl-lib:fref tau-%data% (i) ((1 *)) tau-%offset%)
            (f2cl-lib:array-slice a
                                  double-float
                                  ((+ i 1) (f2cl-lib:int-add i 1))
                                  ((1 lda) (1 *))))

      lda work)
      (setf (f2cl-lib:fref a-%data%
                          ((f2cl-lib:int-add i 1) i)
                          ((1 lda) (1 *)))
            a-%offset%)

      aii)))

end_label
      (return (values nil nil nil nil nil nil nil info))))))

```

## 7.11 dgehrd LAPACK

```
<dgehrd.input>=  
  )set break resume  
  )sys rm -f dgehrd.output  
  )spool dgehrd.output  
  )set message test on  
  )set message auto off  
  )clear all  
  
  )spool  
  )lisp (bye)
```

`<dgehrd.help>=`

```
=====
dgehrd examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

DGEHRD - Reduce a real general matrix A to upper Hessenberg form H by an orthogonal similarity transformation

#### SYNOPSIS

```
SUBROUTINE DGEHRD( N, ILO, IHI, A, LDA, TAU, WORK, LWORK, INFO )
```

```
      INTEGER          IHI, ILO, INFO, LDA, LWORK, N
```

```
      DOUBLE           PRECISION A( LDA, * ), TAU( * ), WORK( * )
```

#### PURPOSE

DGEHRD reduces a real general matrix A to upper Hessenberg form H by an orthogonal similarity transformation:  $Q' * A * Q = H$ .

#### ARGUMENTS

N (input) INTEGER

The order of the matrix A.  $N \geq 0$ .

ILO (input) INTEGER

IHI (input) INTEGER It is assumed that A is already upper triangular in rows and columns 1:ILO-1 and IHI+1:N. ILO and IHI are normally set by a previous call to DGEBAL; otherwise they should be set to 1 and N respectively. See Further Details.

A (input/output) DOUBLE PRECISION array, dimension (LDA,N)

On entry, the N-by-N general matrix to be reduced. On exit, the upper triangle and the first subdiagonal of A are overwritten with the upper Hessenberg matrix H, and the elements below the first subdiagonal, with the array TAU, represent the orthogonal matrix Q as a product of elementary reflectors. See Further Details. LDA (input) INTEGER The leading dimension of the array A.  $LDA \geq \max(1,N)$ .

TAU (output) DOUBLE PRECISION array, dimension (N-1)

The scalar factors of the elementary reflectors (see Further

Details). Elements 1:ILO-1 and IHI:N-1 of TAU are set to zero.

**WORK** (workspace/output) DOUBLE PRECISION array, dimension (LWORK)  
On exit, if INFO = 0, WORK(1) returns the optimal LWORK.

**LWORK** (input) INTEGER  
The length of the array WORK. LWORK  $\geq \max(1, N)$ . For optimum performance LWORK  $\geq N \cdot \text{NB}$ , where NB is the optimal blocksize.

If LWORK = -1, then a workspace query is assumed; the routine only calculates the optimal size of the WORK array, returns this value as the first entry of the WORK array, and no error message related to LWORK is issued by XERBLA.

**INFO** (output) INTEGER  
= 0: successful exit  
< 0: if INFO = -i, the i-th argument had an illegal value.

#### FURTHER DETAILS

The matrix Q is represented as a product of (ihi-ilo) elementary reflectors

$$Q = H(\text{ilo}) H(\text{ilo}+1) \dots H(\text{ihi}-1).$$

Each H(i) has the form

$$H(i) = I - \tau * v * v'$$

where tau is a real scalar, and v is a real vector with  $v(1:i) = 0$ ,  $v(i+1) = 1$  and  $v(\text{ihi}+1:n) = 0$ ;  $v(i+2:\text{ihi})$  is stored on exit in A(i+2:ihi,i), and tau in TAU(i).

The contents of A are illustrated by the following example, with  $n = 7$ , ilo = 2 and ihi = 6:

on entry,

on exit,

```
( a  a  a  a  a  a  a )  ( a  a  h  h  h  h  a )  (  a
a  a  a  a  a  a )      (  a  h  h  h  h  a )  (  a  a  a
a  a  a )              (  h  h  h  h  h  h )  (  a  a  a  a  a
a )                    (  v2 h  h  h  h  h )  (  a  a  a  a  a  a )
(  v2 v3 h  h  h  h )  (  a  a  a  a  a  a )  (
v2 v3 v4 h  h  h )  (  a )  (
a )
```

where a denotes an element of the original matrix A, h denotes a modi-

fied element of the upper Hessenberg matrix  $H$ , and  $v_i$  denotes an element of the vector defining  $H(i)$ .

See Quintana-Orti and Van de Geijn (2005).

```

(LAPACK dgehrd)≡
  (let* ((nbmax 64) (ldt (+ nbmax 1)) (zero 0.0) (one 1.0))
    (declare (type (fixnum 64 64) nbmax)
              (type fixnum ldt)
              (type (double-float 0.0 0.0) zero)
              (type (double-float 1.0 1.0) one))
    (defun dgehrd (n ilo ihi a lda tau work lwork info)
      (declare (type (simple-array double-float (*)) work tau a)
                (type fixnum info lwork lda ihi ilo n))
      (f2cl-lib:with-multi-array-data
        ((a double-float a-%data% a-%offset%)
         (tau double-float tau-%data% tau-%offset%)
         (work double-float work-%data% work-%offset%))
        (prog ((ei 0.0) (i 0) (ib 0) (iinfo 0) (iws 0) (ldwork 0) (lwkopt 0)
              (nb 0) (nbmin 0) (nh 0) (nx 0) (lquery nil)
              (t$
                (make-array (the fixnum (reduce #'* (list ldt nbmax)))
                           :element-type 'double-float)))
              (declare (type (simple-array double-float (*)) t$)
                        (type (double-float) ei)
                        (type fixnum i ib iinfo iws ldwork lwkopt nb
                               nbmin nh nx)
                        (type (member t nil) lquery))
              (setf info 0)
              (setf nb
                (min (the fixnum nbmax)
                     (the fixnum
                      (ilaenv 1 "DGEHRD" " " " n ilo ihi -1))))
              (setf lwkopt (f2cl-lib:int-mul n nb))
              (setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)
                (coerce (the fixnum lwkopt) 'double-float))
              (setf lquery (coerce (= lwork -1) '(member t nil))))
      (cond
        ((< n 0)
         (setf info -1))
        ((or (< ilo 1)
              (> ilo
               (max (the fixnum 1) (the fixnum n))))
         (setf info -2))
        ((or
          (< ihi (min (the fixnum ilo) (the fixnum n)))
          (> ihi n))
         (setf info -3))
        ((< lda (max (the fixnum 1) (the fixnum n)))
         (setf info -5))
        ((and

```

```

        (< lwork (max (the fixnum 1) (the fixnum n)))
        (not lquery))
        (setf info -8)))
(cond
  ((/= info 0)
   (error
    " ** On entry to ~a parameter number ~a had an illegal value~%"
    "DGEHRD" (f2cl-lib:int-sub info))
   (go end_label))
  (lquery
   (go end_label)))
(f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
  ((> i (f2cl-lib:int-add ilo (f2cl-lib:int-sub 1))) nil)
  (tagbody
   (setf (f2cl-lib:fref tau-%data% (i) ((1 *)) tau-%offset%) zero)))
(f2cl-lib:fdo (i
  (max (the fixnum 1)
        (the fixnum ihi))
  (f2cl-lib:int-add i 1))
  ((> i (f2cl-lib:int-add n (f2cl-lib:int-sub 1))) nil)
  (tagbody
   (setf (f2cl-lib:fref tau-%data% (i) ((1 *)) tau-%offset%) zero)))
(setf nh (f2cl-lib:int-add (f2cl-lib:int-sub ihi ilo) 1))
(cond
  ((<= nh 1)
   (setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)
         (coerce (the fixnum 1) 'double-float))
   (go end_label)))
(setf nb
  (min (the fixnum nbmax)
        (the fixnum
         (ilaenv 1 "DGEHRD" " " n ilo ihi -1))))
(setf nbmin 2)
(setf iws 1)
(cond
  ((and (> nb 1) (< nb nh))
   (setf nx
    (max (the fixnum nb)
          (the fixnum
           (ilaenv 3 "DGEHRD" " " n ilo ihi -1))))
   (cond
    ((< nx nh)
     (setf iws (f2cl-lib:int-mul n nb))
     (cond
      ((< lwork iws)
       (setf nbmin

```



```

(max (the fixnum 2)
  (the fixnum
    (ilaenv 2 "DGEHRD" " " " n ilo ihi -1))))
(cond
  ((>= lwork (f2cl-lib:int-mul n nbmin))
   (setf nb (the fixnum (truncate lwork n))))
  (t
   (setf nb 1))))))
(setf ldwork n)
(cond
  ((or (< nb nbmin) (>= nb nh))
   (setf i ilo))
  (t
   (f2cl-lib:fdo (i ilo (f2cl-lib:int-add i nb))
     (> i
      (f2cl-lib:int-add ihi
        (f2cl-lib:int-sub 1)
        (f2cl-lib:int-sub nx)))
     nil)
   (tagbody
    (setf ib
      (min (the fixnum nb)
        (the fixnum (f2cl-lib:int-sub ihi i))))
    (dlahrd ihi i ib
      (f2cl-lib:array-slice a double-float (1 i) ((1 lda) (1 *))) lda
      (f2cl-lib:array-slice tau double-float (i) ((1 *))) t$ ldt work
      ldwork)
    (setf ei
      (f2cl-lib:fref a-%data%
        ((f2cl-lib:int-add i ib)
         (f2cl-lib:int-sub
          (f2cl-lib:int-add i ib)
          1))
        ((1 lda) (1 *))
        a-%offset%))
    (setf (f2cl-lib:fref a-%data%
      ((f2cl-lib:int-add i ib)
       (f2cl-lib:int-sub (f2cl-lib:int-add i ib)
        1))
      ((1 lda) (1 *))
      a-%offset%)
      one)
    (dgemm "No transpose" "Transpose" ihi
      (f2cl-lib:int-add (f2cl-lib:int-sub ihi i ib) 1) ib (- one)
      work ldwork
      (f2cl-lib:array-slice a

```

```

                                double-float
                                ((+ i ib) i)
                                ((1 lda) (1 *)))

lda one
(f2cl-lib:array-slice a
  double-float
  (1 (f2cl-lib:int-add i ib))
  ((1 lda) (1 *)))

lda)
(setf (f2cl-lib:fref a-%data%
  ((f2cl-lib:int-add i ib)
   (f2cl-lib:int-sub (f2cl-lib:int-add i ib)
    1))
  ((1 lda) (1 *))
  a-%offset%)

ei)
(dlarfb "Left" "Transpose" "Forward" "Columnwise"
  (f2cl-lib:int-sub ihi i)
  (f2cl-lib:int-add (f2cl-lib:int-sub n i ib) 1) ib
  (f2cl-lib:array-slice a
    double-float
    ((+ i 1) i)
    ((1 lda) (1 *)))

lda t$ ldt
(f2cl-lib:array-slice a
  double-float
  ((+ i 1) (f2cl-lib:int-add i ib))
  ((1 lda) (1 *)))

lda work ldwork))))))
(multiple-value-bind (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7)
  (dgehd2 n i ihi a lda tau work iinfo)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6))
  (setf iinfo var-7))
(setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)
  (coerce (the fixnum iws) 'double-float))

end_label
(return (values nil nil nil nil nil nil nil info))))))

```

## 7.12 dgelq2 LAPACK

```
<dgelq2.input>≡  
  )set break resume  
  )sys rm -f dgelq2.output  
  )spool dgelq2.output  
  )set message test on  
  )set message auto off  
  )clear all  
  
  )spool  
  )lisp (bye)
```

`<dgelq2.help>=`

```
=====
dgelq2 examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

DGELQ2 - an LQ factorization of a real m by n matrix A

#### SYNOPSIS

```
SUBROUTINE DGELQ2( M, N, A, LDA, TAU, WORK, INFO )
```

```
      INTEGER      INFO, LDA, M, N
```

```
      DOUBLE      PRECISION A( LDA, * ), TAU( * ), WORK( * )
```

#### PURPOSE

DGELQ2 computes an LQ factorization of a real m by n matrix A:  $A = L * Q$ .

#### ARGUMENTS

M (input) INTEGER

The number of rows of the matrix A.  $M \geq 0$ .

N (input) INTEGER

The number of columns of the matrix A.  $N \geq 0$ .

A (input/output) DOUBLE PRECISION array, dimension (LDA,N)

On entry, the m by n matrix A. On exit, the elements on and below the diagonal of the array contain the m by min(m,n) lower trapezoidal matrix L (L is lower triangular if  $m \leq n$ ); the elements above the diagonal, with the array TAU, represent the orthogonal matrix Q as a product of elementary reflectors (see Further Details). LDA (input) INTEGER The leading dimension of the array A.  $LDA \geq \max(1,M)$ .

TAU (output) DOUBLE PRECISION array, dimension (min(M,N))

The scalar factors of the elementary reflectors (see Further Details).

WORK (workspace) DOUBLE PRECISION array, dimension (M)

INFO      (output) INTEGER  
          = 0: successful exit  
          < 0: if INFO = -i, the i-th argument had an illegal value

#### FURTHER DETAILS

The matrix Q is represented as a product of elementary reflectors

$$Q = H(k) \dots H(2) H(1), \text{ where } k = \min(m, n).$$

Each  $H(i)$  has the form

$$H(i) = I - \tau * v * v'$$

where  $\tau$  is a real scalar, and  $v$  is a real vector with  
 $v(1:i-1) = 0$  and  $v(i) = 1$ ;  $v(i+1:n)$  is stored on exit in  $A(i, i+1:n)$ ,  
and  $\tau$  in  $TAU(i)$ .

```

(LAPACK dgelq2)=
  (let* ((one 1.0))
    (declare (type (double-float 1.0 1.0) one))
    (defun dgelq2 (m n a lda tau work info)
      (declare (type (simple-array double-float (*)) work tau a)
        (type fixnum info lda n m))
      (f2cl-lib:with-multi-array-data
        ((a double-float a-%data% a-%offset%)
         (tau double-float tau-%data% tau-%offset%)
         (work double-float work-%data% work-%offset%))
        (prog ((a1i 0.0) (i 0) (k 0))
          (declare (type (double-float) a1i) (type fixnum i k))
          (setf info 0)
          (cond
            ((< m 0)
              (setf info -1))
            ((< n 0)
              (setf info -2))
            ((< lda (max (the fixnum 1) (the fixnum m)))
              (setf info -4)))
          (cond
            ((/= info 0)
              (error
                " ** On entry to ~a parameter number ~a had an illegal value~%"
                "DGELQ2" (f2cl-lib:int-sub info))
              (go end_label)))
          (setf k (min (the fixnum m) (the fixnum n)))
          (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
            ((> i k) nil)
            (tagbody
              (multiple-value-bind (var-0 var-1 var-2 var-3 var-4)
                (dlarf (f2cl-lib:int-add (f2cl-lib:int-sub n i) 1)
                  (f2cl-lib:fref a-%data% (i i) ((1 lda) (1 *)) a-%offset%)
                  (f2cl-lib:array-slice a
                    double-float
                    (i
                      (min
                        (the fixnum
                          (f2cl-lib:int-add i 1))
                        (the fixnum n)))
                    ((1 lda) (1 *)))
                  lda (f2cl-lib:fref tau-%data% (i) ((1 *)) tau-%offset%))
                (declare (ignore var-0 var-2 var-3))
                (setf (f2cl-lib:fref a-%data% (i i) ((1 lda) (1 *)) a-%offset%)
                  var-1)
                (setf (f2cl-lib:fref tau-%data% (i) ((1 *)) tau-%offset%) var-4)))
          (end_label)))
    )
  )

```

```

(cond
  (< i m)
  (setf aii
    (f2cl-lib:fref a-%data%
      (i i)
      ((1 lda) (1 *))
      a-%offset%))
  (setf (f2cl-lib:fref a-%data% (i i) ((1 lda) (1 *)) a-%offset%
    one)
    (dlarf "Right" (f2cl-lib:int-sub m i)
      (f2cl-lib:int-add (f2cl-lib:int-sub n i) 1)
      (f2cl-lib:array-slice a double-float (i i) ((1 lda) (1 *))) lda
      (f2cl-lib:fref tau-%data% (i) ((1 *)) tau-%offset%)
      (f2cl-lib:array-slice a
        double-float
        ((+ i 1) i)
        ((1 lda) (1 *)))
      lda work)
  (setf (f2cl-lib:fref a-%data% (i i) ((1 lda) (1 *)) a-%offset%
    aii))))
end_label
(return (values nil nil nil nil nil nil info))))))

```

### 7.13 dgelqf LAPACK

```

⟨dgelqf.input⟩≡
)set break resume
)sys rm -f dgelqf.output
)spool dgelqf.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)

```

`<dgelqf.help>`≡

```
=====
dgelqf examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

DGELQF - an LQ factorization of a real M-by-N matrix A

#### SYNOPSIS

```
SUBROUTINE DGELQF( M, N, A, LDA, TAU, WORK, LWORK, INFO )
```

```
      INTEGER          INFO, LDA, LWORK, M, N
```

```
      DOUBLE           PRECISION A( LDA, * ), TAU( * ), WORK( * )
```

#### PURPOSE

DGELQF computes an LQ factorization of a real M-by-N matrix A:  $A = L * Q$ .

#### ARGUMENTS

M (input) INTEGER

The number of rows of the matrix A.  $M \geq 0$ .

N (input) INTEGER

The number of columns of the matrix A.  $N \geq 0$ .

A (input/output) DOUBLE PRECISION array, dimension (LDA,N)

On entry, the M-by-N matrix A. On exit, the elements on and below the diagonal of the array contain the m-by-min(m,n) lower trapezoidal matrix L (L is lower triangular if  $m \leq n$ ); the elements above the diagonal, with the array TAU, represent the orthogonal matrix Q as a product of elementary reflectors (see Further Details). LDA (input) INTEGER The leading dimension of the array A.  $LDA \geq \max(1,M)$ .

TAU (output) DOUBLE PRECISION array, dimension (min(M,N))

The scalar factors of the elementary reflectors (see Further Details).

WORK (workspace/output) DOUBLE PRECISION array, dimension (MAX(1,LWORK))



On exit, if INFO = 0, WORK(1) returns the optimal LWORK.

**LWORK** (input) INTEGER  
The dimension of the array WORK. LWORK  $\geq \max(1, M)$ . For optimum performance LWORK  $\geq M \cdot \text{NB}$ , where NB is the optimal block-size.

If LWORK = -1, then a workspace query is assumed; the routine only calculates the optimal size of the WORK array, returns this value as the first entry of the WORK array, and no error message related to LWORK is issued by XERBLA.

**INFO** (output) INTEGER  
= 0: successful exit  
< 0: if INFO = -i, the i-th argument had an illegal value

#### FURTHER DETAILS

The matrix Q is represented as a product of elementary reflectors

$$Q = H(k) \dots H(2) H(1), \text{ where } k = \min(m, n).$$

Each H(i) has the form

$$H(i) = I - \tau * v * v'$$

where tau is a real scalar, and v is a real vector with  $v(1:i-1) = 0$  and  $v(i) = 1$ ;  $v(i+1:n)$  is stored on exit in A(i, i+1:n), and tau in TAU(i).

```

(LAPACK dgelqf)≡
(defun dgelqf (m n a lda tau work lwork info)
  (declare (type (simple-array double-float (*)) work tau a)
    (type fixnum info lwork lda n m))
  (f2cl-lib:with-multi-array-data
    ((a double-float a-%data% a-%offset%)
     (tau double-float tau-%data% tau-%offset%)
     (work double-float work-%data% work-%offset%))
    (prog ((i 0) (ib 0) (iinfo 0) (iws 0) (k 0) (ldwork 0) (lwkopt 0) (nb 0)
      (nbmin 0) (nx 0) (lquery nil))
      (declare (type (member t nil) lquery)
        (type fixnum nx nbmin nb lwkopt ldwork k iws iinfo
          ib i))

      (setf info 0)
      (setf nb (ilaenv 1 "DGELQF" " " m n -1 -1))
      (setf lwkopt (f2cl-lib:int-mul m nb))
      (setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)
        (coerce (the fixnum lwkopt) 'double-float))
      (setf lquery (coerce (= lwork -1) '(member t nil)))
      (cond
        ((< m 0)
          (setf info -1))
        ((< n 0)
          (setf info -2))
        ((< lda (max (the fixnum 1) (the fixnum m)))
          (setf info -4))
        ((and
          (< lwork (max (the fixnum 1) (the fixnum m)))
          (not lquery))
          (setf info -7)))
      (cond
        ((/= info 0)
          (error
            " ** On entry to ~a parameter number ~a had an illegal value~%"
            "DGELQF" (f2cl-lib:int-sub info))
          (go end_label))
        (lquery
          (go end_label)))
      (setf k (min (the fixnum m) (the fixnum n)))
      (cond
        ((= k 0)
          (setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)
            (coerce (the fixnum 1) 'double-float))
          (go end_label)))
      (setf nbmin 2)
      (setf nx 0)

```

```

(setf iws m)
(cond
  ((and (> nb 1) (< nb k))
    (setf nx
      (max (the fixnum 0)
            (the fixnum
              (ilaenv 3 "DGELQF" " " " m n -1 -1)))))
  (cond
    ((< nx k)
      (setf ldwork m)
      (setf iws (f2cl-lib:int-mul ldwork nb))
      (cond
        ((< lwork iws)
          (setf nb (the fixnum (truncate lwork ldwork)))
          (setf nbmin
            (max (the fixnum 2)
                  (the fixnum
                    (ilaenv 2 "DGELQF" " " " m n -1 -1))))))))))
  (cond
    ((and (>= nb nbmin) (< nb k) (< nx k))
      (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i nb))
        ((> i (f2cl-lib:int-add k (f2cl-lib:int-sub nx))) nil)
      (tagbody
        (setf ib
          (min
            (the fixnum
              (f2cl-lib:int-add (f2cl-lib:int-sub k i) 1))
            (the fixnum nb)))
        (multiple-value-bind (var-0 var-1 var-2 var-3 var-4 var-5 var-6)
          (dgelq2 ib (f2cl-lib:int-add (f2cl-lib:int-sub n i) 1)
            (f2cl-lib:array-slice a double-float (i i) ((1 lda) (1 *)))
            lda (f2cl-lib:array-slice tau double-float (i) ((1 *))) work
            iinfo)
          (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5))
          (setf iinfo var-6))
        (cond
          ((<= (f2cl-lib:int-add i ib) m)
            (dlarft "Forward" "Rowwise"
              (f2cl-lib:int-add (f2cl-lib:int-sub n i) 1) ib
              (f2cl-lib:array-slice a double-float (i i) ((1 lda) (1 *)))
              lda (f2cl-lib:array-slice tau double-float (i) ((1 *))) work
              ldwork)
            (dlarfb "Right" "No transpose" "Forward" "Rowwise"
              (f2cl-lib:int-add (f2cl-lib:int-sub m i ib) 1)
              (f2cl-lib:int-add (f2cl-lib:int-sub n i) 1) ib
              (f2cl-lib:array-slice a double-float (i i) ((1 lda) (1 *)))

```

```

        lda work ldwork
        (f2cl-lib:array-slice a
          double-float
          ((+ i ib) i)
          ((1 lda) (1 *)))

        lda
        (f2cl-lib:array-slice work double-float ((+ ib 1)) ((1 *)))
        ldwork))))))

    (t
      (setf i 1)))
  (if (<= i k)
    (multiple-value-bind (var-0 var-1 var-2 var-3 var-4 var-5 var-6)
      (dge1q2 (f2cl-lib:int-add (f2cl-lib:int-sub m i) 1)
        (f2cl-lib:int-add (f2cl-lib:int-sub n i) 1)
        (f2cl-lib:array-slice a double-float (i i) ((1 lda) (1 *))) lda
        (f2cl-lib:array-slice tau double-float (i) ((1 *))) work iinfo)
      (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5))
      (setf iinfo var-6)))
    (setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)
      (coerce (the fixnum iws) 'double-float))
  end_label
  (return (values nil nil nil nil nil nil nil info))))))

```

## 7.14 dgeqr2 LAPACK

```

⟨dgeqr2.input⟩≡
)set break resume
)sys rm -f dgeqr2.output
)spool dgeqr2.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)

```

`<dgeqr2.help>=`

```
=====
dgeqr2 examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

DGEQR2 - a QR factorization of a real m by n matrix A

#### SYNOPSIS

```
SUBROUTINE DGEQR2( M, N, A, LDA, TAU, WORK, INFO )
```

```
      INTEGER          INFO, LDA, M, N
```

```
      DOUBLE          PRECISION A( LDA, * ), TAU( * ), WORK( * )
```

#### PURPOSE

DGEQR2 computes a QR factorization of a real m by n matrix A:  $A = Q * R$ .

#### ARGUMENTS

M (input) INTEGER  
The number of rows of the matrix A.  $M \geq 0$ .

N (input) INTEGER  
The number of columns of the matrix A.  $N \geq 0$ .

A (input/output) DOUBLE PRECISION array, dimension (LDA,N)  
On entry, the m by n matrix A. On exit, the elements on and above the diagonal of the array contain the min(m,n) by n upper trapezoidal matrix R (R is upper triangular if  $m \geq n$ ); the elements below the diagonal, with the array TAU, represent the orthogonal matrix Q as a product of elementary reflectors (see Further Details). LDA (input) INTEGER The leading dimension of the array A.  $LDA \geq \max(1,M)$ .

TAU (output) DOUBLE PRECISION array, dimension (min(M,N))  
The scalar factors of the elementary reflectors (see Further Details).

WORK (workspace) DOUBLE PRECISION array, dimension (N)

INFO      (output) INTEGER  
          = 0: successful exit  
          < 0: if INFO = -i, the i-th argument had an illegal value

#### FURTHER DETAILS

The matrix Q is represented as a product of elementary reflectors

$$Q = H(1) H(2) \dots H(k), \text{ where } k = \min(m,n).$$

Each H(i) has the form

$$H(i) = I - \tau * v * v'$$

where tau is a real scalar, and v is a real vector with  
 $v(1:i-1) = 0$  and  $v(i) = 1$ ;  $v(i+1:m)$  is stored on exit in  $A(i+1:m,i)$ ,  
and tau in TAU(i).

```

(LAPACK dgeqr2)≡
  (let* ((one 1.0))
    (declare (type (double-float 1.0 1.0) one))
    (defun dgeqr2 (m n a lda tau work info)
      (declare (type (simple-array double-float (*)) work tau a)
        (type fixnum info lda n m))
      (f2cl-lib:with-multi-array-data
        ((a double-float a-%data% a-%offset%)
         (tau double-float tau-%data% tau-%offset%)
         (work double-float work-%data% work-%offset%))
        (prog ((aii 0.0) (i 0) (k 0))
          (declare (type (double-float) aii) (type fixnum i k))
          (setf info 0)
          (cond
            ((< m 0)
              (setf info -1))
            ((< n 0)
              (setf info -2))
            ((< lda (max (the fixnum 1) (the fixnum m)))
              (setf info -4)))
          (cond
            ((/= info 0)
              (error
                " ** On entry to ~a parameter number ~a had an illegal value~%"
                "DGEQR2" (f2cl-lib:int-sub info))
              (go end_label)))
          (setf k (min (the fixnum m) (the fixnum n)))
          (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
            ((> i k) nil)
            (tagbody
              (multiple-value-bind (var-0 var-1 var-2 var-3 var-4)
                (dlarfg (f2cl-lib:int-add (f2cl-lib:int-sub m i) 1)
                  (f2cl-lib:fref a-%data% (i i) ((1 lda) (1 *)) a-%offset%)
                  (f2cl-lib:array-slice a
                    double-float
                    ((min (f2cl-lib:int-add i 1) m) i)
                    ((1 lda) (1 *))))
                1 (f2cl-lib:fref tau-%data% (i) ((1 *)) tau-%offset%))
              (declare (ignore var-0 var-2 var-3))
              (setf (f2cl-lib:fref a-%data% (i i) ((1 lda) (1 *)) a-%offset%)
                var-1)
              (setf (f2cl-lib:fref tau-%data% (i) ((1 *)) tau-%offset%) var-4))
              (cond
                ((< i n)
                  (setf aii
                    (f2cl-lib:fref a-%data%

```

```

                                (i i)
                                ((1 lda) (1 *))
                                a-%offset%)
(setf (f2cl-lib:fref a-%data% (i i) ((1 lda) (1 *)) a-%offset%
      one)
      (dlarf "Left" (f2cl-lib:int-add (f2cl-lib:int-sub m i) 1)
        (f2cl-lib:int-sub n i)
        (f2cl-lib:array-slice a double-float (i i) ((1 lda) (1 *))) 1
        (f2cl-lib:fref tau-%data% (i) ((1 *)) tau-%offset%)
        (f2cl-lib:array-slice a
          double-float
          (i (f2cl-lib:int-add i 1))
          ((1 lda) (1 *)))
      lda work)
(setf (f2cl-lib:fref a-%data% (i i) ((1 lda) (1 *)) a-%offset%
      aii))))
end_label
      (return (values nil nil nil nil nil nil info))))))

```

## 7.15 dgeqrf LAPACK

```

⟨dgeqrf.input⟩≡
)set break resume
)sys rm -f dgeqrf.output
)spool dgeqrf.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)

```



`<dgeqrf.help>`≡

```
=====
dgeqrf examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

DGEQRF - a QR factorization of a real M-by-N matrix A

#### SYNOPSIS

```
SUBROUTINE DGEQRF( M, N, A, LDA, TAU, WORK, LWORK, INFO )
```

```
          INTEGER          INFO, LDA, LWORK, M, N
```

```
          DOUBLE          PRECISION A( LDA, * ), TAU( * ), WORK( * )
```

#### PURPOSE

DGEQRF computes a QR factorization of a real M-by-N matrix A:  $A = Q * R$ .

#### ARGUMENTS

M	(input) INTEGER The number of rows of the matrix A. $M \geq 0$ .
N	(input) INTEGER The number of columns of the matrix A. $N \geq 0$ .
A	(input/output) DOUBLE PRECISION array, dimension (LDA,N) On entry, the M-by-N matrix A. On exit, the elements on and above the diagonal of the array contain the min(M,N)-by-N upper trapezoidal matrix R (R is upper triangular if $m \geq n$ ); the elements below the diagonal, with the array TAU, represent the orthogonal matrix Q as a product of min(m,n) elementary reflectors (see Further Details).
LDA	(input) INTEGER The leading dimension of the array A. $LDA \geq \max(1,M)$ .
TAU	(output) DOUBLE PRECISION array, dimension (min(M,N)) The scalar factors of the elementary reflectors (see Further Details).

WORK (workspace/output) DOUBLE PRECISION array, dimension  
(MAX(1,LWORK))

On exit, if INFO = 0, WORK(1) returns the optimal LWORK.

LWORK (input) INTEGER

The dimension of the array WORK. LWORK  $\geq \max(1,N)$ . For optimum performance LWORK  $\geq N \cdot NB$ , where NB is the optimal block-size.

If LWORK = -1, then a workspace query is assumed; the routine only calculates the optimal size of the WORK array, returns this value as the first entry of the WORK array, and no error message related to LWORK is issued by XERBLA.

INFO (output) INTEGER

= 0: successful exit

< 0: if INFO = -i, the i-th argument had an illegal value

#### FURTHER DETAILS

The matrix Q is represented as a product of elementary reflectors

$$Q = H(1) H(2) \dots H(k), \text{ where } k = \min(m,n).$$

Each H(i) has the form

$$H(i) = I - \tau * v * v'$$

where tau is a real scalar, and v is a real vector with  
v(1:i-1) = 0 and v(i) = 1; v(i+1:m) is stored on exit in A(i+1:m,i),  
and tau in TAU(i).

```

(LAPACK dgeqrf)=
  (defun dgeqrf (m n lda tau work lwork info)
    (declare (type (simple-array double-float (*)) work tau a)
              (type fixnum info lwork lda n m))
    (f2cl-lib:with-multi-array-data
      ((a double-float a-%data% a-%offset%)
       (tau double-float tau-%data% tau-%offset%)
       (work double-float work-%data% work-%offset%))
      (prog ((i 0) (ib 0) (iinfo 0) (iws 0) (k 0) (ldwork 0) (lwkopt 0) (nb 0)
              (nbmin 0) (nx 0) (lquery nil))
        (declare (type (member t nil) lquery)
                  (type fixnum nx nbmin nb lwkopt ldwork k iws iinfo
                              ib i))

        (setf info 0)
        (setf nb (ilaenv 1 "DGEQRF" " " m n -1 -1))
        (setf lwkopt (f2cl-lib:int-mul n nb))
        (setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)
              (coerce (the fixnum lwkopt) 'double-float))
        (setf lquery (coerce (= lwork -1) '(member t nil)))
        (cond
          ((< m 0)
            (setf info -1))
          ((< n 0)
            (setf info -2))
          ((< lda (max (the fixnum 1) (the fixnum m)))
            (setf info -4))
          ((and
            (< lwork (max (the fixnum 1) (the fixnum n)))
            (not lquery))
            (setf info -7)))
        (cond
          ((/= info 0)
            (error
              " ** On entry to ~a parameter number ~a had an illegal value~%"
              "DGEQRF" (f2cl-lib:int-sub info))
            (go end_label))
          (lquery
            (go end_label))))
        (setf k (min (the fixnum m) (the fixnum n)))
        (cond
          ((= k 0)
            (setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)
                  (coerce (the fixnum 1) 'double-float))
            (go end_label)))
        (setf nbmin 2)
        (setf nx 0)

```

```

(setf iws n)
(cond
  ((and (> nb 1) (< nb k))
    (setf nx
      (max (the fixnum 0)
            (the fixnum
              (ilaenv 3 "DGEQRF" " " " m n -1 -1))))))
  (cond
    ((< nx k)
      (setf ldwork n)
      (setf iws (f2cl-lib:int-mul ldwork nb))
      (cond
        ((< lwork iws)
          (setf nb (the fixnum (truncate lwork ldwork)))
          (setf nbmin
            (max (the fixnum 2)
                  (the fixnum
                    (ilaenv 2 "DGEQRF" " " " m n -1 -1))))))))))
    (cond
      ((and (>= nb nbmin) (< nb k) (< nx k))
        (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i nb))
          ((> i (f2cl-lib:int-add k (f2cl-lib:int-sub nx))) nil)
          (tagbody
            (setf ib
              (min
                (the fixnum
                  (f2cl-lib:int-add (f2cl-lib:int-sub k i) 1))
                (the fixnum nb)))
            (multiple-value-bind (var-0 var-1 var-2 var-3 var-4 var-5 var-6)
              (dgeqr2 (f2cl-lib:int-add (f2cl-lib:int-sub m i) 1) ib
                (f2cl-lib:array-slice a double-float (i i) ((1 lda) (1 *)))
                lda (f2cl-lib:array-slice tau double-float (i) ((1 *))) work
                iinfo)
              (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5))
              (setf iinfo var-6))
            (cond
              ((<= (f2cl-lib:int-add i ib) n)
                (dlarft "Forward" "Columnwise"
                  (f2cl-lib:int-add (f2cl-lib:int-sub m i) 1) ib
                  (f2cl-lib:array-slice a double-float (i i) ((1 lda) (1 *)))
                  lda (f2cl-lib:array-slice tau double-float (i) ((1 *))) work
                  ldwork)
                (dlarfb "Left" "Transpose" "Forward" "Columnwise"
                  (f2cl-lib:int-add (f2cl-lib:int-sub m i) 1)
                  (f2cl-lib:int-add (f2cl-lib:int-sub n i ib) 1) ib
                  (f2cl-lib:array-slice a double-float (i i) ((1 lda) (1 *))))))
              (t)
                (return))))))
      (t)
        (return))))))

```

```

lda work ldwork
(f2cl-lib:array-slice a
  double-float
  (i (f2cl-lib:int-add i ib))
  ((1 lda) (1 *)))

lda
(f2cl-lib:array-slice work double-float ((+ ib 1)) ((1 *)))
ldwork))))))

(t
  (setf i 1)))
(if (<= i k)
  (multiple-value-bind (var-0 var-1 var-2 var-3 var-4 var-5 var-6)
    (dgeqr2 (f2cl-lib:int-add (f2cl-lib:int-sub m i) 1)
      (f2cl-lib:int-add (f2cl-lib:int-sub n i) 1)
      (f2cl-lib:array-slice a double-float (i i) ((1 lda) (1 *))) lda
      (f2cl-lib:array-slice tau double-float (i) ((1 *))) work iinfo)
    (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5))
    (setf iinfo var-6)))
  (setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)
    (coerce (the fixnum iws) 'double-float))
end_label
(return (values nil nil nil nil nil nil nil info))))

```

## 7.16 dgesdd LAPACK

```

⟨dgesdd.input⟩≡
)set break resume
)sys rm -f dgesdd.output
)spool dgesdd.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)

```

`<dgesdd.help>=`

```
=====
dgesdd examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

DGESDD - the singular value decomposition (SVD) of a real M-by-N matrix A, optionally computing the left and right singular vectors

#### SYNOPSIS

```
SUBROUTINE DGESDD( JOBZ, M, N, A, LDA, S, U, LDU, VT, LDVT, WORK,
                  LWORK, IWORK, INFO )
```

```
      CHARACTER      JOBZ
```

```
      INTEGER        INFO, LDA, LDU, LDVT, LWORK, M, N
```

```
      INTEGER        IWORK( * )
```

```
      DOUBLE         PRECISION  A( LDA, * ), S( * ), U( LDU, * ), VT(
                  LDVT, * ), WORK( * )
```

#### PURPOSE

DGESDD computes the singular value decomposition (SVD) of a real M-by-N matrix A, optionally computing the left and right singular vectors. If singular vectors are desired, it uses a divide-and-conquer algorithm.

The SVD is written

$$A = U * \text{SIGMA} * \text{transpose}(V)$$

where SIGMA is an M-by-N matrix which is zero except for its min(m,n) diagonal elements, U is an M-by-M orthogonal matrix, and V is an N-by-N orthogonal matrix. The diagonal elements of SIGMA are the singular values of A; they are real and non-negative, and are returned in descending order. The first min(m,n) columns of U and V are the left and right singular vectors of A.

Note that the routine returns  $VT = V^{**T}$ , not V.

The divide and conquer algorithm makes very mild assumptions about floating point arithmetic. It will work on machines with a guard digit

in add/subtract, or on those binary machines without guard digits which subtract like the Cray X-MP, Cray Y-MP, Cray C-90, or Cray-2. It could conceivably fail on hexadecimal or decimal machines without guard digits, but we know of none.

#### ARGUMENTS

- JOBZ** (input) CHARACTER\*1  
 Specifies options for computing all or part of the matrix U:  
 = 'A': all M columns of U and all N rows of V\*\*T are returned in the arrays U and VT; = 'S': the first min(M,N) columns of U and the first min(M,N) rows of V\*\*T are returned in the arrays U and VT; = 'O': If M >= N, the first N columns of U are overwritten on the array A and all rows of V\*\*T are returned in the array VT; otherwise, all columns of U are returned in the array U and the first M rows of V\*\*T are overwritten in the array A; = 'N': no columns of U or rows of V\*\*T are computed.
- M** (input) INTEGER  
 The number of rows of the input matrix A. M >= 0.
- N** (input) INTEGER  
 The number of columns of the input matrix A. N >= 0.
- A** (input/output) DOUBLE PRECISION array, dimension (LDA,N)  
 On entry, the M-by-N matrix A. On exit, if JOBZ = 'O', A is overwritten with the first N columns of U (the left singular vectors, stored columnwise) if M >= N; A is overwritten with the first M rows of V\*\*T (the right singular vectors, stored rowwise) otherwise. if JOBZ .ne. 'O', the contents of A are destroyed.
- LDA** (input) INTEGER  
 The leading dimension of the array A. LDA >= max(1,M).
- S** (output) DOUBLE PRECISION array, dimension (min(M,N))  
 The singular values of A, sorted so that S(i) >= S(i+1).
- U** (output) DOUBLE PRECISION array, dimension (LDU,UCOL)  
 UCOL = M if JOBZ = 'A' or JOBZ = 'O' and M < N; UCOL = min(M,N) if JOBZ = 'S'. If JOBZ = 'A' or JOBZ = 'O' and M < N, U contains the M-by-M orthogonal matrix U; if JOBZ = 'S', U contains the first min(M,N) columns of U (the left singular vectors, stored columnwise); if JOBZ = 'O' and M >= N, or JOBZ = 'N', U is not referenced.

LDU (input) INTEGER  
 The leading dimension of the array U.  $LDU \geq 1$ ; if  $JOBZ = 'S'$  or  $'A'$  or  $JOBZ = 'O'$  and  $M < N$ ,  $LDU \geq M$ .

VT (output) DOUBLE PRECISION array, dimension (LDVT,N)  
 If  $JOBZ = 'A'$  or  $JOBZ = 'O'$  and  $M \geq N$ , VT contains the  $N$ -by- $N$  orthogonal matrix  $V^*T$ ; if  $JOBZ = 'S'$ , VT contains the first  $\min(M,N)$  rows of  $V^*T$  (the right singular vectors, stored row-wise); if  $JOBZ = 'O'$  and  $M < N$ , or  $JOBZ = 'N'$ , VT is not referenced.

LDVT (input) INTEGER  
 The leading dimension of the array VT.  $LDVT \geq 1$ ; if  $JOBZ = 'A'$  or  $JOBZ = 'O'$  and  $M \geq N$ ,  $LDVT \geq N$ ; if  $JOBZ = 'S'$ ,  $LDVT \geq \min(M,N)$ .

WORK (workspace/output) DOUBLE PRECISION array, dimension (MAX(1,LWORK))  
 On exit, if  $INFO = 0$ ,  $WORK(1)$  returns the optimal LWORK;

LWORK (input) INTEGER  
 The dimension of the array WORK.  $LWORK \geq 1$ . If  $JOBZ = 'N'$ ,  $LWORK \geq 3 \cdot \min(M,N) + \max(\max(M,N), 7 \cdot \min(M,N))$ . If  $JOBZ = 'O'$ ,  

$$LWORK \geq 3 \cdot \min(M,N) \cdot \min(M,N) + \max(\max(M,N), 5 \cdot \min(M,N) \cdot \min(M,N) + 4 \cdot \min(M,N))$$
 If  $JOBZ = 'S'$  or  $'A'$   

$$LWORK \geq 3 \cdot \min(M,N) \cdot \min(M,N) + \max(\max(M,N), 4 \cdot \min(M,N) \cdot \min(M,N) + 4 \cdot \min(M,N))$$
 For good performance, LWORK should generally be larger. If  $LWORK = -1$  but other input arguments are legal,  $WORK(1)$  returns the optimal LWORK.

IWORK (workspace) INTEGER array, dimension (8\*min(M,N))

INFO (output) INTEGER  
 = 0: successful exit.  
 < 0: if  $INFO = -i$ , the  $i$ -th argument had an illegal value.  
 > 0: DBDSDC did not converge, updating process failed.



```

(LAPACK dgesdd)=
  (let* ((zero 0.0) (one 1.0))
    (declare (type (double-float 0.0 0.0) zero)
              (type (double-float 1.0 1.0) one))
    (defun dgesdd (jobz m n a lda s u ldu vt ldvt work lwork iwork info)
      (declare (type (simple-array fixnum (*)) iwork)
                (type (simple-array double-float (*)) work vt u s a)
                (type fixnum info lwork ldvt ldu lda n m)
                (type character jobz))
      (f2cl-lib:with-multi-array-data
        ((jobz character jobz-%data% jobz-%offset%)
         (a double-float a-%data% a-%offset%)
         (s double-float s-%data% s-%offset%)
         (u double-float u-%data% u-%offset%)
         (vt double-float vt-%data% vt-%offset%)
         (work double-float work-%data% work-%offset%)
         (iwork fixnum iwork-%data% iwork-%offset%))
        (prog ((dum (make-array 1 :element-type 'double-float))
               (idum (make-array 1 :element-type 'fixnum)) (anrm 0.0)
               (bignum 0.0) (eps 0.0) (smlnum 0.0) (bdspac 0) (blk 0) (chunk 0)
               (i 0) (ie 0) (ierr 0) (il 0) (ir 0) (iscl 0) (itau 0) (itaup 0)
               (itauq 0) (iu 0) (ivt 0) (ldwkvt 0) (ldwrkl 0) (ldwrkr 0)
               (ldwrku 0) (maxwrk 0) (minmn 0) (minwrk 0) (mnthr 0) (nwork 0)
               (wrkbl 0) (lquery nil) (wntqa nil) (wntqas nil) (wntqn nil)
               (wntqo nil) (wntqs nil))
              (declare (type (simple-array double-float (1)) dum)
                        (type (simple-array fixnum (1)) idum)
                        (type (double-float) anrm bignum eps smlnum)
                        (type fixnum bdspac blk chunk i ie ierr il ir
                                iscl itau itaup itauq iu ivt ldwkvt
                                ldwrkl ldwrkr ldwrku maxwrk minmn
                                minwrk mnthr nwork wrkbl)
                        (type (member t nil) lquery wntqa wntqas wntqn wntqo wntqs))
              (setf info 0)
              (setf minmn (min (the fixnum m) (the fixnum n)))
              (setf mnthr (f2cl-lib:int (/ (* minmn 11.0) 6.0)))
              (setf wntqa (char-equal jobz #\A))
              (setf wntqs (char-equal jobz #\S))
              (setf wntqas (or wntqa wntqs))
              (setf wntqo (char-equal jobz #\0))
              (setf wntqn (char-equal jobz #\N))
              (setf minwrk 1)
              (setf maxwrk 1)
              (setf lquery (coerce (= lwork -1) '(member t nil)))
              (cond
                ((not (or wntqa wntqs wntqo wntqn))

```

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      (setf info -1))
    ((< m 0)
      (setf info -2))
    ((< n 0)
      (setf info -3))
    ((< lda (max (the fixnum 1) (the fixnum m)))
      (setf info -5))
    ((or (< ldu 1) (and wntqas (< ldu m)) (and wntqo (< m n) (< ldu m)))
      (setf info -8))
    ((or (< ldvt 1)
          (and wntqa (< ldvt n))
          (and wntqs (< ldvt minmn))
          (and wntqo (>= m n) (< ldvt n)))
      (setf info -10)))
  (cond
    ((and (= info 0) (> m 0) (> n 0))
      (cond
        ((>= m n)
          (cond
            (wntqn
              (setf bdspac (f2cl-lib:int-mul 7 n)))
            (t
              (setf bdspac
                (f2cl-lib:int-add (f2cl-lib:int-mul 3 n n)
                                   (f2cl-lib:int-mul 4 n))))))
          (cond
            ((>= m mnthr)
              (cond
                (wntqn
                  (setf wrkbl
                    (f2cl-lib:int-add n
                                       (f2cl-lib:int-mul n
                                                           (ilaenv 1
                                                            "DGEQRF" " " " m
                                                            n -1 -1))))))
                (setf wrkbl
                  (max (the fixnum wrkbl)
                       (the fixnum
                        (f2cl-lib:int-add (f2cl-lib:int-mul 3 n)
                                           (f2cl-lib:int-mul 2
                                                             n
                                                             (ilaenv 1
                                                            "DGEBRD"
                                                            " "
                                                            n n))))))
              )
            )
          )
        )
      )
    )
  )

```

```

-1
-1)))

(setf maxwrk
  (max (the fixnum wrkbl)
        (the fixnum
          (f2cl-lib:int-add bdspac n))))
(setf minwrk (f2cl-lib:int-add bdspac n))
(wntqo
  (setf wrkbl
    (f2cl-lib:int-add n
      (f2cl-lib:int-mul n
        (ilaenv 1
          "DGEQRF" " " " m
            n -1 -1))))))

(setf wrkbl
  (max (the fixnum wrkbl)
        (the fixnum
          (f2cl-lib:int-add n
            (f2cl-lib:int-mul n
              (ilaenv 1
                "DORGQ" " " "
                  m n
                    n
                      -1))))))

(setf wrkbl
  (max (the fixnum wrkbl)
        (the fixnum
          (f2cl-lib:int-add (f2cl-lib:int-mul 3 n)
            (f2cl-lib:int-mul 2
              n
                (ilaenv 1
                  "DGEBR" " " "
                    n n
                      -1
                        -1))))))

(setf wrkbl
  (max (the fixnum wrkbl)
        (the fixnum
          (f2cl-lib:int-add (f2cl-lib:int-mul 3 n)
            (f2cl-lib:int-mul n
              (ilaenv 1

```

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                                "DORMBR"
                                "QLN"
                                n n
                                n
                                -1))))))
(setf wrkbl
  (max (the fixnum wrkbl)
    (the fixnum
      (f2cl-lib:int-add (f2cl-lib:int-mul 3 n)
        (f2cl-lib:int-mul n
          (ilaenv
            1
            "DORMBR"
            "PRT"
            n n
            n
            -1))))))
(setf wrkbl
  (max (the fixnum wrkbl)
    (the fixnum
      (f2cl-lib:int-add bdspac
        (f2cl-lib:int-mul 3
          n))))))
(setf maxwrk
  (f2cl-lib:int-add wrkbl (f2cl-lib:int-mul 2 n n)))
(setf minwrk
  (f2cl-lib:int-add bdspac
    (f2cl-lib:int-mul 2 n n)
    (f2cl-lib:int-mul 3 n)))
(wntqs
  (setf wrkbl
    (f2cl-lib:int-add n
      (f2cl-lib:int-mul n
        (ilaenv 1
          "DGEQRF" " " " m
          n -1 -1))))
(setf wrkbl
  (max (the fixnum wrkbl)
    (the fixnum
      (f2cl-lib:int-add n
        (f2cl-lib:int-mul n
          (ilaenv
            1
            "DORGQR"
            " "
            m n

```

```

n
-1)))
(setf wrkbl
  (max (the fixnum wrkbl)
    (the fixnum
      (f2cl-lib:int-add (f2cl-lib:int-mul 3 n)
        (f2cl-lib:int-mul 2
          n
            (ilaenv
              1
              "DGEBR.
              " "
              n n
              -1
              -1))))))
(setf wrkbl
  (max (the fixnum wrkbl)
    (the fixnum
      (f2cl-lib:int-add (f2cl-lib:int-mul 3 n)
        (f2cl-lib:int-mul n
          (ilaenv
            1
            "DORMB
            "QLN"
            n n
            n
            -1))))))
(setf wrkbl
  (max (the fixnum wrkbl)
    (the fixnum
      (f2cl-lib:int-add (f2cl-lib:int-mul 3 n)
        (f2cl-lib:int-mul n
          (ilaenv
            1
            "DORMB
            "PRT"
            n n
            n
            -1))))))
(setf wrkbl
  (max (the fixnum wrkbl)
    (the fixnum
      (f2cl-lib:int-add bdspace
        (f2cl-lib:int-mul 3
          n))))))
(setf maxwrk

```

```

        (f2cl-lib:int-add wrkbl (f2cl-lib:int-mul n n)))
(setf minwrk
  (f2cl-lib:int-add bdspac
    (f2cl-lib:int-mul n n)
    (f2cl-lib:int-mul 3 n)))
(wntqa
  (setf wrkbl
    (f2cl-lib:int-add n
      (f2cl-lib:int-mul n
        (ilaenv 1
          "DGEQRF" " " " m
            n -1 -1))))))
(setf wrkbl
  (max (the fixnum wrkbl)
    (the fixnum
      (f2cl-lib:int-add n
        (f2cl-lib:int-mul m
          (ilaenv 1
            "DORGQR"
            " "
            m m
            n
            -1)))))))
(setf wrkbl
  (max (the fixnum wrkbl)
    (the fixnum
      (f2cl-lib:int-add (f2cl-lib:int-mul 3 n)
        (f2cl-lib:int-mul 2
          n
          (ilaenv 1
            "DGEBRD"
            " "
            n n
            -1
            -1)))))))
(setf wrkbl
  (max (the fixnum wrkbl)
    (the fixnum
      (f2cl-lib:int-add (f2cl-lib:int-mul 3 n)
        (f2cl-lib:int-mul n
          (ilaenv 1
            "DORMBR"
            "QLN"

```

```

n n
n
-1)))

(setf wrkbl
  (max (the fixnum wrkbl)
    (the fixnum
      (f2cl-lib:int-add (f2cl-lib:int-mul 3 n)
        (f2cl-lib:int-mul n
          (ilaenv
            1
            "DORMB"
            "PRT"
            n n
            n
            -1))))))

(setf wrkbl
  (max (the fixnum wrkbl)
    (the fixnum
      (f2cl-lib:int-add bdspac
        (f2cl-lib:int-mul 3
          n))))))

(setf maxwrk
  (f2cl-lib:int-add wrkbl (f2cl-lib:int-mul n n)))
(setf minwrk
  (f2cl-lib:int-add bdspac
    (f2cl-lib:int-mul n n)
    (f2cl-lib:int-mul 3 n))))))

(t
  (setf wrkbl
    (f2cl-lib:int-add (f2cl-lib:int-mul 3 n)
      (f2cl-lib:int-mul
        (f2cl-lib:int-add m n)
        (ilaenv 1 "DGEBRD" " " " m n -1 -1))))))

(cond
  (wntqn
    (setf maxwrk
      (max (the fixnum wrkbl)
        (the fixnum
          (f2cl-lib:int-add bdspac
            (f2cl-lib:int-mul 3
              n))))))

    (setf minwrk
      (f2cl-lib:int-add (f2cl-lib:int-mul 3 n)
        (max (the fixnum m)
          (the fixnum
            bdspac))))))

```

```

(wntqo
  (setf wrkbl
    (max (the fixnum wrkbl)
      (the fixnum
        (f2cl-lib:int-add (f2cl-lib:int-mul 3 n)
          (f2cl-lib:int-mul n
            (ilaenv
              1
              "DORMBR"
              "QLN"
              m n
              n
              -1))))))

  (setf wrkbl
    (max (the fixnum wrkbl)
      (the fixnum
        (f2cl-lib:int-add (f2cl-lib:int-mul 3 n)
          (f2cl-lib:int-mul n
            (ilaenv
              1
              "DORMBR"
              "PRT"
              n n
              n
              -1))))))

  (setf wrkbl
    (max (the fixnum wrkbl)
      (the fixnum
        (f2cl-lib:int-add bdspace
          (f2cl-lib:int-mul 3
            n))))))

  (setf maxwrk
    (f2cl-lib:int-add wrkbl (f2cl-lib:int-mul m n)))
  (setf minwrk
    (f2cl-lib:int-add (f2cl-lib:int-mul 3 n)
      (max (the fixnum m)
        (the fixnum
          (f2cl-lib:int-add
            (f2cl-lib:int-mul n n)
            bdspace))))))

(wntqs
  (setf wrkbl
    (max (the fixnum wrkbl)
      (the fixnum
        (f2cl-lib:int-add (f2cl-lib:int-mul 3 n)
          (f2cl-lib:int-mul n

```



```

(ilaenv
  1
  "DORMB"
  "QLN"
  m n
  n
  -1)))

(setf wrkbl
  (max (the fixnum wrkbl)
    (the fixnum
      (f2cl-lib:int-add (f2cl-lib:int-mul 3 n)
        (f2cl-lib:int-mul n
          (ilaenv
            1
            "DORMB"
            "PRT"
            n n
            n
            -1))))))

(setf maxwrk
  (max (the fixnum wrkbl)
    (the fixnum
      (f2cl-lib:int-add bdspace
        (f2cl-lib:int-mul 3
          n))))))

(setf minwrk
  (f2cl-lib:int-add (f2cl-lib:int-mul 3 n)
    (max (the fixnum m)
      (the fixnum
        bdspace))))))

(wntqa
  (setf wrkbl
    (max (the fixnum wrkbl)
      (the fixnum
        (f2cl-lib:int-add (f2cl-lib:int-mul 3 n)
          (f2cl-lib:int-mul m
            (ilaenv
              1
              "DORMB"
              "QLN"
              m m
              n
              -1))))))

(setf wrkbl
  (max (the fixnum wrkbl)
    (the fixnum

```

```

(f2cl-lib:int-add (f2cl-lib:int-mul 3 n)
  (f2cl-lib:int-mul n
    (ilaenv
      1
      "DORMBR"
      "PRT"
      n n
      n
      -1))))))

(setf maxwrk
  (max (the fixnum maxwrk)
    (the fixnum
      (f2cl-lib:int-add bdspac
        (f2cl-lib:int-mul 3
          n))))))

(setf minwrk
  (f2cl-lib:int-add (f2cl-lib:int-mul 3 n)
    (max (the fixnum m)
      (the fixnum
        bdspac)))))))))

(t
  (cond
    (wntqn
      (setf bdspac (f2cl-lib:int-mul 7 m)))
    (t
      (setf bdspac
        (f2cl-lib:int-add (f2cl-lib:int-mul 3 m m)
          (f2cl-lib:int-mul 4 m))))))

(cond
  ((>= n mnthr)
    (cond
      (wntqn
        (setf wrkbl
          (f2cl-lib:int-add m
            (f2cl-lib:int-mul m
              (ilaenv 1
                "DGELQF" " " " m
                n -1 -1))))))

    (setf wrkbl
      (max (the fixnum wrkbl)
        (the fixnum
          (f2cl-lib:int-add (f2cl-lib:int-mul 3 m)
            (f2cl-lib:int-mul 2
              m
                (ilaenv
                  1

```

```

"DGEBR.
" "
m m
-1
-1)))

(setf maxwrk
  (max (the fixnum wrkbl)
        (the fixnum
          (f2cl-lib:int-add bdspac m))))
(setf minwrk (f2cl-lib:int-add bdspac m))
(wntqo
  (setf wrkbl
    (f2cl-lib:int-add m
      (f2cl-lib:int-mul m
        (ilaenv 1
          "DGELQF" " " " m
            n -1 -1)))))

(setf wrkbl
  (max (the fixnum wrkbl)
        (the fixnum
          (f2cl-lib:int-add m
            (f2cl-lib:int-mul m
              (ilaenv 1
                "DORGL"
                " "
                m n
                m
                -1))))))

(setf wrkbl
  (max (the fixnum wrkbl)
        (the fixnum
          (f2cl-lib:int-add (f2cl-lib:int-mul 3 m)
            (f2cl-lib:int-mul 2
              m
              (ilaenv 1
                "DGEBR."
                " "
                m m
                -1
                -1))))))

(setf wrkbl
  (max (the fixnum wrkbl)
        (the fixnum
          (f2cl-lib:int-add (f2cl-lib:int-mul 3 m)

```

```

(f2cl-lib:int-mul m
  (ilaenv
    1
    "DORMBR"
    "QLN"
    m m
    m
    -1))))))

(setf wrkbl
  (max (the fixnum wrkbl)
    (the fixnum
      (f2cl-lib:int-add (f2cl-lib:int-mul 3 m)
        (f2cl-lib:int-mul m
          (ilaenv
            1
            "DORMBR"
            "PRT"
            m m
            m
            -1))))))

(setf wrkbl
  (max (the fixnum wrkbl)
    (the fixnum
      (f2cl-lib:int-add bdspac
        (f2cl-lib:int-mul 3
          m))))))

(setf maxwrk
  (f2cl-lib:int-add wrkbl (f2cl-lib:int-mul 2 m m)))
(setf minwrk
  (f2cl-lib:int-add bdspac
    (f2cl-lib:int-mul 2 m m)
    (f2cl-lib:int-mul 3 m)))

(wntqs
  (setf wrkbl
    (f2cl-lib:int-add m
      (f2cl-lib:int-mul m
        (ilaenv 1
          "DGELQF" " " " m
            n -1 -1))))))

(setf wrkbl
  (max (the fixnum wrkbl)
    (the fixnum
      (f2cl-lib:int-add m
        (f2cl-lib:int-mul m
          (ilaenv
            1

```

```

"DORGL
" "
m n
m
-1)))

(setf wrkbl
  (max (the fixnum wrkbl)
    (the fixnum
      (f2cl-lib:int-add (f2cl-lib:int-mul 3 m)
        (f2cl-lib:int-mul 2
          m
          (ilaenv
            1
            "DGEBR.
            " "
            m m
            -1
            -1))))))

(setf wrkbl
  (max (the fixnum wrkbl)
    (the fixnum
      (f2cl-lib:int-add (f2cl-lib:int-mul 3 m)
        (f2cl-lib:int-mul m
          (ilaenv
            1
            "DORMB
            "QLN"
            m m
            m
            -1))))))

(setf wrkbl
  (max (the fixnum wrkbl)
    (the fixnum
      (f2cl-lib:int-add (f2cl-lib:int-mul 3 m)
        (f2cl-lib:int-mul m
          (ilaenv
            1
            "DORMB
            "PRT"
            m m
            m
            -1))))))

(setf wrkbl
  (max (the fixnum wrkbl)
    (the fixnum
      (f2cl-lib:int-add bdspace

```

```

(f2cl-lib:int-mul 3
m))))
(setf maxwrk
  (f2cl-lib:int-add wrkbl (f2cl-lib:int-mul m m))
(setf minwrk
  (f2cl-lib:int-add bdspac
    (f2cl-lib:int-mul m m)
    (f2cl-lib:int-mul 3 m)))
(wntqa
  (setf wrkbl
    (f2cl-lib:int-add m
      (f2cl-lib:int-mul m
        (ilaenv 1
          "DGELQF" " " " m
            n -1 -1))))
  (setf wrkbl
    (max (the fixnum wrkbl)
      (the fixnum
        (f2cl-lib:int-add m
          (f2cl-lib:int-mul n
            (ilaenv 1
              "DORGLQ"
              " "
              n n
              m
              -1))))))
  (setf wrkbl
    (max (the fixnum wrkbl)
      (the fixnum
        (f2cl-lib:int-add (f2cl-lib:int-mul 3 m)
          (f2cl-lib:int-mul 2
            m
            (ilaenv 1
              "DGEBRD"
              " "
              m m
              -1
              -1))))))
  (setf wrkbl
    (max (the fixnum wrkbl)
      (the fixnum
        (f2cl-lib:int-add (f2cl-lib:int-mul 3 m)
          (f2cl-lib:int-mul m
            (ilaenv

```

```

1
"DORMB"
"QLN"
m m
m
-1)))

(setf wrkbl
  (max (the fixnum wrkbl)
    (the fixnum
      (f2cl-lib:int-add (f2cl-lib:int-mul 3 m)
        (f2cl-lib:int-mul m
          (ilaenv 1
            "DORMB"
            "PRT"
            m m
            m
            -1))))))

(setf wrkbl
  (max (the fixnum wrkbl)
    (the fixnum
      (f2cl-lib:int-add bdspace
        (f2cl-lib:int-mul 3
          m))))))

(setf maxwrk
  (f2cl-lib:int-add wrkbl (f2cl-lib:int-mul m m)))
(setf minwrk
  (f2cl-lib:int-add bdspace
    (f2cl-lib:int-mul m m)
    (f2cl-lib:int-mul 3 m))))))

(t
  (setf wrkbl
    (f2cl-lib:int-add (f2cl-lib:int-mul 3 m)
      (f2cl-lib:int-mul
        (f2cl-lib:int-add m n)
        (ilaenv 1 "DGEHRD" " " " m n -1 -1))))

(cond
  (wntqn
    (setf maxwrk
      (max (the fixnum wrkbl)
        (the fixnum
          (f2cl-lib:int-add bdspace
            (f2cl-lib:int-mul 3
              m))))))

    (setf minwrk
      (f2cl-lib:int-add (f2cl-lib:int-mul 3 m)
        (f2cl-lib:int-mul m n))))))

```

```

                                (max (the fixnum n)
                                (the fixnum
                                bdspac))))))
(wntqo
  (setf wrkbl
    (max (the fixnum wrkbl)
      (the fixnum
        (f2cl-lib:int-add (f2cl-lib:int-mul 3 m)
          (f2cl-lib:int-mul m
            (ilaenv
              1
              "DORMBR"
              "QLN"
              m m
              n
              -1)))))))
  (setf wrkbl
    (max (the fixnum wrkbl)
      (the fixnum
        (f2cl-lib:int-add (f2cl-lib:int-mul 3 m)
          (f2cl-lib:int-mul m
            (ilaenv
              1
              "DORMBR"
              "PRT"
              m n
              m
              -1)))))))
  (setf wrkbl
    (max (the fixnum wrkbl)
      (the fixnum
        (f2cl-lib:int-add bdspac
          (f2cl-lib:int-mul 3
            m))))))
  (setf maxwrk
    (f2cl-lib:int-add wrkbl (f2cl-lib:int-mul m n)))
  (setf minwrk
    (f2cl-lib:int-add (f2cl-lib:int-mul 3 m)
      (max (the fixnum n)
        (the fixnum
          (f2cl-lib:int-add
            (f2cl-lib:int-mul m m)
            bdspac))))))
(wntqs
  (setf wrkbl
    (max (the fixnum wrkbl)

```



```

      (the fixnum
        (f2cl-lib:int-add (f2cl-lib:int-mul 3 m)
          (f2cl-lib:int-mul m
            (ilaenv
              1
              "DORMB"
              "QLN"
              m m
              n
              -1))))
    (setf wrkbl
      (max (the fixnum wrkbl)
        (the fixnum
          (f2cl-lib:int-add (f2cl-lib:int-mul 3 m)
            (f2cl-lib:int-mul m
              (ilaenv
                1
                "DORMB"
                "PRT"
                m n
                m
                -1))))))
    (setf maxwrk
      (max (the fixnum wrkbl)
        (the fixnum
          (f2cl-lib:int-add bdspac
            (f2cl-lib:int-mul 3
              m))))))
    (setf minwrk
      (f2cl-lib:int-add (f2cl-lib:int-mul 3 m)
        (max (the fixnum n)
          (the fixnum
            bdspac))))))
(wntqa
  (setf wrkbl
    (max (the fixnum wrkbl)
      (the fixnum
        (f2cl-lib:int-add (f2cl-lib:int-mul 3 m)
          (f2cl-lib:int-mul m
            (ilaenv
              1
              "DORMB"
              "QLN"
              m m
              n
              -1))))))

```

```

      (setf wrkbl
        (max (the fixnum wrkbl)
              (the fixnum
                (f2cl-lib:int-add (f2cl-lib:int-mul 3 m)
                                   (f2cl-lib:int-mul m
                                   (ilaenv
                                    1
                                    "DORMBR"
                                    "PRT"
                                    n n
                                    m
                                    -1))))))

      (setf maxwrk
        (max (the fixnum wrkbl)
              (the fixnum
                (f2cl-lib:int-add bdspace
                                   (f2cl-lib:int-mul 3
                                   m))))))

      (setf minwrk
        (f2cl-lib:int-add (f2cl-lib:int-mul 3 m)
                           (max (the fixnum n)
                                (the fixnum
                                  bdspace))))))

      (setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)
            (coerce (the fixnum maxwrk) 'double-float)))

      (cond
        ((and (< lwork minwrk) (not lquery))
         (setf info -12)))
      (cond
        ((/= info 0)
         (error
          " ** On entry to ~a parameter number ~a had an illegal value~%"
          "DGESDD" (f2cl-lib:int-sub info))
         (go end_label))
        (lquery
         (go end_label)))
      (cond
        ((or (= m 0) (= n 0))
         (if (>= lwork 1)
              (setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%) one))
         (go end_label)))
      (setf eps (dlamch "P"))
      (setf smlnum (/ (f2cl-lib:fsqrt (dlamch "S")) eps))
      (setf bignum (/ one smlnum))
      (setf anrm (dlange "M" m n a lda dum))
      (setf iscl 0)

```

```

(cond
  ((and (> anrm zero) (< anrm smlnum))
    (setf iscl 1)
    (multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9)
      (dlascl "G" 0 0 anrm smlnum m n a lda ierr)
      (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
        var-8))
      (setf ierr var-9)))
  ((> anrm bignum)
    (setf iscl 1)
    (multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9)
      (dlascl "G" 0 0 anrm bignum m n a lda ierr)
      (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
        var-8))
      (setf ierr var-9))))
(cond
  ((>= m n)
    (cond
      ((>= m mnthr)
        (cond
          (wntqn
            (setf itau 1)
            (setf nwork (f2cl-lib:int-add itau n))
            (multiple-value-bind
              (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7)
              (dgeqrf m n a lda
                (f2cl-lib:array-slice work double-float (itau) ((1 *)))
                (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
                (f2cl-lib:int-add (f2cl-lib:int-sub lwork nwork) 1) ierr)
              (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6))
              (setf ierr var-7))
            (dlaset "L" (f2cl-lib:int-sub n 1) (f2cl-lib:int-sub n 1) zero
              zero
              (f2cl-lib:array-slice a double-float (2 1) ((1 lda) (1 *)))
              lda)
            (setf ie 1)
            (setf itauq (f2cl-lib:int-add ie n))
            (setf itaup (f2cl-lib:int-add itauq n))
            (setf nwork (f2cl-lib:int-add itaup n))
            (multiple-value-bind
              (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
                var-9 var-10)
              (dgebrd n n a lda s
                (f2cl-lib:array-slice work double-float (ie) ((1 *))))

```

```

(f2cl-lib:array-slice work double-float (itauq) ((1 *)))
(f2cl-lib:array-slice work double-float (itau) ((1 *)))
(f2cl-lib:array-slice work double-float (nwork) ((1 *)))
(f2cl-lib:int-add (f2cl-lib:int-sub lwork nwork) 1) ierr)
(declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                var-7 var-8 var-9))
(setf ierr var-10))
(setf nwork (f2cl-lib:int-add ie n))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
   var-9 var-10 var-11 var-12 var-13)
  (dbdsdc "U" "N" n s
    (f2cl-lib:array-slice work double-float (ie) ((1 *))) dum
    1 dum 1 dum idum
    (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
    iwork info)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                  var-7 var-8 var-9 var-10 var-11 var-12))
  (setf info var-13)))
(wntqo
  (setf ir 1)
  (cond
    ((>= lwork
      (f2cl-lib:int-add (f2cl-lib:int-mul lda n)
                        (f2cl-lib:int-mul n n)
                        (f2cl-lib:int-mul 3 n)
                        bdspace))
      (setf ldwrkr lda))
    (t
      (setf ldwrkr
        (the fixnum
          (truncate (- lwork (* n n) (* 3 n) bdspace)
                    n))))))
(setf itau (f2cl-lib:int-add ir (f2cl-lib:int-mul ldwrkr n)))
(setf nwork (f2cl-lib:int-add itau n))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7)
  (dgeqrf m n a lda
    (f2cl-lib:array-slice work double-float (itau) ((1 *)))
    (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
    (f2cl-lib:int-add (f2cl-lib:int-sub lwork nwork) 1) ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6))
  (setf ierr var-7))
(dlacpy "U" n n a lda
  (f2cl-lib:array-slice work double-float (ir) ((1 *))) ldwrkr)
(dlaset "L" (f2cl-lib:int-sub n 1) (f2cl-lib:int-sub n 1) zero

```

```

zero
(f2cl-lib:array-slice work double-float ((+ ir 1)) ((1 *)))
ldwrkr)
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8)
  (dorgqr m n n a lda
    (f2cl-lib:array-slice work double-float (itau) ((1 *)))
    (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
    (f2cl-lib:int-add (f2cl-lib:int-sub lwork nwork) 1) ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
    var-7))
  (setf ierr var-8))
(setf ie itau)
(setf itauq (f2cl-lib:int-add ie n))
(setf itaup (f2cl-lib:int-add itauq n))
(setf nwork (f2cl-lib:int-add itaup n))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
    var-9 var-10)
  (dgebrd n n
    (f2cl-lib:array-slice work double-float (ir) ((1 *)))
    ldwrkr s
    (f2cl-lib:array-slice work double-float (ie) ((1 *)))
    (f2cl-lib:array-slice work double-float (itauq) ((1 *)))
    (f2cl-lib:array-slice work double-float (itaup) ((1 *)))
    (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
    (f2cl-lib:int-add (f2cl-lib:int-sub lwork nwork) 1) ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
    var-7 var-8 var-9))
  (setf ierr var-10))
(setf iu nwork)
(setf nwork (f2cl-lib:int-add iu (f2cl-lib:int-mul n n)))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
    var-9 var-10 var-11 var-12 var-13)
  (dbdsdc "U" "I" n s
    (f2cl-lib:array-slice work double-float (ie) ((1 *)))
    (f2cl-lib:array-slice work double-float (iu) ((1 *))) n
    vt ldvt dum idum
    (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
    iwork info)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
    var-7 var-8 var-9 var-10 var-11 var-12))
  (setf info var-13))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8

```

```

      var-9 var-10 var-11 var-12 var-13)
(dormbr "Q" "L" "N" n n n
 (f2cl-lib:array-slice work double-float (ir) ((1 *)))
 ldwrkr
 (f2cl-lib:array-slice work double-float (itauq) ((1 *)))
 (f2cl-lib:array-slice work double-float (iu) ((1 *))) n
 (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
 (f2cl-lib:int-add (f2cl-lib:int-sub lwork nwork) 1) ierr)
(declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                var-7 var-8 var-9 var-10 var-11 var-12))
(setf ierr var-13))
(multiple-value-bind
 (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
  var-9 var-10 var-11 var-12 var-13)
(dormbr "P" "R" "T" n n n
 (f2cl-lib:array-slice work double-float (ir) ((1 *)))
 ldwrkr
 (f2cl-lib:array-slice work double-float (itauq) ((1 *)))
 vt ldvt
 (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
 (f2cl-lib:int-add (f2cl-lib:int-sub lwork nwork) 1) ierr)
(declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                var-7 var-8 var-9 var-10 var-11 var-12))
(setf ierr var-13))
(f2cl-lib:fdo (i 1 (f2cl-lib:int-add i ldwrkr))
              (> i m) nil)
(tagbody
 (setf chunk
      (min
       (the fixnum
        (f2cl-lib:int-add (f2cl-lib:int-sub m i) 1))
       (the fixnum ldwrkr)))
 (dgemm "N" "N" chunk n n one
  (f2cl-lib:array-slice a
                        double-float
                        (i 1)
                        ((1 lda) (1 *)))
  lda (f2cl-lib:array-slice work double-float (iu) ((1 *)))
  n zero
  (f2cl-lib:array-slice work double-float (ir) ((1 *)))
  ldwrkr)
 (dlacpy "F" chunk n
  (f2cl-lib:array-slice work double-float (ir) ((1 *)))
  ldwrkr
  (f2cl-lib:array-slice a
                        double-float

```

```

                                (i 1)
                                ((1 lda) (1 *)))
                                lda))))
(wntqs
 (setf ir 1)
 (setf ldwrkr n)
 (setf itau (f2cl-lib:int-add ir (f2cl-lib:int-mul ldwrkr n)))
 (setf nwork (f2cl-lib:int-add itau n))
 (multiple-value-bind
   (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7)
   (dgegrf m n a lda
    (f2cl-lib:array-slice work double-float (itau) ((1 *)))
    (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
    (f2cl-lib:int-add (f2cl-lib:int-sub lwork nwork) 1) ierr)
   (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6))
   (setf ierr var-7))
 (dlacpy "U" n n a lda
  (f2cl-lib:array-slice work double-float (ir) ((1 *))) ldwrkr)
 (dlaset "L" (f2cl-lib:int-sub n 1) (f2cl-lib:int-sub n 1) zero
  (f2cl-lib:array-slice work double-float ((+ ir 1)) ((1 *)))
  ldwrkr)
 (multiple-value-bind
   (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8)
   (dorgqr m n n a lda
    (f2cl-lib:array-slice work double-float (itau) ((1 *)))
    (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
    (f2cl-lib:int-add (f2cl-lib:int-sub lwork nwork) 1) ierr)
   (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
    var-7))
   (setf ierr var-8))
 (setf ie itau)
 (setf itauq (f2cl-lib:int-add ie n))
 (setf itaup (f2cl-lib:int-add itauq n))
 (setf nwork (f2cl-lib:int-add itaup n))
 (multiple-value-bind
   (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
    var-9 var-10)
   (dgebrd n n
    (f2cl-lib:array-slice work double-float (ir) ((1 *)))
    ldwrkr s
    (f2cl-lib:array-slice work double-float (ie) ((1 *)))
    (f2cl-lib:array-slice work double-float (itauq) ((1 *)))
    (f2cl-lib:array-slice work double-float (itaup) ((1 *)))
    (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
    (f2cl-lib:int-add (f2cl-lib:int-sub lwork nwork) 1) ierr)

```

```

(declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
              var-7 var-8 var-9))
(setf ierr var-10))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
   var-9 var-10 var-11 var-12 var-13)
  (dbdsdc "U" "I" n s
    (f2cl-lib:array-slice work double-float (ie) ((1 *))) u
    ldu vt ldvt dum idum
    (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
    iwork info)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                    var-7 var-8 var-9 var-10 var-11 var-12))
  (setf info var-13))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
   var-9 var-10 var-11 var-12 var-13)
  (dormbr "Q" "L" "N" n n n
    (f2cl-lib:array-slice work double-float (ir) ((1 *)))
    ldwrkr
    (f2cl-lib:array-slice work double-float (itauq) ((1 *)))
    u ldu
    (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
    (f2cl-lib:int-add (f2cl-lib:int-sub lwork nwork) 1) ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                    var-7 var-8 var-9 var-10 var-11 var-12))
  (setf ierr var-13))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
   var-9 var-10 var-11 var-12 var-13)
  (dormbr "P" "R" "T" n n n
    (f2cl-lib:array-slice work double-float (ir) ((1 *)))
    ldwrkr
    (f2cl-lib:array-slice work double-float (itaup) ((1 *)))
    vt ldvt
    (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
    (f2cl-lib:int-add (f2cl-lib:int-sub lwork nwork) 1) ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                    var-7 var-8 var-9 var-10 var-11 var-12))
  (setf ierr var-13))
(dlacpy "F" n n u ldu
  (f2cl-lib:array-slice work double-float (ir) ((1 *))) ldwrkr)
(dgemm "N" "N" m n n one a lda
  (f2cl-lib:array-slice work double-float (ir) ((1 *))) ldwrkr
  zero u ldu))
(wntqa

```



```

(setf iu 1)
(setf ldwrku n)
(setf itau (f2cl-lib:int-add iu (f2cl-lib:int-mul ldwrku n)))
(setf nwork (f2cl-lib:int-add itau n))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7)
  (dgeqrf m n a lda
    (f2cl-lib:array-slice work double-float (itau) ((1 *)))
    (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
    (f2cl-lib:int-add (f2cl-lib:int-sub lwork nwork) 1) ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6))
  (setf ierr var-7))
(dlacpy "L" m n a lda u ldu)
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8)
  (dorgqr m m n u ldu
    (f2cl-lib:array-slice work double-float (itau) ((1 *)))
    (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
    (f2cl-lib:int-add (f2cl-lib:int-sub lwork nwork) 1) ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
    var-7))
  (setf ierr var-8))
(dlaset "L" (f2cl-lib:int-sub n 1) (f2cl-lib:int-sub n 1) zero
  zero
  (f2cl-lib:array-slice a double-float (2 1) ((1 lda) (1 *)))
  lda)
(setf ie itau)
(setf itauq (f2cl-lib:int-add ie n))
(setf itaup (f2cl-lib:int-add itauq n))
(setf nwork (f2cl-lib:int-add itaup n))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
    var-9 var-10)
  (dgebrd n n a lda s
    (f2cl-lib:array-slice work double-float (ie) ((1 *)))
    (f2cl-lib:array-slice work double-float (itauq) ((1 *)))
    (f2cl-lib:array-slice work double-float (itaup) ((1 *)))
    (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
    (f2cl-lib:int-add (f2cl-lib:int-sub lwork nwork) 1) ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
    var-7 var-8 var-9))
  (setf ierr var-10))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
    var-9 var-10 var-11 var-12 var-13)
  (dbdsdc "U" "I" n s

```

```

(f2cl-lib:array-slice work double-float (ie) ((1 *)))
(f2cl-lib:array-slice work double-float (iu) ((1 *))) n
vt ldvt dum idum
(f2cl-lib:array-slice work double-float (nwork) ((1 *)))
iwork info)
(declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
              var-7 var-8 var-9 var-10 var-11 var-12))
(setf info var-13))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
   var-9 var-10 var-11 var-12 var-13)
  (dormbr "Q" "L" "N" n n n a lda
    (f2cl-lib:array-slice work double-float (itauq) ((1 *)))
    (f2cl-lib:array-slice work double-float (iu) ((1 *)))
    ldwrku
    (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
    (f2cl-lib:int-add (f2cl-lib:int-sub lwork nwork) 1) ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                    var-7 var-8 var-9 var-10 var-11 var-12))
  (setf ierr var-13))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
   var-9 var-10 var-11 var-12 var-13)
  (dormbr "P" "R" "T" n n n a lda
    (f2cl-lib:array-slice work double-float (itaup) ((1 *)))
    vt ldvt
    (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
    (f2cl-lib:int-add (f2cl-lib:int-sub lwork nwork) 1) ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                    var-7 var-8 var-9 var-10 var-11 var-12))
  (setf ierr var-13))
(dgemm "N" "N" m n n one u ldu
  (f2cl-lib:array-slice work double-float (iu) ((1 *))) ldwrku
  zero a lda)
(dlacpy "F" m n a lda u ldu)))
(t
  (setf ie 1)
  (setf itauq (f2cl-lib:int-add ie n))
  (setf itaup (f2cl-lib:int-add itauq n))
  (setf nwork (f2cl-lib:int-add itaup n))
  (multiple-value-bind
    (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
     var-9 var-10)
    (dgebrd m n a lda s
      (f2cl-lib:array-slice work double-float (ie) ((1 *)))
      (f2cl-lib:array-slice work double-float (itauq) ((1 *)))

```

```

(f2cl-lib:array-slice work double-float (itaup) ((1 *)))
(f2cl-lib:array-slice work double-float (nwork) ((1 *)))
(f2cl-lib:int-add (f2cl-lib:int-sub lwork nwork) 1) ierr)
(declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
               var-7 var-8 var-9))
(setf ierr var-10))
(cond
  (wntqn
    (multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
       var-9 var-10 var-11 var-12 var-13)
      (dbdsdc "U" "N" n s
        (f2cl-lib:array-slice work double-float (ie) ((1 *))) dum
        1 dum 1 dum idum
        (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
        iwork info)
      (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                       var-7 var-8 var-9 var-10 var-11 var-12))
      (setf info var-13)))
    (wntqo
      (setf iu nwork)
      (cond
        ((>= lwork
          (f2cl-lib:int-add (f2cl-lib:int-mul m n)
                           (f2cl-lib:int-mul 3 n)
                           bdspace))
          (setf ldwrku m)
          (setf nwork
            (f2cl-lib:int-add iu (f2cl-lib:int-mul ldwrku n)))
          (dlaset "F" m n zero zero
            (f2cl-lib:array-slice work double-float (iu) ((1 *)))
            ldwrku))
          (t
            (setf ldwrku n)
            (setf nwork
              (f2cl-lib:int-add iu (f2cl-lib:int-mul ldwrku n)))
            (setf ir nwork)
            (setf ldwrkr
              (the fixnum
                (truncate (- lwork (* n n) (* 3 n)) n))))
            (setf nwork (f2cl-lib:int-add iu (f2cl-lib:int-mul ldwrku n)))
            (multiple-value-bind
              (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
               var-9 var-10 var-11 var-12 var-13)
              (dbdsdc "U" "I" n s
                (f2cl-lib:array-slice work double-float (ie) ((1 *)))

```

```

(f2cl-lib:array-slice work double-float (iu) ((1 *)))
ldwrku vt ldvt dum idum
(f2cl-lib:array-slice work double-float (nwork) ((1 *)))
iwork info)
(declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
              var-7 var-8 var-9 var-10 var-11 var-12))
(setf info var-13))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
   var-9 var-10 var-11 var-12 var-13)
  (dormbr "P" "R" "T" n n n a lda
    (f2cl-lib:array-slice work double-float (itaup) ((1 *)))
    vt ldvt
    (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
    (f2cl-lib:int-add (f2cl-lib:int-sub lwork nwork) 1) ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                    var-7 var-8 var-9 var-10 var-11 var-12))
  (setf ierr var-13))
(cond
  ((>= lwork
    (f2cl-lib:int-add (f2cl-lib:int-mul m n)
                      (f2cl-lib:int-mul 3 n)
                      bdspace))
    (multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8 var-9 var-10 var-11 var-12 var-13)
      (dormbr "Q" "L" "N" m n n a lda
        (f2cl-lib:array-slice work
                              double-float
                              (itaup)
                              ((1 *)))
        (f2cl-lib:array-slice work double-float (iu) ((1 *)))
        ldwrku
        (f2cl-lib:array-slice work
                              double-float
                              (nwork)
                              ((1 *)))
        (f2cl-lib:int-add (f2cl-lib:int-sub lwork nwork) 1)
        ierr)
      (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                        var-6 var-7 var-8 var-9 var-10 var-11
                        var-12))
      (setf ierr var-13))
    (dlacpy "F" m n
      (f2cl-lib:array-slice work double-float (iu) ((1 *)))
      ldwrku a lda))

```

```

(t
  (multiple-value-bind
    (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
     var-8 var-9)
    (dorgbr "Q" m n n a lda
      (f2cl-lib:array-slice work
        double-float
        (itauq)
        ((1 *)))
      (f2cl-lib:array-slice work
        double-float
        (nwork)
        ((1 *)))
      (f2cl-lib:int-add (f2cl-lib:int-sub lwork nwork) 1)
      ierr)
    (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                     var-6 var-7 var-8))
    (setf ierr var-9))
  (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i ldwrkr))
    ((> i m) nil)
    (tagbody
      (setf chunk
        (min
          (the fixnum
            (f2cl-lib:int-add (f2cl-lib:int-sub m i)
                              1))
          (the fixnum ldwrkr)))
      (dgemm "N" "N" chunk n n one
        (f2cl-lib:array-slice a
          double-float
          (i 1)
          ((1 lda) (1 *)))
        lda
        (f2cl-lib:array-slice work double-float (iu) ((1 *)))
        ldwrku zero
        (f2cl-lib:array-slice work double-float (ir) ((1 *)))
        ldwrkr)
      (dlacpy "F" chunk n
        (f2cl-lib:array-slice work double-float (ir) ((1 *)))
        ldwrkr
        (f2cl-lib:array-slice a
          double-float
          (i 1)
          ((1 lda) (1 *)))
        lda))))))
(wntqs

```

```

(dlaset "F" m n zero zero u ldu)
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
   var-9 var-10 var-11 var-12 var-13)
  (dbdsdc "U" "I" n s
   (f2cl-lib:array-slice work double-float (ie) ((1 *))) u
   ldu vt ldvt dum idum
   (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
   iwork info)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                   var-7 var-8 var-9 var-10 var-11 var-12))
  (setf info var-13))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
   var-9 var-10 var-11 var-12 var-13)
  (dormbr "Q" "L" "N" m n n a lda
   (f2cl-lib:array-slice work double-float (itauq) ((1 *)))
   u ldu
   (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
   (f2cl-lib:int-add (f2cl-lib:int-sub lwork nwork) 1) ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                   var-7 var-8 var-9 var-10 var-11 var-12))
  (setf ierr var-13))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
   var-9 var-10 var-11 var-12 var-13)
  (dormbr "P" "R" "T" n n n a lda
   (f2cl-lib:array-slice work double-float (itaup) ((1 *)))
   vt ldvt
   (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
   (f2cl-lib:int-add (f2cl-lib:int-sub lwork nwork) 1) ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                   var-7 var-8 var-9 var-10 var-11 var-12))
  (setf ierr var-13)))
(wntqa
 (dlaset "F" m m zero zero u ldu)
 (multiple-value-bind
   (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
    var-9 var-10 var-11 var-12 var-13)
   (dbdsdc "U" "I" n s
    (f2cl-lib:array-slice work double-float (ie) ((1 *))) u
    ldu vt ldvt dum idum
    (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
    iwork info)
   (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                   var-7 var-8 var-9 var-10 var-11 var-12))

```

```

    (setf info var-13))
  (dlaset "F" (f2cl-lib:int-sub m n) (f2cl-lib:int-sub m n) zero
one
  (f2cl-lib:array-slice u
    double-float
    ((+ n 1) (f2cl-lib:int-add n 1))
    ((1 ldu) (1 *)))
  ldu)
  (multiple-value-bind
    (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
var-9 var-10 var-11 var-12 var-13)
    (dormbr "Q" "L" "N" m m n a lda
      (f2cl-lib:array-slice work double-float (itauq) ((1 *)))
      u ldu
      (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
      (f2cl-lib:int-add (f2cl-lib:int-sub lwork nwork) 1) ierr)
    (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
var-7 var-8 var-9 var-10 var-11 var-12))
    (setf ierr var-13))
  (multiple-value-bind
    (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
var-9 var-10 var-11 var-12 var-13)
    (dormbr "P" "R" "T" n n m a lda
      (f2cl-lib:array-slice work double-float (itaup) ((1 *)))
      vt ldvt
      (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
      (f2cl-lib:int-add (f2cl-lib:int-sub lwork nwork) 1) ierr)
    (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
var-7 var-8 var-9 var-10 var-11 var-12))
    (setf ierr var-13))))))
  (t
    (cond
      ((>= n mnthr)
        (cond
          (wntqn
            (setf itau 1)
            (setf nwork (f2cl-lib:int-add itau m))
            (multiple-value-bind
              (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7)
              (dgelqf m n a lda
                (f2cl-lib:array-slice work double-float (itau) ((1 *)))
                (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
                (f2cl-lib:int-add (f2cl-lib:int-sub lwork nwork) 1) ierr)
              (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6))
              (setf ierr var-7))
            (dlaset "U" (f2cl-lib:int-sub m 1) (f2cl-lib:int-sub m 1) zero

```

```

zero
(f2cl-lib:array-slice a double-float (1 2) ((1 lda) (1 *)))
lda)
(setf ie 1)
(setf itauq (f2cl-lib:int-add ie m))
(setf itaup (f2cl-lib:int-add itauq m))
(setf nwork (f2cl-lib:int-add itaup m))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
   var-9 var-10)
  (dgebrd m m a lda s
   (f2cl-lib:array-slice work double-float (ie) ((1 *)))
   (f2cl-lib:array-slice work double-float (itauq) ((1 *)))
   (f2cl-lib:array-slice work double-float (itaup) ((1 *)))
   (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
   (f2cl-lib:int-add (f2cl-lib:int-sub lwork nwork) 1) ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                   var-7 var-8 var-9))
  (setf ierr var-10))
(setf nwork (f2cl-lib:int-add ie m))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
   var-9 var-10 var-11 var-12 var-13)
  (dbdsdc "U" "N" m s
   (f2cl-lib:array-slice work double-float (ie) ((1 *))) dum
   1 dum 1 dum idum
   (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
   iwork info)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                   var-7 var-8 var-9 var-10 var-11 var-12))
  (setf info var-13)))
(wntqo
 (setf ivt 1)
 (setf il (f2cl-lib:int-add ivt (f2cl-lib:int-mul m m)))
 (cond
  ((>= lwork
    (f2cl-lib:int-add (f2cl-lib:int-mul m n)
                      (f2cl-lib:int-mul m m)
                      (f2cl-lib:int-mul 3 m)
                      bdspace))
   (setf ldwrkl m)
   (setf chunk n))
  (t
   (setf ldwrkl m)
   (setf chunk
    (the fixnum

```



```

(truncate (- lwork (* m m)) m))))
(setf itau (f2cl-lib:int-add il (f2cl-lib:int-mul ldwrkl m)))
(setf nwork (f2cl-lib:int-add itau m))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7)
  (dgelqf m n a lda
    (f2cl-lib:array-slice work double-float (itau) ((1 *)))
    (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
    (f2cl-lib:int-add (f2cl-lib:int-sub lwork nwork) 1) ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6))
  (setf ierr var-7))
(dlacpy "L" m m a lda
  (f2cl-lib:array-slice work double-float (il) ((1 *))) ldwrkl)
(dlaset "U" (f2cl-lib:int-sub m 1) (f2cl-lib:int-sub m 1) zero
  zero
  (f2cl-lib:array-slice work
    double-float
    ((+ il ldwrkl))
    ((1 *)))
  ldwrkl)
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8)
  (dorglq m n m a lda
    (f2cl-lib:array-slice work double-float (itau) ((1 *)))
    (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
    (f2cl-lib:int-add (f2cl-lib:int-sub lwork nwork) 1) ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
    var-7))
  (setf ierr var-8))
(setf ie itau)
(setf itauq (f2cl-lib:int-add ie m))
(setf itaup (f2cl-lib:int-add itauq m))
(setf nwork (f2cl-lib:int-add itaup m))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
    var-9 var-10)
  (dgebrd m m
    (f2cl-lib:array-slice work double-float (il) ((1 *)))
    ldwrkl s
    (f2cl-lib:array-slice work double-float (ie) ((1 *)))
    (f2cl-lib:array-slice work double-float (itauq) ((1 *)))
    (f2cl-lib:array-slice work double-float (itaup) ((1 *)))
    (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
    (f2cl-lib:int-add (f2cl-lib:int-sub lwork nwork) 1) ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
    var-7 var-8 var-9))

```

```

    (setf ierr var-10))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
   var-9 var-10 var-11 var-12 var-13)
  (dbdsdc "U" "I" m s
    (f2cl-lib:array-slice work double-float (ie) ((1 *))) u
    ldu
    (f2cl-lib:array-slice work double-float (ivt) ((1 *))) m
    dum idum
    (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
    iwork info)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
    var-7 var-8 var-9 var-10 var-11 var-12))
  (setf info var-13))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
   var-9 var-10 var-11 var-12 var-13)
  (dormbr "Q" "L" "N" m m m
    (f2cl-lib:array-slice work double-float (il) ((1 *)))
    ldwrkl
    (f2cl-lib:array-slice work double-float (itauq) ((1 *)))
    u ldu
    (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
    (f2cl-lib:int-add (f2cl-lib:int-sub lwork nwork) 1) ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
    var-7 var-8 var-9 var-10 var-11 var-12))
  (setf ierr var-13))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
   var-9 var-10 var-11 var-12 var-13)
  (dormbr "P" "R" "T" m m m
    (f2cl-lib:array-slice work double-float (il) ((1 *)))
    ldwrkl
    (f2cl-lib:array-slice work double-float (itaup) ((1 *)))
    (f2cl-lib:array-slice work double-float (ivt) ((1 *))) m
    (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
    (f2cl-lib:int-add (f2cl-lib:int-sub lwork nwork) 1) ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
    var-7 var-8 var-9 var-10 var-11 var-12))
  (setf ierr var-13))
(f2cl-lib:fdo (i 1 (f2cl-lib:int-add i chunk))
  (> i n) nil)
(tagbody
  (setf blk
    (min
      (the fixnum

```

```

                (f2cl-lib:int-add (f2cl-lib:int-sub n i) 1))
                (the fixnum chunk)))
(dgemm "N" "N" m blk m one
  (f2cl-lib:array-slice work double-float (ivt) ((1 *))) m
  (f2cl-lib:array-slice a
    double-float
    (1 i)
    ((1 lda) (1 *)))

lda zero
(f2cl-lib:array-slice work double-float (il) ((1 *)))
ldwrkl)
(dlacpy "F" m blk
  (f2cl-lib:array-slice work double-float (il) ((1 *)))
  ldwrkl
  (f2cl-lib:array-slice a
    double-float
    (1 i)
    ((1 lda) (1 *)))

lda)))
(wntqs
  (setf il 1)
  (setf ldwrkl m)
  (setf itau (f2cl-lib:int-add il (f2cl-lib:int-mul ldwrkl m)))
  (setf nwork (f2cl-lib:int-add itau m))
  (multiple-value-bind
    (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7)
    (dgelqf m n a lda
      (f2cl-lib:array-slice work double-float (itau) ((1 *)))
      (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
      (f2cl-lib:int-add (f2cl-lib:int-sub lwork nwork) 1) ierr)
    (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6))
    (setf ierr var-7))
  (dlacpy "L" m m a lda
    (f2cl-lib:array-slice work double-float (il) ((1 *))) ldwrkl)
  (dlaset "U" (f2cl-lib:int-sub m 1) (f2cl-lib:int-sub m 1) zero
    zero
    (f2cl-lib:array-slice work
      double-float
      ((+ il ldwrkl))
      ((1 *)))

  ldwrkl)
  (multiple-value-bind
    (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8)
    (dorglq m n m a lda
      (f2cl-lib:array-slice work double-float (itau) ((1 *)))
      (f2cl-lib:array-slice work double-float (nwork) ((1 *)))

```

```

      (f2cl-lib:int-add (f2cl-lib:int-sub lwork nwork) 1) ierr)
    (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
      var-7))
    (setf ierr var-8))
  (setf ie itau)
  (setf itauq (f2cl-lib:int-add ie m))
  (setf itaup (f2cl-lib:int-add itauq m))
  (setf nwork (f2cl-lib:int-add itaup m))
  (multiple-value-bind
    (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
     var-9 var-10)
    (dgebrd m m
      (f2cl-lib:array-slice work double-float (il) ((1 *)))
      ldwrkl s
      (f2cl-lib:array-slice work double-float (ie) ((1 *)))
      (f2cl-lib:array-slice work double-float (itauq) ((1 *)))
      (f2cl-lib:array-slice work double-float (itaup) ((1 *)))
      (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
      (f2cl-lib:int-add (f2cl-lib:int-sub lwork nwork) 1) ierr)
    (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
      var-7 var-8 var-9))
    (setf ierr var-10))
  (multiple-value-bind
    (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
     var-9 var-10 var-11 var-12 var-13)
    (dbdsdc "U" "I" m s
      (f2cl-lib:array-slice work double-float (ie) ((1 *))) u
      ldu vt ldvt dum idum
      (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
      iwork info)
    (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
      var-7 var-8 var-9 var-10 var-11 var-12))
    (setf info var-13))
  (multiple-value-bind
    (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
     var-9 var-10 var-11 var-12 var-13)
    (dormbr "Q" "L" "N" m m m
      (f2cl-lib:array-slice work double-float (il) ((1 *)))
      ldwrkl
      (f2cl-lib:array-slice work double-float (itauq) ((1 *)))
      u ldu
      (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
      (f2cl-lib:int-add (f2cl-lib:int-sub lwork nwork) 1) ierr)
    (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
      var-7 var-8 var-9 var-10 var-11 var-12))
    (setf ierr var-13))

```

```

(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
   var-9 var-10 var-11 var-12 var-13)
  (dormbr "P" "R" "T" m m m
   (f2cl-lib:array-slice work double-float (il) ((1 *)))
   ldwrkl
   (f2cl-lib:array-slice work double-float (itaup) ((1 *)))
   vt ldvt
   (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
   (f2cl-lib:int-add (f2cl-lib:int-sub lwork nwork) 1) ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                   var-7 var-8 var-9 var-10 var-11 var-12))
  (setf ierr var-13))
(dlacpy "F" m m vt ldvt
 (f2cl-lib:array-slice work double-float (il) ((1 *))) ldwrkl)
(dgemm "N" "N" m n m one
 (f2cl-lib:array-slice work double-float (il) ((1 *))) ldwrkl
 a lda zero vt ldvt))
(wntqa
 (setf ivt 1)
 (setf ldwkv m)
 (setf itau (f2cl-lib:int-add ivt (f2cl-lib:int-mul ldwkv m)))
 (setf nwork (f2cl-lib:int-add itau m))
 (multiple-value-bind
   (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7)
   (dgelqf m n a lda
    (f2cl-lib:array-slice work double-float (itau) ((1 *)))
    (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
    (f2cl-lib:int-add (f2cl-lib:int-sub lwork nwork) 1) ierr)
   (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6))
   (setf ierr var-7))
  (dlacpy "U" m n a lda vt ldvt)
  (multiple-value-bind
    (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8)
    (dorglq n n m vt ldvt
     (f2cl-lib:array-slice work double-float (itau) ((1 *)))
     (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork nwork) 1) ierr)
    (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                     var-7))
    (setf ierr var-8))
  (dlaset "U" (f2cl-lib:int-sub m 1) (f2cl-lib:int-sub m 1) zero
   zero
   (f2cl-lib:array-slice a double-float (1 2) ((1 lda) (1 *)))
   lda)
  (setf ie itau)

```

```

(setf itauq (f2cl-lib:int-add ie m))
(setf itaup (f2cl-lib:int-add itauq m))
(setf nwork (f2cl-lib:int-add itaup m))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
   var-9 var-10)
  (dgebrd m m a lda s
   (f2cl-lib:array-slice work double-float (ie) ((1 *)))
   (f2cl-lib:array-slice work double-float (itauq) ((1 *)))
   (f2cl-lib:array-slice work double-float (itaup) ((1 *)))
   (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
   (f2cl-lib:int-add (f2cl-lib:int-sub lwork nwork) 1) ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                   var-7 var-8 var-9))
  (setf ierr var-10))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
   var-9 var-10 var-11 var-12 var-13)
  (dbdsdc "U" "I" m s
   (f2cl-lib:array-slice work double-float (ie) ((1 *))) u
   ldu
   (f2cl-lib:array-slice work double-float (ivt) ((1 *)))
   ldwkv t dum idum
   (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
   iwork info)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                   var-7 var-8 var-9 var-10 var-11 var-12))
  (setf info var-13))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
   var-9 var-10 var-11 var-12 var-13)
  (dormbr "Q" "L" "N" m m m a lda
   (f2cl-lib:array-slice work double-float (itauq) ((1 *)))
   u ldu
   (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
   (f2cl-lib:int-add (f2cl-lib:int-sub lwork nwork) 1) ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                   var-7 var-8 var-9 var-10 var-11 var-12))
  (setf ierr var-13))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
   var-9 var-10 var-11 var-12 var-13)
  (dormbr "P" "R" "T" m m m a lda
   (f2cl-lib:array-slice work double-float (itaup) ((1 *)))
   (f2cl-lib:array-slice work double-float (ivt) ((1 *)))
   ldwkv t

```

```

(f2cl-lib:array-slice work double-float (nwork) ((1 *)))
(f2cl-lib:int-add (f2cl-lib:int-sub lwork nwork) 1) ierr)
(declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
              var-7 var-8 var-9 var-10 var-11 var-12))
(setf ierr var-13))
(dgemm "N" "N" m n m one
(f2cl-lib:array-slice work double-float (ivt) ((1 *))) ldwkv
vt ldvt zero a lda)
(dlacpy "F" m n a lda vt ldvt))))
(t
(setf ie 1)
(setf itauq (f2cl-lib:int-add ie m))
(setf itaup (f2cl-lib:int-add itauq m))
(setf nwork (f2cl-lib:int-add itaup m))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
   var-9 var-10)
  (dgebrd m n a lda s
(f2cl-lib:array-slice work double-float (ie) ((1 *)))
(f2cl-lib:array-slice work double-float (itauq) ((1 *)))
(f2cl-lib:array-slice work double-float (itaup) ((1 *)))
(f2cl-lib:array-slice work double-float (nwork) ((1 *)))
(f2cl-lib:int-add (f2cl-lib:int-sub lwork nwork) 1) ierr)
(declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
              var-7 var-8 var-9))
(setf ierr var-10))
(cond
(wntqn
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
   var-9 var-10 var-11 var-12 var-13)
  (dbdsdc "L" "N" m s
(f2cl-lib:array-slice work double-float (ie) ((1 *))) dum
1 dum 1 dum idum
(f2cl-lib:array-slice work double-float (nwork) ((1 *)))
iwork info)
(declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
              var-7 var-8 var-9 var-10 var-11 var-12))
(setf info var-13)))
(wntqo
(setf ldwkv m)
(setf ivt nwork)
(cond
(>= lwork
(f2cl-lib:int-add (f2cl-lib:int-mul m n)
(f2cl-lib:int-mul 3 m)

```

```

                                bdspace))
(dlaset "F" m n zero zero
 (f2cl-lib:array-slice work double-float (ivt) ((1 *)))
 ldwkv)
(setf nwork
  (f2cl-lib:int-add ivt (f2cl-lib:int-mul ldwkv n)))
(t
 (setf nwork
  (f2cl-lib:int-add ivt (f2cl-lib:int-mul ldwkv m)))
 (setf il nwork)
 (setf chunk
  (the fixnum
   (truncate (- lwork (* m m) (* 3 m) m))))))
(multiple-value-bind
 (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
  var-9 var-10 var-11 var-12 var-13)
 (dbdsdc "L" "I" m s
  (f2cl-lib:array-slice work double-float (ie) ((1 *))) u
  ldu
  (f2cl-lib:array-slice work double-float (ivt) ((1 *)))
  ldwkv dum idum
  (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
  iwork info)
 (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
  var-7 var-8 var-9 var-10 var-11 var-12))
 (setf info var-13))
(multiple-value-bind
 (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
  var-9 var-10 var-11 var-12 var-13)
 (dormbr "Q" "L" "N" m m n a lda
  (f2cl-lib:array-slice work double-float (itauq) ((1 *)))
  u ldu
  (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
  (f2cl-lib:int-add (f2cl-lib:int-sub lwork nwork) 1) ierr)
 (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
  var-7 var-8 var-9 var-10 var-11 var-12))
 (setf ierr var-13))
(cond
 ((>= lwork
  (f2cl-lib:int-add (f2cl-lib:int-mul m n)
   (f2cl-lib:int-mul 3 m)
   bdspace))
  (multiple-value-bind
   (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
    var-8 var-9 var-10 var-11 var-12 var-13)
   (dormbr "P" "R" "T" m n m a lda

```



```

(f2cl-lib:array-slice work
  double-float
  (itaup)
  ((1 *)))
(f2cl-lib:array-slice work double-float (ivt) ((1 *)))
ldwkv
(f2cl-lib:array-slice work
  double-float
  (nwork)
  ((1 *)))
(f2cl-lib:int-add (f2cl-lib:int-sub lwork nwork) 1)
ierr)
(declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
  var-6 var-7 var-8 var-9 var-10 var-11
  var-12))
(setf ierr var-13))
(dlacpy "F" m n
  (f2cl-lib:array-slice work double-float (ivt) ((1 *)))
  ldwkv a lda))
(t
  (multiple-value-bind
    (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
     var-8 var-9)
    (dorgbr "P" m n m a lda
      (f2cl-lib:array-slice work
        double-float
        (itaup)
        ((1 *)))
      (f2cl-lib:array-slice work
        double-float
        (nwork)
        ((1 *)))
      (f2cl-lib:int-add (f2cl-lib:int-sub lwork nwork) 1)
      ierr)
    (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
      var-6 var-7 var-8))
    (setf ierr var-9))
  (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i chunk))
    (> i n) nil)
  (tagbody
    (setf blk
      (min
        (the fixnum
          (f2cl-lib:int-add (f2cl-lib:int-sub n i)
            1))
        (the fixnum chunk)))

```

```

(dgemm "N" "N" m blk m one
 (f2cl-lib:array-slice work double-float (ivt) ((1 *)))
 ldwkv
 (f2cl-lib:array-slice a
                        double-float
                        (1 i)
                        ((1 lda) (1 *)))

 lda zero
 (f2cl-lib:array-slice work double-float (il) ((1 *)))
 m)
(dlacpy "F" m blk
 (f2cl-lib:array-slice work double-float (il) ((1 *)))
 m
 (f2cl-lib:array-slice a
                        double-float
                        (1 i)
                        ((1 lda) (1 *)))

 lda))))))
(wntqs
 (dlaset "F" m n zero zero vt ldvt)
 (multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
   var-9 var-10 var-11 var-12 var-13)
  (dbdsdc "L" "I" m s
   (f2cl-lib:array-slice work double-float (ie) ((1 *))) u
   ldu vt ldvt dum idum
   (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
   iwork info)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                   var-7 var-8 var-9 var-10 var-11 var-12))
  (setf info var-13))
 (multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
   var-9 var-10 var-11 var-12 var-13)
  (dormbr "Q" "L" "N" m m n a lda
   (f2cl-lib:array-slice work double-float (itauq) ((1 *)))
   u ldu
   (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
   (f2cl-lib:int-add (f2cl-lib:int-sub lwork nwork) 1) ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                   var-7 var-8 var-9 var-10 var-11 var-12))
  (setf ierr var-13))
 (multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
   var-9 var-10 var-11 var-12 var-13)
  (dormbr "P" "R" "T" m n m a lda

```

```

(f2cl-lib:array-slice work double-float (itaup) ((1 *)))
vt ldvt
(f2cl-lib:array-slice work double-float (nwork) ((1 *)))
(f2cl-lib:int-add (f2cl-lib:int-sub lwork nwork) 1) ierr)
(declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
              var-7 var-8 var-9 var-10 var-11 var-12))
(setf ierr var-13)))
(wntqa
(dlaset "F" n n zero zero vt ldvt)
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
   var-9 var-10 var-11 var-12 var-13)
  (dbdsdc "L" "I" m s
   (f2cl-lib:array-slice work double-float (ie) ((1 *))) u
   ldu vt ldvt dum idum
   (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
   iwork info)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                    var-7 var-8 var-9 var-10 var-11 var-12))
  (setf info var-13))
(dlaset "F" (f2cl-lib:int-sub n m) (f2cl-lib:int-sub n m) zero
one
(f2cl-lib:array-slice vt
                        double-float
                        ((+ m 1) (f2cl-lib:int-add m 1))
                        ((1 ldvt) (1 *)))
ldvt)
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
   var-9 var-10 var-11 var-12 var-13)
  (dormbr "Q" "L" "N" m m n a lda
   (f2cl-lib:array-slice work double-float (itauq) ((1 *)))
   u ldu
   (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
   (f2cl-lib:int-add (f2cl-lib:int-sub lwork nwork) 1) ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                    var-7 var-8 var-9 var-10 var-11 var-12))
  (setf ierr var-13))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
   var-9 var-10 var-11 var-12 var-13)
  (dormbr "P" "R" "T" n n m a lda
   (f2cl-lib:array-slice work double-float (itaup) ((1 *)))
   vt ldvt
   (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
   (f2cl-lib:int-add (f2cl-lib:int-sub lwork nwork) 1) ierr)

```

```

        (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                      var-7 var-8 var-9 var-10 var-11 var-12))
        (setf ierr var-13)))))))))
(cond
  ((= iscl 1)
   (if (> anrm bignum)
       (multiple-value-bind
         (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
          var-9)
         (dlascl "G" 0 0 bignum anrm minmn 1 s minmn ierr)
         (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                          var-7 var-8))
         (setf ierr var-9)))
       (if (< anrm smlnum)
           (multiple-value-bind
             (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
              var-9)
             (dlascl "G" 0 0 smlnum anrm minmn 1 s minmn ierr)
             (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                              var-7 var-8))
             (setf ierr var-9))))
      (setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)
            (coerce (realpart maxwrk) 'double-float)))
end_label
(return
 (values nil nil nil nil nil nil nil nil nil nil nil nil nil info))))))

```

## 7.17 dgesvd LAPACK

```

⟨dgesvd.input⟩≡
)set break resume
)sys rm -f dgesvd.output
)spool dgesvd.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)

```

`<dgesvd.help>=`

```
=====
dgesvd examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

DGESVD - the singular value decomposition (SVD) of a real M-by-N matrix A, optionally computing the left and/or right singular vectors

#### SYNOPSIS

```
SUBROUTINE DGESVD( JOBU, JOBVT, M, N, A, LDA, S, U, LDU, VT, LDVT,
                   WORK, LWORK, INFO )
```

```
CHARACTER        JOBU, JOBVT
```

```
INTEGER          INFO, LDA, LDU, LDVT, LWORK, M, N
```

```
DOUBLE           PRECISION A( LDA, * ), S( * ), U( LDU, * ), VT(
LDVT, * ), WORK( * )
```

#### PURPOSE

DGESVD computes the singular value decomposition (SVD) of a real M-by-N matrix A, optionally computing the left and/or right singular vectors. The SVD is written

$$A = U * \text{SIGMA} * \text{transpose}(V)$$

where SIGMA is an M-by-N matrix which is zero except for its min(m,n) diagonal elements, U is an M-by-M orthogonal matrix, and V is an N-by-N orthogonal matrix. The diagonal elements of SIGMA are the singular values of A; they are real and non-negative, and are returned in descending order. The first min(m,n) columns of U and V are the left and right singular vectors of A.

Note that the routine returns V\*\*T, not V.

#### ARGUMENTS

JOBU (input) CHARACTER\*1

Specifies options for computing all or part of the matrix U:

= 'A': all M columns of U are returned in array U:

= 'S': the first min(m,n) columns of U (the left singular vec-

tors) are returned in the array U; = 'O': the first  $\min(m,n)$  columns of U (the left singular vectors) are overwritten on the array A; = 'N': no columns of U (no left singular vectors) are computed.

**JOBVT** (input) CHARACTER\*1  
 Specifies options for computing all or part of the matrix  $V^{**T}$ :  
 = 'A': all N rows of  $V^{**T}$  are returned in the array VT;  
 = 'S': the first  $\min(m,n)$  rows of  $V^{**T}$  (the right singular vectors) are returned in the array VT; = 'O': the first  $\min(m,n)$  rows of  $V^{**T}$  (the right singular vectors) are overwritten on the array A; = 'N': no rows of  $V^{**T}$  (no right singular vectors) are computed.

JOBVT and JOBU cannot both be 'O'.

**M** (input) INTEGER  
 The number of rows of the input matrix A.  $M \geq 0$ .

**N** (input) INTEGER  
 The number of columns of the input matrix A.  $N \geq 0$ .

**A** (input/output) DOUBLE PRECISION array, dimension (LDA,N)  
 On entry, the M-by-N matrix A. On exit, if JOBU = 'O', A is overwritten with the first  $\min(m,n)$  columns of U (the left singular vectors, stored columnwise); if JOBVT = 'O', A is overwritten with the first  $\min(m,n)$  rows of  $V^{**T}$  (the right singular vectors, stored rowwise); if JOBU .ne. 'O' and JOBVT .ne. 'O', the contents of A are destroyed.

**LDA** (input) INTEGER  
 The leading dimension of the array A.  $LDA \geq \max(1,M)$ .

**S** (output) DOUBLE PRECISION array, dimension (min(M,N))  
 The singular values of A, sorted so that  $S(i) \geq S(i+1)$ .

**U** (output) DOUBLE PRECISION array, dimension (LDU,UCOL)  
 (LDU,M) if JOBU = 'A' or (LDU,min(M,N)) if JOBU = 'S'. If JOBU = 'A', U contains the M-by-M orthogonal matrix U; if JOBU = 'S', U contains the first  $\min(m,n)$  columns of U (the left singular vectors, stored columnwise); if JOBU = 'N' or 'O', U is not referenced.

**LDU** (input) INTEGER  
 The leading dimension of the array U.  $LDU \geq 1$ ; if JOBU = 'S' or 'A',  $LDU \geq M$ .

VT (output) DOUBLE PRECISION array, dimension (LDVT,N)  
 If JOBVT = 'A', VT contains the N-by-N orthogonal matrix  $V^{**T}$ ;  
 if JOBVT = 'S', VT contains the first  $\min(m,n)$  rows of  $V^{**T}$   
 (the right singular vectors, stored rowwise); if JOBVT = 'N' or  
 'O', VT is not referenced.

LDVT (input) INTEGER  
 The leading dimension of the array VT. LDVT  $\geq 1$ ; if JOBVT =  
 'A', LDVT  $\geq N$ ; if JOBVT = 'S', LDVT  $\geq \min(M,N)$ .

WORK (workspace/output) DOUBLE PRECISION array, dimension  
 (MAX(1,LWORK))  
 On exit, if INFO = 0, WORK(1) returns the optimal LWORK; if  
 INFO  $> 0$ , WORK(2:MIN(M,N)) contains the unconverged superdiago-  
 nal elements of an upper bidiagonal matrix B whose diagonal is  
 in S (not necessarily sorted). B satisfies  $A = U * B * VT$ , so  
 it has the same singular values as A, and singular vectors  
 related by U and VT.

LWORK (input) INTEGER  
 The dimension of the array WORK. LWORK  $\geq$   
 MAX(1,3\*MIN(M,N)+MAX(M,N),5\*MIN(M,N)). For good performance,  
 LWORK should generally be larger.

If LWORK = -1, then a workspace query is assumed; the routine  
 only calculates the optimal size of the WORK array, returns  
 this value as the first entry of the WORK array, and no error  
 message related to LWORK is issued by XERBLA.

INFO (output) INTEGER  
 = 0: successful exit.  
 < 0: if INFO = -i, the i-th argument had an illegal value.  
 > 0: if DBDSQR did not converge, INFO specifies how many  
 superdiagonals of an intermediate bidiagonal form B did not  
 converge to zero. See the description of WORK above for  
 details.

```

(LAPACK dgesvd)=
  (let* ((zero 0.0) (one 1.0))
    (declare (type (double-float 0.0 0.0) zero)
              (type (double-float 1.0 1.0) one))
    (defun dgesvd (jobu jobvt m n a lda s u ldu vt ldvt work lwork info)
      (declare (type (simple-array double-float (*)) work vt u s a)
                (type fixnum info lwork ldvt ldu lda n m)
                (type character jobvt jobu))
      (f2cl-lib:with-multi-array-data
        ((jobu character jobu-%data% jobu-%offset%)
         (jobvt character jobvt-%data% jobvt-%offset%)
         (a double-float a-%data% a-%offset%)
         (s double-float s-%data% s-%offset%)
         (u double-float u-%data% u-%offset%)
         (vt double-float vt-%data% vt-%offset%)
         (work double-float work-%data% work-%offset%))
        (prog ((dum (make-array 1 :element-type 'double-float)) (anrm 0.0)
              (bignum 0.0) (eps 0.0) (smlnum 0.0) (bdspac 0) (blk 0) (chunk 0)
              (i 0) (ie 0) (ierr 0) (ir 0) (iscl 0) (itau 0) (itaup 0) (itauq 0)
              (iu 0) (iwork 0) (ldwrkr 0) (ldwrku 0) (maxwrk 0) (minmn 0)
              (minwrk 0) (mnthr 0) (ncu 0) (ncvt 0) (nru 0) (nrvt 0) (wrkbl 0)
              (lquery nil) (wntua nil) (wntuas nil) (wntun nil) (wntuo nil)
              (wntus nil) (wntva nil) (wntvas nil) (wntvn nil) (wntvo nil)
              (wntvs nil))
              (declare (type (simple-array double-float (1)) dum)
                        (type (double-float) anrm bignum eps smlnum)
                        (type fixnum bdspac blk chunk i ie ierr ir iscl
                                itau itaup itauq iu iwork ldwrkr
                                ldwrku maxwrk minmn minwrk mnthr ncu
                                ncvt nru nrvt wrkbl)
                        (type (member t nil) lquery wntua wntuas wntun wntuo wntus
                                wntva wntvas wntvn wntvo wntvs))

              (setf info 0)
              (setf minmn (min (the fixnum m) (the fixnum n)))
              (setf mnthr (ilaenv 6 "DGESVD" (f2cl-lib:f2cl-// jobu jobvt) m n 0 0))
              (setf wntua (char-equal jobu #\A))
              (setf wntus (char-equal jobu #\S))
              (setf wntuas (or wntua wntus))
              (setf wntuo (char-equal jobu #\0))
              (setf wntun (char-equal jobu #\N))
              (setf wntva (char-equal jobvt #\A))
              (setf wntvs (char-equal jobvt #\S))
              (setf wntvas (or wntva wntvs))
              (setf wntvo (char-equal jobvt #\0))
              (setf wntvn (char-equal jobvt #\N))
              (setf minwrk 1)

```



```

(setf lquery (coerce (= lwork -1) '(member t nil)))
(cond
  ((not (or wntua wntus wntuo wntun))
   (setf info -1))
  ((or (not (or wntva wntvs wntvo wntvn)) (and wntvo wntuo))
   (setf info -2))
  ((< m 0)
   (setf info -3))
  ((< n 0)
   (setf info -4))
  ((< lda (max (the fixnum 1) (the fixnum m)))
   (setf info -6))
  ((or (< ldu 1) (and wntuas (< ldu m)))
   (setf info -9))
  ((or (< ldvt 1) (and wntva (< ldvt n)) (and wntvs (< ldvt minmn)))
   (setf info -11)))
(cond
  ((and (= info 0) (or (>= lwork 1) lquery) (> m 0) (> n 0))
   (cond
     ((>= m n)
      (setf bdspac (f2cl-lib:int-mul 5 n))
      (cond
        ((>= m mnthr)
         (cond
           (wntun
            (setf maxwrk
                  (f2cl-lib:int-add n
                                     (f2cl-lib:int-mul n
                                                         (ilaenv 1
                                                            "DGEQRF" " " " m
                                                            n -1 -1))))))
          (setf maxwrk
                (max (the fixnum maxwrk)
                     (the fixnum
                      (f2cl-lib:int-add (f2cl-lib:int-mul 3 n)
                                         (f2cl-lib:int-mul 2
                                                             n
                                                             (ilaenv 1
                                                                "DGEBR"
                                                                " "
                                                                n n
                                                                -1
                                                                -1))))))
            (if (or wntvo wntvas)
                (setf maxwrk

```

```

(max (the fixnum maxwrk)
  (the fixnum
    (f2cl-lib:int-add
      (f2cl-lib:int-mul 3 n)
      (f2cl-lib:int-mul
        (f2cl-lib:int-sub n 1)
        (ilaenv 1 "DORGBR" "P" n n n
          -1))))))
(setf maxwrk
  (max (the fixnum maxwrk)
    (the fixnum bdspac)))
(setf minwrk
  (max (the fixnum (f2cl-lib:int-mul 4 n))
    (the fixnum bdspac)))
(setf maxwrk
  (max (the fixnum maxwrk)
    (the fixnum minwrk)))
((and wntuo wntvn)
  (setf wrkbl
    (f2cl-lib:int-add n
      (f2cl-lib:int-mul n
        (ilaenv 1
          "DGEQRF" " " " m
            n -1 -1))))))
(setf wrkbl
  (max (the fixnum wrkbl)
    (the fixnum
      (f2cl-lib:int-add n
        (f2cl-lib:int-mul n
          (ilaenv
            1
            "DORGQR"
            " "
            m n
            n
            -1))))))
(setf wrkbl
  (max (the fixnum wrkbl)
    (the fixnum
      (f2cl-lib:int-add (f2cl-lib:int-mul 3 n)
        (f2cl-lib:int-mul 2
          n
          (ilaenv
            1
            "DGEBRD"
            " "

```

```

n n
-1
-1)))

(setf wrkbl
  (max (the fixnum wrkbl)
        (the fixnum
          (f2cl-lib:int-add (f2cl-lib:int-mul 3 n)
                            (f2cl-lib:int-mul n
          (ilaenv 1
            "DORGB"
            "Q"
            n n
            n
            -1))))))

(setf wrkbl
  (max (the fixnum wrkbl)
        (the fixnum bdspace)))
(setf maxwrk
  (max
    (the fixnum
      (f2cl-lib:int-add (f2cl-lib:int-mul n n)
                        wrkbl))
    (the fixnum
      (f2cl-lib:int-add (f2cl-lib:int-mul n n)
                        (f2cl-lib:int-mul m n)
                        n))))))

(setf minwrk
  (max
    (the fixnum
      (f2cl-lib:int-add (f2cl-lib:int-mul 3 n) m))
    (the fixnum bdspace)))
(setf maxwrk
  (max (the fixnum maxwrk)
        (the fixnum minwrk))))
((and wntuo wntvas)
 (setf wrkbl
  (f2cl-lib:int-add n
                    (f2cl-lib:int-mul n
                    (ilaenv 1
                      "DGEQRF" " " " m
                      n -1 -1))))))

(setf wrkbl
  (max (the fixnum wrkbl)
        (the fixnum
          (f2cl-lib:int-add n

```

```

(f2cl-lib:int-mul n
  (ilaenv
    1
    "DORGQR"
    " "
    m n
    n
    -1))))))

(setf wrkbl
  (max (the fixnum wrkbl)
    (the fixnum
      (f2cl-lib:int-add (f2cl-lib:int-mul 3 n)
        (f2cl-lib:int-mul 2
          n
          (ilaenv
            1
            "DGEBRD"
            " "
            n n
            -1
            -1))))))

(setf wrkbl
  (max (the fixnum wrkbl)
    (the fixnum
      (f2cl-lib:int-add (f2cl-lib:int-mul 3 n)
        (f2cl-lib:int-mul n
          (ilaenv
            1
            "DORGBR"
            "Q"
            n n
            n
            -1))))))

(setf wrkbl
  (max (the fixnum wrkbl)
    (the fixnum
      (f2cl-lib:int-add (f2cl-lib:int-mul 3 n)
        (f2cl-lib:int-mul
          (f2cl-lib:int-sub n 1)
          (ilaenv 1 "DORGBR" "P"
            n n n -1))))))

(setf wrkbl
  (max (the fixnum wrkbl)
    (the fixnum bdspace)))

(setf maxwrk
  (max

```

```

      (the fixnum
        (f2cl-lib:int-add (f2cl-lib:int-mul n n)
                           wrkbl))

      (the fixnum
        (f2cl-lib:int-add (f2cl-lib:int-mul n n)
                           (f2cl-lib:int-mul m n)
                           n))))

(setf minwrk
  (max
    (the fixnum
      (f2cl-lib:int-add (f2cl-lib:int-mul 3 n) m))
    (the fixnum bdspace)))

(setf maxwrk
  (max (the fixnum maxwrk)
        (the fixnum minwrk))))

((and wntus wntvn)
 (setf wrkbl
  (f2cl-lib:int-add n
    (f2cl-lib:int-mul n
      (ilaenv 1
        "DGEQRF" " " m
        n -1 -1)))))

(setf wrkbl
  (max (the fixnum wrkbl)
        (the fixnum
          (f2cl-lib:int-add n
            (f2cl-lib:int-mul n
              (ilaenv 1
                "DORGQR" " " m
                n -1 -1)))))

(setf wrkbl
  (max (the fixnum wrkbl)
        (the fixnum
          (f2cl-lib:int-add (f2cl-lib:int-mul 3 n)
            (f2cl-lib:int-mul 2
              n
              (ilaenv 1
                "DGEBR" " " m
                n n
                -1

```

```
-1))))))
(setf wrkbl
  (max (the fixnum wrkbl)
    (the fixnum
      (f2cl-lib:int-add (f2cl-lib:int-mul 3 n)
        (f2cl-lib:int-mul n
          (ilaenv
            1
            "DORGBR"
            "Q"
            n n
            n
            -1)))))))
(setf wrkbl
  (max (the fixnum wrkbl)
    (the fixnum bdspace)))
(setf maxwrk
  (f2cl-lib:int-add (f2cl-lib:int-mul n n) wrkbl))
(setf minwrk
  (max
    (the fixnum
      (f2cl-lib:int-add (f2cl-lib:int-mul 3 n) m))
    (the fixnum bdspace)))
(setf maxwrk
  (max (the fixnum maxwrk)
    (the fixnum minwrk)))
((and wntus wntvo)
  (setf wrkbl
    (f2cl-lib:int-add n
      (f2cl-lib:int-mul n
        (ilaenv 1
          "DGEQRF" " " " m
          n -1 -1)))))
(setf wrkbl
  (max (the fixnum wrkbl)
    (the fixnum
      (f2cl-lib:int-add n
        (f2cl-lib:int-mul n
          (ilaenv
            1
            "DORGQR"
            " " "
            m n
            n
            -1)))))))
(setf wrkbl
```

```

(max (the fixnum wrkbl)
  (the fixnum
    (f2cl-lib:int-add (f2cl-lib:int-mul 3 n)
      (f2cl-lib:int-mul 2
        n
        (ilaenv
          1
          "DGEBR"
          " "
          n n
          -1
          -1))))))

(setf wrkbl
  (max (the fixnum wrkbl)
    (the fixnum
      (f2cl-lib:int-add (f2cl-lib:int-mul 3 n)
        (f2cl-lib:int-mul n
          (ilaenv
            1
            "DORGB"
            "Q"
            n n
            n
            -1))))))

(setf wrkbl
  (max (the fixnum wrkbl)
    (the fixnum
      (f2cl-lib:int-add (f2cl-lib:int-mul 3 n)
        (f2cl-lib:int-mul
          (f2cl-lib:int-sub n 1)
          (ilaenv 1 "DORGBR" "P"
            n n n -1))))))

(setf wrkbl
  (max (the fixnum wrkbl)
    (the fixnum bdspace)))

(setf maxwrk
  (f2cl-lib:int-add (f2cl-lib:int-mul 2 n n) wrkbl))
(setf minwrk
  (max
    (the fixnum
      (f2cl-lib:int-add (f2cl-lib:int-mul 3 n) m))
    (the fixnum bdspace)))
(setf maxwrk
  (max (the fixnum maxwrk)
    (the fixnum minwrk)))
((and wntus wntvas)

```

```

(setf wrkbl
  (f2cl-lib:int-add n
    (f2cl-lib:int-mul n
      (ilaenv 1
        "DGEQRF" " " " m
        n -1 -1))))

(setf wrkbl
  (max (the fixnum wrkbl)
    (the fixnum
      (f2cl-lib:int-add n
        (f2cl-lib:int-mul n
          (ilaenv
            1
            "DORGQR"
            " "
            m n
            n
            -1))))))

(setf wrkbl
  (max (the fixnum wrkbl)
    (the fixnum
      (f2cl-lib:int-add (f2cl-lib:int-mul 3 n)
        (f2cl-lib:int-mul 2
          n
          (ilaenv
            1
            "DGEBRD"
            " "
            n n
            -1
            -1))))))

(setf wrkbl
  (max (the fixnum wrkbl)
    (the fixnum
      (f2cl-lib:int-add (f2cl-lib:int-mul 3 n)
        (f2cl-lib:int-mul n
          (ilaenv
            1
            "DORGBR"
            "Q"
            n n
            n
            -1))))))

(setf wrkbl
  (max (the fixnum wrkbl)
    (the fixnum

```



```

(f2cl-lib:int-add (f2cl-lib:int-mul 3 n)
  (f2cl-lib:int-mul
    (f2cl-lib:int-sub n 1)
    (ilaenv 1 "DORGBR" "P"
      n n n -1))))))
(setf wrkbl
  (max (the fixnum wrkbl)
    (the fixnum bdspace)))
(setf maxwrk
  (f2cl-lib:int-add (f2cl-lib:int-mul n n) wrkbl))
(setf minwrk
  (max
    (the fixnum
      (f2cl-lib:int-add (f2cl-lib:int-mul 3 n) m))
    (the fixnum bdspace)))
(setf maxwrk
  (max (the fixnum maxwrk)
    (the fixnum minwrk)))
((and wntua wntvn)
  (setf wrkbl
    (f2cl-lib:int-add n
      (f2cl-lib:int-mul n
        (ilaenv 1
          "DGEQRF" " " " m
            n -1 -1))))))
(setf wrkbl
  (max (the fixnum wrkbl)
    (the fixnum
      (f2cl-lib:int-add n
        (f2cl-lib:int-mul m
          (ilaenv 1
            "DORGQ" " " "
              m m
                n
                  -1))))))
(setf wrkbl
  (max (the fixnum wrkbl)
    (the fixnum
      (f2cl-lib:int-add (f2cl-lib:int-mul 3 n)
        (f2cl-lib:int-mul 2
          n
            (ilaenv 1
              "DGEBR"

```

```

" "
n n
-1
-1))))))

(setf wrkbl
  (max (the fixnum wrkbl)
        (the fixnum
          (f2cl-lib:int-add (f2cl-lib:int-mul 3 n)
                            (f2cl-lib:int-mul n
          (ilaenv
            1
            "DORGBR"
            "Q"
            n n
            n
            -1))))))

(setf wrkbl
  (max (the fixnum wrkbl)
        (the fixnum bdspace)))
(setf maxwrk
  (f2cl-lib:int-add (f2cl-lib:int-mul n n) wrkbl))
(setf minwrk
  (max
    (the fixnum
      (f2cl-lib:int-add (f2cl-lib:int-mul 3 n) m))
    (the fixnum bdspace)))
(setf maxwrk
  (max (the fixnum maxwrk)
        (the fixnum minwrk)))
((and wntua wntvo)
 (setf wrkbl
  (f2cl-lib:int-add n
                    (f2cl-lib:int-mul n
                    (ilaenv 1
                          "DGEQRF" " " " m
                          n -1 -1))))))

(setf wrkbl
  (max (the fixnum wrkbl)
        (the fixnum
          (f2cl-lib:int-add n
                            (f2cl-lib:int-mul m
          (ilaenv
            1
            "DORGQR"
            " "
            m m
            -1))))))

```

```

n
-1)))
(setf wrkbl
  (max (the fixnum wrkbl)
    (the fixnum
      (f2cl-lib:int-add (f2cl-lib:int-mul 3 n)
        (f2cl-lib:int-mul 2
          n
          (ilaenv
            1
            "DGEBR"
            " "
            n n
            -1
            -1))))))
(setf wrkbl
  (max (the fixnum wrkbl)
    (the fixnum
      (f2cl-lib:int-add (f2cl-lib:int-mul 3 n)
        (f2cl-lib:int-mul n
          (ilaenv
            1
            "DORGB"
            "Q"
            n n
            n
            -1))))))
(setf wrkbl
  (max (the fixnum wrkbl)
    (the fixnum
      (f2cl-lib:int-add (f2cl-lib:int-mul 3 n)
        (f2cl-lib:int-mul
          (f2cl-lib:int-sub n 1)
          (ilaenv 1 "DORGBR" "P"
            n n n -1))))))
(setf wrkbl
  (max (the fixnum wrkbl)
    (the fixnum bdspace)))
(setf maxwrk
  (f2cl-lib:int-add (f2cl-lib:int-mul 2 n n) wrkbl))
(setf minwrk
  (max
    (the fixnum
      (f2cl-lib:int-add (f2cl-lib:int-mul 3 n) m))
    (the fixnum bdspace)))
(setf maxwrk

```

```

(max (the fixnum maxwrk)
      (the fixnum minwrk))))
((and wntua wntvas)
  (setf wrkbl
    (f2cl-lib:int-add n
      (f2cl-lib:int-mul n
        (ilaenv 1
          "DGEQRF" " " m
          n -1 -1))))))
(setf wrkbl
  (max (the fixnum wrkbl)
    (the fixnum
      (f2cl-lib:int-add n
        (f2cl-lib:int-mul m
          (ilaenv
            1
            "DORGQR"
            " "
            m m
            n
            -1)))))))
(setf wrkbl
  (max (the fixnum wrkbl)
    (the fixnum
      (f2cl-lib:int-add (f2cl-lib:int-mul 3 n)
        (f2cl-lib:int-mul 2
          n
          (ilaenv
            1
            "DGEBRD"
            " "
            n n
            -1
            -1)))))))
(setf wrkbl
  (max (the fixnum wrkbl)
    (the fixnum
      (f2cl-lib:int-add (f2cl-lib:int-mul 3 n)
        (f2cl-lib:int-mul n
          (ilaenv
            1
            "DORGBR"
            "Q"
            n n
            n
            -1)))))))

```

```
(setf wrkbl
      (max (the fixnum wrkbl)
            (the fixnum
              (f2cl-lib:int-add (f2cl-lib:int-mul 3 n)
                                (f2cl-lib:int-mul
                                  (f2cl-lib:int-sub n 1)
                                  (ilaenv 1 "DORGBR" "P"
                                           n n n -1)))))))
(setf wrkbl
      (max (the fixnum wrkbl)
            (the fixnum bdspac)))
(setf maxwrk
      (f2cl-lib:int-add (f2cl-lib:int-mul n n) wrkbl))
(setf minwrk
      (max
        (the fixnum
          (f2cl-lib:int-add (f2cl-lib:int-mul 3 n) m))
        (the fixnum bdspac)))
(setf maxwrk
      (max (the fixnum maxwrk)
            (the fixnum minwrk))))))

(t
 (setf maxwrk
       (f2cl-lib:int-add (f2cl-lib:int-mul 3 n)
                         (f2cl-lib:int-mul
                          (f2cl-lib:int-add m n)
                          (ilaenv 1 "DGEBRD" " " m n -1 -1))))

 (if (or wntus wntuo)
     (setf maxwrk
           (max (the fixnum maxwrk)
                 (the fixnum
                   (f2cl-lib:int-add (f2cl-lib:int-mul 3 n)
                                     (f2cl-lib:int-mul
                                      n
                                      (ilaenv 1
                                               "DORGBR"
                                               "Q"
                                               m n
                                               n
                                               -1))))))

 (if wntua
     (setf maxwrk
           (max (the fixnum maxwrk)
                 (the fixnum
                   (f2cl-lib:int-add (f2cl-lib:int-mul 3 n)
                                     (f2cl-lib:int-mul
```

```

(ilaenv
1
"DORGBR"
"Q"
m m
n
-1))))))
(if (not wntvn)
  (setf maxwrk
    (max (the fixnum maxwrk)
      (the fixnum
        (f2cl-lib:int-add (f2cl-lib:int-mul 3 n)
          (f2cl-lib:int-mul
            (f2cl-lib:int-sub n
              1)
            (ilaenv 1 "DORGBR"
              "P" n n n -1)))))))
(setf maxwrk
  (max (the fixnum maxwrk)
    (the fixnum bdspace)))
(setf minwrk
  (max
    (the fixnum
      (f2cl-lib:int-add (f2cl-lib:int-mul 3 n) m))
    (the fixnum bdspace)))
(setf maxwrk
  (max (the fixnum maxwrk)
    (the fixnum minwrk))))))
(t
(setf bdspace (f2cl-lib:int-mul 5 m))
(cond
  ((>= n mnthr)
    (cond
      (wntvn
        (setf maxwrk
          (f2cl-lib:int-add m
            (f2cl-lib:int-mul m
              (ilaenv 1
                "DGELQF" " " " m
                n -1 -1))))))
    (setf maxwrk
      (max (the fixnum maxwrk)
        (the fixnum
          (f2cl-lib:int-add (f2cl-lib:int-mul 3 m)
            (f2cl-lib:int-mul 2
              m

```

```

(ilaenv
  1
  "DGEBR
  " "
  m m
  -1
  -1)))

(if (or wntuo wntuas)
  (setf maxwrk
    (max (the fixnum maxwrk)
      (the fixnum
        (f2cl-lib:int-add
          (f2cl-lib:int-mul 3 m)
          (f2cl-lib:int-mul m
            (ilaenv 1 "DORGBR"
              "Q" m m m
              -1)))))))

(setf maxwrk
  (max (the fixnum maxwrk)
    (the fixnum bdspace)))

(setf minwrk
  (max (the fixnum (f2cl-lib:int-mul 4 m))
    (the fixnum bdspace)))

(setf maxwrk
  (max (the fixnum maxwrk)
    (the fixnum minwrk)))

((and wntvo wntun)
  (setf wrkbl
    (f2cl-lib:int-add m
      (f2cl-lib:int-mul m
        (ilaenv 1
          "DGELQF" " " " m
          n -1 -1))))

(setf wrkbl
  (max (the fixnum wrkbl)
    (the fixnum
      (f2cl-lib:int-add m
        (f2cl-lib:int-mul m
          (ilaenv
            1
            "DORGL
            " "
            m n
            m
            -1))))

(setf wrkbl

```

```

(max (the fixnum wrkbl)
  (the fixnum
    (f2cl-lib:int-add (f2cl-lib:int-mul 3 m)
      (f2cl-lib:int-mul 2
        m
        (ilaenv
          1
          "DGEBRD"
          " "
          m m
          -1
          -1))))))

(setf wrkbl
  (max (the fixnum wrkbl)
    (the fixnum
      (f2cl-lib:int-add (f2cl-lib:int-mul 3 m)
        (f2cl-lib:int-mul
          (f2cl-lib:int-sub m 1)
          (ilaenv 1 "DORGBR" "P"
            m m m -1))))))

(setf wrkbl
  (max (the fixnum wrkbl)
    (the fixnum bdspace)))

(setf maxwrk
  (max
    (the fixnum
      (f2cl-lib:int-add (f2cl-lib:int-mul m m)
        wrkbl))
    (the fixnum
      (f2cl-lib:int-add (f2cl-lib:int-mul m m)
        (f2cl-lib:int-mul m n)
        m))))

(setf minwrk
  (max
    (the fixnum
      (f2cl-lib:int-add (f2cl-lib:int-mul 3 m) n))
    (the fixnum bdspace)))

(setf maxwrk
  (max (the fixnum maxwrk)
    (the fixnum minwrk)))

((and wntvo wntuas)
  (setf wrkbl
    (f2cl-lib:int-add m
      (f2cl-lib:int-mul m
        (ilaenv 1
          "DGELQF" " " " m

```



```

n -1 -1))))
(setf wrkbl
  (max (the fixnum wrkbl)
    (the fixnum
      (f2cl-lib:int-add m
        (f2cl-lib:int-mul m
          (ilaenv
            1
            "DORGL
            " "
            m n
            m
            -1))))))

(setf wrkbl
  (max (the fixnum wrkbl)
    (the fixnum
      (f2cl-lib:int-add (f2cl-lib:int-mul 3 m)
        (f2cl-lib:int-mul 2
          m
          (ilaenv
            1
            "DGEBR
            " "
            m m
            -1
            -1))))))

(setf wrkbl
  (max (the fixnum wrkbl)
    (the fixnum
      (f2cl-lib:int-add (f2cl-lib:int-mul 3 m)
        (f2cl-lib:int-mul
          (f2cl-lib:int-sub m 1)
          (ilaenv 1 "DORGBR" "P"
            m m m -1))))))

(setf wrkbl
  (max (the fixnum wrkbl)
    (the fixnum
      (f2cl-lib:int-add (f2cl-lib:int-mul 3 m)
        (f2cl-lib:int-mul m
          (ilaenv
            1
            "DORGB
            "Q"
            m m
            m
            -1))))))

```



```

1
"DGEGBR"
" "
m m
-1
-1))))
(setf wrkbl
  (max (the fixnum wrkbl)
    (the fixnum
      (f2cl-lib:int-add (f2cl-lib:int-mul 3 m)
        (f2cl-lib:int-mul
          (f2cl-lib:int-sub m 1)
          (ilaenv 1 "DORGBR" "P"
            m m m -1)))))))
(setf wrkbl
  (max (the fixnum wrkbl)
    (the fixnum bdspace)))
(setf maxwrk
  (f2cl-lib:int-add (f2cl-lib:int-mul m m) wrkbl))
(setf minwrk
  (max
    (the fixnum
      (f2cl-lib:int-add (f2cl-lib:int-mul 3 m) n))
    (the fixnum bdspace)))
(setf maxwrk
  (max (the fixnum maxwrk)
    (the fixnum minwrk)))
((and wntvs wntuo)
  (setf wrkbl
    (f2cl-lib:int-add m
      (f2cl-lib:int-mul m
        (ilaenv 1
          "DGELQF" " " " m
            n -1 -1))))))
(setf wrkbl
  (max (the fixnum wrkbl)
    (the fixnum
      (f2cl-lib:int-add m
        (f2cl-lib:int-mul m
          (ilaenv 1
            "DORGL"
            " "
            m n
            m
            -1))))))

```

```

(setf wrkbl
  (max (the fixnum wrkbl)
        (the fixnum
          (f2cl-lib:int-add (f2cl-lib:int-mul 3 m)
                            (f2cl-lib:int-mul 2
                                                  m
                                                  (ilaenv
                                                    1
                                                    "DGEBRD"
                                                    " "
                                                    m m
                                                    -1
                                                    -1))))))

(setf wrkbl
  (max (the fixnum wrkbl)
        (the fixnum
          (f2cl-lib:int-add (f2cl-lib:int-mul 3 m)
                            (f2cl-lib:int-mul
                              (f2cl-lib:int-sub m 1)
                              (ilaenv 1 "DORGBR" "P"
                                        m m m -1))))))

(setf wrkbl
  (max (the fixnum wrkbl)
        (the fixnum
          (f2cl-lib:int-add (f2cl-lib:int-mul 3 m)
                            (f2cl-lib:int-mul m
                                                  (ilaenv
                                                    1
                                                    "DORGBR"
                                                    "Q"
                                                    m m
                                                    m
                                                    -1))))))

(setf wrkbl
  (max (the fixnum wrkbl)
        (the fixnum bdspac)))

(setf maxwrk
  (f2cl-lib:int-add (f2cl-lib:int-mul 2 m m) wrkbl))
(setf minwrk
  (max
    (the fixnum
      (f2cl-lib:int-add (f2cl-lib:int-mul 3 m) n))
    (the fixnum bdspac)))
(setf maxwrk
  (max (the fixnum maxwrk)
        (the fixnum minwrk)))

```

```

((and wntvs wntuas)
  (setf wrkbl
    (f2cl-lib:int-add m
      (f2cl-lib:int-mul m
        (ilaenv 1
          "DGELQF" " " " m
            n -1 -1))))))

(setf wrkbl
  (max (the fixnum wrkbl)
    (the fixnum
      (f2cl-lib:int-add m
        (f2cl-lib:int-mul m
          (ilaenv 1
            "DORGL"
            " "
            m n
            m
            -1))))))

(setf wrkbl
  (max (the fixnum wrkbl)
    (the fixnum
      (f2cl-lib:int-add (f2cl-lib:int-mul 3 m)
        (f2cl-lib:int-mul 2
          m
          (ilaenv 1
            "DGEBR"
            " "
            m m
            -1
            -1))))))

(setf wrkbl
  (max (the fixnum wrkbl)
    (the fixnum
      (f2cl-lib:int-add (f2cl-lib:int-mul 3 m)
        (f2cl-lib:int-mul
          (f2cl-lib:int-sub m 1)
          (ilaenv 1 "DORGBR" "P"
            m m m -1))))))

(setf wrkbl
  (max (the fixnum wrkbl)
    (the fixnum
      (f2cl-lib:int-add (f2cl-lib:int-mul 3 m)
        (f2cl-lib:int-mul m
          (ilaenv

```

```

1
"DORGBR"
"Q"
m m
m
-1))))))

(setf wrkbl
  (max (the fixnum wrkbl)
        (the fixnum bdspac)))
(setf maxwrk
  (f2cl-lib:int-add (f2cl-lib:int-mul m m) wrkbl))
(setf minwrk
  (max
    (the fixnum
      (f2cl-lib:int-add (f2cl-lib:int-mul 3 m) n))
    (the fixnum bdspac)))
(setf maxwrk
  (max (the fixnum maxwrk)
        (the fixnum minwrk)))
((and wntva wntun)
 (setf wrkbl
  (f2cl-lib:int-add m
    (f2cl-lib:int-mul m
      (ilaenv 1
        "DGELQF" " " " m
        n -1 -1)))))

(setf wrkbl
  (max (the fixnum wrkbl)
        (the fixnum
          (f2cl-lib:int-add m
            (f2cl-lib:int-mul n
              (ilaenv 1
                "DORGLQ"
                " "
                n n
                m
                -1))))))

(setf wrkbl
  (max (the fixnum wrkbl)
        (the fixnum
          (f2cl-lib:int-add (f2cl-lib:int-mul 3 m)
            (f2cl-lib:int-mul 2
              m
              (ilaenv 1

```

[illegible]

```

(max (the fixnum wrkbl)
  (the fixnum
    (f2cl-lib:int-add (f2cl-lib:int-mul 3 m)
      (f2cl-lib:int-mul 2
        m
        (ilaenv
          1
          "DGEBRD"
          " "
          m m
          -1
          -1))))))

(setf wrkbl
  (max (the fixnum wrkbl)
    (the fixnum
      (f2cl-lib:int-add (f2cl-lib:int-mul 3 m)
        (f2cl-lib:int-mul
          (f2cl-lib:int-sub m 1)
          (ilaenv 1 "DORGBR" "P"
            m m m -1))))))

(setf wrkbl
  (max (the fixnum wrkbl)
    (the fixnum
      (f2cl-lib:int-add (f2cl-lib:int-mul 3 m)
        (f2cl-lib:int-mul m
          (ilaenv
            1
            "DORGBR"
            "Q"
            m m
            m
            -1))))))

(setf wrkbl
  (max (the fixnum wrkbl)
    (the fixnum bdspac)))

(setf maxwrk
  (f2cl-lib:int-add (f2cl-lib:int-mul 2 m m) wrkbl))
(setf minwrk
  (max
    (the fixnum
      (f2cl-lib:int-add (f2cl-lib:int-mul 3 m) n))
    (the fixnum bdspac)))

(setf maxwrk
  (max (the fixnum maxwrk)
    (the fixnum minwrk)))

((and wntva wntuas)

```



```

(setf wrkbl
  (f2cl-lib:int-add m
    (f2cl-lib:int-mul m
      (ilaenv 1
        "DGELQF" " " " m
          n -1 -1))))))

(setf wrkbl
  (max (the fixnum wrkbl)
    (the fixnum
      (f2cl-lib:int-add m
        (f2cl-lib:int-mul n
          (ilaenv 1
            "DORGL"
            " "
            n n
            m
            -1))))))

(setf wrkbl
  (max (the fixnum wrkbl)
    (the fixnum
      (f2cl-lib:int-add (f2cl-lib:int-mul 3 m)
        (f2cl-lib:int-mul 2
          m
          (ilaenv 1
            "DGEBR"
            " "
            m m
            -1
            -1))))))

(setf wrkbl
  (max (the fixnum wrkbl)
    (the fixnum
      (f2cl-lib:int-add (f2cl-lib:int-mul 3 m)
        (f2cl-lib:int-mul
          (f2cl-lib:int-sub m 1)
          (ilaenv 1 "DORGBR" "P"
            m m m -1))))))

(setf wrkbl
  (max (the fixnum wrkbl)
    (the fixnum
      (f2cl-lib:int-add (f2cl-lib:int-mul 3 m)
        (f2cl-lib:int-mul m
          (ilaenv 1
            "DORGBR"
            " "
            m m m -1))))))

```

```

                                "DORGBR"
                                "Q"
                                m m
                                m
                                -1))))))

(setf wrkbl
  (max (the fixnum wrkbl)
        (the fixnum bdspac)))
(setf maxwrk
  (f2cl-lib:int-add (f2cl-lib:int-mul m m) wrkbl))
(setf minwrk
  (max
    (the fixnum
      (f2cl-lib:int-add (f2cl-lib:int-mul 3 m) n))
    (the fixnum bdspac)))
(setf maxwrk
  (max (the fixnum maxwrk)
        (the fixnum minwrk))))))

(t
  (setf maxwrk
    (f2cl-lib:int-add (f2cl-lib:int-mul 3 m)
                      (f2cl-lib:int-mul
                        (f2cl-lib:int-add m n)
                        (ilaenv 1 "DGEBRD" " " " m n -1 -1))))

  (if (or wntvs wntvo)
    (setf maxwrk
      (max (the fixnum maxwrk)
            (the fixnum
              (f2cl-lib:int-add (f2cl-lib:int-mul 3 m)
                                (f2cl-lib:int-mul m
              (ilaenv
                1
                "DORGBR"
                "P"
                m n
                m
                -1)))))))

  (if wntva
    (setf maxwrk
      (max (the fixnum maxwrk)
            (the fixnum
              (f2cl-lib:int-add (f2cl-lib:int-mul 3 m)
                                (f2cl-lib:int-mul n
              (ilaenv
                1
                "DORGBR"

```

```

"p"
n n
m
-1)))

(if (not wntun)
  (setf maxwrk
    (max (the fixnum maxwrk)
      (the fixnum
        (f2cl-lib:int-add (f2cl-lib:int-mul 3 m)
          (f2cl-lib:int-mul
            (f2cl-lib:int-sub m
              1)
            (ilaenv 1 "DORGBR"
              "Q" m m m -1)))))))

(setf maxwrk
  (max (the fixnum maxwrk)
    (the fixnum bdspac)))
(setf minwrk
  (max
    (the fixnum
      (f2cl-lib:int-add (f2cl-lib:int-mul 3 m) n))
    (the fixnum bdspac)))
(setf maxwrk
  (max (the fixnum maxwrk)
    (the fixnum minwrk))))))
(setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)
  (coerce (the fixnum maxwrk) 'double-float)))
(cond
  ((and (< lwork minwrk) (not lquery))
    (setf info -13)))
(cond
  ((/= info 0)
    (error
      " ** On entry to ~a parameter number ~a had an illegal value~%"
      "DGESVD" (f2cl-lib:int-sub info))
    (go end_label))
  (lquery
    (go end_label)))
(cond
  ((or (= m 0) (= n 0))
    (if (>= lwork 1)
      (setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%) one))
    (go end_label)))
(setf eps (dlamch "P"))
(setf smlnum (/ (f2cl-lib:fsqrt (dlamch "S")) eps))
(setf bignum (/ one smlnum))

```

```

(setf anrm (dlange "M" m n a lda dum))
(setf iscl 0)
(cond
  ((and (> anrm zero) (< anrm smlnum))
    (setf iscl 1)
    (multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9)
      (dlascl "G" 0 0 anrm smlnum m n a lda ierr)
      (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
        var-8))
      (setf ierr var-9)))
    (> anrm bignum)
    (setf iscl 1)
    (multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9)
      (dlascl "G" 0 0 anrm bignum m n a lda ierr)
      (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
        var-8))
      (setf ierr var-9))))
(cond
  ((>= m n)
    (cond
      ((>= m mnthr)
        (cond
          (wntun
            (setf itau 1)
            (setf iwork (f2cl-lib:int-add itau n))
            (multiple-value-bind
              (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7)
              (dgeqrf m n a lda
                (f2cl-lib:array-slice work double-float (itau) ((1 *)))
                (f2cl-lib:array-slice work double-float (iwork) ((1 *)))
                (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1) ierr)
              (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6))
              (setf ierr var-7))
            (dlaset "L" (f2cl-lib:int-sub n 1) (f2cl-lib:int-sub n 1) zero
              zero
              (f2cl-lib:array-slice a double-float (2 1) ((1 lda) (1 *)))
              lda)
            (setf ie 1)
            (setf itauq (f2cl-lib:int-add ie n))
            (setf itaup (f2cl-lib:int-add itauq n))
            (setf iwork (f2cl-lib:int-add itaup n))
            (multiple-value-bind
              (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
                var-9 var-10)

```

```

(dgebrd n n a lda s
  (f2cl-lib:array-slice work double-float (ie) ((1 *)))
  (f2cl-lib:array-slice work double-float (itauq) ((1 *)))
  (f2cl-lib:array-slice work double-float (itaup) ((1 *)))
  (f2cl-lib:array-slice work double-float (iwork) ((1 *)))
  (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1) ierr)
(declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
  var-7 var-8 var-9))
(setf ierr var-10))
(setf ncvvt 0)
(cond
  ((or wntvo wntvas)
    (multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8 var-9)
      (dorgbr "P" n n n a lda
        (f2cl-lib:array-slice work
          double-float
          (itauq)
          ((1 *)))
        (f2cl-lib:array-slice work
          double-float
          (iwork)
          ((1 *)))
        (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
        ierr)
      (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
        var-6 var-7 var-8))
      (setf ierr var-9))
    (setf ncvvt n)))
(setf iwork (f2cl-lib:int-add ie n))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
   var-9 var-10 var-11 var-12 var-13 var-14)
  (dbdsqr "U" n ncvvt 0 0 s
    (f2cl-lib:array-slice work double-float (ie) ((1 *))) a
    lda dum 1 dum 1
    (f2cl-lib:array-slice work double-float (iwork) ((1 *)))
    info)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
    var-7 var-8 var-9 var-10 var-11 var-12
    var-13))
  (setf info var-14))
(if wntvas (dlacpy "F" n n a lda vt ldvt)))
((and wntuo wntvn)
  (cond

```

```

(>= lwork
  (f2cl-lib:int-add (f2cl-lib:int-mul n n)
    (max
      (the fixnum
        (f2cl-lib:int-mul 4 n))
      (the fixnum bdspace))))
(setf ir 1)
(cond
  (>= lwork
    (f2cl-lib:int-add
      (max (the fixnum wrkbl)
        (the fixnum
          (f2cl-lib:int-add
            (f2cl-lib:int-mul lda n)
            n)))
      (f2cl-lib:int-mul lda n)))
    (setf ldwrku lda)
    (setf ldwrkr lda))
  (>= lwork
    (f2cl-lib:int-add
      (max (the fixnum wrkbl)
        (the fixnum
          (f2cl-lib:int-add
            (f2cl-lib:int-mul lda n)
            n)))
      (f2cl-lib:int-mul n n)))
    (setf ldwrku lda)
    (setf ldwrkr n))
  (t
    (setf ldwrku
      (the fixnum
        (truncate (- lwork (* n n) n) n)))
    (setf ldwrkr n)))
(setf itau
  (f2cl-lib:int-add ir (f2cl-lib:int-mul ldwrkr n)))
(setf iwork (f2cl-lib:int-add itau n))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7)
  (dgeqrf m n a lda
    (f2cl-lib:array-slice work
      double-float
      (itau)
      ((1 *)))
    (f2cl-lib:array-slice work
      double-float
      (iwork)

```

```

((1 *)))
(f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
ierr)
(declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
           var-6))
(setf ierr var-7))
(dlacpy "U" n n a lda
(f2cl-lib:array-slice work double-float (ir) ((1 *)))
ldwrkr)
(dlaset "L" (f2cl-lib:int-sub n 1) (f2cl-lib:int-sub n 1)
zero zero
(f2cl-lib:array-slice work
double-float
((+ ir 1))
((1 *)))
ldwrkr)
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
   var-8)
  (dorgqr m n n a lda
    (f2cl-lib:array-slice work
double-float
(itau)
((1 *)))
(f2cl-lib:array-slice work
double-float
(iwork)
((1 *)))
(f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6 var-7))
  (setf ierr var-8))
(setf ie itau)
(setf itauq (f2cl-lib:int-add ie n))
(setf itaup (f2cl-lib:int-add itauq n))
(setf iwork (f2cl-lib:int-add itaup n))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
   var-8 var-9 var-10)
  (dgebrd n n
    (f2cl-lib:array-slice work double-float (ir) ((1 *)))
    ldwrkr s
    (f2cl-lib:array-slice work double-float (ie) ((1 *)))
    (f2cl-lib:array-slice work
double-float

```

```

                                (itauq)
                                ((1 *)))
(f2cl-lib:array-slice work
                                double-float
                                (itaup)
                                ((1 *)))
(f2cl-lib:array-slice work
                                double-float
                                (iwork)
                                ((1 *)))
(f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
ierr)
(declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                                var-6 var-7 var-8 var-9))
(setf ierr var-10))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
   var-8 var-9)
  (dorgbr "Q" n n n
    (f2cl-lib:array-slice work double-float (ir) ((1 *)))
    ldwrkr
    (f2cl-lib:array-slice work
                                double-float
                                (itauq)
                                ((1 *)))
    (f2cl-lib:array-slice work
                                double-float
                                (iwork)
                                ((1 *)))
    (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
    ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                    var-6 var-7 var-8))
  (setf ierr var-9))
(setf iwork (f2cl-lib:int-add ie n))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
   var-8 var-9 var-10 var-11 var-12 var-13 var-14)
  (dbdsqr "U" n 0 n 0 s
    (f2cl-lib:array-slice work double-float (ie) ((1 *)))
    dum 1
    (f2cl-lib:array-slice work double-float (ir) ((1 *)))
    ldwrkr dum 1
    (f2cl-lib:array-slice work
                                double-float
                                (iwork)

```



```

                                ((1 *)))
    info)
    (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                  var-6 var-7 var-8 var-9 var-10 var-11
                  var-12 var-13))
    (setf info var-14))
    (setf iu (f2cl-lib:int-add ie n))
    (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i ldwrku))
                  (> i m) nil)
    (tagbody
      (setf chunk
        (min
          (the fixnum
            (f2cl-lib:int-add (f2cl-lib:int-sub m i)
                              1))
          (the fixnum ldwrku)))
      (dgemm "N" "N" chunk n n one
        (f2cl-lib:array-slice a
          double-float
          (i 1)
          ((1 lda) (1 *)))

        lda
        (f2cl-lib:array-slice work double-float (ir) ((1 *)))
        ldwrkr zero
        (f2cl-lib:array-slice work double-float (iu) ((1 *)))
        ldwrku)
      (dlacpy "F" chunk n
        (f2cl-lib:array-slice work double-float (iu) ((1 *)))
        ldwrku
        (f2cl-lib:array-slice a
          double-float
          (i 1)
          ((1 lda) (1 *)))

        lda))))
    (t
      (setf ie 1)
      (setf itauq (f2cl-lib:int-add ie n))
      (setf itaup (f2cl-lib:int-add itauq n))
      (setf iwork (f2cl-lib:int-add itaup n))
      (multiple-value-bind
        (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
         var-8 var-9 var-10)
        (dgebrd m n a lda s
          (f2cl-lib:array-slice work double-float (ie) ((1 *)))
          (f2cl-lib:array-slice work
            double-float

```

```

                                (itauq)
                                ((1 *)))
(f2cl-lib:array-slice work
 double-float
 (itaup)
 ((1 *)))
(f2cl-lib:array-slice work
 double-float
 (iwork)
 ((1 *)))
(f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
ierr)
(declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
              var-6 var-7 var-8 var-9))
(setf ierr var-10))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
   var-8 var-9)
  (dorgbr "Q" m n n a lda
   (f2cl-lib:array-slice work
    double-float
    (itauq)
    ((1 *)))
   (f2cl-lib:array-slice work
    double-float
    (iwork)
    ((1 *)))
   (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
   ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                    var-6 var-7 var-8))
  (setf ierr var-9))
(setf iwork (f2cl-lib:int-add ie n))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
   var-8 var-9 var-10 var-11 var-12 var-13 var-14)
  (dbdsqr "U" n 0 m 0 s
   (f2cl-lib:array-slice work double-float (ie) ((1 *)))
   dum 1 a lda dum 1
   (f2cl-lib:array-slice work
    double-float
    (iwork)
    ((1 *)))
   info)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                    var-6 var-7 var-8 var-9 var-10 var-11

```

```

                                var-12 var-13))
    (setf info var-14))))))
((and wntuo wntvas)
 (cond
  ((>= lwork
    (f2cl-lib:int-add (f2cl-lib:int-mul n n)
      (max
        (the fixnum
          (f2cl-lib:int-mul 4 n))
        (the fixnum bdspace))))
    (setf ir 1)
    (cond
     ((>= lwork
      (f2cl-lib:int-add
        (max (the fixnum wrkbl)
          (the fixnum
            (f2cl-lib:int-add
              (f2cl-lib:int-mul lda n)
              n)))
        (f2cl-lib:int-mul lda n)))
      (setf ldwrku lda)
      (setf ldwrkr lda))
     ((>= lwork
      (f2cl-lib:int-add
        (max (the fixnum wrkbl)
          (the fixnum
            (f2cl-lib:int-add
              (f2cl-lib:int-mul lda n)
              n)))
        (f2cl-lib:int-mul n n)))
      (setf ldwrku lda)
      (setf ldwrkr n))
     (t
      (setf ldwrku
        (the fixnum
          (truncate (- lwork (* n n) n) n)))
      (setf ldwrkr n)))
    (setf itau
      (f2cl-lib:int-add ir (f2cl-lib:int-mul ldwrkr n)))
    (setf iwork (f2cl-lib:int-add itau n))
    (multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7)
      (dgeqrf m n a lda
        (f2cl-lib:array-slice work
          double-float
          (itau)

```

```

((1 *)))
(f2cl-lib:array-slice work
  double-float
  (iwork)
  ((1 *)))
(f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
ierr)
(declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
  var-6))
(setf ierr var-7))
(dlacpy "U" n n a lda vt ldvt)
(dlaset "L" (f2cl-lib:int-sub n 1) (f2cl-lib:int-sub n 1)
  zero zero
  (f2cl-lib:array-slice vt
    double-float
    (2 1)
    ((1 ldvt) (1 *))))
ldvt)
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
  var-8)
  (dorgqr m n n a lda
    (f2cl-lib:array-slice work
      double-float
      (itau)
      ((1 *)))
    (f2cl-lib:array-slice work
      double-float
      (iwork)
      ((1 *)))
    (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
    ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
    var-6 var-7))
  (setf ierr var-8))
(setf ie itau)
(setf itauq (f2cl-lib:int-add ie n))
(setf itaup (f2cl-lib:int-add itauq n))
(setf iwork (f2cl-lib:int-add itaup n))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
  var-8 var-9 var-10)
  (dgebrd n n vt ldvt s
    (f2cl-lib:array-slice work double-float (ie) ((1 *)))
    (f2cl-lib:array-slice work
      double-float

```

```

                                (itauq)
                                ((1 *)))
(f2cl-lib:array-slice work
 double-float
 (itaup)
 ((1 *)))
(f2cl-lib:array-slice work
 double-float
 (iwork)
 ((1 *)))
(f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
ierr)
(declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
              var-6 var-7 var-8 var-9))
(setf ierr var-10))
(dlapcy "L" n n vt ldvt
(f2cl-lib:array-slice work double-float (ir) ((1 *)))
ldwrkr)
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
   var-8 var-9)
  (dorgbr "Q" n n n
    (f2cl-lib:array-slice work double-float (ir) ((1 *)))
    ldwrkr
    (f2cl-lib:array-slice work
      double-float
      (itauq)
      ((1 *)))
    (f2cl-lib:array-slice work
      double-float
      (iwork)
      ((1 *)))
    (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
    ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                    var-6 var-7 var-8))
  (setf ierr var-9))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
   var-8 var-9)
  (dorgbr "P" n n n vt ldvt
    (f2cl-lib:array-slice work
      double-float
      (itaup)
      ((1 *)))
    (f2cl-lib:array-slice work

```

```

                                double-float
                                (iwork)
                                ((1 *)))
      (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
      ierr)
    (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                    var-6 var-7 var-8))
    (setf ierr var-9))
  (setf iwork (f2cl-lib:int-add ie n))
  (multiple-value-bind
    (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
     var-8 var-9 var-10 var-11 var-12 var-13 var-14)
    (dbdsqr "U" n n n 0 s
      (f2cl-lib:array-slice work double-float (ie) ((1 *)))
      vt ldvt
      (f2cl-lib:array-slice work double-float (ir) ((1 *)))
      ldwrkr dum 1
      (f2cl-lib:array-slice work
                            double-float
                            (iwork)
                            ((1 *)))

      info)
    (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                    var-6 var-7 var-8 var-9 var-10 var-11
                    var-12 var-13))
    (setf info var-14))
  (setf iu (f2cl-lib:int-add ie n))
  (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i ldwrku))
    (> i m) nil)
  (tagbody
    (setf chunk
      (min
        (the fixnum
          (f2cl-lib:int-add (f2cl-lib:int-sub m i)
                            1))
        (the fixnum ldwrku)))
    (dgemm "N" "N" chunk n n one
      (f2cl-lib:array-slice a
                            double-float
                            (i 1)
                            ((1 lda) (1 *)))

      lda
      (f2cl-lib:array-slice work double-float (ir) ((1 *)))
      ldwrkr zero
      (f2cl-lib:array-slice work double-float (iu) ((1 *)))
      ldwrku)

```

```

(dlacpy "F" chunk n
  (f2cl-lib:array-slice work double-float (iu) ((1 *)))
  ldwrku
  (f2cl-lib:array-slice a
    double-float
    (i 1)
    ((1 lda) (1 *)))
  lda)))
(t
  (setf itau 1)
  (setf iwork (f2cl-lib:int-add itau n))
  (multiple-value-bind
    (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7)
    (dgeqrf m n a lda
      (f2cl-lib:array-slice work
        double-float
        (itau)
        ((1 *)))
      (f2cl-lib:array-slice work
        double-float
        (iwork)
        ((1 *)))
      (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
      ierr)
    (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
      var-6))
    (setf ierr var-7))
  (dlacpy "U" n n a lda vt ldvt)
  (dlaset "L" (f2cl-lib:int-sub n 1) (f2cl-lib:int-sub n 1)
    zero zero
    (f2cl-lib:array-slice vt
      double-float
      (2 1)
      ((1 ldvt) (1 *)))
  ldvt)
  (multiple-value-bind
    (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
      var-8)
    (dorgqr m n n a lda
      (f2cl-lib:array-slice work
        double-float
        (itau)
        ((1 *)))
      (f2cl-lib:array-slice work
        double-float
        (iwork)

```

```

((1 *)))
(f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
ierr)
(declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
            var-6 var-7))
(setf ierr var-8))
(setf ie itau)
(setf itauq (f2cl-lib:int-add ie n))
(setf itaup (f2cl-lib:int-add itauq n))
(setf iwork (f2cl-lib:int-add itaup n))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
   var-8 var-9 var-10)
  (dgebrd n n vt ldvt s
   (f2cl-lib:array-slice work double-float (ie) ((1 *)))
   (f2cl-lib:array-slice work
                        double-float
                        (itauq)
                        ((1 *)))
   (f2cl-lib:array-slice work
                        double-float
                        (itaup)
                        ((1 *)))
   (f2cl-lib:array-slice work
                        double-float
                        (iwork)
                        ((1 *)))
   (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
   ierr)
(declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
            var-6 var-7 var-8 var-9))
(setf ierr var-10))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
   var-8 var-9 var-10 var-11 var-12 var-13)
  (dormbr "Q" "R" "N" m n n vt ldvt
   (f2cl-lib:array-slice work
                        double-float
                        (itauq)
                        ((1 *)))
   a lda
   (f2cl-lib:array-slice work
                        double-float
                        (iwork)
                        ((1 *)))
   (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)

```



```

      ierr)
      (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                     var-6 var-7 var-8 var-9 var-10 var-11
                     var-12))
      (setf ierr var-13))
      (multiple-value-bind
        (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
         var-8 var-9)
        (dorgbr "P" n n n vt ldvt
         (f2cl-lib:array-slice work
                               double-float
                               (itaup)
                               ((1 *))))
        (f2cl-lib:array-slice work
                               double-float
                               (iwork)
                               ((1 *))))
        (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
        ierr)
      (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                     var-6 var-7 var-8))
      (setf ierr var-9))
      (setf iwork (f2cl-lib:int-add ie n))
      (multiple-value-bind
        (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
         var-8 var-9 var-10 var-11 var-12 var-13 var-14)
        (dbdsqr "U" n n m 0 s
         (f2cl-lib:array-slice work double-float (ie) ((1 *)))
         vt ldvt a lda dum 1
         (f2cl-lib:array-slice work
                               double-float
                               (iwork)
                               ((1 *))))
        info)
      (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                     var-6 var-7 var-8 var-9 var-10 var-11
                     var-12 var-13))
      (setf info var-14))))))
(wntus
 (cond
  (wntvn
   (cond
    ((>= lwork
      (f2cl-lib:int-add (f2cl-lib:int-mul n n)
                        (max
                          (the fixnum

```

```

                                (f2cl-lib:int-mul 4 n))
                                (the fixnum bdspace)))
(setf ir 1)
(cond
  ((>= lwork
    (f2cl-lib:int-add wrkbl (f2cl-lib:int-mul lda n)))
    (setf ldwrkr lda))
  (t
    (setf ldwrkr n)))
(setf itau
  (f2cl-lib:int-add ir
    (f2cl-lib:int-mul ldwrkr n)))
(setf iwork (f2cl-lib:int-add itau n))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7)
  (dgeqrf m n a lda
    (f2cl-lib:array-slice work
      double-float
      (itau)
      ((1 *)))
    (f2cl-lib:array-slice work
      double-float
      (iwork)
      ((1 *)))
    (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
    ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
    var-6))
  (setf ierr var-7))
(dlacpy "U" n n a lda
  (f2cl-lib:array-slice work double-float (ir) ((1 *)))
  ldwrkr)
(dlaset "L" (f2cl-lib:int-sub n 1)
  (f2cl-lib:int-sub n 1) zero zero
  (f2cl-lib:array-slice work
    double-float
    ((+ ir 1))
    ((1 *)))
  ldwrkr)
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
    var-8)
  (dorgqr m n n a lda
    (f2cl-lib:array-slice work
      double-float
      (itau)

```

```

((1 *)))
(f2cl-lib:array-slice work
  double-float
  (iwork)
  ((1 *)))
(f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
ierr)
(declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
  var-6 var-7))
(setf ierr var-8))
(setf ie itau)
(setf itauq (f2cl-lib:int-add ie n))
(setf itaup (f2cl-lib:int-add itauq n))
(setf iwork (f2cl-lib:int-add itaup n))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
   var-8 var-9 var-10)
  (dgebrd n n
    (f2cl-lib:array-slice work
      double-float
      (ir)
      ((1 *)))

    ldwrkr s
    (f2cl-lib:array-slice work
      double-float
      (ie)
      ((1 *)))

    (f2cl-lib:array-slice work
      double-float
      (itauq)
      ((1 *)))

    (f2cl-lib:array-slice work
      double-float
      (itaup)
      ((1 *)))

    (f2cl-lib:array-slice work
      double-float
      (iwork)
      ((1 *)))

    (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
    ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
    var-6 var-7 var-8 var-9))
  (setf ierr var-10))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7

```

```

      var-8 var-9)
(dorgbr "Q" n n n
  (f2cl-lib:array-slice work
                        double-float
                        (ir)
                        ((1 *)))

  ldwrkr
  (f2cl-lib:array-slice work
                        double-float
                        (itauq)
                        ((1 *)))

  (f2cl-lib:array-slice work
                        double-float
                        (iwork)
                        ((1 *)))

  (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
  ierr)
(declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                var-6 var-7 var-8))
(setf ierr var-9)
(setf iwork (f2cl-lib:int-add ie n))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
   var-8 var-9 var-10 var-11 var-12 var-13 var-14)
  (dbdsqr "U" n 0 n 0 s
    (f2cl-lib:array-slice work
                          double-float
                          (ie)
                          ((1 *)))

    dum 1
    (f2cl-lib:array-slice work
                          double-float
                          (ir)
                          ((1 *)))

    ldwrkr dum 1
    (f2cl-lib:array-slice work
                          double-float
                          (iwork)
                          ((1 *)))

    info)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                  var-6 var-7 var-8 var-9 var-10 var-11
                  var-12 var-13))
  (setf info var-14))
(dgemm "N" "N" m n n one a lda
  (f2cl-lib:array-slice work double-float (ir) ((1 *)))

```

```

ldwrkr zero u ldu))
(t
(setf itau 1)
(setf iwork (f2cl-lib:int-add itau n))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7)
  (dgeqrf m n a lda
    (f2cl-lib:array-slice work
      double-float
      (itau)
      ((1 *)))
    (f2cl-lib:array-slice work
      double-float
      (iwork)
      ((1 *)))
    (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
    ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
    var-6))
  (setf ierr var-7))
(dlacpy "L" m n a lda u ldu)
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
    var-8)
  (dorgqr m n n u ldu
    (f2cl-lib:array-slice work
      double-float
      (itau)
      ((1 *)))
    (f2cl-lib:array-slice work
      double-float
      (iwork)
      ((1 *)))
    (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
    ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
    var-6 var-7))
  (setf ierr var-8))
(setf ie itau)
(setf itauq (f2cl-lib:int-add ie n))
(setf itaup (f2cl-lib:int-add itauq n))
(setf iwork (f2cl-lib:int-add itaup n))
(dlaset "L" (f2cl-lib:int-sub n 1)
  (f2cl-lib:int-sub n 1) zero zero
  (f2cl-lib:array-slice a
    double-float

```

```

                                (2 1)
                                ((1 lda) (1 *)))
lda)
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
   var-8 var-9 var-10)
  (dgebrd n n a lda s
    (f2cl-lib:array-slice work
                           double-float
                           (ie)
                           ((1 *)))
    (f2cl-lib:array-slice work
                           double-float
                           (itauq)
                           ((1 *)))
    (f2cl-lib:array-slice work
                           double-float
                           (itaup)
                           ((1 *)))
    (f2cl-lib:array-slice work
                           double-float
                           (iwork)
                           ((1 *)))
    (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
    ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                    var-6 var-7 var-8 var-9))
  (setf ierr var-10))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
   var-8 var-9 var-10 var-11 var-12 var-13)
  (dormbr "Q" "R" "N" m n n a lda
    (f2cl-lib:array-slice work
                           double-float
                           (itauq)
                           ((1 *)))
    u ldu
    (f2cl-lib:array-slice work
                           double-float
                           (iwork)
                           ((1 *)))
    (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
    ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                    var-6 var-7 var-8 var-9 var-10 var-11
                    var-12)))

```

```

    (setf ierr var-13))
  (setf iwork (f2cl-lib:int-add ie n))
  (multiple-value-bind
    (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
     var-8 var-9 var-10 var-11 var-12 var-13 var-14)
    (dbdsqr "U" n 0 m 0 s
      (f2cl-lib:array-slice work
        double-float
        (ie)
        ((1 *)))
      dum 1 u ldu dum 1
      (f2cl-lib:array-slice work
        double-float
        (iwork)
        ((1 *)))
      info)
    (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
      var-6 var-7 var-8 var-9 var-10 var-11
      var-12 var-13))
    (setf info var-14))))))
(wntvo
  (cond
    ((>= lwork
      (f2cl-lib:int-add (f2cl-lib:int-mul 2 n n)
        (max
          (the fixnum
            (f2cl-lib:int-mul 4 n))
          (the fixnum bdspace))))))
    (setf iu 1)
    (cond
      ((>= lwork
        (f2cl-lib:int-add wrkbl
          (f2cl-lib:int-mul 2 lda n))))
      (setf ldwrku lda)
      (setf ir
        (f2cl-lib:int-add iu
          (f2cl-lib:int-mul ldwrku
            n))))
      (setf ldwrkr lda))
    ((>= lwork
      (f2cl-lib:int-add wrkbl
        (f2cl-lib:int-mul
          (f2cl-lib:int-add lda n)
          n))))
      (setf ldwrku lda)
      (setf ir

```

```

(f2cl-lib:int-add iu
  (f2cl-lib:int-mul ldwrku
    n)))

(setf ldwrkr n))
(t
  (setf ldwrku n)
  (setf ir
    (f2cl-lib:int-add iu
      (f2cl-lib:int-mul ldwrku
        n)))

  (setf ldwrkr n)))
(setf itau
  (f2cl-lib:int-add ir
    (f2cl-lib:int-mul ldwrkr n)))
(setf iwork (f2cl-lib:int-add itau n))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7)
  (dgeqrf m n a lda
    (f2cl-lib:array-slice work
      double-float
      (itau)
      ((1 *)))
    (f2cl-lib:array-slice work
      double-float
      (iwork)
      ((1 *)))
    (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
    ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
    var-6))
  (setf ierr var-7))
(dlacpy "U" n n a lda
  (f2cl-lib:array-slice work double-float (iu) ((1 *)))
  ldwrku)
(dlaset "L" (f2cl-lib:int-sub n 1)
  (f2cl-lib:int-sub n 1) zero zero
  (f2cl-lib:array-slice work
    double-float
    ((+ iu 1))
    ((1 *)))
  ldwrku)
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
    var-8)
  (dorgqr m n n a lda
    (f2cl-lib:array-slice work

```



```

double-float
(itau)
((1 *)))
(f2cl-lib:array-slice work
double-float
(iwork)
((1 *)))
(f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
ierr)
(declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
var-6 var-7))
(setf ierr var-8))
(setf ie itau)
(setf itauq (f2cl-lib:int-add ie n))
(setf itaup (f2cl-lib:int-add itauq n))
(setf iwork (f2cl-lib:int-add itaup n))
(multiple-value-bind
(var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
var-8 var-9 var-10)
(dgebrd n n
(f2cl-lib:array-slice work
double-float
(iu)
((1 *)))
ldwrku s
(f2cl-lib:array-slice work
double-float
(ie)
((1 *)))
(f2cl-lib:array-slice work
double-float
(itauq)
((1 *)))
(f2cl-lib:array-slice work
double-float
(itaup)
((1 *)))
(f2cl-lib:array-slice work
double-float
(iwork)
((1 *)))
(f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
ierr)
(declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
var-6 var-7 var-8 var-9))
(setf ierr var-10))

```

```

(dlacpy "U" n n
  (f2cl-lib:array-slice work double-float (iu) ((1 *)))
  ldwrku
  (f2cl-lib:array-slice work double-float (ir) ((1 *)))
  ldwrkr)
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
   var-8 var-9)
  (dorgbr "Q" n n n
    (f2cl-lib:array-slice work
                          double-float
                          (iu)
                          ((1 *)))

    ldwrku
    (f2cl-lib:array-slice work
                          double-float
                          (itauq)
                          ((1 *)))

    (f2cl-lib:array-slice work
                          double-float
                          (iwork)
                          ((1 *)))

    (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
    ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                    var-6 var-7 var-8))
  (setf ierr var-9))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
   var-8 var-9)
  (dorgbr "P" n n n
    (f2cl-lib:array-slice work
                          double-float
                          (ir)
                          ((1 *)))

    ldwrkr
    (f2cl-lib:array-slice work
                          double-float
                          (itaup)
                          ((1 *)))

    (f2cl-lib:array-slice work
                          double-float
                          (iwork)
                          ((1 *)))

    (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
    ierr)

```

```

(declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
              var-6 var-7 var-8))
(setf ierr var-9))
(setf iwork (f2cl-lib:int-add ie n))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
   var-8 var-9 var-10 var-11 var-12 var-13 var-14)
  (dbdsqr "U" n n n 0 s
    (f2cl-lib:array-slice work
                          double-float
                          (ie)
                          ((1 *)))
    (f2cl-lib:array-slice work
                          double-float
                          (ir)
                          ((1 *)))
    ldwrkr
    (f2cl-lib:array-slice work
                          double-float
                          (iu)
                          ((1 *)))
    ldwrku dum 1
    (f2cl-lib:array-slice work
                          double-float
                          (iwork)
                          ((1 *)))
    info)
(declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
              var-6 var-7 var-8 var-9 var-10 var-11
              var-12 var-13))
(setf info var-14))
(dgemm "N" "N" m n n one a lda
  (f2cl-lib:array-slice work double-float (iu) ((1 *)))
  ldwrku zero u ldu)
(dlacpy "F" n n
  (f2cl-lib:array-slice work double-float (ir) ((1 *)))
  ldwrkr a lda))
(t
  (setf itau 1)
  (setf iwork (f2cl-lib:int-add itau n))
  (multiple-value-bind
    (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7)
    (dgeqrf m n a lda
      (f2cl-lib:array-slice work
                            double-float
                            (itau)

```

```

((1 *)))
(f2cl-lib:array-slice work
  double-float
  (iwork)
  ((1 *)))
(f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
ierr)
(declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
  var-6))
(setf ierr var-7))
(dlacpy "L" m n a lda u ldu)
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
  var-8)
  (dorgqr m n n u ldu
    (f2cl-lib:array-slice work
      double-float
      (itau)
      ((1 *)))
    (f2cl-lib:array-slice work
      double-float
      (iwork)
      ((1 *)))
    (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
    ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
    var-6 var-7))
  (setf ierr var-8))
(setf ie itau)
(setf itauq (f2cl-lib:int-add ie n))
(setf itaup (f2cl-lib:int-add itauq n))
(setf iwork (f2cl-lib:int-add itaup n))
(dlaset "L" (f2cl-lib:int-sub n 1)
  (f2cl-lib:int-sub n 1) zero zero
  (f2cl-lib:array-slice a
    double-float
    (2 1)
    ((1 lda) (1 *)))
  lda)
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
  var-8 var-9 var-10)
  (dgebrd n n a lda s
    (f2cl-lib:array-slice work
      double-float
      (ie)

```

```

((1 *)))
(f2cl-lib:array-slice work
  double-float
  (itauq)
  ((1 *)))
(f2cl-lib:array-slice work
  double-float
  (itaup)
  ((1 *)))
(f2cl-lib:array-slice work
  double-float
  (iwork)
  ((1 *)))
(f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
ierr)
(declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
  var-6 var-7 var-8 var-9))
(setf ierr var-10))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
  var-8 var-9 var-10 var-11 var-12 var-13)
  (dormbr "Q" "R" "N" m n n a lda
    (f2cl-lib:array-slice work
      double-float
      (itauq)
      ((1 *)))
    u ldu
    (f2cl-lib:array-slice work
      double-float
      (iwork)
      ((1 *)))
    (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
    ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
    var-6 var-7 var-8 var-9 var-10 var-11
    var-12))
  (setf ierr var-13))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
  var-8 var-9)
  (dorgbr "P" n n n a lda
    (f2cl-lib:array-slice work
      double-float
      (itaup)
      ((1 *)))
    (f2cl-lib:array-slice work

```

```

                                double-float
                                (iwork)
                                ((1 *)))
      (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
      ierr)
    (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                    var-6 var-7 var-8))
    (setf ierr var-9))
  (setf iwork (f2cl-lib:int-add ie n))
  (multiple-value-bind
    (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
     var-8 var-9 var-10 var-11 var-12 var-13 var-14)
    (dbdsqr "U" n n m 0 s
      (f2cl-lib:array-slice work
                             double-float
                             (ie)
                             ((1 *)))
      a lda u ldu dum 1
      (f2cl-lib:array-slice work
                             double-float
                             (iwork)
                             ((1 *)))
      info)
    (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                    var-6 var-7 var-8 var-9 var-10 var-11
                    var-12 var-13))
    (setf info var-14))))))
(wntvas
(cond
  ((>= lwork
    (f2cl-lib:int-add (f2cl-lib:int-mul n n)
                      (max
                        (the fixnum
                          (f2cl-lib:int-mul 4 n))
                        (the fixnum bdspac)))))
    (setf iu 1)
    (cond
      ((>= lwork
        (f2cl-lib:int-add wrkbl (f2cl-lib:int-mul lda n)))
        (setf ldwrku lda))
      (t
        (setf ldwrku n)))
    (setf itau
      (f2cl-lib:int-add iu
                        (f2cl-lib:int-mul ldwrku n)))
    (setf iwork (f2cl-lib:int-add itau n))

```

```

(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7)
  (dgeqrf m n a lda
    (f2cl-lib:array-slice work
      double-float
      (itau)
      ((1 *)))
    (f2cl-lib:array-slice work
      double-float
      (iwork)
      ((1 *)))
    (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
    ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
    var-6))
  (setf ierr var-7))
(dlacpy "U" n n a lda
  (f2cl-lib:array-slice work double-float (iu) ((1 *)))
  ldwrku)
(dlaset "L" (f2cl-lib:int-sub n 1)
  (f2cl-lib:int-sub n 1) zero zero
  (f2cl-lib:array-slice work
    double-float
    ((+ iu 1))
    ((1 *)))
  ldwrku)
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
  var-8)
  (dorgqr m n n a lda
    (f2cl-lib:array-slice work
      double-float
      (itau)
      ((1 *)))
    (f2cl-lib:array-slice work
      double-float
      (iwork)
      ((1 *)))
    (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
    ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
    var-6 var-7))
  (setf ierr var-8))
(setf ie itau)
(setf itauq (f2cl-lib:int-add ie n))
(setf itaup (f2cl-lib:int-add itauq n))

```

```

(setf iwork (f2cl-lib:int-add itaup n))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
   var-8 var-9 var-10)
  (dgebrd n n
    (f2cl-lib:array-slice work
                           double-float
                           (iu)
                           ((1 *)))

    ldwrku s
    (f2cl-lib:array-slice work
                           double-float
                           (ie)
                           ((1 *)))

    (f2cl-lib:array-slice work
                           double-float
                           (itauq)
                           ((1 *)))

    (f2cl-lib:array-slice work
                           double-float
                           (itaup)
                           ((1 *)))

    (f2cl-lib:array-slice work
                           double-float
                           (iwork)
                           ((1 *)))

    (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
    ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6 var-7 var-8 var-9))
  (setf ierr var-10))
(dlacpy "U" n n
  (f2cl-lib:array-slice work double-float (iu) ((1 *)))
  ldwrku vt ldvt)
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
   var-8 var-9)
  (dorgbr "Q" n n n
    (f2cl-lib:array-slice work
                           double-float
                           (iu)
                           ((1 *)))

    ldwrku
    (f2cl-lib:array-slice work
                           double-float
                           (itauq)

```



```

((1 *)))
(f2cl-lib:array-slice work
  double-float
  (iwork)
  ((1 *)))
(f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
ierr)
(declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
  var-6 var-7 var-8))
(setf ierr var-9))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
  var-8 var-9)
  (dorgbr "P" n n n vt ldvt
    (f2cl-lib:array-slice work
      double-float
      (itaup)
      ((1 *)))
    (f2cl-lib:array-slice work
      double-float
      (iwork)
      ((1 *)))
    (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
    ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
    var-6 var-7 var-8))
  (setf ierr var-9))
(setf iwork (f2cl-lib:int-add ie n))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
  var-8 var-9 var-10 var-11 var-12 var-13 var-14)
  (dbdsqr "U" n n n 0 s
    (f2cl-lib:array-slice work
      double-float
      (ie)
      ((1 *)))
    vt ldvt
    (f2cl-lib:array-slice work
      double-float
      (iu)
      ((1 *)))
    ldwrku dum 1
    (f2cl-lib:array-slice work
      double-float
      (iwork)
      ((1 *)))

```

```

        info)
      (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                    var-6 var-7 var-8 var-9 var-10 var-11
                    var-12 var-13))
      (setf info var-14))
    (dgemm "N" "N" m n n one a lda
      (f2cl-lib:array-slice work double-float (iu) ((1 *)))
      ldwrku zero u ldu))
  (t
    (setf itau 1)
    (setf iwork (f2cl-lib:int-add itau n))
    (multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7)
      (dgeqrf m n a lda
        (f2cl-lib:array-slice work
          double-float
          (itau)
          ((1 *)))
        (f2cl-lib:array-slice work
          double-float
          (iwork)
          ((1 *)))
        (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
        ierr)
      (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                    var-6))
      (setf ierr var-7))
    (dlacpy "L" m n a lda u ldu)
    (multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8)
      (dorgqr m n n u ldu
        (f2cl-lib:array-slice work
          double-float
          (itau)
          ((1 *)))
        (f2cl-lib:array-slice work
          double-float
          (iwork)
          ((1 *)))
        (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
        ierr)
      (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                    var-6 var-7))
      (setf ierr var-8))
    (dlacpy "U" n n a lda vt ldvt)
  )

```

```

(dlaset "L" (f2cl-lib:int-sub n 1)
 (f2cl-lib:int-sub n 1) zero zero
 (f2cl-lib:array-slice vt
  double-float
  (2 1)
  ((1 ldvt) (1 *)))
ldvt)
(setf ie itau)
(setf itauq (f2cl-lib:int-add ie n))
(setf itaup (f2cl-lib:int-add itauq n))
(setf iwork (f2cl-lib:int-add itaup n))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
   var-8 var-9 var-10)
  (dgebrd n n vt ldvt s
   (f2cl-lib:array-slice work
    double-float
    (ie)
    ((1 *)))
   (f2cl-lib:array-slice work
    double-float
    (itauq)
    ((1 *)))
   (f2cl-lib:array-slice work
    double-float
    (itaup)
    ((1 *)))
   (f2cl-lib:array-slice work
    double-float
    (iwork)
    ((1 *)))
   (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
   ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
    var-6 var-7 var-8 var-9))
  (setf ierr var-10))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
   var-8 var-9 var-10 var-11 var-12 var-13)
  (dormbr "Q" "R" "N" m n n vt ldvt
   (f2cl-lib:array-slice work
    double-float
    (itauq)
    ((1 *)))
   u ldu
   (f2cl-lib:array-slice work

```

```

                                double-float
                                (iwork)
                                ((1 *)))
      (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
      ierr)
(declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
              var-6 var-7 var-8 var-9 var-10 var-11
              var-12))
(setf ierr var-13))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
   var-8 var-9)
  (dorgbr "P" n n n vt ldvt
    (f2cl-lib:array-slice work
                           double-float
                           (itaup)
                           ((1 *)))
    (f2cl-lib:array-slice work
                           double-float
                           (iwork)
                           ((1 *)))
    (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
    ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                    var-6 var-7 var-8))
  (setf ierr var-9))
(setf iwork (f2cl-lib:int-add ie n))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
   var-8 var-9 var-10 var-11 var-12 var-13 var-14)
  (dbdsqr "U" n n m 0 s
    (f2cl-lib:array-slice work
                           double-float
                           (ie)
                           ((1 *)))
    vt ldvt u ldu dum 1
    (f2cl-lib:array-slice work
                           double-float
                           (iwork)
                           ((1 *)))
    info)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                    var-6 var-7 var-8 var-9 var-10 var-11
                    var-12 var-13))
  (setf info var-14))))))
(wntua

```

```

(cond
  (wntvn
    (cond
      ((>= lwork
        (f2cl-lib:int-add (f2cl-lib:int-mul n n)
          (max
            (the fixnum
              (f2cl-lib:int-add n m))
            (the fixnum
              (f2cl-lib:int-mul 4 n))
            (the fixnum bdspace))))))
      (setf ir 1)
      (cond
        ((>= lwork
          (f2cl-lib:int-add wrkbl (f2cl-lib:int-mul lda n)))
          (setf ldwrkr lda))
        (t
          (setf ldwrkr n)))
      (setf itau
        (f2cl-lib:int-add ir
          (f2cl-lib:int-mul ldwrkr n)))
      (setf iwork (f2cl-lib:int-add itau n))
      (multiple-value-bind
        (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7)
        (dgeqrf m n a lda
          (f2cl-lib:array-slice work
            double-float
            (itau)
            ((1 *)))
          (f2cl-lib:array-slice work
            double-float
            (iwork)
            ((1 *)))
          (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
          ierr)
        (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
          var-6))
        (setf ierr var-7))
      (dlacpy "L" m n a lda u ldu)
      (dlacpy "U" n n a lda
        (f2cl-lib:array-slice work double-float (ir) ((1 *)))
        ldwrkr)
      (dlaset "L" (f2cl-lib:int-sub n 1)
        (f2cl-lib:int-sub n 1) zero zero
        (f2cl-lib:array-slice work
          double-float

```

```

                                ((+ ir 1))
                                ((1 *)))

ldwrkr)
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
   var-8)
  (dorgqr m m n u ldu
    (f2cl-lib:array-slice work
                           double-float
                           (itau)
                           ((1 *)))
    (f2cl-lib:array-slice work
                           double-float
                           (iwork)
                           ((1 *)))
    (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
    ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                    var-6 var-7))
  (setf ierr var-8))
(setf ie itau)
(setf itauq (f2cl-lib:int-add ie n))
(setf itaup (f2cl-lib:int-add itauq n))
(setf iwork (f2cl-lib:int-add itaup n))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
   var-8 var-9 var-10)
  (dgebrd n n
    (f2cl-lib:array-slice work
                           double-float
                           (ir)
                           ((1 *)))

    ldwrkr s
    (f2cl-lib:array-slice work
                           double-float
                           (ie)
                           ((1 *)))

    (f2cl-lib:array-slice work
                           double-float
                           (itauq)
                           ((1 *)))

    (f2cl-lib:array-slice work
                           double-float
                           (itaup)
                           ((1 *)))

    (f2cl-lib:array-slice work

```

```

double-float
(iwork)
((1 *)))
(f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
ierr)
(declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
var-6 var-7 var-8 var-9))
(setf ierr var-10))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
   var-8 var-9)
  (dorgbr "Q" n n n
    (f2cl-lib:array-slice work
      double-float
      (ir)
      ((1 *)))

    ldwrkr
    (f2cl-lib:array-slice work
      double-float
      (itauq)
      ((1 *)))

    (f2cl-lib:array-slice work
      double-float
      (iwork)
      ((1 *)))

    (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
    ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
var-6 var-7 var-8))
  (setf ierr var-9))
(setf iwork (f2cl-lib:int-add ie n))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
   var-8 var-9 var-10 var-11 var-12 var-13 var-14)
  (dbdsqr "U" n 0 n 0 s
    (f2cl-lib:array-slice work
      double-float
      (ie)
      ((1 *)))

    dum 1
    (f2cl-lib:array-slice work
      double-float
      (ir)
      ((1 *)))

    ldwrkr dum 1
    (f2cl-lib:array-slice work

```

```

                                double-float
                                (iwork)
                                ((1 *)))

    info)
    (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                    var-6 var-7 var-8 var-9 var-10 var-11
                    var-12 var-13))
    (setf info var-14))
    (dgemm "N" "N" m n n one u ldu
    (f2cl-lib:array-slice work double-float (ir) ((1 *)))
    ldwrkr zero a lda)
    (dlacpy "F" m n a lda u ldu))
    (t
    (setf itau 1)
    (setf iwork (f2cl-lib:int-add itau n))
    (multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7)
      (dgeqrf m n a lda
      (f2cl-lib:array-slice work
                            double-float
                            (itau)
                            ((1 *)))
      (f2cl-lib:array-slice work
                            double-float
                            (iwork)
                            ((1 *)))
      (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
      ierr)
    (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                    var-6))
    (setf ierr var-7))
    (dlacpy "L" m n a lda u ldu)
    (multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8)
      (dorgqr m m n u ldu
      (f2cl-lib:array-slice work
                            double-float
                            (itau)
                            ((1 *)))
      (f2cl-lib:array-slice work
                            double-float
                            (iwork)
                            ((1 *)))
      (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
      ierr)

```



```

(declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
            var-6 var-7))
(setf ierr var-8))
(setf ie itau)
(setf itauq (f2cl-lib:int-add ie n))
(setf itaup (f2cl-lib:int-add itauq n))
(setf iwork (f2cl-lib:int-add itaup n))
(dlaset "L" (f2cl-lib:int-sub n 1) zero zero
(f2cl-lib:array-slice a
                      double-float
                      (2 1)
                      ((1 lda) (1 *)))
lda)
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
   var-8 var-9 var-10)
  (dgebrd n n a lda s
(f2cl-lib:array-slice work
                      double-float
                      (ie)
                      ((1 *)))
(f2cl-lib:array-slice work
                      double-float
                      (itauq)
                      ((1 *)))
(f2cl-lib:array-slice work
                      double-float
                      (itaup)
                      ((1 *)))
(f2cl-lib:array-slice work
                      double-float
                      (iwork)
                      ((1 *)))
(f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
  ierr)
(declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
            var-6 var-7 var-8 var-9))
(setf ierr var-10))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
   var-8 var-9 var-10 var-11 var-12 var-13)
  (dormbr "Q" "R" "N" m n n a lda
(f2cl-lib:array-slice work
                      double-float
                      (itauq)

```

```

((1 *)))
u ldu
(f2cl-lib:array-slice work
  double-float
  (iwork)
  ((1 *)))
(f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
ierr)
(declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
  var-6 var-7 var-8 var-9 var-10 var-11
  var-12))
(setf ierr var-13))
(setf iwork (f2cl-lib:int-add ie n))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
   var-8 var-9 var-10 var-11 var-12 var-13 var-14)
  (dbdsqr "U" n 0 m 0 s
    (f2cl-lib:array-slice work
      double-float
      (ie)
      ((1 *)))

    dum 1 u ldu dum 1
    (f2cl-lib:array-slice work
      double-float
      (iwork)
      ((1 *)))

    info)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
    var-6 var-7 var-8 var-9 var-10 var-11
    var-12 var-13))
  (setf info var-14))))))
(wntvo
(cond
  ((>= lwork
    (f2cl-lib:int-add (f2cl-lib:int-mul 2 n n)
      (max
        (the fixnum
          (f2cl-lib:int-add n m))
        (the fixnum
          (f2cl-lib:int-mul 4 n))
        (the fixnum bdspac)))))
    (setf iu 1)
  (cond
    ((>= lwork
      (f2cl-lib:int-add wrkbl
        (f2cl-lib:int-mul 2 lda n)))

```

```

(setf ldwrku lda)
(setf ir
  (f2cl-lib:int-add iu
    (f2cl-lib:int-mul ldwrku
      n)))

(setf ldwrkr lda)
(>= lwork
  (f2cl-lib:int-add wrkbl
    (f2cl-lib:int-mul
      (f2cl-lib:int-add lda n)
      n)))

(setf ldwrku lda)
(setf ir
  (f2cl-lib:int-add iu
    (f2cl-lib:int-mul ldwrku
      n)))

(setf ldwrkr n))
(t
  (setf ldwrku n)
  (setf ir
    (f2cl-lib:int-add iu
      (f2cl-lib:int-mul ldwrku
        n)))

  (setf ldwrkr n)))
(setf itau
  (f2cl-lib:int-add ir
    (f2cl-lib:int-mul ldwrkr n)))
(setf iwork (f2cl-lib:int-add itau n))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7)
  (dgeqrf m n a lda
    (f2cl-lib:array-slice work
      double-float
      (itau)
      ((1 *)))
    (f2cl-lib:array-slice work
      double-float
      (iwork)
      ((1 *)))
    (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
    ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
    var-6))
  (setf ierr var-7))
(dlacpy "L" m n a lda u ldu)
(multiple-value-bind

```

```

      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8)
      (dorgqr m m n u ldu
       (f2cl-lib:array-slice work
        double-float
        (itau)
        ((1 *)))
       (f2cl-lib:array-slice work
        double-float
        (iwork)
        ((1 *)))
       (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
       ierr)
      (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                       var-6 var-7))
      (setf ierr var-8)
      (dlacpy "U" n n a lda
       (f2cl-lib:array-slice work double-float (iu) ((1 *)))
       ldwrku)
      (dlaset "L" (f2cl-lib:int-sub n 1)
       (f2cl-lib:int-sub n 1) zero zero
       (f2cl-lib:array-slice work
        double-float
        ((+ iu 1))
        ((1 *)))
       ldwrku)
      (setf ie itau)
      (setf itauq (f2cl-lib:int-add ie n))
      (setf itaup (f2cl-lib:int-add itauq n))
      (setf iwork (f2cl-lib:int-add itaup n))
      (multiple-value-bind
       (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
        var-8 var-9 var-10)
       (dgebrd n n
        (f2cl-lib:array-slice work
         double-float
         (iu)
         ((1 *)))
        ldwrku s
        (f2cl-lib:array-slice work
         double-float
         (ie)
         ((1 *)))
        (f2cl-lib:array-slice work
         double-float
         (itauq)

```

```

((1 *)))
(f2cl-lib:array-slice work
  double-float
  (itaup)
  ((1 *)))
(f2cl-lib:array-slice work
  double-float
  (iwork)
  ((1 *)))
(f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
ierr)
(declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
  var-6 var-7 var-8 var-9))
(setf ierr var-10))
(dlacpy "U" n n
  (f2cl-lib:array-slice work double-float (iu) ((1 *)))
  ldwrku
  (f2cl-lib:array-slice work double-float (ir) ((1 *)))
  ldwrkr)
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
   var-8 var-9)
  (dorgbr "Q" n n n
    (f2cl-lib:array-slice work
      double-float
      (iu)
      ((1 *)))

    ldwrku
    (f2cl-lib:array-slice work
      double-float
      (itauq)
      ((1 *)))

    (f2cl-lib:array-slice work
      double-float
      (iwork)
      ((1 *)))

    (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
    ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
    var-6 var-7 var-8))
  (setf ierr var-9))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
   var-8 var-9)
  (dorgbr "P" n n n
    (f2cl-lib:array-slice work

```

```

                                double-float
                                (ir)
                                ((1 *)))

ldwrkr
(f2cl-lib:array-slice work
                        double-float
                        (itaup)
                        ((1 *)))

(f2cl-lib:array-slice work
                        double-float
                        (iwork)
                        ((1 *)))

(f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
ierr)
(declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                var-6 var-7 var-8))
(setf ierr var-9))
(setf iwork (f2cl-lib:int-add ie n))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
   var-8 var-9 var-10 var-11 var-12 var-13 var-14)
  (dbdsqr "U" n n n 0 s
          (f2cl-lib:array-slice work
                                double-float
                                (ie)
                                ((1 *)))

          (f2cl-lib:array-slice work
                                double-float
                                (ir)
                                ((1 *)))

          ldwrkr
          (f2cl-lib:array-slice work
                                double-float
                                (iu)
                                ((1 *)))

          ldwrku dum 1
          (f2cl-lib:array-slice work
                                double-float
                                (iwork)
                                ((1 *)))

          info)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                  var-6 var-7 var-8 var-9 var-10 var-11
                  var-12 var-13))
  (setf info var-14))
(dgemm "N" "N" m n n one u ldu

```

```

(f2cl-lib:array-slice work double-float (iu) ((1 *)))
ldwrku zero a lda)
(dlacpy "F" m n a lda u ldu)
(dlacpy "F" n n
 (f2cl-lib:array-slice work double-float (ir) ((1 *)))
 ldwrkr a lda))
(t
 (setf itau 1)
 (setf iwork (f2cl-lib:int-add itau n))
 (multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7)
  (dgeqrf m n a lda
   (f2cl-lib:array-slice work
    double-float
    (itau)
    ((1 *)))
   (f2cl-lib:array-slice work
    double-float
    (iwork)
    ((1 *)))
   (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
   ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
    var-6))
  (setf ierr var-7))
 (dlacpy "L" m n a lda u ldu)
 (multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
   var-8)
  (dorgqr m m n u ldu
   (f2cl-lib:array-slice work
    double-float
    (itau)
    ((1 *)))
   (f2cl-lib:array-slice work
    double-float
    (iwork)
    ((1 *)))
   (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
   ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
    var-6 var-7))
  (setf ierr var-8))
 (setf ie itau)
 (setf itauq (f2cl-lib:int-add ie n))
 (setf itaup (f2cl-lib:int-add itauq n))

```

```

(setf iwork (f2cl-lib:int-add itaup n))
(dlaset "L" (f2cl-lib:int-sub n 1)
  (f2cl-lib:int-sub n 1) zero zero
  (f2cl-lib:array-slice a
    double-float
    (2 1)
    ((1 lda) (1 *)))
lda)
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
   var-8 var-9 var-10)
  (dgebrd n n a lda s
    (f2cl-lib:array-slice work
      double-float
      (ie)
      ((1 *)))
    (f2cl-lib:array-slice work
      double-float
      (itauq)
      ((1 *)))
    (f2cl-lib:array-slice work
      double-float
      (itaup)
      ((1 *)))
    (f2cl-lib:array-slice work
      double-float
      (iwork)
      ((1 *)))
    (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
    ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
    var-6 var-7 var-8 var-9))
  (setf ierr var-10))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
   var-8 var-9 var-10 var-11 var-12 var-13)
  (dormbr "Q" "R" "N" m n n a lda
    (f2cl-lib:array-slice work
      double-float
      (itauq)
      ((1 *)))
    u ldu
    (f2cl-lib:array-slice work
      double-float
      (iwork)
      ((1 *)))

```



```

(f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
ierr)
(declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
              var-6 var-7 var-8 var-9 var-10 var-11
              var-12))
(setf ierr var-13))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
   var-8 var-9)
  (dorgbr "P" n n n a lda
    (f2cl-lib:array-slice work
                          double-float
                          (itaup)
                          ((1 *)))
    (f2cl-lib:array-slice work
                          double-float
                          (iwork)
                          ((1 *)))
    (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
    ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                    var-6 var-7 var-8))
  (setf ierr var-9))
(setf iwork (f2cl-lib:int-add ie n))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
   var-8 var-9 var-10 var-11 var-12 var-13 var-14)
  (dbdsqr "U" n n m 0 s
    (f2cl-lib:array-slice work
                          double-float
                          (ie)
                          ((1 *)))
    a lda u ldu dum 1
    (f2cl-lib:array-slice work
                          double-float
                          (iwork)
                          ((1 *)))
    info)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                    var-6 var-7 var-8 var-9 var-10 var-11
                    var-12 var-13))
  (setf info var-14))))))
(wntvas
  (cond
    ((>= lwork
      (f2cl-lib:int-add (f2cl-lib:int-mul n n)

```

```

(max
  (the fixnum
    (f2cl-lib:int-add n m))
  (the fixnum
    (f2cl-lib:int-mul 4 n))
  (the fixnum bdspace)))
(setf iu 1)
(cond
  ((>= lwork
    (f2cl-lib:int-add wrkbl (f2cl-lib:int-mul lda n)))
    (setf ldwrku lda))
  (t
    (setf ldwrku n)))
(setf itau
  (f2cl-lib:int-add iu
    (f2cl-lib:int-mul ldwrku n)))
(setf iwork (f2cl-lib:int-add itau n))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7)
  (dgeqrf m n a lda
    (f2cl-lib:array-slice work
      double-float
      (itau)
      ((1 *)))
    (f2cl-lib:array-slice work
      double-float
      (iwork)
      ((1 *)))
    (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
    ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
    var-6))
  (setf ierr var-7))
(dlacpy "L" m n a lda u ldu)
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
    var-8)
  (dorgqr m m n u ldu
    (f2cl-lib:array-slice work
      double-float
      (itau)
      ((1 *)))
    (f2cl-lib:array-slice work
      double-float
      (iwork)
      ((1 *)))

```

```

(f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
ierr)
(declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
            var-6 var-7))
(setf ierr var-8))
(dlacpy "U" n n a lda
(f2cl-lib:array-slice work double-float (iu) ((1 *)))
ldwrku)
(dlaset "L" (f2cl-lib:int-sub n 1)
(f2cl-lib:int-sub n 1) zero zero
(f2cl-lib:array-slice work
                        double-float
                        ((+ iu 1))
                        ((1 *)))
ldwrku)
(setf ie itau)
(setf itauq (f2cl-lib:int-add ie n))
(setf itaup (f2cl-lib:int-add itauq n))
(setf iwork (f2cl-lib:int-add itaup n))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
   var-8 var-9 var-10)
  (dgebrd n n
(f2cl-lib:array-slice work
                        double-float
                        (iu)
                        ((1 *)))
ldwrku s
(f2cl-lib:array-slice work
                        double-float
                        (ie)
                        ((1 *)))
(f2cl-lib:array-slice work
                        double-float
                        (itauq)
                        ((1 *)))
(f2cl-lib:array-slice work
                        double-float
                        (itaup)
                        ((1 *)))
(f2cl-lib:array-slice work
                        double-float
                        (iwork)
                        ((1 *)))
(f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
ierr)

```

```

(declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
              var-6 var-7 var-8 var-9))
(setf ierr var-10))
(dlacpy "U" n n
  (f2cl-lib:array-slice work double-float (iu) ((1 *)))
  ldwrku vt ldvt)
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
   var-8 var-9)
  (dorgbr "Q" n n n
    (f2cl-lib:array-slice work
                          double-float
                          (iu)
                          ((1 *)))

    ldwrku
    (f2cl-lib:array-slice work
                          double-float
                          (itauq)
                          ((1 *)))

    (f2cl-lib:array-slice work
                          double-float
                          (iwork)
                          ((1 *)))

    (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
    ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                    var-6 var-7 var-8))
  (setf ierr var-9))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
   var-8 var-9)
  (dorgbr "P" n n n vt ldvt
    (f2cl-lib:array-slice work
                          double-float
                          (itaup)
                          ((1 *)))

    (f2cl-lib:array-slice work
                          double-float
                          (iwork)
                          ((1 *)))

    (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
    ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                    var-6 var-7 var-8))
  (setf ierr var-9))
(setf iwork (f2cl-lib:int-add ie n))

```

```

(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
   var-8 var-9 var-10 var-11 var-12 var-13 var-14)
  (dbdsqr "U" n n n 0 s
    (f2cl-lib:array-slice work
      double-float
      (ie)
      ((1 *)))
    vt ldvt
    (f2cl-lib:array-slice work
      double-float
      (iu)
      ((1 *)))
    ldwrku dum 1
    (f2cl-lib:array-slice work
      double-float
      (iwork)
      ((1 *)))
    info)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
    var-6 var-7 var-8 var-9 var-10 var-11
    var-12 var-13))
  (setf info var-14))
(dgemm "N" "N" m n n one u ldu
  (f2cl-lib:array-slice work double-float (iu) ((1 *)))
  ldwrku zero a lda)
(dlacpy "F" m n a lda u ldu))
(t
  (setf itau 1)
  (setf iwork (f2cl-lib:int-add itau n))
  (multiple-value-bind
    (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7)
    (dgeqrf m n a lda
      (f2cl-lib:array-slice work
        double-float
        (itau)
        ((1 *)))
      (f2cl-lib:array-slice work
        double-float
        (iwork)
        ((1 *)))
      (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
      ierr)
    (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
      var-6))
    (setf ierr var-7))

```

```

(dlacpy "L" m n a lda u ldu)
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
   var-8)
  (dorgqr m m n u ldu
    (f2cl-lib:array-slice work
      double-float
      (itau)
      ((1 *)))
    (f2cl-lib:array-slice work
      double-float
      (iwork)
      ((1 *)))
    (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
    ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
    var-6 var-7))
  (setf ierr var-8))
(dlacpy "U" n n a lda vt ldvt)
(dlaset "L" (f2cl-lib:int-sub n 1)
  (f2cl-lib:int-sub n 1) zero zero
  (f2cl-lib:array-slice vt
    double-float
    (2 1)
    ((1 ldvt) (1 *)))
  ldvt)
(setf ie itau)
(setf itauq (f2cl-lib:int-add ie n))
(setf itaup (f2cl-lib:int-add itauq n))
(setf iwork (f2cl-lib:int-add itaup n))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
   var-8 var-9 var-10)
  (dgebrd n n vt ldvt s
    (f2cl-lib:array-slice work
      double-float
      (ie)
      ((1 *)))
    (f2cl-lib:array-slice work
      double-float
      (itauq)
      ((1 *)))
    (f2cl-lib:array-slice work
      double-float
      (itaup)
      ((1 *)))

```

```

(f2cl-lib:array-slice work
  double-float
  (iwork)
  ((1 *)))
(f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
ierr)
(declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
  var-6 var-7 var-8 var-9))
(setf ierr var-10))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
  var-8 var-9 var-10 var-11 var-12 var-13)
(dormbr "Q" "R" "N" m n n vt ldvt
  (f2cl-lib:array-slice work
    double-float
    (itauq)
    ((1 *)))

  u ldu
  (f2cl-lib:array-slice work
    double-float
    (iwork)
    ((1 *)))

  (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
  ierr)
(declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
  var-6 var-7 var-8 var-9 var-10 var-11
  var-12))
(setf ierr var-13))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
  var-8 var-9)
(dorgbr "P" n n n vt ldvt
  (f2cl-lib:array-slice work
    double-float
    (itaup)
    ((1 *)))

  (f2cl-lib:array-slice work
    double-float
    (iwork)
    ((1 *)))

  (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
  ierr)
(declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
  var-6 var-7 var-8))
(setf ierr var-9))
(setf iwork (f2cl-lib:int-add ie n))

```

```

(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
   var-8 var-9 var-10 var-11 var-12 var-13 var-14)
  (dbdsqr "U" n n m 0 s
    (f2cl-lib:array-slice work
                           double-float
                           (ie)
                           ((1 *)))
    vt ldvt u ldu dum 1
    (f2cl-lib:array-slice work
                           double-float
                           (iwork)
                           ((1 *)))
    info)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                  var-6 var-7 var-8 var-9 var-10 var-11
                  var-12 var-13))
  (setf info var-14)))))))))
(t
  (setf ie 1)
  (setf itauq (f2cl-lib:int-add ie n))
  (setf itaup (f2cl-lib:int-add itauq n))
  (setf iwork (f2cl-lib:int-add itaup n))
  (multiple-value-bind
    (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
     var-9 var-10)
    (dgebrd m n a lda s
      (f2cl-lib:array-slice work double-float (ie) ((1 *)))
      (f2cl-lib:array-slice work double-float (itauq) ((1 *)))
      (f2cl-lib:array-slice work double-float (itaup) ((1 *)))
      (f2cl-lib:array-slice work double-float (iwork) ((1 *)))
      (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1) ierr)
    (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                    var-7 var-8 var-9))
    (setf ierr var-10))
  (cond
    (wntuas
      (dlacpy "L" m n a lda u ldu)
      (if wntus (setf ncu n))
      (if wntua (setf ncu m))
      (multiple-value-bind
        (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
         var-9)
        (dorgbr "Q" m ncu n u ldu
          (f2cl-lib:array-slice work double-float (itauq) ((1 *)))
          (f2cl-lib:array-slice work double-float (iwork) ((1 *)))

```



```

        (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1) ierr)
      (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                    var-7 var-8))
      (setf ierr var-9))))
(cond
  (wntvas
    (dlacpy "U" n n a lda vt ldvt)
    (multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
       var-9)
      (dorgbr "P" n n n vt ldvt
        (f2cl-lib:array-slice work double-float (itauq) ((1 *)))
        (f2cl-lib:array-slice work double-float (iwork) ((1 *)))
        (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1) ierr)
      (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                    var-7 var-8))
      (setf ierr var-9))))
  (cond
    (wntuo
      (multiple-value-bind
        (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
         var-9)
        (dorgbr "Q" m n n a lda
          (f2cl-lib:array-slice work double-float (itauq) ((1 *)))
          (f2cl-lib:array-slice work double-float (iwork) ((1 *)))
          (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1) ierr)
        (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                      var-7 var-8))
        (setf ierr var-9))))
    (cond
      (wntvo
        (multiple-value-bind
          (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
           var-9)
          (dorgbr "P" n n n a lda
            (f2cl-lib:array-slice work double-float (itauq) ((1 *)))
            (f2cl-lib:array-slice work double-float (iwork) ((1 *)))
            (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1) ierr)
          (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                        var-7 var-8))
          (setf ierr var-9))))
      (setf iwork (f2cl-lib:int-add ie n))
      (if (or wntuas wntuo) (setf nru m))
      (if wntun (setf nru 0))
      (if (or wntvas wntvo) (setf ncv t n))
      (if wntvn (setf ncv t 0))

```

```

(cond
  ((and (not wntuo) (not wntvo))
    (multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
       var-9 var-10 var-11 var-12 var-13 var-14)
      (dbdsqr "U" n ncv t nru 0 s
        (f2cl-lib:array-slice work double-float (ie) ((1 *))) vt
        ldvt u ldu dum 1
        (f2cl-lib:array-slice work double-float (iwork) ((1 *)))
        info)
      (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
        var-7 var-8 var-9 var-10 var-11 var-12
        var-13))
      (setf info var-14)))
    ((and (not wntuo) wntvo)
      (multiple-value-bind
        (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
         var-9 var-10 var-11 var-12 var-13 var-14)
        (dbdsqr "U" n ncv t nru 0 s
          (f2cl-lib:array-slice work double-float (ie) ((1 *))) a
          lda u ldu dum 1
          (f2cl-lib:array-slice work double-float (iwork) ((1 *)))
          info)
        (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
          var-7 var-8 var-9 var-10 var-11 var-12
          var-13))
        (setf info var-14)))
      (t
        (multiple-value-bind
          (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
           var-9 var-10 var-11 var-12 var-13 var-14)
          (dbdsqr "U" n ncv t nru 0 s
            (f2cl-lib:array-slice work double-float (ie) ((1 *))) vt
            ldvt a lda dum 1
            (f2cl-lib:array-slice work double-float (iwork) ((1 *)))
            info)
          (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
            var-7 var-8 var-9 var-10 var-11 var-12
            var-13))
          (setf info var-14))))))
    (t
      (cond
        ((>= n mnthr)
          (cond
            (wntvn
              (setf itau 1)

```

```

(setf iwork (f2cl-lib:int-add itau m))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7)
  (dgelqf m n a lda
    (f2cl-lib:array-slice work double-float (itau) ((1 *)))
    (f2cl-lib:array-slice work double-float (iwork) ((1 *)))
    (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1) ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6))
  (setf ierr var-7))
(dlaset "U" (f2cl-lib:int-sub m 1) (f2cl-lib:int-sub m 1) zero
  zero
  (f2cl-lib:array-slice a double-float (1 2) ((1 lda) (1 *)))
  lda)
(setf ie 1)
(setf itauq (f2cl-lib:int-add ie m))
(setf itaup (f2cl-lib:int-add itauq m))
(setf iwork (f2cl-lib:int-add itaup m))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
   var-9 var-10)
  (dgebrd m m a lda s
    (f2cl-lib:array-slice work double-float (ie) ((1 *)))
    (f2cl-lib:array-slice work double-float (itauq) ((1 *)))
    (f2cl-lib:array-slice work double-float (itaup) ((1 *)))
    (f2cl-lib:array-slice work double-float (iwork) ((1 *)))
    (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1) ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
    var-7 var-8 var-9))
  (setf ierr var-10))
(cond
  ((or wntuo wntuas)
    (multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8 var-9)
      (dorgbr "Q" m m m a lda
        (f2cl-lib:array-slice work
          double-float
          (itauq)
          ((1 *)))
        (f2cl-lib:array-slice work
          double-float
          (iwork)
          ((1 *)))
        (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
        ierr)
      (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5

```

```

                                var-6 var-7 var-8))
  (setf ierr var-9))))
(setf iwork (f2cl-lib:int-add ie m))
(setf nru 0)
(if (or wntuo wntuas) (setf nru m))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
   var-9 var-10 var-11 var-12 var-13 var-14)
  (dbdsqr "U" m 0 nru 0 s
    (f2cl-lib:array-slice work double-float (ie) ((1 *))) dum
    1 a lda dum 1
    (f2cl-lib:array-slice work double-float (iwork) ((1 *)))
    info)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                    var-7 var-8 var-9 var-10 var-11 var-12
                    var-13))
  (setf info var-14))
(if wntuas (dlacpy "F" m m a lda u ldu)))
((and wntvo wntun)
 (cond
  ((>= lwork
        (f2cl-lib:int-add (f2cl-lib:int-mul m m)
                           (max
                            (the fixnum
                             (f2cl-lib:int-mul 4 m))
                            (the fixnum bdspace))))
   (setf ir 1)
   (cond
    ((>= lwork
          (f2cl-lib:int-add
            (max (the fixnum wrkbl)
                 (the fixnum
                  (f2cl-lib:int-add
                    (f2cl-lib:int-mul lda n)
                    m))))
            (f2cl-lib:int-mul lda m)))
     (setf ldwrku lda)
     (setf chunk n)
     (setf ldwrkr lda))
    ((>= lwork
          (f2cl-lib:int-add
            (max (the fixnum wrkbl)
                 (the fixnum
                  (f2cl-lib:int-add
                    (f2cl-lib:int-mul lda n)
                    m))))
     ))))

```

```

(f2cl-lib:int-mul m m)))
(setf ldwrku lda)
(setf chunk n)
(setf ldwrkr m))
(t
  (setf ldwrku m)
  (setf chunk
    (the fixnum
      (truncate (- lwork (* m m) m) m)))
  (setf ldwrkr m)))
(setf itau
  (f2cl-lib:int-add ir (f2cl-lib:int-mul ldwrkr m)))
(setf iwork (f2cl-lib:int-add itau m))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7)
  (dgelqf m n a lda
    (f2cl-lib:array-slice work
      double-float
      (itau)
      ((1 *)))
    (f2cl-lib:array-slice work
      double-float
      (iwork)
      ((1 *)))
    (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
    ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
    var-6))
  (setf ierr var-7))
(dlacpy "L" m m a lda
  (f2cl-lib:array-slice work double-float (ir) ((1 *)))
  ldwrkr)
(dlaset "U" (f2cl-lib:int-sub m 1) (f2cl-lib:int-sub m 1)
  zero zero
  (f2cl-lib:array-slice work
    double-float
    ((+ ir ldwrkr))
    ((1 *)))
  ldwrkr)
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
  var-8)
  (dorglq m n m a lda
    (f2cl-lib:array-slice work
      double-float
      (itau)

```

```

((1 *)))
(f2cl-lib:array-slice work
  double-float
  (iwork)
  ((1 *)))
(f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
ierr)
(declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
  var-6 var-7))
(setf ierr var-8))
(setf ie itau)
(setf itauq (f2cl-lib:int-add ie m))
(setf itaup (f2cl-lib:int-add itauq m))
(setf iwork (f2cl-lib:int-add itaup m))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
   var-8 var-9 var-10)
  (dgebrd m m
    (f2cl-lib:array-slice work double-float (ir) ((1 *)))
    ldwrkr s
    (f2cl-lib:array-slice work double-float (ie) ((1 *)))
    (f2cl-lib:array-slice work
      double-float
      (itauq)
      ((1 *)))
    (f2cl-lib:array-slice work
      double-float
      (itaup)
      ((1 *)))
    (f2cl-lib:array-slice work
      double-float
      (iwork)
      ((1 *)))
    (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
    ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
    var-6 var-7 var-8 var-9))
  (setf ierr var-10))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
   var-8 var-9)
  (dorgbr "P" m m m
    (f2cl-lib:array-slice work double-float (ir) ((1 *)))
    ldwrkr
    (f2cl-lib:array-slice work
      double-float

```



```

(f2cl-lib:array-slice work double-float (iu) ((1 *)))
ldwrku)
(dlacpy "F" m blk
(f2cl-lib:array-slice work double-float (iu) ((1 *)))
ldwrku
(f2cl-lib:array-slice a
double-float
(1 i)
((1 lda) (1 *)))
lda)))
(t
(setf ie 1)
(setf itauq (f2cl-lib:int-add ie m))
(setf itaup (f2cl-lib:int-add itauq m))
(setf iwork (f2cl-lib:int-add itaup m))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
   var-8 var-9 var-10)
(dgebrd m n a lda s
(f2cl-lib:array-slice work double-float (ie) ((1 *)))
(f2cl-lib:array-slice work
double-float
(itauq)
((1 *)))
(f2cl-lib:array-slice work
double-float
(itaup)
((1 *)))
(f2cl-lib:array-slice work
double-float
(iwork)
((1 *)))
(f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
ierr)
(declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
var-6 var-7 var-8 var-9))
(setf ierr var-10))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
   var-8 var-9)
(dorgbr "P" m n m a lda
(f2cl-lib:array-slice work
double-float
(itaup)
((1 *)))
(f2cl-lib:array-slice work

```



```

                                double-float
                                (iwork)
                                ((1 *)))
    (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
    ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                  var-6 var-7 var-8))
  (setf ierr var-9))
  (setf iwork (f2cl-lib:int-add ie m))
  (multiple-value-bind
    (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
     var-8 var-9 var-10 var-11 var-12 var-13 var-14)
    (dbdsqr "L" m n 0 0 s
      (f2cl-lib:array-slice work double-float (ie) ((1 *)))
      a lda dum 1
      (f2cl-lib:array-slice work
                            double-float
                            (iwork)
                            ((1 *)))

      info)
    (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                    var-6 var-7 var-8 var-9 var-10 var-11
                    var-12 var-13))
    (setf info var-14))))))
  ((and wntvo wntuas)
   (cond
    ((>= lwork
      (f2cl-lib:int-add (f2cl-lib:int-mul m m)
                        (max
                         (the fixnum
                          (f2cl-lib:int-mul 4 m))
                         (the fixnum bdspace))))
     (setf ir 1)
     (cond
      ((>= lwork
        (f2cl-lib:int-add
          (max (the fixnum wrkbl)
              (the fixnum
               (f2cl-lib:int-add
                (f2cl-lib:int-mul lda n)
                m))))
          (f2cl-lib:int-mul lda m)))
       (setf ldwrku lda)
       (setf chunk n)
       (setf ldwrkr lda))
      ((>= lwork

```

```

(f2cl-lib:int-add
  (max (the fixnum wrkbl)
        (the fixnum
          (f2cl-lib:int-add
            (f2cl-lib:int-mul lda n)
            m)))
    (f2cl-lib:int-mul m m)))
(setf ldwrku lda)
(setf chunk n)
(setf ldwrkr m)
(t
  (setf ldwrku m)
  (setf chunk
    (the fixnum
      (truncate (- lwork (* m m) m) m))))
(setf ldwrkr m))
(setf itau
  (f2cl-lib:int-add ir (f2cl-lib:int-mul ldwrkr m)))
(setf iwork (f2cl-lib:int-add itau m))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7)
  (dgelqf m n a lda
    (f2cl-lib:array-slice work
      double-float
      (itau)
      ((1 *)))
    (f2cl-lib:array-slice work
      double-float
      (iwork)
      ((1 *)))
    (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
    ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
    var-6))
  (setf ierr var-7))
(dlacpy "L" m m a lda u ldu)
(dlaset "U" (f2cl-lib:int-sub m 1) (f2cl-lib:int-sub m 1)
  zero zero
  (f2cl-lib:array-slice u
    double-float
    (1 2)
    ((1 ldu) (1 *)))
  ldu)
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
    var-8)

```

```

(dorglq m n m a lda
  (f2cl-lib:array-slice work
    double-float
    (itau)
    ((1 *)))
  (f2cl-lib:array-slice work
    double-float
    (iwork)
    ((1 *)))
  (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
  ierr)
(declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
  var-6 var-7))
(setf ierr var-8))
(setf ie itau)
(setf itauq (f2cl-lib:int-add ie m))
(setf itaup (f2cl-lib:int-add itauq m))
(setf iwork (f2cl-lib:int-add itaup m))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
  var-8 var-9 var-10)
  (dgebrd m m u ldu s
    (f2cl-lib:array-slice work double-float (ie) ((1 *)))
    (f2cl-lib:array-slice work
      double-float
      (itauq)
      ((1 *)))
    (f2cl-lib:array-slice work
      double-float
      (itaup)
      ((1 *)))
    (f2cl-lib:array-slice work
      double-float
      (iwork)
      ((1 *)))
    (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
    ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
    var-6 var-7 var-8 var-9))
  (setf ierr var-10))
(dlacpy "U" m m u ldu
  (f2cl-lib:array-slice work double-float (ir) ((1 *)))
  ldwrkr)
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
  var-8 var-9)

```

```

(dorgbr "P" m m m
  (f2cl-lib:array-slice work double-float (ir) ((1 *)))
  ldwrkr
  (f2cl-lib:array-slice work
    double-float
    (itaup)
    ((1 *)))
  (f2cl-lib:array-slice work
    double-float
    (iwork)
    ((1 *)))
  (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
  ierr)
(declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
  var-6 var-7 var-8))
(setf ierr var-9)
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
  var-8 var-9)
  (dorgbr "Q" m m m u ldu
    (f2cl-lib:array-slice work
      double-float
      (itauq)
      ((1 *)))
    (f2cl-lib:array-slice work
      double-float
      (iwork)
      ((1 *)))
    (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
    ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
    var-6 var-7 var-8))
  (setf ierr var-9))
(setf iwork (f2cl-lib:int-add ie m))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
  var-8 var-9 var-10 var-11 var-12 var-13 var-14)
  (dbdsqr "U" m m m 0 s
    (f2cl-lib:array-slice work double-float (ie) ((1 *)))
    (f2cl-lib:array-slice work double-float (ir) ((1 *)))
    ldwrkr u ldu dum 1
    (f2cl-lib:array-slice work
      double-float
      (iwork)
      ((1 *)))

  info)

```

```

(declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
            var-6 var-7 var-8 var-9 var-10 var-11
            var-12 var-13))
(setf info var-14))
(setf iu (f2cl-lib:int-add ie m))
(f2cl-lib:fdo (i 1 (f2cl-lib:int-add i chunk))
              (> i n) nil)
(tagbody
  (setf blk
    (min
      (the fixnum
        (f2cl-lib:int-add (f2cl-lib:int-sub n i)
                          1))
      (the fixnum chunk)))
  (dgemm "N" "N" m blk m one
    (f2cl-lib:array-slice work double-float (ir) ((1 *)))
    ldwrkr
    (f2cl-lib:array-slice a
      double-float
      (1 i)
      ((1 lda) (1 *)))
    lda zero
    (f2cl-lib:array-slice work double-float (iu) ((1 *)))
    ldwrku)
  (dlacpy "F" m blk
    (f2cl-lib:array-slice work double-float (iu) ((1 *)))
    ldwrku
    (f2cl-lib:array-slice a
      double-float
      (1 i)
      ((1 lda) (1 *)))
    lda))))
(t
  (setf itau 1)
  (setf iwork (f2cl-lib:int-add itau m))
  (multiple-value-bind
    (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7)
    (dgelqf m n a lda
      (f2cl-lib:array-slice work
        double-float
        (itau)
        ((1 *)))
      (f2cl-lib:array-slice work
        double-float
        (iwork)
        ((1 *)))

```

```

(f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
ierr)
(declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
            var-6))
(setf ierr var-7))
(dlacpy "L" m m a lda u ldu)
(dlaset "U" (f2cl-lib:int-sub m 1) (f2cl-lib:int-sub m 1)
zero zero
(f2cl-lib:array-slice u
                        double-float
                        (1 2)
                        ((1 ldu) (1 *))))
ldu)
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
   var-8)
  (dorglq m n m a lda
    (f2cl-lib:array-slice work
                          double-float
                          (itau)
                          ((1 *)))
    (f2cl-lib:array-slice work
                          double-float
                          (iwork)
                          ((1 *)))
    (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
    ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                  var-6 var-7))
  (setf ierr var-8))
(setf ie itau)
(setf itauq (f2cl-lib:int-add ie m))
(setf itaup (f2cl-lib:int-add itauq m))
(setf iwork (f2cl-lib:int-add itaup m))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
   var-8 var-9 var-10)
  (dgebrd m m u ldu s
    (f2cl-lib:array-slice work double-float (ie) ((1 *)))
    (f2cl-lib:array-slice work
                          double-float
                          (itauq)
                          ((1 *)))
    (f2cl-lib:array-slice work
                          double-float
                          (itaup)

```

```

                                ((1 *)))
(f2cl-lib:array-slice work
  double-float
  (iwork)
  ((1 *)))
(f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
ierr)
(declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
  var-6 var-7 var-8 var-9))
(setf ierr var-10))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
  var-8 var-9 var-10 var-11 var-12 var-13)
(dormbr "P" "L" "T" m n m u ldu
  (f2cl-lib:array-slice work
    double-float
    (itaup)
    ((1 *)))
  a lda
  (f2cl-lib:array-slice work
    double-float
    (iwork)
    ((1 *)))
  (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
  ierr)
(declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
  var-6 var-7 var-8 var-9 var-10 var-11
  var-12))
(setf ierr var-13))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
  var-8 var-9)
(dorgbr "Q" m m m u ldu
  (f2cl-lib:array-slice work
    double-float
    (itauq)
    ((1 *)))
  (f2cl-lib:array-slice work
    double-float
    (iwork)
    ((1 *)))
  (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
  ierr)
(declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
  var-6 var-7 var-8))
(setf ierr var-9))

```

```

(setf iwork (f2cl-lib:int-add ie m))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
   var-8 var-9 var-10 var-11 var-12 var-13 var-14)
  (dbdsqr "U" m n m 0 s
    (f2cl-lib:array-slice work double-float (ie) ((1 *)))
    a lda u ldu dum 1
    (f2cl-lib:array-slice work
      double-float
      (iwork)
      ((1 *)))
    info)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
    var-6 var-7 var-8 var-9 var-10 var-11
    var-12 var-13))
  (setf info var-14))))))
(wntvs
  (cond
    (wntun
      (cond
        ((>= lwork
          (f2cl-lib:int-add (f2cl-lib:int-mul m m)
            (max
              (the fixnum
                (f2cl-lib:int-mul 4 m))
              (the fixnum bdspace))))
          (setf ir 1)
          (cond
            ((>= lwork
              (f2cl-lib:int-add wrkbl (f2cl-lib:int-mul lda m)))
              (setf ldwrkr lda))
            (t
              (setf ldwrkr m)))
          (setf itau
            (f2cl-lib:int-add ir
              (f2cl-lib:int-mul ldwrkr m)))
          (setf iwork (f2cl-lib:int-add itau m))
          (multiple-value-bind
            (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7)
            (dgelqf m n a lda
              (f2cl-lib:array-slice work
                double-float
                (itau)
                ((1 *)))
              (f2cl-lib:array-slice work
                double-float

```



```

                                (iwork)
                                ((1 *)))
    (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
    ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
    var-6))
  (setf ierr var-7))
(dlacpy "L" m m a lda
  (f2cl-lib:array-slice work double-float (ir) ((1 *)))
  ldwrkr)
(dlaset "U" (f2cl-lib:int-sub m 1)
  (f2cl-lib:int-sub m 1) zero zero
  (f2cl-lib:array-slice work
    double-float
    ((+ ir ldwrkr))
    ((1 *)))
  ldwrkr)
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
    var-8)
  (dorglq m n m a lda
    (f2cl-lib:array-slice work
      double-float
      (itau)
      ((1 *)))
    (f2cl-lib:array-slice work
      double-float
      (iwork)
      ((1 *)))
    (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
    ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
    var-6 var-7))
  (setf ierr var-8))
(setf ie itau)
(setf itauq (f2cl-lib:int-add ie m))
(setf itaup (f2cl-lib:int-add itauq m))
(setf iwork (f2cl-lib:int-add itaup m))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
    var-8 var-9 var-10)
  (dgebrd m m
    (f2cl-lib:array-slice work
      double-float
      (ir)
      ((1 *)))

```

```

ldwrkr s
(f2cl-lib:array-slice work
                        double-float
                        (ie)
                        ((1 *)))
(f2cl-lib:array-slice work
                        double-float
                        (itauq)
                        ((1 *)))
(f2cl-lib:array-slice work
                        double-float
                        (itaup)
                        ((1 *)))
(f2cl-lib:array-slice work
                        double-float
                        (iwork)
                        ((1 *)))
(f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
ierr)
(declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                var-6 var-7 var-8 var-9))
(setf ierr var-10))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
   var-8 var-9)
  (dorgbr "P" m m m
    (f2cl-lib:array-slice work
                          double-float
                          (ir)
                          ((1 *)))

    ldwrkr
    (f2cl-lib:array-slice work
                          double-float
                          (itaup)
                          ((1 *)))

    (f2cl-lib:array-slice work
                          double-float
                          (iwork)
                          ((1 *)))

    (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
    ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                  var-6 var-7 var-8))
  (setf ierr var-9))
(setf iwork (f2cl-lib:int-add ie m))
(multiple-value-bind

```

```

      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8 var-9 var-10 var-11 var-12 var-13 var-14)
      (dbdsqr "U" m m 0 0 s
       (f2cl-lib:array-slice work
        double-float
        (ie)
        ((1 *)))
       (f2cl-lib:array-slice work
        double-float
        (ir)
        ((1 *)))
       ldwrkr dum 1 dum 1
       (f2cl-lib:array-slice work
        double-float
        (iwork)
        ((1 *)))
       info)
      (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                       var-6 var-7 var-8 var-9 var-10 var-11
                       var-12 var-13))
      (setf info var-14))
      (dgemm "N" "N" m n m one
       (f2cl-lib:array-slice work double-float (ir) ((1 *)))
       ldwrkr a lda zero vt ldvt))
      (t
       (setf itau 1)
       (setf iwork (f2cl-lib:int-add itau m))
       (multiple-value-bind
        (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7)
        (dgelqf m n a lda
         (f2cl-lib:array-slice work
          double-float
          (itau)
          ((1 *)))
         (f2cl-lib:array-slice work
          double-float
          (iwork)
          ((1 *)))
         (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
         ierr)
        (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                        var-6))
        (setf ierr var-7))
       (dlacpy "U" m n a lda vt ldvt)
       (multiple-value-bind
        (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7

```

```

    var-8)
(dorglq m n m vt ldvt
  (f2cl-lib:array-slice work
    double-float
    (itau)
    ((1 *)))
  (f2cl-lib:array-slice work
    double-float
    (iwork)
    ((1 *)))
  (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
  ierr)
(declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
  var-6 var-7))
(setf ierr var-8)
(setf ie itau)
(setf itauq (f2cl-lib:int-add ie m))
(setf itaup (f2cl-lib:int-add itauq m))
(setf iwork (f2cl-lib:int-add itaup m))
(dlaset "U" (f2cl-lib:int-sub m 1)
  (f2cl-lib:int-sub m 1) zero zero
  (f2cl-lib:array-slice a
    double-float
    (1 2)
    ((1 lda) (1 *)))
lda)
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
  var-8 var-9 var-10)
  (dgebrd m m a lda s
    (f2cl-lib:array-slice work
      double-float
      (ie)
      ((1 *)))
    (f2cl-lib:array-slice work
      double-float
      (itauq)
      ((1 *)))
    (f2cl-lib:array-slice work
      double-float
      (itaup)
      ((1 *)))
    (f2cl-lib:array-slice work
      double-float
      (iwork)
      ((1 *)))

```

```

(f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
ierr)
(declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
            var-6 var-7 var-8 var-9))
(setf ierr var-10))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
   var-8 var-9 var-10 var-11 var-12 var-13)
  (dormbr "P" "L" "T" m n m a lda
    (f2cl-lib:array-slice work
      double-float
      (itaup)
      ((1 *)))
    vt ldvt
    (f2cl-lib:array-slice work
      double-float
      (iwork)
      ((1 *)))
    (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
    ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                  var-6 var-7 var-8 var-9 var-10 var-11
                  var-12))
  (setf ierr var-13))
(setf iwork (f2cl-lib:int-add ie m))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
   var-8 var-9 var-10 var-11 var-12 var-13 var-14)
  (dbdsqr "U" m n 0 0 s
    (f2cl-lib:array-slice work
      double-float
      (ie)
      ((1 *)))
    vt ldvt dum 1 dum 1
    (f2cl-lib:array-slice work
      double-float
      (iwork)
      ((1 *)))
    info)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                  var-6 var-7 var-8 var-9 var-10 var-11
                  var-12 var-13))
  (setf info var-14))))))
(wntuo
  (cond
    ((>= lwork

```

```

(f2cl-lib:int-add (f2cl-lib:int-mul 2 m m)
  (max
    (the fixnum
      (f2cl-lib:int-mul 4 m))
    (the fixnum bdspace))))
(setf iu 1)
(cond
  ((>= lwork
    (f2cl-lib:int-add wrkbl
      (f2cl-lib:int-mul 2 lda m)))
    (setf ldwrku lda)
    (setf ir
      (f2cl-lib:int-add iu
        (f2cl-lib:int-mul ldwrku
          m)))
    (setf ldwrkr lda))
  ((>= lwork
    (f2cl-lib:int-add wrkbl
      (f2cl-lib:int-mul
        (f2cl-lib:int-add lda m)
        m)))
    (setf ldwrku lda)
    (setf ir
      (f2cl-lib:int-add iu
        (f2cl-lib:int-mul ldwrku
          m)))
    (setf ldwrkr m))
  (t
    (setf ldwrku m)
    (setf ir
      (f2cl-lib:int-add iu
        (f2cl-lib:int-mul ldwrku
          m)))
    (setf ldwrkr m)))
(setf itau
  (f2cl-lib:int-add ir
    (f2cl-lib:int-mul ldwrkr m)))
(setf iwork (f2cl-lib:int-add itau m))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7)
  (dgelqf m n a lda
    (f2cl-lib:array-slice work
      double-float
      (itau)
      ((1 *))))
  (f2cl-lib:array-slice work

```

```

double-float
(iwork)
((1 *)))
(f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
ierr)
(declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
var-6))
(setf ierr var-7))
(dlacpy "L" m m a lda
(f2cl-lib:array-slice work double-float (iu) ((1 *)))
ldwrku)
(dlaset "U" (f2cl-lib:int-sub m 1)
(f2cl-lib:int-sub m 1) zero zero
(f2cl-lib:array-slice work
double-float
((+ iu ldwrku))
((1 *)))
ldwrku)
(multiple-value-bind
(var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
var-8)
(dorglq m n m a lda
(f2cl-lib:array-slice work
double-float
(itau)
((1 *)))
(f2cl-lib:array-slice work
double-float
(iwork)
((1 *)))
(f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
ierr)
(declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
var-6 var-7))
(setf ierr var-8))
(setf ie itau)
(setf itauq (f2cl-lib:int-add ie m))
(setf itaup (f2cl-lib:int-add itauq m))
(setf iwork (f2cl-lib:int-add itaup m))
(multiple-value-bind
(var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
var-8 var-9 var-10)
(dgebrd m m
(f2cl-lib:array-slice work
double-float
(iu)

```

```

((1 *)))
ldwrku s
(f2cl-lib:array-slice work
  double-float
  (ie)
  ((1 *)))
(f2cl-lib:array-slice work
  double-float
  (itauq)
  ((1 *)))
(f2cl-lib:array-slice work
  double-float
  (itaup)
  ((1 *)))
(f2cl-lib:array-slice work
  double-float
  (iwork)
  ((1 *)))
(f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
ierr)
(declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
  var-6 var-7 var-8 var-9))
(setf ierr var-10))
(dlacpy "L" m m
  (f2cl-lib:array-slice work double-float (iu) ((1 *)))
  ldwrku
  (f2cl-lib:array-slice work double-float (ir) ((1 *)))
  ldwrkr)
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
   var-8 var-9)
  (dorgbr "P" m m m
    (f2cl-lib:array-slice work
      double-float
      (iu)
      ((1 *)))
    ldwrku
    (f2cl-lib:array-slice work
      double-float
      (itaup)
      ((1 *)))
    (f2cl-lib:array-slice work
      double-float
      (iwork)
      ((1 *)))
    (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)

```



```

      ierr)
      (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                     var-6 var-7 var-8))
      (setf ierr var-9))
      (multiple-value-bind
        (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
         var-8 var-9)
        (dorgbr "Q" m m m
         (f2cl-lib:array-slice work
                                double-float
                                (ir)
                                ((1 *))))

        ldwrkr
        (f2cl-lib:array-slice work
                                double-float
                                (itauq)
                                ((1 *)))

        (f2cl-lib:array-slice work
                                double-float
                                (iwork)
                                ((1 *)))

        (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
        ierr)
      (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                     var-6 var-7 var-8))
      (setf ierr var-9))
      (setf iwork (f2cl-lib:int-add ie m))
      (multiple-value-bind
        (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
         var-8 var-9 var-10 var-11 var-12 var-13 var-14)
        (dbdsqr "U" m m m 0 s
         (f2cl-lib:array-slice work
                                double-float
                                (ie)
                                ((1 *)))

         (f2cl-lib:array-slice work
                                double-float
                                (iu)
                                ((1 *)))

         ldwrku
         (f2cl-lib:array-slice work
                                double-float
                                (ir)
                                ((1 *)))

         ldwrkr dum 1
         (f2cl-lib:array-slice work

```

```

                                double-float
                                (iwork)
                                ((1 *)))

    info)
    (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                    var-6 var-7 var-8 var-9 var-10 var-11
                    var-12 var-13))
    (setf info var-14))
(dgemm "N" "N" m n m one
 (f2cl-lib:array-slice work double-float (iu) ((1 *)))
 ldwrku a lda zero vt ldvt)
(dlacpy "F" m m
 (f2cl-lib:array-slice work double-float (ir) ((1 *)))
 ldwrkr a lda))
(t
 (setf itau 1)
 (setf iwork (f2cl-lib:int-add itau m))
 (multiple-value-bind
   (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7)
   (dgelqf m n a lda
    (f2cl-lib:array-slice work
                          double-float
                          (itau)
                          ((1 *)))
    (f2cl-lib:array-slice work
                          double-float
                          (iwork)
                          ((1 *)))
    (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
    ierr)
   (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                    var-6))
   (setf ierr var-7))
 (dlacpy "U" m n a lda vt ldvt)
 (multiple-value-bind
   (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
    var-8)
   (dorglq m n m vt ldvt
    (f2cl-lib:array-slice work
                          double-float
                          (itau)
                          ((1 *)))
    (f2cl-lib:array-slice work
                          double-float
                          (iwork)
                          ((1 *)))

```

```

(f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
ierr)
(declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
var-6 var-7))
(setf ierr var-8))
(setf ie itau)
(setf itauq (f2cl-lib:int-add ie m))
(setf itaup (f2cl-lib:int-add itauq m))
(setf iwork (f2cl-lib:int-add itaup m))
(dlasel "U" (f2cl-lib:int-sub m 1) zero zero
(f2cl-lib:array-slice a
double-float
(1 2)
((1 lda) (1 *)))
lda)
(multiple-value-bind
(var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
var-8 var-9 var-10)
(dgebrd m m a lda s
(f2cl-lib:array-slice work
double-float
(ie)
((1 *)))
(f2cl-lib:array-slice work
double-float
(itauq)
((1 *)))
(f2cl-lib:array-slice work
double-float
(itaup)
((1 *)))
(f2cl-lib:array-slice work
double-float
(iwork)
((1 *)))
(f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
ierr)
(declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
var-6 var-7 var-8 var-9))
(setf ierr var-10))
(multiple-value-bind
(var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
var-8 var-9 var-10 var-11 var-12 var-13)
(dormbr "P" "L" "T" m n m a lda
(f2cl-lib:array-slice work

```

```

                                double-float
                                (itaup)
                                ((1 *)))

vt ldvt
(f2cl-lib:array-slice work
                        double-float
                        (iwork)
                        ((1 *)))

(f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
ierr)
(declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                var-6 var-7 var-8 var-9 var-10 var-11
                var-12))
(setf ierr var-13))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
   var-8 var-9)
  (dorgbr "Q" m m m a lda
    (f2cl-lib:array-slice work
                          double-float
                          (itauq)
                          ((1 *)))

    (f2cl-lib:array-slice work
                          double-float
                          (iwork)
                          ((1 *)))

    (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
    ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                    var-6 var-7 var-8))
  (setf ierr var-9))
(setf iwork (f2cl-lib:int-add ie m))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
   var-8 var-9 var-10 var-11 var-12 var-13 var-14)
  (dbdsqr "U" m n m 0 s
    (f2cl-lib:array-slice work
                          double-float
                          (ie)
                          ((1 *)))

    vt ldvt a lda dum 1
    (f2cl-lib:array-slice work
                          double-float
                          (iwork)
                          ((1 *)))

    info)

```

```

(declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
            var-6 var-7 var-8 var-9 var-10 var-11
            var-12 var-13))
(setf info var-14))))
(wntuas
 (cond
  ((>= lwork
    (f2cl-lib:int-add (f2cl-lib:int-mul m m)
                      (max
                       (the fixnum
                        (f2cl-lib:int-mul 4 m))
                       (the fixnum bdspace))))
   (setf iu 1)
   (cond
    ((>= lwork
      (f2cl-lib:int-add wrkbl (f2cl-lib:int-mul lda m)))
     (setf ldwrku lda))
    (t
     (setf ldwrku m)))
   (setf itau
    (f2cl-lib:int-add iu
                      (f2cl-lib:int-mul ldwrku m)))
   (setf iwork (f2cl-lib:int-add itau m))
   (multiple-value-bind
    (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7)
    (dgelqf m n a lda
      (f2cl-lib:array-slice work
                            double-float
                            (itau)
                            ((1 *)))
      (f2cl-lib:array-slice work
                            double-float
                            (iwork)
                            ((1 *)))
      (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
      ierr)
    (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                    var-6))
    (setf ierr var-7))
   (dlacpy "L" m m a lda
    (f2cl-lib:array-slice work double-float (iu) ((1 *)))
    ldwrku)
   (dlaset "U" (f2cl-lib:int-sub m 1)
    (f2cl-lib:int-sub m 1) zero zero
    (f2cl-lib:array-slice work
                          double-float

```

```

                                ((+ iu ldwrku))
                                ((1 *)))
ldwrku)
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
   var-8)
  (dorglq m n m a lda
    (f2cl-lib:array-slice work
                           double-float
                           (itau)
                           ((1 *)))
    (f2cl-lib:array-slice work
                           double-float
                           (iwork)
                           ((1 *)))
    (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
    ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                    var-6 var-7))
  (setf ierr var-8))
(setf ie itau)
(setf itauq (f2cl-lib:int-add ie m))
(setf itaup (f2cl-lib:int-add itauq m))
(setf iwork (f2cl-lib:int-add itaup m))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
   var-8 var-9 var-10)
  (dgebrd m m
    (f2cl-lib:array-slice work
                           double-float
                           (iu)
                           ((1 *)))
    ldwrku s
    (f2cl-lib:array-slice work
                           double-float
                           (ie)
                           ((1 *)))
    (f2cl-lib:array-slice work
                           double-float
                           (itauq)
                           ((1 *)))
    (f2cl-lib:array-slice work
                           double-float
                           (itaup)
                           ((1 *)))
    (f2cl-lib:array-slice work

```

```

double-float
(iwork)
((1 *)))
(f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
ierr)
(declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
var-6 var-7 var-8 var-9))
(setf ierr var-10))
(dlacpy "L" m m
(f2cl-lib:array-slice work double-float (iu) ((1 *)))
ldwrku u ldu)
(multiple-value-bind
(var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
var-8 var-9)
(dorgbr "P" m m m
(f2cl-lib:array-slice work
double-float
(iu)
((1 *)))
ldwrku
(f2cl-lib:array-slice work
double-float
(itaup)
((1 *)))
(f2cl-lib:array-slice work
double-float
(iwork)
((1 *)))
(f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
ierr)
(declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
var-6 var-7 var-8))
(setf ierr var-9))
(multiple-value-bind
(var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
var-8 var-9)
(dorgbr "Q" m m m u ldu
(f2cl-lib:array-slice work
double-float
(itaup)
((1 *)))
(f2cl-lib:array-slice work
double-float
(iwork)
((1 *)))
(f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)

```

```

      ierr)
      (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                    var-6 var-7 var-8))
      (setf ierr var-9))
      (setf iwork (f2cl-lib:int-add ie m))
      (multiple-value-bind
        (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
         var-8 var-9 var-10 var-11 var-12 var-13 var-14)
        (dbdsqr "U" m m m 0 s
          (f2cl-lib:array-slice work
                                double-float
                                (ie)
                                ((1 *)))
          (f2cl-lib:array-slice work
                                double-float
                                (iu)
                                ((1 *)))
          ldwrku u ldu dum 1
          (f2cl-lib:array-slice work
                                double-float
                                (iwork)
                                ((1 *)))
          info)
      (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                    var-6 var-7 var-8 var-9 var-10 var-11
                    var-12 var-13))
      (setf info var-14))
      (dgemm "N" "N" m n m one
        (f2cl-lib:array-slice work double-float (iu) ((1 *)))
        ldwrku a lda zero vt ldvt))
      (t
        (setf itau 1)
        (setf iwork (f2cl-lib:int-add itau m))
        (multiple-value-bind
          (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7)
          (dgelqf m n a lda
            (f2cl-lib:array-slice work
                                  double-float
                                  (itau)
                                  ((1 *)))
            (f2cl-lib:array-slice work
                                  double-float
                                  (iwork)
                                  ((1 *)))
            (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
            ierr)

```



```

(declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
              var-6))
(setf ierr var-7))
(dlacpy "U" m n a lda vt ldvt)
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
   var-8)
  (dorglq m n m vt ldvt
    (f2cl-lib:array-slice work
                          double-float
                          (itau)
                          ((1 *)))
    (f2cl-lib:array-slice work
                          double-float
                          (iwork)
                          ((1 *)))
    (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
    ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                    var-6 var-7))
  (setf ierr var-8))
(dlacpy "L" m m a lda u ldu)
(dlaset "U" (f2cl-lib:int-sub m 1)
  (f2cl-lib:int-sub m 1) zero zero
  (f2cl-lib:array-slice u
                        double-float
                        (1 2)
                        ((1 ldu) (1 *))))
ldu)
(setf ie itau)
(setf itauq (f2cl-lib:int-add ie m))
(setf itaup (f2cl-lib:int-add itauq m))
(setf iwork (f2cl-lib:int-add itaup m))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
   var-8 var-9 var-10)
  (dgebrd m m u ldu s
    (f2cl-lib:array-slice work
                          double-float
                          (ie)
                          ((1 *)))
    (f2cl-lib:array-slice work
                          double-float
                          (itauq)
                          ((1 *)))
    (f2cl-lib:array-slice work

```

```

                                double-float
                                (itaup)
                                ((1 *)))
(f2cl-lib:array-slice work
                                double-float
                                (iwork)
                                ((1 *)))
(f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
ierr)
(declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                                var-6 var-7 var-8 var-9))
(setf ierr var-10))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
   var-8 var-9 var-10 var-11 var-12 var-13)
  (dormbr "P" "L" "T" m n m u ldu
    (f2cl-lib:array-slice work
                            double-float
                            (itaup)
                            ((1 *)))

    vt ldvt
    (f2cl-lib:array-slice work
                            double-float
                            (iwork)
                            ((1 *)))

    (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
    ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                    var-6 var-7 var-8 var-9 var-10 var-11
                    var-12))
  (setf ierr var-13))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
   var-8 var-9)
  (dorgbr "Q" m m m u ldu
    (f2cl-lib:array-slice work
                            double-float
                            (itauq)
                            ((1 *)))

    (f2cl-lib:array-slice work
                            double-float
                            (iwork)
                            ((1 *)))

    (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
    ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5

```

```

                                var-6 var-7 var-8))
  (setf ierr var-9))
(setf iwork (f2cl-lib:int-add ie m))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
   var-8 var-9 var-10 var-11 var-12 var-13 var-14)
  (dbdsqr "U" m n m 0 s
    (f2cl-lib:array-slice work
                           double-float
                           (ie)
                           ((1 *))))
    vt ldvt u ldu dum 1
    (f2cl-lib:array-slice work
                           double-float
                           (iwork)
                           ((1 *))))
    info)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6 var-7 var-8 var-9 var-10 var-11
                   var-12 var-13))
  (setf info var-14))))))
(wntva
 (cond
  (wntun
   (cond
    ((>= lwork
      (f2cl-lib:int-add (f2cl-lib:int-mul m m)
                        (max
                         (the fixnum
                          (f2cl-lib:int-add n m))
                         (the fixnum
                          (f2cl-lib:int-mul 4 m))
                         (the fixnum bdspace))))
      (setf ir 1)
      (cond
       ((>= lwork
         (f2cl-lib:int-add wrkbl (f2cl-lib:int-mul lda m)))
        (setf ldwrkr lda)
        (t
         (setf ldwrkr m)))
       (setf itau
        (f2cl-lib:int-add ir
                          (f2cl-lib:int-mul ldwrkr m)))
        (setf iwork (f2cl-lib:int-add itau m))
        (multiple-value-bind
          (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7)

```

```

(dgelqf m n a lda
  (f2cl-lib:array-slice work
    double-float
    (itau)
    ((1 *)))
  (f2cl-lib:array-slice work
    double-float
    (iwork)
    ((1 *)))
  (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
  ierr)
(declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
  var-6))
(setf ierr var-7)
(dlacpy "U" m n a lda vt ldvt)
(dlacpy "L" m m a lda
  (f2cl-lib:array-slice work double-float (ir) ((1 *)))
  ldwrkr)
(dlaset "U" (f2cl-lib:int-sub m 1)
  (f2cl-lib:int-sub m 1) zero zero
  (f2cl-lib:array-slice work
    double-float
    ((+ ir ldwrkr))
    ((1 *)))
  ldwrkr)
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
  var-8)
  (dorglq n n m vt ldvt
    (f2cl-lib:array-slice work
      double-float
      (itau)
      ((1 *)))
    (f2cl-lib:array-slice work
      double-float
      (iwork)
      ((1 *)))
    (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
    ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
    var-6 var-7))
  (setf ierr var-8))
(setf ie itau)
(setf itauq (f2cl-lib:int-add ie m))
(setf itaup (f2cl-lib:int-add itauq m))
(setf iwork (f2cl-lib:int-add itaup m))

```

```

(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
   var-8 var-9 var-10)
  (dgebrd m m
    (f2cl-lib:array-slice work
                           double-float
                           (ir)
                           ((1 *)))

    ldwrkr s
    (f2cl-lib:array-slice work
                           double-float
                           (ie)
                           ((1 *)))

    (f2cl-lib:array-slice work
                           double-float
                           (itauq)
                           ((1 *)))

    (f2cl-lib:array-slice work
                           double-float
                           (itaup)
                           ((1 *)))

    (f2cl-lib:array-slice work
                           double-float
                           (iwork)
                           ((1 *)))

    (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
    ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6 var-7 var-8 var-9))
  (setf ierr var-10))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
   var-8 var-9)
  (dorgbr "P" m m m
    (f2cl-lib:array-slice work
                           double-float
                           (ir)
                           ((1 *)))

    ldwrkr
    (f2cl-lib:array-slice work
                           double-float
                           (itaup)
                           ((1 *)))

    (f2cl-lib:array-slice work
                           double-float
                           (iwork)

```

```

((1 *)))
(f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
ierr)
(declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
            var-6 var-7 var-8))
(setf ierr var-9))
(setf iwork (f2cl-lib:int-add ie m))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
   var-8 var-9 var-10 var-11 var-12 var-13 var-14)
  (dbdsqr "U" m m 0 0 s
    (f2cl-lib:array-slice work
                           double-float
                           (ie)
                           ((1 *)))
    (f2cl-lib:array-slice work
                           double-float
                           (ir)
                           ((1 *)))
    ldwrkr dum 1 dum 1
    (f2cl-lib:array-slice work
                           double-float
                           (iwork)
                           ((1 *)))
    info)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                  var-6 var-7 var-8 var-9 var-10 var-11
                  var-12 var-13))
  (setf info var-14))
(dgemm "N" "N" m n m one
  (f2cl-lib:array-slice work double-float (ir) ((1 *)))
  ldwrkr vt ldvt zero a lda)
(dlacpy "F" m n a lda vt ldvt))
(t
  (setf itau 1)
  (setf iwork (f2cl-lib:int-add itau m))
  (multiple-value-bind
    (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7)
    (dgelqf m n a lda
      (f2cl-lib:array-slice work
                             double-float
                             (itau)
                             ((1 *)))
      (f2cl-lib:array-slice work
                             double-float
                             (iwork)

```

```

((1 *)))
(f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
ierr)
(declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
            var-6))
(setf ierr var-7))
(dlacpy "U" m n a lda vt ldvt)
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
   var-8)
  (dorglq n n m vt ldvt
   (f2cl-lib:array-slice work
                        double-float
                        (itau)
                        ((1 *)))
   (f2cl-lib:array-slice work
                        double-float
                        (iwork)
                        ((1 *)))
   (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
   ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                  var-6 var-7))
  (setf ierr var-8))
(setf ie itau)
(setf itauq (f2cl-lib:int-add ie m))
(setf itaup (f2cl-lib:int-add itauq m))
(setf iwork (f2cl-lib:int-add itaup m))
(dlaset "U" (f2cl-lib:int-sub m 1)
  (f2cl-lib:int-sub m 1) zero zero
  (f2cl-lib:array-slice a
                        double-float
                        (1 2)
                        ((1 lda) (1 *)))
  lda)
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
   var-8 var-9 var-10)
  (dgebrd m m a lda s
   (f2cl-lib:array-slice work
                        double-float
                        (ie)
                        ((1 *)))
   (f2cl-lib:array-slice work
                        double-float
                        (itauq)

```

```

((1 *)))
(f2cl-lib:array-slice work
  double-float
  (itaup)
  ((1 *)))
(f2cl-lib:array-slice work
  double-float
  (iwork)
  ((1 *)))
(f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
ierr)
(declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
  var-6 var-7 var-8 var-9))
(setf ierr var-10))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
   var-8 var-9 var-10 var-11 var-12 var-13)
  (dormbr "P" "L" "T" m n m a lda
    (f2cl-lib:array-slice work
      double-float
      (itaup)
      ((1 *)))

    vt ldvt
    (f2cl-lib:array-slice work
      double-float
      (iwork)
      ((1 *)))

    (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
    ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
    var-6 var-7 var-8 var-9 var-10 var-11
    var-12))
  (setf ierr var-13))
(setf iwork (f2cl-lib:int-add ie m))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
   var-8 var-9 var-10 var-11 var-12 var-13 var-14)
  (dbdsqr "U" m n 0 0 s
    (f2cl-lib:array-slice work
      double-float
      (ie)
      ((1 *)))

    vt ldvt dum 1 dum 1
    (f2cl-lib:array-slice work
      double-float
      (iwork)

```



```

((1 *)))
info)
(declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
            var-6 var-7 var-8 var-9 var-10 var-11
            var-12 var-13))
(setf info var-14))))
(wntuo
(cond
  ((>= lwork
    (f2cl-lib:int-add (f2cl-lib:int-mul 2 m m)
      (max
        (the fixnum
          (f2cl-lib:int-add n m))
        (the fixnum
          (f2cl-lib:int-mul 4 m))
        (the fixnum bdspace))))))
(setf iu 1)
(cond
  ((>= lwork
    (f2cl-lib:int-add wrkbl
      (f2cl-lib:int-mul 2 lda m))))
    (setf ldwrku lda)
    (setf ir
      (f2cl-lib:int-add iu
        (f2cl-lib:int-mul ldwrku
          m))))
    (setf ldwrkr lda)
    (>= lwork
      (f2cl-lib:int-add wrkbl
        (f2cl-lib:int-mul
          (f2cl-lib:int-add lda m)
          m)))
      (setf ldwrku lda)
      (setf ir
        (f2cl-lib:int-add iu
          (f2cl-lib:int-mul ldwrku
            m))))
      (setf ldwrkr m))
    (t
      (setf ldwrku m)
      (setf ir
        (f2cl-lib:int-add iu
          (f2cl-lib:int-mul ldwrku
            m))))
      (setf ldwrkr m)))
(setf itau

```

```

        (f2cl-lib:int-add ir
          (f2cl-lib:int-mul ldwrkr m)))
(setf iwork (f2cl-lib:int-add itau m))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7)
  (dgelqf m n a lda
    (f2cl-lib:array-slice work
      double-float
      (itau)
      ((1 *)))
    (f2cl-lib:array-slice work
      double-float
      (iwork)
      ((1 *)))
    (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
    ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
    var-6))
  (setf ierr var-7))
(dlacpy "U" m n a lda vt ldvt)
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
    var-8)
  (dorglq n n m vt ldvt
    (f2cl-lib:array-slice work
      double-float
      (itau)
      ((1 *)))
    (f2cl-lib:array-slice work
      double-float
      (iwork)
      ((1 *)))
    (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
    ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
    var-6 var-7))
  (setf ierr var-8))
(dlacpy "L" m m a lda
  (f2cl-lib:array-slice work double-float (iu) ((1 *)))
  ldwrku)
(dlaset "U" (f2cl-lib:int-sub m 1)
  (f2cl-lib:int-sub m 1) zero zero
  (f2cl-lib:array-slice work
    double-float
    ((+ iu ldwrku))
    ((1 *)))

```

```

ldwrku)
(setf ie itau)
(setf itauq (f2cl-lib:int-add ie m))
(setf itaup (f2cl-lib:int-add itauq m))
(setf iwork (f2cl-lib:int-add itaup m))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
   var-8 var-9 var-10)
  (dgebrd m m
    (f2cl-lib:array-slice work
                           double-float
                           (iu)
                           ((1 *)))

    ldwrku s
    (f2cl-lib:array-slice work
                           double-float
                           (ie)
                           ((1 *)))

    (f2cl-lib:array-slice work
                           double-float
                           (itauq)
                           ((1 *)))

    (f2cl-lib:array-slice work
                           double-float
                           (itaup)
                           ((1 *)))

    (f2cl-lib:array-slice work
                           double-float
                           (iwork)
                           ((1 *)))

    (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
    ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                    var-6 var-7 var-8 var-9))
  (setf ierr var-10))
(dlacpy "L" m m
  (f2cl-lib:array-slice work double-float (iu) ((1 *)))
  ldwrku
  (f2cl-lib:array-slice work double-float (ir) ((1 *)))
  ldwrkr)
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
   var-8 var-9)
  (dorgbr "P" m m m
    (f2cl-lib:array-slice work
                           double-float

```

```

                                (iu)
                                ((1 *)))
ldwrku
(f2cl-lib:array-slice work
 double-float
 (itaup)
 ((1 *)))
(f2cl-lib:array-slice work
 double-float
 (iwork)
 ((1 *)))
(f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
ierr)
(declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
              var-6 var-7 var-8))
(setf ierr var-9))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
   var-8 var-9)
  (dorgbr "Q" m m m
   (f2cl-lib:array-slice work
    double-float
    (ir)
    ((1 *)))

ldwrkr
(f2cl-lib:array-slice work
 double-float
 (itauq)
 ((1 *)))
(f2cl-lib:array-slice work
 double-float
 (iwork)
 ((1 *)))
(f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
ierr)
(declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
              var-6 var-7 var-8))
(setf ierr var-9))
(setf iwork (f2cl-lib:int-add ie m))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
   var-8 var-9 var-10 var-11 var-12 var-13 var-14)
  (dbdsqr "U" m m m 0 s
   (f2cl-lib:array-slice work
    double-float
    (ie)

```

```

                                ((1 *)))
(f2cl-lib:array-slice work
  double-float
  (iu)
  ((1 *)))

ldwrku
(f2cl-lib:array-slice work
  double-float
  (ir)
  ((1 *)))

ldwrkr dum 1
(f2cl-lib:array-slice work
  double-float
  (iwork)
  ((1 *)))

info)
(declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                var-6 var-7 var-8 var-9 var-10 var-11
                var-12 var-13))
(setf info var-14))
(dgemm "N" "N" m n m one
  (f2cl-lib:array-slice work double-float (iu) ((1 *)))
  ldwrku vt ldvt zero a lda)
(dlacpy "F" m n a lda vt ldvt)
(dlacpy "F" m m
  (f2cl-lib:array-slice work double-float (ir) ((1 *)))
  ldwrkr a lda))
(t
  (setf itau 1)
  (setf iwork (f2cl-lib:int-add itau m))
  (multiple-value-bind
    (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7)
    (dgelqf m n a lda
      (f2cl-lib:array-slice work
        double-float
        (itau)
        ((1 *)))
      (f2cl-lib:array-slice work
        double-float
        (iwork)
        ((1 *)))
      (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
      ierr)
    (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                    var-6))
    (setf ierr var-7)))

```

```

(dlacpy "U" m n a lda vt ldvt)
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
   var-8)
  (dorglq n n m vt ldvt
    (f2cl-lib:array-slice work
                           double-float
                           (itau)
                           ((1 *)))
    (f2cl-lib:array-slice work
                           double-float
                           (iwork)
                           ((1 *)))
    (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
    ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                    var-6 var-7))
  (setf ierr var-8))
(setf ie itau)
(setf itauq (f2cl-lib:int-add ie m))
(setf itaup (f2cl-lib:int-add itauq m))
(setf iwork (f2cl-lib:int-add itaup m))
(dlaset "U" (f2cl-lib:int-sub m 1)
  (f2cl-lib:int-sub m 1) zero zero
  (f2cl-lib:array-slice a
                        double-float
                        (1 2)
                        ((1 lda) (1 *)))
  lda)
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
   var-8 var-9 var-10)
  (dgebrd m m a lda s
    (f2cl-lib:array-slice work
                           double-float
                           (ie)
                           ((1 *)))
    (f2cl-lib:array-slice work
                           double-float
                           (itauq)
                           ((1 *)))
    (f2cl-lib:array-slice work
                           double-float
                           (itaup)
                           ((1 *)))
    (f2cl-lib:array-slice work

```

```

double-float
(iwork)
((1 *)))
(f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
ierr)
(declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
var-6 var-7 var-8 var-9))
(setf ierr var-10))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
   var-8 var-9 var-10 var-11 var-12 var-13)
  (dormbr "P" "L" "T" m n m a lda
   (f2cl-lib:array-slice work
    double-float
    (itaup)
    ((1 *)))
   vt ldvt
   (f2cl-lib:array-slice work
    double-float
    (iwork)
    ((1 *)))
   (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
   ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
var-6 var-7 var-8 var-9 var-10 var-11
var-12))
  (setf ierr var-13))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
   var-8 var-9)
  (dorgbr "Q" m m m a lda
   (f2cl-lib:array-slice work
    double-float
    (itauq)
    ((1 *)))
   (f2cl-lib:array-slice work
    double-float
    (iwork)
    ((1 *)))
   (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
   ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
var-6 var-7 var-8))
  (setf ierr var-9))
(setf iwork (f2cl-lib:int-add ie m))
(multiple-value-bind

```

```

      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8 var-9 var-10 var-11 var-12 var-13 var-14)
      (dbdsqr "U" m n m 0 s
       (f2cl-lib:array-slice work
        double-float
        (ie)
        ((1 *)))
       vt ldvt a lda dum 1
       (f2cl-lib:array-slice work
        double-float
        (iwork)
        ((1 *)))

       info)
      (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                       var-6 var-7 var-8 var-9 var-10 var-11
                       var-12 var-13))
      (setf info var-14))))
(wntuas
 (cond
  ((>= lwork
    (f2cl-lib:int-add (f2cl-lib:int-mul m m)
                      (max
                       (the fixnum
                        (f2cl-lib:int-add n m))
                       (the fixnum
                        (f2cl-lib:int-mul 4 m))
                       (the fixnum bdspace))))
   (setf iu 1)
   (cond
    ((>= lwork
      (f2cl-lib:int-add wrkbl (f2cl-lib:int-mul lda m)))
     (setf ldwrku lda))
    (t
     (setf ldwrku m)))
   (setf itau
    (f2cl-lib:int-add iu
                     (f2cl-lib:int-mul ldwrku m)))
   (setf iwork (f2cl-lib:int-add itau m))
   (multiple-value-bind
    (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7)
    (dgelqf m n a lda
     (f2cl-lib:array-slice work
      double-float
      (itau)
      ((1 *)))
     (f2cl-lib:array-slice work

```



```

double-float
(iwork)
((1 *)))
(f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
ierr)
(declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
var-6))
(setf ierr var-7))
(dlacpy "U" m n a lda vt ldvt)
(multiple-value-bind
(var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
var-8)
(dorglq n n m vt ldvt
(f2cl-lib:array-slice work
double-float
(itau)
((1 *)))
(f2cl-lib:array-slice work
double-float
(iwork)
((1 *)))
(f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
ierr)
(declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
var-6 var-7))
(setf ierr var-8))
(dlacpy "L" m m a lda
(f2cl-lib:array-slice work double-float (iu) ((1 *)))
ldwrku)
(dlaset "U" (f2cl-lib:int-sub m 1)
(f2cl-lib:int-sub m 1) zero zero
(f2cl-lib:array-slice work
double-float
((+ iu ldwrku))
((1 *)))
ldwrku)
(setf ie itau)
(setf itauq (f2cl-lib:int-add ie m))
(setf itaup (f2cl-lib:int-add itauq m))
(setf iwork (f2cl-lib:int-add itaup m))
(multiple-value-bind
(var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
var-8 var-9 var-10)
(dgebrd m m
(f2cl-lib:array-slice work
double-float

```

```

                                (iu)
                                ((1 *)))
ldwrku s
(f2cl-lib:array-slice work
 double-float
 (ie)
 ((1 *)))
(f2cl-lib:array-slice work
 double-float
 (itauq)
 ((1 *)))
(f2cl-lib:array-slice work
 double-float
 (itaup)
 ((1 *)))
(f2cl-lib:array-slice work
 double-float
 (iwork)
 ((1 *)))
(f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
ierr)
(declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
              var-6 var-7 var-8 var-9))
(setf ierr var-10))
(dlacpy "L" m m
 (f2cl-lib:array-slice work double-float (iu) ((1 *)))
 ldwrku u ldu)
(multiple-value-bind
 (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
  var-8 var-9)
 (dorgbr "P" m m m
  (f2cl-lib:array-slice work
   double-float
   (iu)
   ((1 *)))

  ldwrku
  (f2cl-lib:array-slice work
   double-float
   (itaup)
   ((1 *)))

  (f2cl-lib:array-slice work
   double-float
   (iwork)
   ((1 *)))

  (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
  ierr)

```

```

(declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
              var-6 var-7 var-8))
(setf ierr var-9))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
   var-8 var-9)
  (dorgbr "Q" m m m u ldu
    (f2cl-lib:array-slice work
                          double-float
                          (itauq)
                          ((1 *)))
    (f2cl-lib:array-slice work
                          double-float
                          (iwork)
                          ((1 *)))
    (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
    ierr)
(declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
              var-6 var-7 var-8))
(setf ierr var-9))
(setf iwork (f2cl-lib:int-add ie m))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
   var-8 var-9 var-10 var-11 var-12 var-13 var-14)
  (dbdsqr "U" m m m 0 s
    (f2cl-lib:array-slice work
                          double-float
                          (ie)
                          ((1 *)))
    (f2cl-lib:array-slice work
                          double-float
                          (iu)
                          ((1 *)))
    ldwrku u ldu dum 1
    (f2cl-lib:array-slice work
                          double-float
                          (iwork)
                          ((1 *)))
    info)
(declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
              var-6 var-7 var-8 var-9 var-10 var-11
              var-12 var-13))
(setf info var-14))
(dgemm "N" "N" m n m one
  (f2cl-lib:array-slice work double-float (iu) ((1 *)))
  ldwrku vt ldvt zero a lda)

```

```

(dlacpy "F" m n a lda vt ldvt))
(t
  (setf itau 1)
  (setf iwork (f2cl-lib:int-add itau m))
  (multiple-value-bind
    (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7)
    (dgelqf m n a lda
      (f2cl-lib:array-slice work
        double-float
        (itau)
        ((1 *)))
      (f2cl-lib:array-slice work
        double-float
        (iwork)
        ((1 *)))
      (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
      ierr)
    (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
      var-6))
    (setf ierr var-7))
  (dlacpy "U" m n a lda vt ldvt)
  (multiple-value-bind
    (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
      var-8)
    (dorglq n n m vt ldvt
      (f2cl-lib:array-slice work
        double-float
        (itau)
        ((1 *)))
      (f2cl-lib:array-slice work
        double-float
        (iwork)
        ((1 *)))
      (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
      ierr)
    (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
      var-6 var-7))
    (setf ierr var-8))
  (dlacpy "L" m m a lda u ldu)
  (dlaset "U" (f2cl-lib:int-sub m 1)
    (f2cl-lib:int-sub m 1) zero zero
    (f2cl-lib:array-slice u
      double-float
      (1 2)
      ((1 ldu) (1 *)))
  ldu)

```

```

(setf ie itau)
(setf itauq (f2cl-lib:int-add ie m))
(setf itaup (f2cl-lib:int-add itauq m))
(setf iwork (f2cl-lib:int-add itaup m))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
   var-8 var-9 var-10)
  (dgebrd m m u ldu s
   (f2cl-lib:array-slice work
    double-float
    (ie)
    ((1 *)))
   (f2cl-lib:array-slice work
    double-float
    (itauq)
    ((1 *)))
   (f2cl-lib:array-slice work
    double-float
    (itaup)
    ((1 *)))
   (f2cl-lib:array-slice work
    double-float
    (iwork)
    ((1 *)))
   (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
   ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
    var-6 var-7 var-8 var-9))
  (setf ierr var-10))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
   var-8 var-9 var-10 var-11 var-12 var-13)
  (dormbr "P" "L" "T" m n m u ldu
   (f2cl-lib:array-slice work
    double-float
    (itaup)
    ((1 *)))
   vt ldvt
   (f2cl-lib:array-slice work
    double-float
    (iwork)
    ((1 *)))
   (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
   ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
    var-6 var-7 var-8 var-9 var-10 var-11

```

```

                                var-12))
  (setf ierr var-13))
  (multiple-value-bind
    (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
     var-8 var-9)
    (dorgbr "Q" m m m u ldu
      (f2cl-lib:array-slice work
                             double-float
                             (itauq)
                             ((1 *)))
      (f2cl-lib:array-slice work
                             double-float
                             (iwork)
                             ((1 *)))
      (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
      ierr)
    (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                     var-6 var-7 var-8))
    (setf ierr var-9))
  (setf iwork (f2cl-lib:int-add ie m))
  (multiple-value-bind
    (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
     var-8 var-9 var-10 var-11 var-12 var-13 var-14)
    (dbdsqr "U" m n m 0 s
      (f2cl-lib:array-slice work
                             double-float
                             (ie)
                             ((1 *)))
      vt ldvt u ldu dum 1
      (f2cl-lib:array-slice work
                             double-float
                             (iwork)
                             ((1 *)))
      info)
    (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                     var-6 var-7 var-8 var-9 var-10 var-11
                     var-12 var-13))
    (setf info var-14)))))))))
(t
  (setf ie 1)
  (setf itauq (f2cl-lib:int-add ie m))
  (setf itaup (f2cl-lib:int-add itauq m))
  (setf iwork (f2cl-lib:int-add itaup m))
  (multiple-value-bind
    (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
     var-9 var-10)

```

```

(dgebrd m n a lda s
  (f2cl-lib:array-slice work double-float (ie) ((1 *)))
  (f2cl-lib:array-slice work double-float (itauq) ((1 *)))
  (f2cl-lib:array-slice work double-float (itaup) ((1 *)))
  (f2cl-lib:array-slice work double-float (iwork) ((1 *)))
  (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1) ierr)
(declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
  var-7 var-8 var-9))
(setf ierr var-10))
(cond
  (wntuas
    (dlacpy "L" m m a lda u ldu)
    (multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
        var-9)
      (dorgbr "Q" m m n u ldu
        (f2cl-lib:array-slice work double-float (itauq) ((1 *)))
        (f2cl-lib:array-slice work double-float (iwork) ((1 *)))
        (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1) ierr)
      (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
        var-7 var-8))
      (setf ierr var-9))))
  (cond
    (wntvas
      (wntvas
        (dlacpy "U" m n a lda vt ldvt)
        (if wntva (setf nrvt n))
        (if wntvs (setf nrvt m))
        (multiple-value-bind
          (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
            var-9)
          (dorgbr "P" nrvt n m vt ldvt
            (f2cl-lib:array-slice work double-float (itauq) ((1 *)))
            (f2cl-lib:array-slice work double-float (iwork) ((1 *)))
            (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1) ierr)
          (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
            var-7 var-8))
          (setf ierr var-9))))
      (cond
        (wntuo
          (multiple-value-bind
            (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
              var-9)
            (dorgbr "Q" m m n a lda
              (f2cl-lib:array-slice work double-float (itauq) ((1 *)))
              (f2cl-lib:array-slice work double-float (iwork) ((1 *)))
              (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1) ierr)

```

```

        (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                        var-7 var-8))
        (setf ierr var-9)))
(cond
  (wntvo
    (multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
       var-9)
      (dorgbr "P" m n m a lda
        (f2cl-lib:array-slice work double-float (itaup) ((1 *)))
        (f2cl-lib:array-slice work double-float (iwork) ((1 *)))
        (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1) ierr)
      (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                        var-7 var-8))
      (setf ierr var-9))))
  (setf iwork (f2cl-lib:int-add ie m))
  (if (or wntuas wntuo) (setf nru m))
  (if wntun (setf nru 0))
  (if (or wntvas wntvo) (setf ncv t n))
  (if wntvn (setf ncv t 0))
  (cond
    ((and (not wntuo) (not wntvo))
      (multiple-value-bind
        (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
         var-9 var-10 var-11 var-12 var-13 var-14)
        (dbdsqr "L" m ncv t nru 0 s
          (f2cl-lib:array-slice work double-float (ie) ((1 *))) vt
          ldvt u ldu dum 1
          (f2cl-lib:array-slice work double-float (iwork) ((1 *)))
          info)
        (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                          var-7 var-8 var-9 var-10 var-11 var-12
                          var-13))
        (setf info var-14)))
      ((and (not wntuo) wntvo)
        (multiple-value-bind
          (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
           var-9 var-10 var-11 var-12 var-13 var-14)
          (dbdsqr "L" m ncv t nru 0 s
            (f2cl-lib:array-slice work double-float (ie) ((1 *))) a
            lda u ldu dum 1
            (f2cl-lib:array-slice work double-float (iwork) ((1 *)))
            info)
          (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                          var-7 var-8 var-9 var-10 var-11 var-12
                          var-13))

```



```

        (setf info var-14)))
      (t
        (multiple-value-bind
          (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
           var-9 var-10 var-11 var-12 var-13 var-14)
          (dbdsqr "L" m ncvr nru 0 s
            (f2cl-lib:array-slice work double-float (ie) ((1 *))) vt
            ldvt a lda dum 1
            (f2cl-lib:array-slice work double-float (iwork) ((1 *)))
            info)
          (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                           var-7 var-8 var-9 var-10 var-11 var-12
                           var-13))
            (setf info var-14))))))
    (cond
      ((/= info 0)
        (cond
          ((> ie 2)
            (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
              ((> i
                (f2cl-lib:int-add minmn (f2cl-lib:int-sub 1)))
                nil)
            (tagbody
              (setf (f2cl-lib:fref work-%data%
                                   ((f2cl-lib:int-add i 1))
                                   ((1 *))
                                   work-%offset%)
                    (f2cl-lib:fref work-%data%
                                   ((f2cl-lib:int-sub
                                    (f2cl-lib:int-add i ie)
                                    1))
                                   ((1 *))
                                   work-%offset%))))))
          (cond
            ((< ie 2)
              (f2cl-lib:fdo (i (f2cl-lib:int-add minmn (f2cl-lib:int-sub 1))
                            (f2cl-lib:int-add i (f2cl-lib:int-sub 1)))
                ((> i 1) nil)
              (tagbody
                (setf (f2cl-lib:fref work-%data%
                                     ((f2cl-lib:int-add i 1))
                                     ((1 *))
                                     work-%offset%)
                      (f2cl-lib:fref work-%data%
                                     ((f2cl-lib:int-sub
                                      (f2cl-lib:int-add i ie)
                                      1))
                                     ((1 *))
                                     work-%offset%))))))
            (t
              (f2cl-lib:fdo (i (f2cl-lib:int-add minmn (f2cl-lib:int-sub 1))
                            (f2cl-lib:int-add i (f2cl-lib:int-sub 1)))
                ((> i 1) nil)
              (tagbody
                (setf (f2cl-lib:fref work-%data%
                                     ((f2cl-lib:int-add i 1))
                                     ((1 *))
                                     work-%offset%)
                      (f2cl-lib:fref work-%data%
                                     ((f2cl-lib:int-sub
                                      (f2cl-lib:int-add i ie)
                                      1))
                                     ((1 *))
                                     work-%offset%))))))
          (t
            (f2cl-lib:fdo (i (f2cl-lib:int-add minmn (f2cl-lib:int-sub 1))
                          (f2cl-lib:int-add i (f2cl-lib:int-sub 1)))
              ((> i 1) nil)
            (tagbody
              (setf (f2cl-lib:fref work-%data%
                                   ((f2cl-lib:int-add i 1))
                                   ((1 *))
                                   work-%offset%)
                    (f2cl-lib:fref work-%data%
                                   ((f2cl-lib:int-sub
                                    (f2cl-lib:int-add i ie)
                                    1))
                                   ((1 *))
                                   work-%offset%))))))
        (setf info var-14))))))

```

```

1))
((1 *))
work-%offset%)))))))))
(cond
  (= iscl 1)
  (if (> anrm bignum)
    (multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
       var-9)
      (dlascl "G" 0 0 bignum anrm minmn 1 s minmn ierr)
      (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                       var-7 var-8))
      (setf ierr var-9)))
    (if (and (/= info 0) (> anrm bignum))
      (multiple-value-bind
        (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
         var-9)
        (dlascl "G" 0 0 bignum anrm (f2cl-lib:int-sub minmn 1) 1
         (f2cl-lib:array-slice work double-float (2) ((1 *))) minmn
         ierr)
        (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                         var-7 var-8))
        (setf ierr var-9)))
      (if (< anrm smlnum)
        (multiple-value-bind
          (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
           var-9)
          (dlascl "G" 0 0 smlnum anrm minmn 1 s minmn ierr)
          (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                           var-7 var-8))
          (setf ierr var-9)))
        (if (and (/= info 0) (< anrm smlnum))
          (multiple-value-bind
            (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
             var-9)
            (dlascl "G" 0 0 smlnum anrm (f2cl-lib:int-sub minmn 1) 1
             (f2cl-lib:array-slice work double-float (2) ((1 *))) minmn
             ierr)
            (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                             var-7 var-8))
            (setf ierr var-9))))
          (setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)
                (coerce (the fixnum maxwrk) 'double-float)))
    end_label
  (return
   (values nil nil nil nil nil nil nil nil nil nil nil nil info))))))

```

## 7.18 dgesv LAPACK

```
<dgesv.input>≡  
  )set break resume  
  )sys rm -f dgesv.output  
  )spool dgesv.output  
  )set message test on  
  )set message auto off  
  )clear all  
  
  )spool  
  )lisp (bye)
```

*<dgsv.help>*≡

```
=====
dgsv examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

DGESV - the solution to a real system of linear equations  $A * X = B$ ,

#### SYNOPSIS

```
SUBROUTINE DGESV( N, NRHS, A, LDA, IPIV, B, LDB, INFO )
```

```
      INTEGER      INFO, LDA, LDB, N, NRHS
```

```
      INTEGER      IPIV( * )
```

```
      DOUBLE      PRECISION A( LDA, * ), B( LDB, * )
```

#### PURPOSE

DGESV computes the solution to a real system of linear equations

$A * X = B$ , where  $A$  is an  $N$ -by- $N$  matrix and  $X$  and  $B$  are  $N$ -by- $NRHS$  matrices.

The LU decomposition with partial pivoting and row interchanges is used to factor  $A$  as

$$A = P * L * U,$$

where  $P$  is a permutation matrix,  $L$  is unit lower triangular, and  $U$  is upper triangular. The factored form of  $A$  is then used to solve the system of equations  $A * X = B$ .

#### ARGUMENTS

$N$  (input) INTEGER

The number of linear equations, i.e., the order of the matrix  $A$ .  $N \geq 0$ .

$NRHS$  (input) INTEGER

The number of right hand sides, i.e., the number of columns of the matrix  $B$ .  $NRHS \geq 0$ .

$A$  (input/output) DOUBLE PRECISION array, dimension  $(LDA, N)$

On entry, the  $N$ -by- $N$  coefficient matrix  $A$ . On exit, the factors  $L$  and  $U$  from the factorization  $A = P * L * U$ ; the unit diago-

nal elements of L are not stored.

- LDA      (input) INTEGER  
The leading dimension of the array A.  $LDA \geq \max(1,N)$ .
- IPIV      (output) INTEGER array, dimension (N)  
The pivot indices that define the permutation matrix P; row i of the matrix was interchanged with row IPIV(i).
- B        (input/output) DOUBLE PRECISION array, dimension (LDB,NRHS)  
On entry, the N-by-NRHS matrix of right hand side matrix B. On exit, if INFO = 0, the N-by-NRHS solution matrix X.
- LDB      (input) INTEGER  
The leading dimension of the array B.  $LDB \geq \max(1,N)$ .
- INFO      (output) INTEGER  
= 0: successful exit  
< 0: if INFO = -i, the i-th argument had an illegal value  
> 0: if INFO = i, U(i,i) is exactly zero. The factorization has been completed, but the factor U is exactly singular, so the solution could not be computed.

```

(LAPACK dgesv)≡
(defun dgesv (n nrhs a lda ipiv b ldb$ info)
  (declare (type (simple-array fixnum (*)) ipiv)
            (type (simple-array double-float (*)) b a)
            (type fixnum info ldb$ lda nrhs n))
  (f2cl-lib:with-multi-array-data
    ((a double-float a-%data% a-%offset%)
     (b double-float b-%data% b-%offset%)
     (ipiv fixnum ipiv-%data% ipiv-%offset%))
    (prog ()
      (declare)
      (setf info 0)
      (cond
        ((< n 0)
         (setf info -1))
        ((< nrhs 0)
         (setf info -2))
        ((< lda (max (the fixnum 1) (the fixnum n)))
         (setf info -4))
        ((< ldb$ (max (the fixnum 1) (the fixnum n)))
         (setf info -7)))
      (cond
        ((/= info 0)
         (error
          " ** On entry to ~a parameter number ~a had an illegal value~%"
          "DGESV " (f2cl-lib:int-sub info))
         (go end_label)))
      (multiple-value-bind (var-0 var-1 var-2 var-3 var-4 var-5)
        (dgetrf n n a lda ipiv info)
        (declare (ignore var-0 var-1 var-2 var-3 var-4))
        (setf info var-5))
      (cond
        ((= info 0)
         (multiple-value-bind
          (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8)
          (dgetrs "No transpose" n nrhs a lda ipiv b ldb$ info)
          (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7))
          (setf info var-8))))
      (go end_label)
    end_label
    (return (values nil nil nil nil nil nil nil info))))

```

## 7.19 dgetf2 LAPACK

```
<dgetf2.input>≡  
  )set break resume  
  )sys rm -f dgetf2.output  
  )spool dgetf2.output  
  )set message test on  
  )set message auto off  
  )clear all  
  
  )spool  
  )lisp (bye)
```

`<dgetf2.help>`≡

```
=====
dgetf2 examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

DGETF2 - an LU factorization of a general m-by-n matrix A using partial pivoting with row interchanges

#### SYNOPSIS

```
SUBROUTINE DGETF2( M, N, A, LDA, IPIV, INFO )
```

```
      INTEGER      INFO, LDA, M, N
```

```
      INTEGER      IPIV( * )
```

```
      DOUBLE      PRECISION A( LDA, * )
```

#### PURPOSE

DGETF2 computes an LU factorization of a general m-by-n matrix A using partial pivoting with row interchanges.

The factorization has the form

$$A = P * L * U$$

where P is a permutation matrix, L is lower triangular with unit diagonal elements (lower trapezoidal if  $m > n$ ), and U is upper triangular (upper trapezoidal if  $m < n$ ).

This is the right-looking Level 2 BLAS version of the algorithm.

#### ARGUMENTS

M (input) INTEGER

The number of rows of the matrix A.  $M \geq 0$ .

N (input) INTEGER

The number of columns of the matrix A.  $N \geq 0$ .

A (input/output) DOUBLE PRECISION array, dimension (LDA,N)

On entry, the m by n matrix to be factored. On exit, the factors L and U from the factorization  $A = P * L * U$ ; the unit diagonal elements of L are not stored.



LDA      (input) INTEGER  
The leading dimension of the array A.  $LDA \geq \max(1, M)$ .

IPIV      (output) INTEGER array, dimension  $(\min(M, N))$   
The pivot indices; for  $1 \leq i \leq \min(M, N)$ , row  $i$  of the matrix was interchanged with row  $IPIV(i)$ .

INFO      (output) INTEGER  
= 0: successful exit  
< 0: if  $INFO = -k$ , the  $k$ -th argument had an illegal value  
> 0: if  $INFO = k$ ,  $U(k, k)$  is exactly zero. The factorization has been completed, but the factor  $U$  is exactly singular, and division by zero will occur if it is used to solve a system of equations.

```

(LAPACK dgetf2)=
  (let* ((one 1.0) (zero 0.0))
    (declare (type (double-float 1.0 1.0) one)
              (type (double-float 0.0 0.0) zero))
    (defun dgetf2 (m n a lda ipiv info)
      (declare (type (simple-array fixnum (*)) ipiv)
                (type (simple-array double-float (*)) a)
                (type fixnum info lda n m))
      (f2cl-lib:with-multi-array-data
        ((a double-float a-%data% a-%offset%)
         (ipiv fixnum ipiv-%data% ipiv-%offset%))
        (prog ((j 0) (jp 0))
          (declare (type fixnum j jp))
          (setf info 0)
          (cond
            ((< m 0)
             (setf info -1))
            ((< n 0)
             (setf info -2))
            ((< lda (max (the fixnum 1) (the fixnum m)))
             (setf info -4)))
          (cond
            ((/= info 0)
             (error
              " ** On entry to ~a parameter number ~a had an illegal value~%"
              "DGETF2" (f2cl-lib:int-sub info))
             (go end_label)))
          (if (or (= m 0) (= n 0)) (go end_label))
          (f2cl-lib:fd0 (j 1 (f2cl-lib:int-add j 1))
            ((> j
              (min (the fixnum m)
                    (the fixnum n)))
             nil)
            (tagbody
              (setf jp
                (f2cl-lib:int-add (f2cl-lib:int-sub j 1)
                                  (idamax
                                   (f2cl-lib:int-add (f2cl-lib:int-sub m j)
                                                         1)
                                   (f2cl-lib:array-slice a
                                                           double-float
                                                           (j j)
                                                           ((1 lda) (1 *)))
                                                           1)))
                (setf (f2cl-lib:fref ipiv-%data% (j) ((1 *)) ipiv-%offset%) jp)
                (cond

```

```

( (/ = (f2cl-lib:fref a (jp j) ((1 lda) (1 *))) zero)
  (if (/= jp j)
    (dswap n
      (f2cl-lib:array-slice a double-float (j 1) ((1 lda) (1 *)))
      lda
      (f2cl-lib:array-slice a
        double-float
        (jp 1)
        ((1 lda) (1 *)))
      lda))
    (if (< j m)
      (dscal (f2cl-lib:int-sub m j)
        (/ one
          (f2cl-lib:fref a-%data%
            (j j)
            ((1 lda) (1 *))
            a-%offset%))
          (f2cl-lib:array-slice a
            double-float
            ((+ j 1) j)
            ((1 lda) (1 *)))
          1)))
      ((= info 0)
        (setf info j)))
    (cond
      ((< j (min (the fixnum m) (the fixnum n)))
        (dger (f2cl-lib:int-sub m j) (f2cl-lib:int-sub n j) (- one)
          (f2cl-lib:array-slice a
            double-float
            ((+ j 1) j)
            ((1 lda) (1 *)))
          1
          (f2cl-lib:array-slice a
            double-float
            (j (f2cl-lib:int-add j 1))
            ((1 lda) (1 *)))
          lda
          (f2cl-lib:array-slice a
            double-float
            ((+ j 1) (f2cl-lib:int-add j 1))
            ((1 lda) (1 *)))
          lda))))))
      (go end_label)
    end_label
    (return (values nil nil nil nil nil info))))))

```

## 7.20 dgetrf LAPACK

```
<dgetrf.input>=  
  )set break resume  
  )sys rm -f dgetrf.output  
  )spool dgetrf.output  
  )set message test on  
  )set message auto off  
  )clear all  
  
  )spool  
  )lisp (bye)
```

`<dgetrf.help>`≡

```
=====
dgetrf examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

DGETRF - an LU factorization of a general M-by-N matrix A using partial pivoting with row interchanges

#### SYNOPSIS

```
SUBROUTINE DGETRF( M, N, A, LDA, IPIV, INFO )
```

```
      INTEGER      INFO, LDA, M, N
```

```
      INTEGER      IPIV( * )
```

```
      DOUBLE      PRECISION A( LDA, * )
```

#### PURPOSE

DGETRF computes an LU factorization of a general M-by-N matrix A using partial pivoting with row interchanges.

The factorization has the form

$$A = P * L * U$$

where P is a permutation matrix, L is lower triangular with unit diagonal elements (lower trapezoidal if  $m > n$ ), and U is upper triangular (upper trapezoidal if  $m < n$ ).

This is the right-looking Level 3 BLAS version of the algorithm.

#### ARGUMENTS

M (input) INTEGER

The number of rows of the matrix A.  $M \geq 0$ .

N (input) INTEGER

The number of columns of the matrix A.  $N \geq 0$ .

A (input/output) DOUBLE PRECISION array, dimension (LDA,N)

On entry, the M-by-N matrix to be factored. On exit, the factors L and U from the factorization  $A = P*L*U$ ; the unit diagonal elements of L are not stored.

LDA      (input) INTEGER  
          The leading dimension of the array A.  $LDA \geq \max(1, M)$ .

IPIV      (output) INTEGER array, dimension  $(\min(M, N))$   
          The pivot indices; for  $1 \leq i \leq \min(M, N)$ , row  $i$  of the matrix  
          was interchanged with row  $IPIV(i)$ .

INFO      (output) INTEGER  
          = 0: successful exit  
          < 0: if  $INFO = -i$ , the  $i$ -th argument had an illegal value  
          > 0: if  $INFO = i$ ,  $U(i, i)$  is exactly zero. The factorization  
          has been completed, but the factor  $U$  is exactly singular, and  
          division by zero will occur if it is used to solve a system of  
          equations.

```

(LAPACK dgetrf)≡
  (let* ((one 1.0))
    (declare (type (double-float 1.0 1.0) one))
    (defun dgetrf (m n a lda ipiv info)
      (declare (type (simple-array fixnum (*)) ipiv)
                (type (simple-array double-float (*)) a)
                (type fixnum info lda n m))
      (f2cl-lib:with-multi-array-data
        ((a double-float a-%data% a-%offset%)
         (ipiv fixnum ipiv-%data% ipiv-%offset%))
        (prog ((i 0) (iinfo 0) (j 0) (jb 0) (nb 0))
          (declare (type fixnum i iinfo j jb nb))
          (setf info 0)
          (cond
            ((< m 0)
             (setf info -1))
            ((< n 0)
             (setf info -2))
            ((< lda (max (the fixnum 1) (the fixnum m)))
             (setf info -4)))
          (cond
            ((/= info 0)
             (error
              " ** On entry to ~a parameter number ~a had an illegal value~%"
              "DGETRF" (f2cl-lib:int-sub info))
             (go end_label)))
          (if (or (= m 0) (= n 0)) (go end_label))
          (setf nb (ilaenv 1 "DGETRF" " " m n -1 -1))
          (cond
            ((or (<= nb 1)
                  (>= nb
                    (min (the fixnum m) (the fixnum n)))))
            (multiple-value-bind (var-0 var-1 var-2 var-3 var-4 var-5)
              (dgetf2 m n a lda ipiv info)
              (declare (ignore var-0 var-1 var-2 var-3 var-4))
              (setf info var-5)))
            (t
             (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j nb))
                           ((> j
                               (min (the fixnum m)
                                     (the fixnum n))))
                           nil)
             (tagbody
              (setf jb
                (min
                 (the fixnum

```

```

        (f2cl-lib:int-add
        (f2cl-lib:int-sub
        (min (the fixnum m)
              (the fixnum n))
        j)
        1))
    (the fixnum nb)))
(multiple-value-bind (var-0 var-1 var-2 var-3 var-4 var-5)
  (dgetf2 (f2cl-lib:int-add (f2cl-lib:int-sub m j) 1) jb
    (f2cl-lib:array-slice a double-float (j j) ((1 lda) (1 *)))
    lda
    (f2cl-lib:array-slice ipiv fixnum (j) ((1 *)))
    iinfo)
  (declare (ignore var-0 var-1 var-2 var-3 var-4))
  (setf iinfo var-5))
(if (and (= info 0) (> iinfo 0))
  (setf info (f2cl-lib:int-sub (f2cl-lib:int-add iinfo j) 1)))
(f2cl-lib:fdo (i j (f2cl-lib:int-add i 1))
  (> i
    (min (the fixnum m)
          (the fixnum
            (f2cl-lib:int-add j
                                jb
                                (f2cl-lib:int-sub
                                  1))))))
  nil)
(tagbody
  (setf (f2cl-lib:fref ipiv-%data% (i) ((1 *)) ipiv-%offset%
    (f2cl-lib:int-add (f2cl-lib:int-sub j 1)
                      (f2cl-lib:fref ipiv-%data%
                                      (i)
                                      ((1 *))
                                      ipiv-%offset%))))))
(dlaswp (f2cl-lib:int-sub j 1) a lda j
  (f2cl-lib:int-sub (f2cl-lib:int-add j jb) 1) ipiv 1)
(cond
  ((<= (f2cl-lib:int-add j jb) n)
   (dlaswp (f2cl-lib:int-add (f2cl-lib:int-sub n j jb) 1)
    (f2cl-lib:array-slice a
      double-float
      (1 (f2cl-lib:int-add j jb))
      ((1 lda) (1 *)))
    lda j (f2cl-lib:int-sub (f2cl-lib:int-add j jb) 1) ipiv 1)
  (dtrsm "Left" "Lower" "No transpose" "Unit" jb
    (f2cl-lib:int-add (f2cl-lib:int-sub n j jb) 1) one
    (f2cl-lib:array-slice a double-float (j j) ((1 lda) (1 *)))

```



```

lda
(f2cl-lib:array-slice a
  double-float
  (j (f2cl-lib:int-add j jb))
  ((1 lda) (1 *)))

lda)
(cond
  ((<= (f2cl-lib:int-add j jb) m)
    (dgemm "No transpose" "No transpose"
      (f2cl-lib:int-add (f2cl-lib:int-sub m j jb) 1)
      (f2cl-lib:int-add (f2cl-lib:int-sub n j jb) 1) jb (- one)
      (f2cl-lib:array-slice a
        double-float
        ((+ j jb) j)
        ((1 lda) (1 *)))

      lda
      (f2cl-lib:array-slice a
        double-float
        (j (f2cl-lib:int-add j jb))
        ((1 lda) (1 *)))

      lda one
      (f2cl-lib:array-slice a
        double-float
        ((+ j jb) (f2cl-lib:int-add j jb))
        ((1 lda) (1 *)))

      lda)))))))))
end_label
(return (values nil nil nil nil nil info))))))

```

## 7.21 dgetrs LAPACK

```

⟨dgetrs.input⟩≡
)set break resume
)sys rm -f dgetrs.output
)spool dgetrs.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)

```

`<dgetrs.help>`≡

```
=====
dgetrs examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

DGETRS - a system of linear equations  $A * X = B$  or  $A' * X = B$  with a general N-by-N matrix A using the LU factorization computed by DGETRF

#### SYNOPSIS

```
SUBROUTINE DGETRS( TRANS, N, NRHS, A, LDA, IPIV, B, LDB, INFO )
```

```
      CHARACTER      TRANS

      INTEGER        INFO, LDA, LDB, N, NRHS

      INTEGER        IPIV( * )

      DOUBLE         PRECISION A( LDA, * ), B( LDB, * )
```

#### PURPOSE

DGETRS solves a system of linear equations  
 $A * X = B$  or  $A' * X = B$  with a general N-by-N matrix A using the  
 LU factorization computed by DGETRF.

#### ARGUMENTS

```
TRANS  (input) CHARACTER*1
        Specifies the form of the system of equations:
        = 'N':  A * X = B   (No transpose)
        = 'T':  A' * X = B  (Transpose)
        = 'C':  A' * X = B  (Conjugate transpose = Transpose)

N       (input) INTEGER
        The order of the matrix A.  N >= 0.

NRHS    (input) INTEGER
        The number of right hand sides, i.e., the number of columns of
        the matrix B.  NRHS >= 0.

A       (input) DOUBLE PRECISION array, dimension (LDA,N)
        The factors L and U from the factorization A = P*L*U as com-
```

puted by DGETRF.

- LDA      (input) INTEGER  
The leading dimension of the array A.  $LDA \geq \max(1, N)$ .
- IPIV      (input) INTEGER array, dimension (N)  
The pivot indices from DGETRF; for  $1 \leq i \leq N$ , row  $i$  of the matrix was interchanged with row  $IPIV(i)$ .
- B        (input/output) DOUBLE PRECISION array, dimension (LDB, NRHS)  
On entry, the right hand side matrix B. On exit, the solution matrix X.
- LDB      (input) INTEGER  
The leading dimension of the array B.  $LDB \geq \max(1, N)$ .
- INFO      (output) INTEGER  
= 0: successful exit  
< 0: if  $INFO = -i$ , the  $i$ -th argument had an illegal value

```

(LAPACK dgetrs)=
  (let* ((one 1.0))
    (declare (type (double-float 1.0 1.0) one))
    (defun dgetrs (trans n nrhs a lda ipiv b ldb$ info)
      (declare (type (simple-array fixnum (*)) ipiv)
        (type (simple-array double-float (*)) b a)
        (type fixnum info ldb$ lda nrhs n)
        (type character trans))
      (f2cl-lib:with-multi-array-data
        ((trans character trans-%data% trans-%offset%)
         (a double-float a-%data% a-%offset%)
         (b double-float b-%data% b-%offset%)
         (ipiv fixnum ipiv-%data% ipiv-%offset%))
        (prog ((notran nil))
          (declare (type (member t nil) notran))
          (setf info 0)
          (setf notran (char-equal trans #\N))
          (cond
            ((and (not notran) (not (char-equal trans #\T)) (not (char-equal trans #\C)))
              (setf info -1))
            ((< n 0)
              (setf info -2))
            ((< nrhs 0)
              (setf info -3))
            ((< lda (max (the fixnum 1) (the fixnum n)))
              (setf info -5))
            ((< ldb$ (max (the fixnum 1) (the fixnum n)))
              (setf info -8)))
          (cond
            ((/= info 0)
              (error
                " ** On entry to ~a parameter number ~a had an illegal value~%"
                "DGETRS" (f2cl-lib:int-sub info))
              (go end_label)))
          (if (or (= n 0) (= nrhs 0)) (go end_label))
          (cond
            (notran
              (dlaswp nrhs b ldb$ 1 n ipiv 1)
              (dtrsm "Left" "Lower" "No transpose" "Unit" n nrhs one a lda b ldb$)
              (dtrsm "Left" "Upper" "No transpose" "Non-unit" n nrhs one a lda b
                ldb$))
            (t
              (dtrsm "Left" "Upper" "Transpose" "Non-unit" n nrhs one a lda b ldb$)
              (dtrsm "Left" "Lower" "Transpose" "Unit" n nrhs one a lda b ldb$)
              (dlaswp nrhs b ldb$ 1 n ipiv -1)))
          (go end_label)
        )
    )

```

```
end_label  
  (return (values nil nil nil nil nil nil nil nil info))))))
```

## 7.22 dhseqr LAPACK

```
(dhseqr.input)≡  
  )set break resume  
  )sys rm -f dhseqr.output  
  )spool dhseqr.output  
  )set message test on  
  )set message auto off  
  )clear all  
  
  )spool  
  )lisp (bye)
```

`<dhseqr.help>`≡

```
=====
dhseqr examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

DHSEQR - compute the eigenvalues of a Hessenberg matrix  $H$  and, optionally, the matrices  $T$  and  $Z$  from the Schur decomposition  $H = Z T Z^{**T}$ , where  $T$  is an upper quasi-triangular matrix (the Schur form), and  $Z$  is the orthogonal matrix of Schur vectors

#### SYNOPSIS

```
SUBROUTINE DHSEQR( JOB, COMPZ, N, ILO, IHI, H, LDH, WR, WI, Z, LDZ,
                  WORK, LWORK, INFO )
```

```
      INTEGER      IHI, ILO, INFO, LDH, LDZ, LWORK, N
```

```
      CHARACTER    COMPZ, JOB
```

```
      DOUBLE      PRECISION  H( LDH, * ), WI( * ), WORK( * ), WR( * ),
                        Z( LDZ, * )
```

#### PURPOSE

DHSEQR computes the eigenvalues of a Hessenberg matrix  $H$  and, optionally, the matrices  $T$  and  $Z$  from the Schur decomposition  $H = Z T Z^{**T}$ , where  $T$  is an upper quasi-triangular matrix (the Schur form), and  $Z$  is the orthogonal matrix of Schur vectors.

Optionally  $Z$  may be postmultiplied into an input orthogonal matrix  $Q$  so that this routine can give the Schur factorization of a matrix  $A$  which has been reduced to the Hessenberg form  $H$  by the orthogonal matrix  $Q$ :  $A = Q * H * Q^{**T} = (QZ) * T * (QZ)^{**T}$ .

#### ARGUMENTS

**JOB** (input) CHARACTER\*1

= 'E': compute eigenvalues only;

= 'S': compute eigenvalues and the Schur form  $T$ .

**COMPZ** (input) CHARACTER\*1

= 'N': no Schur vectors are computed;

= 'I':  $Z$  is initialized to the unit matrix and the matrix  $Z$  of

Schur vectors of H is returned; = 'V': Z must contain an orthogonal matrix Q on entry, and the product  $Q*Z$  is returned.

- N** (input) INTEGER  
The order of the matrix H.  $N \geq 0$ .
- ILO** (input) INTEGER  
**IHI** (input) INTEGER It is assumed that H is already upper triangular in rows and columns 1:ILO-1 and IHI+1:N. ILO and IHI are normally set by a previous call to DGEBAL, and then passed to DGEHRD when the matrix output by DGEBAL is reduced to Hessenberg form. Otherwise ILO and IHI should be set to 1 and N respectively. If  $N > 0$ , then  $1 \leq ILO \leq IHI \leq N$ . If  $N = 0$ , then  $ILO = 1$  and  $IHI = 0$ .
- H** (input/output) DOUBLE PRECISION array, dimension (LDH,N)  
On entry, the upper Hessenberg matrix H. On exit, if  $INFO = 0$  and  $JOB = 'S'$ , then H contains the upper quasi-triangular matrix T from the Schur decomposition (the Schur form); 2-by-2 diagonal blocks (corresponding to complex conjugate pairs of eigenvalues) are returned in standard form, with  $H(i,i) = H(i+1,i+1)$  and  $H(i+1,i)*H(i,i+1) < 0$ . If  $INFO = 0$  and  $JOB = 'E'$ , the contents of H are unspecified on exit. (The output value of H when  $INFO > 0$  is given under the description of  $INFO$  below.)
- Unlike earlier versions of DHSEQR, this subroutine may explicitly  $H(i,j) = 0$  for  $i > j$  and  $j = 1, 2, \dots, ILO-1$  or  $j = IHI+1, IHI+2, \dots, N$ .
- LDH** (input) INTEGER  
The leading dimension of the array H.  $LDH \geq \max(1,N)$ .
- WR** (output) DOUBLE PRECISION array, dimension (N)  
**WI** (output) DOUBLE PRECISION array, dimension (N) The real and imaginary parts, respectively, of the computed eigenvalues. If two eigenvalues are computed as a complex conjugate pair, they are stored in consecutive elements of WR and WI, say the i-th and (i+1)th, with  $WI(i) > 0$  and  $WI(i+1) < 0$ . If  $JOB = 'S'$ , the eigenvalues are stored in the same order as on the diagonal of the Schur form returned in H, with  $WR(i) = H(i,i)$  and, if  $H(i:i+1,i:i+1)$  is a 2-by-2 diagonal block,  $WI(i) = \sqrt{-H(i+1,i)*H(i,i+1)}$  and  $WI(i+1) = -WI(i)$ .
- Z** (input/output) DOUBLE PRECISION array, dimension (LDZ,N)  
If  $COMPZ = 'N'$ , Z is not referenced. If  $COMPZ = 'I'$ , on entry Z need not be set and on exit, if  $INFO = 0$ , Z contains the orthogo-

nal matrix Z of the Schur vectors of H. If COMPZ = 'V', on entry Z must contain an N-by-N matrix Q, which is assumed to be equal to the unit matrix except for the submatrix Z(ILO:IHI,ILO:IHI). On exit, if INFO = 0, Z contains Q\*Z. Normally Q is the orthogonal matrix generated by DORGHR after the call to DGEHRD which formed the Hessenberg matrix H. (The output value of Z when INFO.GT.0 is given under the description of INFO below.)

LDZ (input) INTEGER

The leading dimension of the array Z. if COMPZ = 'I' or COMPZ = 'V', then LDZ.GE.MAX(1,N). Otherwise, LDZ.GE.1.

WORK (workspace/output) DOUBLE PRECISION array, dimension (LWORK)

On exit, if INFO = 0, WORK(1) returns an estimate of the optimal value for LWORK.

LWORK (input) INTEGER The dimension of the array WORK. LWORK.GE. max(1,N) is sufficient, but LWORK typically as large as 6\*N may be required for optimal performance. A workspace query to determine the optimal workspace size is recommended.

If LWORK = -1, then DHSEQR does a workspace query. In this case, DHSEQR checks the input parameters and estimates the optimal workspace size for the given values of N, ILO and IHI. The estimate is returned in WORK(1). No error message related to LWORK is issued by XERBLA. Neither H nor Z are accessed.

INFO (output) INTEGER

= 0: successful exit  
value

the eigenvalues. Elements 1:ilo-1 and i+1:n of WR and WI contain those eigenvalues which have been successfully computed. (Failures are rare.)

If INFO .GT. 0 and JOB = 'E', then on exit, the remaining unconverged eigenvalues are the eigenvalues of the upper Hessenberg matrix rows and columns ILO through INFO of the final, output value of H.

If INFO .GT. 0 and JOB = 'S', then on exit

(\*) (initial value of H)\*U = U\*(final value of H)

where U is an orthogonal matrix. The final value of H is upper Hessenberg and quasi-triangular in rows and columns INFO+1 through IHI.



If INFO .GT. 0 and COMPZ = 'V', then on exit

(final value of Z) = (initial value of Z)\*U

where U is the orthogonal matrix in (\*) (regardless of the value of JOB.)

If INFO .GT. 0 and COMPZ = 'I', then on exit (final value of Z) = U where U is the orthogonal matrix in (\*) (regardless of the value of JOB.)

If INFO .GT. 0 and COMPZ = 'N', then Z is not accessed.

```

(LAPACK dhseqr)=
  (let* ((zero 0.0) (one 1.0) (two 2.0) (const 1.5) (nsmax 15) (lds nsmax))
    (declare (type (double-float 0.0 0.0) zero)
              (type (double-float 1.0 1.0) one)
              (type (double-float 2.0 2.0) two)
              (type (double-float 1.5 1.5) const)
              (type (fixnum 15 15) nsmax)
              (type (fixnum lds)))
    (defun dhseqr (job compz n ilo ihi h ldh wr wi z ldz work lwork info)
      (declare (type (simple-array double-float (*)) work z wi wr h)
                (type fixnum info lwork ldz ldh ihi ilo n)
                (type character compz job))
      (f2cl-lib:with-multi-array-data
        ((job character job-%data% job-%offset%)
         (compz character compz-%data% compz-%offset%)
         (h double-float h-%data% h-%offset%)
         (wr double-float wr-%data% wr-%offset%)
         (wi double-float wi-%data% wi-%offset%)
         (z double-float z-%data% z-%offset%)
         (work double-float work-%data% work-%offset%))
        (prog ((s
                  (make-array (the fixnum (reduce #'* (list lds nsmax)))
                              :element-type 'double-float))
                (v
                  (make-array (f2cl-lib:int-add nsmax 1)
                              :element-type 'double-float))
                (vv
                  (make-array (f2cl-lib:int-add nsmax 1)
                              :element-type 'double-float))
                (absw 0.0) (ovfl 0.0) (smlnum 0.0) (tau 0.0) (temp 0.0) (tst1 0.0)
                (ulp 0.0) (unfl 0.0) (i 0) (i1 0) (i2 0) (ierr 0) (ii 0) (itemp 0)
                (itn 0) (its 0) (j 0) (k 0) (l 0) (maxb 0) (nh 0) (nr 0) (ns 0)
                (nv 0) (initz nil) (lquery nil) (wantt nil) (wantz nil))
              (declare (type (simple-array double-float (*)) s v vv)
                        (type (double-float) absw ovfl smlnum tau temp tst1 ulp unfl)
                        (type fixnum i i1 i2 ierr ii itemp itn its j k l
                                   maxb nh nr ns nv)
                        (type (member t nil) initz lquery wantt wantz))
              (setf wantt (char-equal job #\S))
              (setf initz (char-equal compz #\I))
              (setf wantz (or initz (char-equal compz #\V)))
              (setf info 0)
              (setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)
                    (coerce
                     (the fixnum
                      (max (the fixnum 1)

```

```

                                (the fixnum n)))
                                'double-float))
(setf lquery (coerce (= lwork -1) '(member t nil)))
(cond
  ((and (not (char-equal job #\E)) (not wantt))
    (setf info -1))
  ((and (not (char-equal compz #\N)) (not wantz))
    (setf info -2))
  ((< n 0)
    (setf info -3))
  ((or (< ilo 1)
        (> ilo
          (max (the fixnum 1) (the fixnum n))))
    (setf info -4))
  ((or
    (< ihi (min (the fixnum ilo) (the fixnum n)))
    (> ihi n))
    (setf info -5))
  ((< ldh (max (the fixnum 1) (the fixnum n)))
    (setf info -7))
  ((or (< ldz 1)
        (and wantz
          (< ldz
            (max (the fixnum 1)
                  (the fixnum n))))))
    (setf info -11))
  ((and
    (< lwork (max (the fixnum 1) (the fixnum n)))
    (not lquery))
    (setf info -13)))
(cond
  ((/= info 0)
    (error
      " ** On entry to ~a parameter number ~a had an illegal value~%"
      "DHSEQR" (f2cl-lib:int-sub info))
    (go end_label))
  (lquery
    (go end_label)))
(if initz (dlaset "Full" n n zero one z ldz))
(f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
  ((> i (f2cl-lib:int-add ilo (f2cl-lib:int-sub 1))) nil)
  (tagbody
    (setf (f2cl-lib:fref wr-%data% (i) ((1 *)) wr-%offset%)
      (f2cl-lib:fref h-%data% (i i) ((1 ldh) (1 *)) h-%offset%))
    (setf (f2cl-lib:fref wi-%data% (i) ((1 *)) wi-%offset%) zero)))
(f2cl-lib:fdo (i (f2cl-lib:int-add ihi 1) (f2cl-lib:int-add i 1))

```

```

        (> i n) nil)
    (tagbody
      (setf (f2cl-lib:fref wr-%data% (i) ((1 *)) wr-%offset%)
            (f2cl-lib:fref h-%data% (i i) ((1 ldh) (1 *)) h-%offset%))
      (setf (f2cl-lib:fref wi-%data% (i) ((1 *)) wi-%offset%) zero)))
    (if (= n 0) (go end_label)))
  (cond
    ((= ilo ihi)
     (setf (f2cl-lib:fref wr-%data% (ilo) ((1 *)) wr-%offset%)
           (f2cl-lib:fref h-%data%
                         (ilo ilo)
                         ((1 ldh) (1 *))
                         h-%offset%))
     (setf (f2cl-lib:fref wi-%data% (ilo) ((1 *)) wi-%offset%) zero)
     (go end_label)))
  (f2cl-lib:fdo (j ilo (f2cl-lib:int-add j 1))
    (> j (f2cl-lib:int-add ihi (f2cl-lib:int-sub 2))) nil)
  (tagbody
    (f2cl-lib:fdo (i (f2cl-lib:int-add j 2) (f2cl-lib:int-add i 1))
      (> i n) nil)
    (tagbody
      (setf (f2cl-lib:fref h-%data% (i j) ((1 ldh) (1 *)) h-%offset%)
            zero))))
  (setf nh (f2cl-lib:int-add (f2cl-lib:int-sub ihi ilo) 1))
  (setf ns (ilaenv 4 "DHSEQR" (f2cl-lib:f2cl-// job compz) n ilo ihi -1))
  (setf maxb
    (ilaenv 8 "DHSEQR" (f2cl-lib:f2cl-// job compz) n ilo ihi -1))
  (cond
    ((or (<= ns 2) (> ns nh) (>= maxb nh))
     (multiple-value-bind
       (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9
        var-10 var-11 var-12 var-13)
       (dlahqr wantt wantz n ilo ihi h ldh wr wi ilo ihi z ldz info)
       (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
                        var-8 var-9 var-10 var-11 var-12))
       (setf info var-13))
     (go end_label)))
  (setf maxb
    (max (the fixnum 3) (the fixnum maxb)))
  (setf ns
    (min (the fixnum ns)
         (the fixnum maxb)
         (the fixnum nsmax)))
  (setf unfl (dlamch "Safe minimum"))
  (setf ovfl (/ one unfl))
  (multiple-value-bind (var-0 var-1)

```

```

        (dlabad unfl ovfl)
        (declare (ignore))
        (setf unfl var-0)
        (setf ovfl var-1))
    (setf ulp (dlamch "Precision"))
    (setf smlnum (* unfl (/ nh ulp)))
    (cond
      (wantt
        (setf i1 1)
        (setf i2 n)))
    (setf itn (f2cl-lib:int-mul 30 nh))
    (setf i ihi)
label150
    (setf l ilo)
    (if (< i ilo) (go label170))
    (f2cl-lib:fdo (its 0 (f2cl-lib:int-add its 1))
      ((> its itn) nil)
      (tagbody
        (f2cl-lib:fdo (k i (f2cl-lib:int-add k (f2cl-lib:int-sub 1)))
          ((> k (f2cl-lib:int-add 1 1)) nil)
          (tagbody
            (setf tst1
              (+
                (abs
                  (f2cl-lib:fref h-%data%
                                ((f2cl-lib:int-sub k 1)
                                 (f2cl-lib:int-sub k 1))
                                ((1 ldh) (1 *)))
                  h-%offset%))
                (abs
                  (f2cl-lib:fref h-%data%
                                (k k)
                                ((1 ldh) (1 *)))
                  h-%offset%))))
            (if (= tst1 zero)
              (setf tst1
                (dlanhs "1"
                  (f2cl-lib:int-add (f2cl-lib:int-sub i 1) 1)
                  (f2cl-lib:array-slice h
                                        double-float
                                        (1 1)
                                        ((1 ldh) (1 *)))
                  ldh work))))
            (if
              (<=
                (abs

```

```

                (f2cl-lib:fref h-%data%
                  (k (f2cl-lib:int-sub k 1))
                  ((1 ldh) (1 *))
                  h-%offset%))
        (max (* ulp tst1) smlnum))
    (go label70))))

label70
  (setf l k)
  (cond
    ((> l ilo)
     (setf (f2cl-lib:fref h-%data%
                          (l (f2cl-lib:int-sub l 1))
                          ((1 ldh) (1 *))
                          h-%offset%)
           zero)))
    (if (>= 1 (f2cl-lib:int-add (f2cl-lib:int-sub i maxb) 1))
        (go label160))
    (cond
      ((not wantt)
       (setf i1 1)
       (setf i2 i)))
    (cond
      ((or (= its 20) (= its 30))
       (f2cl-lib:fdo (ii (f2cl-lib:int-add i (f2cl-lib:int-sub ns) 1))
                     (f2cl-lib:int-add ii 1))
       ((> ii i) nil)
       (tagbody
        (setf (f2cl-lib:fref wr-%data% (ii) ((1 *)) wr-%offset%)
              (* const
                (+
                 (abs
                  (f2cl-lib:fref h-%data%
                                (ii (f2cl-lib:int-sub ii 1))
                                ((1 ldh) (1 *))
                                h-%offset%))
                 (abs
                  (f2cl-lib:fref h-%data%
                                (ii ii)
                                ((1 ldh) (1 *))
                                h-%offset%))))))
        (setf (f2cl-lib:fref wi-%data% (ii) ((1 *)) wi-%offset%)
              zero))))))
    (t
     (dlacpy "Full" ns ns
             (f2cl-lib:array-slice h
                                     double-float

```

```

((+ i (f2cl-lib:int-sub ns) 1)
 (f2cl-lib:int-add
  (f2cl-lib:int-sub i ns)
  1))
((1 ldh) (1 *)))

ldh s lds)
(multiple-value-bind
 (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
  var-9 var-10 var-11 var-12 var-13)
 (dlahqr nil nil ns 1 ns s lds
  (f2cl-lib:array-slice wr
    double-float
    ((+ i (f2cl-lib:int-sub ns) 1))
    ((1 *)))
  (f2cl-lib:array-slice wi
    double-float
    ((+ i (f2cl-lib:int-sub ns) 1))
    ((1 *)))
  1 ns z ldz ierr)
 (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
  var-7 var-8 var-9 var-10 var-11 var-12))
 (setf ierr var-13))
(cond
 ((> ierr 0)
  (f2cl-lib:fdo (ii 1 (f2cl-lib:int-add ii 1))
    ((> ii ierr) nil)
  (tagbody
   (setf (f2cl-lib:fref wr-%data%
    ((f2cl-lib:int-add
     (f2cl-lib:int-sub i ns)
     ii))
    ((1 *))
    wr-%offset%)
    (f2cl-lib:fref s (ii ii) ((1 lds) (1 nsmax))))
   (setf (f2cl-lib:fref wi-%data%
    ((f2cl-lib:int-add
     (f2cl-lib:int-sub i ns)
     ii))
    ((1 *))
    wi-%offset%)
    zero))))))
 (setf (f2cl-lib:fref v (1) ((1 (f2cl-lib:int-add nsmax 1)))) one)
 (f2cl-lib:fdo (ii 2 (f2cl-lib:int-add ii 1))
  ((> ii (f2cl-lib:int-add ns 1)) nil)
 (tagbody
  (setf (f2cl-lib:fref v (ii) ((1 (f2cl-lib:int-add nsmax 1))))

```

```

                                zero)))
(setf nv 1)
(f2cl-lib:fdo (j (f2cl-lib:int-add i (f2cl-lib:int-sub ns) 1)
              (f2cl-lib:int-add j 1))
              ((> j i) nil)
(tagbody
 (cond
  ((>= (f2cl-lib:fref wi (j) ((1 *))) zero)
   (cond
    ((= (f2cl-lib:fref wi (j) ((1 *))) zero)
     (dcopy (f2cl-lib:int-add nv 1) v 1 vv 1)
     (dgemv "No transpose" (f2cl-lib:int-add nv 1) nv one
              (f2cl-lib:array-slice h
                                   double-float
                                   (1 1)
                                   ((1 ldh) (1 *)))

      ldh vv 1
      (- (f2cl-lib:fref wr-%data% (j) ((1 *)) wr-%offset%)) v
      1)
     (setf nv (f2cl-lib:int-add nv 1)))
    (> (f2cl-lib:fref wi (j) ((1 *))) zero)
     (dcopy (f2cl-lib:int-add nv 1) v 1 vv 1)
     (dgemv "No transpose" (f2cl-lib:int-add nv 1) nv one
              (f2cl-lib:array-slice h
                                   double-float
                                   (1 1)
                                   ((1 ldh) (1 *)))

      ldh v 1
      (* (- two)
          (f2cl-lib:fref wr-%data% (j) ((1 *)) wr-%offset%))
      vv 1)
     (setf itemp (idamax (f2cl-lib:int-add nv 1) vv 1))
     (setf temp
              (/ one
                 (max
                  (abs
                   (f2cl-lib:fref vv
                                (itemp)
                                ((1
                                 (f2cl-lib:int-add nsmax
                                   1))))))
                  smlnum))))
     (dscal (f2cl-lib:int-add nv 1) temp vv 1)
     (setf absw
              (dlapy2
               (f2cl-lib:fref wr-%data%

```



```

                                (j)
                                ((1 *))
                                wr-%offset%)
(f2cl-lib:fref wi-%data%
                                (j)
                                ((1 *))
                                wi-%offset%)))
(setf temp (* temp absw absw))
(dgemv "No transpose" (f2cl-lib:int-add nv 2)
(f2cl-lib:int-add nv 1) one
(f2cl-lib:array-slice h
                                double-float
                                (1 1)
                                ((1 ldh) (1 *))))

ldh vv 1 temp v 1)
(setf nv (f2cl-lib:int-add nv 2))))
(setf itemp (idamax nv v 1))
(setf temp
  (abs
    (f2cl-lib:fref v
                    (itemp)
                    ((1 (f2cl-lib:int-add nsmax 1))))))
(cond
  ((= temp zero)
    (setf (f2cl-lib:fref v
                        (1)
                        ((1 (f2cl-lib:int-add nsmax 1))))
          one)
    (f2cl-lib:fdo (ii 2 (f2cl-lib:int-add ii 1))
                  ((> ii nv) nil)
    (tagbody
      (setf (f2cl-lib:fref v
                          (ii)
                          ((1
                            (f2cl-lib:int-add nsmax 1))))
            zero))))
  (t
    (setf temp (max temp smlnum))
    (dscal nv (/ one temp) v 1))))))
(f2cl-lib:fdo (k 1 (f2cl-lib:int-add k 1))
              ((> k (f2cl-lib:int-add i (f2cl-lib:int-sub 1))) nil)
(tagbody
  (setf nr
    (min (the fixnum (f2cl-lib:int-add ns 1))
          (the fixnum
            (f2cl-lib:int-add (f2cl-lib:int-sub i k)

```

```

1))))
(if (> k 1)
  (dcopy nr
    (f2cl-lib:array-slice h
      double-float
      (k (f2cl-lib:int-sub k 1))
      ((1 ldh) (1 *)))
    1 v 1))
(multiple-value-bind (var-0 var-1 var-2 var-3 var-4)
  (dlarfgr nr
    (f2cl-lib:fref v (1) ((1 (f2cl-lib:int-add nsmax 1))))
    (f2cl-lib:array-slice v
      double-float
      (2)
      ((1 (f2cl-lib:int-add nsmax 1))))
    1 tau)
  (declare (ignore var-0 var-2 var-3))
  (setf (f2cl-lib:fref v (1) ((1 (f2cl-lib:int-add nsmax 1))))
    var-1)
  (setf tau var-4))
(cond
  ((> k 1)
    (setf (f2cl-lib:fref h-%data%
      (k (f2cl-lib:int-sub k 1))
      ((1 ldh) (1 *)))
      h-%offset%)
      (f2cl-lib:fref v
        (1)
        ((1 (f2cl-lib:int-add nsmax 1))))
      (f2cl-lib:fdo (ii (f2cl-lib:int-add k 1)
        (f2cl-lib:int-add ii 1))
        ((> ii i) nil)
        (tagbody
          (setf (f2cl-lib:fref h-%data%
            (ii (f2cl-lib:int-sub k 1))
            ((1 ldh) (1 *)))
            h-%offset%)
            zero))))))
(setf (f2cl-lib:fref v (1) ((1 (f2cl-lib:int-add nsmax 1))))
  one)
(dlarfx "Left" nr (f2cl-lib:int-add (f2cl-lib:int-sub i2 k) 1)
  v tau
  (f2cl-lib:array-slice h double-float (k k) ((1 ldh) (1 *)))
  ldh work)
(dlarfx "Right"
  (f2cl-lib:int-add

```

```

        (f2cl-lib:int-sub
        (min (the fixnum (f2cl-lib:int-add k nr))
              (the fixnum i))
        i1)
    1)
nr v tau
(f2cl-lib:array-slice h double-float (i1 k) ((1 ldh) (1 *)))
ldh work)
(cond
  (wantz
   (dlarfx "Right" nh nr v tau
           (f2cl-lib:array-slice z
                                   double-float
                                   (ilo k)
                                   ((1 ldz) (1 *)))
           ldz work))))))
(setf info i)
(go end_label)
label160
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9
   var-10 var-11 var-12 var-13)
  (dlahqr wantt wantz n l i h ldh wr wi ilo ihi z ldz info)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
                    var-8 var-9 var-10 var-11 var-12))
  (setf info var-13))
(if (> info 0) (go end_label))
(setf itn (f2cl-lib:int-sub itn its))
(setf i (f2cl-lib:int-sub 1 1))
(go label50)
label170
(setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)
      (coerce
       (the fixnum
          (max (the fixnum 1)
                (the fixnum n)))
       'double-float))
end_label
(return
 (values nil nil nil nil nil nil nil nil nil nil nil nil info))))

```

## 7.23 dlabad LAPACK

```
<dlabad.input>≡  
  )set break resume  
  )sys rm -f dlabad.output  
  )spool dlabad.output  
  )set message test on  
  )set message auto off  
  )clear all  
  
  )spool  
  )lisp (bye)
```

*<dlabad.help>*≡

```
=====
dlabad examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

DLABAD - a input the values computed by DLAMCH for underflow and overflow, and returns the square root of each of these values if the log of LARGE is sufficiently large

#### SYNOPSIS

```
SUBROUTINE DLABAD( SMALL, LARGE )
```

```
      DOUBLE          PRECISION LARGE, SMALL
```

#### PURPOSE

DLABAD takes as input the values computed by DLAMCH for underflow and overflow, and returns the square root of each of these values if the log of LARGE is sufficiently large. This subroutine is intended to identify machines with a large exponent range, such as the Crays, and redefine the underflow and overflow limits to be the square roots of the values computed by DLAMCH. This subroutine is needed because DLAMCH does not compensate for poor arithmetic in the upper half of the exponent range, as is found on a Cray.

#### ARGUMENTS

SMALL (input/output) DOUBLE PRECISION  
On entry, the underflow threshold as computed by DLAMCH. On exit, if LOG10(LARGE) is sufficiently large, the square root of SMALL, otherwise unchanged.

LARGE (input/output) DOUBLE PRECISION  
On entry, the overflow threshold as computed by DLAMCH. On exit, if LOG10(LARGE) is sufficiently large, the square root of LARGE, otherwise unchanged.

```
(LAPACK dlabad)≡
(defun dlabad (small large)
  (declare (type (double-float) large small))
  (prog ()
    (declare)
    (cond
      ((> (f2cl-lib:log10 large) 2000.0)
       (setf small (f2cl-lib:fsqrt small))
       (setf large (f2cl-lib:fsqrt large))))
    (return (values small large))))
```

## 7.24 dlabrd LAPACK

```
(dlabrd.input)≡
)set break resume
)sys rm -f dlabrd.output
)spool dlabrd.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

`<dlabrd.help>`≡

```
=====
dlabrd examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

DLABRD - the first NB rows and columns of a real general m by n matrix A to upper or lower bidiagonal form by an orthogonal transformation  $Q' * A * P$ , and returns the matrices X and Y which are needed to apply the transformation to the unreduced part of A

#### SYNOPSIS

```
SUBROUTINE DLABRD( M, N, NB, A, LDA, D, E, TAUQ, TAUP, X, LDX, Y, LDY )
```

```
      INTEGER          LDA, LDX, LDY, M, N, NB
```

```
      DOUBLE           PRECISION  A( LDA, * ), D( * ), E( * ), TAUP( * ),
      TAUQ( * ), X( LDX, * ), Y( LDY, * )
```

#### PURPOSE

DLABRD reduces the first NB rows and columns of a real general m by n matrix A to upper or lower bidiagonal form by an orthogonal transformation  $Q' * A * P$ , and returns the matrices X and Y which are needed to apply the transformation to the unreduced part of A.

If  $m \geq n$ , A is reduced to upper bidiagonal form; if  $m < n$ , to lower bidiagonal form.

This is an auxiliary routine called by DGEBRD

#### ARGUMENTS

M (input) INTEGER  
The number of rows in the matrix A.

N (input) INTEGER  
The number of columns in the matrix A.

NB (input) INTEGER  
The number of leading rows and columns of A to be reduced.

A (input/output) DOUBLE PRECISION array, dimension (LDA,N)

On entry, the  $m$  by  $n$  general matrix to be reduced. On exit, the first NB rows and columns of the matrix are overwritten; the rest of the array is unchanged. If  $m \geq n$ , elements on and below the diagonal in the first NB columns, with the array TAUQ, represent the orthogonal matrix  $Q$  as a product of elementary reflectors; and elements above the diagonal in the first NB rows, with the array TAUP, represent the orthogonal matrix  $P$  as a product of elementary reflectors. If  $m < n$ , elements below the diagonal in the first NB columns, with the array TAUQ, represent the orthogonal matrix  $Q$  as a product of elementary reflectors, and elements on and above the diagonal in the first NB rows, with the array TAUP, represent the orthogonal matrix  $P$  as a product of elementary reflectors. See Further Details. LDA (input) INTEGER The leading dimension of the array A.  $LDA \geq \max(1, M)$ .

- D (output) DOUBLE PRECISION array, dimension (NB)  
The diagonal elements of the first NB rows and columns of the reduced matrix.  $D(i) = A(i, i)$ .
- E (output) DOUBLE PRECISION array, dimension (NB)  
The off-diagonal elements of the first NB rows and columns of the reduced matrix.
- TAUQ (output) DOUBLE PRECISION array dimension (NB)  
The scalar factors of the elementary reflectors which represent the orthogonal matrix  $Q$ . See Further Details. TAUP (output) DOUBLE PRECISION array, dimension (NB) The scalar factors of the elementary reflectors which represent the orthogonal matrix  $P$ . See Further Details. X (output) DOUBLE PRECISION array, dimension (LDX, NB) The  $m$ -by- $nb$  matrix  $X$  required to update the unreduced part of A.
- LDX (input) INTEGER  
The leading dimension of the array X.  $LDX \geq M$ .
- Y (output) DOUBLE PRECISION array, dimension (LDY, NB)  
The  $n$ -by- $nb$  matrix  $Y$  required to update the unreduced part of A.
- LDY (input) INTEGER  
The leading dimension of the array Y.  $LDY \geq N$ .

#### FURTHER DETAILS

The matrices  $Q$  and  $P$  are represented as products of elementary reflectors:



$$Q = H(1) \ H(2) \ . \ . \ . \ H(nb) \quad \text{and} \quad P = G(1) \ G(2) \ . \ . \ . \ G(nb)$$

Each  $H(i)$  and  $G(i)$  has the form:

$$H(i) = I - \tau_{uq} * v * v' \quad \text{and} \quad G(i) = I - \tau_{up} * u * u'$$

where  $\tau_{uq}$  and  $\tau_{up}$  are real scalars, and  $v$  and  $u$  are real vectors.

If  $m \geq n$ ,  $v(1:i-1) = 0$ ,  $v(i) = 1$ , and  $v(i:m)$  is stored on exit in  $A(i:m,i)$ ;  $u(1:i) = 0$ ,  $u(i+1) = 1$ , and  $u(i+1:n)$  is stored on exit in  $A(i,i+1:n)$ ;  $\tau_{uq}$  is stored in  $\text{TAUQ}(i)$  and  $\tau_{up}$  in  $\text{TAUP}(i)$ .

If  $m < n$ ,  $v(1:i) = 0$ ,  $v(i+1) = 1$ , and  $v(i+1:m)$  is stored on exit in  $A(i+2:m,i)$ ;  $u(1:i-1) = 0$ ,  $u(i) = 1$ , and  $u(i:n)$  is stored on exit in  $A(i,i+1:n)$ ;  $\tau_{uq}$  is stored in  $\text{TAUQ}(i)$  and  $\tau_{up}$  in  $\text{TAUP}(i)$ .

The elements of the vectors  $v$  and  $u$  together form the  $m$ -by- $nb$  matrix  $V$  and the  $nb$ -by- $n$  matrix  $U'$  which are needed, with  $X$  and  $Y$ , to apply the transformation to the unreduced part of the matrix, using a block update of the form:  $A := A - V*Y' - X*U'$ .

The contents of  $A$  on exit are illustrated by the following examples with  $nb = 2$ :

$m = 6$  and  $n = 5$  ( $m > n$ ):

```
( 1  1  u1  u1  u1 )
( v1 1  1  u2  u2 )
( v1 v2 a  a  a )
( v1 v2 a  a  a )
( v1 v2 a  a  a )
( v1 v2 a  a  a )
```

$m = 5$  and  $n = 6$  ( $m < n$ ):

```
( 1  u1  u1  u1  u1  u1 )
( 1  1  u2  u2  u2  u2 )
( v1 1  a  a  a  a )
( v1 v2 a  a  a  a )
( v1 v2 a  a  a  a )
```

where  $a$  denotes an element of the original matrix which is unchanged,  $v_i$  denotes an element of the vector defining  $H(i)$ , and  $u_i$  an element of the vector defining  $G(i)$ .

```

(LAPACK dlabrd)=
(let* ((zero 0.0) (one 1.0))
  (declare (type (double-float 0.0 0.0) zero)
            (type (double-float 1.0 1.0) one))
  (defun dlabrd (m n nb a lda d e tauq taup x ldx y ldy)
    (declare (type (simple-array double-float (*)) y x taup tauq e d a)
              (type fixnum ldy ldx lda nb n m))
    (f2cl-lib:with-multi-array-data
      ((a double-float a-%data% a-%offset%)
       (d double-float d-%data% d-%offset%)
       (e double-float e-%data% e-%offset%)
       (tauq double-float tauq-%data% tauq-%offset%)
       (taup double-float taup-%data% taup-%offset%)
       (x double-float x-%data% x-%offset%)
       (y double-float y-%data% y-%offset%))
      (prog ((i 0))
        (declare (type fixnum i))
        (if (or (<= m 0) (<= n 0)) (go end_label))
        (cond
          ((>= m n)
           (f2cl-lib:fd0 (i 1 (f2cl-lib:int-add i 1))
                         (> i nb) nil)
           (tagbody
            (dgemv "No transpose"
                  (f2cl-lib:int-add (f2cl-lib:int-sub m i) 1)
                  (f2cl-lib:int-sub i 1) (- one)
                  (f2cl-lib:array-slice a double-float (i 1) ((1 lda) (1 *))) lda
                  (f2cl-lib:array-slice y double-float (i 1) ((1 ldy) (1 *))) ldy
                  one (f2cl-lib:array-slice a double-float (i i) ((1 lda) (1 *)))
                  1)
            (dgemv "No transpose"
                  (f2cl-lib:int-add (f2cl-lib:int-sub m i) 1)
                  (f2cl-lib:int-sub i 1) (- one)
                  (f2cl-lib:array-slice x double-float (i 1) ((1 ldx) (1 *))) ldx
                  (f2cl-lib:array-slice a double-float (1 i) ((1 lda) (1 *))) 1
                  one (f2cl-lib:array-slice a double-float (i i) ((1 lda) (1 *)))
                  1)
            (multiple-value-bind (var-0 var-1 var-2 var-3 var-4)
              (dlarf (f2cl-lib:int-add (f2cl-lib:int-sub m i) 1)
                    (f2cl-lib:fref a-%data% (i i) ((1 lda) (1 *)) a-%offset%)
                    (f2cl-lib:array-slice a
                                          double-float
                                          ((min (f2cl-lib:int-add i 1) m) i)
                                          ((1 lda) (1 *)))
                    1 (f2cl-lib:fref tauq-%data% (i) ((1 *) tauq-%offset%)))
              (declare (ignore var-0 var-2 var-3))

```

```

(setf (f2cl-lib:fref a-%data%
                    (i i)
                    ((1 lda) (1 *)))
      a-%offset%)

      var-1)
(setf (f2cl-lib:fref tauq-%data% (i) ((1 *)) tauq-%offset%)
      var-4))
(setf (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%)
      (f2cl-lib:fref a-%data%
                    (i i)
                    ((1 lda) (1 *)))
      a-%offset%))
(cond
  ((< i n)
    (setf (f2cl-lib:fref a-%data%
                    (i i)
                    ((1 lda) (1 *)))
          a-%offset%)

      one)
  (dgemv "Transpose"
    (f2cl-lib:int-add (f2cl-lib:int-sub m i) 1)
    (f2cl-lib:int-sub n i) one
    (f2cl-lib:array-slice a
                          double-float
                          (i (f2cl-lib:int-add i 1))
                          ((1 lda) (1 *)))

    lda
    (f2cl-lib:array-slice a double-float (i i) ((1 lda) (1 *)))
    1 zero
    (f2cl-lib:array-slice y
                          double-float
                          ((+ i 1) i)
                          ((1 ldy) (1 *)))

    1)
  (dgemv "Transpose"
    (f2cl-lib:int-add (f2cl-lib:int-sub m i) 1)
    (f2cl-lib:int-sub i 1) one
    (f2cl-lib:array-slice a double-float (i 1) ((1 lda) (1 *)))
    lda
    (f2cl-lib:array-slice a double-float (i i) ((1 lda) (1 *)))
    1 zero
    (f2cl-lib:array-slice y double-float (1 i) ((1 ldy) (1 *)))
    1)
  (dgemv "No transpose" (f2cl-lib:int-sub n i)
    (f2cl-lib:int-sub i 1) (- one)
    (f2cl-lib:array-slice y

```

```

                                double-float
                                ((+ i 1) 1)
                                ((1 ldy) (1 *)))

ldy
(f2cl-lib:array-slice y double-float (1 i) ((1 ldy) (1 *)))
1 one
(f2cl-lib:array-slice y
                                double-float
                                ((+ i 1) i)
                                ((1 ldy) (1 *)))

1)
(dgemv "Transpose"
(f2cl-lib:int-add (f2cl-lib:int-sub m i) 1)
(f2cl-lib:int-sub i 1) one
(f2cl-lib:array-slice x double-float (i 1) ((1 ldx) (1 *)))
ldx
(f2cl-lib:array-slice a double-float (i i) ((1 lda) (1 *)))
1 zero
(f2cl-lib:array-slice y double-float (1 i) ((1 ldy) (1 *)))
1)
(dgemv "Transpose" (f2cl-lib:int-sub i 1)
(f2cl-lib:int-sub n i) (- one)
(f2cl-lib:array-slice a
                                double-float
                                (1 (f2cl-lib:int-add i 1))
                                ((1 lda) (1 *)))

lda
(f2cl-lib:array-slice y double-float (1 i) ((1 ldy) (1 *)))
1 one
(f2cl-lib:array-slice y
                                double-float
                                ((+ i 1) i)
                                ((1 ldy) (1 *)))

1)
(dscal (f2cl-lib:int-sub n i)
(f2cl-lib:fref tauq-%data% (i) ((1 *)) tauq-%offset%)
(f2cl-lib:array-slice y
                                double-float
                                ((+ i 1) i)
                                ((1 ldy) (1 *)))

1)
(dgemv "No transpose" (f2cl-lib:int-sub n i) i (- one)
(f2cl-lib:array-slice y
                                double-float
                                ((+ i 1) 1)
                                ((1 ldy) (1 *)))

```

```

ldy
(f2cl-lib:array-slice a double-float (i 1) ((1 lda) (1 *)))
lda one
(f2cl-lib:array-slice a
  double-float
  (i (f2cl-lib:int-add i 1))
  ((1 lda) (1 *)))

lda)
(dgemv "Transpose" (f2cl-lib:int-sub i 1)
(f2cl-lib:int-sub n i) (- one)
(f2cl-lib:array-slice a
  double-float
  (1 (f2cl-lib:int-add i 1))
  ((1 lda) (1 *)))

lda
(f2cl-lib:array-slice x double-float (i 1) ((1 ldx) (1 *)))
ldx one
(f2cl-lib:array-slice a
  double-float
  (i (f2cl-lib:int-add i 1))
  ((1 lda) (1 *)))

lda)
(multiple-value-bind (var-0 var-1 var-2 var-3 var-4)
  (dlarfg (f2cl-lib:int-sub n i)
    (f2cl-lib:fref a-%data%
      (i (f2cl-lib:int-add i 1))
      ((1 lda) (1 *))
      a-%offset%)
    (f2cl-lib:array-slice a
      double-float
      (i
        (min
          (the fixnum
            (f2cl-lib:int-add i 2))
          (the fixnum n)))
      ((1 lda) (1 *)))
    lda
    (f2cl-lib:fref taup-%data% (i) ((1 *)) taup-%offset%))
  (declare (ignore var-0 var-2 var-3))
  (setf (f2cl-lib:fref a-%data%
    (i (f2cl-lib:int-add i 1))
    ((1 lda) (1 *))
    a-%offset%)
    var-1)
  (setf (f2cl-lib:fref taup-%data% (i) ((1 *)) taup-%offset%)
    var-4))

```

```

(setf (f2cl-lib:fref e-%data% (i) ((1 *)) e-%offset%)
      (f2cl-lib:fref a-%data%
                      (i (f2cl-lib:int-add i 1))
                      ((1 lda) (1 *))
                      a-%offset%))
(setf (f2cl-lib:fref a-%data%
                      (i (f2cl-lib:int-add i 1))
                      ((1 lda) (1 *))
                      a-%offset%))

one)
(dgemv "No transpose" (f2cl-lib:int-sub m i)
      (f2cl-lib:int-sub n i) one
      (f2cl-lib:array-slice a
                             double-float
                             ((+ i 1) (f2cl-lib:int-add i 1))
                             ((1 lda) (1 *)))

lda
(f2cl-lib:array-slice a
                       double-float
                       (i (f2cl-lib:int-add i 1))
                       ((1 lda) (1 *)))

lda zero
(f2cl-lib:array-slice x
                       double-float
                       ((+ i 1) i)
                       ((1 ldx) (1 *)))

1)
(dgemv "Transpose" (f2cl-lib:int-sub n i) i one
      (f2cl-lib:array-slice y
                             double-float
                             ((+ i 1) 1)
                             ((1 ldy) (1 *)))

ldy
(f2cl-lib:array-slice a
                       double-float
                       (i (f2cl-lib:int-add i 1))
                       ((1 lda) (1 *)))

lda zero
(f2cl-lib:array-slice x double-float (1 i) ((1 ldx) (1 *)))
1)
(dgemv "No transpose" (f2cl-lib:int-sub m i) i (- one)
      (f2cl-lib:array-slice a
                             double-float
                             ((+ i 1) 1)
                             ((1 lda) (1 *)))

lda

```

```

(f2cl-lib:array-slice x double-float (1 i) ((1 ldx) (1 *)))
1 one
(f2cl-lib:array-slice x
  double-float
  ((+ i 1) i)
  ((1 ldx) (1 *)))
1)
(dgemv "No transpose" (f2cl-lib:int-sub i 1)
  (f2cl-lib:int-sub n i) one
  (f2cl-lib:array-slice a
    double-float
    (1 (f2cl-lib:int-add i 1))
    ((1 lda) (1 *)))
lda
(f2cl-lib:array-slice a
  double-float
  (i (f2cl-lib:int-add i 1))
  ((1 lda) (1 *)))
lda zero
(f2cl-lib:array-slice x double-float (1 i) ((1 ldx) (1 *)))
1)
(dgemv "No transpose" (f2cl-lib:int-sub m i)
  (f2cl-lib:int-sub i 1) (- one)
  (f2cl-lib:array-slice x
    double-float
    ((+ i 1) 1)
    ((1 ldx) (1 *)))
ldx
(f2cl-lib:array-slice x double-float (1 i) ((1 ldx) (1 *)))
1 one
(f2cl-lib:array-slice x
  double-float
  ((+ i 1) i)
  ((1 ldx) (1 *)))
1)
(dscal (f2cl-lib:int-sub m i)
  (f2cl-lib:fref taup-%data% (i) ((1 *)) taup-%offset%)
  (f2cl-lib:array-slice x
    double-float
    ((+ i 1) i)
    ((1 ldx) (1 *)))
1))))))
(t
  (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
    ((> i nb) nil)
  (tagbody

```

```

(dgemv "No transpose"
  (f2cl-lib:int-add (f2cl-lib:int-sub n i) 1)
  (f2cl-lib:int-sub i 1) (- one)
  (f2cl-lib:array-slice y double-float (i 1) ((1 ldy) (1 *))) ldy
  (f2cl-lib:array-slice a double-float (i 1) ((1 lda) (1 *))) lda
  one (f2cl-lib:array-slice a double-float (i i) ((1 lda) (1 *)))
  lda)
(dgemv "Transpose" (f2cl-lib:int-sub i 1)
  (f2cl-lib:int-add (f2cl-lib:int-sub n i) 1) (- one)
  (f2cl-lib:array-slice a double-float (1 i) ((1 lda) (1 *))) lda
  (f2cl-lib:array-slice x double-float (i 1) ((1 ldx) (1 *))) ldx
  one (f2cl-lib:array-slice a double-float (i i) ((1 lda) (1 *)))
  lda)
(multiple-value-bind (var-0 var-1 var-2 var-3 var-4)
  (dlarfg (f2cl-lib:int-add (f2cl-lib:int-sub n i) 1)
    (f2cl-lib:fref a-%data% (i i) ((1 lda) (1 *)) a-%offset%)
    (f2cl-lib:array-slice a
      double-float
      (i
        (min
          (the fixnum
            (f2cl-lib:int-add i 1))
          (the fixnum n)))
        ((1 lda) (1 *)))
      lda (f2cl-lib:fref taup-%data% (i) ((1 *) taup-%offset%))
    (declare (ignore var-0 var-2 var-3))
    (setf (f2cl-lib:fref a-%data%
      (i i)
      ((1 lda) (1 *))
      a-%offset%)
      var-1)
    (setf (f2cl-lib:fref taup-%data% (i) ((1 *) taup-%offset%)
      var-4))
    (setf (f2cl-lib:fref d-%data% (i) ((1 *) d-%offset%)
      (f2cl-lib:fref a-%data%
        (i i)
        ((1 lda) (1 *))
        a-%offset%))
      var-1)
    (cond
      ((< i m)
        (setf (f2cl-lib:fref a-%data%
          (i i)
          ((1 lda) (1 *))
          a-%offset%)
          one)
        (dgemv "No transpose" (f2cl-lib:int-sub m i)

```



```

(f2cl-lib:int-add (f2cl-lib:int-sub n i) 1) one
(f2cl-lib:array-slice a
  double-float
  ((+ i 1) i)
  ((1 lda) (1 *)))

lda
(f2cl-lib:array-slice a double-float (i i) ((1 lda) (1 *)))
lda zero
(f2cl-lib:array-slice x
  double-float
  ((+ i 1) i)
  ((1 ldx) (1 *)))

1)
(dgemv "Transpose"
  (f2cl-lib:int-add (f2cl-lib:int-sub n i) 1)
  (f2cl-lib:int-sub i 1) one
  (f2cl-lib:array-slice y double-float (i 1) ((1 ldy) (1 *)))
  ldy
  (f2cl-lib:array-slice a double-float (i i) ((1 lda) (1 *)))
  lda zero
  (f2cl-lib:array-slice x double-float (1 i) ((1 ldx) (1 *)))
  1)
(dgemv "No transpose" (f2cl-lib:int-sub m i)
  (f2cl-lib:int-sub i 1) (- one)
  (f2cl-lib:array-slice a
    double-float
    ((+ i 1) 1)
    ((1 lda) (1 *)))

lda
(f2cl-lib:array-slice x double-float (1 i) ((1 ldx) (1 *)))
1 one
(f2cl-lib:array-slice x
  double-float
  ((+ i 1) i)
  ((1 ldx) (1 *)))

1)
(dgemv "No transpose" (f2cl-lib:int-sub i 1)
  (f2cl-lib:int-add (f2cl-lib:int-sub n i) 1) one
  (f2cl-lib:array-slice a double-float (1 i) ((1 lda) (1 *)))
  lda
  (f2cl-lib:array-slice a double-float (i i) ((1 lda) (1 *)))
  lda zero
  (f2cl-lib:array-slice x double-float (1 i) ((1 ldx) (1 *)))
  1)
(dgemv "No transpose" (f2cl-lib:int-sub m i)
  (f2cl-lib:int-sub i 1) (- one)

```

```

(f2cl-lib:array-slice x
  double-float
  ((+ i 1) 1)
  ((1 ldx) (1 *)))

ldx
(f2cl-lib:array-slice x double-float (1 i) ((1 ldx) (1 *)))
1 one
(f2cl-lib:array-slice x
  double-float
  ((+ i 1) i)
  ((1 ldx) (1 *)))

1)
(dscal (f2cl-lib:int-sub m i)
  (f2cl-lib:fref taup-%data% (i) ((1 *)) taup-%offset%)
  (f2cl-lib:array-slice x
    double-float
    ((+ i 1) i)
    ((1 ldx) (1 *)))

1)
(dgemv "No transpose" (f2cl-lib:int-sub m i)
  (f2cl-lib:int-sub i 1) (- one)
  (f2cl-lib:array-slice a
    double-float
    ((+ i 1) 1)
    ((1 lda) (1 *)))

lda
(f2cl-lib:array-slice y double-float (i 1) ((1 ldy) (1 *)))
ldy one
(f2cl-lib:array-slice a
  double-float
  ((+ i 1) i)
  ((1 lda) (1 *)))

1)
(dgemv "No transpose" (f2cl-lib:int-sub m i) i (- one)
  (f2cl-lib:array-slice x
    double-float
    ((+ i 1) 1)
    ((1 ldx) (1 *)))

ldx
(f2cl-lib:array-slice a double-float (1 i) ((1 lda) (1 *)))
1 one
(f2cl-lib:array-slice a
  double-float
  ((+ i 1) i)
  ((1 lda) (1 *)))

1)

```

```

(multiple-value-bind (var-0 var-1 var-2 var-3 var-4)
  (dlarf (f2cl-lib:int-sub m i)
    (f2cl-lib:fref a-%data%
      ((f2cl-lib:int-add i 1) i)
      ((1 lda) (1 *)))
    a-%offset%)
  (f2cl-lib:array-slice a
    double-float
    ((min (f2cl-lib:int-add i 2) m) i)
    ((1 lda) (1 *)))
  1 (f2cl-lib:fref tauq-%data% (i) ((1 *)) tauq-%offset%))
(declare (ignore var-0 var-2 var-3))
(setf (f2cl-lib:fref a-%data%
  ((f2cl-lib:int-add i 1) i)
  ((1 lda) (1 *)))
  a-%offset%)

  var-1)
(setf (f2cl-lib:fref tauq-%data% (i) ((1 *)) tauq-%offset%)
  var-4))
(setf (f2cl-lib:fref e-%data% (i) ((1 *)) e-%offset%)
  (f2cl-lib:fref a-%data%
    ((f2cl-lib:int-add i 1) i)
    ((1 lda) (1 *)))
    a-%offset%))
(setf (f2cl-lib:fref a-%data%
  ((f2cl-lib:int-add i 1) i)
  ((1 lda) (1 *)))
  a-%offset%)

  one)
(dgemv "Transpose" (f2cl-lib:int-sub m i)
  (f2cl-lib:int-sub n i) one
  (f2cl-lib:array-slice a
    double-float
    ((+ i 1) (f2cl-lib:int-add i 1))
    ((1 lda) (1 *)))

lda
(f2cl-lib:array-slice a
  double-float
  ((+ i 1) i)
  ((1 lda) (1 *)))

1 zero
(f2cl-lib:array-slice y
  double-float
  ((+ i 1) i)
  ((1 ldy) (1 *)))

1)

```

```

(dgemv "Transpose" (f2cl-lib:int-sub m i)
 (f2cl-lib:int-sub i 1) one
 (f2cl-lib:array-slice a
  double-float
  ((+ i 1) 1)
  ((1 lda) (1 *)))

lda
(f2cl-lib:array-slice a
 double-float
 ((+ i 1) i)
 ((1 lda) (1 *)))

1 zero
(f2cl-lib:array-slice y double-float (1 i) ((1 ldy) (1 *)))
1)
(dgemv "No transpose" (f2cl-lib:int-sub n i)
 (f2cl-lib:int-sub i 1) (- one)
 (f2cl-lib:array-slice y
  double-float
  ((+ i 1) 1)
  ((1 ldy) (1 *)))

ldy
(f2cl-lib:array-slice y double-float (1 i) ((1 ldy) (1 *)))
1 one
(f2cl-lib:array-slice y
 double-float
 ((+ i 1) i)
 ((1 ldy) (1 *)))

1)
(dgemv "Transpose" (f2cl-lib:int-sub m i) i one
 (f2cl-lib:array-slice x
  double-float
  ((+ i 1) 1)
  ((1 ldx) (1 *)))

ldx
(f2cl-lib:array-slice a
 double-float
 ((+ i 1) i)
 ((1 lda) (1 *)))

1 zero
(f2cl-lib:array-slice y double-float (1 i) ((1 ldy) (1 *)))
1)
(dgemv "Transpose" i (f2cl-lib:int-sub n i) (- one)
 (f2cl-lib:array-slice a
  double-float
  (1 (f2cl-lib:int-add i 1))
  ((1 lda) (1 *)))

```

```

lda
(f2cl-lib:array-slice y double-float (1 i) ((1 ldy) (1 *)))
1 one
(f2cl-lib:array-slice y
double-float
((+ i 1) i)
((1 ldy) (1 *)))
1)
(dscal (f2cl-lib:int-sub n i)
(f2cl-lib:fref tauq-%data% (i) ((1 *)) tauq-%offset%)
(f2cl-lib:array-slice y
double-float
((+ i 1) i)
((1 ldy) (1 *)))
1))))))
end_label
(return
(values nil nil nil nil nil nil nil nil nil nil nil nil))))))

```

## 7.25 dlacon LAPACK

```

⟨dlacon.input⟩≡
)set break resume
)sys rm -f dlacon.output
)spool dlacon.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)

```

`<dlacon.help>=`

```
=====
dlacon examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

DLACON - the 1-norm of a square, real matrix A

#### SYNOPSIS

```
SUBROUTINE DLACON( N, V, X, ISGN, EST, KASE )
```

```

      INTEGER          KASE, N

      DOUBLE           PRECISION EST

      INTEGER          ISGN( * )

      DOUBLE           PRECISION V( * ), X( * )
```

#### PURPOSE

DLACON estimates the 1-norm of a square, real matrix A. Reverse communication is used for evaluating matrix-vector products.

#### ARGUMENTS

**N** (input) INTEGER  
The order of the matrix.  $N \geq 1$ .

**V** (workspace) DOUBLE PRECISION array, dimension (N)  
On the final return,  $V = A*W$ , where  $EST = \text{norm}(V)/\text{norm}(W)$  (W is not returned).

**X** (input/output) DOUBLE PRECISION array, dimension (N)  
On an intermediate return, X should be overwritten by  $A * X$ , if  $KASE=1$ ,  $A' * X$ , if  $KASE=2$ , and DLACON must be re-called with all the other parameters unchanged.

**ISGN** (workspace) INTEGER array, dimension (N)

**EST** (input/output) DOUBLE PRECISION  
On entry with  $KASE = 1$  or  $2$  and  $JUMP = 3$ , EST should be unchanged from the previous call to DLACON. On exit, EST is an

estimate (a lower bound) for  $\text{norm}(A)$ .

KASE (input/output) INTEGER

On the initial call to DLACON, KASE should be 0. On an intermediate return, KASE will be 1 or 2, indicating whether  $X$  should be overwritten by  $A * X$  or  $A' * X$ . On the final return from DLACON, KASE will again be 0.

#### FURTHER DETAILS

Reference: N.J. Higham, "FORTRAN codes for estimating the one-norm of a real or complex matrix, with applications to condition estimation", ACM Trans. Math. Soft., vol. 14, no. 4, pp. 381-396, December 1988.

```

(LAPACK dlacon)=
  (let* ((itmax 5) (zero 0.0) (one 1.0) (two 2.0))
    (declare (type (fixnum 5 5) itmax)
              (type (double-float 0.0 0.0) zero)
              (type (double-float 1.0 1.0) one)
              (type (double-float 2.0 2.0) two))
    (let ((altsgn 0.0)
          (estold 0.0)
          (temp 0.0)
          (i 0)
          (iter 0)
          (j 0)
          (jlast 0)
          (jump 0))
      (declare (type fixnum itmax jump jlast j iter i)
                (type (double-float) two one zero temp estold altsgn))
      (defun dlacon (n v x isgn est kase)
        (declare (type (double-float) est)
                  (type (simple-array fixnum (*)) isgn)
                  (type (simple-array double-float (*)) x v)
                  (type fixnum kase n))
        (f2cl-lib:with-multi-array-data
          ((v double-float v-%data% v-%offset%)
           (x double-float x-%data% x-%offset%)
           (isgn fixnum isgn-%data% isgn-%offset%))
          (prog ()
            (declare)
            (cond
              ((= kase 0)
               (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                             ((> i n) nil)
               (tagbody
                 (setf (f2cl-lib:fref x-%data% (i) ((1 *)) x-%offset%)
                       (/ one (coerce (realpart n) 'double-float))))
                 (setf kase 1)
                 (setf jump 1)
                 (go end_label)))
              (f2cl-lib:computed-goto (label20 label40 label70 label110 label140)
                                     jump)
            label20
            (cond
              ((= n 1)
               (setf (f2cl-lib:fref v-%data% (1) ((1 *)) v-%offset%)
                     (f2cl-lib:fref x-%data% (1) ((1 *)) x-%offset%))
               (setf est (abs (f2cl-lib:fref v-%data% (1) ((1 *)) v-%offset%)))
               (go label150)))
            label150
          )
      )
    )

```



```

(setf est (dasum n x 1))
(f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
  ((> i n) nil)
  (tagbody
    (setf (f2cl-lib:fref x-%data% (i) ((1 *)) x-%offset%)
      (f2cl-lib:sign one
        (f2cl-lib:fref x-%data%
          (i)
          ((1 *))
          x-%offset%)))
    (setf (f2cl-lib:fref isgn-%data% (i) ((1 *)) isgn-%offset%)
      (values (round
        (f2cl-lib:fref x-%data% (i) ((1 *)) x-%offset%))))))
(setf kase 2)
(setf jump 2)
(go end_label)
label140
(setf j (idamax n x 1))
(setf iter 2)
label150
(f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
  ((> i n) nil)
  (tagbody
    (setf (f2cl-lib:fref x-%data% (i) ((1 *)) x-%offset%) zero)))
(setf (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%) one)
(setf kase 1)
(setf jump 3)
(go end_label)
label170
(dcopy n x 1 v 1)
(setf estold est)
(setf est (dasum n v 1))
(f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
  ((> i n) nil)
  (tagbody
    (if
      (/=
        (values (round
          (f2cl-lib:sign one
            (f2cl-lib:fref x-%data%
              (i)
              ((1 *))
              x-%offset%))))
          (f2cl-lib:fref isgn-%data% (i) ((1 *)) isgn-%offset%)))
      (go label90))))
(go label120)

```

```

label190
  (if (<= est estold) (go label120))
  (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
    ((> i n) nil)
    (tagbody
      (setf (f2cl-lib:fref x-%data% (i) ((1 *)) x-%offset%)
        (f2cl-lib:sign one
          (f2cl-lib:fref x-%data%
            (i)
            ((1 *))
            x-%offset%)))
      (setf (f2cl-lib:fref isgn-%data% (i) ((1 *)) isgn-%offset%)
        (values (round
          (f2cl-lib:fref x-%data% (i) ((1 *)) x-%offset%))))))
  (setf kase 2)
  (setf jump 4)
  (go end_label)
label1110
  (setf jlast j)
  (setf j (idamax n x 1))
  (cond
    ((and
      (/= (f2cl-lib:fref x (jlast) ((1 *)))
        (abs (f2cl-lib:fref x (j) ((1 *))))
      (< iter itmax))
      (setf iter (f2cl-lib:int-add iter 1))
      (go label150)))
label1120
  (setf altsgn one)
  (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
    ((> i n) nil)
    (tagbody
      (setf (f2cl-lib:fref x-%data% (i) ((1 *)) x-%offset%)
        (* altsgn
          (+ one
            (/
              (coerce (realpart (f2cl-lib:int-sub i 1)) 'double-float)
              (coerce (realpart (f2cl-lib:int-sub n 1)) 'double-float)))))
        (setf altsgn (- altsgn))))
  (setf kase 1)
  (setf jump 5)
  (go end_label)
label1140
  (setf temp
    (* two
      (/ (dasum n x 1)

```

```

        (coerce (realpart (f2cl-lib:int-mul 3 n)) 'double-float))))
    (cond
      ((> temp est)
       (dcopy n x 1 v 1)
       (setf est temp)))
    label150
      (setf kase 0)
    end_label
      (return (values nil nil nil nil est kase))))))

```

## 7.26 dlacpy LAPACK

```

⟨dlacpy.input⟩≡
)set break resume
)sys rm -f dlacpy.output
)spool dlacpy.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)

```

`<dlacpy.help>=`

```
=====
dlacpy examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

DLACPY - all or part of a two-dimensional matrix A to another matrix B

#### SYNOPSIS

```
SUBROUTINE DLACPY( UPLO, M, N, A, LDA, B, LDB )
```

```
      CHARACTER      UPLO
```

```
      INTEGER        LDA, LDB, M, N
```

```
      DOUBLE         PRECISION A( LDA, * ), B( LDB, * )
```

#### PURPOSE

DLACPY copies all or part of a two-dimensional matrix A to another matrix B.

#### ARGUMENTS

```
UPLO    (input) CHARACTER*1
         Specifies the part of the matrix A to be copied to B.   = 'U':
         Upper triangular part
         = 'L':          Lower triangular part
         Otherwise:     All of the matrix A

M        (input) INTEGER
         The number of rows of the matrix A.  M >= 0.

N        (input) INTEGER
         The number of columns of the matrix A.  N >= 0.

A        (input) DOUBLE PRECISION array, dimension (LDA,N)
         The m by n matrix A.  If UPLO = 'U', only the upper triangle or
         trapezoid is accessed; if UPLO = 'L', only the lower triangle
         or trapezoid is accessed.

LDA      (input) INTEGER
         The leading dimension of the array A.  LDA >= max(1,M).
```

B            (output) DOUBLE PRECISION array, dimension (LDB,N)  
On exit, B = A in the locations specified by UPLO.

LDB          (input) INTEGER  
The leading dimension of the array B.  $LDB \geq \max(1,M)$ .

[illegible]

```

(f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
  (> j n) nil)
(tagbody
  (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
    (> i m) nil)
  (tagbody
    (setf (f2cl-lib:fref b-%data%
      (i j)
      ((1 ldb$) (1 *))
      b-%offset%)
      (f2cl-lib:fref a-%data%
        (i j)
        ((1 lda) (1 *))
        a-%offset%))))))
end_label
(return (values nil nil nil nil nil nil nil)))

```

## 7.27 dladiv LAPACK

```

<dladiv.input>≡
)set break resume
)sys rm -f dladiv.output
)spool dladiv.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)

```

`<dladiv.help>`≡

```
=====
dladiv examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

```
DLADIV - complex division in real arithmetic  a + i*b  p + i*q =
-----  c + i*d  The algorithm is due to Robert L
```

#### SYNOPSIS

```
SUBROUTINE DLADIV( A, B, C, D, P, Q )
```

```
DOUBLE          PRECISION A, B, C, D, P, Q
```

#### PURPOSE

DLADIV performs complex division in real arithmetic in D. Knuth, The art of Computer Programming, Vol.2, p.195

#### ARGUMENTS

```
A      (input) DOUBLE PRECISION
B      (input) DOUBLE PRECISION C      (input) DOUBLE PRECI-
SION D      (input) DOUBLE PRECISION The scalars a, b, c,  and
d in the above expression.

P      (output) DOUBLE PRECISION
Q      (output) DOUBLE PRECISION The scalars p and q in the
above expression.
```



```

⟨LAPACK dladiv⟩≡
  (defun dladiv (a b c d p q)
    (declare (type (double-float) q p d c b a))
    (prog ((e 0.0) (f 0.0))
      (declare (type (double-float) f e))
      (cond
        (((< (abs d) (abs c))
          (setf e (/ d c))
          (setf f (+ c (* d e)))
          (setf p (/ (+ a (* b e)) f))
          (setf q (/ (- b (* a e)) f)))
        (t
          (setf e (/ c d))
          (setf f (+ d (* c e)))
          (setf p (/ (+ b (* a e)) f))
          (setf q (/ (- (* b e) a) f))))
      (return (values nil nil nil nil p q))))

```

## 7.28 dlaed6 LAPACK

```

⟨dlaed6.input⟩≡
  )set break resume
  )sys rm -f dlaed6.output
  )spool dlaed6.output
  )set message test on
  )set message auto off
  )clear all

  )spool
  )lisp (bye)

```

$\langle dlaed6.help \rangle =$

```
=====
dlaed6 examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

DLAED6 - the positive or negative root (closest to the origin) of  $z(1)$   
 $z(2) z(3) f(x) = \rho + \frac{z(1)}{d(1)-x} + \frac{z(2)}{d(2)-x} + \frac{z(3)}{d(3)-x}$   
 It is assumed that if ORGATI = .true

#### SYNOPSIS

```
SUBROUTINE DLAED6( KNITER, ORGATI, RHO, D, Z, FINIT, TAU, INFO )
```

LOGICAL	ORGATI
INTEGER	INFO, KNITER
DOUBLE	PRECISION FINIT, RHO, TAU
DOUBLE	PRECISION D( 3 ), Z( 3 )

#### PURPOSE

DLAED6 computes the positive or negative root (closest to the origin) of

$$f(x) = \rho + \frac{z(1)}{d(1)-x} + \frac{z(2)}{d(2)-x} + \frac{z(3)}{d(3)-x}$$

otherwise it is between d(1) and d(2)

This routine will be called by DLAED4 when necessary. In most cases, the root sought is the smallest in magnitude, though it might not be in some extremely rare situations.

#### ARGUMENTS

KNITER	(input) INTEGER Refer to DLAED4 for its significance.
ORGATI	(input) LOGICAL If ORGATI is true, the needed root is between d(2) and d(3); otherwise it is between d(1) and d(2). See DLAED4 for further details.

RHO	(input) DOUBLE PRECISION Refer to the equation $f(x)$ above.
D	(input) DOUBLE PRECISION array, dimension (3) D satisfies $d(1) < d(2) < d(3)$ .
Z	(input) DOUBLE PRECISION array, dimension (3) Each of the elements in $z$ must be positive.
FINIT	(input) DOUBLE PRECISION The value of $f$ at 0. It is more accurate than the one evaluated inside this routine (if someone wants to do so).
TAU	(output) DOUBLE PRECISION The root of the equation $f(x)$ .
INFO	(output) INTEGER = 0: successful exit > 0: if INFO = 1, failure to converge

```

(LAPACK dlaed6)=
  (let* ((maxit 20)
        (zero 0.0)
        (one 1.0)
        (two 2.0)
        (three 3.0)
        (four 4.0)
        (eight 8.0))
    (declare (type (fixnum 20 20) maxit)
              (type (double-float 0.0 0.0) zero)
              (type (double-float 1.0 1.0) one)
              (type (double-float 2.0 2.0) two)
              (type (double-float 3.0 3.0) three)
              (type (double-float 4.0 4.0) four)
              (type (double-float 8.0 8.0) eight))
    (let ((small1 0.0)
          (sminv1 0.0)
          (small2 0.0)
          (sminv2 0.0)
          (eps 0.0)
          (first$ nil))
      (declare (type (member t nil) first$)
                (type (double-float) eps sminv2 small2 sminv1 small1))
      (setq first$ t)
      (defun dlaed6 (kniter orgati rho d z finit tau info)
        (declare (type (simple-array double-float (*)) z d)
                  (type (double-float) tau finit rho)
                  (type (member t nil) orgati)
                  (type fixnum info kniter))
        (f2cl-lib:with-multi-array-data
          ((d double-float d-%data% d-%offset%)
           (z double-float z-%data% z-%offset%))
          (prog ((a 0.0) (b 0.0) (base 0.0) (c 0.0) (ddf 0.0) (df 0.0)
                 (erretm 0.0) (eta 0.0) (f 0.0) (fc 0.0) (sclfac 0.0)
                 (sclinv 0.0) (temp 0.0) (temp1 0.0) (temp2 0.0) (temp3 0.0)
                 (temp4 0.0) (i 0) (iter 0) (niter 0) (scale nil)
                 (dscale (make-array 3 :element-type 'double-float))
                 (zscale (make-array 3 :element-type 'double-float)))
            (declare (type (double-float) a b base c ddf df erretm eta f fc
                           sclfac sclinv temp temp1 temp2 temp3
                           temp4)
                      (type fixnum i iter niter)
                      (type (member t nil) scale)
                      (type (simple-array double-float (3)) dscale zscale))
            (setf info 0)
            (setf niter 1)

```

```

(setf tau zero)
(cond
  ((= kniter 2)
    (cond
      (orgati
        (setf temp
          (/
            (- (f2cl-lib:fref d-%data% (3) ((1 3)) d-%offset%)
              (f2cl-lib:fref d-%data% (2) ((1 3)) d-%offset%))
            two))
        (setf c
          (+ rho
            (/ (f2cl-lib:fref z-%data% (1) ((1 3)) z-%offset%)
              (-
                (f2cl-lib:fref d-%data% (1) ((1 3)) d-%offset%)
                (f2cl-lib:fref d-%data% (2) ((1 3)) d-%offset%)
                temp))))
        (setf a
          (+
            (* c
              (+ (f2cl-lib:fref d-%data% (2) ((1 3)) d-%offset%)
                (f2cl-lib:fref d-%data%
                  (3)
                  ((1 3))
                  d-%offset%)))
            (f2cl-lib:fref z-%data% (2) ((1 3)) z-%offset%)
            (f2cl-lib:fref z-%data% (3) ((1 3)) z-%offset%)))
        (setf b
          (+
            (* c
              (f2cl-lib:fref d-%data% (2) ((1 3)) d-%offset%)
              (f2cl-lib:fref d-%data% (3) ((1 3)) d-%offset%))
            (* (f2cl-lib:fref z-%data% (2) ((1 3)) z-%offset%)
              (f2cl-lib:fref d-%data% (3) ((1 3)) d-%offset%))
            (* (f2cl-lib:fref z-%data% (3) ((1 3)) z-%offset%)
              (f2cl-lib:fref d-%data% (2) ((1 3)) d-%offset%))))
        (t
          (setf temp
            (/
              (- (f2cl-lib:fref d-%data% (1) ((1 3)) d-%offset%)
                (f2cl-lib:fref d-%data% (2) ((1 3)) d-%offset%))
              two))
          (setf c
            (+ rho
              (/ (f2cl-lib:fref z-%data% (3) ((1 3)) z-%offset%)
                (-

```

```

(f2cl-lib:fref d-%data% (3) ((1 3)) d-%offset%)
(f2cl-lib:fref d-%data% (2) ((1 3)) d-%offset%)
temp))))
(setf a
  (+
    (* c
      (+ (f2cl-lib:fref d-%data% (1) ((1 3)) d-%offset%)
        (f2cl-lib:fref d-%data%
          (2)
          ((1 3))
          d-%offset%))))
    (f2cl-lib:fref z-%data% (1) ((1 3)) z-%offset%)
    (f2cl-lib:fref z-%data% (2) ((1 3)) z-%offset%)))
(setf b
  (+
    (* c
      (f2cl-lib:fref d-%data% (1) ((1 3)) d-%offset%)
      (f2cl-lib:fref d-%data% (2) ((1 3)) d-%offset%)
      (* (f2cl-lib:fref z-%data% (1) ((1 3)) z-%offset%)
        (f2cl-lib:fref d-%data% (2) ((1 3)) d-%offset%))
      (* (f2cl-lib:fref z-%data% (2) ((1 3)) z-%offset%)
        (f2cl-lib:fref d-%data% (1) ((1 3)) d-%offset%))))))
(setf temp (max (abs a) (abs b) (abs c)))
(setf a (/ a temp))
(setf b (/ b temp))
(setf c (/ c temp))
(cond
  ((= c zero)
    (setf tau (/ b a)))
  ((<= a zero)
    (setf tau
      (/
        (- a
          (f2cl-lib:fsqrt
            (abs (+ (* a a) (* (- four) b c)))))
        (* two c))))
  (t
    (setf tau
      (/ (* two b)
        (+ a
          (f2cl-lib:fsqrt
            (abs (+ (* a a) (* (- four) b c))))))))))
(setf temp
  (+ rho
    (/ (f2cl-lib:fref z-%data% (1) ((1 3)) z-%offset%)
      (- (f2cl-lib:fref d-%data% (1) ((1 3)) d-%offset%)

```

```

        tau))
      (/ (f2cl-lib:fref z-%data% (2) ((1 3)) z-%offset%)
        (- (f2cl-lib:fref d-%data% (2) ((1 3)) d-%offset%)
          tau))
      (/ (f2cl-lib:fref z-%data% (3) ((1 3)) z-%offset%)
        (- (f2cl-lib:fref d-%data% (3) ((1 3)) d-%offset%)
          tau))))
    (if (<= (abs finit) (abs temp)) (setf tau zero)))
(cond
  (first$
    (setf eps (dlamch "Epsilon"))
    (setf base (dlamch "Base"))
    (setf small1
      (expt base
        (f2cl-lib:int
          (/
            (/ (f2cl-lib:flog (dlamch "SafMin"))
              (f2cl-lib:flog base))
            three))))
    (setf sminv1 (/ one small1))
    (setf small2 (* small1 small1))
    (setf sminv2 (* sminv1 sminv1))
    (setf first$ nil)))
(cond
  (orgati
    (setf temp
      (min
        (abs
          (- (f2cl-lib:fref d-%data% (2) ((1 3)) d-%offset%) tau))
        (abs
          (- (f2cl-lib:fref d-%data% (3) ((1 3)) d-%offset%)
            tau))))))
  (t
    (setf temp
      (min
        (abs
          (- (f2cl-lib:fref d-%data% (1) ((1 3)) d-%offset%) tau))
        (abs
          (- (f2cl-lib:fref d-%data% (2) ((1 3)) d-%offset%)
            tau))))))
  (setf scale nil)
  (cond
    ((<= temp small1)
      (setf scale t)
      (cond
        ((<= temp small2)

```

```

      (setf sclfac sminv2)
      (setf sclinv small2))
    (t
      (setf sclfac sminv1)
      (setf sclinv small1)))
    (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
      ((> i 3) nil)
      (tagbody
        (setf (f2cl-lib:fref dscale (i) ((1 3)))
          (* (f2cl-lib:fref d-%data% (i) ((1 3)) d-%offset%)
            sclfac))
        (setf (f2cl-lib:fref zscale (i) ((1 3)))
          (* (f2cl-lib:fref z-%data% (i) ((1 3)) z-%offset%)
            sclfac))))
    (setf tau (* tau sclfac)))
  (t
    (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
      ((> i 3) nil)
      (tagbody
        (setf (f2cl-lib:fref dscale (i) ((1 3)))
          (f2cl-lib:fref d-%data% (i) ((1 3)) d-%offset%))
        (setf (f2cl-lib:fref zscale (i) ((1 3)))
          (f2cl-lib:fref z-%data% (i) ((1 3)) z-%offset%))))))
  (setf fc zero)
  (setf df zero)
  (setf ddf zero)
  (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
    ((> i 3) nil)
    (tagbody
      (setf temp (/ one (- (f2cl-lib:fref dscale (i) ((1 3))) tau)))
      (setf temp1 (* (f2cl-lib:fref zscale (i) ((1 3))) temp))
      (setf temp2 (* temp1 temp))
      (setf temp3 (* temp2 temp))
      (setf fc (+ fc (/ temp1 (f2cl-lib:fref dscale (i) ((1 3)))))
        (setf df (+ df temp2))
        (setf ddf (+ ddf temp3))))
    (setf f (+ finit (* tau fc)))
    (if (<= (abs f) zero) (go label60))
    (setf iter (f2cl-lib:int-add niter 1))
    (f2cl-lib:fdo (niter iter (f2cl-lib:int-add niter 1))
      ((> niter maxit) nil)
      (tagbody
        (cond
          (orgati
            (setf temp1 (- (f2cl-lib:fref dscale (2) ((1 3))) tau))
            (setf temp2 (- (f2cl-lib:fref dscale (3) ((1 3))) tau)))

```



```

(t
  (setf temp1 (- (f2cl-lib:fref dscale (1) ((1 3))) tau))
  (setf temp2 (- (f2cl-lib:fref dscale (2) ((1 3))) tau)))
(setf a (+ (* (+ temp1 temp2) f) (* (- temp1) temp2 df)))
(setf b (* temp1 temp2 f))
(setf c (+ (- f (* (+ temp1 temp2) df)) (* temp1 temp2 ddf)))
(setf temp (max (abs a) (abs b) (abs c)))
(setf a (/ a temp))
(setf b (/ b temp))
(setf c (/ c temp))
(cond
  ((= c zero)
   (setf eta (/ b a)))
  ((<= a zero)
   (setf eta
    (/
     (- a
      (f2cl-lib:fsqrt
       (abs (+ (* a a) (* (- four) b c)))))
     (* two c))))
(t
  (setf eta
   (/ (* two b)
      (+ a
       (f2cl-lib:fsqrt
        (abs (+ (* a a) (* (- four) b c))))))))
(cond
  ((>= (* f eta) zero)
   (setf eta (/ (- f) df))))
(setf temp (+ eta tau))
(cond
  (orgati
   (if
    (and (> eta zero)
         (>= temp (f2cl-lib:fref dscale (3) ((1 3)))))
    (setf eta (/ (- (f2cl-lib:fref dscale (3) ((1 3))) tau) two)))
   (if
    (and (< eta zero)
         (<= temp (f2cl-lib:fref dscale (2) ((1 3)))))
    (setf eta
     (/ (- (f2cl-lib:fref dscale (2) ((1 3))) tau) two))))
(t
  (if
   (and (> eta zero)
        (>= temp (f2cl-lib:fref dscale (2) ((1 3)))))
   (setf eta (/ (- (f2cl-lib:fref dscale (2) ((1 3))) tau) two)))

```

```

      (if
        (and (< eta zero)
              (<= temp (f2cl-lib:fref dscale (1) ((1 3)))))
        (setf eta
              (/ (- (f2cl-lib:fref dscale (1) ((1 3)) tau)
                    two))))
      (setf tau (+ tau eta))
      (setf fc zero)
      (setf erretm zero)
      (setf df zero)
      (setf ddf zero)
      (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                    ((> i 3) nil)
      (tagbody
        (setf temp
              (/ one (- (f2cl-lib:fref dscale (i) ((1 3)) tau)))
        (setf temp1 (* (f2cl-lib:fref zscale (i) ((1 3)) temp))
        (setf temp2 (* temp1 temp))
        (setf temp3 (* temp2 temp))
        (setf temp4 (/ temp1 (f2cl-lib:fref dscale (i) ((1 3)))))
        (setf fc (+ fc temp4))
        (setf erretm (+ erretm (abs temp4)))
        (setf df (+ df temp2))
        (setf ddf (+ ddf temp3)))
      (setf f (+ finit (* tau fc))
      (setf erretm
              (+ (* eight (+ (abs finit) (* (abs tau) erretm))
                  (* (abs tau) df)))
      (if (<= (abs f) (* eps erretm)) (go label60)))
      (setf info 1)
label60
      (if scale (setf tau (* tau sclinv)))
end_label
      (return (values nil nil nil nil nil nil tau info))))))

```

## 7.29 dlaexc LAPACK

```
<dlaexc.input>≡  
  )set break resume  
  )sys rm -f dlaexc.output  
  )spool dlaexc.output  
  )set message test on  
  )set message auto off  
  )clear all  
  
  )spool  
  )lisp (bye)
```

`<dlaexc.help>`≡

```
=====
dlaexc examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

DLAEXC - adjacent diagonal blocks T11 and T22 of order 1 or 2 in an upper quasi-triangular matrix T by an orthogonal similarity transformation

#### SYNOPSIS

```
SUBROUTINE DLAEXC( WANTQ, N, T, LDT, Q, LDQ, J1, N1, N2, WORK, INFO )
```

```
      LOGICAL      WANTQ
```

```
      INTEGER      INFO, J1, LDQ, LDT, N, N1, N2
```

```
      DOUBLE      PRECISION Q( LDQ, * ), T( LDT, * ), WORK( * )
```

#### PURPOSE

DLAEXC swaps adjacent diagonal blocks T11 and T22 of order 1 or 2 in an upper quasi-triangular matrix T by an orthogonal similarity transformation.

T must be in Schur canonical form, that is, block upper triangular with 1-by-1 and 2-by-2 diagonal blocks; each 2-by-2 diagonal block has its diagonal elements equal and its off-diagonal elements of opposite sign.

#### ARGUMENTS

WANTQ (input) LOGICAL  
 = .TRUE. : accumulate the transformation in the matrix Q;  
 = .FALSE.: do not accumulate the transformation.

N (input) INTEGER  
 The order of the matrix T. N >= 0.

T (input/output) DOUBLE PRECISION array, dimension (LDT,N)  
 On entry, the upper quasi-triangular matrix T, in Schur canonical form. On exit, the updated matrix T, again in Schur canonical form.

LDT      (input) INTEGER  
The leading dimension of the array T.  $LDT \geq \max(1, N)$ .

Q        (input/output) DOUBLE PRECISION array, dimension (LDQ,N)  
On entry, if WANTQ is .TRUE., the orthogonal matrix Q. On exit, if WANTQ is .TRUE., the updated matrix Q. If WANTQ is .FALSE., Q is not referenced.

LDQ      (input) INTEGER  
The leading dimension of the array Q.  $LDQ \geq 1$ ; and if WANTQ is .TRUE.,  $LDQ \geq N$ .

J1        (input) INTEGER  
The index of the first row of the first block T11.

N1        (input) INTEGER  
The order of the first block T11.  $N1 = 0, 1$  or  $2$ .

N2        (input) INTEGER  
The order of the second block T22.  $N2 = 0, 1$  or  $2$ .

WORK     (workspace) DOUBLE PRECISION array, dimension (N)

INFO      (output) INTEGER  
= 0: successful exit  
= 1: the transformed matrix T would be too far from Schur form; the blocks are not swapped and T and Q are unchanged.

```

(LAPACK dlaexc)≡
(let* ((zero 0.0) (one 1.0) (ten 10.0) (ldd 4) (ldx 2))
  (declare (type (double-float 0.0 0.0) zero)
            (type (double-float 1.0 1.0) one)
            (type (double-float 10.0 10.0) ten)
            (type (fixnum 4 4) ldd)
            (type (fixnum 2 2) ldx))
  (defun dlaexc (wantq n t$ ldt q ldq j1 n1 n2 work info)
    (declare (type (simple-array double-float (*)) work q t$)
              (type fixnum info n2 n1 j1 ldq ldt n)
              (type (member t nil) wantq))
    (f2cl-lib:with-multi-array-data
      ((t$ double-float t$-%data% t$-%offset%)
       (q double-float q-%data% q-%offset%)
       (work double-float work-%data% work-%offset%))
      (prog ((d
               (make-array (the fixnum (reduce #'* (list ldd 4)))
                           :element-type 'double-float))
              (u (make-array 3 :element-type 'double-float))
              (u1 (make-array 3 :element-type 'double-float))
              (u2 (make-array 3 :element-type 'double-float))
              (x
               (make-array (the fixnum (reduce #'* (list ldx 2)))
                           :element-type 'double-float))
              (cs 0.0) (dnorm 0.0) (eps 0.0) (scale 0.0) (smlnum 0.0) (sn 0.0)
              (t11 0.0) (t22 0.0) (t33 0.0) (tau 0.0) (tau1 0.0) (tau2 0.0)
              (temp 0.0) (thresh 0.0) (wi1 0.0) (wi2 0.0) (wr1 0.0) (wr2 0.0)
              (xnorm 0.0) (ierr 0) (j2 0) (j3 0) (j4 0) (k 0) (nd 0))
        (declare (type (simple-array double-float (3)) u u1 u2)
                  (type (simple-array double-float (*)) d x)
                  (type (double-float) cs dnorm eps scale smlnum sn t11 t22 t33
                        tau tau1 tau2 temp thresh wi1 wi2 wr1 wr2
                        xnorm)
                  (type fixnum ierr j2 j3 j4 k nd))
        (setf info 0)
        (if (or (= n 0) (= n1 0) (= n2 0)) (go end_label))
        (if (> (f2cl-lib:int-add j1 n1) n) (go end_label))
        (setf j2 (f2cl-lib:int-add j1 1))
        (setf j3 (f2cl-lib:int-add j1 2))
        (setf j4 (f2cl-lib:int-add j1 3))
        (cond
          ((and (= n1 1) (= n2 1))
           (setf t11
                 (f2cl-lib:fref t$-%data%
                                (j1 j1)
                                ((1 ldt) (1 *))

```

```

                                t$-%offset%))
(setf t22
  (f2cl-lib:fref t$-%data%
    (j2 j2)
    ((1 ldt) (1 *))
    t$-%offset%))
(multiple-value-bind (var-0 var-1 var-2 var-3 var-4)
  (dlartg
    (f2cl-lib:fref t$-%data% (j1 j2) ((1 ldt) (1 *)) t$-%offset%)
    (- t22 t11) cs sn temp)
  (declare (ignore var-0 var-1))
  (setf cs var-2)
  (setf sn var-3)
  (setf temp var-4))
(if (<= j3 n)
  (drot (f2cl-lib:int-sub n j1 1)
    (f2cl-lib:array-slice t$ double-float (j1 j3) ((1 ldt) (1 *)))
    ldt
    (f2cl-lib:array-slice t$ double-float (j2 j3) ((1 ldt) (1 *)))
    ldt cs sn))
(drot (f2cl-lib:int-sub j1 1)
  (f2cl-lib:array-slice t$ double-float (1 j1) ((1 ldt) (1 *))) 1
  (f2cl-lib:array-slice t$ double-float (1 j2) ((1 ldt) (1 *))) 1 cs
  sn)
(setf (f2cl-lib:fref t$-%data% (j1 j1) ((1 ldt) (1 *)) t$-%offset%)
  t22)
(setf (f2cl-lib:fref t$-%data% (j2 j2) ((1 ldt) (1 *)) t$-%offset%)
  t11)
(cond
  (wantq
    (drot n
      (f2cl-lib:array-slice q double-float (1 j1) ((1 ldq) (1 *))) 1
      (f2cl-lib:array-slice q double-float (1 j2) ((1 ldq) (1 *))) 1
      cs sn))))
(t
  (tagbody
    (setf nd (f2cl-lib:int-add n1 n2))
    (dlacpy "Full" nd nd
      (f2cl-lib:array-slice t$ double-float (j1 j1) ((1 ldt) (1 *)))
      ldt d ldd)
    (setf dnorm (dlange "Max" nd nd d ldd work))
    (setf eps (dlamch "P"))
    (setf smlnum (/ (dlamch "S") eps))
    (setf thresh (max (* ten eps dnorm) smlnum))
    (multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9

```

```

        var-10 var-11 var-12 var-13 var-14 var-15)
(dlasy2 nil nil -1 n1 n2 d ldd
  (f2cl-lib:array-slice d
    double-float
    ((+ n1 1) (f2cl-lib:int-add n1 1))
    ((1 ldd) (1 4)))
  ldd
  (f2cl-lib:array-slice d
    double-float
    (1 (f2cl-lib:int-add n1 1))
    ((1 ldd) (1 4)))
  ldd scale x ldx xnorm ierr)
(declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
  var-8 var-9 var-10 var-12 var-13))
(setf scale var-11)
(setf xnorm var-14)
(setf ierr var-15))
(setf k (f2cl-lib:int-sub (f2cl-lib:int-add n1 n1 n2) 3))
(f2cl-lib:computed-goto (label10 label20 label30) k)

label10
(setf (f2cl-lib:fref u (1) ((1 3))) scale)
(setf (f2cl-lib:fref u (2) ((1 3)))
  (f2cl-lib:fref x (1 1) ((1 ldx) (1 2))))
(setf (f2cl-lib:fref u (3) ((1 3)))
  (f2cl-lib:fref x (1 2) ((1 ldx) (1 2))))
(multiple-value-bind (var-0 var-1 var-2 var-3 var-4)
  (dlarfg 3 (f2cl-lib:fref u (3) ((1 3))) u 1 tau)
  (declare (ignore var-0 var-2 var-3))
  (setf (f2cl-lib:fref u (3) ((1 3))) var-1)
  (setf tau var-4))
(setf (f2cl-lib:fref u (3) ((1 3))) one)
(setf t11
  (f2cl-lib:fref t$-%data%
    (j1 j1)
    ((1 ldt) (1 *))
    t$-%offset%))
(dlarfx "L" 3 3 u tau d ldd work)
(dlarfx "R" 3 3 u tau d ldd work)
(if
  (>
    (max (abs (f2cl-lib:fref d (3 1) ((1 ldd) (1 4))))
      (abs (f2cl-lib:fref d (3 2) ((1 ldd) (1 4))))
      (abs (- (f2cl-lib:fref d (3 3) ((1 ldd) (1 4))) t11)))
    thresh)
  (go label50))
(dlarfx "L" 3 (f2cl-lib:int-add (f2cl-lib:int-sub n j1) 1) u tau

```



```

(f2cl-lib:array-slice t$ double-float (j1 j1) ((1 ldt) (1 *)))
ldt work)
(dlarfx "R" j2 3 u tau
(f2cl-lib:array-slice t$ double-float (1 j1) ((1 ldt) (1 *))) ldt
work)
(setf (f2cl-lib:fref t$-%data%
                    (j3 j1)
                    ((1 ldt) (1 *)))
      t$-%offset%)
      zero)
(setf (f2cl-lib:fref t$-%data%
                    (j3 j2)
                    ((1 ldt) (1 *)))
      t$-%offset%)
      zero)
(setf (f2cl-lib:fref t$-%data%
                    (j3 j3)
                    ((1 ldt) (1 *)))
      t$-%offset%)
      t11)
(cond
 (wantq
  (dlarfx "R" n 3 u tau
    (f2cl-lib:array-slice q double-float (1 j1) ((1 ldq) (1 *)))
    ldq work)))
(go label40)

label120
(setf (f2cl-lib:fref u (1) ((1 3)))
      (- (f2cl-lib:fref x (1 1) ((1 ldx) (1 2)))))
(setf (f2cl-lib:fref u (2) ((1 3)))
      (- (f2cl-lib:fref x (2 1) ((1 ldx) (1 2)))))
(setf (f2cl-lib:fref u (3) ((1 3))) scale)
(multiple-value-bind (var-0 var-1 var-2 var-3 var-4)
  (dlarfg 3 (f2cl-lib:fref u (1) ((1 3)))
    (f2cl-lib:array-slice u double-float (2) ((1 3))) 1 tau)
  (declare (ignore var-0 var-2 var-3))
  (setf (f2cl-lib:fref u (1) ((1 3))) var-1)
  (setf tau var-4))
(setf (f2cl-lib:fref u (1) ((1 3))) one)
(setf t33
  (f2cl-lib:fref t$-%data%
                (j3 j3)
                ((1 ldt) (1 *)))
  t$-%offset%)
(dlarfx "L" 3 3 u tau d ldd work)
(dlarfx "R" 3 3 u tau d ldd work)

```

```

(if
  (>
    (max (abs (f2cl-lib:fref d (2 1) ((1 ldd) (1 4))))
      (abs (f2cl-lib:fref d (3 1) ((1 ldd) (1 4))))
      (abs (- (f2cl-lib:fref d (1 1) ((1 ldd) (1 4))) t33)))
    thresh)
  (go label50))
(dlarfx "R" j3 3 u tau
  (f2cl-lib:array-slice t$ double-float (1 j1) ((1 ldt) (1 *))) ldt
  work)
(dlarfx "L" 3 (f2cl-lib:int-sub n j1) u tau
  (f2cl-lib:array-slice t$ double-float (j1 j2) ((1 ldt) (1 *)))
  ldt work)
(setf (f2cl-lib:fref t$-%data%
                    (j1 j1)
                    ((1 ldt) (1 *)))
      t$-%offset%)
      t33)
(setf (f2cl-lib:fref t$-%data%
                    (j2 j1)
                    ((1 ldt) (1 *)))
      t$-%offset%)
      zero)
(setf (f2cl-lib:fref t$-%data%
                    (j3 j1)
                    ((1 ldt) (1 *)))
      t$-%offset%)
      zero)
(cond
  (wantq
    (dlarfx "R" n 3 u tau
      (f2cl-lib:array-slice q double-float (1 j1) ((1 ldq) (1 *)))
      ldq work)))
  (go label40))
label30
(setf (f2cl-lib:fref u1 (1) ((1 3)))
      (- (f2cl-lib:fref x (1 1) ((1 ldx) (1 2)))))
(setf (f2cl-lib:fref u1 (2) ((1 3)))
      (- (f2cl-lib:fref x (2 1) ((1 ldx) (1 2)))))
(setf (f2cl-lib:fref u1 (3) ((1 3))) scale)
(multiple-value-bind (var-0 var-1 var-2 var-3 var-4)
  (dlarfg 3 (f2cl-lib:fref u1 (1) ((1 3)))
    (f2cl-lib:array-slice u1 double-float (2) ((1 3))) 1 tau1)
  (declare (ignore var-0 var-2 var-3))
  (setf (f2cl-lib:fref u1 (1) ((1 3))) var-1)
  (setf tau1 var-4))

```

```

(setf (f2cl-lib:fref u1 (1) ((1 3))) one)
(setf temp
  (* (- tau1)
    (+ (f2cl-lib:fref x (1 2) ((1 ldx) (1 2)))
      (* (f2cl-lib:fref u1 (2) ((1 3)))
        (f2cl-lib:fref x (2 2) ((1 ldx) (1 2)))))))
(setf (f2cl-lib:fref u2 (1) ((1 3)))
  (- (* (- temp) (f2cl-lib:fref u1 (2) ((1 3)))
    (f2cl-lib:fref x (2 2) ((1 ldx) (1 2)))))
(setf (f2cl-lib:fref u2 (2) ((1 3)))
  (* (- temp) (f2cl-lib:fref u1 (3) ((1 3)))))
(setf (f2cl-lib:fref u2 (3) ((1 3))) scale)
(multiple-value-bind (var-0 var-1 var-2 var-3 var-4)
  (dlarf3 (f2cl-lib:fref u2 (1) ((1 3)))
    (f2cl-lib:array-slice u2 double-float (2) ((1 3))) 1 tau2)
  (declare (ignore var-0 var-2 var-3))
  (setf (f2cl-lib:fref u2 (1) ((1 3))) var-1)
  (setf tau2 var-4))
(setf (f2cl-lib:fref u2 (1) ((1 3))) one)
(dlarfx "L" 3 4 u1 tau1 d ldd work)
(dlarfx "R" 4 3 u1 tau1 d ldd work)
(dlarfx "L" 3 4 u2 tau2
  (f2cl-lib:array-slice d double-float (2 1) ((1 ldd) (1 4))) ldd
  work)
(dlarfx "R" 4 3 u2 tau2
  (f2cl-lib:array-slice d double-float (1 2) ((1 ldd) (1 4))) ldd
  work)
(if
  (>
    (max (abs (f2cl-lib:fref d (3 1) ((1 ldd) (1 4))))
      (abs (f2cl-lib:fref d (3 2) ((1 ldd) (1 4))))
      (abs (f2cl-lib:fref d (4 1) ((1 ldd) (1 4))))
      (abs (f2cl-lib:fref d (4 2) ((1 ldd) (1 4)))))
    thresh)
  (go label50))
(dlarfx "L" 3 (f2cl-lib:int-add (f2cl-lib:int-sub n j1) 1) u1 tau1
  (f2cl-lib:array-slice t$ double-float (j1 j1) ((1 ldt) (1 *)))
  ldt work)
(dlarfx "R" j4 3 u1 tau1
  (f2cl-lib:array-slice t$ double-float (1 j1) ((1 ldt) (1 *))) ldt
  work)
(dlarfx "L" 3 (f2cl-lib:int-add (f2cl-lib:int-sub n j1) 1) u2 tau2
  (f2cl-lib:array-slice t$ double-float (j2 j1) ((1 ldt) (1 *)))
  ldt work)
(dlarfx "R" j4 3 u2 tau2
  (f2cl-lib:array-slice t$ double-float (1 j2) ((1 ldt) (1 *))) ldt

```

```

        work)
      (setf (f2cl-lib:fref t$-%data%
                        (j3 j1)
                        ((1 ldt) (1 *)))
            t$-%offset%)

        zero)
      (setf (f2cl-lib:fref t$-%data%
                        (j3 j2)
                        ((1 ldt) (1 *)))
            t$-%offset%)

        zero)
      (setf (f2cl-lib:fref t$-%data%
                        (j4 j1)
                        ((1 ldt) (1 *)))
            t$-%offset%)

        zero)
      (setf (f2cl-lib:fref t$-%data%
                        (j4 j2)
                        ((1 ldt) (1 *)))
            t$-%offset%)

        zero)
      (cond
        (wantq
         (dlarfx "R" n 3 u1 tau1
                  (f2cl-lib:array-slice q double-float (1 j1) ((1 ldq) (1 *)))
                  ldq work)
         (dlarfx "R" n 3 u2 tau2
                  (f2cl-lib:array-slice q double-float (1 j2) ((1 ldq) (1 *)))
                  ldq work)))
        label40
        (cond
          ((= n2 2)
           (multiple-value-bind
             (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
              var-9)
             (dlanv2
              (f2cl-lib:fref t$-%data%
                            (j1 j1)
                            ((1 ldt) (1 *)))
                            t$-%offset%)
              (f2cl-lib:fref t$-%data%
                            (j1 j2)
                            ((1 ldt) (1 *)))
                            t$-%offset%)
              (f2cl-lib:fref t$-%data%
                            (j2 j1)

```

```

((1 ldt) (1 *))
t$-%offset%)
(f2cl-lib:fref t$-%data%
(j2 j2)
((1 ldt) (1 *))
t$-%offset%)
wr1 wi1 wr2 wi2 cs sn)
(declare (ignore))
(setf (f2cl-lib:fref t$-%data%
(j1 j1)
((1 ldt) (1 *))
t$-%offset%)
var-0)
(setf (f2cl-lib:fref t$-%data%
(j1 j2)
((1 ldt) (1 *))
t$-%offset%)
var-1)
(setf (f2cl-lib:fref t$-%data%
(j2 j1)
((1 ldt) (1 *))
t$-%offset%)
var-2)
(setf (f2cl-lib:fref t$-%data%
(j2 j2)
((1 ldt) (1 *))
t$-%offset%)
var-3)
(setf wr1 var-4)
(setf wi1 var-5)
(setf wr2 var-6)
(setf wi2 var-7)
(setf cs var-8)
(setf sn var-9))
(drot (f2cl-lib:int-sub n j1 1)
(f2cl-lib:array-slice t$
double-float
(j1 (f2cl-lib:int-add j1 2))
((1 ldt) (1 *))))
ldt
(f2cl-lib:array-slice t$
double-float
(j2 (f2cl-lib:int-add j1 2))
((1 ldt) (1 *))))
ldt cs sn)
(drot (f2cl-lib:int-sub j1 1)

```

```

(f2cl-lib:array-slice t$ double-float (1 j1) ((1 ldt) (1 *)))
1
(f2cl-lib:array-slice t$ double-float (1 j2) ((1 ldt) (1 *)))
1 cs sn)
(if wantq
  (drot n
    (f2cl-lib:array-slice q
      double-float
      (1 j1)
      ((1 ldq) (1 *)))
    1
    (f2cl-lib:array-slice q
      double-float
      (1 j2)
      ((1 ldq) (1 *)))
    1 cs sn))))
(cond
  ((= n1 2)
    (setf j3 (f2cl-lib:int-add j1 n2))
    (setf j4 (f2cl-lib:int-add j3 1))
    (multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
       var-9)
      (dlanv2
        (f2cl-lib:fref t$-%data%
          (j3 j3)
          ((1 ldt) (1 *))
          t$-%offset%)
        (f2cl-lib:fref t$-%data%
          (j3 j4)
          ((1 ldt) (1 *))
          t$-%offset%)
        (f2cl-lib:fref t$-%data%
          (j4 j3)
          ((1 ldt) (1 *))
          t$-%offset%)
        (f2cl-lib:fref t$-%data%
          (j4 j4)
          ((1 ldt) (1 *))
          t$-%offset%)
        wr1 wi1 wr2 wi2 cs sn)
      (declare (ignore))
      (setf (f2cl-lib:fref t$-%data%
        (j3 j3)
        ((1 ldt) (1 *))
        t$-%offset%)

```

```

var-0)
(setf (f2cl-lib:fref t$-%data%
                    (j3 j4)
                    ((1 ldt) (1 *)))
      t$-%offset%)

var-1)
(setf (f2cl-lib:fref t$-%data%
                    (j4 j3)
                    ((1 ldt) (1 *)))
      t$-%offset%)

var-2)
(setf (f2cl-lib:fref t$-%data%
                    (j4 j4)
                    ((1 ldt) (1 *)))
      t$-%offset%)

var-3)
(setf wr1 var-4)
(setf wi1 var-5)
(setf wr2 var-6)
(setf wi2 var-7)
(setf cs var-8)
(setf sn var-9))
(if (<= (f2cl-lib:int-add j3 2) n)
    (drot (f2cl-lib:int-sub n j3 1)
          (f2cl-lib:array-slice t$
                                double-float
                                (j3 (f2cl-lib:int-add j3 2))
                                ((1 ldt) (1 *))))

    ldt
    (f2cl-lib:array-slice t$
                          double-float
                          (j4 (f2cl-lib:int-add j3 2))
                          ((1 ldt) (1 *)))

    ldt cs sn))
(drot (f2cl-lib:int-sub j3 1)
      (f2cl-lib:array-slice t$ double-float (1 j3) ((1 ldt) (1 *)))
      1
      (f2cl-lib:array-slice t$ double-float (1 j4) ((1 ldt) (1 *)))
      1 cs sn)
(if wantq
    (drot n
          (f2cl-lib:array-slice q
                                double-float
                                (1 j3)
                                ((1 ldq) (1 *)))

```

```

                                (f2cl-lib:array-slice q
                                double-float
                                (1 j4)
                                ((1 ldq) (1 *)))
                                1 cs sn))))))
      (go end_label)
label50
      (setf info 1)
end_label
      (return (values nil nil nil nil nil nil nil nil nil info))))))

```

### 7.30 dlahqr LAPACK

```

⟨dlahqr.input⟩≡
)set break resume
)sys rm -f dlahqr.output
)spool dlahqr.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)

```



`<dlahqr.help>`≡

```
=====
dlahqr examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

DLAHQR - An auxiliary routine called by DHSEQR to update the eigenvalues and Schur decomposition already computed by DHSEQR, by dealing with the Hessenberg submatrix in rows and columns ILO to IHI

#### SYNOPSIS

```
SUBROUTINE DLAHQR( WANTT, WANTZ, N, ILO, IHI, H, LDH, WR, WI, ILOZ,
                  IHIZ, Z, LDZ, INFO )
```

```
      INTEGER      IHI, IHIZ, ILO, ILOZ, INFO, LDH, LDZ, N
```

```
      LOGICAL      WANTT, WANTZ
```

```
      DOUBLE      PRECISION H( LDH, * ), WI( * ), WR( * ), Z( LDZ, * )
```

#### PURPOSE

DLAHQR is an auxiliary routine called by DHSEQR to update the eigenvalues and Schur decomposition already computed by DHSEQR, by dealing with the Hessenberg submatrix in rows and columns ILO to IHI.

#### ARGUMENTS

WANTT (input) LOGICAL  
 = .TRUE. : the full Schur form T is required;  
 = .FALSE.: only eigenvalues are required.

WANTZ (input) LOGICAL  
 = .TRUE. : the matrix of Schur vectors Z is required;  
 = .FALSE.: Schur vectors are not required.

N (input) INTEGER  
 The order of the matrix H. N >= 0.

ILO (input) INTEGER  
 IHI (input) INTEGER It is assumed that H is already upper quasi-triangular in rows and columns IHI+1:N, and that

$H(ILO, ILO-1) = 0$  (unless  $ILO = 1$ ). DLAHQRL works primarily with the Hessenberg submatrix in rows and columns  $ILO$  to  $IHI$ , but applies transformations to all of  $H$  if WANTT is .TRUE..  $1 \leq ILO \leq \max(1, IHI)$ ;  $IHI \leq N$ .

- H** (input/output) DOUBLE PRECISION array, dimension (LDH,N)  
On entry, the upper Hessenberg matrix  $H$ . On exit, if INFO is zero and if WANTT is .TRUE.,  $H$  is upper quasi-triangular in rows and columns  $ILO:IHI$ , with any 2-by-2 diagonal blocks in standard form. If INFO is zero and WANTT is .FALSE., the contents of  $H$  are unspecified on exit. The output state of  $H$  if INFO is nonzero is given below under the description of INFO.
- LDH** (input) INTEGER  
The leading dimension of the array  $H$ .  $LDH \geq \max(1, N)$ .
- WR** (output) DOUBLE PRECISION array, dimension (N)  
**WI** (output) DOUBLE PRECISION array, dimension (N) The real and imaginary parts, respectively, of the computed eigenvalues  $ILO$  to  $IHI$  are stored in the corresponding elements of  $WR$  and  $WI$ . If two eigenvalues are computed as a complex conjugate pair, they are stored in consecutive elements of  $WR$  and  $WI$ , say the  $i$ -th and  $(i+1)$ -th, with  $WI(i) > 0$  and  $WI(i+1) < 0$ . If WANTT is .TRUE., the eigenvalues are stored in the same order as on the diagonal of the Schur form returned in  $H$ , with  $WR(i) = H(i, i)$ , and, if  $H(i:i+1, i:i+1)$  is a 2-by-2 diagonal block,  $WI(i) = \sqrt{H(i+1, i) \cdot H(i, i+1)}$  and  $WI(i+1) = -WI(i)$ .
- ILOZ** (input) INTEGER  
**IHI** (input) INTEGER Specify the rows of  $Z$  to which transformations must be applied if WANTZ is .TRUE..  $1 \leq ILOZ \leq ILO$ ;  $IHI \leq IHI \leq N$ .
- Z** (input/output) DOUBLE PRECISION array, dimension (LDZ,N)  
If WANTZ is .TRUE., on entry  $Z$  must contain the current matrix  $Z$  of transformations accumulated by DHSEQR, and on exit  $Z$  has been updated; transformations are applied only to the submatrix  $Z(ILOZ:IHI, ILO:IHI)$ . If WANTZ is .FALSE.,  $Z$  is not referenced.
- LDZ** (input) INTEGER  
The leading dimension of the array  $Z$ .  $LDZ \geq \max(1, N)$ .
- INFO** (output) INTEGER  
= 0: successful exit  
eigenvalues  $ILO$  to  $IHI$  in a total of 30 iterations per eigen-

value; elements  $i+1:ihi$  of  $WR$  and  $WI$  contain those eigenvalues which have been successfully computed.

If  $INFO .GT. 0$  and  $WANTT$  is  $.FALSE.$ , then on exit, the remaining unconverged eigenvalues are the eigenvalues of the upper Hessenberg matrix rows and columns  $ILO$  through  $INFO$  of the final, output value of  $H$ .

If  $INFO .GT. 0$  and  $WANTT$  is  $.TRUE.$ , then on exit (\*) (initial value of  $H$ )\* $U = U$ \*(final value of  $H$ ) where  $U$  is an orthogonal matrix. The final value of  $H$  is upper Hessenberg and triangular in rows and columns  $INFO+1$  through  $IHI$ .

If  $INFO .GT. 0$  and  $WANTZ$  is  $.TRUE.$ , then on exit (final value of  $Z$ ) = (initial value of  $Z$ )\* $U$  where  $U$  is the orthogonal matrix in (\*) (regardless of the value of  $WANTT$ .)

```

(LAPACK dlahqr)=
  (let* ((zero 0.0) (one 1.0) (half 0.5) (dat1 0.75) (dat2 (- 0.4375)))
    (declare (type (double-float 0.0 0.0) zero)
              (type (double-float 1.0 1.0) one)
              (type (double-float 0.5 0.5) half)
              (type (double-float 0.75 0.75) dat1)
              (type (double-float) dat2))
    (defun dlahqr (wantt wantz n ilo ihi h ldh wr wi iloz ihiz z ldz info)
      (declare (type (simple-array double-float (*)) z wi wr h)
                (type fixnum info ldz ihiz iloz ldh ihi ilo n)
                (type (member t nil) wantz wantt))
      (f2cl-lib:with-multi-array-data
        ((h double-float h-%data% h-%offset%)
         (wr double-float wr-%data% wr-%offset%)
         (wi double-float wi-%data% wi-%offset%)
         (z double-float z-%data% z-%offset%))
        (prog ((v (make-array 3 :element-type 'double-float))
               (work (make-array 1 :element-type 'double-float)) (ave 0.0)
               (cs 0.0) (disc 0.0) (h00 0.0) (h10 0.0) (h11 0.0) (h12 0.0)
               (h21 0.0) (h22 0.0) (h33 0.0) (h33s 0.0) (h43h34 0.0) (h44 0.0)
               (h44s 0.0) (ovfl 0.0) (s 0.0) (smlnum 0.0) (sn 0.0) (sum 0.0)
               (t1 0.0) (t2 0.0) (t3 0.0) (tst1 0.0) (ulp 0.0) (unfl 0.0)
               (v1 0.0) (v2 0.0) (v3 0.0) (i 0) (i1 0) (i2 0) (itn 0) (its 0)
               (j 0) (k 0) (l 0) (m 0) (nh 0) (nr 0) (nz 0))
              (declare (type (simple-array double-float (3)) v)
                        (type (simple-array double-float (1)) work)
                        (type (double-float) ave cs disc h00 h10 h11 h12 h21 h22 h33
                               h33s h43h34 h44 h44s ovfl s smlnum sn sum
                               t1 t2 t3 tst1 ulp unfl v1 v2 v3)
                        (type fixnum i i1 i2 itn its j k l m nh nr nz))
              (setf info 0)
              (if (= n 0) (go end_label))
              (cond
                ((= ilo ihi)
                 (setf (f2cl-lib:fref wr-%data% (ilo) ((1 *)) wr-%offset%)
                       (f2cl-lib:fref h-%data%
                                       (ilo ilo)
                                       ((1 ldh) (1 *))
                                       h-%offset%))
                  (setf (f2cl-lib:fref wi-%data% (ilo) ((1 *)) wi-%offset%) zero)
                  (go end_label)))
                (t
                 (setf nh (f2cl-lib:int-add (f2cl-lib:int-sub ihi ilo) 1))
                 (setf nz (f2cl-lib:int-add (f2cl-lib:int-sub ihiz iloz) 1))
                 (setf unfl (dlamch "Safe minimum"))
                 (setf ovfl (/ one unfl))
                 (multiple-value-bind (var-0 var-1)

```

```

        (dlabad unfl ovfl)
        (declare (ignore))
        (setf unfl var-0)
        (setf ovfl var-1))
    (setf ulp (dlamch "Precision"))
    (setf smlnum (* unfl (/ nh ulp)))
    (cond
      (wantt
        (setf i1 1)
        (setf i2 n)))
    (setf itn (f2cl-lib:int-mul 30 nh))
    (setf i ihi)
label10
    (setf l ilo)
    (if (< i ilo) (go end_label))
    (f2cl-lib:fdo (its 0 (f2cl-lib:int-add its 1))
      ((> its itn) nil)
      (tagbody
        (f2cl-lib:fdo (k i (f2cl-lib:int-add k (f2cl-lib:int-sub 1)))
          ((> k (f2cl-lib:int-add 1 1)) nil)
          (tagbody
            (setf tst1
              (+
                (abs
                  (f2cl-lib:fref h-%data%
                                ((f2cl-lib:int-sub k 1)
                                 (f2cl-lib:int-sub k 1))
                                ((1 ldh) (1 *))
                                h-%offset%))
                (abs
                  (f2cl-lib:fref h-%data%
                                (k k)
                                ((1 ldh) (1 *))
                                h-%offset%))))
              (if (= tst1 zero)
                (setf tst1
                  (dlanhs "1"
                    (f2cl-lib:int-add (f2cl-lib:int-sub i 1) 1)
                    (f2cl-lib:array-slice h
                                          double-float
                                          (1 1)
                                          ((1 ldh) (1 *)))
                    ldh work))))
            (if
              (<=
                (abs

```

```

        (f2cl-lib:fref h-%data%
          (k (f2cl-lib:int-sub k 1))
          ((1 ldh) (1 *))
          h-%offset%))
      (max (* ulp tst1) smlnum))
      (go label30))))

label30
  (setf l k)
  (cond
    ((> l ilo)
      (setf (f2cl-lib:fref h-%data%
                          (l (f2cl-lib:int-sub l 1))
                          ((1 ldh) (1 *))
                          h-%offset%))
              zero)))
    (if (>= l (f2cl-lib:int-sub i 1)) (go label140))
    (cond
      ((not wantt)
        (setf i1 l)
        (setf i2 i)))
      (cond
        ((or (= its 10) (= its 20))
          (setf s
            (+
              (abs
                (f2cl-lib:fref h-%data%
                              (i (f2cl-lib:int-sub i 1))
                              ((1 ldh) (1 *))
                              h-%offset%))
              (abs
                (f2cl-lib:fref h-%data%
                              ((f2cl-lib:int-sub i 1)
                               (f2cl-lib:int-sub i 2))
                              ((1 ldh) (1 *))
                              h-%offset%))))))
          (setf h44
            (+ (* dat1 s)
              (f2cl-lib:fref h-%data%
                            (i i)
                            ((1 ldh) (1 *))
                            h-%offset%))))
          (setf h33 h44)
          (setf h43h34 (* dat2 s s)))
        (t
          (setf h44
            (f2cl-lib:fref h-%data%

```

```

(i i)
((1 ldh) (1 *))
h-%offset%)
(setf h33
  (f2cl-lib:fref h-%data%
    ((f2cl-lib:int-sub i 1)
     (f2cl-lib:int-sub i 1))
    ((1 ldh) (1 *))
    h-%offset%))
(setf h43h34
  (*
    (f2cl-lib:fref h-%data%
      (i (f2cl-lib:int-sub i 1))
      ((1 ldh) (1 *))
      h-%offset%)
    (f2cl-lib:fref h-%data%
      ((f2cl-lib:int-sub i 1) i)
      ((1 ldh) (1 *))
      h-%offset%)))
(setf s
  (*
    (f2cl-lib:fref h-%data%
      ((f2cl-lib:int-sub i 1)
       (f2cl-lib:int-sub i 2))
      ((1 ldh) (1 *))
      h-%offset%)
    (f2cl-lib:fref h-%data%
      ((f2cl-lib:int-sub i 1)
       (f2cl-lib:int-sub i 2))
      ((1 ldh) (1 *))
      h-%offset%)))
(setf disc (* (- h33 h44) half))
(setf disc (+ (* disc disc) h43h34))
(cond
  ((> disc zero)
   (setf disc (f2cl-lib:fsqrt disc))
   (setf ave (* half (+ h33 h44)))
   (cond
     ((> (+ (abs h33) (- (abs h44))) zero)
      (setf h33 (- (* h33 h44) h43h34))
      (setf h44 (/ h33 (+ (f2cl-lib:sign disc ave) ave))))
     (t
      (setf h44 (+ (f2cl-lib:sign disc ave) ave))))
   (setf h33 h44)
   (setf h43h34 zero))))
(f2cl-lib:fdo (m (f2cl-lib:int-add i (f2cl-lib:int-sub 2))

```

```

(f2cl-lib:int-add m (f2cl-lib:int-sub 1)))
(> m 1) nil)
(tagbody
  (setf h11
    (f2cl-lib:fref h-%data%
      (m m)
      ((1 ldh) (1 *))
      h-%offset%))
  (setf h22
    (f2cl-lib:fref h-%data%
      ((f2cl-lib:int-add m 1)
       (f2cl-lib:int-add m 1))
      ((1 ldh) (1 *))
      h-%offset%))
  (setf h21
    (f2cl-lib:fref h-%data%
      ((f2cl-lib:int-add m 1) m)
      ((1 ldh) (1 *))
      h-%offset%))
  (setf h12
    (f2cl-lib:fref h-%data%
      (m (f2cl-lib:int-add m 1))
      ((1 ldh) (1 *))
      h-%offset%))
  (setf h44s (- h44 h11))
  (setf h33s (- h33 h11))
  (setf v1 (+ (/ (- (* h33s h44s) h43h34) h21) h12))
  (setf v2 (- h22 h11 h33s h44s))
  (setf v3
    (f2cl-lib:fref h-%data%
      ((f2cl-lib:int-add m 2)
       (f2cl-lib:int-add m 1))
      ((1 ldh) (1 *))
      h-%offset%))
  (setf s (+ (abs v1) (abs v2) (abs v3)))
  (setf v1 (/ v1 s))
  (setf v2 (/ v2 s))
  (setf v3 (/ v3 s))
  (setf (f2cl-lib:fref v (1) ((1 3))) v1)
  (setf (f2cl-lib:fref v (2) ((1 3))) v2)
  (setf (f2cl-lib:fref v (3) ((1 3))) v3)
  (if (= m 1) (go label50))
  (setf h00
    (f2cl-lib:fref h-%data%
      ((f2cl-lib:int-sub m 1)
       (f2cl-lib:int-sub m 1))

```



```

((1 ldh) (1 *))
h-%offset%)

(setf h10
  (f2cl-lib:fref h-%data%
    (m (f2cl-lib:int-sub m 1))
    ((1 ldh) (1 *))
    h-%offset%))
(setf tst1 (* (abs v1) (+ (abs h00) (abs h11) (abs h22))))
(if (<= (* (abs h10) (+ (abs v2) (abs v3))) (* ulp tst1))
  (go label150)))

label150
(f2cl-lib:fdo (k m (f2cl-lib:int-add k 1))
  (> k (f2cl-lib:int-add i (f2cl-lib:int-sub 1))) nil)
(tagbody
  (setf nr
    (min (the fixnum 3)
      (the fixnum
        (f2cl-lib:int-add (f2cl-lib:int-sub i k)
          1))))
  (if (> k m)
    (dcopy nr
      (f2cl-lib:array-slice h
        double-float
        (k (f2cl-lib:int-sub k 1))
        ((1 ldh) (1 *)))
      1 v 1))
  (multiple-value-bind (var-0 var-1 var-2 var-3 var-4)
    (dlarfg nr (f2cl-lib:fref v (1) ((1 3)))
      (f2cl-lib:array-slice v double-float (2) ((1 3))) 1 t1)
    (declare (ignore var-0 var-2 var-3))
    (setf (f2cl-lib:fref v (1) ((1 3))) var-1)
    (setf t1 var-4))
  (cond
    (> k m)
    (setf (f2cl-lib:fref h-%data%
      (k (f2cl-lib:int-sub k 1))
      ((1 ldh) (1 *))
      h-%offset%)
      (f2cl-lib:fref v (1) ((1 3))))
    (setf (f2cl-lib:fref h-%data%
      ((f2cl-lib:int-add k 1)
        (f2cl-lib:int-sub k 1))
      ((1 ldh) (1 *))
      h-%offset%)
      zero)
    (if (< k (f2cl-lib:int-sub i 1))

```

```

      (setf (f2cl-lib:fref h-%data%
                          ((f2cl-lib:int-add k 2)
                           (f2cl-lib:int-sub k 1))
                          ((1 ldh) (1 *)))
            h-%offset%)
      zero)))
  ((> m 1)
   (setf (f2cl-lib:fref h-%data%
                       (k (f2cl-lib:int-sub k 1))
                       ((1 ldh) (1 *)))
         h-%offset%)
   (-
    (f2cl-lib:fref h-%data%
                    (k (f2cl-lib:int-sub k 1))
                    ((1 ldh) (1 *)))
    h-%offset%))))
  (setf v2 (f2cl-lib:fref v (2) ((1 3)))
  (setf t2 (* t1 v2))
  (cond
   ((= nr 3)
    (setf v3 (f2cl-lib:fref v (3) ((1 3)))
    (setf t3 (* t1 v3))
    (f2cl-lib:fdo (j k (f2cl-lib:int-add j 1))
                  ((> j i2) nil)
    (tagbody
     (setf sum
      (+
       (f2cl-lib:fref h-%data%
                       (k j)
                       ((1 ldh) (1 *)))
                       h-%offset%)
       (* v2
        (f2cl-lib:fref h-%data%
                        ((f2cl-lib:int-add k 1) j)
                        ((1 ldh) (1 *)))
                        h-%offset%)
       (* v3
        (f2cl-lib:fref h-%data%
                        ((f2cl-lib:int-add k 2) j)
                        ((1 ldh) (1 *)))
                        h-%offset%))))
     (setf (f2cl-lib:fref h-%data%
                          (k j)
                          ((1 ldh) (1 *)))
           h-%offset%)
     (-

```

```

(f2cl-lib:fref h-%data%
  (k j)
  ((1 ldh) (1 *))
  h-%offset%)
(* sum t1)))
(setf (f2cl-lib:fref h-%data%
  ((f2cl-lib:int-add k 1) j)
  ((1 ldh) (1 *))
  h-%offset%)
(-
  (f2cl-lib:fref h-%data%
    ((f2cl-lib:int-add k 1) j)
    ((1 ldh) (1 *))
    h-%offset%)
  (* sum t2)))
(setf (f2cl-lib:fref h-%data%
  ((f2cl-lib:int-add k 2) j)
  ((1 ldh) (1 *))
  h-%offset%)
(-
  (f2cl-lib:fref h-%data%
    ((f2cl-lib:int-add k 2) j)
    ((1 ldh) (1 *))
    h-%offset%)
  (* sum t3))))
(f2cl-lib:fdo (j i1 (f2cl-lib:int-add j 1))
  (> j
    (min
      (the fixnum
        (f2cl-lib:int-add k 3))
      (the fixnum i)))
    nil)
(tagbody
  (setf sum
    (+
      (f2cl-lib:fref h-%data%
        (j k)
        ((1 ldh) (1 *))
        h-%offset%)
      (* v2
        (f2cl-lib:fref h-%data%
          (j (f2cl-lib:int-add k 1))
          ((1 ldh) (1 *))
          h-%offset%))
      (* v3
        (f2cl-lib:fref h-%data%

```

```
(j (f2cl-lib:int-add k 2))
((1 ldh) (1 *))
h-%offset%)))
(setf (f2cl-lib:fref h-%data%
      (j k)
      ((1 ldh) (1 *))
      h-%offset%)
  (-
    (f2cl-lib:fref h-%data%
      (j k)
      ((1 ldh) (1 *))
      h-%offset%)
    (* sum t1)))
(setf (f2cl-lib:fref h-%data%
      (j (f2cl-lib:int-add k 1))
      ((1 ldh) (1 *))
      h-%offset%)
  (-
    (f2cl-lib:fref h-%data%
      (j (f2cl-lib:int-add k 1))
      ((1 ldh) (1 *))
      h-%offset%)
    (* sum t2)))
(setf (f2cl-lib:fref h-%data%
      (j (f2cl-lib:int-add k 2))
      ((1 ldh) (1 *))
      h-%offset%)
  (-
    (f2cl-lib:fref h-%data%
      (j (f2cl-lib:int-add k 2))
      ((1 ldh) (1 *))
      h-%offset%)
    (* sum t3))))
(cond
 (wantz
  (f2cl-lib:fdo (j iloz (f2cl-lib:int-add j 1))
                (> j ihiz) nil)
  (tagbody
   (setf sum
        (+
         (f2cl-lib:fref z-%data%
           (j k)
           ((1 ldz) (1 *))
           z-%offset%)
         (* v2
          (f2cl-lib:fref z-%data%
```

```

                                (j (f2cl-lib:int-add k 1))
                                ((1 ldz) (1 *))
                                z-%offset%))
(* v3
  (f2cl-lib:fref z-%data%
    (j (f2cl-lib:int-add k 2))
    ((1 ldz) (1 *))
    z-%offset%)))
(setf (f2cl-lib:fref z-%data%
  (j k)
  ((1 ldz) (1 *))
  z-%offset%)
(-
  (f2cl-lib:fref z-%data%
    (j k)
    ((1 ldz) (1 *))
    z-%offset%)
  (* sum t1)))
(setf (f2cl-lib:fref z-%data%
  (j (f2cl-lib:int-add k 1))
  ((1 ldz) (1 *))
  z-%offset%)
(-
  (f2cl-lib:fref z-%data%
    (j (f2cl-lib:int-add k 1))
    ((1 ldz) (1 *))
    z-%offset%)
  (* sum t2)))
(setf (f2cl-lib:fref z-%data%
  (j (f2cl-lib:int-add k 2))
  ((1 ldz) (1 *))
  z-%offset%)
(-
  (f2cl-lib:fref z-%data%
    (j (f2cl-lib:int-add k 2))
    ((1 ldz) (1 *))
    z-%offset%)
  (* sum t3))))))
(= nr 2)
(f2cl-lib:fdo (j k (f2cl-lib:int-add j 1))
  (> j i2) nil)
(tagbody
  (setf sum
    (+
      (f2cl-lib:fref h-%data%
        (k j)

```

```

((1 ldh) (1 *))
h-%offset%)
(* v2
  (f2cl-lib:fref h-%data%
    ((f2cl-lib:int-add k 1) j)
    ((1 ldh) (1 *))
    h-%offset%)))
(setf (f2cl-lib:fref h-%data%
  (k j)
  ((1 ldh) (1 *))
  h-%offset%)
  (-
    (f2cl-lib:fref h-%data%
      (k j)
      ((1 ldh) (1 *))
      h-%offset%)
    (* sum t1)))
(setf (f2cl-lib:fref h-%data%
  ((f2cl-lib:int-add k 1) j)
  ((1 ldh) (1 *))
  h-%offset%)
  (-
    (f2cl-lib:fref h-%data%
      ((f2cl-lib:int-add k 1) j)
      ((1 ldh) (1 *))
      h-%offset%)
    (* sum t2))))
(f2cl-lib:fdo (j i1 (f2cl-lib:int-add j 1))
  (> j i) nil)
(tagbody
  (setf sum
    (+
      (f2cl-lib:fref h-%data%
        (j k)
        ((1 ldh) (1 *))
        h-%offset%)
      (* v2
        (f2cl-lib:fref h-%data%
          (j (f2cl-lib:int-add k 1))
          ((1 ldh) (1 *))
          h-%offset%)))
    (setf (f2cl-lib:fref h-%data%
      (j k)
      ((1 ldh) (1 *))
      h-%offset%)
      (-

```

```

(f2cl-lib:fref h-%data%
  (j k)
  ((1 ldh) (1 *))
  h-%offset%)
(* sum t1)))
(setf (f2cl-lib:fref h-%data%
  (j (f2cl-lib:int-add k 1))
  ((1 ldh) (1 *))
  h-%offset%)
(-
  (f2cl-lib:fref h-%data%
    (j (f2cl-lib:int-add k 1))
    ((1 ldh) (1 *))
    h-%offset%)
  (* sum t2))))))
(cond
  (wantz
    (f2cl-lib:fdo (j iloz (f2cl-lib:int-add j 1))
      (> j ihiz) nil)
    (tagbody
      (setf sum
        (+
          (f2cl-lib:fref z-%data%
            (j k)
            ((1 ldz) (1 *))
            z-%offset%)
          (* v2
            (f2cl-lib:fref z-%data%
              (j (f2cl-lib:int-add k 1))
              ((1 ldz) (1 *))
              z-%offset%))))))
      (setf (f2cl-lib:fref z-%data%
        (j k)
        ((1 ldz) (1 *))
        z-%offset%)
        (-
          (f2cl-lib:fref z-%data%
            (j k)
            ((1 ldz) (1 *))
            z-%offset%)
          (* sum t1)))
      (setf (f2cl-lib:fref z-%data%
        (j (f2cl-lib:int-add k 1))
        ((1 ldz) (1 *))
        z-%offset%)
        (-

```

```

                                (f2cl-lib:fref z-%data%
                                (j (f2cl-lib:int-add k 1))
                                ((1 ldz) (1 *))
                                z-%offset%)
                                (* sum t2)))))))))
(setf info i)
(go end_label)
label140
(cond
  ((= 1 i)
    (setf (f2cl-lib:fref wr-%data% (i) ((1 *)) wr-%offset%)
          (f2cl-lib:fref h-%data% (i i) ((1 ldh) (1 *)) h-%offset%))
    (setf (f2cl-lib:fref wi-%data% (i) ((1 *)) wi-%offset%) zero))
    (= 1 (f2cl-lib:int-add i (f2cl-lib:int-sub 1)))
    (multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9)
      (dlanv2
        (f2cl-lib:fref h-%data%
          ((f2cl-lib:int-sub i 1) (f2cl-lib:int-sub i 1))
          ((1 ldh) (1 *))
          h-%offset%)
        (f2cl-lib:fref h-%data%
          ((f2cl-lib:int-sub i 1) i)
          ((1 ldh) (1 *))
          h-%offset%)
        (f2cl-lib:fref h-%data%
          (i (f2cl-lib:int-sub i 1))
          ((1 ldh) (1 *))
          h-%offset%)
        (f2cl-lib:fref h-%data% (i i) ((1 ldh) (1 *)) h-%offset%)
        (f2cl-lib:fref wr-%data%
          ((f2cl-lib:int-sub i 1))
          ((1 *))
          wr-%offset%)
        (f2cl-lib:fref wi-%data%
          ((f2cl-lib:int-sub i 1))
          ((1 *))
          wi-%offset%)
        (f2cl-lib:fref wr-%data% (i) ((1 *)) wr-%offset%)
        (f2cl-lib:fref wi-%data% (i) ((1 *)) wi-%offset%) cs sn)
      (declare (ignore))
      (setf (f2cl-lib:fref h-%data%
        ((f2cl-lib:int-sub i 1)
         (f2cl-lib:int-sub i 1))
        ((1 ldh) (1 *))
        h-%offset%)

```



```

var-0)
(setf (f2cl-lib:fref h-%data%
                    ((f2cl-lib:int-sub i 1) i)
                    ((1 ldh) (1 *)))
      h-%offset%)

var-1)
(setf (f2cl-lib:fref h-%data%
                    (i (f2cl-lib:int-sub i 1))
                    ((1 ldh) (1 *)))
      h-%offset%)

var-2)
(setf (f2cl-lib:fref h-%data% (i i) ((1 ldh) (1 *)) h-%offset%)
      var-3)
(setf (f2cl-lib:fref wr-%data%
                    ((f2cl-lib:int-sub i 1))
                    ((1 *)))
      wr-%offset%)

var-4)
(setf (f2cl-lib:fref wi-%data%
                    ((f2cl-lib:int-sub i 1))
                    ((1 *)))
      wi-%offset%)

var-5)
(setf (f2cl-lib:fref wr-%data% (i) ((1 *)) wr-%offset%) var-6)
(setf (f2cl-lib:fref wi-%data% (i) ((1 *)) wi-%offset%) var-7)
(setf cs var-8)
(setf sn var-9))
(cond
 (wantt
  (if (> i2 i)
      (drot (f2cl-lib:int-sub i2 i)
            (f2cl-lib:array-slice h
                                   double-float
                                   ((+ i (f2cl-lib:int-sub 1))
                                    (f2cl-lib:int-add i 1))
                                   ((1 ldh) (1 *))))
      (ldh
       (f2cl-lib:array-slice h
                              double-float
                              (i (f2cl-lib:int-add i 1))
                              ((1 ldh) (1 *))))
       (ldh cs sn)))
 (drot (f2cl-lib:int-sub i i1 1)
  (f2cl-lib:array-slice h
                        double-float
                        (i1 (f2cl-lib:int-sub i 1))

```

```

                                ((1 ldh) (1 *)))
      1 (f2cl-lib:array-slice h double-float (i1 i) ((1 ldh) (1 *))) 1
      cs sn)))
(cond
 (wantz
  (drot nz
   (f2cl-lib:array-slice z
    double-float
    (iloz (f2cl-lib:int-sub i 1))
    ((1 ldz) (1 *)))
    1 (f2cl-lib:array-slice z double-float (iloz i) ((1 ldz) (1 *)))
    1 cs sn))))))
(setf itn (f2cl-lib:int-sub itn its))
(setf i (f2cl-lib:int-sub 1 1))
(go label10)
end_label
(return
 (values nil nil nil nil nil nil nil nil nil nil nil nil info))))))

```

## 7.31 dlahrd LAPACK

```

⟨dlahrd.input⟩≡
)set break resume
)sys rm -f dlahrd.output
)spool dlahrd.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)

```

`<dlahrd.help>`≡

```
=====
dlahrd examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

DLAHRD - the first NB columns of a real general n-by-(n-k+1) matrix A so that elements below the k-th subdiagonal are zero

#### SYNOPSIS

```
SUBROUTINE DLAHRD( N, K, NB, A, LDA, TAU, T, LDT, Y, LDY )
```

```
      INTEGER          K, LDA, LDT, LDY, N, NB
```

```
      DOUBLE           PRECISION A( LDA, * ), T( LDT, NB ), TAU( NB ), Y(
LDY, NB )
```

#### PURPOSE

DLAHRD reduces the first NB columns of a real general n-by-(n-k+1) matrix A so that elements below the k-th subdiagonal are zero. The reduction is performed by an orthogonal similarity transformation  $Q' * A * Q$ . The routine returns the matrices V and T which determine Q as a block reflector  $I - V * T * V'$ , and also the matrix  $Y = A * V * T$ .

This is an OBSOLETE auxiliary routine.  
This routine will be 'deprecated' in a future release.  
Please use the new routine DLAHR2 instead.

#### ARGUMENTS

N (input) INTEGER  
The order of the matrix A.

K (input) INTEGER  
The offset for the reduction. Elements below the k-th subdiagonal in the first NB columns are reduced to zero.

NB (input) INTEGER  
The number of columns to be reduced.

A (input/output) DOUBLE PRECISION array, dimension (LDA,N-K+1)  
On entry, the n-by-(n-k+1) general matrix A. On exit, the ele-

ments on and above the  $k$ -th subdiagonal in the first  $NB$  columns are overwritten with the corresponding elements of the reduced matrix; the elements below the  $k$ -th subdiagonal, with the array  $TAU$ , represent the matrix  $Q$  as a product of elementary reflectors. The other columns of  $A$  are unchanged. See Further Details.  $LDA$  (input) INTEGER The leading dimension of the array  $A$ .  $LDA \geq \max(1, N)$ .

$TAU$  (output) DOUBLE PRECISION array, dimension  $(NB)$   
The scalar factors of the elementary reflectors. See Further Details.

$T$  (output) DOUBLE PRECISION array, dimension  $(LDT, NB)$   
The upper triangular matrix  $T$ .

$LDT$  (input) INTEGER  
The leading dimension of the array  $T$ .  $LDT \geq NB$ .

$Y$  (output) DOUBLE PRECISION array, dimension  $(LDY, NB)$   
The  $n$ -by- $nb$  matrix  $Y$ .

$LDY$  (input) INTEGER  
The leading dimension of the array  $Y$ .  $LDY \geq N$ .

#### FURTHER DETAILS

The matrix  $Q$  is represented as a product of  $nb$  elementary reflectors

$$Q = H(1) H(2) \dots H(nb).$$

Each  $H(i)$  has the form

$$H(i) = I - \tau * v * v'$$

where  $\tau$  is a real scalar, and  $v$  is a real vector with  $v(1:i+k-1) = 0$ ,  $v(i+k) = 1$ ;  $v(i+k+1:n)$  is stored on exit in  $A(i+k+1:n, i)$ , and  $\tau$  in  $TAU(i)$ .

The elements of the vectors  $v$  together form the  $(n-k+1)$ -by- $nb$  matrix  $V$  which is needed, with  $T$  and  $Y$ , to apply the transformation to the unreduced part of the matrix, using an update of the form:  $A := (I - V * T * V') * (A - Y * V')$ .

The contents of  $A$  on exit are illustrated by the following example with  $n = 7$ ,  $k = 3$  and  $nb = 2$ :

( a   h   a   a   a )

```

( a  h  a  a  a )
( a  h  a  a  a )
( h  h  a  a  a )
( v1 h  a  a  a )
( v1 v2 a  a  a )
( v1 v2 a  a  a )

```

where  $a$  denotes an element of the original matrix  $A$ ,  $h$  denotes a modified element of the upper Hessenberg matrix  $H$ , and  $v_i$  denotes an element of the vector defining  $H(i)$ .

```

(LAPACK dlahrd)=
(let* ((zero 0.0) (one 1.0))
  (declare (type (double-float 0.0 0.0) zero)
            (type (double-float 1.0 1.0) one))
  (defun dlahrd (n k nb a lda tau t$ ldt y ldy)
    (declare (type (simple-array double-float (*)) y t$ tau a)
              (type fixnum ldy ldt lda nb k n))
    (f2cl-lib:with-multi-array-data
      ((a double-float a-%data% a-%offset%)
       (tau double-float tau-%data% tau-%offset%)
       (t$ double-float t$-%data% t$-%offset%)
       (y double-float y-%data% y-%offset%))
      (prog ((ei 0.0) (i 0))
        (declare (type (double-float) ei) (type fixnum i))
        (if (<= n 1) (go end_label))
        (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                      ((> i nb) nil)
          (tagbody
            (cond
              ((> i 1)
               (dgemv "No transpose" n (f2cl-lib:int-sub i 1) (- one) y ldy
                 (f2cl-lib:array-slice a
                                       double-float
                                       ((+ k i (f2cl-lib:int-sub 1)) 1)
                                       ((1 lda) (1 *)))
               lda one
               (f2cl-lib:array-slice a double-float (1 i) ((1 lda) (1 *))) 1)
              (dcopy (f2cl-lib:int-sub i 1)
                (f2cl-lib:array-slice a
                                      double-float
                                      ((+ k 1) i)
                                      ((1 lda) (1 *)))
                1
                (f2cl-lib:array-slice t$ double-float (1 nb) ((1 ldt) (1 nb)))
                1)
              (dtrmv "Lower" "Transpose" "Unit" (f2cl-lib:int-sub i 1)
                (f2cl-lib:array-slice a
                                      double-float
                                      ((+ k 1) 1)
                                      ((1 lda) (1 *)))
                lda
                (f2cl-lib:array-slice t$ double-float (1 nb) ((1 ldt) (1 nb)))
                1)
              (dgemv "Transpose" (f2cl-lib:int-add (f2cl-lib:int-sub n k i) 1)
                (f2cl-lib:int-sub i 1) one
                (f2cl-lib:array-slice a

```

```

double-float
((+ k i) 1)
((1 lda) (1 *)))

lda
(f2cl-lib:array-slice a
double-float
((+ k i) i)
((1 lda) (1 *)))

1 one
(f2cl-lib:array-slice t$ double-float (1 nb) ((1 ldt) (1 nb)))
1)
(dtrmv "Upper" "Transpose" "Non-unit" (f2cl-lib:int-sub i 1) t$
ldt
(f2cl-lib:array-slice t$ double-float (1 nb) ((1 ldt) (1 nb)))
1)
(dgemv "No transpose"
(f2cl-lib:int-add (f2cl-lib:int-sub n k i) 1)
(f2cl-lib:int-sub i 1) (- one)
(f2cl-lib:array-slice a
double-float
((+ k i) 1)
((1 lda) (1 *)))

lda
(f2cl-lib:array-slice t$ double-float (1 nb) ((1 ldt) (1 nb)))
1 one
(f2cl-lib:array-slice a
double-float
((+ k i) i)
((1 lda) (1 *)))

1)
(dtrmv "Lower" "No transpose" "Unit" (f2cl-lib:int-sub i 1)
(f2cl-lib:array-slice a
double-float
((+ k 1) 1)
((1 lda) (1 *)))

lda
(f2cl-lib:array-slice t$ double-float (1 nb) ((1 ldt) (1 nb)))
1)
(daxpy (f2cl-lib:int-sub i 1) (- one)
(f2cl-lib:array-slice t$ double-float (1 nb) ((1 ldt) (1 nb)))
1
(f2cl-lib:array-slice a
double-float
((+ k 1) i)
((1 lda) (1 *)))

1)

```

```

      (setf (f2cl-lib:fref a-%data%
                          ((f2cl-lib:int-sub (f2cl-lib:int-add k i)
                                               1)
                          (f2cl-lib:int-sub i 1))
                          ((1 lda) (1 *)))
            a-%offset%)
      ei)))
(multiple-value-bind (var-0 var-1 var-2 var-3 var-4)
  (dlarfg (f2cl-lib:int-add (f2cl-lib:int-sub n k i) 1)
    (f2cl-lib:fref a-%data%
                    ((f2cl-lib:int-add k i) i)
                    ((1 lda) (1 *)))
    a-%offset%)
  (f2cl-lib:array-slice a
                        double-float
                        ((min (f2cl-lib:int-add k i 1) n) i)
                        ((1 lda) (1 *)))
  1 (f2cl-lib:fref tau-%data% (i) ((1 nb)) tau-%offset%))
(declare (ignore var-0 var-2 var-3))
(setf (f2cl-lib:fref a-%data%
                    ((f2cl-lib:int-add k i) i)
                    ((1 lda) (1 *)))
      a-%offset%)
      var-1)
(setf (f2cl-lib:fref tau-%data% (i) ((1 nb)) tau-%offset%)
      var-4))
(setf ei
      (f2cl-lib:fref a-%data%
                      ((f2cl-lib:int-add k i) i)
                      ((1 lda) (1 *)))
      a-%offset%))
(setf (f2cl-lib:fref a-%data%
                    ((f2cl-lib:int-add k i) i)
                    ((1 lda) (1 *)))
      a-%offset%)
      one)
(dgemv "No transpose" n
  (f2cl-lib:int-add (f2cl-lib:int-sub n k i) 1) one
  (f2cl-lib:array-slice a
                        double-float
                        (1 (f2cl-lib:int-add i 1))
                        ((1 lda) (1 *)))
  lda
  (f2cl-lib:array-slice a double-float ((+ k i) i) ((1 lda) (1 *)))
  1 zero
  (f2cl-lib:array-slice y double-float (1 i) ((1 ldy) (1 nb))) 1)

```



```

(dgemv "Transpose" (f2cl-lib:int-add (f2cl-lib:int-sub n k i) 1)
  (f2cl-lib:int-sub i 1) one
  (f2cl-lib:array-slice a double-float ((+ k i) 1) ((1 lda) (1 *)))
  lda
  (f2cl-lib:array-slice a double-float ((+ k i) i) ((1 lda) (1 *)))
  1 zero
  (f2cl-lib:array-slice t$ double-float (1 i) ((1 ldt) (1 nb))) 1)
(dgemv "No transpose" n (f2cl-lib:int-sub i 1) (- one) y ldy
  (f2cl-lib:array-slice t$ double-float (1 i) ((1 ldt) (1 nb))) 1
  one (f2cl-lib:array-slice y double-float (1 i) ((1 ldy) (1 nb)))
  1)
(dscal n (f2cl-lib:fref tau-%data% (i) ((1 nb)) tau-%offset%)
  (f2cl-lib:array-slice y double-float (1 i) ((1 ldy) (1 nb))) 1)
(dscal (f2cl-lib:int-sub i 1)
  (- (f2cl-lib:fref tau-%data% (i) ((1 nb)) tau-%offset%)
  (f2cl-lib:array-slice t$ double-float (1 i) ((1 ldt) (1 nb))) 1)
(dtrmv "Upper" "No transpose" "Non-unit" (f2cl-lib:int-sub i 1) t$
  ldt (f2cl-lib:array-slice t$ double-float (1 i) ((1 ldt) (1 nb)))
  1)
(setf (f2cl-lib:fref t$-%data% (i i) ((1 ldt) (1 nb)) t$-%offset%)
      (f2cl-lib:fref tau-%data% (i) ((1 nb)) tau-%offset%)))
(setf (f2cl-lib:fref a-%data%
      ((f2cl-lib:int-add k nb) nb)
      ((1 lda) (1 *))
      a-%offset%)
      ei)
end_label
(return (values nil nil nil nil nil nil nil nil nil nil))))))

```

## 7.32 dlaln2 LAPACK

```

<dlaln2.input>≡
)set break resume
)sys rm -f dlaln2.output
)spool dlaln2.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)

```

`<dlaln2.help>=`

```
=====
dlaln2 examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

DLALN2 - a system of the form  $(ca A - w D) X = s B$  or  $(ca A' - w D) X = s B$  with possible scaling ("s") and perturbation of A

#### SYNOPSIS

```
SUBROUTINE DLALN2( LTRANS, NA, NW, SMIN, CA, A, LDA, D1, D2, B, LDB,
                  WR, WI, X, LDX, SCALE, XNORM, INFO )
```

LOGICAL LTRANS

INTEGER INFO, LDA, LDB, LDX, NA, NW

DOUBLE PRECISION CA, D1, D2, SCALE, SMIN, WI, WR, XNORM

DOUBLE PRECISION A( LDA, \* ), B( LDB, \* ), X( LDX, \* )

#### PURPOSE

DLALN2 solves a system of the form  $(ca A - w D) X = s B$  or  $(ca A' - w D) X = s B$  with possible scaling ("s") and perturbation of A. (A' means A-transpose.)

A is an NA x NA real matrix, ca is a real scalar, D is an NA x NA real diagonal matrix, w is a real or complex value, and X and B are NA x 1 matrices -- real if w is real, complex if w is complex. NA may be 1 or 2.

If w is complex, X and B are represented as NA x 2 matrices, the first column of each being the real part and the second being the imaginary part.

"s" is a scaling factor (LE. 1), computed by DLALN2, which is so chosen that X can be computed without overflow. X is further scaled if necessary to assure that  $\text{norm}(ca A - w D) * \text{norm}(X)$  is less than overflow.

If both singular values of  $(ca A - w D)$  are less than SMIN, SMIN\*identity will be used instead of  $(ca A - w D)$ . If only one singular value

is less than SMIN, one element of  $(ca\ A - w\ D)$  will be perturbed enough to make the smallest singular value roughly SMIN. If both singular values are at least SMIN,  $(ca\ A - w\ D)$  will not be perturbed. In any case, the perturbation will be at most some small multiple of  $\max(SMIN, ulp * \text{norm}(ca\ A - w\ D))$ . The singular values are computed by infinity-norm approximations, and thus will only be correct to a factor of 2 or so.

Note: all input quantities are assumed to be smaller than overflow by a reasonable factor. (See BIGNUM.)

#### ARGUMENTS

- LTRANS (input) LOGICAL  
 =.TRUE.: A-transpose will be used.  
 =.FALSE.: A will be used (not transposed.)
- NA (input) INTEGER  
 The size of the matrix A. It may (only) be 1 or 2.
- NW (input) INTEGER  
 1 if "w" is real, 2 if "w" is complex. It may only be 1 or 2.
- SMIN (input) DOUBLE PRECISION  
 The desired lower bound on the singular values of A. This should be a safe distance away from underflow or overflow, say, between (underflow/machine precision) and (machine precision \* overflow). (See BIGNUM and ULP.)
- CA (input) DOUBLE PRECISION  
 The coefficient c, which A is multiplied by.
- A (input) DOUBLE PRECISION array, dimension (LDA,NA)  
 The NA x NA matrix A.
- LDA (input) INTEGER  
 The leading dimension of A. It must be at least NA.
- D1 (input) DOUBLE PRECISION  
 The 1,1 element in the diagonal matrix D.
- D2 (input) DOUBLE PRECISION  
 The 2,2 element in the diagonal matrix D. Not used if NW=1.
- B (input) DOUBLE PRECISION array, dimension (LDB,NW)  
 The NA x NW matrix B (right-hand side). If NW=2 ("w" is com-

plex), column 1 contains the real part of B and column 2 contains the imaginary part.

- LDB (input) INTEGER  
The leading dimension of B. It must be at least NA.
- WR (input) DOUBLE PRECISION  
The real part of the scalar "w".
- WI (input) DOUBLE PRECISION  
The imaginary part of the scalar "w". Not used if NW=1.
- X (output) DOUBLE PRECISION array, dimension (LDX,NW)  
The NA x NW matrix X (unknowns), as computed by DLALN2. If NW=2 ("w" is complex), on exit, column 1 will contain the real part of X and column 2 will contain the imaginary part.
- LDX (input) INTEGER  
The leading dimension of X. It must be at least NA.
- SCALE (output) DOUBLE PRECISION  
The scale factor that B must be multiplied by to insure that overflow does not occur when computing X. Thus,  $(\text{ca } A - w D) X$  will be  $\text{SCALE} * B$ , not B (ignoring perturbations of A.) It will be at most 1.
- XNORM (output) DOUBLE PRECISION  
The infinity-norm of X, when X is regarded as an NA x NW real matrix.
- INFO (output) INTEGER  
An error flag. It will be set to zero if no error occurs, a negative number if an argument is in error, or a positive number if  $\text{ca } A - w D$  had to be perturbed. The possible values are:  
= 0: No error occurred, and  $(\text{ca } A - w D)$  did not have to be perturbed. = 1:  $(\text{ca } A - w D)$  had to be perturbed to make its smallest (or only) singular value greater than SMIN. NOTE: In the interests of speed, this routine does not check the inputs for errors.

```

(LAPACK dlaln2)=
  (let* ((zero 0.0) (one 1.0) (two 2.0))
    (declare (type (double-float 0.0 0.0) zero)
              (type (double-float 1.0 1.0) one)
              (type (double-float 2.0 2.0) two))
    (let ((zswap
           (make-array 4 :element-type 't :initial-contents '(nil nil t t)))
          (rswap
           (make-array 4 :element-type 't :initial-contents '(nil t nil t)))
          (ipivot
           (make-array 16
                        :element-type 'fixnum
                        :initial-contents '(1 2 3 4 2 1 4 3 3 4 1 2 4 3 2 1))))
      (declare (type (simple-array fixnum (16)) ipivot)
                (type (simple-array (member t nil) (4)) rswap zswap))
      (defun dlaln2
        (ltrans na nw smin ca a lda d1 d2 b ldb$ wr wi x ldx scale xnorm
         info)
        (declare (type (simple-array double-float (*)) x b a)
                  (type (double-float) xnorm scale wi wr d2 d1 ca smin)
                  (type fixnum info ldx ldb$ lda nw na)
                  (type (member t nil) ltrans))
        (f2cl-lib:with-multi-array-data
          ((a double-float a-%data% a-%offset%)
           (b double-float b-%data% b-%offset%)
           (x double-float x-%data% x-%offset%))
          (prog ((ci (make-array 4 :element-type 'double-float))
                 (civ (make-array 4 :element-type 'double-float))
                 (cr (make-array 4 :element-type 'double-float))
                 (crv (make-array 4 :element-type 'double-float)) (bbnd 0.0)
                 (bi1 0.0) (bi2 0.0) (bignum 0.0) (bnorm 0.0) (br1 0.0) (br2 0.0)
                 (ci21 0.0) (ci22 0.0) (cmax 0.0) (cnorm 0.0) (cr21 0.0)
                 (cr22 0.0) (csi 0.0) (csr 0.0) (li21 0.0) (lr21 0.0) (smini 0.0)
                 (smlnum 0.0) (temp 0.0) (u22abs 0.0) (ui11 0.0) (ui11r 0.0)
                 (ui12 0.0) (ui12s 0.0) (ui22 0.0) (ur11 0.0) (ur11r 0.0)
                 (ur12 0.0) (ur12s 0.0) (ur22 0.0) (xi1 0.0) (xi2 0.0) (xr1 0.0)
                 (xr2 0.0) (icmax 0) (j 0))
                 (declare (type (simple-array double-float (4)) ci civ cr crv)
                           (type (double-float) bbnd bi1 bi2 bignum bnorm br1 br2 ci21
                                   ci22 cmax cnorm cr21 cr22 csi csr li21
                                   lr21 smini smlnum temp u22abs ui11
                                   ui11r ui12 ui12s ui22 ur11 ur11r ur12
                                   ur12s ur22 xi1 xi2 xr1 xr2)
                           (type fixnum icmax j))
                 (setf smlnum (* two (dlamch "Safe minimum")))
                 (setf bignum (/ one smlnum)))

```

```

(setf smini (max smin smlnum))
(setf info 0)
(setf scale one)
(cond
  ((= na 1)
    (cond
      ((= nw 1)
        (setf csr
          (-
            (* ca
              (f2cl-lib:fref a-%data%
                (1 1)
                ((1 lda) (1 *))
                a-%offset%))
            (* wr d1)))
        (setf cnorm (abs csr))
        (cond
          ((< cnorm smini)
            (setf csr smini)
            (setf cnorm smini)
            (setf info 1)))
        (setf bnorm
          (abs
            (f2cl-lib:fref b-%data%
              (1 1)
              ((1 ldb$) (1 *))
              b-%offset%)))
        (cond
          ((and (< cnorm one) (> bnorm one))
            (if (> bnorm (* bignum cnorm)) (setf scale (/ one bnorm))))
        (setf (f2cl-lib:fref x-%data% (1 1) ((1 ldx) (1 *)) x-%offset%)
          (/
            (*
              (f2cl-lib:fref b-%data%
                (1 1)
                ((1 ldb$) (1 *))
                b-%offset%)
              scale)
            csr))
        (setf xnorm
          (abs
            (f2cl-lib:fref x-%data%
              (1 1)
              ((1 ldx) (1 *))
              x-%offset%))))
      (t

```

```

(setf csr
  (-
    (* ca
      (f2cl-lib:fref a-%data%
        (1 1)
        ((1 lda) (1 *))
        a-%offset%))
    (* wr d1)))
(setf csi (* (- wi) d1))
(setf cnorm (+ (abs csr) (abs csi)))
(cond
  ((< cnorm smini)
    (setf csr smini)
    (setf csi zero)
    (setf cnorm smini)
    (setf info 1)))
(setf bnorm
  (+
    (abs
      (f2cl-lib:fref b-%data%
        (1 1)
        ((1 ldb$) (1 *))
        b-%offset%))
    (abs
      (f2cl-lib:fref b-%data%
        (1 2)
        ((1 ldb$) (1 *))
        b-%offset%))))
(cond
  ((and (< cnorm one) (> bnorm one))
    (if (> bnorm (* bignum cnorm)) (setf scale (/ one bnorm))))
(multiple-value-bind (var-0 var-1 var-2 var-3 var-4 var-5)
  (dladiv
    (* scale
      (f2cl-lib:fref b-%data%
        (1 1)
        ((1 ldb$) (1 *))
        b-%offset%))
    (* scale
      (f2cl-lib:fref b-%data%
        (1 2)
        ((1 ldb$) (1 *))
        b-%offset%))
    csr csi
    (f2cl-lib:fref x-%data% (1 1) ((1 ldx) (1 *)) x-%offset%)
    (f2cl-lib:fref x-%data% (1 2) ((1 ldx) (1 *)) x-%offset%)))

```

```

(declare (ignore var-0 var-1 var-2 var-3))
(setf (f2cl-lib:fref x-%data%
                    (1 1)
                    ((1 ldx) (1 *)))
      x-%offset%)

      var-4)
(setf (f2cl-lib:fref x-%data%
                    (1 2)
                    ((1 ldx) (1 *)))
      x-%offset%)

      var-5))
(setf xnorm
      (+
        (abs
          (f2cl-lib:fref x-%data%
                        (1 1)
                        ((1 ldx) (1 *)))
          x-%offset%))
        (abs
          (f2cl-lib:fref x-%data%
                        (1 2)
                        ((1 ldx) (1 *)))
          x-%offset%))))))
(t
  (setf (f2cl-lib:fref crv (1) ((1 4)))
        (-
          (* ca
            (f2cl-lib:fref a-%data%
                          (1 1)
                          ((1 lda) (1 *)))
            a-%offset%))
          (* wr d1)))
  (setf (f2cl-lib:fref crv (4) ((1 4)))
        (-
          (* ca
            (f2cl-lib:fref a-%data%
                          (2 2)
                          ((1 lda) (1 *)))
            a-%offset%))
          (* wr d2)))
  (cond
    (ltrans
      (setf (f2cl-lib:fref crv (3) ((1 4)))
            (* ca
              (f2cl-lib:fref a-%data%
                            (2 1)

```



```

((1 lda) (1 *))
a-%offset%)))
(setf (f2cl-lib:fref crv (2) ((1 4)))
  (* ca
    (f2cl-lib:fref a-%data%
      (1 2)
      ((1 lda) (1 *))
      a-%offset%))))
(t
  (setf (f2cl-lib:fref crv (2) ((1 4)))
    (* ca
      (f2cl-lib:fref a-%data%
        (2 1)
        ((1 lda) (1 *))
        a-%offset%))))
  (setf (f2cl-lib:fref crv (3) ((1 4)))
    (* ca
      (f2cl-lib:fref a-%data%
        (1 2)
        ((1 lda) (1 *))
        a-%offset%))))))
(cond
  ((= nw 1)
    (setf cmax zero)
    (setf icmax 0)
    (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
      (> j 4) nil)
    (tagbody
      (cond
        ((> (abs (f2cl-lib:fref crv (j) ((1 4)))) cmax)
          (setf cmax (abs (f2cl-lib:fref crv (j) ((1 4))))))
        (setf icmax j))))))
  (cond
    ((< cmax smini)
      (setf bnorm
        (max
          (abs
            (f2cl-lib:fref b-%data%
              (1 1)
              ((1 ldb$) (1 *))
              b-%offset%))
          (abs
            (f2cl-lib:fref b-%data%
              (2 1)
              ((1 ldb$) (1 *))
              b-%offset%))))))

```

```

(cond
  ((and (< smini one) (> bnorm one))
    (if (> bnorm (* bignum smini))
      (setf scale (/ one bnorm))))))
(setf temp (/ scale smini))
(setf (f2cl-lib:fref x-%data%
                    (1 1)
                    ((1 ldx) (1 *))
                    x-%offset%)
      (* temp
        (f2cl-lib:fref b-%data%
                      (1 1)
                      ((1 ldb$) (1 *))
                      b-%offset%)))
(setf (f2cl-lib:fref x-%data%
                    (2 1)
                    ((1 ldx) (1 *))
                    x-%offset%)
      (* temp
        (f2cl-lib:fref b-%data%
                      (2 1)
                      ((1 ldb$) (1 *))
                      b-%offset%)))
(setf xnorm (* temp bnorm))
(setf info 1)
(go end_label)))
(setf ur11 (f2cl-lib:fref crv (icmax) ((1 4))))
(setf cr21
  (f2cl-lib:fref crv
    ((f2cl-lib:fref ipivot
                     (2 icmax)
                     ((1 4) (1 4))))
    ((1 4))))
(setf ur12
  (f2cl-lib:fref crv
    ((f2cl-lib:fref ipivot
                     (3 icmax)
                     ((1 4) (1 4))))
    ((1 4))))
(setf cr22
  (f2cl-lib:fref crv
    ((f2cl-lib:fref ipivot
                     (4 icmax)
                     ((1 4) (1 4))))
    ((1 4))))
(setf ur11r (/ one ur11))

```

```

(setf lr21 (* ur11r cr21))
(setf ur22 (- cr22 (* ur12 lr21)))
(cond
  ((< (abs ur22) smini)
   (setf ur22 smini)
   (setf info 1)))
(cond
  ((f2cl-lib:fref rswap (icmax) ((1 4)))
   (setf br1
    (f2cl-lib:fref b-%data%
      (2 1)
      ((1 ldb$) (1 *))
      b-%offset%))
   (setf br2
    (f2cl-lib:fref b-%data%
      (1 1)
      ((1 ldb$) (1 *))
      b-%offset%))
   (t
    (setf br1
      (f2cl-lib:fref b-%data%
        (1 1)
        ((1 ldb$) (1 *))
        b-%offset%))
    (setf br2
      (f2cl-lib:fref b-%data%
        (2 1)
        ((1 ldb$) (1 *))
        b-%offset%))))
(setf br2 (- br2 (* lr21 br1)))
(setf bbnd (max (abs (* br1 (* ur22 ur11r))) (abs br2)))
(cond
  ((and (> bbnd one) (< (abs ur22) one))
   (if (>= bbnd (* bignum (abs ur22)))
       (setf scale (/ one bbnd))))
  (setf xr2 (/ (* br2 scale) ur22))
  (setf xr1 (- (* scale br1 ur11r) (* xr2 (* ur11r ur12))))
  (cond
    ((f2cl-lib:fref zswap (icmax) ((1 4)))
     (setf (f2cl-lib:fref x-%data%
      (1 1)
      ((1 ldx) (1 *))
      x-%offset%)
      xr2)
     (setf (f2cl-lib:fref x-%data%
      (2 1)

```

```

                                ((1 ldx) (1 *))
                                x-%offset%)
                                xr1))
(t
  (setf (f2cl-lib:fref x-%data%
                        (1 1)
                        ((1 ldx) (1 *))
                        x-%offset%)
        xr1)
    (setf (f2cl-lib:fref x-%data%
                        (2 1)
                        ((1 ldx) (1 *))
                        x-%offset%)
        xr2)))
(setf xnorm (max (abs xr1) (abs xr2)))
(cond
  ((and (> xnorm one) (> cmax one))
    (cond
      ((> xnorm (f2cl-lib:f2cl/ bignum cmax))
        (setf temp (/ cmax bignum))
        (setf (f2cl-lib:fref x-%data%
                              (1 1)
                              ((1 ldx) (1 *))
                              x-%offset%)
              (* temp
                 (f2cl-lib:fref x-%data%
                               (1 1)
                               ((1 ldx) (1 *))
                               x-%offset%)))
        (setf (f2cl-lib:fref x-%data%
                              (2 1)
                              ((1 ldx) (1 *))
                              x-%offset%)
              (* temp
                 (f2cl-lib:fref x-%data%
                               (2 1)
                               ((1 ldx) (1 *))
                               x-%offset%)))
        (setf xnorm (* temp xnorm))
        (setf scale (* temp scale))))))
(t
  (setf (f2cl-lib:fref civ (1) ((1 4))) (* (- wi) d1))
  (setf (f2cl-lib:fref civ (2) ((1 4))) zero)
  (setf (f2cl-lib:fref civ (3) ((1 4))) zero)
  (setf (f2cl-lib:fref civ (4) ((1 4))) (* (- wi) d2))
  (setf cmax zero)

```

```

(setf icmax 0)
(f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
  ((> j 4) nil)
  (tagbody
    (cond
      ((>
        (+ (abs (f2cl-lib:fref crv (j) ((1 4))))
          (abs (f2cl-lib:fref civ (j) ((1 4))))
          cmax)
        (setf cmax
          (+ (abs (f2cl-lib:fref crv (j) ((1 4))))
            (abs (f2cl-lib:fref civ (j) ((1 4))))))
        (setf icmax j))))))
(cond
  ((< cmax smini)
    (setf bnorm
      (max
        (+
          (abs
            (f2cl-lib:fref b-%data%
              (1 1)
              ((1 ldb$) (1 *)))
            b-%offset%))
          (abs
            (f2cl-lib:fref b-%data%
              (1 2)
              ((1 ldb$) (1 *)))
            b-%offset%))
        (+
          (abs
            (f2cl-lib:fref b-%data%
              (2 1)
              ((1 ldb$) (1 *)))
            b-%offset%))
          (abs
            (f2cl-lib:fref b-%data%
              (2 2)
              ((1 ldb$) (1 *)))
            b-%offset%))))))
  (cond
    ((and (< smini one) (> bnorm one))
      (if (> bnorm (* bignum smini))
        (setf scale (/ one bnorm))))))
(setf temp (/ scale smini))
(setf (f2cl-lib:fref x-%data%
  (1 1)

```

```

((1 ldx) (1 *))
x-%offset%)
(* temp
  (f2cl-lib:fref b-%data%
    (1 1)
    ((1 ldb$) (1 *))
    b-%offset%)))
(setf (f2cl-lib:fref x-%data%
  (2 1)
  ((1 ldx) (1 *))
  x-%offset%)

(* temp
  (f2cl-lib:fref b-%data%
    (2 1)
    ((1 ldb$) (1 *))
    b-%offset%)))
(setf (f2cl-lib:fref x-%data%
  (1 2)
  ((1 ldx) (1 *))
  x-%offset%)

(* temp
  (f2cl-lib:fref b-%data%
    (1 2)
    ((1 ldb$) (1 *))
    b-%offset%)))
(setf (f2cl-lib:fref x-%data%
  (2 2)
  ((1 ldx) (1 *))
  x-%offset%)

(* temp
  (f2cl-lib:fref b-%data%
    (2 2)
    ((1 ldb$) (1 *))
    b-%offset%)))
(setf xnorm (* temp bnorm))
(setf info 1)
(go end_label)))
(setf ur11 (f2cl-lib:fref crv (icmax) ((1 4))))
(setf ui11 (f2cl-lib:fref civ (icmax) ((1 4))))
(setf cr21
  (f2cl-lib:fref crv
    ((f2cl-lib:fref ipivot
      (2 icmax)
      ((1 4) (1 4))))
    ((1 4))))
(setf ci21

```

```

(f2cl-lib:fref civ
  ((f2cl-lib:fref ipivot
    (2 icmax)
    ((1 4) (1 4))))
  ((1 4)))
(setf ur12
  (f2cl-lib:fref crv
    ((f2cl-lib:fref ipivot
      (3 icmax)
      ((1 4) (1 4))))
    ((1 4)))
(setf ui12
  (f2cl-lib:fref civ
    ((f2cl-lib:fref ipivot
      (3 icmax)
      ((1 4) (1 4))))
    ((1 4)))
(setf cr22
  (f2cl-lib:fref crv
    ((f2cl-lib:fref ipivot
      (4 icmax)
      ((1 4) (1 4))))
    ((1 4)))
(setf ci22
  (f2cl-lib:fref civ
    ((f2cl-lib:fref ipivot
      (4 icmax)
      ((1 4) (1 4))))
    ((1 4)))
(cond
  ((or (= icmax 1) (= icmax 4))
    (cond
      ((> (abs ur11) (abs ui11))
        (setf temp (/ ui11 ur11))
        (setf ur11r (/ one (* ur11 (+ one (expt temp 2)))))
        (setf ui11r (* (- temp) ur11r)))
      (t
        (setf temp (/ ur11 ui11))
        (setf ui11r (/ (- one) (* ui11 (+ one (expt temp 2)))))
        (setf ur11r (* (- temp) ui11r))))
    (setf lr21 (* cr21 ur11r))
    (setf li21 (* cr21 ui11r))
    (setf ur12s (* ur12 ur11r))
    (setf ui12s (* ur12 ui11r))
    (setf ur22 (- cr22 (* ur12 lr21)))
    (setf ui22 (- ci22 (* ur12 li21))))

```

```

(t
  (setf ur11r (/ one ur11))
  (setf ui11r zero)
  (setf lr21 (* cr21 ur11r))
  (setf li21 (* ci21 ur11r))
  (setf ur12s (* ur12 ur11r))
  (setf ui12s (* ui12 ur11r))
  (setf ur22 (+ (- cr22 (* ur12 lr21)) (* ui12 li21)))
  (setf ui22 (- (* (- ur12) li21) (* ui12 lr21))))
(setf u22abs (+ (abs ur22) (abs ui22)))
(cond
  ((< u22abs smini)
   (setf ur22 smini)
   (setf ui22 zero)
   (setf info 1)))
(cond
  ((f2cl-lib:fref rswap (icmax) ((1 4)))
   (setf br2
    (f2cl-lib:fref b-%data%
                   (1 1)
                   ((1 ldb$) (1 *))
                   b-%offset%))
   (setf br1
    (f2cl-lib:fref b-%data%
                   (2 1)
                   ((1 ldb$) (1 *))
                   b-%offset%))
   (setf bi2
    (f2cl-lib:fref b-%data%
                   (1 2)
                   ((1 ldb$) (1 *))
                   b-%offset%))
   (setf bi1
    (f2cl-lib:fref b-%data%
                   (2 2)
                   ((1 ldb$) (1 *))
                   b-%offset%)))
(t
  (setf br1
   (f2cl-lib:fref b-%data%
                  (1 1)
                  ((1 ldb$) (1 *))
                  b-%offset%))
  (setf br2
   (f2cl-lib:fref b-%data%
                  (2 1)

```



```

((1 ldb$) (1 *))
b-%offset%)

(setf bi1
  (f2cl-lib:fref b-%data%
    (1 2)
    ((1 ldb$) (1 *))
    b-%offset%))

(setf bi2
  (f2cl-lib:fref b-%data%
    (2 2)
    ((1 ldb$) (1 *))
    b-%offset%)))

(setf br2 (+ (- br2 (* lr21 br1)) (* li21 bi1)))
(setf bi2 (- bi2 (* li21 br1) (* lr21 bi1)))
(setf bbnd
  (max
    (* (+ (abs br1) (abs bi1))
      (* u22abs (+ (abs ur11r) (abs ui11r)))))
    (+ (abs br2) (abs bi2))))

(cond
  ((and (> bbnd one) (< u22abs one))
    (cond
      ((>= bbnd (* bignum u22abs))
        (setf scale (/ one bbnd))
        (setf br1 (* scale br1))
        (setf bi1 (* scale bi1))
        (setf br2 (* scale br2))
        (setf bi2 (* scale bi2)))))
    (multiple-value-bind (var-0 var-1 var-2 var-3 var-4 var-5)
      (dladiv br2 bi2 ur22 ui22 xr2 xi2)
      (declare (ignore var-0 var-1 var-2 var-3))
      (setf xr2 var-4)
      (setf xi2 var-5))
    (setf xr1
      (+ (- (* ur11r br1) (* ui11r bi1) (* ur12s xr2))
        (* ui12s xi2)))
    (setf xi1
      (- (+ (* ui11r br1) (* ur11r bi1))
        (* ui12s xr2)
        (* ur12s xi2)))
    (cond
      ((f2cl-lib:fref zswap (icmax) ((1 4)))
        (setf (f2cl-lib:fref x-%data%
          (1 1)
          ((1 ldx) (1 *))
          x-%offset%))

```

```

        xr2)
      (setf (f2cl-lib:fref x-%data%
        (2 1)
        ((1 ldx) (1 *))
        x-%offset%)

        xr1)
      (setf (f2cl-lib:fref x-%data%
        (1 2)
        ((1 ldx) (1 *))
        x-%offset%)

        xi2)
      (setf (f2cl-lib:fref x-%data%
        (2 2)
        ((1 ldx) (1 *))
        x-%offset%)

        xi1))
    (t
      (setf (f2cl-lib:fref x-%data%
        (1 1)
        ((1 ldx) (1 *))
        x-%offset%)

        xr1)
      (setf (f2cl-lib:fref x-%data%
        (2 1)
        ((1 ldx) (1 *))
        x-%offset%)

        xr2)
      (setf (f2cl-lib:fref x-%data%
        (1 2)
        ((1 ldx) (1 *))
        x-%offset%)

        xi1)
      (setf (f2cl-lib:fref x-%data%
        (2 2)
        ((1 ldx) (1 *))
        x-%offset%)

        xi2)))
    (setf xnorm
      (max (+ (abs xr1) (abs xi1)) (+ (abs xr2) (abs xi2))))
    (cond
      ((and (> xnorm one) (> cmax one))
        (cond
          ((> xnorm (f2cl-lib:f2cl/ bignum cmax))
            (setf temp (/ cmax bignum))
            (setf (f2cl-lib:fref x-%data%
              (1 1)

```



```
nil
nil
nil
nil
nil
nil
nil
nil
scale
xnorm
info))))))
```

### 7.33 dlamch LAPACK

```
<dlamch.input>≡
)set break resume
)sys rm -f dlamch.output
)spool dlamch.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

`<dlamch.help>`≡

```
=====
dlamch examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

DLAMCH - determine double precision machine parameters

#### SYNOPSIS

DOUBLE PRECISION FUNCTION DLAMCH( CMACH )

CHARACTER CMACH

#### PURPOSE

DLAMCH determines double precision machine parameters.

#### ARGUMENTS

CMACH (input) CHARACTER\*1

Specifies the value to be returned by DLAMCH:

```
= 'E' or 'e',   DLAMCH := eps
= 'S' or 's',   DLAMCH := sfmin
= 'B' or 'b',   DLAMCH := base
= 'P' or 'p',   DLAMCH := eps*base
= 'N' or 'n',   DLAMCH := t
= 'R' or 'r',   DLAMCH := rnd
= 'M' or 'm',   DLAMCH := emin
= 'U' or 'u',   DLAMCH := rmin
= 'L' or 'l',   DLAMCH := emax
= 'O' or 'o',   DLAMCH := rmax
```

where

```
eps    = relative machine precision
sfmin  = safe minimum, such that 1/sfmin does not overflow
base   = base of the machine
prec   = eps*base
t       = number of (base)
digits in the mantissa
rnd     = 1.0 when rounding occurs in addition,
0.0 otherwise
emin   = minimum exponent before (gradual)
underflow
rmin    = underflow threshold - base**(emin-1)
emax    = largest exponent before overflow
rmax    = overflow threshold -
(base**emax)*(1-eps)
```

```

(LAPACK dlamch)=
  (let* ((one 1.0) (zero 0.0))
    (declare (type (double-float 1.0 1.0) one)
              (type (double-float 0.0 0.0) zero))
    (let ((eps 0.0)
          (sfmin 0.0)
          (base 0.0)
          (t$ 0.0f0)
          (rnd 0.0)
          (emin 0.0)
          (rmin 0.0)
          (emax 0.0)
          (rmax 0.0)
          (prec 0.0)
          (first$ nil))
      (declare (type (member t nil) first$)
                (type (single-float) t$)
                (type (double-float) prec rmax emax rmin emin rnd base sfmin eps))
      (setq first$ t)
      (defun dlamch (cmach)
        (declare (type character cmach))
        (f2cl-lib:with-multi-array-data
          ((cmach character cmach-%data% cmach-%offset%))
          (prog ((rmach 0.0) (small 0.0) (t$ 0.0) (beta 0) (imax 0) (imin 0)
                 (it 0) (lrnd nil) (dlamch 0.0))
            (declare (type fixnum beta imax imin it)
                      (type (member t nil) lrnd)
                      (type (double-float) rmach small t$ dlamch))
            (cond
             (first$
              (setf first$ nil)
              (multiple-value-bind
                (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7)
                (dlamc2 beta it lrnd eps imin rmin imax rmax)
                (declare (ignore))
                (setf beta var-0)
                (setf it var-1)
                (setf lrnd var-2)
                (setf eps var-3)
                (setf imin var-4)
                (setf rmin var-5)
                (setf imax var-6)
                (setf rmax var-7))
                (setf base (coerce (the fixnum beta) 'double-float))
                (setf t$ (coerce (the fixnum it) 'double-float))
                (cond

```

```

      (lrnd
        (setf rnd one)
        (setf eps (/ (expt base (f2cl-lib:int-sub 1 it)) 2)))
      (t
        (setf rnd zero)
        (setf eps (expt base (f2cl-lib:int-sub 1 it)))))
      (setf prec (* eps base))
      (setf emin (coerce (the fixnum imin) 'double-float))
      (setf emax (coerce (the fixnum imax) 'double-float))
      (setf sfmin rmin)
      (setf small (/ one rmax))
      (cond
        ((>= small sfmin)
          (setf sfmin (* small (+ one eps))))))
      (cond
        ((char-equal cmach #\E)
          (setf rmach eps))
        ((char-equal cmach #\S)
          (setf rmach sfmin))
        ((char-equal cmach #\B)
          (setf rmach base))
        ((char-equal cmach #\P)
          (setf rmach prec))
        ((char-equal cmach #\N)
          (setf rmach t$))
        ((char-equal cmach #\R)
          (setf rmach rnd))
        ((char-equal cmach #\M)
          (setf rmach emin))
        ((char-equal cmach #\U)
          (setf rmach rmin))
        ((char-equal cmach #\L)
          (setf rmach emax))
        ((char-equal cmach #\O)
          (setf rmach rmax)))
      (setf dlamch rmach)
end_label
      (return (values dlamch nil))))))

```

## 7.34 dlamc1 LAPACK

```
<dlamc1.input>≡  
  )set break resume  
  )sys rm -f dlamc1.output  
  )spool dlamc1.output  
  )set message test on  
  )set message auto off  
  )clear all  
  
  )spool  
  )lisp (bye)
```



`<dlamc1.help>`≡

```
=====
dlamc1 examples
=====
```

```
=====
Man Page Details
=====
```

```
-- LAPACK auxiliary routine (version 1.1) --
Univ. of Tennessee, Univ. of California Berkeley, NAG Ltd.,
Courant Institute, Argonne National Lab, and Rice University
October 31, 1992
```

```
.. Scalar Arguments ..
```

```
< LOGICAL IEEE1, RND >
< INTEGER BETA, T >
..
```

```
Purpose
```

```
=====
```

```
DLAMC1 determines the machine parameters given by BETA, T, RND, and
IEEE1.
```

```
Arguments
```

```
=====
```

```
BETA (output) INTEGER
The base of the machine.
```

```
T (output) INTEGER
The number of ( BETA ) digits in the mantissa.
```

```
RND (output) LOGICAL
Specifies whether proper rounding ( RND = .TRUE. ) or
chopping ( RND = .FALSE. ) occurs in addition. This may not
be a reliable guide to the way in which the machine performs
its arithmetic.
```

```
IEEE1 (output) LOGICAL
Specifies whether rounding appears to be done in the IEEE
'round to nearest' style.
```

```
Further Details
```

```
=====
```

See Malcolm M. A. (1972) Algorithms to reveal properties of floating-point arithmetic. Comms. of the ACM, 15, 949-951.

See Gentleman W. M. and Marovich S. B. (1974) More on algorithms that reveal properties of floating point arithmetic units. Comms. of the ACM, 17, 276-277.

```

(LAPACK dlamc1)≡
  (let ((lieee1 nil) (lbeta 0) (lrnd nil) (f2cl-lib:lt 0) (first$ nil))
    (declare (type fixnum f2cl-lib:lt lbeta)
              (type (member t nil) first$ lrnd lieee1))
    (setq first$ t)
    (defun dlamc1 (beta t$ rnd ieee1)
      (declare (type (member t nil) ieee1 rnd)
                (type fixnum t$ beta))
      (prog ((a 0.0) (b 0.0) (c 0.0) (f 0.0) (one 0.0) (qtr 0.0) (savec 0.0)
              (t1 0.0) (t2 0.0))
        (declare (type (double-float) t2 t1 savec qtr one f c b a))
        (cond
         (first$
          (tagbody
           (setf first$ nil)
           (setf one (coerce (the fixnum 1) 'double-float))
           (setf a (coerce (the fixnum 1) 'double-float))
           (setf c (coerce (the fixnum 1) 'double-float))
           label10
           (cond
            ((= c one)
             (setf a (* 2 a))
             (setf c
              (multiple-value-bind (ret-val var-0 var-1)
                (dlamc3 a one)
                (declare (ignore))
                (setf a var-0)
                (setf one var-1)
                ret-val)))
            (setf c
              (multiple-value-bind (ret-val var-0 var-1)
                (dlamc3 c (- a))
                (declare (ignore var-1))
                (setf c var-0)
                ret-val)))
            (go label10)))
          (setf b (coerce (the fixnum 1) 'double-float))
          (setf c
            (multiple-value-bind (ret-val var-0 var-1)
              (dlamc3 a b)
              (declare (ignore))
              (setf a var-0)
              (setf b var-1)
              ret-val)))
          label120
          (cond

```

```

(= c a)
(setf b (* 2 b))
(setf c
  (multiple-value-bind (ret-val var-0 var-1)
    (dlamc3 a b)
    (declare (ignore))
    (setf a var-0)
    (setf b var-1)
    ret-val))
(go label20)))
(setf qtr (/ one 4))
(setf savec c)
(setf c
  (multiple-value-bind (ret-val var-0 var-1)
    (dlamc3 c (- a))
    (declare (ignore var-1))
    (setf c var-0)
    ret-val))
(setf lbeta (f2cl-lib:int (+ c qtr)))
(setf b (coerce (the fixnum lbeta) 'double-float))
(setf f (dlamc3 (/ b 2) (/ (- b) 100)))
(setf c
  (multiple-value-bind (ret-val var-0 var-1)
    (dlamc3 f a)
    (declare (ignore))
    (setf f var-0)
    (setf a var-1)
    ret-val))
(cond
  ((= c a)
   (setf lrnd t))
  (t
   (setf lrnd nil)))
(setf f (dlamc3 (/ b 2) (/ b 100)))
(setf c
  (multiple-value-bind (ret-val var-0 var-1)
    (dlamc3 f a)
    (declare (ignore))
    (setf f var-0)
    (setf a var-1)
    ret-val))
(if (and lrnd (= c a)) (setf lrnd nil))
(setf t1
  (multiple-value-bind (ret-val var-0 var-1)
    (dlamc3 (/ b 2) a)
    (declare (ignore var-0))

```

```

        (setf a var-1)
        ret-val))
(setf t2
  (multiple-value-bind (ret-val var-0 var-1)
    (dlamc3 (/ b 2) savec)
    (declare (ignore var-0))
    (setf savec var-1)
    ret-val))
(setf lieee1 (and (= t1 a) (> t2 savec) lrnd))
(setf f2cl-lib:lt 0)
(setf a (coerce (the fixnum 1) 'double-float))
(setf c (coerce (the fixnum 1) 'double-float))
label30
(cond
  ((= c one)
    (setf f2cl-lib:lt (f2cl-lib:int-add f2cl-lib:lt 1))
    (setf a (* a lbeta))
    (setf c
      (multiple-value-bind (ret-val var-0 var-1)
        (dlamc3 a one)
        (declare (ignore))
        (setf a var-0)
        (setf one var-1)
        ret-val))
    (setf c
      (multiple-value-bind (ret-val var-0 var-1)
        (dlamc3 c (- a))
        (declare (ignore var-1))
        (setf c var-0)
        ret-val))
    (go label30))))))
(setf beta lbeta)
(setf t$ f2cl-lib:lt)
(setf rnd lrnd)
(setf ieee1 lieee1)
end_label
(return (values beta t$ rnd ieee1))))

```

## 7.35 dlamc2 LAPACK

```
<dlamc2.input>=  
  )set break resume  
  )sys rm -f dlamc2.output  
  )spool dlamc2.output  
  )set message test on  
  )set message auto off  
  )clear all  
  
  )spool  
  )lisp (bye)
```

`<dlamc2.help>`≡

```
=====
dlamc2 examples
=====
```

```
=====
Man Page Details
=====
```

```
-- LAPACK auxiliary routine (version 1.1) --
Univ. of Tennessee, Univ. of California Berkeley, NAG Ltd.,
Courant Institute, Argonne National Lab, and Rice University
October 31, 1992
```

```
.. Scalar Arguments ..
```

```
<    LOGICAL          RND >
<    INTEGER          BETA, EMAX, EMIN, T >
<    DOUBLE PRECISION EPS, RMAX, RMIN >
..
```

Purpose

=====

DLAMC2 determines the machine parameters specified in its argument list.

Arguments

=====

BETA      (output) INTEGER  
          The base of the machine.

T          (output) INTEGER  
          The number of ( BETA ) digits in the mantissa.

RND        (output) LOGICAL  
          Specifies whether proper rounding ( RND = .TRUE. ) or  
          chopping ( RND = .FALSE. ) occurs in addition. This may not  
          be a reliable guide to the way in which the machine performs  
          its arithmetic.

EPS        (output) DOUBLE PRECISION  
          The smallest positive number such that

```
fl( 1.0 - EPS ) .LT. 1.0,
```

where fl denotes the computed value.

EMIN     (output) INTEGER  
          The minimum exponent before (gradual) underflow occurs.

RMIN     (output) DOUBLE PRECISION  
          The smallest normalized number for the machine, given by  
           $\text{BASE}^{**}(\text{EMIN} - 1)$ , where BASE is the floating point value  
          of BETA.

EMAX     (output) INTEGER  
          The maximum exponent before overflow occurs.

RMAX     (output) DOUBLE PRECISION  
          The largest positive number for the machine, given by  
           $\text{BASE}^{**}\text{EMAX} * (1 - \text{EPS})$ , where BASE is the floating point  
          value of BETA.

Further Details  
=====

The computation of EPS is based on a routine PARANOIA by  
W. Kahan of the University of California at Berkeley.



```

(LAPACK dlamc2)=
  (let ((lbeta 0)
        (lemax 0)
        (lamin 0)
        (leps 0.0)
        (lrmax 0.0)
        (lrmin 0.0)
        (f2cl-lib:lt 0)
        (first$ nil)
        (iwarn nil))
    (declare (type (member t nil) iwarn first$)
              (type (double-float) lrmin lrmax leps)
              (type fixnum f2cl-lib:lt lamin lemax lbeta))
    (setq first$ t)
    (setq iwarn nil)
    (defun dlamc2 (beta t$ rnd eps emin rmin emax rmax)
      (declare (type (double-float) rmax rmin eps)
                (type (member t nil) rnd)
                (type fixnum emax emin t$ beta))
      (prog ((a 0.0) (b 0.0) (c 0.0) (half 0.0) (one 0.0) (rbase 0.0)
             (sixth$ 0.0) (small 0.0) (third$ 0.0) (two 0.0) (zero 0.0) (gnmin 0)
             (gpmin 0) (i 0) (ngnmin 0) (ngpmin 0) (ieee nil) (lieee1 nil)
             (lrnd nil))
        (declare (type (member t nil) lrnd lieee1 ieee)
                  (type fixnum ngpmin ngnmin i gpmin gnmin)
                  (type (double-float) zero two third$ small sixth$ rbase one half
                          c b a))
        (cond
         (first$
          (tagbody
           (setf first$ nil)
           (setf zero (coerce (the fixnum 0) 'double-float))
           (setf one (coerce (the fixnum 1) 'double-float))
           (setf two (coerce (the fixnum 2) 'double-float))
           (multiple-value-bind (var-0 var-1 var-2 var-3)
             (dlamc1 lbeta f2cl-lib:lt lrnd lieee1)
             (declare (ignore))
             (setf lbeta var-0)
             (setf f2cl-lib:lt var-1)
             (setf lrnd var-2)
             (setf lieee1 var-3))
           (setf b (coerce (the fixnum lbeta) 'double-float))
           (setf a (expt b (f2cl-lib:int-sub f2cl-lib:lt)))
           (setf leps a)
           (setf b (/ two 3))
           (setf half (/ one 2))

```

```

      (setf sixth$
        (multiple-value-bind (ret-val var-0 var-1)
          (dlamc3 b (- half))
          (declare (ignore var-1))
          (setf b var-0)
          ret-val))
      (setf third$
        (multiple-value-bind (ret-val var-0 var-1)
          (dlamc3 sixth$ sixth$)
          (declare (ignore))
          (setf sixth$ var-0)
          (setf sixth$ var-1)
          ret-val))
      (setf b
        (multiple-value-bind (ret-val var-0 var-1)
          (dlamc3 third$ (- half))
          (declare (ignore var-1))
          (setf third$ var-0)
          ret-val))
      (setf b
        (multiple-value-bind (ret-val var-0 var-1)
          (dlamc3 b sixth$)
          (declare (ignore))
          (setf b var-0)
          (setf sixth$ var-1)
          ret-val))
      (setf b (abs b))
      (if (< b leps) (setf b leps))
      (setf leps (coerce (the fixnum 1) 'double-float))
label10
      (cond
        ((and (> leps b) (> b zero))
         (setf leps b)
         (setf c (dlamc3 (* half leps) (* (expt two 5) (expt leps 2))))
         (setf c
           (multiple-value-bind (ret-val var-0 var-1)
             (dlamc3 half (- c))
             (declare (ignore var-1))
             (setf half var-0)
             ret-val))
         (setf b
           (multiple-value-bind (ret-val var-0 var-1)
             (dlamc3 half c)
             (declare (ignore))
             (setf half var-0)
             (setf c var-1)

```

```

        ret-val))
(setf c
  (multiple-value-bind (ret-val var-0 var-1)
    (dlamc3 half (- b))
    (declare (ignore var-1))
    (setf half var-0)
    ret-val))
(setf b
  (multiple-value-bind (ret-val var-0 var-1)
    (dlamc3 half c)
    (declare (ignore))
    (setf half var-0)
    (setf c var-1)
    ret-val))
(go label10)))
(if (< a leps) (setf leps a))
(setf rbase (/ one lbeta))
(setf small one)
(f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
  (> i 3) nil)
(tagbody
  (setf small
    (multiple-value-bind (ret-val var-0 var-1)
      (dlamc3 (* small rbase) zero)
      (declare (ignore var-0))
      (setf zero var-1)
      ret-val))))
(setf a
  (multiple-value-bind (ret-val var-0 var-1)
    (dlamc3 one small)
    (declare (ignore))
    (setf one var-0)
    (setf small var-1)
    ret-val))
(multiple-value-bind (var-0 var-1 var-2)
  (dlamc4 ngpmin one lbeta)
  (declare (ignore var-1 var-2))
  (setf ngpmin var-0))
(multiple-value-bind (var-0 var-1 var-2)
  (dlamc4 ngnmin (- one) lbeta)
  (declare (ignore var-1 var-2))
  (setf ngnmin var-0))
(multiple-value-bind (var-0 var-1 var-2)
  (dlamc4 gpmin a lbeta)
  (declare (ignore var-1 var-2))
  (setf gpmin var-0))

```

```

(multiple-value-bind (var-0 var-1 var-2)
  (dlamc4 gnmin (- a) lbeta)
  (declare (ignore var-1 var-2))
  (setf gnmin var-0))
(setf ieee nil)
(cond
  ((and (= ngpmin ngnmin) (= gpmin gnmin))
   (cond
     ((= ngpmin gpmin)
      (setf lemin ngpmin))
     ((= (f2cl-lib:int-add gpmin (f2cl-lib:int-sub ngpmin)) 3)
      (setf lemin
        (f2cl-lib:int-add (f2cl-lib:int-sub ngpmin 1)
                          f2cl-lib:lt))
      (setf ieee t))
     (t
      (setf lemin
        (min (the fixnum ngpmin)
              (the fixnum gpmin)))
      (setf iwarn t))))
  ((and (= ngpmin gpmin) (= ngnmin gnmin))
   (cond
     ((= (abs (f2cl-lib:int-add ngpmin (f2cl-lib:int-sub ngnmin))) 1)
      (setf lemin
        (max (the fixnum ngpmin)
              (the fixnum ngnmin))))
     (t
      (setf lemin
        (min (the fixnum ngpmin)
              (the fixnum ngnmin)))
      (setf iwarn t))))
  ((and
    (= (abs (f2cl-lib:int-add ngpmin (f2cl-lib:int-sub ngnmin))) 1)
    (= gpmin gnmin))
   (cond
     ((=
       (f2cl-lib:int-add gpmin
                         (f2cl-lib:int-sub
                          (min (the fixnum ngpmin)
                                (the fixnum ngnmin))))
        3)
      (setf lemin
        (f2cl-lib:int-add
         (f2cl-lib:int-sub
          (max (the fixnum ngpmin)
                (the fixnum ngnmin))
          1)
         1))
      (setf ieee t))
     (t
      (setf lemin
        (min (the fixnum ngpmin)
              (the fixnum ngnmin)))
      (setf iwarn t))))
  (t
   (setf lemin
     (min (the fixnum ngpmin)
           (the fixnum gpmin)))
   (setf iwarn t))))

```

```

1)
f2cl-lib:lt)))
(t
  (setf lemin
    (min (the fixnum ngpmin)
          (the fixnum ngnmin)))
    (setf iwarn t))))
(t
  (setf lemin
    (min (the fixnum ngpmin)
          (the fixnum ngnmin)
          (the fixnum gpmin)
          (the fixnum gnmin)))
    (setf iwarn t)))
(cond
  (iwarn
    (setf first$ t)
    (format t "~&~s~a~s~%~s~%~s~s~%"
      "WARNING. The value EMIN may be incorrect:- EMIN = "
      lemin
      " If, after inspection, the value EMIN looks acceptable "
      "please comment out "
      " the IF block as marked within the code of routine DLAMC2,"
      " otherwise supply EMIN explicitly.")))
  (setf ieee (or ieee lieee1))
  (setf lrmin (coerce (the fixnum 1) 'double-float))
  (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
    ((> i (f2cl-lib:int-add 1 (f2cl-lib:int-sub lemin)))
     nil)
    (tagbody
      (setf lrmin
        (multiple-value-bind (ret-val var-0 var-1)
          (dlamc3 (* lrmin rbase) zero)
          (declare (ignore var-0))
          (setf zero var-1)
          ret-val))))
    (multiple-value-bind (var-0 var-1 var-2 var-3 var-4 var-5)
      (dlamc5 lbeta f2cl-lib:lt lemin ieee lemax lrmax)
      (declare (ignore var-1))
      (setf lbeta var-0)
      (setf lemin var-2)
      (setf ieee var-3)
      (setf lemax var-4)
      (setf lrmax var-5))))
  (setf beta lbeta)
  (setf t$ f2cl-lib:lt)

```

```
(setf rnd lrnd)
(setf eps leps)
(setf emin lemin)
(setf rmin lrmin)
(setf emax lemax)
(setf rmax lrmax)
end_label
(return (values beta t$ rnd eps emin rmin emax rmax))))
```

## 7.36 dlamc3 LAPACK

```
<dlamc3.input>≡
)set break resume
)sys rm -f dlamc3.output
)spool dlamc3.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

`<dlamc3.help>`≡

```
=====
dlamc3 examples
=====
```

```
=====
Man Page Details
=====
```

```
-- LAPACK auxiliary routine (version 1.1) --
Univ. of Tennessee, Univ. of California Berkeley, NAG Ltd.,
Courant Institute, Argonne National Lab, and Rice University
October 31, 1992
```

```
.. Scalar Arguments ..
<    DOUBLE PRECISION    A, B >
..
```

```
Purpose
=====
```

DLAMC3 is intended to force A and B to be stored prior to doing the addition of A and B, for use in situations where optimizers might hold one of these in a register.

```
Arguments
=====
```

```
A, B    (input) DOUBLE PRECISION
         The values A and B.
```

`<LAPACK dlamc3>`≡

```
(defun dlamc3 (a b)
  (declare (type (double-float) b a))
  (prog ((dlamc3 0.0))
    (declare (type (double-float) dlamc3))
    (setf dlamc3 (+ a b))
    (return (values dlamc3 a b))))
```

## 7.37 dlamc4 LAPACK

```
<dlamc4.input>≡  
  )set break resume  
  )sys rm -f dlamc4.output  
  )spool dlamc4.output  
  )set message test on  
  )set message auto off  
  )clear all  
  
  )spool  
  )lisp (bye)
```



`<dlamc4.help>`≡

```
=====
dlamc4 examples
=====
```

```
=====
Man Page Details
=====
```

```
-- LAPACK auxiliary routine (version 1.1) --
Univ. of Tennessee, Univ. of California Berkeley, NAG Ltd.,
Courant Institute, Argonne National Lab, and Rice University
October 31, 1992
```

```
.. Scalar Arguments ..
```

```
<    INTEGER          BASE, EMIN >
```

```
<    DOUBLE PRECISION  START >
```

```
..
```

```
Purpose
```

```
=====
```

```
DLAMC4 is a service routine for DLAMC2.
```

```
Arguments
```

```
=====
```

```
EMIN    (output) EMIN
```

```
The minimum exponent before (gradual) underflow, computed by
setting A = START and dividing by BASE until the previous A
can not be recovered.
```

```
START    (input) DOUBLE PRECISION
```

```
The starting point for determining EMIN.
```

```
BASE    (input) INTEGER
```

```
The base of the machine.
```

```

(LAPACK dlamc4)≡
(defun dlamc4 (emin start base)
  (declare (type (double-float) start) (type fixnum base emin))
  (prog ((a 0.0) (b1 0.0) (b2 0.0) (c1 0.0) (c2 0.0) (d1 0.0) (d2 0.0)
        (one 0.0) (rbase 0.0) (zero 0.0) (i 0))
    (declare (type fixnum i)
      (type (double-float) zero rbase one d2 d1 c2 c1 b2 b1 a))
    (setf a start)
    (setf one (coerce (the fixnum 1) 'double-float))
    (setf rbase (/ one base))
    (setf zero (coerce (the fixnum 0) 'double-float))
    (setf emin 1)
    (setf b1
      (multiple-value-bind (ret-val var-0 var-1)
        (dlamc3 (* a rbase) zero)
        (declare (ignore var-0))
        (setf zero var-1)
        ret-val))
    (setf c1 a)
    (setf c2 a)
    (setf d1 a)
    (setf d2 a)
  label10
    (cond
      ((and (= c1 a) (= c2 a) (= d1 a) (= d2 a))
        (setf emin (f2cl-lib:int-sub emin 1))
        (setf a b1)
        (setf b1
          (multiple-value-bind (ret-val var-0 var-1)
            (dlamc3 (/ a base) zero)
            (declare (ignore var-0))
            (setf zero var-1)
            ret-val))
        (setf c1
          (multiple-value-bind (ret-val var-0 var-1)
            (dlamc3 (* b1 base) zero)
            (declare (ignore var-0))
            (setf zero var-1)
            ret-val))
        (setf d1 zero)
        (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
          ((> i base) nil)
          (tagbody (setf d1 (+ d1 b1)) label20))
        (setf b2
          (multiple-value-bind (ret-val var-0 var-1)
            (dlamc3 (* a rbase) zero)

```

```

        (declare (ignore var-0))
        (setf zero var-1)
        ret-val))
(setf c2
  (multiple-value-bind (ret-val var-0 var-1)
    (dlamc3 (/ b2 rbase) zero)
    (declare (ignore var-0))
    (setf zero var-1)
    ret-val))
(setf d2 zero)
(f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
  (> i base) nil)
  (tagbody (setf d2 (+ d2 b2)) label130))
  (go label10)))
end_label
(return (values emin nil nil))))

```

### 7.38 dlamc5 LAPACK

```

⟨dlamc5.input⟩≡
)set break resume
)sys rm -f dlamc5.output
)spool dlamc5.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)

```

`<dlamc5.help>≡`

```
=====
dlamc5 examples
=====
```

```
=====
Man Page Details
=====
```

```
-- LAPACK auxiliary routine (version 1.1) --
   Univ. of Tennessee, Univ. of California Berkeley, NAG Ltd.,
   Courant Institute, Argonne National Lab, and Rice University
   October 31, 1992
```

```
.. Scalar Arguments ..
<    LOGICAL          IEEE >
<    INTEGER          BETA, EMAX, EMIN, P >
<    DOUBLE PRECISION RMAX >
..
```

Purpose

```
=====
```

DLAMC5 attempts to compute RMAX, the largest machine floating-point number, without overflow. It assumes that EMAX + abs(EMIN) sum approximately to a power of 2. It will fail on machines where this assumption does not hold, for example, the Cyber 205 (EMIN = -28625, EMAX = 28718). It will also fail if the value supplied for EMIN is too large (i.e. too close to zero), probably with overflow.

Arguments

```
=====
```

BETA	(input) INTEGER	The base of floating-point arithmetic.
P	(input) INTEGER	The number of base BETA digits in the mantissa of a floating-point value.
EMIN	(input) INTEGER	The minimum exponent before (gradual) underflow.
IEEE	(input) LOGICAL	A logical flag specifying whether or not the arithmetic system is thought to comply with the IEEE standard.

EMAX     (output) INTEGER  
          The largest exponent before overflow

RMAX     (output) DOUBLE PRECISION  
          The largest machine floating-point number.

```

(LAPACK dlamc5)=
  (let* ((zero 0.0) (one 1.0))
    (declare (type (double-float 0.0 0.0) zero)
              (type (double-float 1.0 1.0) one))
    (defun dlamc5 (beta p emin ieee emax rmax)
      (declare (type (double-float) rmax)
                (type (member t nil) ieee)
                (type fixnum emax emin p beta))
      (prog ((oldy 0.0) (recbas 0.0) (y 0.0) (z 0.0) (exbits 0) (expsum 0) (i 0)
             (lexp 0) (nbits 0) (try 0) (uexp 0))
        (declare (type (double-float) oldy recbas y z)
                  (type fixnum exbits expsum i lexp nbits try uexp))
        (setf lexp 1)
        (setf exbits 1)
      label10
        (setf try (f2cl-lib:int-mul lexp 2))
        (cond
          ((<= try (f2cl-lib:int-sub emin))
            (setf lexp try)
            (setf exbits (f2cl-lib:int-add exbits 1))
            (go label10)))
        (cond
          ((= lexp (f2cl-lib:int-sub emin))
            (setf uexp lexp))
          (t
            (setf uexp try)
            (setf exbits (f2cl-lib:int-add exbits 1)))))
        (cond
          ((> (f2cl-lib:int-add uexp emin)
              (f2cl-lib:int-add (f2cl-lib:int-sub lexp) (f2cl-lib:int-sub emin)))
            (setf expsum (f2cl-lib:int-mul 2 lexp)))
          (t
            (setf expsum (f2cl-lib:int-mul 2 uexp))))
        (setf emax (f2cl-lib:int-sub (f2cl-lib:int-add expsum emin) 1))
        (setf nbits (f2cl-lib:int-add 1 exbits p))
        (cond
          ((and (= (mod nbits 2) 1) (= beta 2))
            (setf emax (f2cl-lib:int-sub emax 1))))
        (cond
          (ieee
            (setf emax (f2cl-lib:int-sub emax 1))))
        (setf recbas (/ one beta))
        (setf z (- beta one))
        (setf y zero)
        (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                      (> i p) nil)

```

```

(tagbody
  (setf z (* z recbas))
  (if (< y one) (setf oldy y))
  (setf y
    (multiple-value-bind (ret-val var-0 var-1)
      (dlamc3 y z)
      (declare (ignore))
      (setf y var-0)
      (setf z var-1)
      ret-val))))
(if (>= y one) (setf y oldy))
(f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
  ((> i emax) nil)
  (tagbody
    (setf y
      (multiple-value-bind (ret-val var-0 var-1)
        (dlamc3 (* y beta) zero)
        (declare (ignore var-0))
        (setf zero var-1)
        ret-val))))
    (setf rmax y)
  end_label
  (return (values beta nil emin ieee emax rmax))))

```

### 7.39 dlamrg LAPACK

```

⟨dlamrg.input⟩≡
)set break resume
)sys rm -f dlamrg.output
)spool dlamrg.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)

```

`<dlamrg.help>=`

```
=====
dlamrg examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

DLAMRG - create a permutation list which will merge the elements of A (which is composed of two independently sorted sets) into a single set which is sorted in ascending order

#### SYNOPSIS

```
SUBROUTINE DLAMRG( N1, N2, A, DTRD1, DTRD2, INDEX )
```

```
      INTEGER      DTRD1, DTRD2, N1, N2
```

```
      INTEGER      INDEX( * )
```

```
      DOUBLE      PRECISION A( * )
```

#### PURPOSE

DLAMRG will create a permutation list which will merge the elements of A (which is composed of two independently sorted sets) into a single set which is sorted in ascending order.

#### ARGUMENTS

N1 (input) INTEGER

N2 (input) INTEGER These arguments contain the respective lengths of the two sorted lists to be merged.

A (input) DOUBLE PRECISION array, dimension (N1+N2)

The first N1 elements of A contain a list of numbers which are sorted in either ascending or descending order. Likewise for the final N2 elements.

DTRD1 (input) INTEGER

DTRD2 (input) INTEGER These are the strides to be taken through the array A. Allowable strides are 1 and -1. They indicate whether a subset of A is sorted in ascending (DTRDx = 1) or descending (DTRDx = -1) order.

INDEX (output) INTEGER array, dimension (N1+N2)



On exit this array will contain a permutation such that if  $B(I) = A(\text{INDEX}(I))$  for  $I=1, N1+N2$ , then  $B$  will be sorted in ascending order.

```

(LAPACK dlamrg)≡
(defun dlamrg (n1 n2 a dtrd1 dtrd2 indx)
  (declare (type (simple-array fixnum (*)) indx)
            (type (simple-array double-float (*)) a)
            (type fixnum dtrd2 dtrd1 n2 n1))
  (f2cl-lib:with-multi-array-data
    ((a double-float a-%data% a-%offset%)
     (indx fixnum indx-%data% indx-%offset%))
    (prog ((i 0) (ind1 0) (ind2 0) (n1sv 0) (n2sv 0))
      (declare (type fixnum n2sv n1sv ind2 ind1 i))
      (setf n1sv n1)
      (setf n2sv n2)
      (cond
        ((> dtrd1 0)
         (setf ind1 1))
        (t
         (setf ind1 n1)))
      (cond
        ((> dtrd2 0)
         (setf ind2 (f2cl-lib:int-add 1 n1)))
        (t
         (setf ind2 (f2cl-lib:int-add n1 n2))))
      (setf i 1)
    label10
    (cond
      ((and (> n1sv 0) (> n2sv 0))
       (cond
         ((<= (f2cl-lib:fref a (ind1) ((1 *))
                           (f2cl-lib:fref a (ind2) ((1 *))))
          (setf (f2cl-lib:fref indx-%data% (i) ((1 *)) indx-%offset%) ind1)
          (setf i (f2cl-lib:int-add i 1))
          (setf ind1 (f2cl-lib:int-add ind1 dtrd1))
          (setf n1sv (f2cl-lib:int-sub n1sv 1)))
         (t
          (setf (f2cl-lib:fref indx-%data% (i) ((1 *)) indx-%offset%) ind2)
          (setf i (f2cl-lib:int-add i 1))
          (setf ind2 (f2cl-lib:int-add ind2 dtrd2))
          (setf n2sv (f2cl-lib:int-sub n2sv 1))))
        (go label10)))
      ((= n1sv 0)
       (f2cl-lib:fd0 (n1sv 1 (f2cl-lib:int-add n1sv 1))
                     ((> n1sv n2sv) nil)
       (tagbody
        (setf (f2cl-lib:fref indx-%data% (i) ((1 *)) indx-%offset%) ind2)
        (setf i (f2cl-lib:int-add i 1))

```

```

        (setf ind2 (f2cl-lib:int-add ind2 dtrd2))))))
(t
  (f2cl-lib:fdo (n2sv 1 (f2cl-lib:int-add n2sv 1))
    (> n2sv n1sv) nil)
  (tagbody
    (setf (f2cl-lib:fref indx-%data% (i) ((1 *)) indx-%offset%) ind1)
    (setf i (f2cl-lib:int-add i 1))
    (setf ind1 (f2cl-lib:int-add ind1 dtrd1))))))
end_label
(return (values nil nil nil nil nil nil))))

```

## 7.40 dlange LAPACK

```

⟨dlange.input⟩≡
)set break resume
)sys rm -f dlange.output
)spool dlange.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)

```

`<dlange.help>=`

```
=====
dlange examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

DLANGE - the value of the one norm, or the Frobenius norm, or the infinity norm, or the element of largest absolute value of a real matrix A

#### SYNOPSIS

DOUBLE PRECISION FUNCTION DLANGE( NORM, M, N, A, LDA, WORK )

CHARACTER NORM

INTEGER LDA, M, N

DOUBLE PRECISION A( LDA, \* ), WORK( \* )

#### PURPOSE

DLANGE returns the value of the one norm, or the Frobenius norm, or the infinity norm, or the element of largest absolute value of a real matrix A.

#### DESCRIPTION

DLANGE returns the value

```
DLANGE = ( max(abs(A(i,j))), NORM = 'M' or 'm'
(
( norm1(A),          NORM = '1', 'O' or 'o'
(
( normI(A),          NORM = 'I' or 'i'
(
( normF(A),          NORM = 'F', 'f', 'E' or 'e'
```

where norm1 denotes the one norm of a matrix (maximum column sum), normI denotes the infinity norm of a matrix (maximum row sum) and normF denotes the Frobenius norm of a matrix (square root of sum of squares). Note that max(abs(A(i,j))) is not a consistent matrix norm.

## ARGUMENTS

- NORM** (input) CHARACTER\*1  
Specifies the value to be returned in DLANGE as described above.
- M** (input) INTEGER  
The number of rows of the matrix A.  $M \geq 0$ . When  $M = 0$ , DLANGE is set to zero.
- N** (input) INTEGER  
The number of columns of the matrix A.  $N \geq 0$ . When  $N = 0$ , DLANGE is set to zero.
- A** (input) DOUBLE PRECISION array, dimension (LDA,N)  
The m by n matrix A.
- LDA** (input) INTEGER  
The leading dimension of the array A.  $LDA \geq \max(M,1)$ .
- WORK** (workspace) DOUBLE PRECISION array, dimension (MAX(1,LWORK)),  
where LWORK  $\geq M$  when NORM = 'I'; otherwise, WORK is not referenced.

```

(LAPACK dlange)≡
(let* ((one 1.0) (zero 0.0))
  (declare (type (double-float 1.0 1.0) one)
           (type (double-float 0.0 0.0) zero))
  (defun dlange (norm m n a lda work)
    (declare (type (simple-array double-float (*)) work a)
             (type fixnum lda n m)
             (type character norm))
    (f2cl-lib:with-multi-array-data
      ((norm character norm-%data% norm-%offset%)
       (a double-float a-%data% a-%offset%)
       (work double-float work-%data% work-%offset%))
      (prog ((scale 0.0) (sum 0.0) (value 0.0) (i 0) (j 0) (dlange 0.0))
        (declare (type fixnum i j)
                  (type (double-float) scale sum value dlange))
        (cond
          ((= (min (the fixnum m) (the fixnum n)) 0)
           (setf value zero))
          ((char-equal norm #\M)
           (setf value zero)
           (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                         ((> j n) nil)
           (tagbody
            (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                          ((> i m) nil)
            (tagbody
             (setf value
                   (max value
                       (abs
                        (f2cl-lib:fref a-%data%
                                       (i j)
                                       ((1 lda) (1 *))
                                       a-%offset%))))))))))
          ((or (char-equal norm #\O) (f2cl-lib:fstring-= norm "1"))
           (setf value zero)
           (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                         ((> j n) nil)
           (tagbody
            (setf sum zero)
            (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                          ((> i m) nil)
            (tagbody
             (setf sum
                   (+ sum
                     (abs
                      (f2cl-lib:fref a-%data%

```

```

                                (i j)
                                ((1 lda) (1 *))
                                a-%offset%))))))
    (setf value (max value sum))))))
((char-equal norm #\I)
 (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
               (> i m) nil)
  (tagbody
    (setf (f2cl-lib:fref work-%data% (i) ((1 *)) work-%offset%)
          zero)))
(f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
              (> j n) nil)
  (tagbody
    (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                  (> i m) nil)
      (tagbody
        (setf (f2cl-lib:fref work-%data% (i) ((1 *)) work-%offset%)
              (+
                (f2cl-lib:fref work-%data%
                               (i)
                               ((1 *))
                               work-%offset%)
                (abs
                 (f2cl-lib:fref a-%data%
                               (i j)
                               ((1 lda) (1 *))
                               a-%offset%))))))))))
(setf value zero)
(f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
              (> i m) nil)
  (tagbody
    (setf value
          (max value
            (f2cl-lib:fref work-%data%
                          (i)
                          ((1 *))
                          work-%offset%))))))
((or (char-equal norm #\F) (char-equal norm #\E))
 (setf scale zero)
 (setf sum one)
 (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
               (> j n) nil)
  (tagbody
    (multiple-value-bind (var-0 var-1 var-2 var-3 var-4)
      (dlassq m
        (f2cl-lib:array-slice a double-float (1 j) ((1 lda) (1 *)))

```

```

        1 scale sum)
      (declare (ignore var-0 var-1 var-2))
      (setf scale var-3)
      (setf sum var-4))))
    (setf value (* scale (f2cl-lib:fsqrt sum))))
    (setf dlange value)
  end_label
  (return (values dlange nil nil nil nil nil nil))))))

```

## 7.41 dlanhs LAPACK

```

⟨dlanhs.input⟩≡
)set break resume
)sys rm -f dlanhs.output
)spool dlanhs.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)

```



`<dlanhs.help>=`

```
=====
dlanhs examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

DLANHS - the value of the one norm, or the Frobenius norm, or the infinity norm, or the element of largest absolute value of a Hessenberg matrix A

#### SYNOPSIS

```
DOUBLE PRECISION FUNCTION DLANHS( NORM, N, A, LDA, WORK )
```

```
CHARACTER      NORM
```

```
INTEGER        LDA, N
```

```
DOUBLE         PRECISION A( LDA, * ), WORK( * )
```

#### PURPOSE

DLANHS returns the value of the one norm, or the Frobenius norm, or the infinity norm, or the element of largest absolute value of a Hessenberg matrix A.

#### DESCRIPTION

DLANHS returns the value

```
DLANHS = ( max(abs(A(i,j))), NORM = 'M' or 'm'
(
( norm1(A),          NORM = '1', 'O' or 'o'
(
( normI(A),          NORM = 'I' or 'i'
(
( normF(A),          NORM = 'F', 'f', 'E' or 'e'
```

where norm1 denotes the one norm of a matrix (maximum column sum), normI denotes the infinity norm of a matrix (maximum row sum) and normF denotes the Frobenius norm of a matrix (square root of sum of squares). Note that max(abs(A(i,j))) is not a consistent matrix norm.

## ARGUMENTS

- NORM (input) CHARACTER\*1  
Specifies the value to be returned in DLANHS as described above.
- N (input) INTEGER  
The order of the matrix A.  $N \geq 0$ . When  $N = 0$ , DLANHS is set to zero.
- A (input) DOUBLE PRECISION array, dimension (LDA,N)  
The  $n$  by  $n$  upper Hessenberg matrix A; the part of A below the first sub-diagonal is not referenced.
- LDA (input) INTEGER  
The leading dimension of the array A.  $LDA \geq \max(N,1)$ .
- WORK (workspace) DOUBLE PRECISION array, dimension  $(\max(1,LWORK))$ , where  $LWORK \geq N$  when  $NORM = 'I'$ ; otherwise, WORK is not referenced.

```

(LAPACK dlanhs)=
(let* ((one 1.0) (zero 0.0))
  (declare (type (double-float 1.0 1.0) one)
    (type (double-float 0.0 0.0) zero))
  (defun dlanhs (norm n a lda work)
    (declare (type (simple-array double-float (*)) work a)
      (type fixnum lda n)
      (type character norm))
    (f2cl-lib:with-multi-array-data
      ((norm character norm-%data% norm-%offset%)
       (a double-float a-%data% a-%offset%)
       (work double-float work-%data% work-%offset%))
      (prog ((scale 0.0) (sum 0.0) (value 0.0) (i 0) (j 0) (dlanhs 0.0))
        (declare (type fixnum i j)
          (type (double-float) scale sum value dlanhs))
        (cond
          ((= n 0)
            (setf value zero))
          ((char-equal norm #\M)
            (setf value zero)
            (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
              ((> j n) nil)
              (tagbody
                (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                  ((> i
                    (min (the fixnum n)
                      (the fixnum
                        (f2cl-lib:int-add j 1))))
                    nil)
                  (tagbody
                    (setf value
                      (max value
                        (abs
                          (f2cl-lib:fref a-%data%
                            (i j)
                            ((1 lda) (1 *))
                            a-%offset%))))))))
            ((or (char-equal norm #\O) (f2cl-lib:fstring-= norm "1"))
              (setf value zero)
              (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                ((> j n) nil)
                (tagbody
                  (setf sum zero)
                  (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                    ((> i
                      (min (the fixnum n)

```

```

                                (the fixnum
                                (f2cl-lib:int-add j 1))))
                                nil)
    (tagbody
      (setf sum
        (+ sum
          (abs
            (f2cl-lib:fref a-%data%
                          (i j)
                          ((1 lda) (1 *))
                          a-%offset%))))))
      (setf value (max value sum))))
  ((char-equal norm #\I)
   (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                 ((> i n) nil)
   (tagbody
     (setf (f2cl-lib:fref work-%data% (i) ((1 *)) work-%offset%)
           zero)))
   (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                 ((> j n) nil)
   (tagbody
     (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                   ((> i
                     (min (the fixnum n)
                          (the fixnum
                            (f2cl-lib:int-add j 1))))
                     nil)
     (tagbody
       (setf (f2cl-lib:fref work-%data% (i) ((1 *)) work-%offset%)
             (+
              (f2cl-lib:fref work-%data%
                              (i)
                              ((1 *))
                              work-%offset%)
              (abs
                (f2cl-lib:fref a-%data%
                              (i j)
                              ((1 lda) (1 *))
                              a-%offset%))))))))
     (setf value zero)
     (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                   ((> i n) nil)
     (tagbody
       (setf value
         (max value
          (f2cl-lib:fref work-%data%

```

```

(i)
((1 *))
work-%offset%))))))
((or (char-equal norm #\F) (char-equal norm #\E))
(setf scale zero)
(setf sum one)
(f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
              (> j n) nil)
(tagbody
  (multiple-value-bind (var-0 var-1 var-2 var-3 var-4)
    (dlassq
      (min (the fixnum n)
            (the fixnum (f2cl-lib:int-add j 1)))
      (f2cl-lib:array-slice a double-float (1 j) ((1 lda) (1 *)))
      1 scale sum)
    (declare (ignore var-0 var-1 var-2))
    (setf scale var-3)
    (setf sum var-4))))
(setf value (* scale (f2cl-lib:fsqrt sum))))
(setf dlanhs value)
end_label
(return (values dlanhs nil nil nil nil nil))))))

```

## 7.42 dlanst LAPACK

```

<dlanst.input>≡
)set break resume
)sys rm -f dlanst.output
)spool dlanst.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)

```

`<dlanst.help>`≡

```
=====
dlanst examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

DLANST - the value of the one norm, or the Frobenius norm, or the infinity norm, or the element of largest absolute value of a real symmetric tridiagonal matrix A

#### SYNOPSIS

```
DOUBLE PRECISION FUNCTION DLANST( NORM, N, D, E )
```

```
CHARACTER    NORM
```

```
INTEGER      N
```

```
DOUBLE       PRECISION D( * ), E( * )
```

#### PURPOSE

DLANST returns the value of the one norm, or the Frobenius norm, or the infinity norm, or the element of largest absolute value of a real symmetric tridiagonal matrix A.

#### DESCRIPTION

DLANST returns the value

```
DLANST = ( max(abs(A(i,j))), NORM = 'M' or 'm'
          (
            ( norm1(A),          NORM = '1', 'O' or 'o'
              (
                ( normI(A),      NORM = 'I' or 'i'
                  (
                    ( normF(A),  NORM = 'F', 'f', 'E' or 'e'
```

where norm1 denotes the one norm of a matrix (maximum column sum), normI denotes the infinity norm of a matrix (maximum row sum) and normF denotes the Frobenius norm of a matrix (square root of sum of squares). Note that max(abs(A(i,j))) is not a consistent matrix norm.

## ARGUMENTS

- NORM (input) CHARACTER\*1  
Specifies the value to be returned in DLANST as described above.
- N (input) INTEGER  
The order of the matrix A.  $N \geq 0$ . When  $N = 0$ , DLANST is set to zero.
- D (input) DOUBLE PRECISION array, dimension (N)  
The diagonal elements of A.
- E (input) DOUBLE PRECISION array, dimension (N-1)  
The (n-1) sub-diagonal or super-diagonal elements of A.

```

(LAPACK dlanst)=
(let* ((one 1.0) (zero 0.0))
  (declare (type (double-float 1.0 1.0) one)
    (type (double-float 0.0 0.0) zero))
  (defun dlanst (norm n d e)
    (declare (type (simple-array double-float (*)) e d)
      (type fixnum n)
      (type character norm))
    (f2cl-lib:with-multi-array-data
      ((norm character norm-%data% norm-%offset%)
        (d double-float d-%data% d-%offset%)
        (e double-float e-%data% e-%offset%))
      (prog ((anorm 0.0) (scale 0.0) (sum 0.0) (i 0) (dlanst 0.0))
        (declare (type fixnum i)
          (type (double-float) anorm scale sum dlanst))
        (cond
          ((<= n 0)
            (setf anorm zero))
          ((char-equal norm #\M)
            (setf anorm (abs (f2cl-lib:fref d-%data% (n) ((1 *)) d-%offset%)))
            (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
              ((> i (f2cl-lib:int-add n (f2cl-lib:int-sub 1))) nil)
              (tagbody
                (setf anorm
                  (max anorm
                    (abs
                     (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%))))
                (setf anorm
                  (max anorm
                    (abs
                     (f2cl-lib:fref e-%data% (i) ((1 *)) e-%offset%))))))))
          ((or (char-equal norm #\O) (f2cl-lib:fstring-= norm "1") (char-equal norm #\I))
            (cond
              ((= n 1)
                (setf anorm
                  (abs (f2cl-lib:fref d-%data% (1) ((1 *)) d-%offset%))))
              (t
                (setf anorm
                  (max
                    (+ (abs (f2cl-lib:fref d-%data% (1) ((1 *)) d-%offset%))
                      (abs
                       (f2cl-lib:fref e-%data% (1) ((1 *)) e-%offset%)))
                    (+
                     (abs
                      (f2cl-lib:fref e-%data%
                        ((f2cl-lib:int-sub n 1))

```



```

((1 *))
e-%offset%))
(abs (f2cl-lib:fref d-%data% (n) ((1 *)) d-%offset%))))
(f2cl-lib:fdo (i 2 (f2cl-lib:int-add i 1))
  (> i (f2cl-lib:int-add n (f2cl-lib:int-sub 1)))
  nil)
(tagbody
  (setf anorm
    (max anorm
      (+
        (abs
          (f2cl-lib:fref d-%data%
            (i)
            ((1 *))
            d-%offset%))
        (abs
          (f2cl-lib:fref e-%data%
            (i)
            ((1 *))
            e-%offset%))
        (abs
          (f2cl-lib:fref e-%data%
            ((f2cl-lib:int-sub i 1))
            ((1 *))
            e-%offset%))))))
  ((or (char-equal norm #\F) (char-equal norm #\E))
    (setf scale zero)
    (setf sum one)
    (cond
      (> n 1)
      (multiple-value-bind (var-0 var-1 var-2 var-3 var-4)
        (dlassq (f2cl-lib:int-sub n 1) e 1 scale sum)
        (declare (ignore var-0 var-1 var-2))
        (setf scale var-3)
        (setf sum var-4))
      (setf sum (* 2 sum))))
    (multiple-value-bind (var-0 var-1 var-2 var-3 var-4)
      (dlassq n d 1 scale sum)
      (declare (ignore var-0 var-1 var-2))
      (setf scale var-3)
      (setf sum var-4))
      (setf anorm (* scale (f2cl-lib:fsqrt sum))))
    (setf dlanst anorm)
  end_label
  (return (values dlanst nil nil nil nil))))

```

## 7.43 dlanv2 LAPACK

```
<dlanv2.input>=  
  )set break resume  
  )sys rm -f dlanv2.output  
  )spool dlanv2.output  
  )set message test on  
  )set message auto off  
  )clear all  
  
  )spool  
  )lisp (bye)
```

`<dlanv2.help>=`

```
=====
dlanv2 examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

DLANV2 - the Schur factorization of a real 2-by-2 nonsymmetric matrix in standard form

#### SYNOPSIS

```
SUBROUTINE DLANV2( A, B, C, D, RT1R, RT1I, RT2R, RT2I, CS, SN )
```

```
DOUBLE PRECISION A, B, C, CS, D, RT1I, RT1R, RT2I, RT2R, SN
```

#### PURPOSE

DLANV2 computes the Schur factorization of a real 2-by-2 nonsymmetric matrix in standard form:

$$\begin{bmatrix} A & B \\ C & D \end{bmatrix} = \begin{bmatrix} CS & -SN \\ SN & CS \end{bmatrix} \begin{bmatrix} AA & BB \\ CC & DD \end{bmatrix} \begin{bmatrix} CS & SN \\ -SN & CS \end{bmatrix}$$

where either

1)  $CC = 0$  so that  $AA$  and  $DD$  are real eigenvalues of the matrix, or 2)  $AA = DD$  and  $BB*CC < 0$ , so that  $AA + \text{or} - \sqrt{BB*CC}$  are complex conjugate eigenvalues.

#### ARGUMENTS

A (input/output) DOUBLE PRECISION  
 B (input/output) DOUBLE PRECISION C (input/output) DOUBLE PRECISION D (input/output) DOUBLE PRECISION On entry, the elements of the input matrix. On exit, they are overwritten by the elements of the standardised Schur form.

RT1R (output) DOUBLE PRECISION  
 RT1I (output) DOUBLE PRECISION RT2R (output) DOUBLE PRECISION RT2I (output) DOUBLE PRECISION The real and imaginary parts of the eigenvalues. If the eigenvalues are a complex conjugate pair,  $RT1I > 0$ .

CS (output) DOUBLE PRECISION  
 SN (output) DOUBLE PRECISION Parameters of the rotation

`matrix.`

```

(LAPACK dlanv2)≡
  (let* ((zero 0.0) (half 0.5) (one 1.0) (multpl 4.0))
    (declare (type (double-float 0.0 0.0) zero)
              (type (double-float 0.5 0.5) half)
              (type (double-float 1.0 1.0) one)
              (type (double-float 4.0 4.0) multpl))
    (defun dlanv2 (a b c d rt1r rt1i rt2r rt2i cs sn)
      (declare (type (double-float) sn cs rt2i rt2r rt1i rt1r d c b a))
      (prog ((aa 0.0) (bb 0.0) (bcmax 0.0) (bcmis 0.0) (cc 0.0) (cs1 0.0)
              (dd 0.0) (eps 0.0) (p 0.0) (sab 0.0) (sac 0.0) (scale 0.0)
              (sigma 0.0) (sn1 0.0) (tau 0.0) (temp 0.0) (z 0.0))
        (declare (type (double-float) aa bb bcmax bcmis cc cs1 dd eps p sab sac
                        scale sigma sn1 tau temp z))

        (setf eps (dlamch "P"))
        (cond
          ((= c zero)
            (setf cs one)
            (setf sn zero)
            (go label10))
          ((= b zero)
            (setf cs zero)
            (setf sn one)
            (setf temp d)
            (setf d a)
            (setf a temp)
            (setf b (- c))
            (setf c zero)
            (go label10))
          ((and (= (+ a (- d)) zero)
                (/= (f2cl-lib:sign one b) (f2cl-lib:sign one c)))
            (setf cs one)
            (setf sn zero)
            (go label10))
          (t
            (setf temp (- a d))
            (setf p (* half temp))
            (setf bcmax (max (abs b) (abs c)))
            (setf bcmis
              (* (min (abs b) (abs c))
                 (f2cl-lib:sign one b)
                 (f2cl-lib:sign one c)))
            (setf scale (max (abs p) bcmax))
            (setf z (+ (* (/ p scale) p) (* (/ bcmax scale) bcmis)))
            (cond
              ((>= z (* multpl eps))
                (setf z

```

```

      (+ p
        (f2cl-lib:sign
          (* (f2cl-lib:fsqrt scale) (f2cl-lib:fsqrt z))
          p)))
    (setf a (+ d z))
    (setf d (- d (* (/ bmax z) bmis)))
    (setf tau (dlapy2 c z))
    (setf cs (/ z tau))
    (setf sn (/ c tau))
    (setf b (- b c))
    (setf c zero))
  (t
    (setf sigma (+ b c))
    (setf tau (dlapy2 sigma temp))
    (setf cs (f2cl-lib:fsqrt (* half (+ one (/ (abs sigma) tau)))))
    (setf sn (* (- (/ p (* tau cs))) (f2cl-lib:sign one sigma)))
    (setf aa (+ (* a cs) (* b sn)))
    (setf bb (+ (* (- a) sn) (* b cs)))
    (setf cc (+ (* c cs) (* d sn)))
    (setf dd (+ (* (- c) sn) (* d cs)))
    (setf a (+ (* aa cs) (* cc sn)))
    (setf b (+ (* bb cs) (* dd sn)))
    (setf c (+ (* (- aa) sn) (* cc cs)))
    (setf d (+ (* (- bb) sn) (* dd cs)))
    (setf temp (* half (+ a d)))
    (setf a temp)
    (setf d temp)
    (cond
      ((/= c zero)
        (cond
          ((/= b zero)
            (cond
              ((= (f2cl-lib:sign one b) (f2cl-lib:sign one c))
                (setf sab (f2cl-lib:fsqrt (abs b)))
                (setf sac (f2cl-lib:fsqrt (abs c)))
                (setf p (f2cl-lib:sign (* sab sac) c))
                (setf tau (/ one (f2cl-lib:fsqrt (abs (+ b c)))))
                (setf a (+ temp p))
                (setf d (- temp p))
                (setf b (- b c))
                (setf c zero)
                (setf cs1 (* sab tau))
                (setf sn1 (* sac tau))
                (setf temp (- (* cs cs1) (* sn sn1)))
                (setf sn (+ (* cs sn1) (* sn cs1)))
                (setf cs temp))))
              (t
                (setf a (+ temp p))
                (setf d (- temp p))
                (setf b (- b c))
                (setf c zero)
                (setf cs1 (* sab tau))
                (setf sn1 (* sac tau))
                (setf temp (- (* cs cs1) (* sn sn1)))
                (setf sn (+ (* cs sn1) (* sn cs1)))
                (setf cs temp))))
            ))
          (t
            (setf a (+ temp p))
            (setf d (- temp p))
            (setf b (- b c))
            (setf c zero)
            (setf cs1 (* sab tau))
            (setf sn1 (* sac tau))
            (setf temp (- (* cs cs1) (* sn sn1)))
            (setf sn (+ (* cs sn1) (* sn cs1)))
            (setf cs temp))))
        ))
      (t
        (setf a (+ temp p))
        (setf d (- temp p))
        (setf b (- b c))
        (setf c zero)
        (setf cs1 (* sab tau))
        (setf sn1 (* sac tau))
        (setf temp (- (* cs cs1) (* sn sn1)))
        (setf sn (+ (* cs sn1) (* sn cs1)))
        (setf cs temp))))
    ))
  )

```

```

(t
  (setf b (- c))
  (setf c zero)
  (setf temp cs)
  (setf cs (- sn))
  (setf sn temp)))))))))
label10
  (setf rt1r a)
  (setf rt2r d)
  (cond
    ((= c zero)
      (setf rt1i zero)
      (setf rt2i zero))
    (t
      (setf rt1i (* (f2cl-lib:fsqrt (abs b)) (f2cl-lib:fsqrt (abs c))))
      (setf rt2i (- rt1i))))
end_label
  (return (values a b c d rt1r rt1i rt2r rt2i cs sn))))))

```

## 7.44 dlapy2 LAPACK

```

⟨dlapy2.input⟩≡
)set break resume
)sys rm -f dlapy2.output
)spool dlapy2.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)

```

`<dlapy2.help>=`

```
=====
dlapy2 examples
=====
```

```
=====
Man Page Details
=====
```

NAME

DLAPY2 - `sqrt(x**2+y**2)`, taking care not to cause unnecessary overflow

SYNOPSIS

DOUBLE PRECISION FUNCTION DLAPY2( X, Y )

DOUBLE PRECISION X, Y

PURPOSE

DLAPY2 returns `sqrt(x**2+y**2)`, taking care not to cause unnecessary overflow.

ARGUMENTS

X (input) DOUBLE PRECISION

Y (input) DOUBLE PRECISION X and Y specify the values x and y.



```

<LAPACK dlapy2>≡
  (let* ((zero 0.0) (one 1.0))
    (declare (type (double-float 0.0 0.0) zero)
              (type (double-float 1.0 1.0) one))
    (defun dlapy2 (x y)
      (declare (type (double-float) y x))
      (prog ((w 0.0) (xabs 0.0) (yabs 0.0) (z 0.0) (dlapy2 0.0))
        (declare (type (double-float) w xabs yabs z dlapy2))
        (setf xabs (abs x))
        (setf yabs (abs y))
        (setf w (max xabs yabs))
        (setf z (min xabs yabs))
        (cond
          ((= z zero)
           (setf dlapy2 w))
          (t
           (setf dlapy2 (* w (f2cl-lib:fsqrt (+ one (expt (/ z w) 2)))))))
        (return (values dlapy2 nil nil)))))

```

## 7.45 dlaqtr LAPACK

```

<dlaqtr.input>≡
  )set break resume
  )sys rm -f dlaqtr.output
  )spool dlaqtr.output
  )set message test on
  )set message auto off
  )clear all

  )spool
  )lisp (bye)

```

`<dlaqtr.help>`≡

```
=====
dlaqtr examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

DLAQTR - the real quasi-triangular system  $op(T)*p = scale*c$ , if LREAL = .TRUE

#### SYNOPSIS

```
SUBROUTINE DLAQTR( LTRAN, LREAL, N, T, LDT, B, W, SCALE, X, WORK, INFO
)
```

LOGICAL LREAL, LTRAN

INTEGER INFO, LDT, N

DOUBLE PRECISION SCALE, W

DOUBLE PRECISION B( \* ), T( LDT, \* ), WORK( \* ), X( \* )

#### PURPOSE

DLAQTR solves the real quasi-triangular system

or the complex quasi-triangular systems

$$op(T + iB)*(p+iq) = scale*(c+id), \text{ if } LREAL = .FALSE.$$

in real arithmetic, where T is upper quasi-triangular.

If LREAL = .FALSE., then the first diagonal block of T must be 1 by 1, B is the specially structured matrix

$$B = \begin{bmatrix} b(1) & b(2) & \dots & b(n) \\ & w & & \\ & & w & \\ & & & . \\ & & & & w \end{bmatrix}$$

$op(A) = A$  or  $A'$ ,  $A'$  denotes the conjugate transpose of matrix A.

On input,  $X = [c]$ . On output,  $X = [p]$ .

[ d ]

[ q ]

This subroutine is designed for the condition number estimation in routine DTRSNA.

#### ARGUMENTS

- LTRAN** (input) LOGICAL  
On entry, LTRAN specifies the option of conjugate transpose: = .FALSE.,  $op(T+i*B) = T+i*B$ , = .TRUE.,  $op(T+i*B) = (T+i*B)'$ .
- LREAL** (input) LOGICAL  
On entry, LREAL specifies the input matrix structure: = .FALSE., the input is complex = .TRUE., the input is real
- N** (input) INTEGER  
On entry, N specifies the order of  $T+i*B$ .  $N \geq 0$ .
- T** (input) DOUBLE PRECISION array, dimension (LDT,N)  
On entry, T contains a matrix in Schur canonical form. If LREAL = .FALSE., then the first diagonal block of T must be 1 by 1.
- LDT** (input) INTEGER  
The leading dimension of the matrix T.  $LDT \geq \max(1,N)$ .
- B** (input) DOUBLE PRECISION array, dimension (N)  
On entry, B contains the elements to form the matrix B as described above. If LREAL = .TRUE., B is not referenced.
- W** (input) DOUBLE PRECISION  
On entry, W is the diagonal element of the matrix B. If LREAL = .TRUE., W is not referenced.
- SCALE** (output) DOUBLE PRECISION  
On exit, SCALE is the scale factor.
- X** (input/output) DOUBLE PRECISION array, dimension (2\*N)  
On entry, X contains the right hand side of the system. On exit, X is overwritten by the solution.
- WORK** (workspace) DOUBLE PRECISION array, dimension (N)
- INFO** (output) INTEGER

On exit, INFO is set to 0: successful exit.

1: the some diagonal 1 by 1 block has been perturbed by a small number SMIN to keep nonsingularity. 2: the some diagonal 2 by 2 block has been perturbed by a small number in DLALN2 to keep nonsingularity. NOTE: In the interests of speed, this routine does not check the inputs for errors.

```

(LAPACK dlaqtr)≡
  (let* ((zero 0.0) (one 1.0))
    (declare (type (double-float 0.0 0.0) zero)
              (type (double-float 1.0 1.0) one))
    (defun dlaqtr (ltran lreal n t$ ldt b w scale x work info)
      (declare (type (double-float) scale w)
                (type (simple-array double-float (*)) work x b t$)
                (type fixnum info ldt n)
                (type (member t nil) lreal ltran))
      (f2cl-lib:with-multi-array-data
        ((t$ double-float t$-%data% t$-%offset%)
         (b double-float b-%data% b-%offset%)
         (x double-float x-%data% x-%offset%)
         (work double-float work-%data% work-%offset%))
        (prog ((d (make-array 4 :element-type 'double-float))
               (v (make-array 4 :element-type 'double-float)) (bignum 0.0)
               (eps 0.0) (rec 0.0) (scaloc 0.0) (si 0.0) (smin 0.0) (sminw 0.0)
               (smlnum 0.0) (sr 0.0) (tjj 0.0) (tmp 0.0) (xj 0.0) (xmax 0.0)
               (xnorm 0.0) (z 0.0) (i 0) (ierr 0) (j 0) (j1 0) (j2 0) (jnext 0)
               (k 0) (n1 0) (n2 0) (notran nil))
              (declare (type (simple-array double-float (4)) d v)
                        (type (double-float) bignum eps rec scaloc si smin sminw
                               smlnum sr tjj tmp xj xmax xnorm z)
                        (type fixnum i ierr j j1 j2 jnext k n1 n2)
                        (type (member t nil) notran))
              (setf notran (not ltran))
              (setf info 0)
              (if (= n 0) (go end_label))
              (setf eps (dlamch "P"))
              (setf smlnum (/ (dlamch "S") eps))
              (setf bignum (/ one smlnum))
              (setf xnorm (dlange "M" n n t$ ldt d))
              (if (not lreal)
                  (setf xnorm (max xnorm (abs w) (dlange "M" n 1 b n d))))
              (setf smin (max smlnum (* eps xnorm)))
              (setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%) zero)
              (f2cl-lib:fdo (j 2 (f2cl-lib:int-add j 1))
                            ((> j n) nil)
                (tagbody
                  (setf (f2cl-lib:fref work-%data% (j) ((1 *)) work-%offset%)
                        (dasum (f2cl-lib:int-sub j 1)
                              (f2cl-lib:array-slice t$
                                                        double-float
                                                        (1 j)
                                                        ((1 ldt) (1 *))))
                  1))))))

```

```

(cond
  ((not lreal)
    (f2cl-lib:fdo (i 2 (f2cl-lib:int-add i 1))
      ((> i n) nil)
      (tagbody
        (setf (f2cl-lib:fref work-%data% (i) ((1 *)) work-%offset%)
          (+ (f2cl-lib:fref work-%data% (i) ((1 *)) work-%offset%)
            (abs
              (f2cl-lib:fref b-%data% (i) ((1 *)) b-%offset%))))))));tpd
  (setf n2 (f2cl-lib:int-mul 2 n))
  (setf n1 n)
  (if (not lreal) (setf n1 n2))
  (setf k (idamax n1 x 1))
  (setf xmax (abs (f2cl-lib:fref x-%data% (k) ((1 *)) x-%offset%)))
  (setf scale one)
  (cond
    ((> xmax bignum)
      (setf scale (/ bignum xmax))
      (dscal n1 scale x 1)
      (setf xmax bignum)))
  (cond
    (lreal
      (cond
        (notran
          (setf jnext n)
          (f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
            ((> j 1) nil)
            (tagbody
              (if (> j jnext) (go label130))
              (setf j1 j)
              (setf j2 j)
              (setf jnext (f2cl-lib:int-sub j 1))
              (cond
                ((> j 1)
                  (cond
                    ((/=
                      (f2cl-lib:fref t$
                        (j
                          (f2cl-lib:int-add j
                            (f2cl-lib:int-sub
                              1)))
                      ((1 ldt) (1 *)))
                      zero)
                    (setf j1 (f2cl-lib:int-sub j 1))
                    (setf jnext (f2cl-lib:int-sub j 2))))))
              (cond

```

```

(= j1 j2)
(setf xj
  (abs
    (f2cl-lib:fref x-%data% (j1) ((1 *)) x-%offset%)))
(setf tjj
  (abs
    (f2cl-lib:fref t$-%data%
      (j1 j1)
      ((1 ldt) (1 *))
      t$-%offset%)))
(setf tmp
  (f2cl-lib:fref t$-%data%
    (j1 j1)
    ((1 ldt) (1 *))
    t$-%offset%))
(cond
  ((< tjj smin)
    (setf tmp smin)
    (setf tjj smin)
    (setf info 1)))
(if (= xj zero) (go label30))
(cond
  ((< tjj one)
    (cond
      ((> xj (* bignum tjj))
        (setf rec (/ one xj))
        (dscal n rec x 1)
        (setf scale (* scale rec))
        (setf xmax (* xmax rec))))))
(setf (f2cl-lib:fref x-%data% (j1) ((1 *)) x-%offset%)
  (/
    (f2cl-lib:fref x-%data% (j1) ((1 *)) x-%offset%)
    tmp))
(setf xj
  (abs
    (f2cl-lib:fref x-%data% (j1) ((1 *)) x-%offset%)))
(cond
  ((> xj one)
    (setf rec (/ one xj))
    (cond
      ((> (f2cl-lib:fref work (j1) ((1 *)))
        (* (+ bignum (- xmax)) rec))
        (dscal n rec x 1)
        (setf scale (* scale rec))))))
(cond
  ((> j1 1)

```

```

(daxpy (f2cl-lib:int-sub j1 1)
  (- (f2cl-lib:fref x-%data% (j1) ((1 *)) x-%offset%))
  (f2cl-lib:array-slice t$
    double-float
    (1 j1)
    ((1 ldt) (1 *))))
1 x 1)
(setf k (idamax (f2cl-lib:int-sub j1 1) x 1))
(setf xmax
  (abs
    (f2cl-lib:fref x-%data%
      (k)
      ((1 *))
      x-%offset%))))))
(t
  (setf (f2cl-lib:fref d (1 1) ((1 2) (1 2)))
    (f2cl-lib:fref x-%data% (j1) ((1 *)) x-%offset%))
  (setf (f2cl-lib:fref d (2 1) ((1 2) (1 2)))
    (f2cl-lib:fref x-%data% (j2) ((1 *)) x-%offset%))
  (multiple-value-bind
    (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
     var-8 var-9 var-10 var-11 var-12 var-13 var-14
     var-15 var-16 var-17)
    (dlaln2 nil 2 1 smin one
      (f2cl-lib:array-slice t$
        double-float
        (j1 j1)
        ((1 ldt) (1 *)))
      ldt one one d 2 zero zero v 2 scaloc xnorm ierr)
    (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
      var-6 var-7 var-8 var-9 var-10 var-11
      var-12 var-13 var-14))
    (setf scaloc var-15)
    (setf xnorm var-16)
    (setf ierr var-17))
  (if (/= ierr 0) (setf info 2))
  (cond
    ((/= scaloc one)
     (dscal n scaloc x 1)
     (setf scale (* scale scaloc))))
  (setf (f2cl-lib:fref x-%data% (j1) ((1 *)) x-%offset%)
    (f2cl-lib:fref v (1 1) ((1 2) (1 2))))
  (setf (f2cl-lib:fref x-%data% (j2) ((1 *)) x-%offset%)
    (f2cl-lib:fref v (2 1) ((1 2) (1 2))))
  (setf xj
    (max (abs (f2cl-lib:fref v (1 1) ((1 2) (1 2))))

```



```

                                (abs (f2cl-lib:fref v (2 1) ((1 2) (1 2))))))
(cond
  (> xj one)
  (setf rec (/ one xj))
  (cond
    (>
      (max (f2cl-lib:fref work (j1) ((1 *)))
            (f2cl-lib:fref work (j2) ((1 *))))
      (* (+ bignum (- xmax)) rec))
    (dscal n rec x 1)
    (setf scale (* scale rec))))))
(cond
  (> j1 1)
  (daxpy (f2cl-lib:int-sub j1 1)
    (- (f2cl-lib:fref x-%data% (j1) ((1 *)) x-%offset%)
      (f2cl-lib:array-slice t$
        double-float
        (1 j1)
        ((1 ldt) (1 *)))
        1 x 1)
    (daxpy (f2cl-lib:int-sub j1 1)
      (- (f2cl-lib:fref x-%data% (j2) ((1 *)) x-%offset%)
        (f2cl-lib:array-slice t$
          double-float
          (1 j2)
          ((1 ldt) (1 *)))
          1 x 1)
      (setf k (idamax (f2cl-lib:int-sub j1 1) x 1))
      (setf xmax
        (abs
          (f2cl-lib:fref x-%data%
            (k)
            ((1 *))
            x-%offset%))))))
label30)))
(t
  (setf jnext 1)
  (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
    (> j n) nil)
  (tagbody
    (if (< j jnext) (go label40))
    (setf j1 j)
    (setf j2 j)
    (setf jnext (f2cl-lib:int-add j 1))
    (cond
      (< j n)

```

```

(cond
  ((/=
    (f2cl-lib:fref t$
      ((f2cl-lib:int-add j 1) j)
      ((1 ldt) (1 *)))
    zero)
    (setf j2 (f2cl-lib:int-add j 1))
    (setf jnext (f2cl-lib:int-add j 2))))))
(cond
  ((= j1 j2)
    (setf xj
      (abs
        (f2cl-lib:fref x-%data% (j1) ((1 *)) x-%offset%)))
    (cond
      ((> xmax one)
        (setf rec (/ one xmax))
        (cond
          ((> (f2cl-lib:fref work (j1) ((1 *)))
            (* (+ bignum (- xj)) rec))
            (dscal n rec x 1)
            (setf scale (* scale rec))
            (setf xmax (* xmax rec))))))
      (setf (f2cl-lib:fref x-%data% (j1) ((1 *)) x-%offset%)
        (-
          (f2cl-lib:fref x-%data% (j1) ((1 *)) x-%offset%)
          (ddot (f2cl-lib:int-sub j1 1)
            (f2cl-lib:array-slice t$
              double-float
              (1 j1)
              ((1 ldt) (1 *)))
            1 x 1)))
      (setf xj
        (abs
          (f2cl-lib:fref x-%data% (j1) ((1 *)) x-%offset%)))
      (setf tjj
        (abs
          (f2cl-lib:fref t$-%data%
            (j1 j1)
            ((1 ldt) (1 *))
            t$-%offset%)))
      (setf tmp
        (f2cl-lib:fref t$-%data%
          (j1 j1)
          ((1 ldt) (1 *))
          t$-%offset%)))
    (cond

```

```

      ((< tjj smin)
       (setf tmp smin)
       (setf tjj smin)
       (setf info 1)))
    (cond
      ((< tjj one)
       (cond
         ((> xj (* bignum tjj))
          (setf rec (/ one xj))
          (dscal n rec x 1)
          (setf scale (* scale rec))
          (setf xmax (* xmax rec))))))
      (setf (f2cl-lib:fref x-%data% (j1) ((1 *)) x-%offset%)
            (/
              (f2cl-lib:fref x-%data% (j1) ((1 *)) x-%offset%)
              tmp))
      (setf xmax
            (max xmax
                  (abs
                   (f2cl-lib:fref x-%data%
                                   (j1)
                                   ((1 *))
                                   x-%offset%))))))
    (t
     (setf xj
           (max
            (abs
             (f2cl-lib:fref x-%data%
                             (j1)
                             ((1 *))
                             x-%offset%))
            (abs
             (f2cl-lib:fref x-%data%
                             (j2)
                             ((1 *))
                             x-%offset%))))))
    (cond
      ((> xmax one)
       (setf rec (/ one xmax))
       (cond
         ((>
          (max (f2cl-lib:fref work (j2) ((1 *)))
                (f2cl-lib:fref work (j1) ((1 *))))
          (* (+ bignum (- xj)) rec))
          (dscal n rec x 1)
          (setf scale (* scale rec))

```

```

        (setf xmax (* xmax rec))))))
(setf (f2cl-lib:fref d (1 1) ((1 2) (1 2)))
      (-
        (f2cl-lib:fref x-%data% (j1) ((1 *)) x-%offset%)
        (ddot (f2cl-lib:int-sub j1 1)
              (f2cl-lib:array-slice t$
                                     double-float
                                     (1 j1)
                                     ((1 ldt) (1 *)))
              1 x 1)))
(setf (f2cl-lib:fref d (2 1) ((1 2) (1 2)))
      (-
        (f2cl-lib:fref x-%data% (j2) ((1 *)) x-%offset%)
        (ddot (f2cl-lib:int-sub j1 1)
              (f2cl-lib:array-slice t$
                                     double-float
                                     (1 j2)
                                     ((1 ldt) (1 *)))
              1 x 1)))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
   var-8 var-9 var-10 var-11 var-12 var-13 var-14
   var-15 var-16 var-17)
  (dlaln2 t 2 1 smin one
    (f2cl-lib:array-slice t$
                          double-float
                          (j1 j1)
                          ((1 ldt) (1 *)))
    ldt one one d 2 zero zero v 2 scaloc xnorm ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
    var-6 var-7 var-8 var-9 var-10 var-11
    var-12 var-13 var-14))
  (setf scaloc var-15)
  (setf xnorm var-16)
  (setf ierr var-17))
(if (/= ierr 0) (setf info 2))
(cond
  ((/= scaloc one)
   (dscal n scaloc x 1)
   (setf scale (* scale scaloc))))
(setf (f2cl-lib:fref x-%data% (j1) ((1 *)) x-%offset%)
      (f2cl-lib:fref v (1 1) ((1 2) (1 2))))
(setf (f2cl-lib:fref x-%data% (j2) ((1 *)) x-%offset%)
      (f2cl-lib:fref v (2 1) ((1 2) (1 2))))
(setf xmax
  (max

```

```

                                (abs
                                (f2cl-lib:fref x-%data%
                                                  (j1)
                                                  ((1 *))
                                                  x-%offset%))
                                (abs
                                (f2cl-lib:fref x-%data%
                                                  (j2)
                                                  ((1 *))
                                                  x-%offset%))
                                xmax))))
label40))))))
(t
 (setf sminw (max (* eps (abs w)) smin))
 (cond
  (notran
   (setf jnext n)
   (f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
                 ((> j 1) nil)
   (tagbody
    (if (> j jnext) (go label70))
    (setf j1 j)
    (setf j2 j)
    (setf jnext (f2cl-lib:int-sub j 1))
    (cond
     ((> j 1)
      (cond
       ((/=
        (f2cl-lib:fref t$
                        (j
                          (f2cl-lib:int-add j
                                                (f2cl-lib:int-sub
                                                  (f2cl-lib:int-sub
                                                    1))))
        ((1 ldt) (1 *)))
        zero)
       (setf j1 (f2cl-lib:int-sub j 1))
       (setf jnext (f2cl-lib:int-sub j 2))))))
    (cond
     ((= j1 j2)
      (setf z w)
      (if (= j1 1)
          (setf z
                (f2cl-lib:fref b-%data%
                                (1)
                                ((1 *))
                                b-%offset%)))

```

```

(setf xj
  (+
    (abs
      (f2cl-lib:fref x-%data%
                     (j1)
                     ((1 *))
                     x-%offset%))
    (abs
      (f2cl-lib:fref x-%data%
                     ((f2cl-lib:int-add n j1))
                     ((1 *))
                     x-%offset%))))
(setf tjj
  (+
    (abs
      (f2cl-lib:fref t$-%data%
                     (j1 j1)
                     ((1 ldt) (1 *))
                     t$-%offset%))
    (abs z)))
(setf tmp
  (f2cl-lib:fref t$-%data%
                 (j1 j1)
                 ((1 ldt) (1 *))
                 t$-%offset%))
(cond
  ((< tjj sminw)
   (setf tmp sminw)
   (setf tjj sminw)
   (setf info 1)))
(if (= xj zero) (go label70))
(cond
  ((< tjj one)
   (cond
    ((> xj (* bignum tjj))
     (setf rec (/ one xj))
     (dscal n2 rec x 1)
     (setf scale (* scale rec))
     (setf xmax (* xmax rec))))))
(multiple-value-bind (var-0 var-1 var-2 var-3 var-4 var-5)
  (dladiv
   (f2cl-lib:fref x-%data% (j1) ((1 *)) x-%offset%)
   (f2cl-lib:fref x-%data%
                  ((f2cl-lib:int-add n j1))
                  ((1 *))
                  x-%offset%)))

```

```

    tmp z sr si)
  (declare (ignore var-0 var-1 var-2 var-3))
  (setf sr var-4)
  (setf si var-5))
(setf (f2cl-lib:fref x-%data% (j1) ((1 *)) x-%offset%) sr)
(setf (f2cl-lib:fref x-%data%
                    ((f2cl-lib:int-add n j1))
                    ((1 *))
                    x-%offset%)
      si)
(setf xj
      (+
        (abs
          (f2cl-lib:fref x-%data%
                        (j1)
                        ((1 *))
                        x-%offset%))
        (abs
          (f2cl-lib:fref x-%data%
                        ((f2cl-lib:int-add n j1))
                        ((1 *))
                        x-%offset%))))))
(cond
  ((> xj one)
   (setf rec (/ one xj))
   (cond
     ((> (f2cl-lib:fref work (j1) ((1 *)))
          (* (+ bignum (- xmax)) rec))
      (dscal n2 rec x 1)
      (setf scale (* scale rec))))))
(cond
  ((> j1 1)
   (daxpy (f2cl-lib:int-sub j1 1)
          (- (f2cl-lib:fref x-%data% (j1) ((1 *)) x-%offset%)
             (f2cl-lib:array-slice t$
                                   double-float
                                   (1 j1)
                                   ((1 ldt) (1 *)))
          1 x 1)
   (daxpy (f2cl-lib:int-sub j1 1)
          (-
            (f2cl-lib:fref x-%data%
                          ((f2cl-lib:int-add n j1))
                          ((1 *))
                          x-%offset%)
            (f2cl-lib:array-slice t$

```

```

double-float
(1 j1)
((1 ldt) (1 *)))

1
(f2cl-lib:array-slice x
double-float
((+ n 1))
((1 *)))

1)
(setf (f2cl-lib:fref x-%data% (1) ((1 *)) x-%offset%)
(+
(f2cl-lib:fref x-%data%
(1)
((1 *))
x-%offset%)
(*
(f2cl-lib:fref b-%data%
(j1)
((1 *))
b-%offset%)
(f2cl-lib:fref x-%data%
((f2cl-lib:int-add n j1))
((1 *))
x-%offset%))))
(setf (f2cl-lib:fref x-%data%
((f2cl-lib:int-add n 1))
((1 *))
x-%offset%)
(-
(f2cl-lib:fref x-%data%
((f2cl-lib:int-add n 1))
((1 *))
x-%offset%)
(*
(f2cl-lib:fref b-%data%
(j1)
((1 *))
b-%offset%)
(f2cl-lib:fref x-%data%
(j1)
((1 *))
x-%offset%))))
(setf xmax zero)
(f2cl-lib:fdo (k 1 (f2cl-lib:int-add k 1))
(> k
(f2cl-lib:int-add j1

```



```

(f2cl-lib:int-sub
1)))

nil)

(tagbody
  (setf xmax
    (max xmax
      (+
        (abs
          (f2cl-lib:fref x-%data%
            (k)
            ((1 *))
            x-%offset%))
        (abs
          (f2cl-lib:fref x-%data%
            ((f2cl-lib:int-add k
              n))
            ((1 *))
            x-%offset%)))))))))

(t
  (setf (f2cl-lib:fref d (1 1) ((1 2) (1 2)))
    (f2cl-lib:fref x-%data% (j1) ((1 *)) x-%offset%))
  (setf (f2cl-lib:fref d (2 1) ((1 2) (1 2)))
    (f2cl-lib:fref x-%data% (j2) ((1 *)) x-%offset%))
  (setf (f2cl-lib:fref d (1 2) ((1 2) (1 2)))
    (f2cl-lib:fref x-%data%
      ((f2cl-lib:int-add n j1))
      ((1 *))
      x-%offset%))
  (setf (f2cl-lib:fref d (2 2) ((1 2) (1 2)))
    (f2cl-lib:fref x-%data%
      ((f2cl-lib:int-add n j2))
      ((1 *))
      x-%offset%))
  (multiple-value-bind
    (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
     var-8 var-9 var-10 var-11 var-12 var-13 var-14
     var-15 var-16 var-17)
    (dlaln2 nil 2 2 sminw one
      (f2cl-lib:array-slice t$
        double-float
        (j1 j1)
        ((1 ldt) (1 *)))
      ldt one one d 2 zero (- w) v 2 scaloc xnorm ierr)
    (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
      var-6 var-7 var-8 var-9 var-10 var-11
      var-12 var-13 var-14)))

```

```

      (setf scaloc var-15)
      (setf xnorm var-16)
      (setf ierr var-17))
    (if (/= ierr 0) (setf info 2))
    (cond
      ((/= scaloc one)
        (dscal (f2cl-lib:int-mul 2 n) scaloc x 1)
        (setf scale (* scaloc scale))))
      (setf (f2cl-lib:fref x-%data% (j1) ((1 *)) x-%offset%)
        (f2cl-lib:fref v (1 1) ((1 2) (1 2))))
      (setf (f2cl-lib:fref x-%data% (j2) ((1 *)) x-%offset%)
        (f2cl-lib:fref v (2 1) ((1 2) (1 2))))
      (setf (f2cl-lib:fref x-%data%
        ((f2cl-lib:int-add n j1))
        ((1 *))
        x-%offset%)
        (f2cl-lib:fref v (1 2) ((1 2) (1 2))))
      (setf (f2cl-lib:fref x-%data%
        ((f2cl-lib:int-add n j2))
        ((1 *))
        x-%offset%)
        (f2cl-lib:fref v (2 2) ((1 2) (1 2))))
      (setf xj
        (max
          (+ (abs (f2cl-lib:fref v (1 1) ((1 2) (1 2))))
            (abs (f2cl-lib:fref v (1 2) ((1 2) (1 2))))
            (+ (abs (f2cl-lib:fref v (2 1) ((1 2) (1 2))))
              (abs (f2cl-lib:fref v (2 2) ((1 2) (1 2)))))))
        (cond
          ((> xj one)
            (setf rec (/ one xj))
            (cond
              ((>
                (max (f2cl-lib:fref work (j1) ((1 *)))
                  (f2cl-lib:fref work (j2) ((1 *))))
                (* (+ bignum (- xmax)) rec))
                (dscal n2 rec x 1)
                (setf scale (* scale rec))))))
          (cond
            ((> j1 1)
              (daxpy (f2cl-lib:int-sub j1 1)
                (- (f2cl-lib:fref x-%data% (j1) ((1 *)) x-%offset%)
                  (f2cl-lib:array-slice t$
                    double-float
                    (1 j1)
                    ((1 ldt) (1 *))))

```

```

1 x 1)
(daxpy (f2cl-lib:int-sub j1 1)
(- (f2cl-lib:fref x-%data% (j2) ((1 *)) x-%offset%))
(f2cl-lib:array-slice t$
double-float
(1 j2)
((1 ldt) (1 *)))

1 x 1)
(daxpy (f2cl-lib:int-sub j1 1)
(-
(f2cl-lib:fref x-%data%
((f2cl-lib:int-add n j1))
((1 *))
x-%offset%))
(f2cl-lib:array-slice t$
double-float
(1 j1)
((1 ldt) (1 *)))

1
(f2cl-lib:array-slice x
double-float
((+ n 1))
((1 *)))

1)
(daxpy (f2cl-lib:int-sub j1 1)
(-
(f2cl-lib:fref x-%data%
((f2cl-lib:int-add n j2))
((1 *))
x-%offset%))
(f2cl-lib:array-slice t$
double-float
(1 j2)
((1 ldt) (1 *)))

1
(f2cl-lib:array-slice x
double-float
((+ n 1))
((1 *)))

1)
(setf (f2cl-lib:fref x-%data% (1) ((1 *)) x-%offset%)
(+
(f2cl-lib:fref x-%data%
(1)
((1 *))
x-%offset%)

```

```

(*
  (f2cl-lib:fref b-%data%
                 (j1)
                 ((1 *))
                 b-%offset%)
  (f2cl-lib:fref x-%data%
                 ((f2cl-lib:int-add n j1))
                 ((1 *))
                 x-%offset%))
(*
  (f2cl-lib:fref b-%data%
                 (j2)
                 ((1 *))
                 b-%offset%)
  (f2cl-lib:fref x-%data%
                 ((f2cl-lib:int-add n j2))
                 ((1 *))
                 x-%offset%))))
(setf (f2cl-lib:fref x-%data%
                    ((f2cl-lib:int-add n 1))
                    ((1 *))
                    x-%offset%))

(-
  (f2cl-lib:fref x-%data%
                 ((f2cl-lib:int-add n 1))
                 ((1 *))
                 x-%offset%))

(*
  (f2cl-lib:fref b-%data%
                 (j1)
                 ((1 *))
                 b-%offset%)
  (f2cl-lib:fref x-%data%
                 (j1)
                 ((1 *))
                 x-%offset%))

(*
  (f2cl-lib:fref b-%data%
                 (j2)
                 ((1 *))
                 b-%offset%)
  (f2cl-lib:fref x-%data%
                 (j2)
                 ((1 *))
                 x-%offset%))))
(setf xmax zero)

```

```

(f2cl-lib:fdo (k 1 (f2cl-lib:int-add k 1))
  (> k
    (f2cl-lib:int-add j1
      (f2cl-lib:int-sub
        1)))
    nil)
  (tagbody
    (setf xmax
      (max
        (+
          (abs
            (f2cl-lib:fref x-%data%
              (k)
              ((1 *))
              x-%offset%))
          (abs
            (f2cl-lib:fref x-%data%
              ((f2cl-lib:int-add k n))
              ((1 *))
              x-%offset%)))
        xmax))))))
label70)))
(t
  (setf jnext 1)
  (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
    (> j n) nil)
  (tagbody
    (if (< j jnext) (go label80))
    (setf j1 j)
    (setf j2 j)
    (setf jnext (f2cl-lib:int-add j 1))
    (cond
      ((< j n)
        (cond
          ((/=
            (f2cl-lib:fref t$
              ((f2cl-lib:int-add j 1) j)
              ((1 ldt) (1 *)))
            zero)
            (setf j2 (f2cl-lib:int-add j 1))
            (setf jnext (f2cl-lib:int-add j 2))))))
      (cond
        ((= j1 j2)
          (setf xj
            (+
              (abs

```

```

(f2cl-lib:fref x-%data%
  (j1)
  ((1 *))
  x-%offset%))
(abs
  (f2cl-lib:fref x-%data%
    ((f2cl-lib:int-add j1 n))
    ((1 *))
    x-%offset%))))
(cond
  (> xmax one)
  (setf rec (/ one xmax))
  (cond
    (> (f2cl-lib:fref work (j1) ((1 *)))
      (* (+ bignum (- xj)) rec))
    (dscal n2 rec x 1)
    (setf scale (* scale rec))
    (setf xmax (* xmax rec))))))
(setf (f2cl-lib:fref x-%data% (j1) ((1 *)) x-%offset%)
  (-
    (f2cl-lib:fref x-%data% (j1) ((1 *)) x-%offset%)
    (ddot (f2cl-lib:int-sub j1 1)
      (f2cl-lib:array-slice t$
        double-float
        (1 j1)
        ((1 ldt) (1 *)))
        1 x 1)))
(setf (f2cl-lib:fref x-%data%
  ((f2cl-lib:int-add n j1))
  ((1 *))
  x-%offset%)
  (-
    (f2cl-lib:fref x-%data%
      ((f2cl-lib:int-add n j1))
      ((1 *))
      x-%offset%)
    (ddot (f2cl-lib:int-sub j1 1)
      (f2cl-lib:array-slice t$
        double-float
        (1 j1)
        ((1 ldt) (1 *)))
        1
        (f2cl-lib:array-slice x
          double-float
          ((+ n 1))
          ((1 *)))

```

```

1)))
(cond
  (> j1 1)
  (setf (f2cl-lib:fref x-%data% (j1) ((1 *)) x-%offset%)
    (-
      (f2cl-lib:fref x-%data%
        (j1)
        ((1 *))
        x-%offset%)
      (*
        (f2cl-lib:fref b-%data%
          (j1)
          ((1 *))
          b-%offset%)
        (f2cl-lib:fref x-%data%
          ((f2cl-lib:int-add n 1))
          ((1 *))
          x-%offset%))))))
  (setf (f2cl-lib:fref x-%data%
    ((f2cl-lib:int-add n j1))
    ((1 *))
    x-%offset%)
    (+
      (f2cl-lib:fref x-%data%
        ((f2cl-lib:int-add n j1))
        ((1 *))
        x-%offset%)
      (*
        (f2cl-lib:fref b-%data%
          (j1)
          ((1 *))
          b-%offset%)
        (f2cl-lib:fref x-%data%
          (1)
          ((1 *))
          x-%offset%))))))
  (setf xj
    (+
      (abs
        (f2cl-lib:fref x-%data%
          (j1)
          ((1 *))
          x-%offset%))
      (abs
        (f2cl-lib:fref x-%data%
          ((f2cl-lib:int-add j1 n))

```

```

((1 *))
x-%offset%))))
(setf z w)
(if (= j1 1)
  (setf z
    (f2cl-lib:fref b-%data%
      (1)
      ((1 *))
      b-%offset%)))
(setf tjj
  (+
    (abs
      (f2cl-lib:fref t$-%data%
        (j1 j1)
        ((1 ldt) (1 *))
        t$-%offset%))
    (abs z)))
(setf tmp
  (f2cl-lib:fref t$-%data%
    (j1 j1)
    ((1 ldt) (1 *))
    t$-%offset%))
(cond
  ((< tjj sminw)
   (setf tmp sminw)
   (setf tjj sminw)
   (setf info 1)))
(cond
  ((< tjj one)
   (cond
    ((> xj (* bignum tjj))
     (setf rec (/ one xj))
     (dscal n2 rec x 1)
     (setf scale (* scale rec))
     (setf xmax (* xmax rec))))))
(multiple-value-bind (var-0 var-1 var-2 var-3 var-4 var-5)
  (dladiv
   (f2cl-lib:fref x-%data% (j1) ((1 *)) x-%offset%)
   (f2cl-lib:fref x-%data%
     ((f2cl-lib:int-add n j1))
     ((1 *))
     x-%offset%)
   tmp (- z) sr si)
  (declare (ignore var-0 var-1 var-2 var-3))
  (setf sr var-4)
  (setf si var-5))

```



```

(setf (f2cl-lib:fref x-%data% (j1) ((1 *)) x-%offset%) sr)
(setf (f2cl-lib:fref x-%data%
                    ((f2cl-lib:int-add j1 n))
                    ((1 *))
                    x-%offset%)
      si)
(setf xmax
      (max
        (+
          (abs
            (f2cl-lib:fref x-%data%
                          (j1)
                          ((1 *))
                          x-%offset%))
          (abs
            (f2cl-lib:fref x-%data%
                          ((f2cl-lib:int-add j1 n))
                          ((1 *))
                          x-%offset%)))
        xmax)))
(t
  (setf xj
        (max
          (+
            (abs
              (f2cl-lib:fref x-%data%
                            (j1)
                            ((1 *))
                            x-%offset%))
            (abs
              (f2cl-lib:fref x-%data%
                            ((f2cl-lib:int-add n j1))
                            ((1 *))
                            x-%offset%)))
          (+
            (abs
              (f2cl-lib:fref x-%data%
                            (j2)
                            ((1 *))
                            x-%offset%))
            (abs
              (f2cl-lib:fref x-%data%
                            ((f2cl-lib:int-add n j2))
                            ((1 *))
                            x-%offset%))))))
  (cond

```

```

(> xmax one)
(setf rec (/ one xmax))
(cond
  (>
    (max (f2cl-lib:fref work (j1) ((1 *)))
          (f2cl-lib:fref work (j2) ((1 *))))
    (f2cl-lib:f2cl/ (+ bignum (- xj)) xmax))
  (dscal n2 rec x 1)
  (setf scale (* scale rec))
  (setf xmax (* xmax rec))))))
(setf (f2cl-lib:fref d (1 1) ((1 2) (1 2)))
  (-
    (f2cl-lib:fref x-%data% (j1) ((1 *)) x-%offset%)
    (ddot (f2cl-lib:int-sub j1 1)
          (f2cl-lib:array-slice t$
                                double-float
                                (1 j1)
                                ((1 ldt) (1 *)))
          1 x 1)))
(setf (f2cl-lib:fref d (2 1) ((1 2) (1 2)))
  (-
    (f2cl-lib:fref x-%data% (j2) ((1 *)) x-%offset%)
    (ddot (f2cl-lib:int-sub j1 1)
          (f2cl-lib:array-slice t$
                                double-float
                                (1 j2)
                                ((1 ldt) (1 *)))
          1 x 1)))
(setf (f2cl-lib:fref d (1 2) ((1 2) (1 2)))
  (-
    (f2cl-lib:fref x-%data%
                    ((f2cl-lib:int-add n j1))
                    ((1 *))
                    x-%offset%)
    (ddot (f2cl-lib:int-sub j1 1)
          (f2cl-lib:array-slice t$
                                double-float
                                (1 j1)
                                ((1 ldt) (1 *)))
          1
          (f2cl-lib:array-slice x
                                double-float
                                ((+ n 1))
                                ((1 *)))
          1)))
(setf (f2cl-lib:fref d (2 2) ((1 2) (1 2)))

```

```

(-
  (f2cl-lib:fref x-%data%
    ((f2cl-lib:int-add n j2))
    ((1 *))
    x-%offset%)
  (ddot (f2cl-lib:int-sub j1 1)
    (f2cl-lib:array-slice t$
      double-float
      (1 j2)
      ((1 ldt) (1 *)))
    1
    (f2cl-lib:array-slice x
      double-float
      ((+ n 1))
      ((1 *)))
    1)))
(setf (f2cl-lib:fref d (1 1) ((1 2) (1 2)))
  (- (f2cl-lib:fref d (1 1) ((1 2) (1 2)))
    (*
      (f2cl-lib:fref b-%data%
        (j1)
        ((1 *))
        b-%offset%)
      (f2cl-lib:fref x-%data%
        ((f2cl-lib:int-add n 1))
        ((1 *))
        x-%offset%))))
(setf (f2cl-lib:fref d (2 1) ((1 2) (1 2)))
  (- (f2cl-lib:fref d (2 1) ((1 2) (1 2)))
    (*
      (f2cl-lib:fref b-%data%
        (j2)
        ((1 *))
        b-%offset%)
      (f2cl-lib:fref x-%data%
        ((f2cl-lib:int-add n 1))
        ((1 *))
        x-%offset%))))
(setf (f2cl-lib:fref d (1 2) ((1 2) (1 2)))
  (+ (f2cl-lib:fref d (1 2) ((1 2) (1 2)))
    (*
      (f2cl-lib:fref b-%data%
        (j1)
        ((1 *))
        b-%offset%)
      (f2cl-lib:fref x-%data%

```

```

(1)
((1 *))
x-%offset%)))
(setf (f2cl-lib:fref d (2 2) ((1 2) (1 2)))
      (+ (f2cl-lib:fref d (2 2) ((1 2) (1 2)))
         (*
          (f2cl-lib:fref b-%data%
                        (j2)
                        ((1 *))
                        b-%offset%)
          (f2cl-lib:fref x-%data%
                        (1)
                        ((1 *))
                        x-%offset%))))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
   var-8 var-9 var-10 var-11 var-12 var-13 var-14
   var-15 var-16 var-17)
  (dlaln2 t 2 2 sminw one
    (f2cl-lib:array-slice t$
                          double-float
                          (j1 j1)
                          ((1 ldt) (1 *)))
    ldt one one d 2 zero w v 2 scaloc xnorm ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6 var-7 var-8 var-9 var-10 var-11
                   var-12 var-13 var-14))
  (setf scaloc var-15)
  (setf xnorm var-16)
  (setf ierr var-17))
(if (/= ierr 0) (setf info 2))
(cond
 ((/= scaloc one)
  (dscal n2 scaloc x 1)
  (setf scale (* scaloc scale))))
(setf (f2cl-lib:fref x-%data% (j1) ((1 *)) x-%offset%)
      (f2cl-lib:fref v (1 1) ((1 2) (1 2))))
(setf (f2cl-lib:fref x-%data% (j2) ((1 *)) x-%offset%)
      (f2cl-lib:fref v (2 1) ((1 2) (1 2))))
(setf (f2cl-lib:fref x-%data%
                    ((f2cl-lib:int-add n j1))
                    ((1 *))
                    x-%offset%)
      (f2cl-lib:fref v (1 2) ((1 2) (1 2))))
(setf (f2cl-lib:fref x-%data%
                    ((f2cl-lib:int-add n j2))

```

```

((1 *))
x-%offset%)
(f2cl-lib:fref v (2 2) ((1 2) (1 2))))
(setf xmax
  (max
    (+
      (abs
        (f2cl-lib:fref x-%data%
          (j1)
          ((1 *))
          x-%offset%))
      (abs
        (f2cl-lib:fref x-%data%
          ((f2cl-lib:int-add n j1))
          ((1 *))
          x-%offset%))
      (+
        (abs
          (f2cl-lib:fref x-%data%
            (j2)
            ((1 *))
            x-%offset%))
        (abs
          (f2cl-lib:fref x-%data%
            ((f2cl-lib:int-add n j2))
            ((1 *))
            x-%offset%))
      xmax))))
label80))))))
end_label
(return (values nil nil nil nil nil nil nil scale nil nil info))))))

```

## 7.46 dlarfb LAPACK

```
<dlarfb.input>≡  
  )set break resume  
  )sys rm -f dlarfb.output  
  )spool dlarfb.output  
  )set message test on  
  )set message auto off  
  )clear all  
  
  )spool  
  )lisp (bye)
```

`<dlarfb.help>`≡

```
=====
dlarfb examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

DLARFB - a real block reflector H or its transpose H' to a real m by n matrix C, from either the left or the right

#### SYNOPSIS

```
SUBROUTINE DLARFB( SIDE, TRANS, DIRECT, STOREV, M, N, K, V, LDV, T,
                  LDT, C, LDC, WORK, LDWORK )
```

```
      CHARACTER      DIRECT, SIDE, STOREV, TRANS
```

```
      INTEGER        K, LDC, LDT, LDV, LDWORK, M, N
```

```
      DOUBLE         PRECISION C( LDC, * ), T( LDT, * ), V( LDV, * ),
                        WORK( LDWORK, * )
```

#### PURPOSE

DLARFB applies a real block reflector H or its transpose H' to a real m by n matrix C, from either the left or the right.

#### ARGUMENTS

SIDE (input) CHARACTER\*1  
 = 'L': apply H or H' from the Left  
 = 'R': apply H or H' from the Right

TRANS (input) CHARACTER\*1  
 = 'N': apply H (No transpose)  
 = 'T': apply H' (Transpose)

DIRECT (input) CHARACTER\*1  
 Indicates how H is formed from a product of elementary reflectors = 'F': H = H(1) H(2) . . . H(k) (Forward)  
 = 'B': H = H(k) . . . H(2) H(1) (Backward)

STOREV (input) CHARACTER\*1  
 Indicates how the vectors which define the elementary reflectors are stored:

```

      = 'C': Columnwise
      = 'R': Rowwise

M      (input) INTEGER
      The number of rows of the matrix C.

N      (input) INTEGER
      The number of columns of the matrix C.

K      (input) INTEGER
      The order of the matrix T (= the number of elementary reflectors whose product defines the block reflector).

V      (input) DOUBLE PRECISION array, dimension
      (LDV,K) if STOREV = 'C' (LDV,M) if STOREV = 'R' and SIDE = 'L'
      (LDV,N) if STOREV = 'R' and SIDE = 'R' The matrix V. See further details.

LDV     (input) INTEGER
      The leading dimension of the array V. If STOREV = 'C' and SIDE = 'L', LDV >= max(1,M); if STOREV = 'C' and SIDE = 'R', LDV >= max(1,N); if STOREV = 'R', LDV >= K.

T      (input) DOUBLE PRECISION array, dimension (LDT,K)
      The triangular k by k matrix T in the representation of the block reflector.

LDT     (input) INTEGER
      The leading dimension of the array T. LDT >= K.

C      (input/output) DOUBLE PRECISION array, dimension (LDC,N)
      On entry, the m by n matrix C. On exit, C is overwritten by H*C or H'*C or C*H or C*H'.

LDC     (input) INTEGER
      The leading dimension of the array C. LDA >= max(1,M).

WORK    (workspace) DOUBLE PRECISION array, dimension (LDWORK,K)

LDWORK  (input) INTEGER
      The leading dimension of the array WORK. If SIDE = 'L', LDWORK >= max(1,N); if SIDE = 'R', LDWORK >= max(1,M).

```



```

(LAPACK dlarfb)=
(let* ((one 1.0))
  (declare (type (double-float 1.0 1.0) one))
  (defun dlarfb (side trans direct storev m n k v ldv t$ ldc work ldwork)
    (declare (type (simple-array double-float (*)) work c t$ v)
      (type fixnum ldwork ldc ldc ldt ldv k n m)
      (type character storev direct trans side))
    (f2cl-lib:with-multi-array-data
      ((side character side-%data% side-%offset%)
       (trans character trans-%data% trans-%offset%)
       (direct character direct-%data% direct-%offset%)
       (storev character storev-%data% storev-%offset%)
       (v double-float v-%data% v-%offset%)
       (t$ double-float t$-%data% t$-%offset%)
       (c double-float c-%data% c-%offset%)
       (work double-float work-%data% work-%offset%))
      (prog ((i 0) (j 0))
        (transt
          (make-array '(1) :element-type 'character :initial-element #\ )))
        (declare (type fixnum i j)
          (type (simple-array character (1)) transt))
        (if (or (<= m 0) (<= n 0)) (go end_label))
        (cond
          ((char-equal trans #\N)
            (f2cl-lib:f2cl-set-string transt "T" (string 1)))
          (t
            (f2cl-lib:f2cl-set-string transt "N" (string 1))))
        (cond
          ((char-equal storev #\C)
            (cond
              ((char-equal direct #\F)
                (cond
                  ((char-equal side #\L)
                    (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                      ((> j k) nil)
                    (tagbody
                      (dcopy n
                        (f2cl-lib:array-slice c
                          double-float
                          (j 1)
                          ((1 ldc) (1 *)))
                        ldc
                        (f2cl-lib:array-slice work
                          double-float
                          (1 j)
                          ((1 ldwork) (1 *)))

```

```

1)))
(dtrmm "Right" "Lower" "No transpose" "Unit" n k one v ldv
work ldwork)
(cond
  (> m k)
  (dgemm "Transpose" "No transpose" n k
    (f2cl-lib:int-sub m k) one
    (f2cl-lib:array-slice c
      double-float
      ((+ k 1) 1)
      ((1 ldc) (1 *)))
    ldc
    (f2cl-lib:array-slice v
      double-float
      ((+ k 1) 1)
      ((1 ldv) (1 *)))
    ldv one work ldwork)))
(dtrmm "Right" "Upper" transt "Non-unit" n k one t$ ldt work
ldwork)
(cond
  (> m k)
  (dgemm "No transpose" "Transpose" (f2cl-lib:int-sub m k) n
    k (- one)
    (f2cl-lib:array-slice v
      double-float
      ((+ k 1) 1)
      ((1 ldv) (1 *)))
    ldv work ldwork one
    (f2cl-lib:array-slice c
      double-float
      ((+ k 1) 1)
      ((1 ldc) (1 *)))
    ldc)))
(dtrmm "Right" "Lower" "Transpose" "Unit" n k one v ldv work
ldwork)
(f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
  (> j k) nil)
(tagbody
  (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
    (> i n) nil)
  (tagbody
    (setf (f2cl-lib:fref c-%data%
      (j i)
      ((1 ldc) (1 *))
      c-%offset%)
      (-

```

```

(f2cl-lib:fref c-%data%
  (j i)
  ((1 ldc) (1 *)))
c-%offset%)
(f2cl-lib:fref work-%data%
  (i j)
  ((1 ldwork) (1 *)))
work-%offset%))))))
(char-equal side #\R)
(f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
  ((> j k) nil)
  (tagbody
    (dcopy m
      (f2cl-lib:array-slice c
        double-float
        (1 j)
        ((1 ldc) (1 *)))
      1
      (f2cl-lib:array-slice work
        double-float
        (1 j)
        ((1 ldwork) (1 *)))
      1)))
(dtrmm "Right" "Lower" "No transpose" "Unit" m k one v ldv
  work ldwork)
(cond
  ((> n k)
    (dgemm "No transpose" "No transpose" m k
      (f2cl-lib:int-sub n k) one
      (f2cl-lib:array-slice c
        double-float
        (1 (f2cl-lib:int-add k 1))
        ((1 ldc) (1 *)))
      ldc
      (f2cl-lib:array-slice v
        double-float
        ((+ k 1) 1)
        ((1 ldv) (1 *)))
      ldv one work ldwork)))
(dtrmm "Right" "Upper" trans "Non-unit" m k one t$ ldt work
  ldwork)
(cond
  ((> n k)
    (dgemm "No transpose" "Transpose" m (f2cl-lib:int-sub n k)
      k (- one) work ldwork
      (f2cl-lib:array-slice v

```

```

                                double-float
                                ((+ k 1) 1)
                                ((1 ldv) (1 *)))

ldv one
(f2cl-lib:array-slice c
                                double-float
                                (1 (f2cl-lib:int-add k 1))
                                ((1 ldc) (1 *)))

ldc)))
(dtrmm "Right" "Lower" "Transpose" "Unit" m k one v ldv work
ldwork)
(f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
              (> j k) nil)
(tagbody
  (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                (> i m) nil)
  (tagbody
    (setf (f2cl-lib:fref c-%data%
                        (i j)
                        ((1 ldc) (1 *))
                        c-%offset%)
          (-
            (f2cl-lib:fref c-%data%
                          (i j)
                          ((1 ldc) (1 *))
                          c-%offset%)
            (f2cl-lib:fref work-%data%
                          (i j)
                          ((1 ldwork) (1 *))
                          work-%offset%)))))))))

(t
  (cond
    ((char-equal side #\L)
      (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                    (> j k) nil)
      (tagbody
        (dcopy n
          (f2cl-lib:array-slice c
                                double-float
                                ((+ m (f2cl-lib:int-sub k) j) 1)
                                ((1 ldc) (1 *)))

ldc
(f2cl-lib:array-slice work
                      double-float
                      (1 j)
                      ((1 ldwork) (1 *)))

```

```

1)))
(dtrmm "Right" "Upper" "No transpose" "Unit" n k one
  (f2cl-lib:array-slice v
    double-float
    ((+ m (f2cl-lib:int-sub k) 1) 1)
    ((1 ldv) (1 *))))
ldv work ldwork)
(cond
  ((> m k)
    (dgemm "Transpose" "No transpose" n k
      (f2cl-lib:int-sub m k) one c ldc v ldv one work ldwork)))
(dtrmm "Right" "Lower" transt "Non-unit" n k one t$ ldt work
  ldwork)
(cond
  ((> m k)
    (dgemm "No transpose" "Transpose" (f2cl-lib:int-sub m k) n
      k (- one) v ldv work ldwork one c ldc)))
(dtrmm "Right" "Upper" "Transpose" "Unit" n k one
  (f2cl-lib:array-slice v
    double-float
    ((+ m (f2cl-lib:int-sub k) 1) 1)
    ((1 ldv) (1 *))))
ldv work ldwork)
(f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
  ((> j k) nil)
  (tagbody
    (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
      ((> i n) nil)
      (tagbody
        (setf (f2cl-lib:fref c-%data%
          ((f2cl-lib:int-add
            (f2cl-lib:int-sub m k)
            j)
            i)
          ((1 ldc) (1 *)))
          c-%offset%)
          (-
            (f2cl-lib:fref c-%data%
              ((f2cl-lib:int-add
                (f2cl-lib:int-sub m k)
                j)
                i)
              ((1 ldc) (1 *)))
              c-%offset%)
            (f2cl-lib:fref work-%data%
              (i j)

```

```

((1 ldwork) (1 *))
work-%offset%)))))))))
(char-equal side #\R)
(f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
  (> j k) nil)
(tagbody
  (dcopy m
    (f2cl-lib:array-slice c
      double-float
      (1
        (f2cl-lib:int-add
          (f2cl-lib:int-sub n k)
          j))
        ((1 ldc) (1 *)))
    1
    (f2cl-lib:array-slice work
      double-float
      (1 j)
      ((1 ldwork) (1 *)))
    1)))
(dtrmm "Right" "Upper" "No transpose" "Unit" m k one
  (f2cl-lib:array-slice v
    double-float
    ((+ n (f2cl-lib:int-sub k) 1) 1)
    ((1 ldv) (1 *)))
  ldv work ldwork)
(cond
  (> n k)
  (dgemm "No transpose" "No transpose" m k
    (f2cl-lib:int-sub n k) one c ldc v ldv one work ldwork)))
(dtrmm "Right" "Lower" trans "Non-unit" m k one t$ ldt work
  ldwork)
(cond
  (> n k)
  (dgemm "No transpose" "Transpose" m (f2cl-lib:int-sub n k)
    k (- one) work ldwork v ldv one c ldc)))
(dtrmm "Right" "Upper" "Transpose" "Unit" m k one
  (f2cl-lib:array-slice v
    double-float
    ((+ n (f2cl-lib:int-sub k) 1) 1)
    ((1 ldv) (1 *)))
  ldv work ldwork)
(f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
  (> j k) nil)
(tagbody
  (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))

```

```

                                (> i m) nil)
(tagbody
  (setf (f2cl-lib:fref c-%data%
    (i
      (f2cl-lib:int-add
        (f2cl-lib:int-sub n k)
        j))
    ((1 ldc) (1 *))
    c-%offset%)
  (-
    (f2cl-lib:fref c-%data%
      (i
        (f2cl-lib:int-add
          (f2cl-lib:int-sub n k)
          j))
        ((1 ldc) (1 *))
        c-%offset%)
    (f2cl-lib:fref work-%data%
      (i j)
      ((1 ldwork) (1 *))
      work-%offset%)))))))))
(char-equal storev #\R)
(cond
  (cond
    ((char-equal direct #\F)
      (cond
        ((char-equal side #\L)
          (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
            (> j k) nil)
            (tagbody
              (dcopy n
                (f2cl-lib:array-slice c
                  double-float
                  (j 1)
                  ((1 ldc) (1 *)))
                ldc
                (f2cl-lib:array-slice work
                  double-float
                  (1 j)
                  ((1 ldwork) (1 *)))
                1)))
          (dtrmm "Right" "Upper" "Transpose" "Unit" n k one v ldv work
            ldwork)
          (cond
            (> m k)
            (dgemm "Transpose" "Transpose" n k (f2cl-lib:int-sub m k)
              one

```

```

(f2cl-lib:array-slice c
  double-float
  ((+ k 1) 1)
  ((1 ldc) (1 *)))

ldc
(f2cl-lib:array-slice v
  double-float
  (1 (f2cl-lib:int-add k 1))
  ((1 ldv) (1 *)))

ldv one work ldwork)))
(dtrmm "Right" "Upper" transt "Non-unit" n k one t$ ldt work
  ldwork)
(cond
  (> m k)
  (dgemm "Transpose" "Transpose" (f2cl-lib:int-sub m k) n k
    (- one)
    (f2cl-lib:array-slice v
      double-float
      (1 (f2cl-lib:int-add k 1))
      ((1 ldv) (1 *)))

    ldv work ldwork one
    (f2cl-lib:array-slice c
      double-float
      ((+ k 1) 1)
      ((1 ldc) (1 *)))

    ldc)))
(dtrmm "Right" "Upper" "No transpose" "Unit" n k one v ldv
  work ldwork)
(f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
  (> j k) nil)
(tagbody
  (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
    (> i n) nil)
  (tagbody
    (setf (f2cl-lib:fref c-%data%
      (j i)
      ((1 ldc) (1 *))
      c-%offset%)

      (-
        (f2cl-lib:fref c-%data%
          (j i)
          ((1 ldc) (1 *))
          c-%offset%)
        (f2cl-lib:fref work-%data%
          (i j)
          ((1 ldwork) (1 *)))

```



```

work-%offset%)))))))))
((char-equal side #\R)
 (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
  (> j k) nil)
  (tagbody
   (dcopy m
    (f2cl-lib:array-slice c
     double-float
     (1 j)
     ((1 ldc) (1 *)))
    1
    (f2cl-lib:array-slice work
     double-float
     (1 j)
     ((1 ldwork) (1 *)))
    1)))
(dtrmm "Right" "Upper" "Transpose" "Unit" m k one v ldc work
 ldwork)
(cond
 (> n k)
 (dgemm "No transpose" "Transpose" m k
  (f2cl-lib:int-sub n k) one
  (f2cl-lib:array-slice c
   double-float
   (1 (f2cl-lib:int-add k 1))
   ((1 ldc) (1 *)))
  ldc
  (f2cl-lib:array-slice v
   double-float
   (1 (f2cl-lib:int-add k 1))
   ((1 ldv) (1 *)))
  ldv one work ldwork)))
(dtrmm "Right" "Upper" trans "Non-unit" m k one t$ ldt work
 ldwork)
(cond
 (> n k)
 (dgemm "No transpose" "No transpose" m
  (f2cl-lib:int-sub n k) k (- one) work ldwork
  (f2cl-lib:array-slice v
   double-float
   (1 (f2cl-lib:int-add k 1))
   ((1 ldv) (1 *)))
  ldv one
  (f2cl-lib:array-slice c
   double-float
   (1 (f2cl-lib:int-add k 1))

```

```

                                ((1 ldc) (1 *)))
      ldc)))
      (dtrmm "Right" "Upper" "No transpose" "Unit" m k one v ldv
        work ldwork)
      (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
        ((> j k) nil)
      (tagbody
        (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
          ((> i m) nil)
          (tagbody
            (setf (f2cl-lib:fref c-%data%
                                (i j)
                                ((1 ldc) (1 *))
                                c-%offset%)
              (-
                (f2cl-lib:fref c-%data%
                              (i j)
                              ((1 ldc) (1 *))
                              c-%offset%)
                (f2cl-lib:fref work-%data%
                              (i j)
                              ((1 ldwork) (1 *))
                              work-%offset%))))))))))
      (t
      (cond
        ((char-equal side #\L)
          (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
            ((> j k) nil)
            (tagbody
              (dcopy n
                (f2cl-lib:array-slice c
                                      double-float
                                      ((+ m (f2cl-lib:int-sub k) j) 1)
                                      ((1 ldc) (1 *)))

                ldc
                (f2cl-lib:array-slice work
                                      double-float
                                      (1 j)
                                      ((1 ldwork) (1 *)))

                1)))
          (dtrmm "Right" "Lower" "Transpose" "Unit" n k one
            (f2cl-lib:array-slice v
                                  double-float
                                  (1
                (f2cl-lib:int-add
                  (f2cl-lib:int-sub m k)

```

```

1))
((1 ldv) (1 *)))

ldv work ldwork)
(cond
  (> m k)
    (dgemm "Transpose" "Transpose" n k (f2cl-lib:int-sub m k)
      one c ldc v ldv one work ldwork)))
(dtrmm "Right" "Lower" transt "Non-unit" n k one t$ ldt work
ldwork)
(cond
  (> m k)
    (dgemm "Transpose" "Transpose" (f2cl-lib:int-sub m k) n k
      (- one) v ldv work ldwork one c ldc)))
(dtrmm "Right" "Lower" "No transpose" "Unit" n k one
  (f2cl-lib:array-slice v
    double-float
    (1
      (f2cl-lib:int-add
        (f2cl-lib:int-sub m k)
        1))
    ((1 ldv) (1 *)))

ldv work ldwork)
(f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
  (> j k) nil)

(tagbody
  (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
    (> i n) nil)
  (tagbody
    (setf (f2cl-lib:fref c-%data%
      ((f2cl-lib:int-add
        (f2cl-lib:int-sub m k)
        j)
        i)
      ((1 ldc) (1 *)))
      c-%offset%)
    (-
      (f2cl-lib:fref c-%data%
        ((f2cl-lib:int-add
          (f2cl-lib:int-sub m k)
          j)
          i)
        ((1 ldc) (1 *)))
        c-%offset%)
      (f2cl-lib:fref work-%data%
        (i j)
        ((1 ldwork) (1 *)))

```

```

work-%offset%)))))))))
((char-equal side #\R)
 (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
  (> j k) nil)
  (tagbody
   (dcopy m
    (f2cl-lib:array-slice c
     double-float
     (1
      (f2cl-lib:int-add
       (f2cl-lib:int-sub n k)
       j))
      ((1 ldc) (1 *)))
    1
    (f2cl-lib:array-slice work
     double-float
     (1 j)
     ((1 ldwork) (1 *)))
    1)))
(dtrmm "Right" "Lower" "Transpose" "Unit" m k one
 (f2cl-lib:array-slice v
  double-float
  (1
   (f2cl-lib:int-add
    (f2cl-lib:int-sub n k)
    1))
   ((1 ldv) (1 *)))
  ldv work ldwork)
(cond
 (> n k)
 (dgemm "No transpose" "Transpose" m k
  (f2cl-lib:int-sub n k) one c ldc v ldv one work ldwork)))
(dtrmm "Right" "Lower" trans "Non-unit" m k one t$ ldt work
 ldwork)
(cond
 (> n k)
 (dgemm "No transpose" "No transpose" m
  (f2cl-lib:int-sub n k) k (- one) work ldwork v ldv one c
  ldc)))
(dtrmm "Right" "Lower" "No transpose" "Unit" m k one
 (f2cl-lib:array-slice v
  double-float
  (1
   (f2cl-lib:int-add
    (f2cl-lib:int-sub n k)
    1))

```

[illegible]

## 7.47 dlarfg LAPACK

```
<dlarfg.input>≡  
  )set break resume  
  )sys rm -f dlarfg.output  
  )spool dlarfg.output  
  )set message test on  
  )set message auto off  
  )clear all  
  
  )spool  
  )lisp (bye)
```

`<dlarfg.help>`≡

```
=====
dlarfg examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

DLARFG - a real elementary reflector H of order n, such that  $H * \begin{pmatrix} \alpha \\ \text{alpha} \end{pmatrix} = \begin{pmatrix} \beta \\ \text{beta} \end{pmatrix}$ ,  $H' * H = I$

#### SYNOPSIS

```
SUBROUTINE DLARFG( N, ALPHA, X, INCX, TAU )
```

```
      INTEGER          INCX, N
```

```
      DOUBLE           PRECISION ALPHA, TAU
```

```
      DOUBLE           PRECISION X( * )
```

#### PURPOSE

DLARFG generates a real elementary reflector H of order n, such that

$$\begin{pmatrix} x \\ \text{x} \end{pmatrix} \begin{pmatrix} 0 \\ \text{0} \end{pmatrix}$$

where alpha and beta are scalars, and x is an (n-1)-element real vector. H is represented in the form

$$H = I - \tau * \begin{pmatrix} 1 \\ \text{1} \end{pmatrix} * \begin{pmatrix} 1 & v' \\ \text{v} \end{pmatrix},$$

where tau is a real scalar and v is a real (n-1)-element vector.

If the elements of x are all zero, then tau = 0 and H is taken to be the unit matrix.

Otherwise  $1 \leq \tau \leq 2$ .

#### ARGUMENTS

N (input) INTEGER  
The order of the elementary reflector.

ALPHA (input/output) DOUBLE PRECISION

On entry, the value alpha. On exit, it is overwritten with the value beta.

X (input/output) DOUBLE PRECISION array, dimension  $(1+(N-2)*abs(INCX))$  On entry, the vector x. On exit, it is overwritten with the vector v.

INCX (input) INTEGER  
The increment between elements of X.  $INCX > 0$ .

TAU (output) DOUBLE PRECISION  
The value tau.



```

(LAPACK dlarfg)≡
  (let* ((one 1.0) (zero 0.0))
    (declare (type (double-float 1.0 1.0) one)
              (type (double-float 0.0 0.0) zero))
    (defun dlarfg (n alpha x incx tau)
      (declare (type (simple-array double-float (*)) x)
                (type (double-float) tau alpha)
                (type fixnum incx n))
      (f2cl-lib:with-multi-array-data
        ((x double-float x-%data% x-%offset%))
        (prog ((beta 0.0) (rsafmn 0.0) (safmin 0.0) (xnorm 0.0) (j 0) (knt 0))
          (declare (type (double-float) beta rsafmn safmin xnorm)
                    (type fixnum j knt))
          (cond
            ((<= n 1)
             (setf tau zero)
             (go end_label)))
          (setf xnorm (dnrm2 (f2cl-lib:int-sub n 1) x incx))
          (cond
            ((= xnorm zero)
             (setf tau zero))
            (t
             (setf beta (- (f2cl-lib:sign (dlapy2 alpha xnorm) alpha))
                     (setf safmin (/ (dlamch "S") (dlamch "E"))))
             (cond
               ((< (abs beta) safmin)
                (tagbody
                 (setf rsafmn (/ one safmin))
                 (setf knt 0)
                 label10
                 (setf knt (f2cl-lib:int-add knt 1))
                 (dscal (f2cl-lib:int-sub n 1) rsafmn x incx)
                 (setf beta (* beta rsafmn))
                 (setf alpha (* alpha rsafmn))
                 (if (< (abs beta) safmin) (go label10))
                 (setf xnorm (dnrm2 (f2cl-lib:int-sub n 1) x incx))
                 (setf beta (- (f2cl-lib:sign (dlapy2 alpha xnorm) alpha))
                             (setf tau (/ (- beta alpha) beta))
                 (dscal (f2cl-lib:int-sub n 1) (/ one (- alpha beta)) x incx)
                 (setf alpha beta)
                 (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                               ((> j knt) nil)
                 (tagbody (setf alpha (* alpha safmin)) label20))))
             (t
              (setf tau (/ (- beta alpha) beta))
              (dscal (f2cl-lib:int-sub n 1) (/ one (- alpha beta)) x incx)

```

```
                (setf alpha beta))))))
end_label
    (return (values nil alpha nil nil tau))))))
```

## 7.48 dlarf LAPACK

```
<dlarf.input>≡
)set break resume
)sys rm -f dlarf.output
)spool dlarf.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

`<dlarf.help>`≡

```
=====
dlarf examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

DLARF - a real elementary reflector H to a real m by n matrix C, from either the left or the right

#### SYNOPSIS

```
SUBROUTINE DLARF( SIDE, M, N, V, INCV, TAU, C, LDC, WORK )
```

```
      CHARACTER      SIDE
```

```
      INTEGER        INCV, LDC, M, N
```

```
      DOUBLE         PRECISION TAU
```

```
      DOUBLE         PRECISION C( LDC, * ), V( * ), WORK( * )
```

#### PURPOSE

DLARF applies a real elementary reflector H to a real m by n matrix C, from either the left or the right. H is represented in the form

$$H = I - \tau * v * v'$$

where tau is a real scalar and v is a real vector.

If tau = 0, then H is taken to be the unit matrix.

#### ARGUMENTS

```
SIDE      (input) CHARACTER*1
           = 'L': form  H * C
           = 'R': form  C * H
```

```
M          (input) INTEGER
           The number of rows of the matrix C.
```

```
N          (input) INTEGER
           The number of columns of the matrix C.
```

V        (input) DOUBLE PRECISION array, dimension  
          (1 + (M-1)\*abs(INCV)) if SIDE = 'L' or (1 + (N-1)\*abs(INCV)) if  
          SIDE = 'R' The vector v in the representation of H. V is not  
          used if TAU = 0.

INCV     (input) INTEGER  
          The increment between elements of v. INCV <> 0.

TAU      (input) DOUBLE PRECISION  
          The value tau in the representation of H.

C        (input/output) DOUBLE PRECISION array, dimension (LDC,N)  
          On entry, the m by n matrix C. On exit, C is overwritten by  
          the matrix  $H * C$  if SIDE = 'L', or  $C * H$  if SIDE = 'R'.

LDC      (input) INTEGER  
          The leading dimension of the array C. LDC >= max(1,M).

WORK     (workspace) DOUBLE PRECISION array, dimension  
          (N) if SIDE = 'L' or (M) if SIDE = 'R'

```

(LAPACK dlarf)≡
  (let* ((one 1.0) (zero 0.0))
    (declare (type (double-float 1.0 1.0) one)
              (type (double-float 0.0 0.0) zero))
    (defun dlarf (side m n v incv tau c ldc work)
      (declare (type (double-float) tau)
                (type (simple-array double-float (*)) work c v)
                (type fixnum ldc incv n m)
                (type character side))
      (f2cl-lib:with-multi-array-data
        ((side character side-%data% side-%offset%)
         (v double-float v-%data% v-%offset%)
         (c double-float c-%data% c-%offset%)
         (work double-float work-%data% work-%offset%))
        (prog ()
          (declare)
          (cond
            ((char-equal side #\L)
              (cond
                ((/= tau zero)
                 (dgemv "Transpose" m n one c ldc v incv zero work 1)
                 (dger m n (- tau) v incv work 1 c ldc))))
            (t
              (cond
                ((/= tau zero)
                 (dgemv "No transpose" m n one c ldc v incv zero work 1)
                 (dger m n (- tau) work 1 v incv c ldc))))
            (return (values nil nil nil nil nil nil nil nil))))))

```

## 7.49 dlarft LAPACK

```

(dlarft.input)≡
  )set break resume
  )sys rm -f dlarft.output
  )spool dlarft.output
  )set message test on
  )set message auto off
  )clear all

  )spool
  )lisp (bye)

```

`<dlarft.help>=`

```
=====
dlarft examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

DLARFT - the triangular factor T of a real block reflector H of order n, which is defined as a product of k elementary reflectors

#### SYNOPSIS

```
SUBROUTINE DLARFT( DIRECT, STOREV, N, K, V, LDV, TAU, T, LDT )
```

```
      CHARACTER      DIRECT, STOREV
```

```
      INTEGER        K, LDT, LDV, N
```

```
      DOUBLE         PRECISION T( LDT, * ), TAU( * ), V( LDV, * )
```

#### PURPOSE

DLARFT forms the triangular factor T of a real block reflector H of order n, which is defined as a product of k elementary reflectors.

If DIRECT = 'F', H = H(1) H(2) . . . H(k) and T is upper triangular;

If DIRECT = 'B', H = H(k) . . . H(2) H(1) and T is lower triangular.

If STOREV = 'C', the vector which defines the elementary reflector H(i) is stored in the i-th column of the array V, and

$$H = I - V * T * V'$$

If STOREV = 'R', the vector which defines the elementary reflector H(i) is stored in the i-th row of the array V, and

$$H = I - V' * T * V$$

#### ARGUMENTS

DIRECT (input) CHARACTER\*1

Specifies the order in which the elementary reflectors are multiplied to form the block reflector:

= 'F': H = H(1) H(2) . . . H(k) (Forward)

= 'B':  $H = H(k) \dots H(2) H(1)$  (Backward)

STOREV (input) CHARACTER\*1  
 Specifies how the vectors which define the elementary reflectors are stored (see also Further Details):  
 = 'R': rowwise

N (input) INTEGER  
 The order of the block reflector  $H$ .  $N \geq 0$ .

K (input) INTEGER  
 The order of the triangular factor  $T$  (= the number of elementary reflectors).  $K \geq 1$ .

V (input/output) DOUBLE PRECISION array, dimension (LDV,K) if STOREV = 'C' (LDV,N) if STOREV = 'R' The matrix  $V$ . See further details.

LDV (input) INTEGER  
 The leading dimension of the array  $V$ . If STOREV = 'C',  $LDV \geq \max(1,N)$ ; if STOREV = 'R',  $LDV \geq K$ .

TAU (input) DOUBLE PRECISION array, dimension (K)  
 TAU(i) must contain the scalar factor of the elementary reflector  $H(i)$ .

T (output) DOUBLE PRECISION array, dimension (LDT,K)  
 The  $k$  by  $k$  triangular factor  $T$  of the block reflector. If DIRECT = 'F',  $T$  is upper triangular; if DIRECT = 'B',  $T$  is lower triangular. The rest of the array is not used.

LDT (input) INTEGER  
 The leading dimension of the array  $T$ .  $LDT \geq K$ .

#### FURTHER DETAILS

The shape of the matrix  $V$  and the storage of the vectors which define the  $H(i)$  is best illustrated by the following example with  $n = 5$  and  $k = 3$ . The elements equal to 1 are not stored; the corresponding array elements are modified but restored on exit. The rest of the array is not used.

DIRECT = 'F' and STOREV = 'C':

$$V = \begin{pmatrix} 1 & & \\ v_1 & 1 & \\ v_1 & v_2 & 1 \end{pmatrix}$$

DIRECT = 'F' and STOREV = 'R':

$$V = \begin{pmatrix} 1 & v_1 & v_1 & v_1 & v_1 \\ & 1 & v_2 & v_2 & v_2 \\ & & 1 & v_3 & v_3 \end{pmatrix}$$

```
( v1 v2 v3 )
( v1 v2 v3 )
```

DIRECT = 'B' and STOREV = 'C':

```
V = ( v1 v2 v3 )
      ( v1 v2 v3 )
      ( 1 v2 v3 )
      (      1 v3 )
      (          1 )
```

DIRECT = 'B' and STOREV = 'R':

```
V = ( v1 v1 1      )
      ( v2 v2 v2 1  )
      ( v3 v3 v3 v3 1 )
```



```

(LAPACK dlarft)≡
  (let* ((one 1.0) (zero 0.0))
    (declare (type (double-float 1.0 1.0) one)
              (type (double-float 0.0 0.0) zero))
    (defun dlarft (direct storev n k v ldv tau t$ ldt)
      (declare (type (simple-array double-float (*)) t$ tau v)
                (type fixnum ldt ldv k n)
                (type character storev direct))
      (f2cl-lib:with-multi-array-data
        ((direct character direct-%data% direct-%offset%)
         (storev character storev-%data% storev-%offset%)
         (v double-float v-%data% v-%offset%)
         (tau double-float tau-%data% tau-%offset%)
         (t$ double-float t$-%data% t$-%offset%))
        (prog ((vii 0.0) (i 0) (j 0))
          (declare (type (double-float) vii) (type fixnum i j))
          (if (= n 0) (go end_label))
          (cond
            ((char-equal direct #\F)
             (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                           ((> i k) nil)
             (tagbody
              (cond
                ((= (f2cl-lib:fref tau (i) ((1 *)) zero)
                  (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                                ((> j i) nil)
                  (tagbody
                   (setf (f2cl-lib:fref t$-%data%
                                       (j i)
                                       ((1 ldt) (1 *))
                                       t$-%offset%)
                     zero))))
              (t
               (setf vii
                     (f2cl-lib:fref v-%data%
                                   (i i)
                                   ((1 ldv) (1 *))
                                   v-%offset%))
               (setf (f2cl-lib:fref v-%data%
                                   (i i)
                                   ((1 ldv) (1 *))
                                   v-%offset%)
                 one)
              (cond
                ((char-equal storev #\C)
                 (dgemv "Transpose"

```

```

(f2cl-lib:int-add (f2cl-lib:int-sub n i) 1)
(f2cl-lib:int-sub i 1)
(- (f2cl-lib:fref tau-%data% (i) ((1 *)) tau-%offset%))
(f2cl-lib:array-slice v
  double-float
  (i 1)
  ((1 ldv) (1 *)))
ldv
(f2cl-lib:array-slice v
  double-float
  (i i)
  ((1 ldv) (1 *)))
1 zero
(f2cl-lib:array-slice t$
  double-float
  (1 i)
  ((1 ldt) (1 *)))
1))
(t
(dgemv "No transpose" (f2cl-lib:int-sub i 1)
(f2cl-lib:int-add (f2cl-lib:int-sub n i) 1)
(- (f2cl-lib:fref tau-%data% (i) ((1 *)) tau-%offset%))
(f2cl-lib:array-slice v
  double-float
  (1 i)
  ((1 ldv) (1 *)))
ldv
(f2cl-lib:array-slice v
  double-float
  (i i)
  ((1 ldv) (1 *)))
ldv zero
(f2cl-lib:array-slice t$
  double-float
  (1 i)
  ((1 ldt) (1 *)))
1)))
(setf (f2cl-lib:fref v-%data%
  (i i)
  ((1 ldv) (1 *))
  v-%offset%)
vii)
(dtrmv "Upper" "No transpose" "Non-unit"
(f2cl-lib:int-sub i 1) t$ ldt
(f2cl-lib:array-slice t$ double-float (1 i) ((1 ldt) (1 *)))
1)

```

```

      (setf (f2cl-lib:fref t$-%data%
        (i i)
        ((1 ldt) (1 *)))
        t$-%offset%)
      (f2cl-lib:fref tau-%data%
        (i)
        ((1 *)))
        tau-%offset%))))))
(t
  (f2cl-lib:fdo (i k (f2cl-lib:int-add i (f2cl-lib:int-sub 1)))
    ((> i 1) nil)
    (tagbody
      (cond
        ((= (f2cl-lib:fref tau (i) ((1 *))) zero)
          (f2cl-lib:fdo (j i (f2cl-lib:int-add j 1))
            ((> j k) nil)
            (tagbody
              (setf (f2cl-lib:fref t$-%data%
                (j i)
                ((1 ldt) (1 *)))
                t$-%offset%)
                zero))))
      (t
        (cond
          ((< i k)
            (cond
              ((char-equal storev #\C)
                (setf vii
                  (f2cl-lib:fref v-%data%
                    ((f2cl-lib:int-add
                      (f2cl-lib:int-sub n k)
                      i)
                    i)
                    ((1 ldv) (1 *)))
                    v-%offset%))
                (setf (f2cl-lib:fref v-%data%
                  ((f2cl-lib:int-add
                    (f2cl-lib:int-sub n k)
                    i)
                  i)
                    ((1 ldv) (1 *)))
                    v-%offset%)
                    one)
                (dgemv "Transpose"
                  (f2cl-lib:int-add (f2cl-lib:int-sub n k) i)
                  (f2cl-lib:int-sub k i)

```

```

(-
  (f2cl-lib:fref tau-%data% (i) ((1 *)) tau-%offset%))
(f2cl-lib:array-slice v
  double-float
  (1 (f2cl-lib:int-add i 1))
  ((1 ldv) (1 *)))

ldv
(f2cl-lib:array-slice v
  double-float
  (1 i)
  ((1 ldv) (1 *)))

1 zero
(f2cl-lib:array-slice t$
  double-float
  ((+ i 1) i)
  ((1 ldt) (1 *)))

1)
(setf (f2cl-lib:fref v-%data%
  ((f2cl-lib:int-add
    (f2cl-lib:int-sub n k)
    i)
    i)
  ((1 ldv) (1 *))
  v-%offset%))
  vii))

(t
  (setf vii
    (f2cl-lib:fref v-%data%
      (i
        (f2cl-lib:int-add
          (f2cl-lib:int-sub n k)
          i))
        ((1 ldv) (1 *))
        v-%offset%))
    (setf (f2cl-lib:fref v-%data%
      (i
        (f2cl-lib:int-add
          (f2cl-lib:int-sub n k)
          i))
        ((1 ldv) (1 *))
        v-%offset%))
      one)
  (dgemv "No transpose" (f2cl-lib:int-sub k i)
    (f2cl-lib:int-add (f2cl-lib:int-sub n k) i)
    (-
      (f2cl-lib:fref tau-%data% (i) ((1 *)) tau-%offset%))

```

```

(f2cl-lib:array-slice v
  double-float
  ((+ i 1) 1)
  ((1 ldv) (1 *)))

ldv
(f2cl-lib:array-slice v
  double-float
  (i 1)
  ((1 ldv) (1 *)))

ldv zero
(f2cl-lib:array-slice t$
  double-float
  ((+ i 1) i)
  ((1 ldt) (1 *)))

1)
(setf (f2cl-lib:fref v-%data%
  (i
    (f2cl-lib:int-add
      (f2cl-lib:int-sub n k)
      i))
    ((1 ldv) (1 *))
    v-%offset%)
  vii)))
(dtrmv "Lower" "No transpose" "Non-unit"
  (f2cl-lib:int-sub k i)
  (f2cl-lib:array-slice t$
    double-float
    ((+ i 1) (f2cl-lib:int-add i 1))
    ((1 ldt) (1 *)))

ldt
(f2cl-lib:array-slice t$
  double-float
  ((+ i 1) i)
  ((1 ldt) (1 *)))

1)))
(setf (f2cl-lib:fref t$-%data%
  (i i)
  ((1 ldt) (1 *))
  t$-%offset%)
  (f2cl-lib:fref tau-%data%
    (i)
    ((1 *))
    tau-%offset%))))))

end_label
(return (values nil nil nil nil nil nil nil nil))

```

## 7.50 dlarfx LAPACK

```
<dlarfx.input>≡  
  )set break resume  
  )sys rm -f dlarfx.output  
  )spool dlarfx.output  
  )set message test on  
  )set message auto off  
  )clear all  
  
  )spool  
  )lisp (bye)
```

`<dlarfx.help>`≡

```
=====
dlarfx examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

DLARFX - a real elementary reflector H to a real m by n matrix C, from either the left or the right

#### SYNOPSIS

```
SUBROUTINE DLARFX( SIDE, M, N, V, TAU, C, LDC, WORK )
```

```

      CHARACTER      SIDE
      INTEGER        LDC, M, N
      DOUBLE         PRECISION TAU
      DOUBLE         PRECISION C( LDC, * ), V( * ), WORK( * )
```

#### PURPOSE

DLARFX applies a real elementary reflector H to a real m by n matrix C, from either the left or the right. H is represented in the form

$$H = I - \tau * v * v'$$

where tau is a real scalar and v is a real vector.

If tau = 0, then H is taken to be the unit matrix

This version uses inline code if H has order < 11.

#### ARGUMENTS

```

SIDE      (input) CHARACTER*1
           = 'L': form  H * C
           = 'R': form  C * H

M          (input) INTEGER
           The number of rows of the matrix C.

N          (input) INTEGER
```

The number of columns of the matrix C.

V (input) DOUBLE PRECISION array, dimension (M) if SIDE = 'L' or (N) if SIDE = 'R' The vector v in the representation of H.

TAU (input) DOUBLE PRECISION  
The value tau in the representation of H.

C (input/output) DOUBLE PRECISION array, dimension (LDC,N)  
On entry, the m by n matrix C. On exit, C is overwritten by the matrix  $H * C$  if SIDE = 'L', or  $C * H$  if SIDE = 'R'.

LDC (input) INTEGER  
The leading dimension of the array C. LDA  $\geq$  (1,M).

WORK (workspace) DOUBLE PRECISION array, dimension  
(N) if SIDE = 'L' or (M) if SIDE = 'R' WORK is not referenced if H has order  $< 11$ .



```

(LAPACK dlarfx)≡
  (let* ((zero 0.0) (one 1.0))
    (declare (type (double-float 0.0 0.0) zero)
              (type (double-float 1.0 1.0) one))
    (defun dlarfx (side m n v tau c ldc work)
      (declare (type (double-float) tau)
                (type (simple-array double-float (*)) work c v)
                (type fixnum ldc n m)
                (type character side))
      (f2cl-lib:with-multi-array-data
        ((side character side-%data% side-%offset%)
         (v double-float v-%data% v-%offset%)
         (c double-float c-%data% c-%offset%)
         (work double-float work-%data% work-%offset%))
        (prog ((sum 0.0) (t1 0.0) (t10 0.0) (t2 0.0) (t3 0.0) (t4 0.0) (t5 0.0)
              (t6 0.0) (t7 0.0) (t8 0.0) (t9 0.0) (v1 0.0) (v10 0.0) (v2 0.0)
              (v3 0.0) (v4 0.0) (v5 0.0) (v6 0.0) (v7 0.0) (v8 0.0) (v9 0.0)
              (j 0))
              (declare (type (double-float) sum t1 t10 t2 t3 t4 t5 t6 t7 t8 t9 v1 v10
                              v2 v3 v4 v5 v6 v7 v8 v9)
                        (type fixnum j))
              (if (= tau zero) (go end_label))
              (cond
                ((char-equal side #\L)
                 (tagbody
                  (f2cl-lib:computed-goto
                   (label10 label130 label150 label170 label190 label110 label130
                     label150 label170 label190)
                   m)
                  (dgemv "Transpose" m n one c ldc v 1 zero work 1)
                  (dger m n (- tau) v 1 work 1 c ldc)
                  (go end_label)
                  label10
                  (setf t1
                       (+ one
                          (* (- tau)
                             (f2cl-lib:fref v-%data% (1) ((1 *)) v-%offset%)
                             (f2cl-lib:fref v-%data% (1) ((1 *)) v-%offset%))))
                  (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                                (> j n) nil)
                  (tagbody
                   (setf (f2cl-lib:fref c-%data%
                                         (1 j)
                                         ((1 ldc) (1 *))
                                         c-%offset%)
                         (* t1

```

```

                                (f2cl-lib:fref c-%data%
                                (1 j)
                                ((1 ldc) (1 *))
                                c-%offset%))))))
label30 (go end_label)
(setf v1 (f2cl-lib:fref v-%data% (1) ((1 *)) v-%offset%))
(setf t1 (* tau v1))
(setf v2 (f2cl-lib:fref v-%data% (2) ((1 *)) v-%offset%))
(setf t2 (* tau v2))
(f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
              ((> j n) nil)
  (tagbody
    (setf sum
      (+
        (* v1
          (f2cl-lib:fref c-%data%
            (1 j)
            ((1 ldc) (1 *))
            c-%offset%))
        (* v2
          (f2cl-lib:fref c-%data%
            (2 j)
            ((1 ldc) (1 *))
            c-%offset%))))))
    (setf (f2cl-lib:fref c-%data%
      (1 j)
      ((1 ldc) (1 *))
      c-%offset%)
      (-
        (f2cl-lib:fref c-%data%
          (1 j)
          ((1 ldc) (1 *))
          c-%offset%)
        (* sum t1))))
    (setf (f2cl-lib:fref c-%data%
      (2 j)
      ((1 ldc) (1 *))
      c-%offset%)
      (-
        (f2cl-lib:fref c-%data%
          (2 j)
          ((1 ldc) (1 *))
          c-%offset%)
        (* sum t2))))))
  (go end_label)

```

label150

```

(setf v1 (f2cl-lib:fref v-%data% (1) ((1 *)) v-%offset%))
(setf t1 (* tau v1))
(setf v2 (f2cl-lib:fref v-%data% (2) ((1 *)) v-%offset%))
(setf t2 (* tau v2))
(setf v3 (f2cl-lib:fref v-%data% (3) ((1 *)) v-%offset%))
(setf t3 (* tau v3))
(f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
  (> j n) nil)
(tagbody
  (setf sum
    (+
      (* v1
        (f2cl-lib:fref c-%data%
          (1 j)
          ((1 ldc) (1 *))
          c-%offset%))
      (* v2
        (f2cl-lib:fref c-%data%
          (2 j)
          ((1 ldc) (1 *))
          c-%offset%))
      (* v3
        (f2cl-lib:fref c-%data%
          (3 j)
          ((1 ldc) (1 *))
          c-%offset%))))))
(setf (f2cl-lib:fref c-%data%
  (1 j)
  ((1 ldc) (1 *))
  c-%offset%)
  (-
    (f2cl-lib:fref c-%data%
      (1 j)
      ((1 ldc) (1 *))
      c-%offset%)
    (* sum t1)))
(setf (f2cl-lib:fref c-%data%
  (2 j)
  ((1 ldc) (1 *))
  c-%offset%)
  (-
    (f2cl-lib:fref c-%data%
      (2 j)
      ((1 ldc) (1 *))
      c-%offset%)
    (* sum t2)))
(setf (f2cl-lib:fref c-%data%
  (3 j)
  ((1 ldc) (1 *))
  c-%offset%)
  (-
    (f2cl-lib:fref c-%data%
      (3 j)
      ((1 ldc) (1 *))
      c-%offset%)
    (* sum t3)))

```

```

        (* sum t2)))
      (setf (f2cl-lib:fref c-%data%
        (3 j)
        ((1 ldc) (1 *))
        c-%offset%)
        (-
          (f2cl-lib:fref c-%data%
            (3 j)
            ((1 ldc) (1 *))
            c-%offset%)
          (* sum t3))))))
      (go end_label)
label170
      (setf v1 (f2cl-lib:fref v-%data% (1) ((1 *)) v-%offset%))
      (setf t1 (* tau v1))
      (setf v2 (f2cl-lib:fref v-%data% (2) ((1 *)) v-%offset%))
      (setf t2 (* tau v2))
      (setf v3 (f2cl-lib:fref v-%data% (3) ((1 *)) v-%offset%))
      (setf t3 (* tau v3))
      (setf v4 (f2cl-lib:fref v-%data% (4) ((1 *)) v-%offset%))
      (setf t4 (* tau v4))
      (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
        (> j n) nil)
      (tagbody
        (setf sum
          (+
            (* v1
              (f2cl-lib:fref c-%data%
                (1 j)
                ((1 ldc) (1 *))
                c-%offset%))
            (* v2
              (f2cl-lib:fref c-%data%
                (2 j)
                ((1 ldc) (1 *))
                c-%offset%))
            (* v3
              (f2cl-lib:fref c-%data%
                (3 j)
                ((1 ldc) (1 *))
                c-%offset%))
            (* v4
              (f2cl-lib:fref c-%data%
                (4 j)
                ((1 ldc) (1 *))
                c-%offset%))))))

```

```

      (setf (f2cl-lib:fref c-%data%
        (1 j)
        ((1 ldc) (1 *))
        c-%offset%)
        (-
          (f2cl-lib:fref c-%data%
            (1 j)
            ((1 ldc) (1 *))
            c-%offset%)
          (* sum t1)))
      (setf (f2cl-lib:fref c-%data%
        (2 j)
        ((1 ldc) (1 *))
        c-%offset%)
        (-
          (f2cl-lib:fref c-%data%
            (2 j)
            ((1 ldc) (1 *))
            c-%offset%)
          (* sum t2)))
      (setf (f2cl-lib:fref c-%data%
        (3 j)
        ((1 ldc) (1 *))
        c-%offset%)
        (-
          (f2cl-lib:fref c-%data%
            (3 j)
            ((1 ldc) (1 *))
            c-%offset%)
          (* sum t3)))
      (setf (f2cl-lib:fref c-%data%
        (4 j)
        ((1 ldc) (1 *))
        c-%offset%)
        (-
          (f2cl-lib:fref c-%data%
            (4 j)
            ((1 ldc) (1 *))
            c-%offset%)
          (* sum t4))))
      (go end_label)

label190
      (setf v1 (f2cl-lib:fref v-%data% (1) ((1 *)) v-%offset%))
      (setf t1 (* tau v1))
      (setf v2 (f2cl-lib:fref v-%data% (2) ((1 *)) v-%offset%))
      (setf t2 (* tau v2))

```

```

(setf v3 (f2cl-lib:fref v-%data% (3) ((1 *)) v-%offset%))
(setf t3 (* tau v3))
(setf v4 (f2cl-lib:fref v-%data% (4) ((1 *)) v-%offset%))
(setf t4 (* tau v4))
(setf v5 (f2cl-lib:fref v-%data% (5) ((1 *)) v-%offset%))
(setf t5 (* tau v5))
(f2cl-lib:fd0 (j 1 (f2cl-lib:int-add j 1))
  (> j n) nil)
(tagbody
  (setf sum
    (+
      (* v1
        (f2cl-lib:fref c-%data%
          (1 j)
          ((1 ldc) (1 *))
          c-%offset%))
      (* v2
        (f2cl-lib:fref c-%data%
          (2 j)
          ((1 ldc) (1 *))
          c-%offset%))
      (* v3
        (f2cl-lib:fref c-%data%
          (3 j)
          ((1 ldc) (1 *))
          c-%offset%))
      (* v4
        (f2cl-lib:fref c-%data%
          (4 j)
          ((1 ldc) (1 *))
          c-%offset%))
      (* v5
        (f2cl-lib:fref c-%data%
          (5 j)
          ((1 ldc) (1 *))
          c-%offset%))))
    (setf (f2cl-lib:fref c-%data%
      (1 j)
      ((1 ldc) (1 *))
      c-%offset%)
      (-
        (f2cl-lib:fref c-%data%
          (1 j)
          ((1 ldc) (1 *))
          c-%offset%)
        (* sum t1)))

```

```

      (setf (f2cl-lib:fref c-%data%
                          (2 j)
                          ((1 ldc) (1 *)))
            c-%offset%)
      (-
        (f2cl-lib:fref c-%data%
                        (2 j)
                        ((1 ldc) (1 *)))
        c-%offset%)
      (* sum t2)))
    (setf (f2cl-lib:fref c-%data%
                        (3 j)
                        ((1 ldc) (1 *)))
          c-%offset%)
    (-
      (f2cl-lib:fref c-%data%
                      (3 j)
                      ((1 ldc) (1 *)))
      c-%offset%)
      (* sum t3)))
    (setf (f2cl-lib:fref c-%data%
                        (4 j)
                        ((1 ldc) (1 *)))
          c-%offset%)
    (-
      (f2cl-lib:fref c-%data%
                      (4 j)
                      ((1 ldc) (1 *)))
      c-%offset%)
      (* sum t4)))
    (setf (f2cl-lib:fref c-%data%
                        (5 j)
                        ((1 ldc) (1 *)))
          c-%offset%)
    (-
      (f2cl-lib:fref c-%data%
                      (5 j)
                      ((1 ldc) (1 *)))
      c-%offset%)
      (* sum t5))))
    (go end_label)
label1110
    (setf v1 (f2cl-lib:fref v-%data% (1) ((1 *)) v-%offset%))
    (setf t1 (* tau v1))
    (setf v2 (f2cl-lib:fref v-%data% (2) ((1 *)) v-%offset%))
    (setf t2 (* tau v2))

```

```

(setf v3 (f2cl-lib:fref v-%data% (3) ((1 *)) v-%offset%))
(setf t3 (* tau v3))
(setf v4 (f2cl-lib:fref v-%data% (4) ((1 *)) v-%offset%))
(setf t4 (* tau v4))
(setf v5 (f2cl-lib:fref v-%data% (5) ((1 *)) v-%offset%))
(setf t5 (* tau v5))
(setf v6 (f2cl-lib:fref v-%data% (6) ((1 *)) v-%offset%))
(setf t6 (* tau v6))
(f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
  (> j n) nil)
(tagbody
  (setf sum
    (+
      (* v1
        (f2cl-lib:fref c-%data%
          (1 j)
          ((1 ldc) (1 *))
          c-%offset%))
      (* v2
        (f2cl-lib:fref c-%data%
          (2 j)
          ((1 ldc) (1 *))
          c-%offset%))
      (* v3
        (f2cl-lib:fref c-%data%
          (3 j)
          ((1 ldc) (1 *))
          c-%offset%))
      (* v4
        (f2cl-lib:fref c-%data%
          (4 j)
          ((1 ldc) (1 *))
          c-%offset%))
      (* v5
        (f2cl-lib:fref c-%data%
          (5 j)
          ((1 ldc) (1 *))
          c-%offset%))
      (* v6
        (f2cl-lib:fref c-%data%
          (6 j)
          ((1 ldc) (1 *))
          c-%offset%))))))
(setf (f2cl-lib:fref c-%data%
  (1 j)
  ((1 ldc) (1 *))

```



```

                                c-%offset%)
(-
  (f2cl-lib:fref c-%data%
    (1 j)
    ((1 ldc) (1 *)))
    c-%offset%)
  (* sum t1)))
(setf (f2cl-lib:fref c-%data%
  (2 j)
  ((1 ldc) (1 *)))
  c-%offset%)
(-
  (f2cl-lib:fref c-%data%
    (2 j)
    ((1 ldc) (1 *)))
    c-%offset%)
  (* sum t2)))
(setf (f2cl-lib:fref c-%data%
  (3 j)
  ((1 ldc) (1 *)))
  c-%offset%)
(-
  (f2cl-lib:fref c-%data%
    (3 j)
    ((1 ldc) (1 *)))
    c-%offset%)
  (* sum t3)))
(setf (f2cl-lib:fref c-%data%
  (4 j)
  ((1 ldc) (1 *)))
  c-%offset%)
(-
  (f2cl-lib:fref c-%data%
    (4 j)
    ((1 ldc) (1 *)))
    c-%offset%)
  (* sum t4)))
(setf (f2cl-lib:fref c-%data%
  (5 j)
  ((1 ldc) (1 *)))
  c-%offset%)
(-
  (f2cl-lib:fref c-%data%
    (5 j)
    ((1 ldc) (1 *)))
    c-%offset%)

```

```

        (* sum t5)))
      (setf (f2cl-lib:fref c-%data%
                          (6 j)
                          ((1 ldc) (1 *)))
            c-%offset%)
      (-
        (f2cl-lib:fref c-%data%
                      (6 j)
                      ((1 ldc) (1 *)))
        c-%offset%)
      (* sum t6))))))
      (go end_label)
label130
      (setf v1 (f2cl-lib:fref v-%data% (1) ((1 *)) v-%offset%))
      (setf t1 (* tau v1))
      (setf v2 (f2cl-lib:fref v-%data% (2) ((1 *)) v-%offset%))
      (setf t2 (* tau v2))
      (setf v3 (f2cl-lib:fref v-%data% (3) ((1 *)) v-%offset%))
      (setf t3 (* tau v3))
      (setf v4 (f2cl-lib:fref v-%data% (4) ((1 *)) v-%offset%))
      (setf t4 (* tau v4))
      (setf v5 (f2cl-lib:fref v-%data% (5) ((1 *)) v-%offset%))
      (setf t5 (* tau v5))
      (setf v6 (f2cl-lib:fref v-%data% (6) ((1 *)) v-%offset%))
      (setf t6 (* tau v6))
      (setf v7 (f2cl-lib:fref v-%data% (7) ((1 *)) v-%offset%))
      (setf t7 (* tau v7))
      (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                    ((> j n) nil)
      (tagbody
        (setf sum
          (+
            (* v1
              (f2cl-lib:fref c-%data%
                            (1 j)
                            ((1 ldc) (1 *)))
              c-%offset%))
            (* v2
              (f2cl-lib:fref c-%data%
                            (2 j)
                            ((1 ldc) (1 *)))
              c-%offset%))
            (* v3
              (f2cl-lib:fref c-%data%
                            (3 j)
                            ((1 ldc) (1 *)))
              c-%offset%))
          ))

```

```

                                c-%offset%))
(* v4
  (f2cl-lib:fref c-%data%
    (4 j)
    ((1 ldc) (1 *))
    c-%offset%))
(* v5
  (f2cl-lib:fref c-%data%
    (5 j)
    ((1 ldc) (1 *))
    c-%offset%))
(* v6
  (f2cl-lib:fref c-%data%
    (6 j)
    ((1 ldc) (1 *))
    c-%offset%))
(* v7
  (f2cl-lib:fref c-%data%
    (7 j)
    ((1 ldc) (1 *))
    c-%offset%)))
(setf (f2cl-lib:fref c-%data%
  (1 j)
  ((1 ldc) (1 *))
  c-%offset%)
  (-
    (f2cl-lib:fref c-%data%
      (1 j)
      ((1 ldc) (1 *))
      c-%offset%)
    (* sum t1)))
(setf (f2cl-lib:fref c-%data%
  (2 j)
  ((1 ldc) (1 *))
  c-%offset%)
  (-
    (f2cl-lib:fref c-%data%
      (2 j)
      ((1 ldc) (1 *))
      c-%offset%)
    (* sum t2)))
(setf (f2cl-lib:fref c-%data%
  (3 j)
  ((1 ldc) (1 *))
  c-%offset%)
  (-

```

```

        (f2cl-lib:fref c-%data%
          (3 j)
          ((1 ldc) (1 *))
          c-%offset%)
      (* sum t3)))
(setf (f2cl-lib:fref c-%data%
  (4 j)
  ((1 ldc) (1 *))
  c-%offset%)
(-
  (f2cl-lib:fref c-%data%
    (4 j)
    ((1 ldc) (1 *))
    c-%offset%)
  (* sum t4)))
(setf (f2cl-lib:fref c-%data%
  (5 j)
  ((1 ldc) (1 *))
  c-%offset%)
(-
  (f2cl-lib:fref c-%data%
    (5 j)
    ((1 ldc) (1 *))
    c-%offset%)
  (* sum t5)))
(setf (f2cl-lib:fref c-%data%
  (6 j)
  ((1 ldc) (1 *))
  c-%offset%)
(-
  (f2cl-lib:fref c-%data%
    (6 j)
    ((1 ldc) (1 *))
    c-%offset%)
  (* sum t6)))
(setf (f2cl-lib:fref c-%data%
  (7 j)
  ((1 ldc) (1 *))
  c-%offset%)
(-
  (f2cl-lib:fref c-%data%
    (7 j)
    ((1 ldc) (1 *))
    c-%offset%)
  (* sum t7))))
(go end_label)

```

label150

```

(setf v1 (f2cl-lib:fref v-%data% (1) ((1 *)) v-%offset%))
(setf t1 (* tau v1))
(setf v2 (f2cl-lib:fref v-%data% (2) ((1 *)) v-%offset%))
(setf t2 (* tau v2))
(setf v3 (f2cl-lib:fref v-%data% (3) ((1 *)) v-%offset%))
(setf t3 (* tau v3))
(setf v4 (f2cl-lib:fref v-%data% (4) ((1 *)) v-%offset%))
(setf t4 (* tau v4))
(setf v5 (f2cl-lib:fref v-%data% (5) ((1 *)) v-%offset%))
(setf t5 (* tau v5))
(setf v6 (f2cl-lib:fref v-%data% (6) ((1 *)) v-%offset%))
(setf t6 (* tau v6))
(setf v7 (f2cl-lib:fref v-%data% (7) ((1 *)) v-%offset%))
(setf t7 (* tau v7))
(setf v8 (f2cl-lib:fref v-%data% (8) ((1 *)) v-%offset%))
(setf t8 (* tau v8))
(f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
  (> j n) nil)
(tagbody
  (setf sum
    (+
      (* v1
        (f2cl-lib:fref c-%data%
          (1 j)
          ((1 ldc) (1 *))
          c-%offset%))
      (* v2
        (f2cl-lib:fref c-%data%
          (2 j)
          ((1 ldc) (1 *))
          c-%offset%))
      (* v3
        (f2cl-lib:fref c-%data%
          (3 j)
          ((1 ldc) (1 *))
          c-%offset%))
      (* v4
        (f2cl-lib:fref c-%data%
          (4 j)
          ((1 ldc) (1 *))
          c-%offset%))
      (* v5
        (f2cl-lib:fref c-%data%
          (5 j)
          ((1 ldc) (1 *))

```

```

                                c-%offset%))
(* v6
  (f2cl-lib:fref c-%data%
    (6 j)
    ((1 ldc) (1 *))
    c-%offset%))
(* v7
  (f2cl-lib:fref c-%data%
    (7 j)
    ((1 ldc) (1 *))
    c-%offset%))
(* v8
  (f2cl-lib:fref c-%data%
    (8 j)
    ((1 ldc) (1 *))
    c-%offset%)))
(setf (f2cl-lib:fref c-%data%
  (1 j)
  ((1 ldc) (1 *))
  c-%offset%)
(-
  (f2cl-lib:fref c-%data%
    (1 j)
    ((1 ldc) (1 *))
    c-%offset%)
  (* sum t1)))
(setf (f2cl-lib:fref c-%data%
  (2 j)
  ((1 ldc) (1 *))
  c-%offset%)
(-
  (f2cl-lib:fref c-%data%
    (2 j)
    ((1 ldc) (1 *))
    c-%offset%)
  (* sum t2)))
(setf (f2cl-lib:fref c-%data%
  (3 j)
  ((1 ldc) (1 *))
  c-%offset%)
(-
  (f2cl-lib:fref c-%data%
    (3 j)
    ((1 ldc) (1 *))
    c-%offset%)
  (* sum t3)))

```

```

(setf (f2cl-lib:fref c-%data%
                    (4 j)
                    ((1 ldc) (1 *)))
      c-%offset%)

(-
  (f2cl-lib:fref c-%data%
                (4 j)
                ((1 ldc) (1 *)))
    c-%offset%)

(* sum t4)))
(setf (f2cl-lib:fref c-%data%
                    (5 j)
                    ((1 ldc) (1 *)))
      c-%offset%)

(-
  (f2cl-lib:fref c-%data%
                (5 j)
                ((1 ldc) (1 *)))
    c-%offset%)

(* sum t5)))
(setf (f2cl-lib:fref c-%data%
                    (6 j)
                    ((1 ldc) (1 *)))
      c-%offset%)

(-
  (f2cl-lib:fref c-%data%
                (6 j)
                ((1 ldc) (1 *)))
    c-%offset%)

(* sum t6)))
(setf (f2cl-lib:fref c-%data%
                    (7 j)
                    ((1 ldc) (1 *)))
      c-%offset%)

(-
  (f2cl-lib:fref c-%data%
                (7 j)
                ((1 ldc) (1 *)))
    c-%offset%)

(* sum t7)))
(setf (f2cl-lib:fref c-%data%
                    (8 j)
                    ((1 ldc) (1 *)))
      c-%offset%)

(-
  (f2cl-lib:fref c-%data%

```

```

                                (8 j)
                                ((1 ldc) (1 *))
                                c-%offset%)
                                (* sum t8))))
    (go end_label)
label170
    (setf v1 (f2cl-lib:fref v-%data% (1) ((1 *)) v-%offset%))
    (setf t1 (* tau v1))
    (setf v2 (f2cl-lib:fref v-%data% (2) ((1 *)) v-%offset%))
    (setf t2 (* tau v2))
    (setf v3 (f2cl-lib:fref v-%data% (3) ((1 *)) v-%offset%))
    (setf t3 (* tau v3))
    (setf v4 (f2cl-lib:fref v-%data% (4) ((1 *)) v-%offset%))
    (setf t4 (* tau v4))
    (setf v5 (f2cl-lib:fref v-%data% (5) ((1 *)) v-%offset%))
    (setf t5 (* tau v5))
    (setf v6 (f2cl-lib:fref v-%data% (6) ((1 *)) v-%offset%))
    (setf t6 (* tau v6))
    (setf v7 (f2cl-lib:fref v-%data% (7) ((1 *)) v-%offset%))
    (setf t7 (* tau v7))
    (setf v8 (f2cl-lib:fref v-%data% (8) ((1 *)) v-%offset%))
    (setf t8 (* tau v8))
    (setf v9 (f2cl-lib:fref v-%data% (9) ((1 *)) v-%offset%))
    (setf t9 (* tau v9))
    (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                  (> j n) nil)
    (tagbody
      (setf sum
        (+
          (* v1
            (f2cl-lib:fref c-%data%
                          (1 j)
                          ((1 ldc) (1 *))
                          c-%offset%))
          (* v2
            (f2cl-lib:fref c-%data%
                          (2 j)
                          ((1 ldc) (1 *))
                          c-%offset%))
          (* v3
            (f2cl-lib:fref c-%data%
                          (3 j)
                          ((1 ldc) (1 *))
                          c-%offset%))
          (* v4
            (f2cl-lib:fref c-%data%

```



```

(4 j)
((1 ldc) (1 *))
c-%offset%))
(* v5
  (f2cl-lib:fref c-%data%
    (5 j)
    ((1 ldc) (1 *))
    c-%offset%))
(* v6
  (f2cl-lib:fref c-%data%
    (6 j)
    ((1 ldc) (1 *))
    c-%offset%))
(* v7
  (f2cl-lib:fref c-%data%
    (7 j)
    ((1 ldc) (1 *))
    c-%offset%))
(* v8
  (f2cl-lib:fref c-%data%
    (8 j)
    ((1 ldc) (1 *))
    c-%offset%))
(* v9
  (f2cl-lib:fref c-%data%
    (9 j)
    ((1 ldc) (1 *))
    c-%offset%)))
(setf (f2cl-lib:fref c-%data%
  (1 j)
  ((1 ldc) (1 *))
  c-%offset%)
(-
  (f2cl-lib:fref c-%data%
    (1 j)
    ((1 ldc) (1 *))
    c-%offset%)
  (* sum t1)))
(setf (f2cl-lib:fref c-%data%
  (2 j)
  ((1 ldc) (1 *))
  c-%offset%)
(-
  (f2cl-lib:fref c-%data%
    (2 j)
    ((1 ldc) (1 *))

```



```

(-
  (f2cl-lib:fref c-%data%
    (7 j)
    ((1 ldc) (1 *))
    c-%offset%)
  (* sum t7)))
(setf (f2cl-lib:fref c-%data%
  (8 j)
  ((1 ldc) (1 *))
  c-%offset%)
(-
  (f2cl-lib:fref c-%data%
    (8 j)
    ((1 ldc) (1 *))
    c-%offset%)
  (* sum t8)))
(setf (f2cl-lib:fref c-%data%
  (9 j)
  ((1 ldc) (1 *))
  c-%offset%)
(-
  (f2cl-lib:fref c-%data%
    (9 j)
    ((1 ldc) (1 *))
    c-%offset%)
  (* sum t9))))
(go end_label)

label190
(setf v1 (f2cl-lib:fref v-%data% (1) ((1 *)) v-%offset%))
(setf t1 (* tau v1))
(setf v2 (f2cl-lib:fref v-%data% (2) ((1 *)) v-%offset%))
(setf t2 (* tau v2))
(setf v3 (f2cl-lib:fref v-%data% (3) ((1 *)) v-%offset%))
(setf t3 (* tau v3))
(setf v4 (f2cl-lib:fref v-%data% (4) ((1 *)) v-%offset%))
(setf t4 (* tau v4))
(setf v5 (f2cl-lib:fref v-%data% (5) ((1 *)) v-%offset%))
(setf t5 (* tau v5))
(setf v6 (f2cl-lib:fref v-%data% (6) ((1 *)) v-%offset%))
(setf t6 (* tau v6))
(setf v7 (f2cl-lib:fref v-%data% (7) ((1 *)) v-%offset%))
(setf t7 (* tau v7))
(setf v8 (f2cl-lib:fref v-%data% (8) ((1 *)) v-%offset%))
(setf t8 (* tau v8))
(setf v9 (f2cl-lib:fref v-%data% (9) ((1 *)) v-%offset%))
(setf t9 (* tau v9))

```

```

(setf v10 (f2cl-lib:fref v-%data% (10) ((1 *)) v-%offset%))
(setf t10 (* tau v10))
(f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
  ((> j n) nil)
  (tagbody
    (setf sum
      (+
        (* v1
          (f2cl-lib:fref c-%data%
            (1 j)
            ((1 ldc) (1 *))
            c-%offset%))
        (* v2
          (f2cl-lib:fref c-%data%
            (2 j)
            ((1 ldc) (1 *))
            c-%offset%))
        (* v3
          (f2cl-lib:fref c-%data%
            (3 j)
            ((1 ldc) (1 *))
            c-%offset%))
        (* v4
          (f2cl-lib:fref c-%data%
            (4 j)
            ((1 ldc) (1 *))
            c-%offset%))
        (* v5
          (f2cl-lib:fref c-%data%
            (5 j)
            ((1 ldc) (1 *))
            c-%offset%))
        (* v6
          (f2cl-lib:fref c-%data%
            (6 j)
            ((1 ldc) (1 *))
            c-%offset%))
        (* v7
          (f2cl-lib:fref c-%data%
            (7 j)
            ((1 ldc) (1 *))
            c-%offset%))
        (* v8
          (f2cl-lib:fref c-%data%
            (8 j)
            ((1 ldc) (1 *))

```

```

                                c-%offset%))
(* v9
  (f2cl-lib:fref c-%data%
    (9 j)
    ((1 ldc) (1 *))
    c-%offset%))
(* v10
  (f2cl-lib:fref c-%data%
    (10 j)
    ((1 ldc) (1 *))
    c-%offset%)))
(setf (f2cl-lib:fref c-%data%
  (1 j)
  ((1 ldc) (1 *))
  c-%offset%)
(-
  (f2cl-lib:fref c-%data%
    (1 j)
    ((1 ldc) (1 *))
    c-%offset%)
  (* sum t1)))
(setf (f2cl-lib:fref c-%data%
  (2 j)
  ((1 ldc) (1 *))
  c-%offset%)
(-
  (f2cl-lib:fref c-%data%
    (2 j)
    ((1 ldc) (1 *))
    c-%offset%)
  (* sum t2)))
(setf (f2cl-lib:fref c-%data%
  (3 j)
  ((1 ldc) (1 *))
  c-%offset%)
(-
  (f2cl-lib:fref c-%data%
    (3 j)
    ((1 ldc) (1 *))
    c-%offset%)
  (* sum t3)))
(setf (f2cl-lib:fref c-%data%
  (4 j)
  ((1 ldc) (1 *))
  c-%offset%)
(-

```

```

(f2cl-lib:fref c-%data%
  (4 j)
  ((1 ldc) (1 *))
  c-%offset%)
(* sum t4))
(setf (f2cl-lib:fref c-%data%
  (5 j)
  ((1 ldc) (1 *))
  c-%offset%)
(-
  (f2cl-lib:fref c-%data%
    (5 j)
    ((1 ldc) (1 *))
    c-%offset%)
  (* sum t5)))
(setf (f2cl-lib:fref c-%data%
  (6 j)
  ((1 ldc) (1 *))
  c-%offset%)
(-
  (f2cl-lib:fref c-%data%
    (6 j)
    ((1 ldc) (1 *))
    c-%offset%)
  (* sum t6)))
(setf (f2cl-lib:fref c-%data%
  (7 j)
  ((1 ldc) (1 *))
  c-%offset%)
(-
  (f2cl-lib:fref c-%data%
    (7 j)
    ((1 ldc) (1 *))
    c-%offset%)
  (* sum t7)))
(setf (f2cl-lib:fref c-%data%
  (8 j)
  ((1 ldc) (1 *))
  c-%offset%)
(-
  (f2cl-lib:fref c-%data%
    (8 j)
    ((1 ldc) (1 *))
    c-%offset%)
  (* sum t8)))
(setf (f2cl-lib:fref c-%data%

```

```

(9 j)
((1 ldc) (1 *))
c-%offset%)

(-
  (f2cl-lib:fref c-%data%
    (9 j)
    ((1 ldc) (1 *))
    c-%offset%)
    (* sum t9)))
(setf (f2cl-lib:fref c-%data%
  (10 j)
  ((1 ldc) (1 *))
  c-%offset%)
  (-
    (f2cl-lib:fref c-%data%
      (10 j)
      ((1 ldc) (1 *))
      c-%offset%)
      (* sum t10))))))
(go end_label)))
(t
  (tagbody
    (f2cl-lib:computed-goto
      (label210 label230 label250 label270 label290 label310 label330
        label350 label370 label390)
      n)
    (dgemv "No transpose" m n one c ldc v 1 zero work 1)
    (dger m n (- tau) work 1 v 1 c ldc)
    (go end_label)
label210
    (setf t1
      (+ one
        (* (- tau)
          (f2cl-lib:fref v-%data% (1) ((1 *)) v-%offset%)
          (f2cl-lib:fref v-%data% (1) ((1 *)) v-%offset%))))))
    (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
      (> j m) nil)
    (tagbody
      (setf (f2cl-lib:fref c-%data%
        (j 1)
        ((1 ldc) (1 *))
        c-%offset%)
        (* t1
          (f2cl-lib:fref c-%data%
            (j 1)
            ((1 ldc) (1 *))

```

```

                                                    c-%offset%))))))
label230 (go end_label)
(setf v1 (f2cl-lib:fref v-%data% (1) ((1 *)) v-%offset%))
(setf t1 (* tau v1))
(setf v2 (f2cl-lib:fref v-%data% (2) ((1 *)) v-%offset%))
(setf t2 (* tau v2))
(f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
  (> j m) nil)
(tagbody
  (setf sum
    (+
      (* v1
        (f2cl-lib:fref c-%data%
          (j 1)
          ((1 ldc) (1 *))
          c-%offset%))
      (* v2
        (f2cl-lib:fref c-%data%
          (j 2)
          ((1 ldc) (1 *))
          c-%offset%))))))
  (setf (f2cl-lib:fref c-%data%
    (j 1)
    ((1 ldc) (1 *))
    c-%offset%)
    (-
      (f2cl-lib:fref c-%data%
        (j 1)
        ((1 ldc) (1 *))
        c-%offset%)
      (* sum t1)))
  (setf (f2cl-lib:fref c-%data%
    (j 2)
    ((1 ldc) (1 *))
    c-%offset%)
    (-
      (f2cl-lib:fref c-%data%
        (j 2)
        ((1 ldc) (1 *))
        c-%offset%)
      (* sum t2))))))
label250 (go end_label)
(setf v1 (f2cl-lib:fref v-%data% (1) ((1 *)) v-%offset%))
(setf t1 (* tau v1))

```



```

(setf v2 (f2cl-lib:fref v-%data% (2) ((1 *)) v-%offset%))
(setf t2 (* tau v2))
(setf v3 (f2cl-lib:fref v-%data% (3) ((1 *)) v-%offset%))
(setf t3 (* tau v3))
(f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
              (> j m) nil)
(tagbody
  (setf sum
    (+
      (* v1
        (f2cl-lib:fref c-%data%
          (j 1)
          ((1 ldc) (1 *))
          c-%offset%))
      (* v2
        (f2cl-lib:fref c-%data%
          (j 2)
          ((1 ldc) (1 *))
          c-%offset%))
      (* v3
        (f2cl-lib:fref c-%data%
          (j 3)
          ((1 ldc) (1 *))
          c-%offset%))))))
(setf (f2cl-lib:fref c-%data%
  (j 1)
  ((1 ldc) (1 *))
  c-%offset%))
(-
  (f2cl-lib:fref c-%data%
    (j 1)
    ((1 ldc) (1 *))
    c-%offset%)
  (* sum t1)))
(setf (f2cl-lib:fref c-%data%
  (j 2)
  ((1 ldc) (1 *))
  c-%offset%))
(-
  (f2cl-lib:fref c-%data%
    (j 2)
    ((1 ldc) (1 *))
    c-%offset%)
  (* sum t2)))
(setf (f2cl-lib:fref c-%data%
  (j 3)
  ((1 ldc) (1 *))
  c-%offset%))

```

```

((1 ldc) (1 *))
c-%offset%)
(-
  (f2cl-lib:fref c-%data%
    (j 3)
    ((1 ldc) (1 *))
    c-%offset%)
    (* sum t3))))
(go end_label)
label270
(setf v1 (f2cl-lib:fref v-%data% (1) ((1 *)) v-%offset%))
(setf t1 (* tau v1))
(setf v2 (f2cl-lib:fref v-%data% (2) ((1 *)) v-%offset%))
(setf t2 (* tau v2))
(setf v3 (f2cl-lib:fref v-%data% (3) ((1 *)) v-%offset%))
(setf t3 (* tau v3))
(setf v4 (f2cl-lib:fref v-%data% (4) ((1 *)) v-%offset%))
(setf t4 (* tau v4))
(f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
  (> j m) nil)
(tagbody
  (setf sum
    (+
      (* v1
        (f2cl-lib:fref c-%data%
          (j 1)
          ((1 ldc) (1 *))
          c-%offset%))
      (* v2
        (f2cl-lib:fref c-%data%
          (j 2)
          ((1 ldc) (1 *))
          c-%offset%))
      (* v3
        (f2cl-lib:fref c-%data%
          (j 3)
          ((1 ldc) (1 *))
          c-%offset%))
      (* v4
        (f2cl-lib:fref c-%data%
          (j 4)
          ((1 ldc) (1 *))
          c-%offset%))))
  (setf (f2cl-lib:fref c-%data%
    (j 1)
    ((1 ldc) (1 *))

```

```

                                c-%offset%)
(-
  (f2cl-lib:fref c-%data%
    (j 1)
    ((1 ldc) (1 *)))
    c-%offset%)
  (* sum t1)))
(setf (f2cl-lib:fref c-%data%
  (j 2)
  ((1 ldc) (1 *)))
  c-%offset%)
(-
  (f2cl-lib:fref c-%data%
    (j 2)
    ((1 ldc) (1 *)))
    c-%offset%)
  (* sum t2)))
(setf (f2cl-lib:fref c-%data%
  (j 3)
  ((1 ldc) (1 *)))
  c-%offset%)
(-
  (f2cl-lib:fref c-%data%
    (j 3)
    ((1 ldc) (1 *)))
    c-%offset%)
  (* sum t3)))
(setf (f2cl-lib:fref c-%data%
  (j 4)
  ((1 ldc) (1 *)))
  c-%offset%)
(-
  (f2cl-lib:fref c-%data%
    (j 4)
    ((1 ldc) (1 *)))
    c-%offset%)
  (* sum t4))))
(go end_label)

label290
(setf v1 (f2cl-lib:fref v-%data% (1) ((1 *)) v-%offset%))
(setf t1 (* tau v1))
(setf v2 (f2cl-lib:fref v-%data% (2) ((1 *)) v-%offset%))
(setf t2 (* tau v2))
(setf v3 (f2cl-lib:fref v-%data% (3) ((1 *)) v-%offset%))
(setf t3 (* tau v3))
(setf v4 (f2cl-lib:fref v-%data% (4) ((1 *)) v-%offset%))

```

```

(setf t4 (* tau v4))
(setf v5 (f2cl-lib:fref v-%data% (5) ((1 *)) v-%offset%))
(setf t5 (* tau v5))
(f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
  (> j m) nil)
(tagbody
  (setf sum
    (+
      (* v1
        (f2cl-lib:fref c-%data%
          (j 1)
          ((1 ldc) (1 *))
          c-%offset%))
      (* v2
        (f2cl-lib:fref c-%data%
          (j 2)
          ((1 ldc) (1 *))
          c-%offset%))
      (* v3
        (f2cl-lib:fref c-%data%
          (j 3)
          ((1 ldc) (1 *))
          c-%offset%))
      (* v4
        (f2cl-lib:fref c-%data%
          (j 4)
          ((1 ldc) (1 *))
          c-%offset%))
      (* v5
        (f2cl-lib:fref c-%data%
          (j 5)
          ((1 ldc) (1 *))
          c-%offset%))))))
(setf (f2cl-lib:fref c-%data%
  (j 1)
  ((1 ldc) (1 *))
  c-%offset%))
(-
  (f2cl-lib:fref c-%data%
    (j 1)
    ((1 ldc) (1 *))
    c-%offset%)
  (* sum t1)))
(setf (f2cl-lib:fref c-%data%
  (j 2)
  ((1 ldc) (1 *))

```

```

                                c-%offset%)
(-
  (f2cl-lib:fref c-%data%
    (j 2)
    ((1 ldc) (1 *)))
    c-%offset%)
  (* sum t2)))
(setf (f2cl-lib:fref c-%data%
  (j 3)
  ((1 ldc) (1 *)))
  c-%offset%)
(-
  (f2cl-lib:fref c-%data%
    (j 3)
    ((1 ldc) (1 *)))
    c-%offset%)
  (* sum t3)))
(setf (f2cl-lib:fref c-%data%
  (j 4)
  ((1 ldc) (1 *)))
  c-%offset%)
(-
  (f2cl-lib:fref c-%data%
    (j 4)
    ((1 ldc) (1 *)))
    c-%offset%)
  (* sum t4)))
(setf (f2cl-lib:fref c-%data%
  (j 5)
  ((1 ldc) (1 *)))
  c-%offset%)
(-
  (f2cl-lib:fref c-%data%
    (j 5)
    ((1 ldc) (1 *)))
    c-%offset%)
  (* sum t5))))
(go end_label)

label310
(setf v1 (f2cl-lib:fref v-%data% (1) ((1 *)) v-%offset%))
(setf t1 (* tau v1))
(setf v2 (f2cl-lib:fref v-%data% (2) ((1 *)) v-%offset%))
(setf t2 (* tau v2))
(setf v3 (f2cl-lib:fref v-%data% (3) ((1 *)) v-%offset%))
(setf t3 (* tau v3))
(setf v4 (f2cl-lib:fref v-%data% (4) ((1 *)) v-%offset%))

```

```

(setf t4 (* tau v4))
(setf v5 (f2cl-lib:fref v-%data% (5) ((1 *)) v-%offset%))
(setf t5 (* tau v5))
(setf v6 (f2cl-lib:fref v-%data% (6) ((1 *)) v-%offset%))
(setf t6 (* tau v6))
(f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
  (> j m) nil)
(tagbody
  (setf sum
    (+
      (* v1
        (f2cl-lib:fref c-%data%
          (j 1)
          ((1 ldc) (1 *))
          c-%offset%))
      (* v2
        (f2cl-lib:fref c-%data%
          (j 2)
          ((1 ldc) (1 *))
          c-%offset%))
      (* v3
        (f2cl-lib:fref c-%data%
          (j 3)
          ((1 ldc) (1 *))
          c-%offset%))
      (* v4
        (f2cl-lib:fref c-%data%
          (j 4)
          ((1 ldc) (1 *))
          c-%offset%))
      (* v5
        (f2cl-lib:fref c-%data%
          (j 5)
          ((1 ldc) (1 *))
          c-%offset%))
      (* v6
        (f2cl-lib:fref c-%data%
          (j 6)
          ((1 ldc) (1 *))
          c-%offset%))))
    (setf (f2cl-lib:fref c-%data%
      (j 1)
      ((1 ldc) (1 *))
      c-%offset%)
      (-
        (f2cl-lib:fref c-%data%

```

```

                                (j 1)
                                ((1 ldc) (1 *))
                                c-%offset%)
      (* sum t1)))
(setf (f2cl-lib:fref c-%data%
      (j 2)
      ((1 ldc) (1 *))
      c-%offset%)
      (-
        (f2cl-lib:fref c-%data%
          (j 2)
          ((1 ldc) (1 *))
          c-%offset%)
        (* sum t2)))
(setf (f2cl-lib:fref c-%data%
      (j 3)
      ((1 ldc) (1 *))
      c-%offset%)
      (-
        (f2cl-lib:fref c-%data%
          (j 3)
          ((1 ldc) (1 *))
          c-%offset%)
        (* sum t3)))
(setf (f2cl-lib:fref c-%data%
      (j 4)
      ((1 ldc) (1 *))
      c-%offset%)
      (-
        (f2cl-lib:fref c-%data%
          (j 4)
          ((1 ldc) (1 *))
          c-%offset%)
        (* sum t4)))
(setf (f2cl-lib:fref c-%data%
      (j 5)
      ((1 ldc) (1 *))
      c-%offset%)
      (-
        (f2cl-lib:fref c-%data%
          (j 5)
          ((1 ldc) (1 *))
          c-%offset%)
        (* sum t5)))
(setf (f2cl-lib:fref c-%data%
      (j 6)

```

```

((1 ldc) (1 *))
c-%offset%)
(-
  (f2cl-lib:fref c-%data%
    (j 6)
    ((1 ldc) (1 *))
    c-%offset%)
  (* sum t6))))
(go end_label)
label330
(setf v1 (f2cl-lib:fref v-%data% (1) ((1 *)) v-%offset%))
(setf t1 (* tau v1))
(setf v2 (f2cl-lib:fref v-%data% (2) ((1 *)) v-%offset%))
(setf t2 (* tau v2))
(setf v3 (f2cl-lib:fref v-%data% (3) ((1 *)) v-%offset%))
(setf t3 (* tau v3))
(setf v4 (f2cl-lib:fref v-%data% (4) ((1 *)) v-%offset%))
(setf t4 (* tau v4))
(setf v5 (f2cl-lib:fref v-%data% (5) ((1 *)) v-%offset%))
(setf t5 (* tau v5))
(setf v6 (f2cl-lib:fref v-%data% (6) ((1 *)) v-%offset%))
(setf t6 (* tau v6))
(setf v7 (f2cl-lib:fref v-%data% (7) ((1 *)) v-%offset%))
(setf t7 (* tau v7))
(f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
  (> j m) nil)
(tagbody
  (setf sum
    (+
      (* v1
        (f2cl-lib:fref c-%data%
          (j 1)
          ((1 ldc) (1 *))
          c-%offset%))
      (* v2
        (f2cl-lib:fref c-%data%
          (j 2)
          ((1 ldc) (1 *))
          c-%offset%))
      (* v3
        (f2cl-lib:fref c-%data%
          (j 3)
          ((1 ldc) (1 *))
          c-%offset%))
      (* v4
        (f2cl-lib:fref c-%data%

```



```

                                (j 4)
                                ((1 ldc) (1 *))
                                c-%offset%))
(* v5
  (f2cl-lib:fref c-%data%
    (j 5)
    ((1 ldc) (1 *))
    c-%offset%))
(* v6
  (f2cl-lib:fref c-%data%
    (j 6)
    ((1 ldc) (1 *))
    c-%offset%))
(* v7
  (f2cl-lib:fref c-%data%
    (j 7)
    ((1 ldc) (1 *))
    c-%offset%)))
(setf (f2cl-lib:fref c-%data%
  (j 1)
  ((1 ldc) (1 *))
  c-%offset%)
(-
  (f2cl-lib:fref c-%data%
    (j 1)
    ((1 ldc) (1 *))
    c-%offset%)
  (* sum t1)))
(setf (f2cl-lib:fref c-%data%
  (j 2)
  ((1 ldc) (1 *))
  c-%offset%)
(-
  (f2cl-lib:fref c-%data%
    (j 2)
    ((1 ldc) (1 *))
    c-%offset%)
  (* sum t2)))
(setf (f2cl-lib:fref c-%data%
  (j 3)
  ((1 ldc) (1 *))
  c-%offset%)
(-
  (f2cl-lib:fref c-%data%
    (j 3)
    ((1 ldc) (1 *))

```

```

                                c-%offset%)
      (* sum t3)))
    (setf (f2cl-lib:fref c-%data%
      (j 4)
      ((1 ldc) (1 *))
      c-%offset%)
      (-
        (f2cl-lib:fref c-%data%
          (j 4)
          ((1 ldc) (1 *))
          c-%offset%)
        (* sum t4)))
    (setf (f2cl-lib:fref c-%data%
      (j 5)
      ((1 ldc) (1 *))
      c-%offset%)
      (-
        (f2cl-lib:fref c-%data%
          (j 5)
          ((1 ldc) (1 *))
          c-%offset%)
        (* sum t5)))
    (setf (f2cl-lib:fref c-%data%
      (j 6)
      ((1 ldc) (1 *))
      c-%offset%)
      (-
        (f2cl-lib:fref c-%data%
          (j 6)
          ((1 ldc) (1 *))
          c-%offset%)
        (* sum t6)))
    (setf (f2cl-lib:fref c-%data%
      (j 7)
      ((1 ldc) (1 *))
      c-%offset%)
      (-
        (f2cl-lib:fref c-%data%
          (j 7)
          ((1 ldc) (1 *))
          c-%offset%)
        (* sum t7))))))
    (go end_label)
label350
    (setf v1 (f2cl-lib:fref v-%data% (1) ((1 *)) v-%offset%))
    (setf t1 (* tau v1))

```

```

(setf v2 (f2cl-lib:fref v-%data% (2) ((1 *)) v-%offset%))
(setf t2 (* tau v2))
(setf v3 (f2cl-lib:fref v-%data% (3) ((1 *)) v-%offset%))
(setf t3 (* tau v3))
(setf v4 (f2cl-lib:fref v-%data% (4) ((1 *)) v-%offset%))
(setf t4 (* tau v4))
(setf v5 (f2cl-lib:fref v-%data% (5) ((1 *)) v-%offset%))
(setf t5 (* tau v5))
(setf v6 (f2cl-lib:fref v-%data% (6) ((1 *)) v-%offset%))
(setf t6 (* tau v6))
(setf v7 (f2cl-lib:fref v-%data% (7) ((1 *)) v-%offset%))
(setf t7 (* tau v7))
(setf v8 (f2cl-lib:fref v-%data% (8) ((1 *)) v-%offset%))
(setf t8 (* tau v8))
(f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
              (> j m) nil)
(tagbody
  (setf sum
    (+
      (* v1
        (f2cl-lib:fref c-%data%
          (j 1)
          ((1 ldc) (1 *))
          c-%offset%))
      (* v2
        (f2cl-lib:fref c-%data%
          (j 2)
          ((1 ldc) (1 *))
          c-%offset%))
      (* v3
        (f2cl-lib:fref c-%data%
          (j 3)
          ((1 ldc) (1 *))
          c-%offset%))
      (* v4
        (f2cl-lib:fref c-%data%
          (j 4)
          ((1 ldc) (1 *))
          c-%offset%))
      (* v5
        (f2cl-lib:fref c-%data%
          (j 5)
          ((1 ldc) (1 *))
          c-%offset%))
      (* v6
        (f2cl-lib:fref c-%data%

```

```

                                (j 6)
                                ((1 ldc) (1 *))
                                c-%offset%))
(* v7
  (f2cl-lib:fref c-%data%
    (j 7)
    ((1 ldc) (1 *))
    c-%offset%))
(* v8
  (f2cl-lib:fref c-%data%
    (j 8)
    ((1 ldc) (1 *))
    c-%offset%)))
(setf (f2cl-lib:fref c-%data%
  (j 1)
  ((1 ldc) (1 *))
  c-%offset%)
(-
  (f2cl-lib:fref c-%data%
    (j 1)
    ((1 ldc) (1 *))
    c-%offset%)
  (* sum t1)))
(setf (f2cl-lib:fref c-%data%
  (j 2)
  ((1 ldc) (1 *))
  c-%offset%)
(-
  (f2cl-lib:fref c-%data%
    (j 2)
    ((1 ldc) (1 *))
    c-%offset%)
  (* sum t2)))
(setf (f2cl-lib:fref c-%data%
  (j 3)
  ((1 ldc) (1 *))
  c-%offset%)
(-
  (f2cl-lib:fref c-%data%
    (j 3)
    ((1 ldc) (1 *))
    c-%offset%)
  (* sum t3)))
(setf (f2cl-lib:fref c-%data%
  (j 4)
  ((1 ldc) (1 *))

```

```

                                c-%offset%)
(-
  (f2cl-lib:fref c-%data%
    (j 4)
    ((1 ldc) (1 *)))
    c-%offset%)
  (* sum t4)))
(setf (f2cl-lib:fref c-%data%
  (j 5)
  ((1 ldc) (1 *)))
  c-%offset%)
(-
  (f2cl-lib:fref c-%data%
    (j 5)
    ((1 ldc) (1 *)))
    c-%offset%)
  (* sum t5)))
(setf (f2cl-lib:fref c-%data%
  (j 6)
  ((1 ldc) (1 *)))
  c-%offset%)
(-
  (f2cl-lib:fref c-%data%
    (j 6)
    ((1 ldc) (1 *)))
    c-%offset%)
  (* sum t6)))
(setf (f2cl-lib:fref c-%data%
  (j 7)
  ((1 ldc) (1 *)))
  c-%offset%)
(-
  (f2cl-lib:fref c-%data%
    (j 7)
    ((1 ldc) (1 *)))
    c-%offset%)
  (* sum t7)))
(setf (f2cl-lib:fref c-%data%
  (j 8)
  ((1 ldc) (1 *)))
  c-%offset%)
(-
  (f2cl-lib:fref c-%data%
    (j 8)
    ((1 ldc) (1 *)))
    c-%offset%)

```

```

                                (* sum t8))))
      (go end_label)
label370
      (setf v1 (f2cl-lib:fref v-%data% (1) ((1 *)) v-%offset%))
      (setf t1 (* tau v1))
      (setf v2 (f2cl-lib:fref v-%data% (2) ((1 *)) v-%offset%))
      (setf t2 (* tau v2))
      (setf v3 (f2cl-lib:fref v-%data% (3) ((1 *)) v-%offset%))
      (setf t3 (* tau v3))
      (setf v4 (f2cl-lib:fref v-%data% (4) ((1 *)) v-%offset%))
      (setf t4 (* tau v4))
      (setf v5 (f2cl-lib:fref v-%data% (5) ((1 *)) v-%offset%))
      (setf t5 (* tau v5))
      (setf v6 (f2cl-lib:fref v-%data% (6) ((1 *)) v-%offset%))
      (setf t6 (* tau v6))
      (setf v7 (f2cl-lib:fref v-%data% (7) ((1 *)) v-%offset%))
      (setf t7 (* tau v7))
      (setf v8 (f2cl-lib:fref v-%data% (8) ((1 *)) v-%offset%))
      (setf t8 (* tau v8))
      (setf v9 (f2cl-lib:fref v-%data% (9) ((1 *)) v-%offset%))
      (setf t9 (* tau v9))
      (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                    (> j m) nil)
      (tagbody
        (setf sum
          (+
            (* v1
              (f2cl-lib:fref c-%data%
                             (j 1)
                             ((1 ldc) (1 *))
                             c-%offset%))
            (* v2
              (f2cl-lib:fref c-%data%
                             (j 2)
                             ((1 ldc) (1 *))
                             c-%offset%))
            (* v3
              (f2cl-lib:fref c-%data%
                             (j 3)
                             ((1 ldc) (1 *))
                             c-%offset%))
            (* v4
              (f2cl-lib:fref c-%data%
                             (j 4)
                             ((1 ldc) (1 *))
                             c-%offset%))

```

```

(* v5
  (f2cl-lib:fref c-%data%
    (j 5)
    ((1 ldc) (1 *))
    c-%offset%))

(* v6
  (f2cl-lib:fref c-%data%
    (j 6)
    ((1 ldc) (1 *))
    c-%offset%))

(* v7
  (f2cl-lib:fref c-%data%
    (j 7)
    ((1 ldc) (1 *))
    c-%offset%))

(* v8
  (f2cl-lib:fref c-%data%
    (j 8)
    ((1 ldc) (1 *))
    c-%offset%))

(* v9
  (f2cl-lib:fref c-%data%
    (j 9)
    ((1 ldc) (1 *))
    c-%offset%)))

(setf (f2cl-lib:fref c-%data%
  (j 1)
  ((1 ldc) (1 *))
  c-%offset%)

(-
  (f2cl-lib:fref c-%data%
    (j 1)
    ((1 ldc) (1 *))
    c-%offset%)

  (* sum t1)))

(setf (f2cl-lib:fref c-%data%
  (j 2)
  ((1 ldc) (1 *))
  c-%offset%)

(-
  (f2cl-lib:fref c-%data%
    (j 2)
    ((1 ldc) (1 *))
    c-%offset%)

  (* sum t2)))

(setf (f2cl-lib:fref c-%data%

```

```

                (j 3)
                ((1 ldc) (1 *))
                c-%offset%)
(-
  (f2cl-lib:fref c-%data%
    (j 3)
    ((1 ldc) (1 *))
    c-%offset%)
    (* sum t3)))
(setf (f2cl-lib:fref c-%data%
  (j 4)
  ((1 ldc) (1 *))
  c-%offset%)
(-
  (f2cl-lib:fref c-%data%
    (j 4)
    ((1 ldc) (1 *))
    c-%offset%)
    (* sum t4)))
(setf (f2cl-lib:fref c-%data%
  (j 5)
  ((1 ldc) (1 *))
  c-%offset%)
(-
  (f2cl-lib:fref c-%data%
    (j 5)
    ((1 ldc) (1 *))
    c-%offset%)
    (* sum t5)))
(setf (f2cl-lib:fref c-%data%
  (j 6)
  ((1 ldc) (1 *))
  c-%offset%)
(-
  (f2cl-lib:fref c-%data%
    (j 6)
    ((1 ldc) (1 *))
    c-%offset%)
    (* sum t6)))
(setf (f2cl-lib:fref c-%data%
  (j 7)
  ((1 ldc) (1 *))
  c-%offset%)
(-
  (f2cl-lib:fref c-%data%
    (j 7)

```



```

((1 ldc) (1 *))
c-%offset%)

(* sum t7)))
(setf (f2cl-lib:fref c-%data%
      (j 8)
      ((1 ldc) (1 *))
      c-%offset%)
(-
  (f2cl-lib:fref c-%data%
    (j 8)
    ((1 ldc) (1 *))
    c-%offset%)
  (* sum t8)))
(setf (f2cl-lib:fref c-%data%
      (j 9)
      ((1 ldc) (1 *))
      c-%offset%)
(-
  (f2cl-lib:fref c-%data%
    (j 9)
    ((1 ldc) (1 *))
    c-%offset%)
  (* sum t9))))
(go end_label)

label390
(setf v1 (f2cl-lib:fref v-%data% (1) ((1 *)) v-%offset%))
(setf t1 (* tau v1))
(setf v2 (f2cl-lib:fref v-%data% (2) ((1 *)) v-%offset%))
(setf t2 (* tau v2))
(setf v3 (f2cl-lib:fref v-%data% (3) ((1 *)) v-%offset%))
(setf t3 (* tau v3))
(setf v4 (f2cl-lib:fref v-%data% (4) ((1 *)) v-%offset%))
(setf t4 (* tau v4))
(setf v5 (f2cl-lib:fref v-%data% (5) ((1 *)) v-%offset%))
(setf t5 (* tau v5))
(setf v6 (f2cl-lib:fref v-%data% (6) ((1 *)) v-%offset%))
(setf t6 (* tau v6))
(setf v7 (f2cl-lib:fref v-%data% (7) ((1 *)) v-%offset%))
(setf t7 (* tau v7))
(setf v8 (f2cl-lib:fref v-%data% (8) ((1 *)) v-%offset%))
(setf t8 (* tau v8))
(setf v9 (f2cl-lib:fref v-%data% (9) ((1 *)) v-%offset%))
(setf t9 (* tau v9))
(setf v10 (f2cl-lib:fref v-%data% (10) ((1 *)) v-%offset%))
(setf t10 (* tau v10))
(f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))

```

```

                                (< j m) nil)
(tagbody
  (setf sum
    (+
      (* v1
        (f2cl-lib:fref c-%data%
          (j 1)
          ((1 ldc) (1 *))
          c-%offset%))
      (* v2
        (f2cl-lib:fref c-%data%
          (j 2)
          ((1 ldc) (1 *))
          c-%offset%))
      (* v3
        (f2cl-lib:fref c-%data%
          (j 3)
          ((1 ldc) (1 *))
          c-%offset%))
      (* v4
        (f2cl-lib:fref c-%data%
          (j 4)
          ((1 ldc) (1 *))
          c-%offset%))
      (* v5
        (f2cl-lib:fref c-%data%
          (j 5)
          ((1 ldc) (1 *))
          c-%offset%))
      (* v6
        (f2cl-lib:fref c-%data%
          (j 6)
          ((1 ldc) (1 *))
          c-%offset%))
      (* v7
        (f2cl-lib:fref c-%data%
          (j 7)
          ((1 ldc) (1 *))
          c-%offset%))
      (* v8
        (f2cl-lib:fref c-%data%
          (j 8)
          ((1 ldc) (1 *))
          c-%offset%))
      (* v9
        (f2cl-lib:fref c-%data%

```

```

                                (j 9)
                                ((1 ldc) (1 *))
                                c-%offset%))
(* v10
  (f2cl-lib:fref c-%data%
    (j 10)
    ((1 ldc) (1 *))
    c-%offset%)))
(setf (f2cl-lib:fref c-%data%
  (j 1)
  ((1 ldc) (1 *))
  c-%offset%)
(-
  (f2cl-lib:fref c-%data%
    (j 1)
    ((1 ldc) (1 *))
    c-%offset%)
  (* sum t1)))
(setf (f2cl-lib:fref c-%data%
  (j 2)
  ((1 ldc) (1 *))
  c-%offset%)
(-
  (f2cl-lib:fref c-%data%
    (j 2)
    ((1 ldc) (1 *))
    c-%offset%)
  (* sum t2)))
(setf (f2cl-lib:fref c-%data%
  (j 3)
  ((1 ldc) (1 *))
  c-%offset%)
(-
  (f2cl-lib:fref c-%data%
    (j 3)
    ((1 ldc) (1 *))
    c-%offset%)
  (* sum t3)))
(setf (f2cl-lib:fref c-%data%
  (j 4)
  ((1 ldc) (1 *))
  c-%offset%)
(-
  (f2cl-lib:fref c-%data%
    (j 4)
    ((1 ldc) (1 *))

```

```

                                c-%offset%)
      (* sum t4)))
(setf (f2cl-lib:fref c-%data%
      (j 5)
      ((1 ldc) (1 *)))
      c-%offset%)
(-
  (f2cl-lib:fref c-%data%
    (j 5)
    ((1 ldc) (1 *)))
    c-%offset%)
  (* sum t5)))
(setf (f2cl-lib:fref c-%data%
      (j 6)
      ((1 ldc) (1 *)))
      c-%offset%)
(-
  (f2cl-lib:fref c-%data%
    (j 6)
    ((1 ldc) (1 *)))
    c-%offset%)
  (* sum t6)))
(setf (f2cl-lib:fref c-%data%
      (j 7)
      ((1 ldc) (1 *)))
      c-%offset%)
(-
  (f2cl-lib:fref c-%data%
    (j 7)
    ((1 ldc) (1 *)))
    c-%offset%)
  (* sum t7)))
(setf (f2cl-lib:fref c-%data%
      (j 8)
      ((1 ldc) (1 *)))
      c-%offset%)
(-
  (f2cl-lib:fref c-%data%
    (j 8)
    ((1 ldc) (1 *)))
    c-%offset%)
  (* sum t8)))
(setf (f2cl-lib:fref c-%data%
      (j 9)
      ((1 ldc) (1 *)))
      c-%offset%)

```

```

(-
  (f2cl-lib:fref c-%data%
    (j 9)
    ((1 ldc) (1 *))
    c-%offset%)
    (* sum t9)))
(setf (f2cl-lib:fref c-%data%
  (j 10)
  ((1 ldc) (1 *))
  c-%offset%)
  (-
    (f2cl-lib:fref c-%data%
      (j 10)
      ((1 ldc) (1 *))
      c-%offset%)
      (* sum t10))))))
(go end_label)))
end_label
(return (values nil nil nil nil nil nil nil nil))))))

```

## 7.51 dlartg LAPACK

```

<dlartg.input>≡
)set break resume
)sys rm -f dlartg.output
)spool dlartg.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)

```

`<dlartg.help>`≡

```
=====
dlartg examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

DLARTG - a plane rotation so that  $\begin{bmatrix} CS & SN \end{bmatrix}$

#### SYNOPSIS

```
SUBROUTINE DLARTG( F, G, CS, SN, R )
```

```
      DOUBLE          PRECISION CS, F, G, R, SN
```

#### PURPOSE

DLARTG generate a plane rotation so that

$$\begin{bmatrix} -SN & CS \end{bmatrix} \begin{bmatrix} F \\ G \end{bmatrix} = \begin{bmatrix} 0 \\ R \end{bmatrix}$$

This is a slower, more accurate version of the BLAS1 routine DROTG, with the following other differences:

F and G are unchanged on return.

If G=0, then CS=1 and SN=0.

If F=0 and (G .ne. 0), then CS=0 and SN=1 without doing any floating point operations (saves work in DBDSQR when there are zeros on the diagonal).

If F exceeds G in magnitude, CS will be positive.

#### ARGUMENTS

F	(input) DOUBLE PRECISION The first component of vector to be rotated.
G	(input) DOUBLE PRECISION The second component of vector to be rotated.
CS	(output) DOUBLE PRECISION The cosine of the rotation.
SN	(output) DOUBLE PRECISION The sine of the rotation.
R	(output) DOUBLE PRECISION

The nonzero component of the rotated vector.

```

(LAPACK dlartg)≡
  (let* ((zero 0.0) (one 1.0) (two 2.0))
    (declare (type (double-float 0.0 0.0) zero)
              (type (double-float 1.0 1.0) one)
              (type (double-float 2.0 2.0) two))
    (let ((safmx2 0.0) (safmin 0.0) (safmn2 0.0) (first$ nil))
      (declare (type (member t nil) first$)
                (type (double-float) safmn2 safmin safmx2))
      (setq first$ t)
      (defun dlartg (f g cs sn r)
        (declare (type (double-float) r sn cs g f))
        (prog ((eps 0.0) (f1 0.0) (g1 0.0) (scale 0.0) (i 0) (count$ 0))
          (declare (type (double-float) eps f1 g1 scale)
                    (type fixnum count$ i))
          (cond
            (first$
             (setf first$ nil)
             (setf safmin (dlamch "S"))
             (setf eps (dlamch "E"))
             (setf safmn2
                    (expt (dlamch "B")
                          (f2cl-lib:int
                           (/
                            (/ (f2cl-lib:flog (/ safmin eps))
                                (f2cl-lib:flog (dlamch "B"))
                                two))))))
             (setf safmx2 (/ one safmn2))))
            (cond
              ((= g zero)
               (setf cs one)
               (setf sn zero)
               (setf r f))
              ((= f zero)
               (setf cs zero)
               (setf sn one)
               (setf r g))
              (t
               (setf f1 f)
               (setf g1 g)
               (setf scale (max (abs f1) (abs g1))))
              (cond
                ((>= scale safmx2)
                 (tagbody
                  (setf count$ 0)
label110
                  (setf count$ (f2cl-lib:int-add count$ 1))

```



```

      (setf f1 (* f1 safmn2))
      (setf g1 (* g1 safmn2))
      (setf scale (max (abs f1) (abs g1)))
      (if (>= scale safmx2) (go label10))
      (setf r (f2cl-lib:fsqrt (+ (expt f1 2) (expt g1 2))))
      (setf cs (/ f1 r))
      (setf sn (/ g1 r))
      (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                    ((> i count$) nil)
        (tagbody (setf r (* r safmx2)) label20))))
    ((<= scale safmn2)
     (tagbody
      (setf count$ 0)

label30
      (setf count$ (f2cl-lib:int-add count$ 1))
      (setf f1 (* f1 safmx2))
      (setf g1 (* g1 safmx2))
      (setf scale (max (abs f1) (abs g1)))
      (if (<= scale safmn2) (go label30))
      (setf r (f2cl-lib:fsqrt (+ (expt f1 2) (expt g1 2))))
      (setf cs (/ f1 r))
      (setf sn (/ g1 r))
      (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                    ((> i count$) nil)
        (tagbody (setf r (* r safmn2)) label40))))
    (t
     (setf r (f2cl-lib:fsqrt (+ (expt f1 2) (expt g1 2))))
     (setf cs (/ f1 r))
     (setf sn (/ g1 r))))
    (cond
     ((and (> (abs f) (abs g)) (< cs zero))
      (setf cs (- cs))
      (setf sn (- sn))
      (setf r (- r))))))
end_label
(return (values nil nil cs sn r))))

```

**7.52 dlas2 LAPACK**

```
<dlas2.input>=  
  )set break resume  
  )sys rm -f dlas2.output  
  )spool dlas2.output  
  )set message test on  
  )set message auto off  
  )clear all  
  
  )spool  
  )lisp (bye)
```

`<dlas2.help>=`

```
=====
dlas2 examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

DLAS2 - the singular values of the 2-by-2 matrix  $\begin{bmatrix} F & G \\ 0 & H \end{bmatrix}$

#### SYNOPSIS

```
SUBROUTINE DLAS2( F, G, H, SSMIN, SSMAX )
```

```
      DOUBLE          PRECISION F, G, H, SSMAX, SSMIN
```

#### PURPOSE

DLAS2 computes the singular values of the 2-by-2 matrix  
 $\begin{bmatrix} F & G \\ 0 & H \end{bmatrix}$ . On return, SSMIN is the smaller singular value and  
 SSMAX is the larger singular value.

#### ARGUMENTS

F	(input) DOUBLE PRECISION The (1,1) element of the 2-by-2 matrix.
G	(input) DOUBLE PRECISION The (1,2) element of the 2-by-2 matrix.
H	(input) DOUBLE PRECISION The (2,2) element of the 2-by-2 matrix.
SSMIN	(output) DOUBLE PRECISION The smaller singular value.
SSMAX	(output) DOUBLE PRECISION The larger singular value.

#### FURTHER DETAILS

Barring over/underflow, all output quantities are correct to within a few units in the last place (ulps), even in the absence of a guard digit in addition/subtraction.

In IEEE arithmetic, the code works correctly if one matrix element is

infinite.

Overflow will not occur unless the largest singular value itself overflows, or is within a few ulps of overflow. (On machines with partial overflow, like the Cray, overflow may occur if the largest singular value is within a factor of 2 of overflow.)

Underflow is harmless if underflow is gradual. Otherwise, results may correspond to a matrix modified by perturbations of size near the underflow threshold.

```

(LAPACK dlas2)≡
  (let* ((zero 0.0) (one 1.0) (two 2.0))
    (declare (type (double-float) 0.0 0.0) zero)
    (type (double-float) 1.0 1.0) one)
    (type (double-float) 2.0 2.0) two))
  (defun dlas2 (f g h ssmin ssmax)
    (declare (type (double-float) ssmax ssmin h g f))
    (prog ((as 0.0) (at 0.0) (au 0.0) (c 0.0) (fa 0.0) (fhmn 0.0) (fhmx 0.0)
      (ga 0.0) (ha 0.0))
      (declare (type (double-float) as at au c fa fhmn fhmx ga ha))
      (setf fa (abs f))
      (setf ga (abs g))
      (setf ha (abs h))
      (setf fhmn (min fa ha))
      (setf fhmx (max fa ha))
      (cond
        ((= fhmn zero)
          (setf ssmin zero)
          (cond
            ((= fhmx zero)
              (setf ssmax ga))
            (t
              (setf ssmax
                (* (max fhmx ga)
                  (f2cl-lib:fsqrt
                    (+ one (expt (/ (min fhmx ga) (max fhmx ga)) 2))))))))
          (t
            (cond
              ((< ga fhmx)
                (setf as (+ one (/ fhmn fhmx)))
                (setf at (/ (- fhmx fhmn) fhmx))
                (setf au (expt (/ ga fhmx) 2))
                (setf c
                  (/ two
                    (+ (f2cl-lib:fsqrt (+ (* as as) au))
                      (f2cl-lib:fsqrt (+ (* at at) au)))))
                (setf ssmin (* fhmn c))
                (setf ssmax (/ fhmx c)))
              (t
                (setf au (/ fhmx ga))
                (cond
                  ((= au zero)
                    (setf ssmin (/ (* fhmn fhmx) ga))
                    (setf ssmax ga))
                  (t
                    (setf as (+ one (/ fhmn fhmx))))
                )
              )
            )
          )
        )
      )
    )
  )

```

```

(setf at (/ (- fhm x fhm n) fhm x))
(setf c
  (/ one
    (+ (f2cl-lib:fsqrt (+ one (expt (* as au) 2)))
      (f2cl-lib:fsqrt (+ one (expt (* at au) 2))))))
(setf ssmin (* fhm n c au))
(setf ssmin (+ ssmin ssmin))
(setf ssmax (/ ga (+ c c))))))
(return (values nil nil nil ssmin ssmax))))

```

## 7.53 dlascl LAPACK

```

<dlascl.input>≡
)set break resume
)sys rm -f dlascl.output
)spool dlascl.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)

```

`<dlascl.help>`≡

```
=====
dlascl examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

DLASCL - the M by N real matrix A by the real scalar CTO/CFROM

#### SYNOPSIS

```
SUBROUTINE DLASCL( TYPE, KL, KU, CFROM, CTO, M, N, A, LDA, INFO )
```

CHARACTER	TYPE
INTEGER	INFO, KL, KU, LDA, M, N
DOUBLE	PRECISION CFROM, CTO
DOUBLE	PRECISION A( LDA, * )

#### PURPOSE

DLASCL multiplies the M by N real matrix A by the real scalar CTO/CFROM. This is done without over/underflow as long as the final result  $CTO \cdot A(I,J) / CFROM$  does not over/underflow. TYPE specifies that A may be full, upper triangular, lower triangular, upper Hessenberg, or banded.

#### ARGUMENTS

TYPE (input) CHARACTER\*1  
 TYPE indices the storage type of the input matrix. = 'G': A is a full matrix.  
 = 'L': A is a lower triangular matrix.  
 = 'U': A is an upper triangular matrix.  
 = 'H': A is an upper Hessenberg matrix.  
 = 'B': A is a symmetric band matrix with lower bandwidth KL and upper bandwidth KU and with the only the lower half stored.  
 = 'Q': A is a symmetric band matrix with lower bandwidth KL and upper bandwidth KU and with the only the upper half stored.  
 = 'Z': A is a band matrix with lower bandwidth KL and upper bandwidth KU.

KL (input) INTEGER

The lower bandwidth of A. Referenced only if TYPE = 'B', 'Q' or 'Z'.

KU        (input) INTEGER  
The upper bandwidth of A. Referenced only if TYPE = 'B', 'Q' or 'Z'.

CFROM    (input) DOUBLE PRECISION  
CTO       (input) DOUBLE PRECISION The matrix A is multiplied by CTO/CFROM. A(I,J) is computed without over/underflow if the final result CTO\*A(I,J)/CFROM can be represented without over/underflow. CFROM must be nonzero.

M        (input) INTEGER  
The number of rows of the matrix A.  $M \geq 0$ .

N        (input) INTEGER  
The number of columns of the matrix A.  $N \geq 0$ .

A        (input/output) DOUBLE PRECISION array, dimension (LDA,N)  
The matrix to be multiplied by CTO/CFROM. See TYPE for the storage type.

LDA       (input) INTEGER  
The leading dimension of the array A.  $LDA \geq \max(1,M)$ .

INFO      (output) INTEGER  
0 - successful exit <0 - if INFO = -i, the i-th argument had an illegal value.



```

(LAPACK dlascl)≡
  (let* ((zero 0.0) (one 1.0))
    (declare (type (double-float 0.0 0.0) zero)
              (type (double-float 1.0 1.0) one))
    (defun dlascl (type kl ku cfrom cto m n a lda info)
      (declare (type (simple-array double-float (*)) a)
                (type (double-float) cto cfrom)
                (type fixnum info lda n m ku kl)
                (type character type))
      (f2cl-lib:with-multi-array-data
        ((type double-float type-%data% type-%offset%)
         (a double-float a-%data% a-%offset%))
        (prog ((bignum 0.0) (cfrom1 0.0) (cfromc 0.0) (cto1 0.0) (ctoc 0.0)
              (mul 0.0) (smlnum 0.0) (i 0) (itype 0) (j 0) (k1 0) (k2 0) (k3 0)
              (k4 0) (done nil))
              (declare (type (double-float) bignum cfrom1 cfromc cto1 ctoc mul
                              smlnum)
                      (type fixnum i itype j k1 k2 k3 k4)
                      (type (member t nil) done))
              (setf info 0)
              (cond
                ((char-equal type #\G)
                 (setf itype 0))
                ((char-equal type #\L)
                 (setf itype 1))
                ((char-equal type #\U)
                 (setf itype 2))
                ((char-equal type #\H)
                 (setf itype 3))
                ((char-equal type #\B)
                 (setf itype 4))
                ((char-equal type #\Q)
                 (setf itype 5))
                ((char-equal type #\Z)
                 (setf itype 6))
                (t
                 (setf itype -1)))
              (cond
                ((= itype (f2cl-lib:int-sub 1))
                 (setf info -1))
                ((= cfrom zero)
                 (setf info -4))
                ((< m 0)
                 (setf info -6))
                ((or (< n 0) (and (= itype 4) (/= n m)) (and (= itype 5) (/= n m)))
                 (setf info -7)))

```

```

((and (<= itype 3)
      (< lda
         (max (the fixnum 1) (the fixnum m)))))
(setf info -9))
(>= itype 4)
(cond
  ((or (< kl 0)
        (> kl
           (max
            (the fixnum
              (f2cl-lib:int-add m (f2cl-lib:int-sub 1)))
            (the fixnum 0)))))
    (setf info -2))
  ((or (< ku 0)
        (> ku
           (max
            (the fixnum
              (f2cl-lib:int-add n (f2cl-lib:int-sub 1)))
            (the fixnum 0)))))
    (and (or (= itype 4) (= itype 5)) (/= kl ku)))
    (setf info -3))
  ((or (and (= itype 4) (< lda (f2cl-lib:int-add kl 1)))
        (and (= itype 5) (< lda (f2cl-lib:int-add ku 1)))
        (and (= itype 6)
              (< lda (f2cl-lib:int-add (f2cl-lib:int-mul 2 kl) ku 1))))
    (setf info -9))))))
(cond
  ((/= info 0)
   (error
    " ** On entry to ~a parameter number ~a had an illegal value~%"
    "DLASCL" (f2cl-lib:int-sub info))
   (go end_label)))
(if (or (= n 0) (= m 0)) (go end_label))
(setf smlnum (dlamch "S"))
(setf bignum (/ one smlnum))
(setf cfromc cfrom)
(setf ctoc cto)
label10
(setf cfrom1 (* cfromc smlnum))
(setf cto1 (/ ctoc bignum))
(cond
  ((and (> (abs cfrom1) (abs ctoc)) (/= ctoc zero))
   (setf mul smlnum)
   (setf done nil)
   (setf cfromc cfrom1))
  ((> (abs cto1) (abs cfromc))
   (setf done nil)
   (setf ctoc cto1))))

```

```

      (setf mul bignum)
      (setf done nil)
      (setf ctoc ctol))
    (t
      (setf mul (/ ctoc cfromc))
      (setf done t)))
  (cond
    ((= itype 0)
      (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
        (> j n) nil)
      (tagbody
        (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
          (> i m) nil)
          (tagbody
            (setf (f2cl-lib:fref a-%data%
                                (i j)
                                ((1 lda) (1 *))
                                a-%offset%)
              (*
                (f2cl-lib:fref a-%data%
                                (i j)
                                ((1 lda) (1 *))
                                a-%offset%)
                mul))))))
    ((= itype 1)
      (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
        (> j n) nil)
      (tagbody
        (f2cl-lib:fdo (i j (f2cl-lib:int-add i 1))
          (> i m) nil)
          (tagbody
            (setf (f2cl-lib:fref a-%data%
                                (i j)
                                ((1 lda) (1 *))
                                a-%offset%)
              (*
                (f2cl-lib:fref a-%data%
                                (i j)
                                ((1 lda) (1 *))
                                a-%offset%)
                mul))))))
    ((= itype 2)
      (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
        (> j n) nil)
      (tagbody
        (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))

```

```

        (> i
         (min (the fixnum j)
              (the fixnum m)))
      nil)
    (tagbody
      (setf (f2cl-lib:fref a-%data%
                          (i j)
                          ((1 lda) (1 *)))
            a-%offset%)
      (*
        (f2cl-lib:fref a-%data%
                        (i j)
                        ((1 lda) (1 *)))
        a-%offset%)
      mul))))))
  ((= itype 3)
   (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                 (> j n) nil)
   (tagbody
     (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                   (> i
                     (min
                      (the fixnum
                       (f2cl-lib:int-add j 1))
                      (the fixnum m)))
                     nil)
     (tagbody
       (setf (f2cl-lib:fref a-%data%
                           (i j)
                           ((1 lda) (1 *)))
             a-%offset%)
       (*
         (f2cl-lib:fref a-%data%
                         (i j)
                         ((1 lda) (1 *)))
         a-%offset%)
       mul))))))
  ((= itype 4)
   (setf k3 (f2cl-lib:int-add k1 1))
   (setf k4 (f2cl-lib:int-add n 1))
   (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                 (> j n) nil)
   (tagbody
     (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                   (> i
                     (min (the fixnum k3)

```

```

                                (the fixnum
                                (f2cl-lib:int-add k4
                                (f2cl-lib:int-sub
                                j))))))
                                nil)
    (tagbody
      (setf (f2cl-lib:fref a-%data%
                          (i j)
                          ((1 lda) (1 *))
                          a-%offset%)
            (*
              (f2cl-lib:fref a-%data%
                              (i j)
                              ((1 lda) (1 *))
                              a-%offset%)
              (mul))))))
  ((= itype 5)
   (setf k1 (f2cl-lib:int-add ku 2))
   (setf k3 (f2cl-lib:int-add ku 1))
   (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                 (> j n) nil)
   (tagbody
     (f2cl-lib:fdo (i
                    (max
                     (the fixnum
                      (f2cl-lib:int-add k1 (f2cl-lib:int-sub j)))
                     (the fixnum 1))
                     (f2cl-lib:int-add i 1))
                    (> i k3) nil)
       (tagbody
         (setf (f2cl-lib:fref a-%data%
                              (i j)
                              ((1 lda) (1 *))
                              a-%offset%)
               (*
                 (f2cl-lib:fref a-%data%
                                 (i j)
                                 ((1 lda) (1 *))
                                 a-%offset%)
                 (mul))))))
  ((= itype 6)
   (setf k1 (f2cl-lib:int-add kl ku 2))
   (setf k2 (f2cl-lib:int-add kl 1))
   (setf k3 (f2cl-lib:int-add (f2cl-lib:int-mul 2 k1) ku 1))
   (setf k4 (f2cl-lib:int-add kl ku 1 m))
   (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))

```

```

                                (< j n) nil)
  (tagbody
    (f2cl-lib:fdo (i
      (max
        (the fixnum
          (f2cl-lib:int-add k1 (f2cl-lib:int-sub j)))
        (the fixnum k2))
      (f2cl-lib:int-add i 1))
    (< i
      (min (the fixnum k3)
        (the fixnum
          (f2cl-lib:int-add k4
            (f2cl-lib:int-sub
              j))))))
    nil)
  (tagbody
    (setf (f2cl-lib:fref a-%data%
      (i j)
      ((1 lda) (1 *))
      a-%offset%)
      (*
        (f2cl-lib:fref a-%data%
          (i j)
          ((1 lda) (1 *))
          a-%offset%)
        (mul))))))
    (if (not done) (go label10))
  end_label
  (return (values nil nil nil nil nil nil nil nil info))))))

```

## 7.54 dlasd0 LAPACK

```

<dlasd0.input>≡
)set break resume
)sys rm -f dlasd0.output
)spool dlasd0.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)

```

`<dlasd0.help>`≡

```
=====
dlasd0 examples
=====
```

```
=====
Man Page Details
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```

#### NAME

DLASD0 - divide and conquer approach, DLASD0 computes the singular value decomposition (SVD) of a real upper bidiagonal N-by-M matrix B with diagonal D and offdiagonal E, where  $M = N + \text{SQRE}$

#### SYNOPSIS

```
SUBROUTINE DLASD0( N,  SQRE, D,  E,  U,  LDU, VT, LDVT, SMLSIZ, IWORK,
                  WORK, INFO )

      INTEGER      INFO, LDU, LDVT, N, SMLSIZ, SQRE

      INTEGER      IWORK( * )

      DOUBLE       PRECISION D( * ), E( * ), U( LDU, * ), VT( LDVT, *
                  ), WORK( * )
```

#### PURPOSE

Using a divide and conquer approach, DLASD0 computes the singular value decomposition (SVD) of a real upper bidiagonal N-by-M matrix B with diagonal D and offdiagonal E, where  $M = N + \text{SQRE}$ . The algorithm computes orthogonal matrices U and VT such that  $B = U * S * VT$ . The singular values S are overwritten on D.

A related subroutine, DLASDA, computes only the singular values, and optionally, the singular vectors in compact form.

#### ARGUMENTS

**N** (input) INTEGER  
On entry, the row dimension of the upper bidiagonal matrix. This is also the dimension of the main diagonal array D.

**SQRE** (input) INTEGER  
Specifies the column dimension of the bidiagonal matrix. = 0:  
The bidiagonal matrix has column dimension  $M = N$ ;  
= 1: The bidiagonal matrix has column dimension  $M = N+1$ ;

**D** (input/output) DOUBLE PRECISION array, dimension (N)  
 On entry D contains the main diagonal of the bidiagonal matrix.  
 On exit D, if INFO = 0, contains its singular values.

**E** (input) DOUBLE PRECISION array, dimension (M-1)  
 Contains the subdiagonal entries of the bidiagonal matrix. On  
 exit, E has been destroyed.

**U** (output) DOUBLE PRECISION array, dimension at least (LDQ, N)  
 On exit, U contains the left singular vectors.

**LDU** (input) INTEGER  
 On entry, leading dimension of U.

**VT** (output) DOUBLE PRECISION array, dimension at least (LDVT, M)  
 On exit, VT' contains the right singular vectors.

**LDVT** (input) INTEGER  
 On entry, leading dimension of VT.

**SMLSIZ** (input) INTEGER On entry, maximum size of the subproblems  
 at the bottom of the computation tree.

**IWORK** (workspace) INTEGER work array.  
 Dimension must be at least  $(8 * N)$

**WORK** (workspace) DOUBLE PRECISION work array.  
 Dimension must be at least  $(3 * M^2 + 2 * M)$

**INFO** (output) INTEGER  
 = 0: successful exit.  
 < 0: if INFO = -i, the i-th argument had an illegal value.  
 > 0: if INFO = 1, an singular value did not converge



```

(LAPACK dlasd0)≡
  (defun dlasd0 (n sqre d e u ldu vt ldvt smlsiz iwork work info)
    (declare (type (simple-array fixnum (*)) iwork)
              (type (simple-array double-float (*)) work vt u e d)
              (type fixnum info smlsiz ldvt ldu sqre n))
    (f2cl-lib:with-multi-array-data
      ((d double-float d-%data% d-%offset%)
       (e double-float e-%data% e-%offset%)
       (u double-float u-%data% u-%offset%)
       (vt double-float vt-%data% vt-%offset%)
       (work double-float work-%data% work-%offset%)
       (iwork fixnum iwork-%data% iwork-%offset%))
      (prog ((alpha 0.0) (beta 0.0) (i 0) (il 0) (ic 0) (idxq 0) (idxqc 0)
              (im1 0) (inode 0) (itemp 0) (iwk 0) (j 0) (lf 0) (ll 0) (lvl 0)
              (m 0) (ncc 0) (nd 0) (ndb1 0) (ndiml 0) (ndimr 0) (nl 0) (nlf 0)
              (nlp1 0) (nlvl 0) (nr 0) (nrf 0) (nrp1 0) (sqrei 0))
        (declare (type fixnum sqrei nrp1 nrf nr nlvl nlp1 nlf nl
                                ndimr ndiml ndb1 nd ncc m lvl ll lf j
                                iwk itemp inode im1 idxqc idxq ic il
                                i)
                  (type (double-float) beta alpha))
        (setf info 0)
        (cond
          ((< n 0)
            (setf info -1))
          ((or (< sqre 0) (> sqre 1))
            (setf info -2)))
        (setf m (f2cl-lib:int-add n sqre))
        (cond
          ((< ldu n)
            (setf info -6))
          ((< ldvt m)
            (setf info -8))
          ((< smlsiz 3)
            (setf info -9)))
        (cond
          ((/= info 0)
            (error
              " ** On entry to ~a parameter number ~a had an illegal value~%"
              "DLASD0" (f2cl-lib:int-sub info))
            (go end_label)))
        (cond
          ((<= n smlsiz)
            (multiple-value-bind
              (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9
               var-10 var-11 var-12 var-13 var-14 var-15)

```

```

      (dlasdq "U" sqre n m n 0 d e vt ldvt u ldu u ldu work info)
      (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
                    var-8 var-9 var-10 var-11 var-12 var-13 var-14))
      (setf info var-15))
      (go end_label)))
      (setf inode 1)
      (setf ndiml (f2cl-lib:int-add inode n))
      (setf ndimr (f2cl-lib:int-add ndiml n))
      (setf idxq (f2cl-lib:int-add ndimr n))
      (setf iwk (f2cl-lib:int-add idxq n))
      (multiple-value-bind (var-0 var-1 var-2 var-3 var-4 var-5 var-6)
        (dlsdt n nlvl nd
          (f2cl-lib:array-slice iwork fixnum (inode) ((1 *)))
          (f2cl-lib:array-slice iwork fixnum (ndiml) ((1 *)))
          (f2cl-lib:array-slice iwork fixnum (ndimr) ((1 *)))
          smlsiz)
        (declare (ignore var-0 var-3 var-4 var-5 var-6))
        (setf nlvl var-1)
        (setf nd var-2))
      (setf ndb1 (the fixnum (truncate (+ nd 1) 2)))
      (setf ncc 0)
      (f2cl-lib:fdo (i ndb1 (f2cl-lib:int-add i 1))
        ((> i nd) nil)
        (tagbody
          (setf i1 (f2cl-lib:int-sub i 1))
          (setf ic
            (f2cl-lib:fref iwork-%data%
                          ((f2cl-lib:int-add inode i1))
                          ((1 *))
                          iwork-%offset%))
          (setf nl
            (f2cl-lib:fref iwork-%data%
                          ((f2cl-lib:int-add ndiml i1))
                          ((1 *))
                          iwork-%offset%))
          (setf nlp1 (f2cl-lib:int-add nl 1))
          (setf nr
            (f2cl-lib:fref iwork-%data%
                          ((f2cl-lib:int-add ndimr i1))
                          ((1 *))
                          iwork-%offset%))
          (setf nrp1 (f2cl-lib:int-add nr 1))
          (setf nlf (f2cl-lib:int-sub ic nl))
          (setf nrf (f2cl-lib:int-add ic 1))
          (setf sqrei 1)
          (multiple-value-bind

```

```

      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9
        var-10 var-11 var-12 var-13 var-14 var-15)
(dlasdq "U" sqrei nl nlp1 nl ncc
  (f2cl-lib:array-slice d double-float (nlf) ((1 *)))
  (f2cl-lib:array-slice e double-float (nlf) ((1 *)))
  (f2cl-lib:array-slice vt
    double-float
    (nlf nlf)
    ((1 ldvt) (1 *)))
  ldvt
  (f2cl-lib:array-slice u double-float (nlf nlf) ((1 ldu) (1 *)))
  ldu
  (f2cl-lib:array-slice u double-float (nlf nlf) ((1 ldu) (1 *)))
  ldu work info)
(declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
  var-8 var-9 var-10 var-11 var-12 var-13 var-14))
(setf info var-15))
(cond
  ((/= info 0)
   (go end_label)))
(setf itemp (f2cl-lib:int-sub (f2cl-lib:int-add idxq nlf) 2))
(f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
  ((> j nl) nil)
  (tagbody
    (setf (f2cl-lib:fref iwork-%data%
      ((f2cl-lib:int-add itemp j))
      ((1 *))
      iwork-%offset%)
      j)))
(cond
  ((= i nd)
   (setf sqrei sqre))
  (t
   (setf sqrei 1)))
(setf nrp1 (f2cl-lib:int-add nr sqrei))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9
    var-10 var-11 var-12 var-13 var-14 var-15)
  (dlasdq "U" sqrei nr nrp1 nr ncc
    (f2cl-lib:array-slice d double-float (nrf) ((1 *)))
    (f2cl-lib:array-slice e double-float (nrf) ((1 *)))
    (f2cl-lib:array-slice vt
      double-float
      (nrf nrf)
      ((1 ldvt) (1 *)))
    ldvt

```

```

(f2cl-lib:array-slice u double-float (nrf nrf) ((1 ldu) (1 *)))
ldu
(f2cl-lib:array-slice u double-float (nrf nrf) ((1 ldu) (1 *)))
ldu work info)
(declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
               var-8 var-9 var-10 var-11 var-12 var-13 var-14))
(setf info var-15))
(cond
  ((/= info 0)
   (go end_label)))
(setf itemp (f2cl-lib:int-add idxq ic))
(f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
  (> j nr) nil)
(tagbody
  (setf (f2cl-lib:fref iwork-%data%
                      ((f2cl-lib:int-sub
                        (f2cl-lib:int-add itemp j)
                        1))
                      ((1 *)))
        iwork-%offset%))
  j))))
(f2cl-lib:fdo (lvl nlvl (f2cl-lib:int-add lvl (f2cl-lib:int-sub 1)))
  (> lvl 1) nil)
(tagbody
  (cond
    ((= lvl 1)
     (setf lf 1)
     (setf ll 1))
    (t
     (setf lf (expt 2 (f2cl-lib:int-sub lvl 1)))
     (setf ll (f2cl-lib:int-sub (f2cl-lib:int-mul 2 lf) 1))))
  (f2cl-lib:fdo (i lf (f2cl-lib:int-add i 1))
    (> i ll) nil)
  (tagbody
    (setf im1 (f2cl-lib:int-sub i 1))
    (setf ic
      (f2cl-lib:fref iwork-%data%
                      ((f2cl-lib:int-add inode im1)
                      ((1 *)))
                      iwork-%offset%))
    (setf nl
      (f2cl-lib:fref iwork-%data%
                      ((f2cl-lib:int-add ndiml im1)
                      ((1 *)))
                      iwork-%offset%))
    (setf nr

```

```

        (f2cl-lib:fref iwork-%data%
          ((f2cl-lib:int-add ndimr im1))
          ((1 *))
          iwork-%offset%))
(setf nlf (f2cl-lib:int-sub ic n1))
(cond
  ((and (= sqre 0) (= i 11))
    (setf sqrei sqre))
  (t
    (setf sqrei 1)))
(setf idxqc (f2cl-lib:int-sub (f2cl-lib:int-add idxq nlf) 1))
(setf alpha (f2cl-lib:fref d-%data% (ic) ((1 *)) d-%offset%))
(setf beta (f2cl-lib:fref e-%data% (ic) ((1 *)) e-%offset%))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
   var-9 var-10 var-11 var-12 var-13)
  (dlasd1 nl nr sqrei
   (f2cl-lib:array-slice d double-float (nlf) ((1 *))) alpha
   beta
   (f2cl-lib:array-slice u
     double-float
     (nlf nlf)
     ((1 ldu) (1 *)))
   ldu
   (f2cl-lib:array-slice vt
     double-float
     (nlf nlf)
     ((1 ldvt) (1 *)))
   ldvt
   (f2cl-lib:array-slice iwork
     fixnum
     (idxqc)
     ((1 *)))
   (f2cl-lib:array-slice iwork fixnum (iwk) ((1 *)))
   work info)
  (declare (ignore var-0 var-1 var-2 var-3 var-6 var-7 var-8
    var-9 var-10 var-11 var-12))
  (setf alpha var-4)
  (setf beta var-5)
  (setf info var-13))
(cond
  ((/= info 0)
    (go end_label))))))
end_label
(return (values nil nil nil nil nil nil nil nil nil nil info))))

```

## 7.55 dlasd1 LAPACK

```
<dlasd1.input>≡  
  )set break resume  
  )sys rm -f dlasd1.output  
  )spool dlasd1.output  
  )set message test on  
  )set message auto off  
  )clear all  
  
  )spool  
  )lisp (bye)
```

`<dlasd1.help>`≡

```
=====
dlasd1 examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

DLASD1 - the SVD of an upper bidiagonal N-by-M matrix B,

#### SYNOPSIS

```
SUBROUTINE DLASD1( NL, NR, SQRE, D, ALPHA, BETA, U, LDU, VT, LDVT,
                  IDXQ, IWORK, WORK, INFO )
```

```
      INTEGER      INFO, LDU, LDVT, NL, NR, SQRE
```

```
      DOUBLE      PRECISION ALPHA, BETA
```

```
      INTEGER      IDXQ( * ), IWORK( * )
```

```
      DOUBLE      PRECISION D( * ), U( LDU, * ), VT( LDVT, * ), WORK(
                  * )
```

#### PURPOSE

DLASD1 computes the SVD of an upper bidiagonal N-by-M matrix B, where  $N = NL + NR + 1$  and  $M = N + SQRE$ . DLASD1 is called from DLASD0.

A related subroutine DLASD7 handles the case in which the singular values (and the singular vectors in factored form) are desired.

DLASD1 computes the SVD as follows:

$$B = U(\text{in}) * \begin{pmatrix} D1(\text{in}) & 0 & 0 & 0 \\ Z1' & a & Z2' & b \\ 0 & 0 & D2(\text{in}) & 0 \end{pmatrix} * VT(\text{in})$$

$$= U(\text{out}) * ( D(\text{out}) \ 0 ) * VT(\text{out})$$

where  $Z' = (Z1' \ a \ Z2' \ b) = u' VT'$ , and u is a vector of dimension M with ALPHA and BETA in the NL+1 and NL+2 th entries and zeros elsewhere; and the entry b is empty if SQRE = 0.

The left singular vectors of the original matrix are stored in U, and the transpose of the right singular vectors are stored in VT, and the

singular values are in D. The algorithm consists of three stages:

The first stage consists of deflating the size of the problem when there are multiple singular values or when there are zeros in the Z vector. For each such occurrence the dimension of the secular equation problem is reduced by one. This stage is performed by the routine DLASD2.

The second stage consists of calculating the updated singular values. This is done by finding the square roots of the roots of the secular equation via the routine DLASD4 (as called by DLASD3). This routine also calculates the singular vectors of the current problem.

The final stage consists of computing the updated singular vectors directly using the updated singular values. The singular vectors for the current problem are multiplied with the singular vectors from the overall problem.

#### ARGUMENTS

- NL      (input) INTEGER  
The row dimension of the upper block. NL  $\geq$  1.
- NR      (input) INTEGER  
The row dimension of the lower block. NR  $\geq$  1.
- SQRE    (input) INTEGER  
= 0: the lower block is an NR-by-NR square matrix.  
= 1: the lower block is an NR-by-(NR+1) rectangular matrix.
- The bidiagonal matrix has row dimension  $N = NL + NR + 1$ , and column dimension  $M = N + SQRE$ .
- D      (input/output) DOUBLE PRECISION array,  
dimension (N = NL+NR+1). On entry D(1:NL,1:NL) contains the singular values of the upper block; and D(NL+2:N) contains the singular values of the lower block. On exit D(1:N) contains the singular values of the modified matrix.
- ALPHA   (input/output) DOUBLE PRECISION  
Contains the diagonal element associated with the added row.
- BETA    (input/output) DOUBLE PRECISION  
Contains the off-diagonal element associated with the added row.



**U** (input/output) DOUBLE PRECISION array, dimension(LDU,N)  
 On entry U(1:NL, 1:NL) contains the left singular vectors of the upper block; U(NL+2:N, NL+2:N) contains the left singular vectors of the lower block. On exit U contains the left singular vectors of the bidiagonal matrix.

**LDU** (input) INTEGER  
 The leading dimension of the array U.  $LDU \geq \max(1, N)$ .

**VT** (input/output) DOUBLE PRECISION array, dimension(LDVT,M)  
 where  $M = N + \text{SQRE}$ . On entry VT(1:NL+1, 1:NL+1)' contains the right singular vectors of the upper block; VT(NL+2:M, NL+2:M)' contains the right singular vectors of the lower block. On exit VT' contains the right singular vectors of the bidiagonal matrix.

**LDVT** (input) INTEGER  
 The leading dimension of the array VT.  $LDVT \geq \max(1, M)$ .

**IDXQ** (output) INTEGER array, dimension(N)  
 This contains the permutation which will reintegrate the subproblem just solved back into sorted order, i.e. D( IDXQ( I = 1, N ) ) will be in ascending order.

**IWORK** (workspace) INTEGER array, dimension( 4 \* N )

**WORK** (workspace) DOUBLE PRECISION array, dimension( 3\*M\*\*2 + 2\*M )

**INFO** (output) INTEGER  
 = 0: successful exit.  
 < 0: if INFO = -i, the i-th argument had an illegal value.  
 > 0: if INFO = 1, an singular value did not converge

```

(LAPACK dlasd1)=
  (let* ((one 1.0) (zero 0.0))
    (declare (type (double-float 1.0 1.0) one)
              (type (double-float 0.0 0.0) zero))
    (defun dlasd1 (nl nr sqre d alpha beta u ldu vt ldvt idxq iwork work info)
      (declare (type (simple-array fixnum (*)) iwork idxq)
                (type (double-float) beta alpha)
                (type (simple-array double-float (*)) work vt u d)
                (type fixnum info ldvt ldu sqre nr nl))
      (f2cl-lib:with-multi-array-data
        ((d double-float d-%data% d-%offset%)
         (u double-float u-%data% u-%offset%)
         (vt double-float vt-%data% vt-%offset%)
         (work double-float work-%data% work-%offset%)
         (idxq fixnum idxq-%data% idxq-%offset%)
         (iwork fixnum iwork-%data% iwork-%offset%))
        (prog ((orgnrm 0.0) (coltyp 0) (i 0) (idx 0) (idxc 0) (idxp 0) (iq 0)
              (isigma 0) (iu2 0) (ivt2 0) (iz 0) (k 0) (ldq 0) (ldu2 0)
              (ldvt2 0) (m 0) (n 0) (n1 0) (n2 0))
          (declare (type (double-float) orgnrm)
                    (type fixnum coltyp i idx idxc idxp iq isigma iu2
                              ivt2 iz k ldq ldu2 ldvt2 m n n1 n2))

          (setf info 0)
          (cond
            ((< nl 1)
              (setf info -1))
            ((< nr 1)
              (setf info -2))
            ((or (< sqre 0) (> sqre 1))
              (setf info -3)))
          (cond
            ((/= info 0)
              (error
               " ** On entry to ~a parameter number ~a had an illegal value~%"
               "DLASD1" (f2cl-lib:int-sub info))
              (go end_label)))
          (setf n (f2cl-lib:int-add nl nr 1))
          (setf m (f2cl-lib:int-add n sqre))
          (setf ldu2 n)
          (setf ldvt2 m)
          (setf iz 1)
          (setf isigma (f2cl-lib:int-add iz m))
          (setf iu2 (f2cl-lib:int-add isigma n))
          (setf ivt2 (f2cl-lib:int-add iu2 (f2cl-lib:int-mul ldu2 n)))
          (setf iq (f2cl-lib:int-add ivt2 (f2cl-lib:int-mul ldvt2 m)))
          (setf idx 1)

```

```

(setf idxc (f2cl-lib:int-add idx n))
(setf coltyp (f2cl-lib:int-add idxc n))
(setf idxp (f2cl-lib:int-add coltyp n))
(setf orgnrm (max (abs alpha) (abs beta)))
(setf (f2cl-lib:fref d-%data%
                    ((f2cl-lib:int-add nl 1))
                    ((1 *))
                    d-%offset%)
      zero)
(f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
              ((> i n) nil)
  (tagbody
    (cond
      ((> (abs (f2cl-lib:fref d (i) ((1 *)))) orgnrm)
        (setf orgnrm
              (abs (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%))))))
  (multiple-value-bind
    (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9)
    (dlascl "G" 0 0 orgnrm one n 1 d n info)
    (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
                     var-8))
    (setf info var-9))
  (setf alpha (/ alpha orgnrm))
  (setf beta (/ beta orgnrm))
  (multiple-value-bind
    (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9
     var-10 var-11 var-12 var-13 var-14 var-15 var-16 var-17 var-18
     var-19 var-20 var-21 var-22)
    (dlasd2 nl nr sqre k d
      (f2cl-lib:array-slice work double-float (iz) ((1 *))) alpha beta u
      ldu vt ldvt
      (f2cl-lib:array-slice work double-float (isigma) ((1 *)))
      (f2cl-lib:array-slice work double-float (iu2) ((1 *))) ldu2
      (f2cl-lib:array-slice work double-float (ivt2) ((1 *))) ldvt2
      (f2cl-lib:array-slice iwork fixnum (idxp) ((1 *)))
      (f2cl-lib:array-slice iwork fixnum (idx) ((1 *)))
      (f2cl-lib:array-slice iwork fixnum (idxc) ((1 *))) idxq
      (f2cl-lib:array-slice iwork fixnum (coltyp) ((1 *)))
      info)
    (declare (ignore var-0 var-1 var-2 var-4 var-5 var-6 var-7 var-8
                     var-9 var-10 var-11 var-12 var-13 var-14 var-15
                     var-16 var-17 var-18 var-19 var-20 var-21))
    (setf k var-3)
    (setf info var-22))
  (setf ldq k)
  (multiple-value-bind

```



## 7.56 dlasd2 LAPACK

```
<dlasd2.input>=  
  )set break resume  
  )sys rm -f dlasd2.output  
  )spool dlasd2.output  
  )set message test on  
  )set message auto off  
  )clear all  
  
  )spool  
  )lisp (bye)
```

`<dlasd2.help>=`

```
=====
dlasd2 examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

DLASD2 - the two sets of singular values together into a single sorted set

#### SYNOPSIS

```
SUBROUTINE DLASD2( NL, NR, SQRE, K, D, Z, ALPHA, BETA, U, LDU, VT,
                  LDVT, DSIGMA, U2, LDU2, VT2, LDVT2, IDXP, IDX, IDXC,
                  IDXQ, COLTYP, INFO )
```

```
      INTEGER      INFO, K, LDU, LDU2, LDVT, LDVT2, NL, NR, SQRE
```

```
      DOUBLE      PRECISION ALPHA, BETA
```

```
      INTEGER      COLTYP( * ), IDX( * ), IDXC( * ), IDXP( * ), IDXQ( *
                  )
```

```
      DOUBLE      PRECISION D( * ), DSIGMA( * ), U( LDU, * ), U2(
                  LDU2, * ), VT( LDVT, * ), VT2( LDVT2, * ), Z( * )
```

#### PURPOSE

DLASD2 merges the two sets of singular values together into a single sorted set. Then it tries to deflate the size of the problem. There are two ways in which deflation can occur: when two or more singular values are close together or if there is a tiny entry in the Z vector. For each such occurrence the order of the related secular equation problem is reduced by one.

DLASD2 is called from DLASD1.

#### ARGUMENTS

NL (input) INTEGER  
The row dimension of the upper block. NL >= 1.

NR (input) INTEGER  
The row dimension of the lower block. NR >= 1.

- SQRE** (input) INTEGER  
 = 0: the lower block is an NR-by-NR square matrix.  
 = 1: the lower block is an NR-by-(NR+1) rectangular matrix.
- The bidiagonal matrix has  $N = NL + NR + 1$  rows and  $M = N + SQRE \geq N$  columns.
- K** (output) INTEGER  
 Contains the dimension of the non-deflated matrix, This is the order of the related secular equation.  $1 \leq K \leq N$ .
- D** (input/output) DOUBLE PRECISION array, dimension(N)  
 On entry D contains the singular values of the two submatrices to be combined. On exit D contains the trailing (N-K) updated singular values (those which were deflated) sorted into increasing order.
- Z** (output) DOUBLE PRECISION array, dimension(N)  
 On exit Z contains the updating row vector in the secular equation.
- ALPHA** (input) DOUBLE PRECISION  
 Contains the diagonal element associated with the added row.
- BETA** (input) DOUBLE PRECISION  
 Contains the off-diagonal element associated with the added row.
- U** (input/output) DOUBLE PRECISION array, dimension(LDU,N)  
 On entry U contains the left singular vectors of two submatrices in the two square blocks with corners at (1,1), (NL, NL), and (NL+2, NL+2), (N,N). On exit U contains the trailing (N-K) updated left singular vectors (those which were deflated) in its last N-K columns.
- LDU** (input) INTEGER  
 The leading dimension of the array U.  $LDU \geq N$ .
- VT** (input/output) DOUBLE PRECISION array, dimension(LDVT,M)  
 On entry VT' contains the right singular vectors of two submatrices in the two square blocks with corners at (1,1), (NL+1, NL+1), and (NL+2, NL+2), (M,M). On exit VT' contains the trailing (N-K) updated right singular vectors (those which were deflated) in its last N-K columns. In case  $SQRE = 1$ , the last row of VT spans the right null space.
- LDVT** (input) INTEGER

The leading dimension of the array VT. LDVT  $\geq$  M.

DSIGMA (output) DOUBLE PRECISION array, dimension (N) Contains a copy of the diagonal elements (K-1 singular values and one zero) in the secular equation.

U2 (output) DOUBLE PRECISION array, dimension(LDU2,N)  
Contains a copy of the first K-1 left singular vectors which will be used by DLASD3 in a matrix multiply (DGEMM) to solve for the new left singular vectors. U2 is arranged into four blocks. The first block contains a column with 1 at NL+1 and zero everywhere else; the second block contains non-zero entries only at and above NL; the third contains non-zero entries only below NL+1; and the fourth is dense.

LDU2 (input) INTEGER  
The leading dimension of the array U2. LDU2  $\geq$  N.

VT2 (output) DOUBLE PRECISION array, dimension(LDVT2,N)  
VT2' contains a copy of the first K right singular vectors which will be used by DLASD3 in a matrix multiply (DGEMM) to solve for the new right singular vectors. VT2 is arranged into three blocks. The first block contains a row that corresponds to the special 0 diagonal element in SIGMA; the second block contains non-zeros only at and before NL +1; the third block contains non-zeros only at and after NL +2.

LDVT2 (input) INTEGER  
The leading dimension of the array VT2. LDVT2  $\geq$  M.

IDXP (workspace) INTEGER array dimension(N)  
This will contain the permutation used to place deflated values of D at the end of the array. On output IDXP(2:K) points to the nondeflated D-values and IDXP(K+1:N) points to the deflated singular values.

IDX (workspace) INTEGER array dimension(N)  
This will contain the permutation used to sort the contents of D into ascending order.

IDXC (output) INTEGER array dimension(N)  
This will contain the permutation used to arrange the columns of the deflated U matrix into three groups: the first group contains non-zero entries only at and above NL, the second contains non-zero entries only below NL+2, and the third is dense.



IDXQ (input/output) INTEGER array dimension(N)  
This contains the permutation which separately sorts the two sub-problems in D into ascending order. Note that entries in the first half of this permutation must first be moved one position backward; and entries in the second half must first have NL+1 added to their values.

COLTYP (workspace/output) INTEGER array dimension(N) As workspace, this will contain a label which will indicate which of the following types a column in the U2 matrix or a row in the VT2 matrix is:

- 1 : non-zero in the upper half only
- 2 : non-zero in the lower half only
- 3 : dense
- 4 : deflated

On exit, it is an array of dimension 4, with COLTYP(I) being the dimension of the I-th type columns.

INFO (output) INTEGER  
= 0: successful exit.  
< 0: if INFO = -i, the i-th argument had an illegal value.

```

(LAPACK dlasd2)=
  (let* ((zero 0.0) (one 1.0) (two 2.0) (eight 8.0))
    (declare (type (double-float 0.0 0.0) zero)
              (type (double-float 1.0 1.0) one)
              (type (double-float 2.0 2.0) two)
              (type (double-float 8.0 8.0) eight))
    (defun dlasd2
      (nl nr sqre k d z alpha beta u ldu vt ldvt dsigma u2 ldu2 vt2 ldvt2
       idxp idx idxc idxq coltyp info)
      (declare (type (simple-array fixnum (*)) coltyp idxq idxc idx idxp)
                (type (double-float) beta alpha)
                (type (simple-array double-float (*)) vt2 u2 dsigma vt u z d)
                (type fixnum info ldvt2 ldu2 ldvt ldu k sqre nr nl))
      (f2cl-lib:with-multi-array-data
        ((d double-float d-%data% d-%offset%)
         (z double-float z-%data% z-%offset%)
         (u double-float u-%data% u-%offset%)
         (vt double-float vt-%data% vt-%offset%)
         (dsigma double-float dsigma-%data% dsigma-%offset%)
         (u2 double-float u2-%data% u2-%offset%)
         (vt2 double-float vt2-%data% vt2-%offset%)
         (idxp fixnum idxp-%data% idxp-%offset%)
         (idx fixnum idx-%data% idx-%offset%)
         (idxc fixnum idxc-%data% idxc-%offset%)
         (idxq fixnum idxq-%data% idxq-%offset%)
         (coltyp fixnum coltyp-%data% coltyp-%offset%))
        (prog ((c 0.0) (eps 0.0) (hlftol 0.0) (s 0.0) (tau 0.0) (tol 0.0)
              (z1 0.0) (ct 0) (i 0) (idxi 0) (idxj 0) (idxjp 0) (j 0) (jp 0)
              (jprev 0) (k2 0) (m 0) (n 0) (nlp1 0) (nlp2 0)
              (ctot (make-array 4 :element-type 'fixnum))
              (psm (make-array 4 :element-type 'fixnum)))
              (declare (type (double-float) c eps hlftol s tau tol z1)
                        (type fixnum ct i idxi idxj idxjp j jp jprev k2 m
                                n nlp1 nlp2)
                        (type (simple-array fixnum (4)) ctot psm))
              (setf info 0)
              (cond
                ((< nl 1)
                 (setf info -1))
                ((< nr 1)
                 (setf info -2))
                ((and (/= sqre 1) (/= sqre 0))
                 (setf info -3)))
              (setf n (f2cl-lib:int-add nl nr 1))
              (setf m (f2cl-lib:int-add n sqre))
              (cond

```

```

((< ldu n)
 (setf info -10))
((< ldvt m)
 (setf info -12))
((< ldu2 n)
 (setf info -15))
((< ldvt2 m)
 (setf info -17)))
(cond
 ((/= info 0)
  (error
   (error
    " ** On entry to ~a parameter number ~a had an illegal value~%"
    "DLASD2" (f2cl-lib:int-sub info))
   (go end_label))))
(setf nlp1 (f2cl-lib:int-add nl 1))
(setf nlp2 (f2cl-lib:int-add nl 2))
(setf z1
  (* alpha
    (f2cl-lib:fref vt-%data%
                   (nlp1 nlp1)
                   ((1 ldvt) (1 *))
                   vt-%offset%)))
(setf (f2cl-lib:fref z-%data% (1) ((1 *)) z-%offset%) z1)
(f2cl-lib:fd0 (i nl (f2cl-lib:int-add i (f2cl-lib:int-sub 1)))
  ((> i 1) nil)
  (tagbody
   (setf (f2cl-lib:fref z-%data%
                       ((f2cl-lib:int-add i 1))
                       ((1 *))
                       z-%offset%)
         (* alpha
           (f2cl-lib:fref vt-%data%
                           (i nlp1)
                           ((1 ldvt) (1 *))
                           vt-%offset%)))
   (setf (f2cl-lib:fref d-%data%
                       ((f2cl-lib:int-add i 1))
                       ((1 *))
                       d-%offset%)
         (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%))
   (setf (f2cl-lib:fref idxq-%data%
                       ((f2cl-lib:int-add i 1))
                       ((1 *))
                       idxq-%offset%)
         (f2cl-lib:int-add
          (f2cl-lib:fref idxq-%data% (i) ((1 *)) idxq-%offset%)

```

```

1))))
(f2cl-lib:fdo (i nlp2 (f2cl-lib:int-add i 1))
  (> i m) nil)
(tagbody
  (setf (f2cl-lib:fref z-%data% (i) ((1 *)) z-%offset%)
    (* beta
      (f2cl-lib:fref vt-%data%
        (i nlp2)
        ((1 ldvt) (1 *))
        vt-%offset%))))))
(f2cl-lib:fdo (i 2 (f2cl-lib:int-add i 1))
  (> i nlp1) nil)
(tagbody
  (setf (f2cl-lib:fref coltyp-%data% (i) ((1 *)) coltyp-%offset%) 1)))
(f2cl-lib:fdo (i nlp2 (f2cl-lib:int-add i 1))
  (> i n) nil)
(tagbody
  (setf (f2cl-lib:fref coltyp-%data% (i) ((1 *)) coltyp-%offset%) 2)))
(f2cl-lib:fdo (i nlp2 (f2cl-lib:int-add i 1))
  (> i n) nil)
(tagbody
  (setf (f2cl-lib:fref idxq-%data% (i) ((1 *)) idxq-%offset%)
    (f2cl-lib:int-add
      (f2cl-lib:fref idxq-%data% (i) ((1 *)) idxq-%offset%)
      nlp1))))
(f2cl-lib:fdo (i 2 (f2cl-lib:int-add i 1))
  (> i n) nil)
(tagbody
  (setf (f2cl-lib:fref dsigma-%data% (i) ((1 *)) dsigma-%offset%)
    (f2cl-lib:fref d-%data%
      ((f2cl-lib:fref idxq (i) ((1 *)))
        ((1 *))
        d-%offset%))
    (setf (f2cl-lib:fref u2-%data% (i 1) ((1 ldu2) (1 *)) u2-%offset%)
      (f2cl-lib:fref z-%data%
        ((f2cl-lib:fref idxq (i) ((1 *)))
          ((1 *))
          z-%offset%))
      (setf (f2cl-lib:fref idxc-%data% (i) ((1 *)) idxc-%offset%)
        (f2cl-lib:fref coltyp-%data%
          ((f2cl-lib:fref idxq (i) ((1 *)))
            ((1 *))
            coltyp-%offset%))))))
(dlamrg nl nr (f2cl-lib:array-slice dsigma double-float (2) ((1 *))) 1
  1 (f2cl-lib:array-slice idx fixnum (2) ((1 *))))
(f2cl-lib:fdo (i 2 (f2cl-lib:int-add i 1))

```

```

                                (> i n) nil)
(tagbody
  (setf idxi
    (f2cl-lib:int-add 1
      (f2cl-lib:fref idx-%data%
        (i)
        ((1 *))
        idx-%offset%)))
  (setf (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%)
    (f2cl-lib:fref dsigma-%data%
      (idxi)
      ((1 *))
      dsigma-%offset%))
  (setf (f2cl-lib:fref z-%data% (i) ((1 *)) z-%offset%)
    (f2cl-lib:fref u2-%data%
      (idxi 1)
      ((1 ldu2) (1 *))
      u2-%offset%))
  (setf (f2cl-lib:fref coltyp-%data% (i) ((1 *)) coltyp-%offset%)
    (f2cl-lib:fref idxc-%data% (idxi) ((1 *)) idxc-%offset%)))
(setf eps (dlamch "Epsilon"))
(setf tol (max (abs alpha) (abs beta)))
(setf tol
  (* eight
    eps
    (max (abs (f2cl-lib:fref d-%data% (n) ((1 *)) d-%offset%))
      tol)))
(setf k 1)
(setf k2 (f2cl-lib:int-add n 1))
(f2cl-lib:fdo (j 2 (f2cl-lib:int-add j 1))
  (> j n) nil)
(tagbody
  (cond
    ((<= (abs (f2cl-lib:fref z (j) ((1 *)))) tol)
      (setf k2 (f2cl-lib:int-sub k2 1))
      (setf (f2cl-lib:fref idxp-%data% (k2) ((1 *)) idxp-%offset%) j)
      (setf (f2cl-lib:fref coltyp-%data% (j) ((1 *)) coltyp-%offset%)
        4)
      (if (= j n) (go label120)))
    (t
      (setf jprev j)
      (go label190))))
label190
  (setf j jprev)
label1100
  (setf j (f2cl-lib:int-add j 1))

```

```

(if (> j n) (go label110))
(cond
  ((<= (abs (f2cl-lib:fref z (j) ((1 *)))) tol)
    (setf k2 (f2cl-lib:int-sub k2 1))
    (setf (f2cl-lib:fref idxp-%data% (k2) ((1 *)) idxp-%offset%) j)
    (setf (f2cl-lib:fref coltyp-%data% (j) ((1 *)) coltyp-%offset%) 4))
  (t
    (cond
      ((<=
        (abs
          (+ (f2cl-lib:fref d (j) ((1 *)))
            (- (f2cl-lib:fref d (jprev) ((1 *))))))
        tol)
        (setf s (f2cl-lib:fref z-%data% (jprev) ((1 *)) z-%offset%))
        (setf c (f2cl-lib:fref z-%data% (j) ((1 *)) z-%offset%))
        (setf tau (dlapy2 c s))
        (setf c (/ c tau))
        (setf s (/ (- s) tau))
        (setf (f2cl-lib:fref z-%data% (j) ((1 *)) z-%offset%) tau)
        (setf (f2cl-lib:fref z-%data% (jprev) ((1 *)) z-%offset%) zero)
        (setf idxjp
          (f2cl-lib:fref idxq-%data%
            ((f2cl-lib:int-add
              (f2cl-lib:fref idx (jprev) ((1 *)))
              1))
            ((1 *))
            idxq-%offset%))
        (setf idxj
          (f2cl-lib:fref idxq-%data%
            ((f2cl-lib:int-add
              (f2cl-lib:fref idx (j) ((1 *)))
              1))
            ((1 *))
            idxq-%offset%))
        (cond
          ((<= idxjp nlp1)
            (setf idxjp (f2cl-lib:int-sub idxjp 1))))
        (cond
          ((<= idxj nlp1)
            (setf idxj (f2cl-lib:int-sub idxj 1))))
        (drot n
          (f2cl-lib:array-slice u double-float (1 idxjp) ((1 ldu) (1 *)))
          1 (f2cl-lib:array-slice u double-float (1 idxj) ((1 ldu) (1 *)))
          1 c s)
        (drot m
          (f2cl-lib:array-slice vt

```

```

double-float
(idxjp 1)
((1 ldvt) (1 *)))

ldvt
(f2cl-lib:array-slice vt double-float (idxj 1) ((1 ldvt) (1 *)))
ldvt c s)
(cond
  ((/= (f2cl-lib:fref coltyp (j) ((1 *)))
        (f2cl-lib:fref coltyp (jprev) ((1 *))))
    (setf (f2cl-lib:fref coltyp-%data%
                        (j)
                        ((1 *))
                        coltyp-%offset%)
          3)))
  (setf (f2cl-lib:fref coltyp-%data%
                      (jprev)
                      ((1 *))
                      coltyp-%offset%)
        4)
  (setf k2 (f2cl-lib:int-sub k2 1))
  (setf (f2cl-lib:fref idxp-%data% (k2) ((1 *)) idxp-%offset%)
        jprev)
  (setf jprev j))
(t
  (setf k (f2cl-lib:int-add k 1))
  (setf (f2cl-lib:fref u2-%data%
                      (k 1)
                      ((1 ldu2) (1 *))
                      u2-%offset%)
        (f2cl-lib:fref z-%data% (jprev) ((1 *)) z-%offset%))
  (setf (f2cl-lib:fref dsigma-%data% (k) ((1 *)) dsigma-%offset%)
        (f2cl-lib:fref d-%data% (jprev) ((1 *)) d-%offset%))
  (setf (f2cl-lib:fref idxp-%data% (k) ((1 *)) idxp-%offset%) jprev)
  (setf jprev j))))
(go label100)
label110
  (setf k (f2cl-lib:int-add k 1))
  (setf (f2cl-lib:fref u2-%data% (k 1) ((1 ldu2) (1 *)) u2-%offset%)
        (f2cl-lib:fref z-%data% (jprev) ((1 *)) z-%offset%))
  (setf (f2cl-lib:fref dsigma-%data% (k) ((1 *)) dsigma-%offset%)
        (f2cl-lib:fref d-%data% (jprev) ((1 *)) d-%offset%))
  (setf (f2cl-lib:fref idxp-%data% (k) ((1 *)) idxp-%offset%) jprev)
label1120
  (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                (> j 4) nil)
  (tagbody (setf (f2cl-lib:fref ctot (j) ((1 4))) 0)))

```

```
(f2cl-lib:fdo (j 2 (f2cl-lib:int-add j 1))
  (> j n) nil)

(tagbody
  (setf ct (f2cl-lib:fref coltyp-%data% (j) ((1 *)) coltyp-%offset%))
  (setf (f2cl-lib:fref ctot (ct) ((1 4)))
    (f2cl-lib:int-add (f2cl-lib:fref ctot (ct) ((1 4))) 1))))
(setf (f2cl-lib:fref psm (1) ((1 4))) 2)
(setf (f2cl-lib:fref psm (2) ((1 4)))
  (f2cl-lib:int-add 2 (f2cl-lib:fref ctot (1) ((1 4)))))
(setf (f2cl-lib:fref psm (3) ((1 4)))
  (f2cl-lib:int-add (f2cl-lib:fref psm (2) ((1 4)))
    (f2cl-lib:fref ctot (2) ((1 4)))))
(setf (f2cl-lib:fref psm (4) ((1 4)))
  (f2cl-lib:int-add (f2cl-lib:fref psm (3) ((1 4)))
    (f2cl-lib:fref ctot (3) ((1 4)))))
(f2cl-lib:fdo (j 2 (f2cl-lib:int-add j 1))
  (> j n) nil)

(tagbody
  (setf jp (f2cl-lib:fref idxp-%data% (j) ((1 *)) idxp-%offset%))
  (setf ct
    (f2cl-lib:fref coltyp-%data% (jp) ((1 *)) coltyp-%offset%))
  (setf (f2cl-lib:fref idxc-%data%
    ((f2cl-lib:fref psm (ct) ((1 4)))
    ((1 *))
    idxc-%offset%))
    j)
  (setf (f2cl-lib:fref psm (ct) ((1 4)))
    (f2cl-lib:int-add (f2cl-lib:fref psm (ct) ((1 4))) 1))))
(f2cl-lib:fdo (j 2 (f2cl-lib:int-add j 1))
  (> j n) nil)

(tagbody
  (setf jp (f2cl-lib:fref idxp-%data% (j) ((1 *)) idxp-%offset%))
  (setf (f2cl-lib:fref dsigma-%data% (j) ((1 *)) dsigma-%offset%)
    (f2cl-lib:fref d-%data% (jp) ((1 *)) d-%offset%))
  (setf idxj
    (f2cl-lib:fref idxq-%data%
      ((f2cl-lib:int-add
        (f2cl-lib:fref idx
          ((f2cl-lib:fref
            idxc
            (j)
            ((1 *))))
          ((1 *))))
        ((1 *)))
      1))
```



```

      ((1 *))
      idxq-%offset%))
(cond
  ((<= idxj nlp1)
   (setf idxj (f2cl-lib:int-sub idxj 1))))
(dcopy n
  (f2cl-lib:array-slice u double-float (1 idxj) ((1 ldu) (1 *))) 1
  (f2cl-lib:array-slice u2 double-float (1 j) ((1 ldu2) (1 *))) 1)
(dcopy m
  (f2cl-lib:array-slice vt double-float (idxj 1) ((1 ldvt) (1 *)))
  ldvt
  (f2cl-lib:array-slice vt2 double-float (j 1) ((1 ldvt2) (1 *)))
  ldvt2)))
(setf (f2cl-lib:fref dsigma-%data% (1) ((1 *)) dsigma-%offset%) zero)
(setf hlftol (/ tol two))
(if
  (<= (abs (f2cl-lib:fref dsigma-%data% (2) ((1 *)) dsigma-%offset%)
        hlftol)
    (setf (f2cl-lib:fref dsigma-%data% (2) ((1 *)) dsigma-%offset%)
          hlftol))
  (cond
    (> m n)
    (setf (f2cl-lib:fref z-%data% (1) ((1 *)) z-%offset%)
          (dlapy2 z1 (f2cl-lib:fref z-%data% (m) ((1 *)) z-%offset%)))
    (cond
      ((<= (f2cl-lib:fref z (1) ((1 *))) tol)
       (setf c one)
       (setf s zero)
       (setf (f2cl-lib:fref z-%data% (1) ((1 *)) z-%offset%) tol))
      (t
       (setf c (/ z1 (f2cl-lib:fref z-%data% (1) ((1 *)) z-%offset%)))
       (setf s
        (/ (f2cl-lib:fref z-%data% (m) ((1 *)) z-%offset%)
           (f2cl-lib:fref z-%data% (1) ((1 *)) z-%offset%))))))
    (t
     (cond
       ((<= (abs z1) tol)
        (setf (f2cl-lib:fref z-%data% (1) ((1 *)) z-%offset%) tol))
       (t
        (setf (f2cl-lib:fref z-%data% (1) ((1 *)) z-%offset%) z1))))))
  (dcopy (f2cl-lib:int-sub k 1)
    (f2cl-lib:array-slice u2 double-float (2 1) ((1 ldu2) (1 *))) 1
    (f2cl-lib:array-slice z double-float (2) ((1 *))) 1)
  (dlaset "A" n 1 zero zero u2 ldu2)
  (setf (f2cl-lib:fref u2-%data% (nlp1 1) ((1 ldu2) (1 *)) u2-%offset%)
        one)

```

```

(cond
  (> m n)
  (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
    (> i nlp1) nil)
  (tagbody
    (setf (f2cl-lib:fref vt-%data%
      (m i)
      ((1 ldvt) (1 *))
      vt-%offset%)
      (* (- s)
        (f2cl-lib:fref vt-%data%
          (nlp1 i)
          ((1 ldvt) (1 *))
          vt-%offset%)))
      (setf (f2cl-lib:fref vt2-%data%
        (1 i)
        ((1 ldvt2) (1 *))
        vt2-%offset%)
        (* c
          (f2cl-lib:fref vt-%data%
            (nlp1 i)
            ((1 ldvt) (1 *))
            vt-%offset%))))))
  (f2cl-lib:fdo (i nlp2 (f2cl-lib:int-add i 1))
    (> i m) nil)
  (tagbody
    (setf (f2cl-lib:fref vt2-%data%
      (1 i)
      ((1 ldvt2) (1 *))
      vt2-%offset%)
      (* s
        (f2cl-lib:fref vt-%data%
          (m i)
          ((1 ldvt) (1 *))
          vt-%offset%)))
      (setf (f2cl-lib:fref vt-%data%
        (m i)
        ((1 ldvt) (1 *))
        vt-%offset%)
        (* c
          (f2cl-lib:fref vt-%data%
            (m i)
            ((1 ldvt) (1 *))
            vt-%offset%))))))
  (t
    (dcopy m

```

```

(f2cl-lib:array-slice vt double-float (nlp1 1) ((1 ldvt) (1 *)))
ldvt
(f2cl-lib:array-slice vt2 double-float (1 1) ((1 ldvt2) (1 *)))
ldvt2)))
(cond
  (> m n)
  (dcopy m
    (f2cl-lib:array-slice vt double-float (m 1) ((1 ldvt) (1 *))) ldvt
    (f2cl-lib:array-slice vt2 double-float (m 1) ((1 ldvt2) (1 *)))
    ldvt2)))
(cond
  (> n k)
  (dcopy (f2cl-lib:int-sub n k)
    (f2cl-lib:array-slice dsigma double-float ((+ k 1)) ((1 *))) 1
    (f2cl-lib:array-slice d double-float ((+ k 1)) ((1 *))) 1)
  (dlacpy "A" n (f2cl-lib:int-sub n k)
    (f2cl-lib:array-slice u2
      double-float
      (1 (f2cl-lib:int-add k 1))
      ((1 ldu2) (1 *)))

    ldu2
    (f2cl-lib:array-slice u
      double-float
      (1 (f2cl-lib:int-add k 1))
      ((1 ldu) (1 *)))

    ldu)
  (dlacpy "A" (f2cl-lib:int-sub n k) m
    (f2cl-lib:array-slice vt2
      double-float
      ((+ k 1) 1)
      ((1 ldvt2) (1 *)))

    ldvt2
    (f2cl-lib:array-slice vt double-float ((+ k 1) 1) ((1 ldvt) (1 *)))
    ldvt)))
(f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
  (> j 4) nil)
(tagbody
  (setf (f2cl-lib:fref coltyp-%data% (j) ((1 *)) coltyp-%offset%)
    (f2cl-lib:fref ctot (j) ((1 4)))))
end_label
(return
  (values nil
    nil
    nil
    k
    nil

```

```
nil
nil
nil
nil
nil
nil
nil
nil
nil
nil
nil
nil
nil
nil
nil
nil
nil
nil
nil
nil
info))))))
```

## 7.57 dlasd3 LAPACK

```
(dlasd3.input)≡
)set break resume
)sys rm -f dlasd3.output
)spool dlasd3.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

`<dlasd3.help>=`

```
=====
dlasd3 examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

DLASD3 - all the square roots of the roots of the secular equation, as defined by the values in D and Z

#### SYNOPSIS

```
SUBROUTINE DLASD3( NL, NR, SQRE, K, D, Q, LDQ, DSIGMA, U, LDU, U2,
                  LDU2, VT, LDVT, VT2, LDVT2, IDXC, CTOT, Z, INFO )
```

```
      INTEGER      INFO, K, LDQ, LDU, LDU2, LDVT, LDVT2, NL, NR, SQRE
```

```
      INTEGER      CTOT( * ), IDXC( * )
```

```
      DOUBLE      PRECISION D( * ), DSIGMA( * ), Q( LDQ, * ), U( LDU,
* ), U2( LDU2, * ), VT( LDVT, * ), VT2( LDVT2, * ),
Z( * )
```

#### PURPOSE

DLASD3 finds all the square roots of the roots of the secular equation, as defined by the values in D and Z. It makes the appropriate calls to DLASD4 and then updates the singular vectors by matrix multiplication.

This code makes very mild assumptions about floating point arithmetic. It will work on machines with a guard digit in add/subtract, or on those binary machines without guard digits which subtract like the Cray XMP, Cray YMP, Cray C 90, or Cray 2. It could conceivably fail on hexadecimal or decimal machines without guard digits, but we know of none.

DLASD3 is called from DLASD1.

#### ARGUMENTS

NL (input) INTEGER  
The row dimension of the upper block. NL >= 1.

NR (input) INTEGER  
The row dimension of the lower block. NR >= 1.

**SQRE** (input) INTEGER  
 = 0: the lower block is an NR-by-NR square matrix.  
 = 1: the lower block is an NR-by-(NR+1) rectangular matrix.  
  
 The bidiagonal matrix has  $N = NL + NR + 1$  rows and  $M = N + SQRE$   
 $\geq N$  columns.

**K** (input) INTEGER  
 The size of the secular equation,  $1 \leq K \leq N$ .

**D** (output) DOUBLE PRECISION array, dimension(K)  
 On exit the square roots of the roots of the secular equation,  
 in ascending order.

**Q** (workspace) DOUBLE PRECISION array,  
 dimension at least (LDQ,K).

**LDQ** (input) INTEGER  
 The leading dimension of the array Q.  $LDQ \geq K$ .

**DSIGMA** (input) DOUBLE PRECISION array, dimension(K) The first K  
 elements of this array contain the old roots of the deflated  
 updating problem. These are the poles of the secular equation.

**U** (output) DOUBLE PRECISION array, dimension (LDU, N)  
 The last  $N - K$  columns of this matrix contain the deflated left  
 singular vectors.

**LDU** (input) INTEGER  
 The leading dimension of the array U.  $LDU \geq N$ .

**U2** (input/output) DOUBLE PRECISION array, dimension (LDU2, N)  
 The first K columns of this matrix contain the non-deflated left  
 singular vectors for the split problem.

**LDU2** (input) INTEGER  
 The leading dimension of the array U2.  $LDU2 \geq N$ .

**VT** (output) DOUBLE PRECISION array, dimension (LDVT, M)  
 The last  $M - K$  columns of VT' contain the deflated right singu-  
 lar vectors.

**LDVT** (input) INTEGER  
 The leading dimension of the array VT.  $LDVT \geq N$ .

**VT2** (input/output) DOUBLE PRECISION array, dimension (LDVT2, N)

The first  $K$  columns of  $VT2'$  contain the non-deflated right singular vectors for the split problem.

LDVT2 (input) INTEGER

The leading dimension of the array VT2. LDVT2  $\geq$  N.

IDXC (input) INTEGER array, dimension ( N )

The permutation used to arrange the columns of U (and rows of VT) into three groups: the first group contains non-zero entries only at and above (or before) NL +1; the second contains non-zero entries only at and below (or after) NL+2; and the third is dense. The first column of U and the row of VT are treated separately, however.

The rows of the singular vectors found by DLASD4 must be likewise permuted before the matrix multiplies can take place.

CTOT (input) INTEGER array, dimension ( 4 )

A count of the total number of the various types of columns in U (or rows in VT), as described in IDXC. The fourth column type is any column which has been deflated.

Z (input) DOUBLE PRECISION array, dimension (K)

The first  $K$  elements of this array contain the components of the deflation-adjusted updating row vector.

INFO (output) INTEGER

= 0: successful exit.

< 0: if INFO = -i, the i-th argument had an illegal value.

> 0: if INFO = 1, an singular value did not converge

```

(LAPACK dlasd3)=
  (let* ((one 1.0) (zero 0.0) (negone (- 1.0)))
    (declare (type (double-float 1.0 1.0) one)
              (type (double-float 0.0 0.0) zero)
              (type (double-float) negone))
    (defun dlasd3
      (nl nr sqre k d q ldq dsigma u ldu u2 ldu2 vt ldvt vt2 ldvt2 idxc ctot
       z info)
      (declare (type (simple-array fixnum (*)) ctot idxc)
                (type (simple-array double-float (*)) z vt2 vt u2 u dsigma q d)
                (type fixnum info ldvt2 ldvt ldu2 ldu ldq k sqre nr
                        nl))
      (f2cl-lib:with-multi-array-data
        ((d double-float d-%data% d-%offset%)
         (q double-float q-%data% q-%offset%)
         (dsigma double-float dsigma-%data% dsigma-%offset%)
         (u double-float u-%data% u-%offset%)
         (u2 double-float u2-%data% u2-%offset%)
         (vt double-float vt-%data% vt-%offset%)
         (vt2 double-float vt2-%data% vt2-%offset%)
         (z double-float z-%data% z-%offset%)
         (idxc fixnum idxc-%data% idxc-%offset%)
         (ctot fixnum ctot-%data% ctot-%offset%))
        (prog ((rho 0.0) (temp 0.0) (ctemp 0) (i 0) (j 0) (jc 0) (ktemp 0) (m 0)
              (n 0) (nlp1 0) (nlp2 0) (nrp1 0))
          (declare (type (double-float) rho temp)
                    (type fixnum ctemp i j jc ktemp m n nlp1 nlp2
                            nrp1))

          (setf info 0)
          (cond
            ((< nl 1)
              (setf info -1))
            ((< nr 1)
              (setf info -2))
            ((and (/= sqre 1) (/= sqre 0))
              (setf info -3)))
          (setf n (f2cl-lib:int-add nl nr 1))
          (setf m (f2cl-lib:int-add n sqre))
          (setf nlp1 (f2cl-lib:int-add nl 1))
          (setf nlp2 (f2cl-lib:int-add nl 2))
          (cond
            ((or (< k 1) (> k n))
              (setf info -4))
            ((< ldq k)
              (setf info -7))
            ((< ldu n)

```



```

      (setf info -10))
    (< ldu2 n)
    (setf info -12))
    (< ldvt m)
    (setf info -14))
    (< ldvt2 m)
    (setf info -16)))
  (cond
    ((/= info 0)
     (error
      " ** On entry to ~a parameter number ~a had an illegal value~%"
      "DLASD3" (f2cl-lib:int-sub info))
     (go end_label)))
  (cond
    ((= k 1)
     (setf (f2cl-lib:fref d-%data% (1) ((1 *)) d-%offset%)
           (abs (f2cl-lib:fref z-%data% (1) ((1 *)) z-%offset%)))
     (dcopy m
      (f2cl-lib:array-slice vt2 double-float (1 1) ((1 ldvt2) (1 *)))
      ldvt2 (f2cl-lib:array-slice vt double-float (1 1) ((1 ldvt) (1 *)))
      ldvt)
     (cond
      ((> (f2cl-lib:fref z (1) ((1 *))) zero)
       (dcopy n
        (f2cl-lib:array-slice u2 double-float (1 1) ((1 ldu2) (1 *))) 1
        (f2cl-lib:array-slice u double-float (1 1) ((1 ldu) (1 *))) 1))
      (t
       (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                     (> i n) nil)
       (tagbody
        (setf (f2cl-lib:fref u-%data%
                           (i 1)
                           ((1 ldu) (1 *))
                           u-%offset%)
              (-
               (f2cl-lib:fref u2-%data%
                           (i 1)
                           ((1 ldu2) (1 *))
                           u2-%offset%))))))
      (go end_label)))
    (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                  (> i k) nil)
    (tagbody
     (setf (f2cl-lib:fref dsigma-%data% (i) ((1 *)) dsigma-%offset%)
           (-
            (multiple-value-bind (ret-val var-0 var-1)

```

```

(dlamc3
  (f2cl-lib:fref dsigma-%data%
    (i)
    ((1 *))
    dsigma-%offset%)
  (f2cl-lib:fref dsigma-%data%
    (i)
    ((1 *))
    dsigma-%offset%))
(declare (ignore))
(setf (f2cl-lib:fref dsigma-%data%
  (i)
  ((1 *))
  dsigma-%offset%)
  var-0)
(setf (f2cl-lib:fref dsigma-%data%
  (i)
  ((1 *))
  dsigma-%offset%)
  var-1)
ret-val)
(f2cl-lib:fref dsigma-%data%
  (i)
  ((1 *))
  dsigma-%offset%))))))
(dcopy k z 1 q 1)
(setf rho (dnrm2 k z 1))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9)
  (dlascl "G" 0 0 rho one k 1 z k info)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
    var-8))
  (setf info var-9))
(setf rho (* rho rho))
(f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
  (> j k) nil)
(tagbody
  (multiple-value-bind
    (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8)
    (dlasd4 k j dsigma z
      (f2cl-lib:array-slice u double-float (1 j) ((1 ldu) (1 *)))
      rho (f2cl-lib:fref d-%data% (j) ((1 *)) d-%offset%)
      (f2cl-lib:array-slice vt double-float (1 j) ((1 ldvt) (1 *)))
      info)
    (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-7))
    (setf (f2cl-lib:fref d-%data% (j) ((1 *)) d-%offset%) var-6)

```

```

      (setf info var-8))
    (cond
      ((/= info 0)
       (go end_label))))
    (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
      ((> i k) nil)
    (tagbody
      (setf (f2cl-lib:fref z-%data% (i) ((1 *)) z-%offset%)
        (*
          (f2cl-lib:fref u-%data% (i k) ((1 ldu) (1 *)) u-%offset%)
          (f2cl-lib:fref vt-%data%
            (i k)
            ((1 ldvt) (1 *))
            vt-%offset%)))
      (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
        ((> j (f2cl-lib:int-add i (f2cl-lib:int-sub 1))) nil)
      (tagbody
        (setf (f2cl-lib:fref z-%data% (i) ((1 *)) z-%offset%)
          (* (f2cl-lib:fref z-%data% (i) ((1 *)) z-%offset%)
            (/
              (/
                (*
                  (f2cl-lib:fref u-%data%
                    (i j)
                    ((1 ldu) (1 *))
                    u-%offset%)
                  (f2cl-lib:fref vt-%data%
                    (i j)
                    ((1 ldvt) (1 *))
                    vt-%offset%))
                (-
                  (f2cl-lib:fref dsigma-%data%
                    (i)
                    ((1 *))
                    dsigma-%offset%)
                  (f2cl-lib:fref dsigma-%data%
                    (j)
                    ((1 *))
                    dsigma-%offset%)))
              (+
                (f2cl-lib:fref dsigma-%data%
                  (i)
                  ((1 *))
                  dsigma-%offset%)
                (f2cl-lib:fref dsigma-%data%
                  (j)

```

```

((1 *))
dsigma-%offset%))))))
(f2cl-lib:fdo (j i (f2cl-lib:int-add j 1))
  ((> j (f2cl-lib:int-add k (f2cl-lib:int-sub 1))) nil)
(tagbody
  (setf (f2cl-lib:fref z-%data% (i) ((1 *)) z-%offset%)
    (* (f2cl-lib:fref z-%data% (i) ((1 *)) z-%offset%)
      (/
        (/
          (*
            (f2cl-lib:fref u-%data%
              (i j)
              ((1 ldu) (1 *))
              u-%offset%)
            (f2cl-lib:fref vt-%data%
              (i j)
              ((1 ldvt) (1 *))
              vt-%offset%))
          (-
            (f2cl-lib:fref dsigma-%data%
              (i)
              ((1 *))
              dsigma-%offset%)
            (f2cl-lib:fref dsigma-%data%
              ((f2cl-lib:int-add j 1))
              ((1 *))
              dsigma-%offset%)))
          (+
            (f2cl-lib:fref dsigma-%data%
              (i)
              ((1 *))
              dsigma-%offset%)
            (f2cl-lib:fref dsigma-%data%
              ((f2cl-lib:int-add j 1))
              ((1 *))
              dsigma-%offset%))))))
  (setf (f2cl-lib:fref z-%data% (i) ((1 *)) z-%offset%)
    (f2cl-lib:sign
      (f2cl-lib:fsqrt
        (abs (f2cl-lib:fref z-%data% (i) ((1 *)) z-%offset%)))
      (f2cl-lib:fref q-%data%
        (i 1)
        ((1 ldq) (1 *))
        q-%offset%))))))
(f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
  ((> i k) nil)

```

```

(tagbody
  (setf (f2cl-lib:fref vt-%data% (1 i) ((1 ldvt) (1 *)) vt-%offset%)
    (/
      (/ (f2cl-lib:fref z-%data% (1) ((1 *)) z-%offset%)
        (f2cl-lib:fref u-%data%
          (1 i)
          ((1 ldu) (1 *))
          u-%offset%))
      (f2cl-lib:fref vt-%data%
        (1 i)
        ((1 ldvt) (1 *))
        vt-%offset%)))
  (setf (f2cl-lib:fref u-%data% (1 i) ((1 ldu) (1 *)) u-%offset%)
    negone)
  (f2cl-lib:fdo (j 2 (f2cl-lib:int-add j 1))
    ((> j k) nil)
    (tagbody
      (setf (f2cl-lib:fref vt-%data%
        (j i)
        ((1 ldvt) (1 *))
        vt-%offset%)
        (/
          (/ (f2cl-lib:fref z-%data% (j) ((1 *)) z-%offset%)
            (f2cl-lib:fref u-%data%
              (j i)
              ((1 ldu) (1 *))
              u-%offset%))
          (f2cl-lib:fref vt-%data%
            (j i)
            ((1 ldvt) (1 *))
            vt-%offset%)))
      (setf (f2cl-lib:fref u-%data% (j i) ((1 ldu) (1 *)) u-%offset%)
        (*
          (f2cl-lib:fref dsigma-%data%
            (j)
            ((1 *))
            dsigma-%offset%)
          (f2cl-lib:fref vt-%data%
            (j i)
            ((1 ldvt) (1 *))
            vt-%offset%))))))
  (setf temp
    (dnrm2 k
      (f2cl-lib:array-slice u
        double-float
        (1 i)

```

```

((1 ldu) (1 *)))
1))
(setf (f2cl-lib:fref q-%data% (1 i) ((1 ldq) (1 *)) q-%offset%)
(/
(f2cl-lib:fref u-%data% (1 i) ((1 ldu) (1 *)) u-%offset%)
temp))
(f2cl-lib:fdo (j 2 (f2cl-lib:int-add j 1))
(> j k) nil)
(tagbody
(setf jc (f2cl-lib:fref idxc-%data% (j) ((1 *)) idxc-%offset%))
(setf (f2cl-lib:fref q-%data% (j i) ((1 ldq) (1 *)) q-%offset%)
(/
(f2cl-lib:fref u-%data%
(jc i)
((1 ldu) (1 *))
u-%offset%)
temp))))))
(cond
(= k 2)
(dgemm "N" "N" n k k one u2 ldu2 q ldq zero u ldu)
(go label100)))
(cond
(> (f2cl-lib:fref ctot (1) ((1 *))) 0)
(dgemm "N" "N" nl k
(f2cl-lib:fref ctot-%data% (1) ((1 *)) ctot-%offset%) one
(f2cl-lib:array-slice u2 double-float (1 2) ((1 ldu2) (1 *))) ldu2
(f2cl-lib:array-slice q double-float (2 1) ((1 ldq) (1 *))) ldq
zero (f2cl-lib:array-slice u double-float (1 1) ((1 ldu) (1 *)))
ldu)
(cond
(> (f2cl-lib:fref ctot (3) ((1 *))) 0)
(setf ktemp
(f2cl-lib:int-add 2
(f2cl-lib:fref ctot-%data%
(1)
((1 *))
ctot-%offset%)
(f2cl-lib:fref ctot-%data%
(2)
((1 *))
ctot-%offset%)))
(dgemm "N" "N" nl k
(f2cl-lib:fref ctot-%data% (3) ((1 *)) ctot-%offset%) one
(f2cl-lib:array-slice u2
double-float
(1 ktemp)

```

```

((1 ldu2) (1 *)))
ldu2
(f2cl-lib:array-slice q double-float (ktemp 1) ((1 ldq) (1 *)))
ldq one
(f2cl-lib:array-slice u double-float (1 1) ((1 ldu) (1 *)))
ldu)))
((> (f2cl-lib:fref ctot (3) ((1 *))) 0)
(setf ktemp
  (f2cl-lib:int-add 2
    (f2cl-lib:fref ctot-%data%
      (1)
      ((1 *))
      ctot-%offset%)
    (f2cl-lib:fref ctot-%data%
      (2)
      ((1 *))
      ctot-%offset%)))
(dgemm "N" "N" nl k
  (f2cl-lib:fref ctot-%data% (3) ((1 *)) ctot-%offset%) one
  (f2cl-lib:array-slice u2 double-float (1 ktemp) ((1 ldu2) (1 *)))
  ldu2
  (f2cl-lib:array-slice q double-float (ktemp 1) ((1 ldq) (1 *))) ldq
  zero (f2cl-lib:array-slice u double-float (1 1) ((1 ldu) (1 *)))
  ldu))
(t
  (dlacpy "F" nl k u2 ldu2 u ldu)))
(dcopy k (f2cl-lib:array-slice q double-float (1 1) ((1 ldq) (1 *)))
  ldq (f2cl-lib:array-slice u double-float (nlp1 1) ((1 ldu) (1 *)))
  ldu)
(setf ktemp
  (f2cl-lib:int-add 2
    (f2cl-lib:fref ctot-%data%
      (1)
      ((1 *))
      ctot-%offset%)))
(setf ctemp
  (f2cl-lib:int-add
    (f2cl-lib:fref ctot-%data% (2) ((1 *)) ctot-%offset%)
    (f2cl-lib:fref ctot-%data% (3) ((1 *)) ctot-%offset%)))
(dgemm "N" "N" nr k ctemp one
  (f2cl-lib:array-slice u2 double-float (nlp2 ktemp) ((1 ldu2) (1 *)))
  ldu2 (f2cl-lib:array-slice q double-float (ktemp 1) ((1 ldq) (1 *)))
  ldq zero
  (f2cl-lib:array-slice u double-float (nlp2 1) ((1 ldu) (1 *))) ldu)
label100
(f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))

```

```

        (> i k) nil)
(tagbody
  (setf temp
    (dnrm2 k
      (f2cl-lib:array-slice vt
        double-float
        (1 i)
        ((1 ldvt) (1 *)))
      1))
  (setf (f2cl-lib:fref q-%data% (i 1) ((1 ldq) (1 *)) q-%offset%)
    (/
      (f2cl-lib:fref vt-%data%
        (1 i)
        ((1 ldvt) (1 *))
        vt-%offset%)
      temp))
  (f2cl-lib:fdo (j 2 (f2cl-lib:int-add j 1))
    (> j k) nil)
  (tagbody
    (setf jc (f2cl-lib:fref idxc-%data% (j) ((1 *)) idxc-%offset%))
    (setf (f2cl-lib:fref q-%data% (i j) ((1 ldq) (1 *)) q-%offset%)
      (/
        (f2cl-lib:fref vt-%data%
          (jc i)
          ((1 ldvt) (1 *))
          vt-%offset%)
        temp))))))
(cond
  (= k 2)
  (dgemm "N" "N" k m k one q ldq vt2 ldvt2 zero vt ldvt)
  (go end_label)))
(setf ktemp
  (f2cl-lib:int-add 1
    (f2cl-lib:fref ctot-%data%
      (1)
      ((1 *))
      ctot-%offset%)))
(dgemm "N" "N" k nlp1 ktemp one
  (f2cl-lib:array-slice q double-float (1 1) ((1 ldq) (1 *))) ldq
  (f2cl-lib:array-slice vt2 double-float (1 1) ((1 ldvt2) (1 *))) ldvt2
  zero (f2cl-lib:array-slice vt double-float (1 1) ((1 ldvt) (1 *)))
  ldvt)
(setf ktemp
  (f2cl-lib:int-add 2
    (f2cl-lib:fref ctot-%data%
      (1)

```



```

((1 *))
ctot-%offset%)
(f2cl-lib:fref ctot-%data%
(2)
((1 *))
ctot-%offset%)))

(if (<= ktemp ldvt2)
  (dgemm "N" "N" k nlp1
    (f2cl-lib:fref ctot-%data% (3) ((1 *)) ctot-%offset%) one
    (f2cl-lib:array-slice q double-float (1 ktemp) ((1 ldq) (1 *)))
    ldq
    (f2cl-lib:array-slice vt2
      double-float
      (ktemp 1)
      ((1 ldvt2) (1 *)))

    ldvt2 one
    (f2cl-lib:array-slice vt double-float (1 1) ((1 ldvt) (1 *)))
    ldvt))
(setf ktemp
  (f2cl-lib:int-add
    (f2cl-lib:int-add
      (f2cl-lib:fref ctot-%data% (1) ((1 *)) ctot-%offset%)
      1))
(setf nrp1 (f2cl-lib:int-add nr sqre))
(cond
  (> ktemp 1)
  (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
    (> i k) nil)
  (tagbody
    (setf (f2cl-lib:fref q-%data%
      (i ktemp)
      ((1 ldq) (1 *))
      q-%offset%)
      (f2cl-lib:fref q-%data%
        (i 1)
        ((1 ldq) (1 *))
        q-%offset%))))
(f2cl-lib:fdo (i nlp2 (f2cl-lib:int-add i 1))
  (> i m) nil)
(tagbody
  (setf (f2cl-lib:fref vt2-%data%
    (ktemp i)
    ((1 ldvt2) (1 *))
    vt2-%offset%)
    (f2cl-lib:fref vt2-%data%
      (1 i)
      ((1 ldvt2) (1 *)))

```



## 7.58 dlasd4 LAPACK

```
<dlasd4.input>=  
  )set break resume  
  )sys rm -f dlasd4.output  
  )spool dlasd4.output  
  )set message test on  
  )set message auto off  
  )clear all  
  
  )spool  
  )lisp (bye)
```

`<dlasd4.help>=`

```
=====
dlasd4 examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

DLASD4 - compute the square root of the I-th updated eigenvalue of a positive symmetric rank-one modification to a positive diagonal matrix whose entries are given as the squares of the corresponding entries in the array d, and that  $0 \leq D(i) < D(j)$  for  $i < j$  and that  $RHO > 0$

#### SYNOPSIS

```
SUBROUTINE DLASD4( N, I, D, Z, DELTA, RHO, SIGMA, WORK, INFO )
```

```
      INTEGER      I, INFO, N
```

```
      DOUBLE      PRECISION RHO, SIGMA
```

```
      DOUBLE      PRECISION D( * ), DELTA( * ), WORK( * ), Z( * )
```

#### PURPOSE

This subroutine computes the square root of the I-th updated eigenvalue of a positive symmetric rank-one modification to a positive diagonal matrix whose entries are given as the squares of the corresponding entries in the array d, and that no loss in generality. The rank-one modified system is thus

$$\text{diag}(D) * \text{diag}(D) + RHO * Z * Z_{\text{transpose}}.$$

where we assume the Euclidean norm of Z is 1.

The method consists of approximating the rational functions in the secular equation by simpler interpolating rational functions.

#### ARGUMENTS

N (input) INTEGER  
The length of all arrays.

I (input) INTEGER  
The index of the eigenvalue to be computed.  $1 \leq I \leq N$ .

- D** (input) DOUBLE PRECISION array, dimension ( *N* )  
The original eigenvalues. It is assumed that they are in order,  
 $0 \leq D(I) < D(J)$  for  $I < J$ .
- Z** (input) DOUBLE PRECISION array, dimension ( *N* )  
The components of the updating vector.
- DELTA** (output) DOUBLE PRECISION array, dimension ( *N* )  
If *N* .ne. 1, DELTA contains  $(D(j) - \text{sigma\_I})$  in its *j*-th component. If *N* = 1, then DELTA(1) = 1. The vector DELTA contains the information necessary to construct the (singular) eigenvectors.
- RHO** (input) DOUBLE PRECISION  
The scalar in the symmetric updating formula.
- SIGMA** (output) DOUBLE PRECISION  
The computed sigma\_I, the I-th updated eigenvalue.
- WORK** (workspace) DOUBLE PRECISION array, dimension ( *N* )  
If *N* .ne. 1, WORK contains  $(D(j) + \text{sigma\_I})$  in its *j*-th component. If *N* = 1, then WORK( 1 ) = 1.
- INFO** (output) INTEGER  
= 0: successful exit  
> 0: if INFO = 1, the updating process failed.

#### PARAMETERS

Logical variable **ORGATI** (origin-at-i?) is used for distinguishing whether *D(i)* or *D(i+1)* is treated as the origin.

**ORGATI** = .true.    origin at *i*    **ORGATI** = .false.    origin at *i+1*

Logical variable **SWTCH3** (switch-for-3-poles?) is for noting if we are working with THREE poles!

**MAXIT** is the maximum number of iterations allowed for each eigenvalue.

```

(LAPACK dlasd4)=
  (let* ((maxit 20)
        (zero 0.0)
        (one 1.0)
        (two 2.0)
        (three 3.0)
        (four 4.0)
        (eight 8.0)
        (ten 10.0))
    (declare (type (fixnum 20 20) maxit)
              (type (double-float 0.0 0.0) zero)
              (type (double-float 1.0 1.0) one)
              (type (double-float 2.0 2.0) two)
              (type (double-float 3.0 3.0) three)
              (type (double-float 4.0 4.0) four)
              (type (double-float 8.0 8.0) eight)
              (type (double-float 10.0 10.0) ten))
    (defun dlasd4 (n i d z delta rho sigma work info)
      (declare (type (double-float) sigma rho)
                (type (simple-array double-float (*)) work delta z d)
                (type fixnum info i n))
      (f2cl-lib:with-multi-array-data
        ((d double-float d-%data% d-%offset%)
         (z double-float z-%data% z-%offset%)
         (delta double-float delta-%data% delta-%offset%)
         (work double-float work-%data% work-%offset%))
        (prog ((dd (make-array 3 :element-type 'double-float))
               (zz (make-array 3 :element-type 'double-float)) (a 0.0) (b 0.0)
               (c 0.0) (delsq 0.0) (delsq2 0.0) (dphi 0.0) (dpsi 0.0) (dtiim 0.0)
               (dtiip 0.0) (dtipsq 0.0) (dtisq 0.0) (dtnsq 0.0) (dtnsq1 0.0)
               (dw 0.0) (eps 0.0) (erretm 0.0) (eta 0.0) (phi 0.0) (prew 0.0)
               (psi 0.0) (rhoinv 0.0) (sg2lb 0.0) (sg2ub 0.0) (tau 0.0)
               (temp 0.0) (temp1 0.0) (temp2 0.0) (w 0.0) (ii 0) (iim1 0)
               (iip1 0) (ip1 0) (iter 0) (j 0) (niter 0) (orgati nil) (swtch nil)
               (swtch3 nil))
              (declare (type (simple-array double-float (3)) dd zz)
                        (type (double-float) a b c delsq delsq2 dphi dpsi dtiim dtiip
                                dtipsq dtisq dtnsq dtnsq1 dw eps erretm
                                eta phi prew psi rhoinv sg2lb sg2ub tau
                                temp temp1 temp2 w)
                        (type fixnum ii iim1 iip1 ip1 iter j niter)
                        (type (member t nil) orgati swtch swtch3))
              (setf info 0)
              (cond
                ((= n 1)
                 (setf sigma

```

```

(f2cl-lib:fsqrt
(+
  (* (f2cl-lib:fref d-%data% (1) ((1 *)) d-%offset%)
     (f2cl-lib:fref d-%data% (1) ((1 *)) d-%offset%))
  (* rho
     (f2cl-lib:fref z-%data% (1) ((1 *)) z-%offset%)
     (f2cl-lib:fref z-%data% (1) ((1 *)) z-%offset%))))))
(setf (f2cl-lib:fref delta-%data% (1) ((1 *)) delta-%offset%) one)
(setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%) one)
(go end_label)))
(cond
  ((= n 2)
   (multiple-value-bind (var-0 var-1 var-2 var-3 var-4 var-5 var-6)
     (dlasd5 i d z delta rho sigma work)
     (declare (ignore var-0 var-1 var-2 var-3 var-4 var-6))
     (setf sigma var-5)
     (go end_label)))
  (setf eps (dlamch "Epsilon"))
  (setf rhoinv (/ one rho))
  (cond
    ((= i n)
     (setf ii (f2cl-lib:int-sub n 1))
     (setf niter 1)
     (setf temp (/ rho two))
     (setf temp1
        (/ temp
           (+ (f2cl-lib:fref d-%data% (n) ((1 *)) d-%offset%)
              (f2cl-lib:fsqrt
                (+
                  (* (f2cl-lib:fref d-%data% (n) ((1 *)) d-%offset%)
                     (f2cl-lib:fref d-%data% (n) ((1 *)) d-%offset%))
                  temp))))))
     (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
       ((> j n) nil)
       (tagbody
         (setf (f2cl-lib:fref work-%data% (j) ((1 *)) work-%offset%)
              (+ (f2cl-lib:fref d-%data% (j) ((1 *)) d-%offset%)
                 (f2cl-lib:fref d-%data% (n) ((1 *)) d-%offset%)
                 temp1))
         (setf (f2cl-lib:fref delta-%data% (j) ((1 *)) delta-%offset%)
              (- (f2cl-lib:fref d-%data% (j) ((1 *)) d-%offset%)
                 (f2cl-lib:fref d-%data% (n) ((1 *)) d-%offset%)
                 temp1))))
     (setf psi zero)
     (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
       ((> j (f2cl-lib:int-add n (f2cl-lib:int-sub 2))) nil)

```

```

(tagbody
  (setf psi
    (+ psi
      (/
        (* (f2cl-lib:fref z-%data% (j) ((1 *)) z-%offset%)
          (f2cl-lib:fref z-%data% (j) ((1 *)) z-%offset%))
        (*
          (f2cl-lib:fref delta-%data%
            (j)
            ((1 *))
            delta-%offset%)
          (f2cl-lib:fref work-%data%
            (j)
            ((1 *))
            work-%offset%))))))
(setf c (+ rhoinv psi))
(setf w
  (+ c
    (/
      (* (f2cl-lib:fref z-%data% (ii) ((1 *)) z-%offset%)
        (f2cl-lib:fref z-%data% (ii) ((1 *)) z-%offset%))
      (*
        (f2cl-lib:fref delta-%data%
          (ii)
          ((1 *))
          delta-%offset%)
        (f2cl-lib:fref work-%data%
          (ii)
          ((1 *))
          work-%offset%)))
    (/
      (* (f2cl-lib:fref z-%data% (n) ((1 *)) z-%offset%)
        (f2cl-lib:fref z-%data% (n) ((1 *)) z-%offset%))
      (*
        (f2cl-lib:fref delta-%data% (n) ((1 *)) delta-%offset%)
        (f2cl-lib:fref work-%data%
          (n)
          ((1 *))
          work-%offset%))))))
(cond
  ((<= w zero)
    (setf temp1
      (f2cl-lib:fsqrt
        (+
          (* (f2cl-lib:fref d-%data% (n) ((1 *)) d-%offset%)
            (f2cl-lib:fref d-%data% (n) ((1 *)) d-%offset%))

```



```

rho)))
(setf temp
  (+
    (/
      (*
        (f2cl-lib:fref z-%data%
                      ((f2cl-lib:int-sub n 1))
                      ((1 *))
                      z-%offset%)
        (f2cl-lib:fref z-%data%
                      ((f2cl-lib:int-sub n 1))
                      ((1 *))
                      z-%offset%))
      (*
        (+
          (f2cl-lib:fref d-%data%
                        ((f2cl-lib:int-sub n 1))
                        ((1 *))
                        d-%offset%)
          temp1)
        (+
          (- (f2cl-lib:fref d-%data% (n) ((1 *)) d-%offset%)
             (f2cl-lib:fref d-%data%
                           ((f2cl-lib:int-sub n 1))
                           ((1 *))
                           d-%offset%))
          (/ rho
              (+ (f2cl-lib:fref d-%data% (n) ((1 *)) d-%offset%)
                  temp1))))))
    (/
      (* (f2cl-lib:fref z-%data% (n) ((1 *)) z-%offset%)
         (f2cl-lib:fref z-%data% (n) ((1 *)) z-%offset%))
      rho)))
(cond
  ((=< c temp)
   (setf tau rho))
  (t
   (setf delsq
     (*
       (- (f2cl-lib:fref d-%data% (n) ((1 *)) d-%offset%)
          (f2cl-lib:fref d-%data%
                        ((f2cl-lib:int-sub n 1))
                        ((1 *))
                        d-%offset%))
       (+ (f2cl-lib:fref d-%data% (n) ((1 *)) d-%offset%)
          (f2cl-lib:fref d-%data%
                        ((f2cl-lib:int-sub n 1))
                        ((1 *))
                        d-%offset%))
       delsq))))

```

```

((f2cl-lib:int-sub n 1))
((1 *))
d-%offset%))))
(setf a
  (+ (* (- c) delsq)
    (*
      (f2cl-lib:fref z-%data%
        ((f2cl-lib:int-sub n 1))
        ((1 *))
        z-%offset%)
      (f2cl-lib:fref z-%data%
        ((f2cl-lib:int-sub n 1))
        ((1 *))
        z-%offset%))
    (* (f2cl-lib:fref z-%data% (n) ((1 *)) z-%offset%)
      (f2cl-lib:fref z-%data%
        (n)
        ((1 *))
        z-%offset%))))))
(setf b
  (* (f2cl-lib:fref z-%data% (n) ((1 *)) z-%offset%)
    (f2cl-lib:fref z-%data% (n) ((1 *)) z-%offset%)
    delsq))
(cond
  ((< a zero)
    (setf tau
      (/ (* two b)
        (- (f2cl-lib:fsqrt (+ (* a a) (* four b c)))
          a))))
  (t
    (setf tau
      (/ (+ a (f2cl-lib:fsqrt (+ (* a a) (* four b c))))
        (* two c))))))
(t
  (setf delsq
    (*
      (- (f2cl-lib:fref d-%data% (n) ((1 *)) d-%offset%)
        (f2cl-lib:fref d-%data%
          ((f2cl-lib:int-sub n 1))
          ((1 *))
          d-%offset%))
      (+ (f2cl-lib:fref d-%data% (n) ((1 *)) d-%offset%)
        (f2cl-lib:fref d-%data%
          ((f2cl-lib:int-sub n 1))
          ((1 *))
          d-%offset%))))))

```

```

(setf a
  (+ (* (- c) delsq)
    (*
      (f2cl-lib:fref z-%data%
        ((f2cl-lib:int-sub n 1))
        ((1 *))
        z-%offset%)
      (f2cl-lib:fref z-%data%
        ((f2cl-lib:int-sub n 1))
        ((1 *))
        z-%offset%))
    (* (f2cl-lib:fref z-%data% (n) ((1 *)) z-%offset%)
      (f2cl-lib:fref z-%data% (n) ((1 *)) z-%offset%))))
(setf b
  (* (f2cl-lib:fref z-%data% (n) ((1 *)) z-%offset%)
    (f2cl-lib:fref z-%data% (n) ((1 *)) z-%offset%)
    delsq))
(cond
  ((< a zero)
    (setf tau
      (/ (* two b)
        (- (f2cl-lib:fsqrt (+ (* a a) (* four b c))) a))))
  (t
    (setf tau
      (/ (+ a (f2cl-lib:fsqrt (+ (* a a) (* four b c))))
        (* two c))))))
(setf eta
  (/ tau
    (+ (f2cl-lib:fref d-%data% (n) ((1 *)) d-%offset%)
      (f2cl-lib:fsqrt
        (+
          (* (f2cl-lib:fref d-%data% (n) ((1 *)) d-%offset%)
            (f2cl-lib:fref d-%data% (n) ((1 *)) d-%offset%))
          tau))))))
(setf sigma (+ (f2cl-lib:fref d-%data% (n) ((1 *)) d-%offset%) eta))
(f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
  ((> j n) nil)
  (tagbody
    (setf (f2cl-lib:fref delta-%data% (j) ((1 *)) delta-%offset%)
      (- (f2cl-lib:fref d-%data% (j) ((1 *)) d-%offset%)
        (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%)
        eta))
    (setf (f2cl-lib:fref work-%data% (j) ((1 *)) work-%offset%)
      (+ (f2cl-lib:fref d-%data% (j) ((1 *)) d-%offset%)
        (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%)
        eta))))

```

```

(setf dpsi zero)
(setf psi zero)
(setf erretm zero)
(f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
  ((> j ii) nil)
  (tagbody
    (setf temp
      (/ (f2cl-lib:fref z-%data% (j) ((1 *)) z-%offset%)
        (*
          (f2cl-lib:fref delta-%data%
            (j)
            ((1 *))
            delta-%offset%)
          (f2cl-lib:fref work-%data%
            (j)
            ((1 *))
            work-%offset%))))))
    (setf psi
      (+ psi
        (* (f2cl-lib:fref z-%data% (j) ((1 *)) z-%offset%)
          temp)))
    (setf dpsi (+ dpsi (* temp temp)))
    (setf erretm (+ erretm psi))))
(setf erretm (abs erretm))
(setf temp
  (/ (f2cl-lib:fref z-%data% (n) ((1 *)) z-%offset%)
    (*
      (f2cl-lib:fref delta-%data% (n) ((1 *)) delta-%offset%)
      (f2cl-lib:fref work-%data% (n) ((1 *)) work-%offset%))))
(setf phi (* (f2cl-lib:fref z-%data% (n) ((1 *)) z-%offset%) temp))
(setf dphi (* temp temp))
(setf erretm
  (+ (- (+ (* eight (- (- psi) phi)) erretm) phi)
    rhoinv
    (* (abs tau) (+ dpsi dphi))))
(setf w (+ rhoinv phi psi))
(cond
  ((<= (abs w) (* eps erretm))
    (go end_label)))
(setf niter (f2cl-lib:int-add niter 1))
(setf dtnsq1
  (*
    (f2cl-lib:fref work-%data%
      ((f2cl-lib:int-sub n 1))
      ((1 *))
      work-%offset%))

```

```

(f2cl-lib:fref delta-%data%
  ((f2cl-lib:int-sub n 1))
  ((1 *))
  delta-%offset%)))
(setf dtnsq
  (* (f2cl-lib:fref work-%data% (n) ((1 *)) work-%offset%)
     (f2cl-lib:fref delta-%data% (n) ((1 *)) delta-%offset%)))
(setf c (- w (* dtnsq1 dps1) (* dtnsq dphi)))
(setf a
  (+ (* (+ dtnsq dtnsq1) w)
     (* (- dtnsq) dtnsq1 (+ dps1 dphi))))
(setf b (* dtnsq dtnsq1 w))
(if (< c zero) (setf c (abs c)))
(cond
  ((= c zero)
   (setf eta (- rho (* sigma sigma))))
  ((>= a zero)
   (setf eta
    (/
     (+ a
      (f2cl-lib:fsqrt (abs (+ (* a a) (* (- four) b c))))))
     (* two c))))
  (t
   (setf eta
    (/ (* two b)
       (- a
        (f2cl-lib:fsqrt
         (abs (+ (* a a) (* (- four) b c))))))))))
(if (> (* w eta) zero) (setf eta (/ (- w) (+ dps1 dphi))))
(setf temp (- eta dtnsq))
(if (> temp rho) (setf eta (+ rho dtnsq)))
(setf tau (+ tau eta))
(setf eta (/ eta (+ sigma (f2cl-lib:fsqrt (+ eta (* sigma sigma)))))
(f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
  ((> j n) nil)
  (tagbody
    (setf (f2cl-lib:fref delta-%data% (j) ((1 *)) delta-%offset%)
      (-
        (f2cl-lib:fref delta-%data% (j) ((1 *)) delta-%offset%)
        eta))
    (setf (f2cl-lib:fref work-%data% (j) ((1 *)) work-%offset%)
      (+ (f2cl-lib:fref work-%data% (j) ((1 *)) work-%offset%)
         eta))))
(setf sigma (+ sigma eta))
(setf dps1 zero)
(setf psi zero)

```

```

(setf erretm zero)
(f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
  (> j ii) nil)
(tagbody
  (setf temp
    (/ (f2cl-lib:fref z-%data% (j) ((1 *)) z-%offset%)
      (*
        (f2cl-lib:fref work-%data%
          (j)
          ((1 *))
          work-%offset%)
        (f2cl-lib:fref delta-%data%
          (j)
          ((1 *))
          delta-%offset%))))))
(setf psi
  (+ psi
    (* (f2cl-lib:fref z-%data% (j) ((1 *)) z-%offset%)
      temp)))
(setf dpsi (+ dpsi (* temp temp)))
(setf erretm (+ erretm psi)))
(setf erretm (abs erretm))
(setf temp
  (/ (f2cl-lib:fref z-%data% (n) ((1 *)) z-%offset%)
    (* (f2cl-lib:fref work-%data% (n) ((1 *)) work-%offset%)
      (f2cl-lib:fref delta-%data%
        (n)
        ((1 *))
        delta-%offset%))))))
(setf phi (* (f2cl-lib:fref z-%data% (n) ((1 *)) z-%offset%) temp))
(setf dphi (* temp temp))
(setf erretm
  (+ (- (+ (* eight (- (- psi) phi)) erretm) phi)
    rhoinv
    (* (abs tau) (+ dpsi dphi))))
(setf w (+ rhoinv phi psi))
(setf iter (f2cl-lib:int-add niter 1))
(f2cl-lib:fdo (niter iter (f2cl-lib:int-add niter 1))
  (> niter maxit) nil)
(tagbody
  (cond
    ((<= (abs w) (* eps erretm))
      (go end_label)))
  (setf dtnsq1
    (*
      (f2cl-lib:fref work-%data%

```

```

((f2cl-lib:int-sub n 1))
((1 *))
work-%offset%)
(f2cl-lib:fref delta-%data%
((f2cl-lib:int-sub n 1))
((1 *))
delta-%offset%)))
(setf dtnsq
  (* (f2cl-lib:fref work-%data% (n) ((1 *)) work-%offset%)
     (f2cl-lib:fref delta-%data%
                     (n)
                     ((1 *))
                     delta-%offset%)))
  (setf c (- w (* dtnsq1 dpsi) (* dtnsq dphi)))
  (setf a
    (+ (* (+ dtnsq dtnsq1) w)
       (* (- dtnsq1) dtnsq (+ dpsi dphi))))
  (setf b (* dtnsq1 dtnsq w))
  (cond
    ((>= a zero)
     (setf eta
       (/
        (+ a
          (f2cl-lib:fsqrt
            (abs (+ (* a a) (* (- four) b c))))))
        (* two c))))
    (t
     (setf eta
       (/ (* two b)
          (- a
            (f2cl-lib:fsqrt
              (abs (+ (* a a) (* (- four) b c))))))))
    (if (> (* w eta) zero) (setf eta (/ (- w) (+ dpsi dphi))))
    (setf temp (- eta dtnsq))
    (if (<= temp zero) (setf eta (/ eta two)))
    (setf tau (+ tau eta))
    (setf eta
      (/ eta
        (+ sigma (f2cl-lib:fsqrt (+ eta (* sigma sigma))))))
    (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
      ((> j n) nil)
      (tagbody
        (setf (f2cl-lib:fref delta-%data%
                             (j)
                             ((1 *))
                             delta-%offset%)

```

```

(-
  (f2cl-lib:fref delta-%data%
    (j)
    ((1 *))
    delta-%offset%)
  eta))
(setf (f2cl-lib:fref work-%data% (j) ((1 *)) work-%offset%)
  (+
    (f2cl-lib:fref work-%data%
      (j)
      ((1 *))
      work-%offset%)
    eta))))
(setf sigma (+ sigma eta))
(setf dpsl zero)
(setf psi zero)
(setf erretm zero)
(f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
  (> j ii) nil)
(tagbody
  (setf temp
    (/ (f2cl-lib:fref z-%data% (j) ((1 *)) z-%offset%)
      (*
        (f2cl-lib:fref work-%data%
          (j)
          ((1 *))
          work-%offset%)
        (f2cl-lib:fref delta-%data%
          (j)
          ((1 *))
          delta-%offset%))))))
(setf psi
  (+ psi
    (*
      (f2cl-lib:fref z-%data% (j) ((1 *)) z-%offset%)
      temp)))
(setf dpsl (+ dpsl (* temp temp)))
(setf erretm (+ erretm psi)))
(setf erretm (abs erretm))
(setf temp
  (/ (f2cl-lib:fref z-%data% (n) ((1 *)) z-%offset%)
    (*
      (f2cl-lib:fref work-%data%
        (n)
        ((1 *))
        work-%offset%)

```



```

(f2cl-lib:fref delta-%data%
  (n)
  ((1 *))
  delta-%offset%))))
(setf phi
  (* (f2cl-lib:fref z-%data% (n) ((1 *)) z-%offset%)
    temp))
(setf dphi (* temp temp))
(setf erretm
  (+ (- (+ (* eight (- (- psi) phi)) erretm) phi)
    rhoinv
    (* (abs tau) (+ dpsd dphi))))
(setf w (+ rhoinv phi psi)))
(setf info 1)
(go end_label))
(t
  (setf niter 1)
  (setf ip1 (f2cl-lib:int-add i 1))
  (setf delsq
    (*
      (- (f2cl-lib:fref d-%data% (ip1) ((1 *)) d-%offset%)
        (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%))
      (+ (f2cl-lib:fref d-%data% (ip1) ((1 *)) d-%offset%)
        (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%))))
  (setf delsq2 (/ delsq two))
  (setf temp
    (/ delsq2
      (+ (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%)
        (f2cl-lib:fsqrt
          (+
            (* (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%)
              (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%))
            delsq2))))))
  (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
    ((> j n) nil)
    (tagbody
      (setf (f2cl-lib:fref work-%data% (j) ((1 *)) work-%offset%)
        (+ (f2cl-lib:fref d-%data% (j) ((1 *)) d-%offset%)
          (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%)
          temp))
      (setf (f2cl-lib:fref delta-%data% (j) ((1 *)) delta-%offset%)
        (- (f2cl-lib:fref d-%data% (j) ((1 *)) d-%offset%)
          (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%)
          temp))))
  (setf psi zero)
  (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))

```

```

(<=> j (f2cl-lib:int-add i (f2cl-lib:int-sub 1))) nil)
  (tagbody
    (setf psi
      (+ psi
        (/
          (* (f2cl-lib:fref z-%data% (j) ((1 *)) z-%offset%)
             (f2cl-lib:fref z-%data% (j) ((1 *)) z-%offset%))
          (*
            (f2cl-lib:fref work-%data%
                          (j)
                          ((1 *))
                          work-%offset%)
            (f2cl-lib:fref delta-%data%
                          (j)
                          ((1 *))
                          delta-%offset%))))))))
(setf phi zero)
(f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
  (<=> j (f2cl-lib:int-add i 2)) nil)
  (tagbody
    (setf phi
      (+ phi
        (/
          (* (f2cl-lib:fref z-%data% (j) ((1 *)) z-%offset%)
             (f2cl-lib:fref z-%data% (j) ((1 *)) z-%offset%))
          (*
            (f2cl-lib:fref work-%data%
                          (j)
                          ((1 *))
                          work-%offset%)
            (f2cl-lib:fref delta-%data%
                          (j)
                          ((1 *))
                          delta-%offset%))))))))
(setf c (+ rhoinv psi phi))
(setf w
  (+ c
    (/
      (* (f2cl-lib:fref z-%data% (i) ((1 *)) z-%offset%)
         (f2cl-lib:fref z-%data% (i) ((1 *)) z-%offset%))
      (* (f2cl-lib:fref work-%data% (i) ((1 *)) work-%offset%)
         (f2cl-lib:fref delta-%data%
                       (i)
                       ((1 *))
                       delta-%offset%))))
    (/

```

```

(* (f2cl-lib:fref z-%data% (ip1) ((1 *)) z-%offset%)
  (f2cl-lib:fref z-%data% (ip1) ((1 *)) z-%offset%))
(*
  (f2cl-lib:fref work-%data% (ip1) ((1 *)) work-%offset%)
  (f2cl-lib:fref delta-%data%
    (ip1)
    ((1 *))
    delta-%offset%))))))
(cond
  (> w zero)
  (setf orgati t)
  (setf sg2lb zero)
  (setf sg2ub delsq2)
  (setf a
    (+ (* c delsq)
      (* (f2cl-lib:fref z-%data% (i) ((1 *)) z-%offset%)
        (f2cl-lib:fref z-%data% (i) ((1 *)) z-%offset%))
      (* (f2cl-lib:fref z-%data% (ip1) ((1 *)) z-%offset%)
        (f2cl-lib:fref z-%data% (ip1) ((1 *)) z-%offset%))))))
  (setf b
    (* (f2cl-lib:fref z-%data% (i) ((1 *)) z-%offset%)
      (f2cl-lib:fref z-%data% (i) ((1 *)) z-%offset%)
      delsq))
  (cond
    (> a zero)
    (setf tau
      (/ (* two b)
        (+ a
          (f2cl-lib:fsqrt
            (abs (+ (* a a) (* (- four) b c))))))))
    (t
      (setf tau
        (/
          (- a
            (f2cl-lib:fsqrt
              (abs (+ (* a a) (* (- four) b c))))
            (* two c))))))
  (setf eta
    (/ tau
      (+ (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%)
        (f2cl-lib:fsqrt
          (+
            (*
              (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%)
              (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%)
              tau))))))

```

```

(t
  (setf orgati nil)
  (setf sg2lb (- delsq2))
  (setf sg2ub zero)
  (setf a
    (- (* c delsq)
      (* (f2cl-lib:fref z-%data% (i) ((1 *)) z-%offset%)
        (f2cl-lib:fref z-%data% (i) ((1 *)) z-%offset%))
      (* (f2cl-lib:fref z-%data% (ip1) ((1 *)) z-%offset%)
        (f2cl-lib:fref z-%data% (ip1) ((1 *)) z-%offset%))))
  (setf b
    (* (f2cl-lib:fref z-%data% (ip1) ((1 *)) z-%offset%)
      (f2cl-lib:fref z-%data% (ip1) ((1 *)) z-%offset%)
      delsq))
  (cond
    ((< a zero)
      (setf tau
        (/ (* two b)
          (- a
            (f2cl-lib:fsqrt
              (abs (+ (* a a) (* four b c))))))))
    (t
      (setf tau
        (/
          (-
            (+ a
              (f2cl-lib:fsqrt (abs (+ (* a a) (* four b c))))))
            (* two c))))
      (setf eta
        (/ tau
          (+ (f2cl-lib:fref d-%data% (ip1) ((1 *)) d-%offset%)
            (f2cl-lib:fsqrt
              (abs
                (+
                  (*
                    (f2cl-lib:fref d-%data%
                      (ip1)
                      ((1 *))
                      d-%offset%)
                    (f2cl-lib:fref d-%data%
                      (ip1)
                      ((1 *))
                      d-%offset%))
                  tau))))))))
  (cond
    (orgati

```

```
(setf ii i)
(setf sigma
  (+ (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%) eta))
(f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
  (> j n) nil)
(tagbody
  (setf (f2cl-lib:fref work-%data% (j) ((1 *)) work-%offset%)
    (+ (f2cl-lib:fref d-%data% (j) ((1 *)) d-%offset%)
      (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%)
      eta))
  (setf (f2cl-lib:fref delta-%data% (j) ((1 *)) delta-%offset%)
    (- (f2cl-lib:fref d-%data% (j) ((1 *)) d-%offset%)
      (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%)
      eta))))))
(t
  (setf ii (f2cl-lib:int-add i 1))
  (setf sigma
    (+ (f2cl-lib:fref d-%data% (ip1) ((1 *)) d-%offset%) eta))
  (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
    (> j n) nil)
  (tagbody
    (setf (f2cl-lib:fref work-%data% (j) ((1 *)) work-%offset%)
      (+ (f2cl-lib:fref d-%data% (j) ((1 *)) d-%offset%)
        (f2cl-lib:fref d-%data% (ip1) ((1 *)) d-%offset%)
        eta))
    (setf (f2cl-lib:fref delta-%data% (j) ((1 *)) delta-%offset%)
      (- (f2cl-lib:fref d-%data% (j) ((1 *)) d-%offset%)
        (f2cl-lib:fref d-%data% (ip1) ((1 *)) d-%offset%)
        eta))))))
(setf iim1 (f2cl-lib:int-sub ii 1))
(setf iip1 (f2cl-lib:int-add ii 1))
(setf dpsl zero)
(setf psi zero)
(setf erretm zero)
(f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
  (> j iim1) nil)
(tagbody
  (setf temp
    (/ (f2cl-lib:fref z-%data% (j) ((1 *)) z-%offset%)
      (*
        (f2cl-lib:fref work-%data%
          (j)
          ((1 *))
          work-%offset%)
        (f2cl-lib:fref delta-%data%
          (j)
```

```

((1 *))
delta-%offset%))))

(setf psi
  (+ psi
    (* (f2cl-lib:fref z-%data% (j) ((1 *)) z-%offset%)
      temp)))
(setf dpsi (+ dpsi (* temp temp)))
(setf erretm (+ erretm psi))))
(setf erretm (abs erretm))
(setf dphi zero)
(setf phi zero)
(f2cl-lib:fd0 (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
  (> j iip1) nil)
(tagbody
  (setf temp
    (/ (f2cl-lib:fref z-%data% (j) ((1 *)) z-%offset%)
      (*
        (f2cl-lib:fref work-%data%
          (j)
          ((1 *))
          work-%offset%)
        (f2cl-lib:fref delta-%data%
          (j)
          ((1 *))
          delta-%offset%))))))
(setf phi
  (+ phi
    (* (f2cl-lib:fref z-%data% (j) ((1 *)) z-%offset%)
      temp)))
(setf dphi (+ dphi (* temp temp)))
(setf erretm (+ erretm phi))))
(setf w (+ rhoinv phi psi))
(setf swtch3 nil)
(cond
  (orgati
    (if (< w zero) (setf swtch3 t)))
  (t
    (if (> w zero) (setf swtch3 t))))
(if (or (= ii 1) (= ii n)) (setf swtch3 nil))
(setf temp
  (/ (f2cl-lib:fref z-%data% (ii) ((1 *)) z-%offset%)
    (* (f2cl-lib:fref work-%data% (ii) ((1 *)) work-%offset%)
      (f2cl-lib:fref delta-%data%
        (ii)
        ((1 *))
        delta-%offset%))))))

```

```

(setf dw (+ dpsl dphi (* temp temp)))
(setf temp (* (f2cl-lib:fref z-%data% (ii) ((1 *)) z-%offset%) temp))
(setf w (+ w temp))
(setf erretm
  (+ (* eight (- phi psi))
     erretm
     (* two rhoinv)
     (* three (abs temp))
     (* (abs tau) dw)))
(cond
  ((<= (abs w) (* eps erretm))
   (go end_label)))
(cond
  ((<= w zero)
   (setf sg2lb (max sg2lb tau)))
  (t
   (setf sg2ub (min sg2ub tau))))
(setf niter (f2cl-lib:int-add niter 1))
(cond
  ((not swtch3)
   (setf dtipsq
    (*
     (f2cl-lib:fref work-%data% (ip1) ((1 *)) work-%offset%)
     (f2cl-lib:fref delta-%data%
      (ip1)
      ((1 *))
      delta-%offset%)))
   (setf dtisq
    (* (f2cl-lib:fref work-%data% (i) ((1 *)) work-%offset%)
       (f2cl-lib:fref delta-%data%
        (i)
        ((1 *))
        delta-%offset%)))
   (cond
     (orgati
      (setf c
        (+ (- w (* dtipsq dw))
           (* delsq
              (expt
               (/
                (f2cl-lib:fref z-%data%
                  (i)
                  ((1 *))
                  z-%offset%)
                dtisq)
              2))))))

```

```

(t
  (setf c
    (- w
      (* dtisq dw)
      (* delsq
        (expt
          (/
            (f2cl-lib:fref z-%data%
                          (ip1)
                          ((1 *))
                          z-%offset%)
            dtipsq)
          2))))))
(setf a (+ (* (+ dtipsq dtisq) w) (* (- dtipsq) dtisq dw)))
(setf b (* dtipsq dtisq w))
(cond
  ((= c zero)
    (cond
      ((= a zero)
        (cond
          (orgati
            (setf a
              (+
                (*
                  (f2cl-lib:fref z-%data%
                                (i)
                                ((1 *))
                                z-%offset%)
                  (f2cl-lib:fref z-%data%
                                (i)
                                ((1 *))
                                z-%offset%))
                (* dtipsq dtipsq (+ dpsi dphi))))))
        (t
          (setf a
            (+
              (*
                (f2cl-lib:fref z-%data%
                              (ip1)
                              ((1 *))
                              z-%offset%)
                (f2cl-lib:fref z-%data%
                              (ip1)
                              ((1 *))
                              z-%offset%))
              (* dtisq dtisq (+ dpsi dphi))))))))))

```



```

      (setf eta (/ b a)))
    ((<= a zero)
      (setf eta
        (/
          (- a
            (f2cl-lib:fsqrt
              (abs (+ (* a a) (* (- four) b c))))))
          (* two c))))
    (t
      (setf eta
        (/ (* two b)
          (+ a
            (f2cl-lib:fsqrt
              (abs (+ (* a a) (* (- four) b c))))))))))
  (t
    (setf dtiim
      (*
        (f2cl-lib:fref work-%data% (iim1) ((1 *)) work-%offset%)
        (f2cl-lib:fref delta-%data%
          (iim1)
          ((1 *))
          delta-%offset%)))
    (setf dtiip
      (*
        (f2cl-lib:fref work-%data% (iip1) ((1 *)) work-%offset%)
        (f2cl-lib:fref delta-%data%
          (iip1)
          ((1 *))
          delta-%offset%)))
    (setf temp (+ rhoinv psi phi))
    (cond
      (orgati
        (setf temp1
          (/ (f2cl-lib:fref z-%data% (iim1) ((1 *)) z-%offset%)
            dtiim))
        (setf temp1 (* temp1 temp1))
        (setf c
          (+ (- temp (* dtiip (+ dpsl dphi)))
            (*
              (-
                (-
                  (f2cl-lib:fref d-%data%
                    (iim1)
                    ((1 *))
                    d-%offset%)
                  (f2cl-lib:fref d-%data%
                    (iim1)
                    ((1 *))
                    d-%offset%)
                )
              )
            )
          )
        )
      )
    )
  )

```

```

                                (iip1)
                                ((1 *))
                                d-%offset%)))
    (+
      (f2cl-lib:fref d-%data%
                     (iim1)
                     ((1 *))
                     d-%offset%)
      (f2cl-lib:fref d-%data%
                     (iip1)
                     ((1 *))
                     d-%offset%))
      temp1)))
(setf (f2cl-lib:fref zz (1) ((1 3)))
      (* (f2cl-lib:fref z-%data% (iim1) ((1 *)) z-%offset%)
         (f2cl-lib:fref z-%data% (iip1) ((1 *)) z-%offset%)))
(cond
  ((< dpsi temp1)
   (setf (f2cl-lib:fref zz (3) ((1 3))) (* dtiip dtiip dphi)))
  (t
   (setf (f2cl-lib:fref zz (3) ((1 3)))
         (* dtiip dtiip (+ (- dpsi temp1) dphi)))))
(t
 (setf temp1
       (/ (f2cl-lib:fref z-%data% (iip1) ((1 *)) z-%offset%)
          dtiip))
 (setf temp1 (* temp1 temp1))
 (setf c
       (+ (- temp (* dtiim (+ dpsi dphi)))
          (*
            (-
              (-
                (f2cl-lib:fref d-%data%
                               (iip1)
                               ((1 *))
                               d-%offset%)
                (f2cl-lib:fref d-%data%
                               (iim1)
                               ((1 *))
                               d-%offset%)))
            (+
              (f2cl-lib:fref d-%data%
                             (iim1)
                             ((1 *))
                             d-%offset%)
              (f2cl-lib:fref d-%data%
                             (iip1)
                             ((1 *))
                             d-%offset%)))))

```

```

                                (iip1)
                                ((1 *))
                                d-%offset%))
                                temp1)))
(cond
  ((< dphi temp1)
   (setf (f2cl-lib:fref zz (1) ((1 3))) (* dtiim dtiim dps)))
  (t
   (setf (f2cl-lib:fref zz (1) ((1 3)))
         (* dtiim dtiim (+ dps (- dphi temp1))))))
  (setf (f2cl-lib:fref zz (3) ((1 3)))
        (* (f2cl-lib:fref z-%data% (iip1) ((1 *)) z-%offset%
            (f2cl-lib:fref z-%data%
                          (iip1)
                          ((1 *))
                          z-%offset%))))))
  (setf (f2cl-lib:fref zz (2) ((1 3)))
        (* (f2cl-lib:fref z-%data% (ii) ((1 *)) z-%offset%
            (f2cl-lib:fref z-%data% (ii) ((1 *)) z-%offset%))))
  (setf (f2cl-lib:fref dd (1) ((1 3))) dtiim)
  (setf (f2cl-lib:fref dd (2) ((1 3)))
        (*
          (f2cl-lib:fref delta-%data% (ii) ((1 *)) delta-%offset%)
          (f2cl-lib:fref work-%data% (ii) ((1 *)) work-%offset%)))
  (setf (f2cl-lib:fref dd (3) ((1 3))) dtiip)
  (multiple-value-bind
    (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7)
    (dlaed6 niter orgati c dd zz w eta info)
    (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5))
    (setf eta var-6)
    (setf info var-7))
    (if (/= info 0) (go end_label))))
(if (>= (* w eta) zero) (setf eta (/ (- w) dw)))
(cond
  (orgati
   (setf temp1
         (* (f2cl-lib:fref work-%data% (i) ((1 *)) work-%offset%
            (f2cl-lib:fref delta-%data%
                          (i)
                          ((1 *))
                          delta-%offset%))))
   (setf temp (- eta temp1)))
  (t
   (setf temp1
         (*
          (f2cl-lib:fref work-%data% (ip1) ((1 *)) work-%offset%)

```

```

(f2cl-lib:fref delta-%data%
  (ip1)
  ((1 *))
  delta-%offset%)))
(setf temp (- eta temp1)))
(cond
  ((or (> temp sg2ub) (< temp sg2lb))
    (cond
      ((< w zero)
        (setf eta (/ (- sg2ub tau) two)))
      (t
        (setf eta (/ (- sg2lb tau) two))))))
(setf tau (+ tau eta))
(setf eta (/ eta (+ sigma (f2cl-lib:fsqrt (+ (* sigma sigma) eta)))))
(setf prew w)
(setf sigma (+ sigma eta))
(f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
  (> j n) nil)
(tagbody
  (setf (f2cl-lib:fref work-%data% (j) ((1 *)) work-%offset%
    (+ (f2cl-lib:fref work-%data% (j) ((1 *)) work-%offset%
      eta))
    (setf (f2cl-lib:fref delta-%data% (j) ((1 *)) delta-%offset%
      (-
        (f2cl-lib:fref delta-%data% (j) ((1 *)) delta-%offset%
          eta))))))
(setf dpsl zero)
(setf psi zero)
(setf erretm zero)
(f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
  (> j iim1) nil)
(tagbody
  (setf temp
    (/ (f2cl-lib:fref z-%data% (j) ((1 *)) z-%offset%)
      (*
        (f2cl-lib:fref work-%data%
          (j)
          ((1 *))
          work-%offset%)
        (f2cl-lib:fref delta-%data%
          (j)
          ((1 *))
          delta-%offset%))))))
(setf psi
  (+ psi
    (* (f2cl-lib:fref z-%data% (j) ((1 *)) z-%offset%)

```

```

temp)))
(setf dpsl (+ dpsl (* temp temp)))
(setf erretm (+ erretm psi)))
(setf erretm (abs erretm))
(setf dphi zero)
(setf phi zero)
(f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
  ((> j iip1) nil)
  (tagbody
    (setf temp
      (/ (f2cl-lib:fref z-%data% (j) ((1 *)) z-%offset%)
        (*
          (f2cl-lib:fref work-%data%
            (j)
            ((1 *))
            work-%offset%)
          (f2cl-lib:fref delta-%data%
            (j)
            ((1 *))
            delta-%offset%))))))
    (setf phi
      (+ phi
        (* (f2cl-lib:fref z-%data% (j) ((1 *)) z-%offset%)
          temp)))
    (setf dphi (+ dphi (* temp temp)))
    (setf erretm (+ erretm phi)))
  (setf temp
    (/ (f2cl-lib:fref z-%data% (ii) ((1 *)) z-%offset%)
      (* (f2cl-lib:fref work-%data% (ii) ((1 *)) work-%offset%)
        (f2cl-lib:fref delta-%data%
          (ii)
          ((1 *))
          delta-%offset%))))))
  (setf dw (+ dpsl dphi (* temp temp)))
  (setf temp (* (f2cl-lib:fref z-%data% (ii) ((1 *)) z-%offset%) temp))
  (setf w (+ rhoinv phi psi temp))
  (setf erretm
    (+ (* eight (- phi psi))
      erretm
      (* two rhoinv)
      (* three (abs temp))
      (* (abs tau) dw)))
  (cond
    ((<= w zero)
     (setf sg2lb (max sg2lb tau)))
    (t

```

```

      (setf sg2ub (min sg2ub tau))))
(setf swtch nil)
(cond
  (orgati
    (if (> (- w) (/ (abs prew) ten)) (setf swtch t)))
  (t
    (if (> w (/ (abs prew) ten)) (setf swtch t))))
(setf iter (f2cl-lib:int-add niter 1))
(f2cl-lib:fdof (niter iter (f2cl-lib:int-add niter 1))
  ((> niter maxit) nil)
  (tagbody
    (cond
      ((<= (abs w) (* eps erretm))
        (go end_label)))
    (cond
      ((not swtch3)
        (setf dtipsq
          (*
            (f2cl-lib:fref work-%data%
                          (ip1)
                          ((1 *))
                          work-%offset%)
            (f2cl-lib:fref delta-%data%
                          (ip1)
                          ((1 *))
                          delta-%offset%))))
        (setf dtisq
          (*
            (f2cl-lib:fref work-%data%
                          (i)
                          ((1 *))
                          work-%offset%)
            (f2cl-lib:fref delta-%data%
                          (i)
                          ((1 *))
                          delta-%offset%))))
      (cond
        ((not swtch)
          (cond
            (orgati
              (setf c
                (+ (- w (* dtipsq dw))
                  (* delsq
                    (expt
                      (/
                        (f2cl-lib:fref z-%data%

```

```

                                (i)
                                ((1 *))
                                z-%offset%)
                                dtisq)
                                2))))))
(t
  (setf c
    (- w
      (* dtisq dw)
      (* delsq
        (expt
          (/
            (f2cl-lib:fref z-%data%
                          (ip1)
                          ((1 *))
                          z-%offset%)
            dtipsq)
          2)))))))
(t
  (setf temp
    (/
      (f2cl-lib:fref z-%data% (ii) ((1 *)) z-%offset%)
      (*
        (f2cl-lib:fref work-%data%
                      (ii)
                      ((1 *))
                      work-%offset%)
        (f2cl-lib:fref delta-%data%
                      (ii)
                      ((1 *))
                      delta-%offset%))))))
(cond
  (orgati
    (setf dpsi (+ dpsi (* temp temp))))
  (t
    (setf dphi (+ dphi (* temp temp))))
  (setf c (- w (* dtisq dpsi) (* dtipsq dphi))))
(setf a (+ (* (+ dtipsq dtisq) w) (* (- dtipsq) dtisq dw)))
(setf b (* dtipsq dtisq w))
(cond
  ((= c zero)
    (cond
      ((= a zero)
        (cond
          ((not swtch)
            (cond

```

```

(orgati
  (setf a
    (+
      (*
        (f2cl-lib:fref z-%data%
          (i)
          ((1 *))
          z-%offset%)
        (f2cl-lib:fref z-%data%
          (i)
          ((1 *))
          z-%offset%))
      (* dtipsq dtipsq (+ dpsi dphi))))
  (t
    (setf a
      (+
        (*
          (f2cl-lib:fref z-%data%
            (ip1)
            ((1 *))
            z-%offset%)
          (f2cl-lib:fref z-%data%
            (ip1)
            ((1 *))
            z-%offset%))
        (* dtisq dtisq (+ dpsi dphi))))))
  (t
    (setf a
      (+ (* dtisq dtisq dpsi)
        (* dtipsq dtipsq dphi))))
    (setf eta (/ b a))
    ((<= a zero)
      (setf eta
        (/
          (- a
            (f2cl-lib:fsqrt
              (abs (+ (* a a) (* (- four) b c))))
            (* two c))))
      (t
        (setf eta
          (/ (* two b)
            (+ a
              (f2cl-lib:fsqrt
                (abs (+ (* a a) (* (- four) b c))))))))
      (t
        (setf dtiim

```



```

(*
  (f2cl-lib:fref work-%data%
    (iim1)
    ((1 *))
    work-%offset%)
  (f2cl-lib:fref delta-%data%
    (iim1)
    ((1 *))
    delta-%offset%)))
(setf dtiip
  (*
    (f2cl-lib:fref work-%data%
      (iip1)
      ((1 *))
      work-%offset%)
    (f2cl-lib:fref delta-%data%
      (iip1)
      ((1 *))
      delta-%offset%)))
(setf temp (+ rhoinv psi phi))
(cond
  (swtch
    (setf c (- temp (* dtiim dpsi) (* dtiip dphi)))
    (setf (f2cl-lib:fref zz (1) ((1 3))) (* dtiim dtiim dpsi))
    (setf (f2cl-lib:fref zz (3) ((1 3))) (* dtiip dtiip dphi)))
  (t
    (cond
      (orgati
        (setf temp1
          (/
            (f2cl-lib:fref z-%data%
              (iim1)
              ((1 *))
              z-%offset%)
            dtiim))
        (setf temp1 (* temp1 temp1))
        (setf temp2
          (*
            (-
              (f2cl-lib:fref d-%data%
                (iim1)
                ((1 *))
                d-%offset%)
              (f2cl-lib:fref d-%data%
                (iip1)
                ((1 *))
                d-%offset%)))
            dtiim)))

```

```

                                d-%offset%))
(+
  (f2cl-lib:fref d-%data%
    (iim1)
    ((1 *))
    d-%offset%)
  (f2cl-lib:fref d-%data%
    (iip1)
    ((1 *))
    d-%offset%))
temp1))
(setf c (- temp (* dtiip (+ dpsi dphi)) temp2))
(setf (f2cl-lib:fref zz (1) ((1 3)))
  (*
    (f2cl-lib:fref z-%data%
      (iim1)
      ((1 *))
      z-%offset%)
    (f2cl-lib:fref z-%data%
      (iim1)
      ((1 *))
      z-%offset%)))
(cond
  ((< dpsi temp1)
    (setf (f2cl-lib:fref zz (3) ((1 3)))
      (* dtiip dtiip dphi)))
  (t
    (setf (f2cl-lib:fref zz (3) ((1 3)))
      (* dtiip dtiip (+ (- dpsi temp1) dphi))))))
(t
  (setf temp1
    (/
      (f2cl-lib:fref z-%data%
        (iip1)
        ((1 *))
        z-%offset%)
      dtiip))
  (setf temp1 (* temp1 temp1))
  (setf temp2
    (*
      (-
        (f2cl-lib:fref d-%data%
          (iip1)
          ((1 *))
          d-%offset%)
        (f2cl-lib:fref d-%data%
```

```

                                (iim1)
                                ((1 *))
                                d-%offset%)
(+
  (f2cl-lib:fref d-%data%
    (iim1)
    ((1 *))
    d-%offset%)
  (f2cl-lib:fref d-%data%
    (iip1)
    ((1 *))
    d-%offset%))
temp1))
(setf c (- temp (* dtiim (+ dpsl dphi)) temp2))
(cond
  ((< dphi temp1)
    (setf (f2cl-lib:fref zz (1) ((1 3)))
      (* dtiim dtiim dpsl)))
  (t
    (setf (f2cl-lib:fref zz (1) ((1 3)))
      (* dtiim dtiim (+ dpsl (- dphi temp1))))))
(setf (f2cl-lib:fref zz (3) ((1 3)))
  (*
    (f2cl-lib:fref z-%data%
      (iip1)
      ((1 *))
      z-%offset%)
    (f2cl-lib:fref z-%data%
      (iip1)
      ((1 *))
      z-%offset%))))))
(setf (f2cl-lib:fref dd (1) ((1 3))) dtiim)
(setf (f2cl-lib:fref dd (2) ((1 3)))
  (*
    (f2cl-lib:fref delta-%data%
      (ii)
      ((1 *))
      delta-%offset%)
    (f2cl-lib:fref work-%data%
      (ii)
      ((1 *))
      work-%offset%)))
(setf (f2cl-lib:fref dd (3) ((1 3))) dtiip)
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7)
  (dlaed6 niter orgati c dd zz w eta info)

```

```

      (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5))
      (setf eta var-6)
      (setf info var-7))
      (if (/= info 0) (go end_label))))
      (if (>= (* w eta) zero) (setf eta (/ (- w) dw)))
      (cond
        (orgati
          (setf temp1
            (*
              (f2cl-lib:fref work-%data%
                             (i)
                             ((1 *))
                             work-%offset%)
              (f2cl-lib:fref delta-%data%
                             (i)
                             ((1 *))
                             delta-%offset%)))
            (setf temp (- eta temp1)))
          (t
            (setf temp1
              (*
                (f2cl-lib:fref work-%data%
                               (ip1)
                               ((1 *))
                               work-%offset%)
                (f2cl-lib:fref delta-%data%
                               (ip1)
                               ((1 *))
                               delta-%offset%)))
              (setf temp (- eta temp1))))
          (cond
            ((or (> temp sg2ub) (< temp sg2lb))
              (cond
                ((< w zero)
                  (setf eta (/ (- sg2ub tau) two)))
                (t
                  (setf eta (/ (- sg2lb tau) two))))))
            (setf tau (+ tau eta))
            (setf eta
              (/ eta
                (+ sigma (f2cl-lib:fsqrt (+ (* sigma sigma) eta)))))
            (setf sigma (+ sigma eta))
            (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
              ((> j n) nil)
              (tagbody
                (setf (f2cl-lib:fref work-%data% (j) ((1 *)) work-%offset%)

```

```

      (+
        (f2cl-lib:fref work-%data%
          (j)
          ((1 *))
          work-%offset%)
        eta))
      (setf (f2cl-lib:fref delta-%data%
        (j)
        ((1 *))
        delta-%offset%)
        (-
          (f2cl-lib:fref delta-%data%
            (j)
            ((1 *))
            delta-%offset%)
          eta))))
      (setf prew w)
      (setf dpsl zero)
      (setf psi zero)
      (setf erretm zero)
      (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
        ((> j iim1) nil)
        (tagbody
          (setf temp
            (/ (f2cl-lib:fref z-%data% (j) ((1 *)) z-%offset%)
              (*
                (f2cl-lib:fref work-%data%
                  (j)
                  ((1 *))
                  work-%offset%)
                (f2cl-lib:fref delta-%data%
                  (j)
                  ((1 *))
                  delta-%offset%))))))
          (setf psi
            (+ psi
              (*
                (f2cl-lib:fref z-%data% (j) ((1 *)) z-%offset%)
                temp))))
          (setf dpsl (+ dpsl (* temp temp)))
          (setf erretm (+ erretm psi))))
      (setf erretm (abs erretm))
      (setf dphi zero)
      (setf phi zero)
      (f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
        ((> j iip1) nil)

```

```

(tagbody
  (setf temp
    (/ (f2cl-lib:fref z-%data% (j) ((1 *)) z-%offset%)
      (*
        (f2cl-lib:fref work-%data%
          (j)
          ((1 *))
          work-%offset%)
        (f2cl-lib:fref delta-%data%
          (j)
          ((1 *))
          delta-%offset%))))
  (setf phi
    (+ phi
      (*
        (f2cl-lib:fref z-%data% (j) ((1 *)) z-%offset%)
        temp)))
  (setf dphi (+ dphi (* temp temp)))
  (setf erretm (+ erretm phi)))
(setf temp
  (/ (f2cl-lib:fref z-%data% (ii) ((1 *)) z-%offset%)
    (*
      (f2cl-lib:fref work-%data%
        (ii)
        ((1 *))
        work-%offset%)
      (f2cl-lib:fref delta-%data%
        (ii)
        ((1 *))
        delta-%offset%))))
(setf dw (+ dpsi dphi (* temp temp)))
(setf temp
  (* (f2cl-lib:fref z-%data% (ii) ((1 *)) z-%offset%)
    temp))
(setf w (+ rhoinv phi psi temp))
(setf erretm
  (+ (* eight (- phi psi))
    erretm
    (* two rhoinv)
    (* three (abs temp))
    (* (abs tau) dw)))
(if (and (> (* w prew) zero) (> (abs w) (/ (abs prew) ten)))
  (setf swtch (not swtch)))
(cond
  ((<= w zero)
    (setf sg2lb (max sg2lb tau)))

```

```

                                (t
                                (setf sg2ub (min sg2ub tau))))))
                                (setf info 1)))
end_label
    (return (values nil nil nil nil nil nil sigma nil info))))))

```

## 7.59 dlasd5 LAPACK

```

⟨dlasd5.input⟩≡
)set break resume
)sys rm -f dlasd5.output
)spool dlasd5.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)

```

`<dlasd5.help>=`

```
=====
dlasd5 examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

DLASD5 - compute the square root of the I-th eigenvalue of a positive symmetric rank-one modification of a 2-by-2 diagonal matrix `diag( D ) * diag( D ) + RHO`. The diagonal entries in the array `D` are assumed to satisfy `0 <= D(i) < D(j)` for `i < j`.

#### SYNOPSIS

```
SUBROUTINE DLASD5( I, D, Z, DELTA, RHO, DSIGMA, WORK )
```

```
      INTEGER      I
```

```
      DOUBLE      PRECISION DSIGMA, RHO
```

```
      DOUBLE      PRECISION D( 2 ), DELTA( 2 ), WORK( 2 ), Z( 2 )
```

#### PURPOSE

This subroutine computes the square root of the I-th eigenvalue of a positive symmetric rank-one modification of a 2-by-2 diagonal matrix

We also assume `RHO > 0` and that the Euclidean norm of the vector `Z` is one.

#### ARGUMENTS

`I` (input) INTEGER

The index of the eigenvalue to be computed. `I = 1` or `I = 2`.

`D` (input) DOUBLE PRECISION array, dimension ( 2 )

The original eigenvalues. We assume `0 <= D(1) < D(2)`.

`Z` (input) DOUBLE PRECISION array, dimension ( 2 )

The components of the updating vector.

`DELTA` (output) DOUBLE PRECISION array, dimension ( 2 )

Contains `(D(j) - sigma_I)` in its `j`-th component. The vector `DELTA` contains the information necessary to construct the eigenvectors.



RHO      (input) DOUBLE PRECISION  
The scalar in the symmetric updating formula.

DSIGMA (output) DOUBLE PRECISION The computed  $\sigma_I$ , the  $I$ -th  
updated eigenvalue.

WORK    (workspace) DOUBLE PRECISION array, dimension ( 2 )  
WORK contains  $D(j) + \sigma_I$  in its  $j$ -th component.

```

(LAPACK dlasd5)=
  (let* ((zero 0.0) (one 1.0) (two 2.0) (three 3.0) (four 4.0))
    (declare (type (double-float 0.0 0.0) zero)
              (type (double-float 1.0 1.0) one)
              (type (double-float 2.0 2.0) two)
              (type (double-float 3.0 3.0) three)
              (type (double-float 4.0 4.0) four))
    (defun dlasd5 (i d z delta rho dsigma work)
      (declare (type (double-float) dsigma rho)
                (type (simple-array double-float (*)) work delta z d)
                (type fixnum i))
      (f2cl-lib:with-multi-array-data
        ((d double-float d-%data% d-%offset%)
         (z double-float z-%data% z-%offset%)
         (delta double-float delta-%data% delta-%offset%)
         (work double-float work-%data% work-%offset%))
        (prog ((b 0.0) (c 0.0) (del 0.0) (delsq 0.0) (tau 0.0) (w 0.0))
          (declare (type (double-float) b c del delsq tau w))
          (setf del
            (- (f2cl-lib:fref d-%data% (2) ((1 2)) d-%offset%)
               (f2cl-lib:fref d-%data% (1) ((1 2)) d-%offset%)))
          (setf delsq
            (* del
               (+ (f2cl-lib:fref d-%data% (2) ((1 2)) d-%offset%)
                  (f2cl-lib:fref d-%data% (1) ((1 2)) d-%offset%))))
          (cond
            ((= i 1)
             (setf w
               (+ one
                  (/
                    (* four
                       rho
                       (+
                         (/
                           (* (f2cl-lib:fref z-%data% (2) ((1 2)) z-%offset%)
                              (f2cl-lib:fref z-%data% (2) ((1 2)) z-%offset%))
                           (+ (f2cl-lib:fref d-%data% (1) ((1 2)) d-%offset%)
                              (* three
                                 (f2cl-lib:fref d-%data%
                                                  (2)
                                                  ((1 2))
                                                  d-%offset%))))
                         (/
                           (*
                             (-
                               (f2cl-lib:fref z-%data% (1) ((1 2)) z-%offset%)

```

```

(f2cl-lib:fref z-%data% (1) ((1 2)) z-%offset%))
(+
  (* three
    (f2cl-lib:fref d-%data%
      (1)
      ((1 2))
      d-%offset%))
    (f2cl-lib:fref d-%data%
      (2)
      ((1 2))
      d-%offset%))))))
del)))
(cond
  ((> w zero)
    (setf b
      (+ delsq
        (* rho
          (+
            (* (f2cl-lib:fref z-%data% (1) ((1 2)) z-%offset%)
              (f2cl-lib:fref z-%data%
                (1)
                ((1 2))
                z-%offset%))
            (* (f2cl-lib:fref z-%data% (2) ((1 2)) z-%offset%)
              (f2cl-lib:fref z-%data%
                (2)
                ((1 2))
                z-%offset%)))))))
    (setf c
      (* rho
        (f2cl-lib:fref z-%data% (1) ((1 2)) z-%offset%)
        (f2cl-lib:fref z-%data% (1) ((1 2)) z-%offset%)
        delsq))
    (setf tau
      (/ (* two c)
        (+ b (f2cl-lib:fsqrt (abs (- (* b b) (* four c)))))))
    (setf tau
      (/ tau
        (+ (f2cl-lib:fref d-%data% (1) ((1 2)) d-%offset%)
          (f2cl-lib:fsqrt
            (+
              (*
                (f2cl-lib:fref d-%data% (1) ((1 2)) d-%offset%)
                (f2cl-lib:fref d-%data% (1) ((1 2)) d-%offset%)
                tau))))))
    (setf dsigma

```

```

      (+ (f2cl-lib:fref d-%data% (1) ((1 2)) d-%offset%) tau))
(setf (f2cl-lib:fref delta-%data% (1) ((1 2)) delta-%offset%)
      (- tau))
(setf (f2cl-lib:fref delta-%data% (2) ((1 2)) delta-%offset%)
      (- del tau))
(setf (f2cl-lib:fref work-%data% (1) ((1 2)) work-%offset%)
      (+
        (* two (f2cl-lib:fref d-%data% (1) ((1 2)) d-%offset%)
          tau))
(setf (f2cl-lib:fref work-%data% (2) ((1 2)) work-%offset%)
      (+ (f2cl-lib:fref d-%data% (1) ((1 2)) d-%offset%)
          tau
          (f2cl-lib:fref d-%data% (2) ((1 2)) d-%offset%))))
(t
  (setf b
    (-
      (* rho
        (+
          (* (f2cl-lib:fref z-%data% (1) ((1 2)) z-%offset%)
            (f2cl-lib:fref z-%data% (1) ((1 2)) z-%offset%))
          (* (f2cl-lib:fref z-%data% (2) ((1 2)) z-%offset%)
            (f2cl-lib:fref z-%data%
                          (2)
                          ((1 2))
                          z-%offset%))))
      delsq))
  (setf c
    (* rho
      (f2cl-lib:fref z-%data% (2) ((1 2)) z-%offset%)
      (f2cl-lib:fref z-%data% (2) ((1 2)) z-%offset%)
      delsq))
  (cond
    ((> b zero)
     (setf tau
       (/ (* (- two) c)
          (+ b (f2cl-lib:fsqrt (+ (* b b) (* four c)))))))
    (t
     (setf tau
       (/ (- b (f2cl-lib:fsqrt (+ (* b b) (* four c))))
          two))))
  (setf tau
    (/ tau
      (+ (f2cl-lib:fref d-%data% (2) ((1 2)) d-%offset%)
        (f2cl-lib:fsqrt
          (abs
            (+

```

```

(*
  (f2cl-lib:fref d-%data% (2) ((1 2)) d-%offset%)
  (f2cl-lib:fref d-%data%
    (2)
    ((1 2))
    d-%offset%))
tau))))))
(setf dsigma
  (+ (f2cl-lib:fref d-%data% (2) ((1 2)) d-%offset%) tau))
(setf (f2cl-lib:fref delta-%data% (1) ((1 2)) delta-%offset%)
  (- (+ del tau)))
(setf (f2cl-lib:fref delta-%data% (2) ((1 2)) delta-%offset%)
  (- tau))
(setf (f2cl-lib:fref work-%data% (1) ((1 2)) work-%offset%)
  (+ (f2cl-lib:fref d-%data% (1) ((1 2)) d-%offset%)
    tau
    (f2cl-lib:fref d-%data% (2) ((1 2)) d-%offset%)))
(setf (f2cl-lib:fref work-%data% (2) ((1 2)) work-%offset%)
  (+
    (* two (f2cl-lib:fref d-%data% (2) ((1 2)) d-%offset%)
      tau))))))
(t
  (setf b
    (-
      (* rho
        (+
          (* (f2cl-lib:fref z-%data% (1) ((1 2)) z-%offset%)
            (f2cl-lib:fref z-%data% (1) ((1 2)) z-%offset%))
          (* (f2cl-lib:fref z-%data% (2) ((1 2)) z-%offset%)
            (f2cl-lib:fref z-%data% (2) ((1 2)) z-%offset%))))
      delsq))
    (setf c
      (* rho
        (f2cl-lib:fref z-%data% (2) ((1 2)) z-%offset%)
        (f2cl-lib:fref z-%data% (2) ((1 2)) z-%offset%)
        delsq))
    (cond
      ((> b zero)
        (setf tau (/ (+ b (f2cl-lib:fsqrt (+ (* b b) (* four c)))) two)))
      (t
        (setf tau
          (/ (* two c)
            (- (f2cl-lib:fsqrt (+ (* b b) (* four c))) b))))))
    (setf tau
      (/ tau
        (+ (f2cl-lib:fref d-%data% (2) ((1 2)) d-%offset%)

```

```

(f2cl-lib:fsqrt
 (+
  (* (f2cl-lib:fref d-%data% (2) ((1 2)) d-%offset%)
     (f2cl-lib:fref d-%data% (2) ((1 2)) d-%offset%))
   tau))))
(setf dsigma (+ (f2cl-lib:fref d-%data% (2) ((1 2)) d-%offset%) tau))
(setf (f2cl-lib:fref delta-%data% (1) ((1 2)) delta-%offset%)
      (- (+ del tau)))
(setf (f2cl-lib:fref delta-%data% (2) ((1 2)) delta-%offset%)
      (- tau))
(setf (f2cl-lib:fref work-%data% (1) ((1 2)) work-%offset%)
      (+ (f2cl-lib:fref d-%data% (1) ((1 2)) d-%offset%)
          tau
          (f2cl-lib:fref d-%data% (2) ((1 2)) d-%offset%)))
(setf (f2cl-lib:fref work-%data% (2) ((1 2)) work-%offset%)
      (+ (* two (f2cl-lib:fref d-%data% (2) ((1 2)) d-%offset%)
          tau))))
(return (values nil nil nil nil nil dsigma nil))))))

```

## 7.60 dlasd6 LAPACK

```

⟨dlasd6.input⟩≡
)set break resume
)sys rm -f dlasd6.output
)spool dlasd6.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)

```

`<dlasd6.help>`≡

```
=====
dlasd6 examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

DLASD6 - the SVD of an updated upper bidiagonal matrix B obtained by merging two smaller ones by appending a row

#### SYNOPSIS

```
SUBROUTINE DLASD6( ICOMPQ, NL, NR, SQRE, D, VF, VL, ALPHA, BETA, IDXQ,
                   PERM, GIVPTR, GIVCOL, LDGCOL, GIVNUM, LDGNUM, POLES,
                   DIFL, DIFR, Z, K, C, S, WORK, IWORK, INFO )

    INTEGER          GIVPTR, ICOMPQ, INFO, K, LDGCOL, LDGNUM, NL, NR,
                     SQRE

    DOUBLE           PRECISION ALPHA, BETA, C, S

    INTEGER          GIVCOL( LDGCOL, * ), IDXQ( * ), IWORK( * ), PERM( *
                           )

    DOUBLE           PRECISION D( * ), DIFL( * ), DIFR( * ), GIVNUM(
                     LDGNUM, * ), POLES( LDGNUM, * ), VF( * ), VL( * ),
                     WORK( * ), Z( * )
```

#### PURPOSE

DLASD6 computes the SVD of an updated upper bidiagonal matrix B obtained by merging two smaller ones by appending a row. This routine is used only for the problem which requires all singular values and optionally singular vector matrices in factored form. B is an N-by-M matrix with  $N = NL + NR + 1$  and  $M = N + SQRE$ . A related subroutine, DLASD1, handles the case in which all singular values and singular vectors of the bidiagonal matrix are desired.

DLASD6 computes the SVD as follows:

$$\begin{aligned}
 B &= U(in) * \begin{pmatrix} D1(in) & 0 & 0 & 0 \\ Z1' & a & Z2' & b \\ 0 & 0 & D2(in) & 0 \end{pmatrix} * VT(in) \\
 &= U(out) * ( D(out) \ 0 ) * VT(out)
 \end{aligned}$$

where  $Z' = (Z1' \ a \ Z2' \ b) = u' \ VT'$ , and  $u$  is a vector of dimension  $M$  with  $\text{ALPHA}$  and  $\text{BETA}$  in the  $NL+1$  and  $NL+2$  th entries and zeros elsewhere; and the entry  $b$  is empty if  $\text{SQRE} = 0$ .

The singular values of  $B$  can be computed using  $D1$ ,  $D2$ , the first components of all the right singular vectors of the lower block, and the last components of all the right singular vectors of the upper block. These components are stored and updated in  $VF$  and  $VL$ , respectively, in `DLASD6`. Hence  $U$  and  $VT$  are not explicitly referenced.

The singular values are stored in  $D$ . The algorithm consists of two stages:

The first stage consists of deflating the size of the problem when there are multiple singular values or if there is a zero in the  $Z$  vector. For each such occurrence the dimension of the secular equation problem is reduced by one. This stage is performed by the routine `DLASD7`.

The second stage consists of calculating the updated singular values. This is done by finding the roots of the secular equation via the routine `DLASD4` (as called by `DLASD8`). This routine also updates  $VF$  and  $VL$  and computes the distances between the updated singular values and the old singular values.

`DLASD6` is called from `DLASDA`.

#### ARGUMENTS

`ICOMPQ` (input) INTEGER Specifies whether singular vectors are to be computed in factored form:  
 = 0: Compute singular values only.  
 = 1: Compute singular vectors in factored form as well.

`NL` (input) INTEGER  
 The row dimension of the upper block.  $NL \geq 1$ .

`NR` (input) INTEGER  
 The row dimension of the lower block.  $NR \geq 1$ .

`SQRE` (input) INTEGER  
 = 0: the lower block is an  $NR$ -by- $NR$  square matrix.  
 = 1: the lower block is an  $NR$ -by- $(NR+1)$  rectangular matrix.



The bidiagonal matrix has row dimension  $N = NL + NR + 1$ , and column dimension  $M = N + SQRE$ .

- D** (input/output) DOUBLE PRECISION array, dimension (  $NL+NR+1$  ).  
On entry  $D(1:NL,1:NL)$  contains the singular values of the upper block, and  $D(NL+2:N)$  contains the singular values of the lower block. On exit  $D(1:N)$  contains the singular values of the modified matrix.
- VF** (input/output) DOUBLE PRECISION array, dimension (  $M$  )  
On entry,  $VF(1:NL+1)$  contains the first components of all right singular vectors of the upper block; and  $VF(NL+2:M)$  contains the first components of all right singular vectors of the lower block. On exit,  $VF$  contains the first components of all right singular vectors of the bidiagonal matrix.
- VL** (input/output) DOUBLE PRECISION array, dimension (  $M$  )  
On entry,  $VL(1:NL+1)$  contains the last components of all right singular vectors of the upper block; and  $VL(NL+2:M)$  contains the last components of all right singular vectors of the lower block. On exit,  $VL$  contains the last components of all right singular vectors of the bidiagonal matrix.
- ALPHA** (input/output) DOUBLE PRECISION  
Contains the diagonal element associated with the added row.
- BETA** (input/output) DOUBLE PRECISION  
Contains the off-diagonal element associated with the added row.
- IDXQ** (output) INTEGER array, dimension (  $N$  )  
This contains the permutation which will reintegrate the subproblem just solved back into sorted order, i.e.  $D( \text{IDXQ}( I = 1, N ) )$  will be in ascending order.
- PERM** (output) INTEGER array, dimension (  $N$  )  
The permutations (from deflation and sorting) to be applied to each block. Not referenced if  $ICOMPQ = 0$ .
- GIVPTR** (output) INTEGER The number of Givens rotations which took place in this subproblem. Not referenced if  $ICOMPQ = 0$ .
- GIVCOL** (output) INTEGER array, dimension (  $LDGCOL, 2$  ) Each pair of numbers indicates a pair of columns to take place in a Givens rotation. Not referenced if  $ICOMPQ = 0$ .
- LDGCOL** (input) INTEGER leading dimension of **GIVCOL**, must be at

least N.

GIVNUM (output) DOUBLE PRECISION array, dimension ( LDGNUM, 2 )  
Each number indicates the C or S value to be used in the corresponding Givens rotation. Not referenced if ICOMPQ = 0.

LDGNUM (input) INTEGER The leading dimension of GIVNUM and POLES, must be at least N.

POLES (output) DOUBLE PRECISION array, dimension ( LDGNUM, 2 )  
On exit, POLES(1,\*) is an array containing the new singular values obtained from solving the secular equation, and POLES(2,\*) is an array containing the poles in the secular equation. Not referenced if ICOMPQ = 0.

DIFL (output) DOUBLE PRECISION array, dimension ( N )  
On exit, DIFL(I) is the distance between I-th updated (undeflated) singular value and the I-th (undeflated) old singular value.

DIFR (output) DOUBLE PRECISION array,  
dimension ( LDGNUM, 2 ) if ICOMPQ = 1 and dimension ( N ) if ICOMPQ = 0. On exit, DIFR(I, 1) is the distance between I-th updated (undeflated) singular value and the I+1-th (undeflated) old singular value.

If ICOMPQ = 1, DIFR(1:K,2) is an array containing the normalizing factors for the right singular vector matrix.

See DLASD8 for details on DIFL and DIFR.

Z (output) DOUBLE PRECISION array, dimension ( M )  
The first elements of this array contain the components of the deflation-adjusted updating row vector.

K (output) INTEGER  
Contains the dimension of the non-deflated matrix, This is the order of the related secular equation.  $1 \leq K \leq N$ .

C (output) DOUBLE PRECISION  
C contains garbage if SQRE = 0 and the C-value of a Givens rotation related to the right null space if SQRE = 1.

S (output) DOUBLE PRECISION  
S contains garbage if SQRE = 0 and the S-value of a Givens rotation related to the right null space if SQRE = 1.

WORK (workspace) DOUBLE PRECISION array, dimension ( 4 \* M )

IWORK (workspace) INTEGER array, dimension ( 3 \* N )

INFO (output) INTEGER

- = 0: successful exit.
- < 0: if INFO = -i, the i-th argument had an illegal value.
- > 0: if INFO = 1, an singular value did not converge

```

(LAPACK dlasd6)=
  (let* ((one 1.0) (zero 0.0))
    (declare (type (double-float 1.0 1.0) one)
              (type (double-float 0.0 0.0) zero))
    (defun dlasd6
      (icompq nl nr sqre d vf vl alpha beta idxq perm givptr givcol ldgcol
       givnum ldgnum poles difl difr z k c s work iwork info)
      (declare (type (simple-array fixnum (*)) iwork givcol perm idxq)
                (type (double-float) s c beta alpha)
                (type (simple-array double-float (*)) work z difr difl poles givnum vl vf
                      d)
                (type fixnum info k ldgnum ldgcol givptr sqre nr nl
                      icompq))
      (f2cl-lib:with-multi-array-data
        ((d double-float d-%data% d-%offset%)
         (vf double-float vf-%data% vf-%offset%)
         (vl double-float vl-%data% vl-%offset%)
         (givnum double-float givnum-%data% givnum-%offset%)
         (poles double-float poles-%data% poles-%offset%)
         (difl double-float difl-%data% difl-%offset%)
         (difr double-float difr-%data% difr-%offset%)
         (z double-float z-%data% z-%offset%)
         (work double-float work-%data% work-%offset%)
         (idxq fixnum idxq-%data% idxq-%offset%)
         (perm fixnum perm-%data% perm-%offset%)
         (givcol fixnum givcol-%data% givcol-%offset%)
         (iwork fixnum iwork-%data% iwork-%offset%))
        (prog ((orgnrm 0.0) (i 0) (idx 0) (idxc 0) (idxp 0) (isigma 0) (ivfw 0)
              (ivlw 0) (iw 0) (m 0) (n 0) (n1 0) (n2 0))
          (declare (type (double-float) orgnrm)
                    (type fixnum i idx idxc idxp isigma ivfw ivlw iw
                          m n n1 n2))

          (setf info 0)
          (setf n (f2cl-lib:int-add nl nr 1))
          (setf m (f2cl-lib:int-add n sqre))
          (cond
            ((or (< icompq 0) (> icompq 1))
             (setf info -1))
            ((< nl 1)
             (setf info -2))
            ((< nr 1)
             (setf info -3))
            ((or (< sqre 0) (> sqre 1))
             (setf info -4))
            ((< ldgcol n)
             (setf info -14))
          )
      )
    )
  )

```

```

((< ldgnum n)
 (setf info -16)))
(cond
 ((/= info 0)
  (error
   " ** On entry to ~a parameter number ~a had an illegal value~%"
   "DLASD6" (f2cl-lib:int-sub info))
  (go end_label)))
(setf isigma 1)
(setf iw (f2cl-lib:int-add isigma n))
(setf ivfw (f2cl-lib:int-add iw m))
(setf ivlw (f2cl-lib:int-add ivfw m))
(setf idx 1)
(setf idxc (f2cl-lib:int-add idx n))
(setf idxp (f2cl-lib:int-add idxc n))
(setf orgnrm (max (abs alpha) (abs beta)))
(setf (f2cl-lib:fref d-%data%
                    ((f2cl-lib:int-add nl 1))
                    ((1 *))
                    d-%offset%)
      zero)
(f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
              ((> i n) nil)
  (tagbody
   (cond
    ((> (abs (f2cl-lib:fref d (i) ((1 *)))) orgnrm)
     (setf orgnrm
            (abs (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%))))))
  (multiple-value-bind
   (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9)
   (dlascl "G" 0 0 orgnrm one n 1 d n info)
   (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
                    var-8))
   (setf info var-9))
  (setf alpha (/ alpha orgnrm))
  (setf beta (/ beta orgnrm))
  (multiple-value-bind
   (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9
    var-10 var-11 var-12 var-13 var-14 var-15 var-16 var-17 var-18
    var-19 var-20 var-21 var-22 var-23 var-24 var-25 var-26)
   (dlasd7 icompeq nl nr sqre k d z
    (f2cl-lib:array-slice work double-float (iw) ((1 *))) vf
    (f2cl-lib:array-slice work double-float (ivfw) ((1 *))) vl
    (f2cl-lib:array-slice work double-float (ivlw) ((1 *))) alpha beta
    (f2cl-lib:array-slice work double-float (isigma) ((1 *)))
    (f2cl-lib:array-slice iwork fixnum (idx) ((1 *)))

```

[illegible]

```
beta
nil
nil
givptr
nil
nil
nil
nil
nil
nil
nil
nil
nil
k
c
s
nil
nil
info))))))
```

## 7.61 dlasd7 LAPACK

```
<dlasd7.input>≡
)set break resume
)sys rm -f dlasd7.output
)spool dlasd7.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

<dlasd7.help>=

```
=====
dlasd7 examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

DLASD7 - the two sets of singular values together into a single sorted set

#### SYNOPSIS

```
SUBROUTINE DLASD7( ICOMPQ, NL, NR, SQRE, K, D, Z, ZW, VF, VFW, VL, VLW,
                  ALPHA, BETA, DSIGMA, IDX, IDXP, IDXQ, PERM, GIVPTR,
                  GIVCOL, LDGCOL, GIVNUM, LDGNUM, C, S, INFO )

      INTEGER      GIVPTR, ICOMPQ, INFO, K, LDGCOL, LDGNUM, NL, NR,
                  SQRE

      DOUBLE       PRECISION ALPHA, BETA, C, S

      INTEGER      GIVCOL( LDGCOL, * ), IDX( * ), IDXP( * ), IDXQ( * ),
                  PERM( * )

      DOUBLE       PRECISION D( * ), DSIGMA( * ), GIVNUM( LDGNUM, * ),
                  VF( * ), VFW( * ), VL( * ), VLW( * ), Z( * ), ZW( * )
)
```

#### PURPOSE

DLASD7 merges the two sets of singular values together into a single sorted set. Then it tries to deflate the size of the problem. There are two ways in which deflation can occur: when two or more singular values are close together or if there is a tiny entry in the Z vector. For each such occurrence the order of the related secular equation problem is reduced by one.

DLASD7 is called from DLASD6.

#### ARGUMENTS

ICOMPQ (input) INTEGER  
 Specifies whether singular vectors are to be computed in compact form, as follows:  
 = 0: Compute singular values only.



- = 1: Compute singular vectors of upper bidiagonal matrix in compact form.
- NL (input) INTEGER  
The row dimension of the upper block.  $NL \geq 1$ .
- NR (input) INTEGER  
The row dimension of the lower block.  $NR \geq 1$ .
- SQRE (input) INTEGER  
= 0: the lower block is an  $NR$ -by- $NR$  square matrix.  
= 1: the lower block is an  $NR$ -by- $(NR+1)$  rectangular matrix.
- The bidiagonal matrix has  $N = NL + NR + 1$  rows and  $M = N + SQRE \geq N$  columns.
- K (output) INTEGER  
Contains the dimension of the non-deflated matrix, this is the order of the related secular equation.  $1 \leq K \leq N$ .
- D (input/output) DOUBLE PRECISION array, dimension ( N )  
On entry D contains the singular values of the two submatrices to be combined. On exit D contains the trailing  $(N-K)$  updated singular values (those which were deflated) sorted into increasing order.
- Z (output) DOUBLE PRECISION array, dimension ( M )  
On exit Z contains the updating row vector in the secular equation.
- ZW (workspace) DOUBLE PRECISION array, dimension ( M )  
Workspace for Z.
- VF (input/output) DOUBLE PRECISION array, dimension ( M )  
On entry,  $VF(1:NL+1)$  contains the first components of all right singular vectors of the upper block; and  $VF(NL+2:M)$  contains the first components of all right singular vectors of the lower block. On exit, VF contains the first components of all right singular vectors of the bidiagonal matrix.
- VFW (workspace) DOUBLE PRECISION array, dimension ( M )  
Workspace for VF.
- VL (input/output) DOUBLE PRECISION array, dimension ( M )  
On entry,  $VL(1:NL+1)$  contains the last components of all right singular vectors of the upper block; and  $VL(NL+2:M)$  con-

tains the last components of all right singular vectors of the lower block. On exit, VL contains the last components of all right singular vectors of the bidiagonal matrix.

VLW (workspace) DOUBLE PRECISION array, dimension ( M )  
Workspace for VL.

ALPHA (input) DOUBLE PRECISION  
Contains the diagonal element associated with the added row.

BETA (input) DOUBLE PRECISION  
Contains the off-diagonal element associated with the added row.

DSIGMA (output) DOUBLE PRECISION array, dimension ( N ) Contains a copy of the diagonal elements (K-1 singular values and one zero) in the secular equation.

IDX (workspace) INTEGER array, dimension ( N )  
This will contain the permutation used to sort the contents of D into ascending order.

IDXP (workspace) INTEGER array, dimension ( N )  
This will contain the permutation used to place deflated values of D at the end of the array. On output IDXP(2:K) points to the nondeflated D-values and IDXP(K+1:N) points to the deflated singular values.

IDXQ (input) INTEGER array, dimension ( N )  
This contains the permutation which separately sorts the two sub-problems in D into ascending order. Note that entries in the first half of this permutation must first be moved one position backward; and entries in the second half must first have NL+1 added to their values.

PERM (output) INTEGER array, dimension ( N )  
The permutations (from deflation and sorting) to be applied to each singular block. Not referenced if ICOMPQ = 0.

GIVPTR (output) INTEGER The number of Givens rotations which took place in this subproblem. Not referenced if ICOMPQ = 0.

GIVCOL (output) INTEGER array, dimension ( LDGCOL, 2 ) Each pair of numbers indicates a pair of columns to take place in a Givens rotation. Not referenced if ICOMPQ = 0.

LDGCOL (input) INTEGER The leading dimension of GIVCOL, must be

at least N.

GIVNUM (output) DOUBLE PRECISION array, dimension ( LDGNUM, 2 )  
Each number indicates the C or S value to be used in the corresponding Givens rotation. Not referenced if ICOMPQ = 0.

LDGNUM (input) INTEGER The leading dimension of GIVNUM, must be at least N.

C (output) DOUBLE PRECISION  
C contains garbage if SQRE = 0 and the C-value of a Givens rotation related to the right null space if SQRE = 1.

S (output) DOUBLE PRECISION  
S contains garbage if SQRE = 0 and the S-value of a Givens rotation related to the right null space if SQRE = 1.

INFO (output) INTEGER  
= 0: successful exit.  
< 0: if INFO = -i, the i-th argument had an illegal value.

```

(LAPACK dlasd7)=
  (let* ((zero 0.0) (one 1.0) (two 2.0) (eight 8.0))
    (declare (type (double-float 0.0 0.0) zero)
              (type (double-float 1.0 1.0) one)
              (type (double-float 2.0 2.0) two)
              (type (double-float 8.0 8.0) eight))
    (defun dlasd7
      (icompq nl nr sqre k d z zw vf vfw vl vlw alpha beta dsigma idx idxp
       idxq perm givptr givcol ldgcol givnum ldgnum c s info)
      (declare (type (simple-array fixnum (*)) givcol perm idxq idxp idx)
                (type (double-float) s c beta alpha)
                (type (simple-array double-float (*)) givnum dsigma vlw vl vfw vf zw z d)
                (type fixnum info ldgnum ldgcol givptr k sqre nr nl
                        icompq))
      (f2cl-lib:with-multi-array-data
        ((d double-float d-%data% d-%offset%)
         (z double-float z-%data% z-%offset%)
         (zw double-float zw-%data% zw-%offset%)
         (vf double-float vf-%data% vf-%offset%)
         (vfw double-float vfw-%data% vfw-%offset%)
         (vl double-float vl-%data% vl-%offset%)
         (vlw double-float vlw-%data% vlw-%offset%)
         (dsigma double-float dsigma-%data% dsigma-%offset%)
         (givnum double-float givnum-%data% givnum-%offset%)
         (idx fixnum idx-%data% idx-%offset%)
         (idxp fixnum idxp-%data% idxp-%offset%)
         (idxq fixnum idxq-%data% idxq-%offset%)
         (perm fixnum perm-%data% perm-%offset%)
         (givcol fixnum givcol-%data% givcol-%offset%))
        (prog ((eps 0.0) (hlftol 0.0) (tau 0.0) (tol 0.0) (z1 0.0) (i 0) (idxi 0)
              (idxj 0) (idxjp 0) (j 0) (jp 0) (jprev 0) (k2 0) (m 0) (n 0)
              (nlp1 0) (nlp2 0))
              (declare (type (double-float) eps hlftol tau tol z1)
                        (type fixnum i idxi idxj idxjp j jp jprev k2 m n
                                nlp1 nlp2))
              (setf info 0)
              (setf n (f2cl-lib:int-add nl nr 1))
              (setf m (f2cl-lib:int-add n sqre))
              (cond
                ((or (< icompq 0) (> icompq 1))
                 (setf info -1))
                ((< nl 1)
                 (setf info -2))
                ((< nr 1)
                 (setf info -3))
                ((or (< sqre 0) (> sqre 1))

```

```

      (setf info -4))
    (< ldgcol n)
    (setf info -22))
    (< ldgnum n)
    (setf info -24)))
  (cond
    ((/= info 0)
     (error
      " ** On entry to ~a parameter number ~a had an illegal value~%"
      "DLASD7" (f2cl-lib:int-sub info))
     (go end_label)))
  (setf nlp1 (f2cl-lib:int-add nl 1))
  (setf nlp2 (f2cl-lib:int-add nl 2))
  (cond
    ((= icompq 1)
     (setf givptr 0)))
  (setf z1
    (* alpha (f2cl-lib:fref vl-%data% (nlp1) ((1 *)) vl-%offset%)))
  (setf (f2cl-lib:fref vl-%data% (nlp1) ((1 *)) vl-%offset%) zero)
  (setf tau (f2cl-lib:fref vf-%data% (nlp1) ((1 *)) vf-%offset%))
  (f2cl-lib:fd0 (i nl (f2cl-lib:int-add i (f2cl-lib:int-sub 1)))
    (> i 1) nil)
  (tagbody
    (setf (f2cl-lib:fref z-%data%
                        ((f2cl-lib:int-add i 1))
                        ((1 *))
                        z-%offset%)
      (* alpha
        (f2cl-lib:fref vl-%data% (i) ((1 *)) vl-%offset%)))
    (setf (f2cl-lib:fref vl-%data% (i) ((1 *)) vl-%offset%) zero)
    (setf (f2cl-lib:fref vf-%data%
                        ((f2cl-lib:int-add i 1))
                        ((1 *))
                        vf-%offset%)
      (f2cl-lib:fref vf-%data% (i) ((1 *)) vf-%offset%))
    (setf (f2cl-lib:fref d-%data%
                        ((f2cl-lib:int-add i 1))
                        ((1 *))
                        d-%offset%)
      (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%))
    (setf (f2cl-lib:fref idxq-%data%
                        ((f2cl-lib:int-add i 1))
                        ((1 *))
                        idxq-%offset%)
      (f2cl-lib:int-add
        (f2cl-lib:fref idxq-%data% (i) ((1 *)) idxq-%offset%)

```

```

1))))
(setf (f2cl-lib:fref vf-%data% (1) ((1 *)) vf-%offset%) tau)
(f2cl-lib:fdo (i nlp2 (f2cl-lib:int-add i 1))
  (> i m) nil)
(tagbody
  (setf (f2cl-lib:fref z-%data% (i) ((1 *)) z-%offset%)
    (* beta (f2cl-lib:fref vf-%data% (i) ((1 *)) vf-%offset%)))
  (setf (f2cl-lib:fref vf-%data% (i) ((1 *)) vf-%offset%) zero)))
(f2cl-lib:fdo (i nlp2 (f2cl-lib:int-add i 1))
  (> i n) nil)
(tagbody
  (setf (f2cl-lib:fref idxq-%data% (i) ((1 *)) idxq-%offset%)
    (f2cl-lib:int-add
      (f2cl-lib:fref idxq-%data% (i) ((1 *)) idxq-%offset%)
      nlp1))))
(f2cl-lib:fdo (i 2 (f2cl-lib:int-add i 1))
  (> i n) nil)
(tagbody
  (setf (f2cl-lib:fref dsigma-%data% (i) ((1 *)) dsigma-%offset%)
    (f2cl-lib:fref d-%data%
      ((f2cl-lib:fref idxq (i) ((1 *)))
       (1 *))
      d-%offset%))
  (setf (f2cl-lib:fref zw-%data% (i) ((1 *)) zw-%offset%)
    (f2cl-lib:fref z-%data%
      ((f2cl-lib:fref idxq (i) ((1 *)))
       (1 *))
      z-%offset%))
  (setf (f2cl-lib:fref vfw-%data% (i) ((1 *)) vfw-%offset%)
    (f2cl-lib:fref vf-%data%
      ((f2cl-lib:fref idxq (i) ((1 *)))
       (1 *))
      vf-%offset%))
  (setf (f2cl-lib:fref vlw-%data% (i) ((1 *)) vlw-%offset%)
    (f2cl-lib:fref vl-%data%
      ((f2cl-lib:fref idxq (i) ((1 *)))
       (1 *))
      vl-%offset%))))
(dlamrg nl nr (f2cl-lib:array-slice dsigma double-float (2) ((1 *))) 1
  1 (f2cl-lib:array-slice idx fixnum (2) ((1 *))))
(f2cl-lib:fdo (i 2 (f2cl-lib:int-add i 1))
  (> i n) nil)
(tagbody
  (setf idxi
    (f2cl-lib:int-add 1
      (f2cl-lib:fref idx-%data%

```

```

                                (i)
                                ((1 *))
                                idx-%offset%)))
(setf (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%)
      (f2cl-lib:fref dsigma-%data%
                    (idxi)
                    ((1 *))
                    dsigma-%offset%))
(setf (f2cl-lib:fref z-%data% (i) ((1 *)) z-%offset%)
      (f2cl-lib:fref zw-%data% (idxi) ((1 *)) zw-%offset%))
(setf (f2cl-lib:fref vf-%data% (i) ((1 *)) vf-%offset%)
      (f2cl-lib:fref vfw-%data% (idxi) ((1 *)) vfw-%offset%))
(setf (f2cl-lib:fref vl-%data% (i) ((1 *)) vl-%offset%)
      (f2cl-lib:fref vlw-%data% (idxi) ((1 *)) vlw-%offset%)))
(setf eps (dlamch "Epsilon"))
(setf tol (max (abs alpha) (abs beta)))
(setf tol
  (* eight
    eight
    eps
    (max (abs (f2cl-lib:fref d-%data% (n) ((1 *)) d-%offset%)
          tol))))
(setf k 1)
(setf k2 (f2cl-lib:int-add n 1))
(f2cl-lib:fdo (j 2 (f2cl-lib:int-add j 1))
              (> j n) nil)
(tagbody
  (cond
    ((<= (abs (f2cl-lib:fref z (j) ((1 *)))) tol)
      (setf k2 (f2cl-lib:int-sub k2 1))
      (setf (f2cl-lib:fref idxp-%data% (k2) ((1 *)) idxp-%offset%) j)
      (if (= j n) (go label100)))
    (t
      (setf jprev j)
      (go label70)))))
label70
  (setf j jprev)
label80
  (setf j (f2cl-lib:int-add j 1))
  (if (> j n) (go label90))
  (cond
    ((<= (abs (f2cl-lib:fref z (j) ((1 *)))) tol)
      (setf k2 (f2cl-lib:int-sub k2 1))
      (setf (f2cl-lib:fref idxp-%data% (k2) ((1 *)) idxp-%offset%) j))
    (t
      (cond

```

```

((<=
  (abs
    (+ (f2cl-lib:fref d (j) ((1 *)))
      (- (f2cl-lib:fref d (jprev) ((1 *))))))
  tol)
(setf s (f2cl-lib:fref z-%data% (jprev) ((1 *)) z-%offset%))
(setf c (f2cl-lib:fref z-%data% (j) ((1 *)) z-%offset%))
(setf tau (dlapy2 c s))
(setf (f2cl-lib:fref z-%data% (j) ((1 *)) z-%offset%) tau)
(setf (f2cl-lib:fref z-%data% (jprev) ((1 *)) z-%offset%) zero)
(setf c (/ c tau))
(setf s (/ (- s) tau))
(cond
  ((= icompq 1)
    (setf givptr (f2cl-lib:int-add givptr 1))
    (setf idxjp
      (f2cl-lib:fref idxq-%data%
        ((f2cl-lib:int-add
          (f2cl-lib:fref idx (jprev) ((1 *)))
          1))
        ((1 *))
        idxq-%offset%))
    (setf idxj
      (f2cl-lib:fref idxq-%data%
        ((f2cl-lib:int-add
          (f2cl-lib:fref idx (j) ((1 *)))
          1))
        ((1 *))
        idxq-%offset%))
    (cond
      ((<= idxjp nlp1)
        (setf idxjp (f2cl-lib:int-sub idxjp 1))))
    (cond
      ((<= idxj nlp1)
        (setf idxj (f2cl-lib:int-sub idxj 1))))
    (setf (f2cl-lib:fref givcol-%data%
      (givptr 2)
      ((1 ldgcol) (1 *))
      givcol-%offset%)
      idxjp)
    (setf (f2cl-lib:fref givcol-%data%
      (givptr 1)
      ((1 ldgcol) (1 *))
      givcol-%offset%)
      idxj)
    (setf (f2cl-lib:fref givnum-%data%

```



```

(givptr 2)
((1 ldgnum) (1 *))
givnum-%offset%)

c)
(setf (f2cl-lib:fref givnum-%data%
(givptr 1)
((1 ldgnum) (1 *))
givnum-%offset%)

s)))
(drot 1 (f2cl-lib:array-slice vf double-float (jprev) ((1 *))) 1
(f2cl-lib:array-slice vf double-float (j) ((1 *))) 1 c s)
(drot 1 (f2cl-lib:array-slice vl double-float (jprev) ((1 *))) 1
(f2cl-lib:array-slice vl double-float (j) ((1 *))) 1 c s)
(setf k2 (f2cl-lib:int-sub k2 1))
(setf (f2cl-lib:fref idxp-%data% (k2) ((1 *)) idxp-%offset%)
jprev)
(setf jprev j))
(t
(setf k (f2cl-lib:int-add k 1))
(setf (f2cl-lib:fref zw-%data% (k) ((1 *)) zw-%offset%)
(f2cl-lib:fref z-%data% (jprev) ((1 *)) z-%offset%))
(setf (f2cl-lib:fref dsigma-%data% (k) ((1 *)) dsigma-%offset%)
(f2cl-lib:fref d-%data% (jprev) ((1 *)) d-%offset%))
(setf (f2cl-lib:fref idxp-%data% (k) ((1 *)) idxp-%offset%) jprev)
(setf jprev j))))
(go label80)
label90
(setf k (f2cl-lib:int-add k 1))
(setf (f2cl-lib:fref zw-%data% (k) ((1 *)) zw-%offset%)
(f2cl-lib:fref z-%data% (jprev) ((1 *)) z-%offset%))
(setf (f2cl-lib:fref dsigma-%data% (k) ((1 *)) dsigma-%offset%)
(f2cl-lib:fref d-%data% (jprev) ((1 *)) d-%offset%))
(setf (f2cl-lib:fref idxp-%data% (k) ((1 *)) idxp-%offset%) jprev)
label100
(f2cl-lib:fdo (j 2 (f2cl-lib:int-add j 1))
(> j n) nil)
(tagbody
(setf jp (f2cl-lib:fref idxp-%data% (j) ((1 *)) idxp-%offset%))
(setf (f2cl-lib:fref dsigma-%data% (j) ((1 *)) dsigma-%offset%)
(f2cl-lib:fref d-%data% (jp) ((1 *)) d-%offset%))
(setf (f2cl-lib:fref vfw-%data% (j) ((1 *)) vfw-%offset%)
(f2cl-lib:fref vf-%data% (jp) ((1 *)) vf-%offset%))
(setf (f2cl-lib:fref vlw-%data% (j) ((1 *)) vlw-%offset%)
(f2cl-lib:fref vl-%data% (jp) ((1 *)) vl-%offset%))))
(cond
(= icompq 1)

```

```

(f2cl-lib:fdo (j 2 (f2cl-lib:int-add j 1))
  (> j n) nil)
(tagbody
  (setf jp (f2cl-lib:fref idxp-%data% (j) ((1 *)) idxp-%offset%))
  (setf (f2cl-lib:fref perm-%data% (j) ((1 *)) perm-%offset%)
    (f2cl-lib:fref idxq-%data%
      ((f2cl-lib:int-add
        (f2cl-lib:fref idx (jp) ((1 *)))
        1))
      ((1 *))
      idxq-%offset%))
  (cond
    ((<= (f2cl-lib:fref perm (j) ((1 *))) nlp1)
      (setf (f2cl-lib:fref perm-%data% (j) ((1 *)) perm-%offset%)
        (f2cl-lib:int-sub
          (f2cl-lib:fref perm-%data%
            (j)
            ((1 *))
            perm-%offset%)
          1))))))
(dcopy (f2cl-lib:int-sub n k)
  (f2cl-lib:array-slice dsigma double-float ((+ k 1)) ((1 *))) 1
  (f2cl-lib:array-slice d double-float ((+ k 1)) ((1 *))) 1)
(setf (f2cl-lib:fref dsigma-%data% (1) ((1 *)) dsigma-%offset%) zero)
(setf hlftol (/ tol two))
(if
  (<= (abs (f2cl-lib:fref dsigma-%data% (2) ((1 *)) dsigma-%offset%))
    hlftol)
  (setf (f2cl-lib:fref dsigma-%data% (2) ((1 *)) dsigma-%offset%)
    hlftol))
(cond
  (> m n)
  (setf (f2cl-lib:fref z-%data% (1) ((1 *)) z-%offset%)
    (dlapy2 z1 (f2cl-lib:fref z-%data% (m) ((1 *)) z-%offset%)))
  (cond
    ((<= (f2cl-lib:fref z (1) ((1 *))) tol)
      (setf c one)
      (setf s zero)
      (setf (f2cl-lib:fref z-%data% (1) ((1 *)) z-%offset%) tol))
    (t
      (setf c (/ z1 (f2cl-lib:fref z-%data% (1) ((1 *)) z-%offset%)))
      (setf s
        (/ (- (f2cl-lib:fref z-%data% (m) ((1 *)) z-%offset%)
          (f2cl-lib:fref z-%data% (1) ((1 *)) z-%offset%))))))
  (drot 1 (f2cl-lib:array-slice vf double-float (m) ((1 *))) 1
    (f2cl-lib:array-slice vf double-float (1) ((1 *))) 1 c s)

```

[illegible]

## 7.62 dlasd8 LAPACK

```
(dlasd8.input)≡  
  )set break resume  
  )sys rm -f dlasd8.output  
  )spool dlasd8.output  
  )set message test on  
  )set message auto off  
  )clear all  
  
  )spool  
  )lisp (bye)
```

`<dlasd8.help>=`

```
=====
dlasd8 examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

DLASD8 - the square roots of the roots of the secular equation,

#### SYNOPSIS

```
SUBROUTINE DLASD8( ICOMPQ, K, D, Z, VF, VL, DIFL, DIFR, LDDIFR, DSIGMA,
                   WORK, INFO )
```

```
      INTEGER      ICOMPQ, INFO, K, LDDIFR
```

```
      DOUBLE      PRECISION D( * ), DIFL( * ), DIFR( LDDIFR, * ),
                   DSIGMA( * ), VF( * ), VL( * ), WORK( * ), Z( * )
```

#### PURPOSE

DLASD8 finds the square roots of the roots of the secular equation, as defined by the values in DSIGMA and Z. It makes the appropriate calls to DLASD4, and stores, for each element in D, the distance to its two nearest poles (elements in DSIGMA). It also updates the arrays VF and VL, the first and last components of all the right singular vectors of the original bidiagonal matrix.

DLASD8 is called from DLASD6.

#### ARGUMENTS

ICOMPQ (input) INTEGER

Specifies whether singular vectors are to be computed in factored form in the calling routine:

= 0: Compute singular values only.

= 1: Compute singular vectors in factored form as well.

K (input) INTEGER

The number of terms in the rational function to be solved by DLASD4.  $K \geq 1$ .

D (output) DOUBLE PRECISION array, dimension ( K )

On output, D contains the updated singular values.

- Z** (input) DOUBLE PRECISION array, dimension ( K )  
The first K elements of this array contain the components of the deflation-adjusted updating row vector.
- VF** (input/output) DOUBLE PRECISION array, dimension ( K )  
On entry, VF contains information passed through DBEDE8. On exit, VF contains the first K components of the first components of all right singular vectors of the bidiagonal matrix.
- VL** (input/output) DOUBLE PRECISION array, dimension ( K )  
On entry, VL contains information passed through DBEDE8. On exit, VL contains the first K components of the last components of all right singular vectors of the bidiagonal matrix.
- DIFL** (output) DOUBLE PRECISION array, dimension ( K )  
On exit,  $DIFL(I) = D(I) - DSIGMA(I)$ .
- DIFR** (output) DOUBLE PRECISION array,  
dimension ( LDDIFR, 2 ) if ICOMPQ = 1 and dimension ( K ) if ICOMPQ = 0. On exit,  $DIFR(I,1) = D(I) - DSIGMA(I+1)$ ,  $DIFR(K,1)$  is not defined and will not be referenced.
- If ICOMPQ = 1,  $DIFR(1:K,2)$  is an array containing the normalizing factors for the right singular vector matrix.
- LDDIFR** (input) INTEGER  
The leading dimension of DIFR, must be at least K.
- DSIGMA** (input) DOUBLE PRECISION array, dimension ( K )  
The first K elements of this array contain the old roots of the deflated updating problem. These are the poles of the secular equation.
- WORK** (workspace) DOUBLE PRECISION array, dimension at least  $3 * K$
- INFO** (output) INTEGER  
= 0: successful exit.  
< 0: if INFO = -i, the i-th argument had an illegal value.  
> 0: if INFO = 1, an singular value did not converge

```

(LAPACK dlasd8)=
  (let* ((one 1.0))
    (declare (type (double-float 1.0 1.0) one))
    (defun dlasd8 (icompq k d z vf vl difl difr lddifr dsigma work info)
      (declare (type (simple-array double-float (*)) work dsigma difr difl vl vf z
                    (type fixnum info lddifr k icompq))
        (f2cl-lib:with-multi-array-data
          ((d double-float d-%data% d-%offset%)
           (z double-float z-%data% z-%offset%)
           (vf double-float vf-%data% vf-%offset%)
           (vl double-float vl-%data% vl-%offset%)
           (difl double-float difl-%data% difl-%offset%)
           (difr double-float difr-%data% difr-%offset%)
           (dsigma double-float dsigma-%data% dsigma-%offset%)
           (work double-float work-%data% work-%offset%))
        (prog ((diflj 0.0) (difrj 0.0) (dj 0.0) (dsigj 0.0) (dsigjp 0.0)
              (rho 0.0) (temp 0.0) (i 0) (iwk1 0) (iwk2 0) (iwk2i 0) (iwk3 0)
              (iwk3i 0) (j 0))
          (declare (type (double-float) diflj difrj dj dsigj dsigjp rho temp)
            (type fixnum i iwkl iwkl2 iwkl2i iwkl3 iwkl3i j))
          (setf info 0)
          (cond
            ((or (< icompq 0) (> icompq 1))
              (setf info -1))
            ((< k 1)
              (setf info -2))
            ((< lddifr k)
              (setf info -9)))
          (cond
            ((/= info 0)
              (error
               " ** On entry to ~a parameter number ~a had an illegal value~%"
               "DLASD8" (f2cl-lib:int-sub info))
              (go end_label)))
          (cond
            ((= k 1)
              (setf (f2cl-lib:fref d-%data% (1) ((1 *)) d-%offset%)
                    (abs (f2cl-lib:fref z-%data% (1) ((1 *)) z-%offset%)))
              (setf (f2cl-lib:fref difl-%data% (1) ((1 *)) difl-%offset%)
                    (f2cl-lib:fref d-%data% (1) ((1 *)) d-%offset%))
              (cond
                ((= icompq 1)
                  (setf (f2cl-lib:fref difl-%data% (2) ((1 *)) difl-%offset%) one)
                  (setf (f2cl-lib:fref difr-%data%
                                         (1 2)
                                         ((1 lddifr) (1 *)))
                        (1 2)
                        ((1 lddifr) (1 *)))

```

```

                                difr-%offset%)
                                one)))
    (go end_label)))
  (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
    (> i k) nil)
  (tagbody
    (setf (f2cl-lib:fref dsigma-%data% (i) ((1 *)) dsigma-%offset%)
      (-
        (multiple-value-bind (ret-val var-0 var-1)
          (dlamc3
            (f2cl-lib:fref dsigma-%data%
              (i)
              ((1 *))
              dsigma-%offset%)
            (f2cl-lib:fref dsigma-%data%
              (i)
              ((1 *))
              dsigma-%offset%)))
          (declare (ignore))
          (setf (f2cl-lib:fref dsigma-%data%
            (i)
            ((1 *))
            dsigma-%offset%)
              var-0)
          (setf (f2cl-lib:fref dsigma-%data%
            (i)
            ((1 *))
            dsigma-%offset%)
              var-1)
          ret-val)
        (f2cl-lib:fref dsigma-%data%
          (i)
          ((1 *))
          dsigma-%offset%))))))
  (setf iwk1 1)
  (setf iwk2 (f2cl-lib:int-add iwk1 k))
  (setf iwk3 (f2cl-lib:int-add iwk2 k))
  (setf iwk2i (f2cl-lib:int-sub iwk2 1))
  (setf iwk3i (f2cl-lib:int-sub iwk3 1))
  (setf rho (dnrm2 k z 1))
  (multiple-value-bind
    (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9)
    (dlascl "G" 0 0 rho one k 1 z k info)
    (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
      var-8))
    (setf info var-9))

```



```

(setf rho (* rho rho))
(dlaset "A" k 1 one one
  (f2cl-lib:array-slice work double-float (iwk3) ((1 *))) k)
(f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
  (> j k) nil)
(tagbody
  (multiple-value-bind
    (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8)
    (dlasd4 k j dsigma z
      (f2cl-lib:array-slice work double-float (iwk1) ((1 *))) rho
      (f2cl-lib:fref d-%data% (j) ((1 *)) d-%offset%)
      (f2cl-lib:array-slice work double-float (iwk2) ((1 *))) info)
    (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-7))
    (setf (f2cl-lib:fref d-%data% (j) ((1 *)) d-%offset%) var-6)
    (setf info var-8))
  (cond
    ((/= info 0)
     (go end_label)))
  (setf (f2cl-lib:fref work-%data%
    ((f2cl-lib:int-add iw3i j))
    ((1 *))
    work-%offset%)
    (*
      (f2cl-lib:fref work-%data%
        ((f2cl-lib:int-add iw3i j))
        ((1 *))
        work-%offset%)
      (f2cl-lib:fref work-%data% (j) ((1 *)) work-%offset%)
      (f2cl-lib:fref work-%data%
        ((f2cl-lib:int-add iw2i j))
        ((1 *))
        work-%offset%)))
  (setf (f2cl-lib:fref difl-%data% (j) ((1 *)) difl-%offset%)
    (- (f2cl-lib:fref work-%data% (j) ((1 *)) work-%offset%)))
  (setf (f2cl-lib:fref difr-%data%
    (j 1)
    ((1 lddifr) (1 *))
    difr-%offset%)
    (-
      (f2cl-lib:fref work-%data%
        ((f2cl-lib:int-add j 1))
        ((1 *))
        work-%offset%)))
  (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
    (> i (f2cl-lib:int-add j (f2cl-lib:int-sub 1))) nil)
  (tagbody

```



```

(*
  (f2cl-lib:fref work-%data%
    ((f2cl-lib:int-add iwk3i i))
    ((1 *))
    work-%offset%)
  (f2cl-lib:fref work-%data%
    (i)
    ((1 *))
    work-%offset%)
  (f2cl-lib:fref work-%data%
    ((f2cl-lib:int-add iwk2i i))
    ((1 *))
    work-%offset%))
(-
  (f2cl-lib:fref dsigma-%data%
    (i)
    ((1 *))
    dsigma-%offset%)
  (f2cl-lib:fref dsigma-%data%
    (j)
    ((1 *))
    dsigma-%offset%)))
(+
  (f2cl-lib:fref dsigma-%data%
    (i)
    ((1 *))
    dsigma-%offset%)
  (f2cl-lib:fref dsigma-%data%
    (j)
    ((1 *))
    dsigma-%offset%))))))
(f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
  (> i k) nil)
(tagbody
  (setf (f2cl-lib:fref z-%data% (i) ((1 *)) z-%offset%)
    (f2cl-lib:sign
      (f2cl-lib:fsqrt
        (abs
          (f2cl-lib:fref work-%data%
            ((f2cl-lib:int-add iwk3i i))
            ((1 *))
            work-%offset%)))
        (f2cl-lib:fref z-%data% (i) ((1 *)) z-%offset%))))))
(f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
  (> j k) nil)
(tagbody

```

```

(setf diflj (f2cl-lib:fref difl-%data% (j) ((1 *)) difl-%offset%))
(setf dj (f2cl-lib:fref d-%data% (j) ((1 *)) d-%offset%))
(setf dsigj
  (-
    (f2cl-lib:fref dsigma-%data%
      (j)
      ((1 *))
      dsigma-%offset%)))
(cond
  ((< j k)
    (setf difrj
      (-
        (f2cl-lib:fref difr-%data%
          (j 1)
          ((1 lddifr) (1 *))
          difr-%offset%)))

    (setf dsigjp
      (-
        (f2cl-lib:fref dsigma-%data%
          ((f2cl-lib:int-add j 1))
          ((1 *))
          dsigma-%offset%))))))
(setf (f2cl-lib:fref work-%data% (j) ((1 *)) work-%offset%)
  (/
    (/ (- (f2cl-lib:fref z-%data% (j) ((1 *)) z-%offset%)
      diflj)
      (+
        (f2cl-lib:fref dsigma-%data% (j) ((1 *)) dsigma-%offset%)
        dj)))
(f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
  ((> i (f2cl-lib:int-add j (f2cl-lib:int-sub 1))) nil)
(tagbody
  (setf (f2cl-lib:fref work-%data% (i) ((1 *)) work-%offset%)
    (/
      (/ (f2cl-lib:fref z-%data% (i) ((1 *)) z-%offset%)
        (-
          (multiple-value-bind (ret-val var-0 var-1)
            (dlamc3
              (f2cl-lib:fref dsigma-%data%
                (i)
                ((1 *))
                dsigma-%offset%)
              dsigj)
            (declare (ignore))
            (setf (f2cl-lib:fref dsigma-%data%
              (i)

```

```

                                ((1 *))
                                dsigma-%offset%)
                                var-0)
                                (setf dsigj var-1)
                                ret-val)
                                diflj))
(+
  (f2cl-lib:fref dsigma-%data%
    (i)
    ((1 *))
    dsigma-%offset%)
  dj))))
(f2cl-lib:fdo (i (f2cl-lib:int-add j 1) (f2cl-lib:int-add i 1))
  (> i k) nil)
(tagbody
  (setf (f2cl-lib:fref work-%data% (i) ((1 *)) work-%offset%)
    (/
      (/ (f2cl-lib:fref z-%data% (i) ((1 *)) z-%offset%)
        (+
          (multiple-value-bind (ret-val var-0 var-1)
            (dlamc3
              (f2cl-lib:fref dsigma-%data%
                (i)
                ((1 *))
                dsigma-%offset%)
              dsigjp)
            (declare (ignore))
            (setf (f2cl-lib:fref dsigma-%data%
              (i)
              ((1 *))
              dsigma-%offset%)
                var-0)
              (setf dsigjp var-1)
              ret-val)
            difrj))
          (+
            (f2cl-lib:fref dsigma-%data%
              (i)
              ((1 *))
              dsigma-%offset%)
            dj))))))
(setf temp (dnrm2 k work 1))
(setf (f2cl-lib:fref work-%data%
  ((f2cl-lib:int-add iwk2i j))
  ((1 *))
  work-%offset%)

```

```

        (/ (ddot k work 1 vf 1) temp))
      (setf (f2cl-lib:fref work-%data%
                          ((f2cl-lib:int-add iwk3i j))
                          ((1 *))
                          work-%offset%))
        (/ (ddot k work 1 vl 1) temp))
    (cond
      ((= icompq 1)
       (setf (f2cl-lib:fref difr-%data%
                           (j 2)
                           ((1 lddifr) (1 *))
                           difr-%offset%))
         temp))))
    (dcopy k (f2cl-lib:array-slice work double-float (iwk2) ((1 *))) 1 vf 1)
    (dcopy k (f2cl-lib:array-slice work double-float (iwk3) ((1 *))) 1 vl 1)
  end_label
  (return (values nil nil nil nil nil nil nil nil nil nil info))))))

```

## 7.63 dlasda LAPACK

```

<dlasda.input>≡
)set break resume
)sys rm -f dlasda.output
)spool dlasda.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)

```

`<dlasda.help>=`

```
=====
dlasda examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

DLASDA - divide and conquer approach, DLASDA computes the singular value decomposition (SVD) of a real upper bidiagonal N-by-M matrix B with diagonal D and offdiagonal E, where  $M = N + \text{SQRE}$

#### SYNOPSIS

```
SUBROUTINE DLASDA( ICOMPQ, SMLSIZ, N, SQRE, D, E, U, LDU, VT, K, DIFL,
                  DIFR, Z, POLES, GIVPTR, GIVCOL, LDGCOL, PERM,
                  GIVNUM, C, S, WORK, IWORK, INFO )
```

```
      INTEGER      ICOMPQ, INFO, LDGCOL, LDU, N, SMLSIZ, SQRE
```

```
      INTEGER      GIVCOL( LDGCOL, * ), GIVPTR( * ), IWORK( * ), K( *
                        ), PERM( LDGCOL, * )
```

```
      DOUBLE      PRECISION C( * ), D( * ), DIFL( LDU, * ), DIFR( LDU,
                        * ), E( * ), GIVNUM( LDU, * ), POLES( LDU, * ), S( *
                        ), U( LDU, * ), VT( LDU, * ), WORK( * ), Z( LDU, * )
```

#### PURPOSE

Using a divide and conquer approach, DLASDA computes the singular value decomposition (SVD) of a real upper bidiagonal N-by-M matrix B with diagonal D and offdiagonal E, where  $M = N + \text{SQRE}$ . The algorithm computes the singular values in the SVD  $B = U * S * VT$ . The orthogonal matrices U and VT are optionally computed in compact form.

A related subroutine, DLASDO, computes the singular values and the singular vectors in explicit form.

#### ARGUMENTS

ICOMPQ (input) INTEGER Specifies whether singular vectors are to be computed in compact form, as follows = 0: Compute singular values only. = 1: Compute singular vectors of upper bidiagonal matrix in compact form.

SMLSIZ (input) INTEGER The maximum size of the subproblems at the bot-

tom of the computation tree.

- N (input) INTEGER  
The row dimension of the upper bidiagonal matrix. This is also the dimension of the main diagonal array D.
- SQRE (input) INTEGER  
Specifies the column dimension of the bidiagonal matrix. = 0:  
The bidiagonal matrix has column dimension  $M = N$ ;  
= 1: The bidiagonal matrix has column dimension  $M = N + 1$ .
- D (input/output) DOUBLE PRECISION array, dimension ( N )  
On entry D contains the main diagonal of the bidiagonal matrix.  
On exit D, if INFO = 0, contains its singular values.
- E (input) DOUBLE PRECISION array, dimension ( M-1 )  
Contains the subdiagonal entries of the bidiagonal matrix. On exit, E has been destroyed.
- U (output) DOUBLE PRECISION array,  
dimension ( LDU, SMLSIZ ) if ICOMPQ = 1, and not referenced if ICOMPQ = 0. If ICOMPQ = 1, on exit, U contains the left singular vector matrices of all subproblems at the bottom level.
- LDU (input) INTEGER, LDU = > N.  
The leading dimension of arrays U, VT, DIFL, DIFR, POLES, GIVNUM, and Z.
- VT (output) DOUBLE PRECISION array,  
dimension ( LDU, SMLSIZ+1 ) if ICOMPQ = 1, and not referenced if ICOMPQ = 0. If ICOMPQ = 1, on exit, VT' contains the right singular vector matrices of all subproblems at the bottom level.
- K (output) INTEGER array,  
dimension ( N ) if ICOMPQ = 1 and dimension 1 if ICOMPQ = 0. If ICOMPQ = 1, on exit, K(I) is the dimension of the I-th secular equation on the computation tree.
- DIFL (output) DOUBLE PRECISION array, dimension ( LDU, NLVL ),  
where NLVL = floor(log<sub>2</sub> (N/SMLSIZ)).
- DIFR (output) DOUBLE PRECISION array,  
dimension ( LDU, 2 \* NLVL ) if ICOMPQ = 1 and dimension ( N ) if ICOMPQ = 0. If ICOMPQ = 1, on exit, DIFL(1:N, I) and DIFR(1:N, 2 \* I - 1) record distances between singular values on the I-th level and singular values on the (I -1)-th level, and DIFR(1:N,



$2 * I$  ) contains the normalizing factors for the right singular vector matrix. See DLASD8 for details.

**Z** (output) DOUBLE PRECISION array,  
dimension ( LDU, NLVL ) if ICOMPQ = 1 and dimension ( N ) if ICOMPQ = 0. The first K elements of Z(1, I) contain the components of the deflation-adjusted updating row vector for subproblems on the I-th level.

**POLES** (output) DOUBLE PRECISION array,  
dimension ( LDU,  $2 * NLVL$  ) if ICOMPQ = 1, and not referenced if ICOMPQ = 0. If ICOMPQ = 1, on exit, POLES(1,  $2*I - 1$ ) and POLES(1,  $2*I$ ) contain the new and old singular values involved in the secular equations on the I-th level.

**GIVPTR** (output) INTEGER array, dimension ( N ) if ICOMPQ = 1, and not referenced if ICOMPQ = 0. If ICOMPQ = 1, on exit, GIVPTR( I ) records the number of Givens rotations performed on the I-th problem on the computation tree.

**GIVCOL** (output) INTEGER array, dimension ( LDGCOL,  $2 * NLVL$  ) if ICOMPQ = 1, and not referenced if ICOMPQ = 0. If ICOMPQ = 1, on exit, for each I, GIVCOL(1,  $2 * I - 1$ ) and GIVCOL(1,  $2 * I$ ) record the locations of Givens rotations performed on the I-th level on the computation tree.

**LDGCOL** (input) INTEGER, LDGCOL = > N. The leading dimension of arrays GIVCOL and PERM.

**PERM** (output) INTEGER array,  
dimension ( LDGCOL, NLVL ) if ICOMPQ = 1, and not referenced if ICOMPQ = 0. If ICOMPQ = 1, on exit, PERM(1, I) records permutations done on the I-th level of the computation tree.

**GIVNUM** (output) DOUBLE PRECISION array, dimension ( LDU,  $2 * NLVL$  ) if ICOMPQ = 1, and not referenced if ICOMPQ = 0. If ICOMPQ = 1, on exit, for each I, GIVNUM(1,  $2 * I - 1$ ) and GIVNUM(1,  $2 * I$ ) record the C- and S- values of Givens rotations performed on the I-th level on the computation tree.

**C** (output) DOUBLE PRECISION array,  
dimension ( N ) if ICOMPQ = 1, and dimension 1 if ICOMPQ = 0. If ICOMPQ = 1 and the I-th subproblem is not square, on exit, C( I ) contains the C-value of a Givens rotation related to the right null space of the I-th subproblem.

**S** (output) DOUBLE PRECISION array, dimension (  $N$  ) if  $ICOMPQ = 1$ , and dimension 1 if  $ICOMPQ = 0$ . If  $ICOMPQ = 1$  and the  $I$ -th subproblem is not square, on exit,  $S(I)$  contains the  $S$ -value of a Givens rotation related to the right null space of the  $I$ -th subproblem.

**WORK** (workspace) DOUBLE PRECISION array, dimension  $(6 * N + (SMLSIZ + 1) * (SMLSIZ + 1))$ .

**IWORK** (workspace) INTEGER array.  
Dimension must be at least  $(7 * N)$ .

**INFO** (output) INTEGER  
= 0: successful exit.  
< 0: if  $INFO = -i$ , the  $i$ -th argument had an illegal value.  
> 0: if  $INFO = 1$ , an singular value did not converge

```

(LAPACK dlasda)=
  (let* ((zero 0.0) (one 1.0))
    (declare (type (double-float 0.0 0.0) zero)
              (type (double-float 1.0 1.0) one))
    (defun dlasda
      (icompq smlsiz n sqre d e u ldu vt k difl difr z poles givptr givcol
       ldgcol perm givnum c s work iwork info)
      (declare (type (simple-array fixnum (*)) iwork perm givcol givptr k)
                (type (simple-array double-float (*)) work s c givnum poles z difr d
                      vt u e d)
                (type fixnum info ldgcol ldu sqre n smlsiz icompq))
      (f2cl-lib:with-multi-array-data
        ((d double-float d-%data% d-%offset%)
         (e double-float e-%data% e-%offset%)
         (u double-float u-%data% u-%offset%)
         (vt double-float vt-%data% vt-%offset%)
         (difl double-float difl-%data% difl-%offset%)
         (difr double-float difr-%data% difr-%offset%)
         (z double-float z-%data% z-%offset%)
         (poles double-float poles-%data% poles-%offset%)
         (givnum double-float givnum-%data% givnum-%offset%)
         (c double-float c-%data% c-%offset%)
         (s double-float s-%data% s-%offset%)
         (work double-float work-%data% work-%offset%)
         (k fixnum k-%data% k-%offset%)
         (givptr fixnum givptr-%data% givptr-%offset%)
         (givcol fixnum givcol-%data% givcol-%offset%)
         (perm fixnum perm-%data% perm-%offset%)
         (iwork fixnum iwork-%data% iwork-%offset%))
        (prog ((alpha 0.0) (beta 0.0) (i 0) (i1 0) (ic 0) (idxq 0) (idxqi 0)
              (im1 0) (inode 0) (itemp 0) (iwk 0) (j 0) (lf 0) (ll 0) (lvl 0)
              (lvl2 0) (m 0) (ncc 0) (nd 0) (ndb1 0) (ndiml 0) (ndimr 0) (nl 0)
              (nlf 0) (nlp1 0) (nlvl 0) (nr 0) (nrf 0) (nrp1 0) (nru 0)
              (nwork1 0) (nwork2 0) (smlszp 0) (sqrei 0) (vf 0) (vfi 0) (vl 0)
              (vli 0))
              (declare (type (double-float) alpha beta)
                        (type fixnum i i1 ic idxq idxqi im1 inode itemp
                               iw k j lf ll lvl lvl2 m ncc nd ndb1
                               ndiml ndimr nl nlf nlp1 nlvl nr nrf
                               nrp1 nru nwork1 nwork2 smlszp sqrei
                               vf vfi vl vli))

              (setf info 0)
              (cond
                ((or (< icompq 0) (> icompq 1))
                 (setf info -1))
                ((< smlsiz 3)
                 (setf info -1))
                (t
                 (setf info 0))))))

```

```

      (setf info -2))
    ((< n 0)
      (setf info -3))
    ((or (< sqre 0) (> sqre 1))
      (setf info -4))
    ((< ldu (f2cl-lib:int-add n sqre))
      (setf info -8))
    ((< ldgcol n)
      (setf info -17)))
  (cond
    ((/= info 0)
      (error
        " ** On entry to ~a parameter number ~a had an illegal value~%"
        "DLASDA" (f2cl-lib:int-sub info))
      (go end_label)))
  (setf m (f2cl-lib:int-add n sqre))
  (cond
    ((<= n smlsiz)
      (cond
        ((= icompq 0)
          (multiple-value-bind
            (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
             var-9 var-10 var-11 var-12 var-13 var-14 var-15)
            (dlasdq "U" sqre n 0 0 0 d e vt ldu u ldu u ldu work info)
            (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                           var-7 var-8 var-9 var-10 var-11 var-12 var-13
                           var-14))
              (setf info var-15))))
          (t
            (multiple-value-bind
              (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
               var-9 var-10 var-11 var-12 var-13 var-14 var-15)
              (dlasdq "U" sqre n m n 0 d e vt ldu u ldu u ldu work info)
              (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                             var-7 var-8 var-9 var-10 var-11 var-12 var-13
                             var-14))
                (setf info var-15))))
            (go end_label)))
      (setf inode 1)
      (setf ndiml (f2cl-lib:int-add inode n))
      (setf ndimr (f2cl-lib:int-add ndiml n))
      (setf idxq (f2cl-lib:int-add ndimr n))
      (setf iwk (f2cl-lib:int-add idxq n))
      (setf ncc 0)
      (setf nru 0)
      (setf smlszp (f2cl-lib:int-add smlsiz 1))

```

```

(setf vf 1)
(setf vl (f2cl-lib:int-add vf m))
(setf nwork1 (f2cl-lib:int-add vl m))
(setf nwork2
  (f2cl-lib:int-add nwork1 (f2cl-lib:int-mul smlszp smlszp)))
(multiple-value-bind (var-0 var-1 var-2 var-3 var-4 var-5 var-6)
  (dlasdt n nlvl nd
    (f2cl-lib:array-slice iwork fixnum (inode) ((1 *)))
    (f2cl-lib:array-slice iwork fixnum (ndiml) ((1 *)))
    (f2cl-lib:array-slice iwork fixnum (ndimr) ((1 *)))
    smlsiz)
  (declare (ignore var-0 var-3 var-4 var-5 var-6))
  (setf nlvl var-1)
  (setf nd var-2))
(setf ndb1 (the fixnum (truncate (+ nd 1) 2)))
(f2cl-lib:fdo (i ndb1 (f2cl-lib:int-add i 1))
  (> i nd) nil)
(tagbody
  (setf i1 (f2cl-lib:int-sub i 1))
  (setf ic
    (f2cl-lib:fref iwork-%data%
      ((f2cl-lib:int-add inode i1))
      ((1 *))
      iwork-%offset%))
  (setf nl
    (f2cl-lib:fref iwork-%data%
      ((f2cl-lib:int-add ndiml i1))
      ((1 *))
      iwork-%offset%))
  (setf nlp1 (f2cl-lib:int-add nl 1))
  (setf nr
    (f2cl-lib:fref iwork-%data%
      ((f2cl-lib:int-add ndimr i1))
      ((1 *))
      iwork-%offset%))
  (setf nlf (f2cl-lib:int-sub ic nl))
  (setf nrf (f2cl-lib:int-add ic 1))
  (setf idxqi (f2cl-lib:int-sub (f2cl-lib:int-add idxq nlf) 2))
  (setf vfi (f2cl-lib:int-sub (f2cl-lib:int-add vf nlf) 1))
  (setf vli (f2cl-lib:int-sub (f2cl-lib:int-add vl nlf) 1))
  (setf sqrei 1)
  (cond
    ((= icompq 0)
     (dlaset "A" nlp1 nlp1 zero one
       (f2cl-lib:array-slice work double-float (nwork1) ((1 *)))
       smlszp)

```

```

(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
   var-9 var-10 var-11 var-12 var-13 var-14 var-15)
  (dlasdq "U" sqrei nl nlp1 nru ncc
   (f2cl-lib:array-slice d double-float (nlf) ((1 *)))
   (f2cl-lib:array-slice e double-float (nlf) ((1 *)))
   (f2cl-lib:array-slice work double-float (nwork1) ((1 *)))
   smlszp
   (f2cl-lib:array-slice work double-float (nwork2) ((1 *)))
   nl
   (f2cl-lib:array-slice work double-float (nwork2) ((1 *)))
   nl
   (f2cl-lib:array-slice work double-float (nwork2) ((1 *)))
   info)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                   var-7 var-8 var-9 var-10 var-11 var-12 var-13
                   var-14))
  (setf info var-15))
(setf itemp
  (f2cl-lib:int-add nwork1 (f2cl-lib:int-mul nl smlszp)))
(dcopy nlp1
  (f2cl-lib:array-slice work double-float (nwork1) ((1 *))) 1
  (f2cl-lib:array-slice work double-float (vfi) ((1 *))) 1)
(dcopy nlp1
  (f2cl-lib:array-slice work double-float (itemp) ((1 *))) 1
  (f2cl-lib:array-slice work double-float (vli) ((1 *))) 1))
(t
  (dlaset "A" nl nl zero one
   (f2cl-lib:array-slice u double-float (nlf 1) ((1 ldu) (1 *)))
   ldu)
  (dlaset "A" nlp1 nlp1 zero one
   (f2cl-lib:array-slice vt double-float (nlf 1) ((1 ldu) (1 *)))
   ldu)
  (multiple-value-bind
    (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
     var-9 var-10 var-11 var-12 var-13 var-14 var-15)
    (dlasdq "U" sqrei nl nlp1 nl ncc
     (f2cl-lib:array-slice d double-float (nlf) ((1 *)))
     (f2cl-lib:array-slice e double-float (nlf) ((1 *)))
     (f2cl-lib:array-slice vt
                          double-float
                          (nlf 1)
                          ((1 ldu) (1 *)))
     ldu
     (f2cl-lib:array-slice u
                          double-float

```

```

(nlf 1)
((1 ldu) (1 *)))

ldu
(f2cl-lib:array-slice u
  double-float
  (nlf 1)
  ((1 ldu) (1 *)))

ldu
(f2cl-lib:array-slice work double-float (nwork1) ((1 *)))
info)
(declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
  var-7 var-8 var-9 var-10 var-11 var-12 var-13
  var-14))
(setf info var-15))
(dcopy nlp1
  (f2cl-lib:array-slice vt double-float (nlf 1) ((1 ldu) (1 *)))
  1 (f2cl-lib:array-slice work double-float (vfi) ((1 *))) 1)
(dcopy nlp1
  (f2cl-lib:array-slice vt
    double-float
    (nlf nlp1)
    ((1 ldu) (1 *)))
  1 (f2cl-lib:array-slice work double-float (vli) ((1 *))) 1)))
(cond
  ((/= info 0)
   (go end_label)))
(f2cl-lib:fd0 (j 1 (f2cl-lib:int-add j 1))
  ((> j nl) nil)
(tagbody
  (setf (f2cl-lib:fref iwork-%data%
    ((f2cl-lib:int-add idxqi j))
    ((1 *))
    iwork-%offset%)
    j)))
(cond
  ((and (= i nd) (= sqre 0))
   (setf sqrei 0))
  (t
   (setf sqrei 1)))
(setf idxqi (f2cl-lib:int-add idxqi nlp1))
(setf vfi (f2cl-lib:int-add vfi nlp1))
(setf vli (f2cl-lib:int-add vli nlp1))
(setf nrp1 (f2cl-lib:int-add nr sqrei))
(cond
  ((= icompq 0)
   (dlaset "A" nrp1 nrp1 zero one

```

```

(f2cl-lib:array-slice work double-float (nwork1) ((1 *)))
smlszp)
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
   var-9 var-10 var-11 var-12 var-13 var-14 var-15)
  (dlasdq "U" sqrei nr nrp1 nru ncc
   (f2cl-lib:array-slice d double-float (nrf) ((1 *)))
   (f2cl-lib:array-slice e double-float (nrf) ((1 *)))
   (f2cl-lib:array-slice work double-float (nwork1) ((1 *)))
   smlszp
   (f2cl-lib:array-slice work double-float (nwork2) ((1 *)))
   nr
   (f2cl-lib:array-slice work double-float (nwork2) ((1 *)))
   nr
   (f2cl-lib:array-slice work double-float (nwork2) ((1 *)))
   info)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                   var-7 var-8 var-9 var-10 var-11 var-12 var-13
                   var-14))
  (setf info var-15))
(setf itemp
  (f2cl-lib:int-add nwork1
    (f2cl-lib:int-mul
      (f2cl-lib:int-sub nrp1 1)
      smlszp)))
(dcopy nrp1
  (f2cl-lib:array-slice work double-float (nwork1) ((1 *))) 1
  (f2cl-lib:array-slice work double-float (vfi) ((1 *))) 1)
(dcopy nrp1
  (f2cl-lib:array-slice work double-float (itemp) ((1 *))) 1
  (f2cl-lib:array-slice work double-float (vli) ((1 *))) 1))
(t
  (dlaset "A" nr nr zero one
    (f2cl-lib:array-slice u double-float (nrf 1) ((1 ldu) (1 *)))
    ldu)
  (dlaset "A" nrp1 nrp1 zero one
    (f2cl-lib:array-slice vt double-float (nrf 1) ((1 ldu) (1 *)))
    ldu)
  (multiple-value-bind
    (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
     var-9 var-10 var-11 var-12 var-13 var-14 var-15)
    (dlasdq "U" sqrei nr nrp1 nr ncc
     (f2cl-lib:array-slice d double-float (nrf) ((1 *)))
     (f2cl-lib:array-slice e double-float (nrf) ((1 *)))
     (f2cl-lib:array-slice vt
                          double-float

```



```

                                (nrf 1)
                                ((1 ldu) (1 *)))

ldu
(f2cl-lib:array-slice u
 double-float
 (nrf 1)
 ((1 ldu) (1 *)))

ldu
(f2cl-lib:array-slice u
 double-float
 (nrf 1)
 ((1 ldu) (1 *)))

ldu
(f2cl-lib:array-slice work double-float (nwork1) ((1 *)))
info)
(declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                var-7 var-8 var-9 var-10 var-11 var-12 var-13
                var-14))
(setf info var-15))
(dcopy nrp1
 (f2cl-lib:array-slice vt double-float (nrf 1) ((1 ldu) (1 *)))
 1 (f2cl-lib:array-slice work double-float (vfi) ((1 *))) 1)
(dcopy nrp1
 (f2cl-lib:array-slice vt
 double-float
 (nrf nrp1)
 ((1 ldu) (1 *)))
 1 (f2cl-lib:array-slice work double-float (vli) ((1 *))) 1)))
(cond
 ((/= info 0)
 (go end_label)))
(f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
 (> j nr) nil)
(tagbody
 (setf (f2cl-lib:fref iwork-%data%
 ((f2cl-lib:int-add idxqi j))
 ((1 *))
 iwork-%offset%)
 j))))
(setf j (expt 2 nlvl))
(f2cl-lib:fdo (lvl nlvl (f2cl-lib:int-add lvl (f2cl-lib:int-sub 1)))
 (> lvl 1) nil)
(tagbody
 (setf lvl2 (f2cl-lib:int-sub (f2cl-lib:int-mul lvl 2) 1))
 (cond
 ((= lvl 1)

```

```

(setf lf 1)
(setf ll 1))
(t
  (setf lf (expt 2 (f2cl-lib:int-sub lvl 1)))
  (setf ll (f2cl-lib:int-sub (f2cl-lib:int-mul 2 lf) 1)))
(f2cl-lib:fdo (i lf (f2cl-lib:int-add i 1))
  ((> i ll) nil)
(tagbody
  (setf im1 (f2cl-lib:int-sub i 1))
  (setf ic
    (f2cl-lib:fref iwork-%data%
      ((f2cl-lib:int-add inode im1))
      ((1 *))
      iwork-%offset%))
  (setf nl
    (f2cl-lib:fref iwork-%data%
      ((f2cl-lib:int-add ndiml im1))
      ((1 *))
      iwork-%offset%))
  (setf nr
    (f2cl-lib:fref iwork-%data%
      ((f2cl-lib:int-add ndimr im1))
      ((1 *))
      iwork-%offset%))
  (setf nlf (f2cl-lib:int-sub ic nl))
  (setf nrf (f2cl-lib:int-add ic 1))
  (cond
    ((= i ll)
     (setf sqrei sqre))
    (t
     (setf sqrei 1)))
  (setf vfi (f2cl-lib:int-sub (f2cl-lib:int-add vf nlf) 1))
  (setf vli (f2cl-lib:int-sub (f2cl-lib:int-add vl nlf) 1))
  (setf idxqi (f2cl-lib:int-sub (f2cl-lib:int-add idxq nlf) 1))
  (setf alpha (f2cl-lib:fref d-%data% (ic) ((1 *)) d-%offset%))
  (setf beta (f2cl-lib:fref e-%data% (ic) ((1 *)) e-%offset%))
  (cond
    ((= icompq 0)
     (multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
       var-9 var-10 var-11 var-12 var-13 var-14 var-15
       var-16 var-17 var-18 var-19 var-20 var-21 var-22
       var-23 var-24 var-25)
      (dlasd6 icompq nl nr sqrei
        (f2cl-lib:array-slice d double-float (nlf) ((1 *)))
        (f2cl-lib:array-slice work double-float (vfi) ((1 *)))

```

```

(f2cl-lib:array-slice work double-float (vli) ((1 *)))
alpha beta
(f2cl-lib:array-slice iwork
  fixnum
  (idxqi)
  ((1 *)))

perm
(f2cl-lib:fref givptr-%data%
  (1)
  ((1 *))
  givptr-%offset%)
givcol ldgcol givnum ldu poles difl difr z
(f2cl-lib:fref k-%data% (1) ((1 *)) k-%offset%)
(f2cl-lib:fref c-%data% (1) ((1 *)) c-%offset%)
(f2cl-lib:fref s-%data% (1) ((1 *)) s-%offset%)
(f2cl-lib:array-slice work
  double-float
  (nwork1)
  ((1 *)))
(f2cl-lib:array-slice iwork
  fixnum
  (iwk)
  ((1 *)))

info)
(declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
  var-9 var-10 var-12 var-13 var-14 var-15
  var-16 var-17 var-18 var-19 var-23
  var-24))
(setf alpha var-7)
(setf beta var-8)
(setf (f2cl-lib:fref givptr-%data%
  (1)
  ((1 *))
  givptr-%offset%)
  var-11)
(setf (f2cl-lib:fref k-%data% (1) ((1 *)) k-%offset%)
  var-20)
(setf (f2cl-lib:fref c-%data% (1) ((1 *)) c-%offset%)
  var-21)
(setf (f2cl-lib:fref s-%data% (1) ((1 *)) s-%offset%)
  var-22)
(setf info var-25)))
(t
  (setf j (f2cl-lib:int-sub j 1))
  (multiple-value-bind
    (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8

```

```

var-9 var-10 var-11 var-12 var-13 var-14 var-15
var-16 var-17 var-18 var-19 var-20 var-21 var-22
var-23 var-24 var-25)
(dlasd6 icomq nl nr sqrei
(f2cl-lib:array-slice d double-float (nlf) ((1 *)))
(f2cl-lib:array-slice work double-float (vfi) ((1 *)))
(f2cl-lib:array-slice work double-float (vli) ((1 *)))
alpha beta
(f2cl-lib:array-slice iwork
      fixnum
      (idxqi)
      ((1 *)))
(f2cl-lib:array-slice perm
      fixnum
      (nlf lvl)
      ((1 ldgcol) (1 *)))
(f2cl-lib:fref givptr-%data%
      (j)
      ((1 *))
      givptr-%offset%)
(f2cl-lib:array-slice givcol
      fixnum
      (nlf lvl2)
      ((1 ldgcol) (1 *)))
ldgcol
(f2cl-lib:array-slice givnum
      double-float
      (nlf lvl2)
      ((1 ldu) (1 *)))
ldu
(f2cl-lib:array-slice poles
      double-float
      (nlf lvl2)
      ((1 ldu) (1 *)))
(f2cl-lib:array-slice difl
      double-float
      (nlf lvl)
      ((1 ldu) (1 *)))
(f2cl-lib:array-slice difr
      double-float
      (nlf lvl2)
      ((1 ldu) (1 *)))
(f2cl-lib:array-slice z
      double-float
      (nlf lvl)
      ((1 ldu) (1 *)))

```

[illegible]

```
nil
nil
nil
nil
nil
nil
nil
nil
nil
nil
nil
nil
nil
nil
info))))))
```

## 7.64 dlasdq LAPACK

```
(dlasdq.input)≡
)set break resume
)sys rm -f dlasdq.output
)spool dlasdq.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

`<dlasdq.help>`≡

```
=====
dlasdq examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

DLASDQ - the singular value decomposition (SVD) of a real (upper or lower) bidiagonal matrix with diagonal D and offdiagonal E, accumulating the transformations if desired

#### SYNOPSIS

```
SUBROUTINE DLASDQ( UPLO, SQRE, N, NCVT, NRU, NCC, D, E, VT, LDVT, U,
                  LDU, C, LDC, WORK, INFO )
```

```
      CHARACTER      UPLO
```

```
      INTEGER        INFO, LDC, LDU, LDVT, N, NCC, NCVT, NRU, SQRE
```

```
      DOUBLE         PRECISION C( LDC, * ), D( * ), E( * ), U( LDU, * ),
                        VT( LDVT, * ), WORK( * )
```

#### PURPOSE

DLASDQ computes the singular value decomposition (SVD) of a real (upper or lower) bidiagonal matrix with diagonal D and offdiagonal E, accumulating the transformations if desired. Letting B denote the input bidiagonal matrix, the algorithm computes orthogonal matrices Q and P such that  $B = Q * S * P'$  ( $P'$  denotes the transpose of P). The singular values S are overwritten on D.

The input matrix U is changed to  $U * Q$  if desired.

The input matrix VT is changed to  $P' * VT$  if desired.

The input matrix C is changed to  $Q' * C$  if desired.

See "Computing Small Singular Values of Bidiagonal Matrices With Guaranteed High Relative Accuracy," by J. Demmel and W. Kahan, LAPACK Working Note #3, for a detailed description of the algorithm.

#### ARGUMENTS

UPLO (input) CHARACTER\*1

On entry, UPLO specifies whether the input bidiagonal matrix is upper or lower bidiagonal, and whether it is square or not. UPLO

= 'U' or 'u' B is upper bidiagonal. UPLO = 'L' or 'l' B is lower bidiagonal.

SQRE (input) INTEGER  
 = 0: then the input matrix is N-by-N.  
 = 1: then the input matrix is N-by-(N+1) if UPLU = 'U' and (N+1)-by-N if UPLU = 'L'.

The bidiagonal matrix has  $N = NL + NR + 1$  rows and  $M = N + SQRE \geq N$  columns.

N (input) INTEGER  
 On entry, N specifies the number of rows and columns in the matrix. N must be at least 0.

NCVT (input) INTEGER  
 On entry, NCVT specifies the number of columns of the matrix VT. NCVT must be at least 0.

NRU (input) INTEGER  
 On entry, NRU specifies the number of rows of the matrix U. NRU must be at least 0.

NCC (input) INTEGER  
 On entry, NCC specifies the number of columns of the matrix C. NCC must be at least 0.

D (input/output) DOUBLE PRECISION array, dimension (N)  
 On entry, D contains the diagonal entries of the bidiagonal matrix whose SVD is desired. On normal exit, D contains the singular values in ascending order.

E (input/output) DOUBLE PRECISION array.  
 dimension is (N-1) if SQRE = 0 and N if SQRE = 1. On entry, the entries of E contain the offdiagonal entries of the bidiagonal matrix whose SVD is desired. On normal exit, E will contain 0. If the algorithm does not converge, D and E will contain the diagonal and superdiagonal entries of a bidiagonal matrix orthogonally equivalent to the one given as input.

VT (input/output) DOUBLE PRECISION array, dimension (LDVT, NCVT)  
 On entry, contains a matrix which on exit has been premultiplied by P', dimension N-by-NCVT if SQRE = 0 and (N+1)-by-NCVT if SQRE = 1 (not referenced if NCVT=0).

LDVT (input) INTEGER



On entry, LDVT specifies the leading dimension of VT as declared in the calling (sub) program. LDVT must be at least 1. If NCVT is nonzero LDVT must also be at least N.

- U (input/output) DOUBLE PRECISION array, dimension (LDU, N)  
On entry, contains a matrix which on exit has been postmultiplied by Q, dimension NRU-by-N if SQRE = 0 and NRU-by-(N+1) if SQRE = 1 (not referenced if NRU=0).
- LDU (input) INTEGER  
On entry, LDU specifies the leading dimension of U as declared in the calling (sub) program. LDU must be at least  $\max(1, \text{NRU})$ .
- C (input/output) DOUBLE PRECISION array, dimension (LDC, NCC)  
On entry, contains an N-by-NCC matrix which on exit has been pre-multiplied by Q' dimension N-by-NCC if SQRE = 0 and (N+1)-by-NCC if SQRE = 1 (not referenced if NCC=0).
- LDC (input) INTEGER  
On entry, LDC specifies the leading dimension of C as declared in the calling (sub) program. LDC must be at least 1. If NCC is nonzero, LDC must also be at least N.
- WORK (workspace) DOUBLE PRECISION array, dimension (4\*N)  
Workspace. Only referenced if one of NCVT, NRU, or NCC is nonzero, and if N is at least 2.
- INFO (output) INTEGER  
On exit, a value of 0 indicates a successful exit. If  $\text{INFO} < 0$ , argument number -INFO is illegal. If  $\text{INFO} > 0$ , the algorithm did not converge, and INFO specifies how many superdiagonals did not converge.

```

(LAPACK dlasdq)=
  (let* ((zero 0.0))
    (declare (type (double-float 0.0 0.0) zero))
    (defun dlasdq (uplo sqre n ncvr nru ncc d e vt ldvt u ldu c ldc work info)
      (declare (type (simple-array double-float (*)) work c u vt e d)
        (type fixnum info ldc ldu ldvt ncc nru ncvr n sqre)
        (type character uplo))
      (f2cl-lib:with-multi-array-data
        ((uplo character uplo-%data% uplo-%offset%)
         (d double-float d-%data% d-%offset%)
         (e double-float e-%data% e-%offset%)
         (vt double-float vt-%data% vt-%offset%)
         (u double-float u-%data% u-%offset%)
         (c double-float c-%data% c-%offset%)
         (work double-float work-%data% work-%offset%))
        (prog ((cs 0.0) (r 0.0) (smin 0.0) (sn 0.0) (i 0) (isub 0) (iuplo 0)
              (j 0) (np1 0) (sqre1 0) (rotate nil))
          (declare (type (double-float) cs r smin sn)
            (type fixnum i isub iuplo j np1 sqre1)
            (type (member t nil) rotate))
          (setf info 0)
          (setf iuplo 0)
          (if (char-equal uplo #\U) (setf iuplo 1))
          (if (char-equal uplo #\L) (setf iuplo 2))
          (cond
            ((= iuplo 0)
             (setf info -1))
            ((or (< sqre 0) (> sqre 1))
             (setf info -2))
            ((< n 0)
             (setf info -3))
            ((< ncvr 0)
             (setf info -4))
            ((< nru 0)
             (setf info -5))
            ((< ncc 0)
             (setf info -6))
            ((or (and (= ncvr 0) (< ldvt 1))
                 (and (> ncvr 0)
                     (< ldvt
                      (max (the fixnum 1)
                           (the fixnum n))))))
             (setf info -10))
            ((< ldu (max (the fixnum 1) (the fixnum nru)))
             (setf info -12))
            ((or (and (= ncc 0) (< ldc 1))

```

```

      (and (> ncc 0)
        (< ldc
          (max (the fixnum 1)
                (the fixnum n))))))
      (setf info -14)))
(cond
  ((/= info 0)
   (error
    " ** On entry to ~a parameter number ~a had an illegal value~%"
    "DLASDQ" (f2cl-lib:int-sub info))
   (go end_label)))
(if (= n 0) (go end_label))
(setf rotate (or (> ncvt 0) (> nru 0) (> ncc 0)))
(setf np1 (f2cl-lib:int-add n 1))
(setf sqre1 sqre)
(cond
  ((and (= iuplo 1) (= sqre1 1))
   (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                 ((> i (f2cl-lib:int-add n (f2cl-lib:int-sub 1))) nil)
   (tagbody
    (multiple-value-bind (var-0 var-1 var-2 var-3 var-4)
      (dlartg (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%)
              (f2cl-lib:fref e-%data% (i) ((1 *)) e-%offset%) cs sn r)
      (declare (ignore var-0 var-1))
      (setf cs var-2)
      (setf sn var-3)
      (setf r var-4))
    (setf (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%) r)
    (setf (f2cl-lib:fref e-%data% (i) ((1 *)) e-%offset%)
          (* sn
            (f2cl-lib:fref d-%data%
                          ((f2cl-lib:int-add i 1))
                          ((1 *))
                          d-%offset%)))
    (setf (f2cl-lib:fref d-%data%
                          ((f2cl-lib:int-add i 1))
                          ((1 *))
                          d-%offset%)
          (* cs
            (f2cl-lib:fref d-%data%
                          ((f2cl-lib:int-add i 1))
                          ((1 *))
                          d-%offset%)))
    (cond
      (rotate
       (setf (f2cl-lib:fref work-%data% (i) ((1 *)) work-%offset%)

```

```

        cs)
        (setf (f2cl-lib:fref work-%data%
                           ((f2cl-lib:int-add n i))
                           ((1 *))
                           work-%offset%)
              sn))))
(multiple-value-bind (var-0 var-1 var-2 var-3 var-4)
  (dlartg (f2cl-lib:fref d-%data% (n) ((1 *)) d-%offset%)
          (f2cl-lib:fref e-%data% (n) ((1 *)) e-%offset%) cs sn r)
  (declare (ignore var-0 var-1))
  (setf cs var-2)
  (setf sn var-3)
  (setf r var-4))
(setf (f2cl-lib:fref d-%data% (n) ((1 *)) d-%offset%) r)
(setf (f2cl-lib:fref e-%data% (n) ((1 *)) e-%offset%) zero)
(cond
  (rotate
   (setf (f2cl-lib:fref work-%data% (n) ((1 *)) work-%offset%) cs)
   (setf (f2cl-lib:fref work-%data%
                       ((f2cl-lib:int-add n n))
                       ((1 *))
                       work-%offset%)
         sn)))
  (setf iuplo 2)
  (setf sqre1 0)
  (if (> ncvt 0)
      (dlasr "L" "V" "F" np1 ncvt
             (f2cl-lib:array-slice work double-float (1) ((1 *)))
             (f2cl-lib:array-slice work double-float (np1) ((1 *))) vt
             ldvt))))
(cond
  (= iuplo 2)
  (f2cl-lib:fd0 (i 1 (f2cl-lib:int-add i 1))
                ((> i (f2cl-lib:int-add n (f2cl-lib:int-sub 1))) nil)
  (tagbody
   (multiple-value-bind (var-0 var-1 var-2 var-3 var-4)
     (dlartg (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%)
             (f2cl-lib:fref e-%data% (i) ((1 *)) e-%offset%) cs sn r)
     (declare (ignore var-0 var-1))
     (setf cs var-2)
     (setf sn var-3)
     (setf r var-4))
   (setf (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%) r)
   (setf (f2cl-lib:fref e-%data% (i) ((1 *)) e-%offset%)
         (* sn
           (f2cl-lib:fref d-%data%

```

```

((f2cl-lib:int-add i 1))
((1 *))
d-%offset%)))
(setf (f2cl-lib:fref d-%data%
((f2cl-lib:int-add i 1))
((1 *))
d-%offset%))
(* cs
(f2cl-lib:fref d-%data%
((f2cl-lib:int-add i 1))
((1 *))
d-%offset%)))
(cond
(rotate
(setf (f2cl-lib:fref work-%data% (i) ((1 *)) work-%offset%)
cs)
(setf (f2cl-lib:fref work-%data%
((f2cl-lib:int-add n i))
((1 *))
work-%offset%)
sn))))))
(cond
(= sqre1 1)
(multiple-value-bind (var-0 var-1 var-2 var-3 var-4)
(dlartg (f2cl-lib:fref d-%data% (n) ((1 *)) d-%offset%)
(f2cl-lib:fref e-%data% (n) ((1 *)) e-%offset%) cs sn r)
(declare (ignore var-0 var-1))
(setf cs var-2)
(setf sn var-3)
(setf r var-4))
(setf (f2cl-lib:fref d-%data% (n) ((1 *)) d-%offset%) r)
(cond
(rotate
(setf (f2cl-lib:fref work-%data% (n) ((1 *)) work-%offset%) cs)
(setf (f2cl-lib:fref work-%data%
((f2cl-lib:int-add n n))
((1 *))
work-%offset%)
sn))))))
(cond
(> nru 0)
(cond
(= sqre1 0)
(dlasr "R" "V" "F" nru n
(f2cl-lib:array-slice work double-float (1) ((1 *)))
(f2cl-lib:array-slice work double-float (np1) ((1 *))) u ldu))

```

```

(t
  (dlasr "R" "V" "F" nru np1
    (f2cl-lib:array-slice work double-float (1) ((1 *)))
    (f2cl-lib:array-slice work double-float (np1) ((1 *))) u
    ldu))))
(cond
  (> ncc 0)
  (cond
    (= sqre1 0)
    (dlasr "L" "V" "F" n ncc
      (f2cl-lib:array-slice work double-float (1) ((1 *)))
      (f2cl-lib:array-slice work double-float (np1) ((1 *))) c ldc))
    (t
      (dlasr "L" "V" "F" np1 ncc
        (f2cl-lib:array-slice work double-float (1) ((1 *)))
        (f2cl-lib:array-slice work double-float (np1) ((1 *))) c
        ldc))))))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9
   var-10 var-11 var-12 var-13 var-14)
  (dbdsqr "U" n ncv nru ncc d e vt ldvt u ldu c ldc work info)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
    var-8 var-9 var-10 var-11 var-12 var-13))
  (setf info var-14))
(f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
  (> i n) nil)
(tagbody
  (setf isub i)
  (setf smin (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%))
  (f2cl-lib:fdo (j (f2cl-lib:int-add i 1) (f2cl-lib:int-add j 1))
    (> j n) nil)
  (tagbody
    (cond
      ((< (f2cl-lib:fref d (j) ((1 *))) smin)
        (setf isub j)
        (setf smin
          (f2cl-lib:fref d-%data% (j) ((1 *)) d-%offset%))))))
  (cond
    (/= isub i)
    (setf (f2cl-lib:fref d-%data% (isub) ((1 *)) d-%offset%)
      (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%))
    (setf (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%) smin)
    (if (> ncv 0)
      (dswap ncv
        (f2cl-lib:array-slice vt
          double-float

```



## 7.65 dlasdt LAPACK

```
<dlasdt.input>≡  
  )set break resume  
  )sys rm -f dlasdt.output  
  )spool dlasdt.output  
  )set message test on  
  )set message auto off  
  )clear all  
  
  )spool  
  )lisp (bye)
```



`<dlasdt.help>`≡

```
=====
dlasdt examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

DLASDT - a tree of subproblems for bidiagonal divide and conquer

#### SYNOPSIS

```
SUBROUTINE DLASDT( N, LVL, ND, INODE, NDIML, NDIMR, MSUB )
```

```
      INTEGER          LVL, MSUB, N, ND
```

```
      INTEGER          INODE( * ), NDIML( * ), NDIMR( * )
```

#### PURPOSE

DLASDT creates a tree of subproblems for bidiagonal divide and conquer.

#### ARGUMENTS

N	(input) INTEGER On entry, the number of diagonal elements of the bidiagonal matrix.
LVL	(output) INTEGER On exit, the number of levels on the computation tree.
ND	(output) INTEGER On exit, the number of nodes on the tree.
INODE	(output) INTEGER array, dimension ( N ) On exit, centers of subproblems.
NDIML	(output) INTEGER array, dimension ( N ) On exit, row dimensions of left children.
NDIMR	(output) INTEGER array, dimension ( N ) On exit, row dimensions of right children.
MSUB	(input) INTEGER. On entry, the maximum row dimension each subproblem at the bottom of the tree can be of.



```

(LAPACK dlasdt)≡
  (let* ((two 2.0))
    (declare (type (double-float 2.0 2.0) two))
    (defun dlasdt (n lvl nd inode ndiml ndimr msub)
      (declare (type (simple-array fixnum (*)) ndimr ndiml inode)
        (type fixnum msub nd lvl n))
      (f2cl-lib:with-multi-array-data
        ((inode fixnum inode-%data% inode-%offset%)
         (ndiml fixnum ndiml-%data% ndiml-%offset%)
         (ndimr fixnum ndimr-%data% ndimr-%offset%))
        (prog ((temp 0.0) (i 0) (il 0) (ir 0) (llst 0) (maxn 0) (ncrnt 0)
              (nlvl 0))
          (declare (type (double-float) temp)
            (type fixnum i il ir llst maxn ncrnt nlvl))
          (setf maxn (max (the fixnum 1) (the fixnum n)))
          (setf temp
            (/
              (f2cl-lib:flog
                (/ (coerce (realpart maxn) 'double-float)
                  (coerce (realpart (f2cl-lib:int-add msub 1)) 'double-float)))
              (f2cl-lib:flog two)))
          (setf lvl (f2cl-lib:int-add (f2cl-lib:int temp) 1))
          (setf i (the fixnum (truncate n 2)))
          (setf (f2cl-lib:fref inode-%data% (1) ((1 *)) inode-%offset%)
            (f2cl-lib:int-add i 1))
          (setf (f2cl-lib:fref ndiml-%data% (1) ((1 *)) ndiml-%offset%) i)
          (setf (f2cl-lib:fref ndimr-%data% (1) ((1 *)) ndimr-%offset%)
            (f2cl-lib:int-sub n i 1))
          (setf il 0)
          (setf ir 1)
          (setf llst 1)
          (f2cl-lib:fdo (nlvl 1 (f2cl-lib:int-add nlvl 1))
            ((> nlvl (f2cl-lib:int-add lvl (f2cl-lib:int-sub 1)))) nil)
          (tagbody
            (f2cl-lib:fdo (i 0 (f2cl-lib:int-add i 1))
              ((> i (f2cl-lib:int-add llst (f2cl-lib:int-sub 1))))
              nil)
            (tagbody
              (setf il (f2cl-lib:int-add il 2))
              (setf ir (f2cl-lib:int-add ir 2))
              (setf ncrnt (f2cl-lib:int-add llst i))
              (setf (f2cl-lib:fref ndiml-%data% (il) ((1 *)) ndiml-%offset%)
                (the fixnum
                  (truncate
                    (f2cl-lib:fref ndiml-%data%
                      (ncrnt)

```

```

                                ((1 *))
                                ndiml-%offset%)
                2)))
(setf (f2cl-lib:fref ndimr-%data% (il) ((1 *)) ndimr-%offset%)
      (f2cl-lib:int-sub
        (f2cl-lib:fref ndiml-%data%
                        (ncrnt)
                        ((1 *))
                        ndiml-%offset%)
        (f2cl-lib:fref ndiml-%data%
                        (il)
                        ((1 *))
                        ndiml-%offset%)
        1))
(setf (f2cl-lib:fref inode-%data% (il) ((1 *)) inode-%offset%)
      (f2cl-lib:int-sub
        (f2cl-lib:fref inode-%data%
                        (ncrnt)
                        ((1 *))
                        inode-%offset%)
        (f2cl-lib:fref ndimr-%data%
                        (il)
                        ((1 *))
                        ndimr-%offset%)
        1))
(setf (f2cl-lib:fref ndiml-%data% (ir) ((1 *)) ndiml-%offset%)
      (the fixnum
        (truncate
          (f2cl-lib:fref ndimr-%data%
                          (ncrnt)
                          ((1 *))
                          ndimr-%offset%)
          2)))
(setf (f2cl-lib:fref ndimr-%data% (ir) ((1 *)) ndimr-%offset%)
      (f2cl-lib:int-sub
        (f2cl-lib:fref ndimr-%data%
                        (ncrnt)
                        ((1 *))
                        ndimr-%offset%)
        (f2cl-lib:fref ndiml-%data%
                        (ir)
                        ((1 *))
                        ndiml-%offset%)
        1))
(setf (f2cl-lib:fref inode-%data% (ir) ((1 *)) inode-%offset%)
      (f2cl-lib:int-add

```

```

(f2cl-lib:fref inode-%data%
  (ncrnt)
  ((1 *))
  inode-%offset%)
(f2cl-lib:fref ndiml-%data%
  (ir)
  ((1 *))
  ndiml-%offset%)
1)))
(setf llst (f2cl-lib:int-mul llst 2)))
(setf nd (f2cl-lib:int-sub (f2cl-lib:int-mul llst 2) 1))
end_label
(return (values nil lvl nd nil nil nil nil))))))

```

## 7.66 dlaset LAPACK

```

⟨dlaset.input⟩≡
)set break resume
)sys rm -f dlaset.output
)spool dlaset.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)

```

`<dlaset.help>`≡

```
=====
dlaset examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

DLASET - an m-by-n matrix A to BETA on the diagonal and ALPHA on the offdiagonals

#### SYNOPSIS

```
SUBROUTINE DLASET( UPLO, M, N, ALPHA, BETA, A, LDA )
```

```

      CHARACTER      UPLO
      INTEGER        LDA, M, N
      DOUBLE         PRECISION ALPHA, BETA
      DOUBLE         PRECISION A( LDA, * )
```

#### PURPOSE

DLASET initializes an m-by-n matrix A to BETA on the diagonal and ALPHA on the offdiagonals.

#### ARGUMENTS

```

UPLO    (input) CHARACTER*1
        Specifies the part of the matrix A to be set.  = 'U':
        Upper triangular part is set; the strictly lower triangular
        part of A is not changed.  = 'L':      Lower triangular part is
        set; the strictly upper triangular part of A is not changed.
        Otherwise: All of the matrix A is set.

M        (input) INTEGER
        The number of rows of the matrix A.  M >= 0.

N        (input) INTEGER
        The number of columns of the matrix A.  N >= 0.

ALPHA    (input) DOUBLE PRECISION
        The constant to which the offdiagonal elements are to be set.
```

BETA      (input) DOUBLE PRECISION  
The constant to which the diagonal elements are to be set.

A          (input/output) DOUBLE PRECISION array, dimension (LDA,N)  
On exit, the leading m-by-n submatrix of A is set as follows:

if UPLO = 'U',  $A(i,j) = \text{ALPHA}$ ,  $1 \leq i \leq j-1$ ,  $1 \leq j \leq n$ , if UPLO =  
'L',  $A(i,j) = \text{ALPHA}$ ,  $j+1 \leq i \leq m$ ,  $1 \leq j \leq n$ , otherwise,  $A(i,j)$   
= ALPHA,  $1 \leq i \leq m$ ,  $1 \leq j \leq n$ ,  $i \neq j$ ,

and, for all UPLO,  $A(i,i) = \text{BETA}$ ,  $1 \leq i \leq \min(m,n)$ .

LDA        (input) INTEGER  
The leading dimension of the array A.  $\text{LDA} \geq \max(1,M)$ .

```

(LAPACK dlaset)≡
(defun dlaset (uplo m n alpha beta a lda)
  (declare (type (simple-array double-float (*)) a)
            (type (double-float) beta alpha)
            (type fixnum lda n m)
            (type character uplo))
  (f2cl-lib:with-multi-array-data
    ((uplo character uplo-%data% uplo-%offset%)
     (a double-float a-%data% a-%offset%))
    (prog ((i 0) (j 0))
      (declare (type fixnum j i))
      (cond
        ((char-equal uplo #\U)
         (f2cl-lib:fdo (j 2 (f2cl-lib:int-add j 1))
                       ((> j n) nil)
          (tagbody
            (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                          ((> i
                            (min
                             (the fixnum
                              (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
                             (the fixnum m)))
                            nil)
              (tagbody
                (setf (f2cl-lib:fref a-%data%
                                     (i j)
                                     ((1 lda) (1 *))
                                     a-%offset%)
                      alpha))))))
        ((char-equal uplo #\L)
         (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                       ((> j
                            (min (the fixnum m)
                                (the fixnum n)))
                            nil)
          (tagbody
            (f2cl-lib:fdo (i (f2cl-lib:int-add j 1) (f2cl-lib:int-add i 1))
                          ((> i m) nil)
              (tagbody
                (setf (f2cl-lib:fref a-%data%
                                     (i j)
                                     ((1 lda) (1 *))
                                     a-%offset%)
                      alpha))))))
      (t
       (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))

```



```

                                (> j n) nil)
  (tagbody
    (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
      (> i m) nil)
    (tagbody
      (setf (f2cl-lib:fref a-%data%
                          (i j)
                          ((1 lda) (1 *))
                          a-%offset%)
        alpha))))))
  (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
    (> i
      (min (the fixnum m)
        (the fixnum n)))
    nil)
  (tagbody
    (setf (f2cl-lib:fref a-%data% (i i) ((1 lda) (1 *)) a-%offset%) beta)))
  (return (values nil nil nil nil nil nil nil)))

```

## 7.67 dlasq1 LAPACK

```

⟨dlasq1.input⟩≡
  )set break resume
  )sys rm -f dlasq1.output
  )spool dlasq1.output
  )set message test on
  )set message auto off
  )clear all

  )spool
  )lisp (bye)

```

`<dlasq1.help>`≡

```
=====
dlasq1 examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

DLASQ1 - the singular values of a real N-by-N bidiagonal matrix with diagonal D and off-diagonal E

#### SYNOPSIS

```
SUBROUTINE DLASQ1( N, D, E, WORK, INFO )
```

```
      INTEGER          INFO, N
```

```
      DOUBLE           PRECISION D( * ), E( * ), WORK( * )
```

#### PURPOSE

DLASQ1 computes the singular values of a real N-by-N bidiagonal matrix with diagonal D and off-diagonal E. The singular values are computed to high relative accuracy, in the absence of denormalization, underflow and overflow. The algorithm was first presented in

"Accurate singular values and differential qd algorithms" by K. V. Fernando and B. N. Parlett, Numer. Math., Vol-67, No. 2, pp. 191-230, 1994,

and the present implementation is described in "An implementation of the dqds Algorithm (Positive Case)", LAPACK Working Note.

#### ARGUMENTS

N (input) INTEGER

The number of rows and columns in the matrix. N >= 0.

D (input/output) DOUBLE PRECISION array, dimension (N)

On entry, D contains the diagonal elements of the bidiagonal matrix whose SVD is desired. On normal exit, D contains the singular values in decreasing order.

E (input/output) DOUBLE PRECISION array, dimension (N)

On entry, elements E(1:N-1) contain the off-diagonal elements of the bidiagonal matrix whose SVD is desired. On exit, E is over-

written.

WORK (workspace) DOUBLE PRECISION array, dimension (4\*N)

INFO (output) INTEGER

= 0: successful exit

< 0: if INFO = -i, the i-th argument had an illegal value

> 0: the algorithm failed = 1, a split was marked by a positive value in E = 2, current block of Z not diagonalized after 30\*N iterations (in inner while loop) = 3, termination criterion of outer while loop not met (program created more than N unreduced blocks)

```

(LAPACK dlasq1)=
  (let* ((zero 0.0))
    (declare (type (double-float 0.0 0.0) zero))
    (defun dlasq1 (n d e work info)
      (declare (type (simple-array double-float (*)) work e d)
        (type fixnum info n))
      (f2cl-lib:with-multi-array-data
        ((d double-float d-%data% d-%offset%)
         (e double-float e-%data% e-%offset%)
         (work double-float work-%data% work-%offset%))
        (prog ((eps 0.0) (scale 0.0) (safmin 0.0) (sigmn 0.0) (sigmx 0.0) (i 0)
              (iinfo 0))
          (declare (type (double-float) eps scale safmin sigmn sigmx)
            (type fixnum i iinfo))
          (setf info 0)
          (cond
            ((< n 0)
              (setf info -2)
              (error
                " ** On entry to ~a parameter number ~a had an illegal value~%"
                "DLASQ1" (f2cl-lib:int-sub info))
              (go end_label))
            (>= n 0)
              (go end_label))
            ((= n 1)
              (setf (f2cl-lib:fref d-%data% (1) ((1 *)) d-%offset%)
                (abs (f2cl-lib:fref d-%data% (1) ((1 *)) d-%offset%)))
              (go end_label))
            ((= n 2)
              (multiple-value-bind (var-0 var-1 var-2 var-3 var-4)
                (dlas2 (f2cl-lib:fref d-%data% (1) ((1 *)) d-%offset%)
                  (f2cl-lib:fref e-%data% (1) ((1 *)) e-%offset%)
                  (f2cl-lib:fref d-%data% (2) ((1 *)) d-%offset%) sigmn sigmx)
                (declare (ignore var-0 var-1 var-2))
                (setf sigmn var-3)
                (setf sigmx var-4))
              (setf (f2cl-lib:fref d-%data% (1) ((1 *)) d-%offset%) sigmx)
              (setf (f2cl-lib:fref d-%data% (2) ((1 *)) d-%offset%) sigmn)
              (go end_label)))
          (setf sigmx zero)
          (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
            (> i (f2cl-lib:int-add n (f2cl-lib:int-sub 1))) nil)
          (tagbody
            (setf (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%)
              (abs (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%)))
            (setf sigmx

```

```

(max sigmx
  (abs
    (f2cl-lib:fref e-%data% (i) ((1 *)) e-%offset%))))))
(setf (f2cl-lib:fref d-%data% (n) ((1 *)) d-%offset%)
  (abs (f2cl-lib:fref d-%data% (n) ((1 *)) d-%offset%)))
(cond
  ((= sigmx zero)
    (multiple-value-bind (var-0 var-1 var-2 var-3)
      (dlasrt "D" n d iinfo)
      (declare (ignore var-0 var-1 var-2))
      (setf iinfo var-3))
    (go end_label)))
(f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
  ((> i n) nil)

  (tagbody
    (setf sigmx
      (max sigmx
        (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%))))
    (setf eps (dlamch "Precision"))
    (setf safmin (dlamch "Safe minimum"))
    (setf scale (f2cl-lib:fsqrt (/ eps safmin)))
    (dcopy n d 1 (f2cl-lib:array-slice work double-float (1) ((1 *))) 2)
    (dcopy (f2cl-lib:int-sub n 1) e 1
      (f2cl-lib:array-slice work double-float (2) ((1 *))) 2)
    (multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9)
      (dlascl "G" 0 0 sigmx scale
        (f2cl-lib:int-sub (f2cl-lib:int-mul 2 n) 1) 1 work
        (f2cl-lib:int-sub (f2cl-lib:int-mul 2 n) 1) iinfo)
      (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
        var-8))
      (setf iinfo var-9))
    (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
      ((> i
        (f2cl-lib:int-add (f2cl-lib:int-mul 2 n)
          (f2cl-lib:int-sub 1)))
        nil)
      (tagbody
        (setf (f2cl-lib:fref work-%data% (i) ((1 *)) work-%offset%)
          (expt (f2cl-lib:fref work-%data% (i) ((1 *)) work-%offset%)
            2))))
    (setf (f2cl-lib:fref work-%data%
      ((f2cl-lib:int-mul 2 n)
        ((1 *))
        work-%offset%)
      zero)

```

```

(multiple-value-bind (var-0 var-1 var-2)
  (dlasq2 n work info)
  (declare (ignore var-0 var-1))
  (setf info var-2))
(cond
  ((= info 0)
   (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
     ((> i n) nil)
     (tagbody
      (setf (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%)
        (f2cl-lib:fsqrt
         (f2cl-lib:fref work-%data% (i) ((1 *)) work-%offset%))))))
  (multiple-value-bind
    (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9)
    (dlascl "G" 0 0 scale sigmx n 1 d n iinfo)
    (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
      var-8))
    (setf iinfo var-9))))
end_label
(return (values nil nil nil nil info))))))

```

## 7.68 dlasq2 LAPACK

```

⟨dlasq2.input⟩≡
)set break resume
)sys rm -f dlasq2.output
)spool dlasq2.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)

```

`<dlasq2.help>=`

```
=====
dlasq2 examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

DLASQ2 - all the eigenvalues of the symmetric positive definite tridiagonal matrix associated with the qd array Z to high relative accuracy are computed to high relative accuracy, in the absence of denormalization, underflow and overflow

#### SYNOPSIS

```
SUBROUTINE DLASQ2( N, Z, INFO )

      INTEGER      INFO, N

      DOUBLE      PRECISION Z( * )
```

#### PURPOSE

DLASQ2 computes all the eigenvalues of the symmetric positive definite tridiagonal matrix associated with the qd array Z to high relative accuracy are computed to high relative accuracy, in the absence of denormalization, underflow and overflow.

To see the relation of Z to the tridiagonal matrix, let L be a unit lower bidiagonal matrix with subdiagonals Z(2,4,6,...) and let U be an upper bidiagonal matrix with 1's above and diagonal Z(1,3,5,...). The tridiagonal is L\*U or, if you prefer, the symmetric tridiagonal to which it is similar.

Note : DLASQ2 defines a logical variable, IEEE, which is true on machines which follow ieee-754 floating-point standard in their handling of infinities and NaNs, and false otherwise. This variable is passed to DLAZQ3.

#### ARGUMENTS

N (input) INTEGER  
The number of rows and columns in the matrix. N >= 0.

Z (workspace) DOUBLE PRECISION array, dimension ( 4\*N )  
On entry Z holds the qd array. On exit, entries 1 to N hold the

eigenvalues in decreasing order,  $Z(2*N+1)$  holds the trace, and  $Z(2*N+2)$  holds the sum of the eigenvalues. If  $N > 2$ , then  $Z(2*N+3)$  holds the iteration count,  $Z(2*N+4)$  holds  $NDIVS/NIN^2$ , and  $Z(2*N+5)$  holds the percentage of shifts that failed.

INFO (output) INTEGER

= 0: successful exit

< 0: if the i-th argument is a scalar and had an illegal value, then  $INFO = -i$ , if the i-th argument is an array and the j-entry had an illegal value, then  $INFO = -(i*100+j) > 0$ : the algorithm failed = 1, a split was marked by a positive value in  $E = 2$ , current block of  $Z$  not diagonalized after  $30*N$  iterations (in inner while loop) = 3, termination criterion of outer while loop not met (program created more than  $N$  unreduced blocks)

#### FURTHER DETAILS

The shifts are accumulated in SIGMA. Iteration count is in ITER. Ping-pong is controlled by PP (alternates between 0 and 1).



```

(LAPACK dlasq2)=
  (let* ((cbias 1.5)
        (zero 0.0)
        (half 0.5)
        (one 1.0)
        (two 2.0)
        (four 4.0)
        (hundrd 100.0))
    (declare (type (double-float 1.5 1.5) cbias)
              (type (double-float 0.0 0.0) zero)
              (type (double-float 0.5 0.5) half)
              (type (double-float 1.0 1.0) one)
              (type (double-float 2.0 2.0) two)
              (type (double-float 4.0 4.0) four)
              (type (double-float 100.0 100.0) hundrd))
    (defun dlasq2 (n z info)
      (declare (type (simple-array double-float (*)) z)
                (type fixnum info n))
      (f2cl-lib:with-multi-array-data
        ((z double-float z-%data% z-%offset%))
        (prog ((d 0.0) (desig 0.0) (dmin 0.0) (e 0.0) (emax 0.0) (emin 0.0)
              (eps 0.0) (oldemn 0.0) (qmax 0.0) (qmin 0.0) (s 0.0) (safmin 0.0)
              (sigma 0.0) (temp 0.0) (tol 0.0) (tol2 0.0) (zmax 0.0) (i0 0)
              (i4 0) (iinfo 0) (ipn4 0) (iter 0) (iwhila 0) (iwhilb 0) (k 0)
              (n0 0) (nbig 0) (ndiv 0) (nfail 0) (pp 0) (spltt 0) (ieee nil)
              (trace$ 0.0) (t$ 0.0))
        (declare (type (double-float) t$ trace$ d desig dmin e emax emin eps
                      oldemn qmax qmin s safmin sigma temp tol
                      tol2 zmax)
                  (type fixnum i0 i4 iinfo ipn4 iter iwhila iwhilb
                      k n0 nbig ndiv nfail pp spltt)
                  (type (member t nil) ieee))
        (setf info 0)
        (setf eps (dlamch "Precision"))
        (setf safmin (dlamch "Safe minimum"))
        (setf tol (* eps hundrd))
        (setf tol2 (expt tol 2))
        (cond
          ((< n 0)
            (setf info -1)
            (error
              " ** On entry to ~a parameter number ~a had an illegal value~%"
              "DLASQ2" 1)
            (go end_label))
          ((= n 0)
            (go end_label)))
      )
    )
  )

```

```

(= n 1)
(cond
  ((< (f2cl-lib:fref z (1) ((1 *))) zero)
    (setf info -201)
    (error
      " ** On entry to ~a parameter number ~a had an illegal value~%"
      "DLASQ2" 2)))
(go end_label))
(= n 2)
(cond
  ((or (< (f2cl-lib:fref z (2) ((1 *))) zero)
        (< (f2cl-lib:fref z (3) ((1 *))) zero))
    (setf info -2)
    (error
      " ** On entry to ~a parameter number ~a had an illegal value~%"
      "DLASQ2" 2)
    (go end_label))
  (> (f2cl-lib:fref z (3) ((1 *))) (f2cl-lib:fref z (1) ((1 *))))
  (setf d (f2cl-lib:fref z-%data% (3) ((1 *)) z-%offset%)
    (setf (f2cl-lib:fref z-%data% (3) ((1 *)) z-%offset%)
      (f2cl-lib:fref z-%data% (1) ((1 *)) z-%offset%)
      (setf (f2cl-lib:fref z-%data% (1) ((1 *)) z-%offset%) d)))
  (setf (f2cl-lib:fref z-%data% (5) ((1 *)) z-%offset%)
    (+ (f2cl-lib:fref z-%data% (1) ((1 *)) z-%offset%)
      (f2cl-lib:fref z-%data% (2) ((1 *)) z-%offset%)
      (f2cl-lib:fref z-%data% (3) ((1 *)) z-%offset%)))
  (cond
    (> (f2cl-lib:fref z (2) ((1 *)))
      (* (f2cl-lib:fref z (3) ((1 *))) tol2))
    (setf t$
      (* half
        (+
          (- (f2cl-lib:fref z-%data% (1) ((1 *)) z-%offset%)
            (f2cl-lib:fref z-%data% (3) ((1 *)) z-%offset%))
          (f2cl-lib:fref z-%data% (2) ((1 *)) z-%offset%))))
    (setf s
      (* (f2cl-lib:fref z-%data% (3) ((1 *)) z-%offset%)
        (/ (f2cl-lib:fref z-%data% (2) ((1 *)) z-%offset%)
          t$)))
    (cond
      (<= s t$)
      (setf s
        (* (f2cl-lib:fref z-%data% (3) ((1 *)) z-%offset%)
          (/ (f2cl-lib:fref z-%data% (2) ((1 *)) z-%offset%)
            (* t$
              (+ one (f2cl-lib:fsqrt (+ one (/ s t$))))))))))

```

```

(t
  (setf s
    (* (f2cl-lib:fref z-%data% (3) ((1 *)) z-%offset%)
      (/ (f2cl-lib:fref z-%data% (2) ((1 *)) z-%offset%)
        (+ t$
          (* (f2cl-lib:fsqrt t$)
            (f2cl-lib:fsqrt (+ t$ s))))))))
  (setf t$
    (+ (f2cl-lib:fref z-%data% (1) ((1 *)) z-%offset%)
      (+ s (f2cl-lib:fref z-%data% (2) ((1 *)) z-%offset%))))
  (setf (f2cl-lib:fref z-%data% (3) ((1 *)) z-%offset%)
    (* (f2cl-lib:fref z-%data% (3) ((1 *)) z-%offset%)
      (/ (f2cl-lib:fref z-%data% (1) ((1 *)) z-%offset%)
        t$)))
  (setf (f2cl-lib:fref z-%data% (1) ((1 *)) z-%offset%) t$))
  (setf (f2cl-lib:fref z-%data% (2) ((1 *)) z-%offset%)
    (f2cl-lib:fref z-%data% (3) ((1 *)) z-%offset%))
  (setf (f2cl-lib:fref z-%data% (6) ((1 *)) z-%offset%)
    (+ (f2cl-lib:fref z-%data% (2) ((1 *)) z-%offset%)
      (f2cl-lib:fref z-%data% (1) ((1 *)) z-%offset%)))
  (go end_label)))
(setf (f2cl-lib:fref z-%data%
  ((f2cl-lib:int-mul 2 n))
  ((1 *))
  z-%offset%)
  zero)
(setf emin (f2cl-lib:fref z-%data% (2) ((1 *)) z-%offset%))
(setf qmax zero)
(setf zmax zero)
(setf d zero)
(setf e zero)
(f2cl-lib:fdo (k 1 (f2cl-lib:int-add k 2))
  (> k
    (f2cl-lib:int-mul 2
      (f2cl-lib:int-add n
        (f2cl-lib:int-sub
          1))))
  nil)
(tagbody
  (cond
    ((< (f2cl-lib:fref z (k) ((1 *))) zero)
      (setf info (f2cl-lib:int-sub (f2cl-lib:int-add 200 k)))
      (error
        " ** On entry to ~a parameter number ~a had an illegal value~%"
        "DLASQ2" 2)
      (go end_label)))

```

```

      ((< (f2cl-lib:fref z ((f2cl-lib:int-add k 1)) ((1 *))) zero)
      (setf info (f2cl-lib:int-sub (f2cl-lib:int-add 200 k 1)))
      (error
        " ** On entry to ~a parameter number ~a had an illegal value~%"
        "DLASQ2" 2)
      (go end_label)))
    (setf d (+ d (f2cl-lib:fref z-%data% (k) ((1 *)) z-%offset%)))
    (setf e
      (+ e
        (f2cl-lib:fref z-%data%
          ((f2cl-lib:int-add k 1))
          ((1 *))
          z-%offset%)))
    (setf qmax
      (max qmax (f2cl-lib:fref z-%data% (k) ((1 *)) z-%offset%)))
    (setf emin
      (min emin
        (f2cl-lib:fref z-%data%
          ((f2cl-lib:int-add k 1))
          ((1 *))
          z-%offset%)))
    (setf zmax
      (max qmax
        zmax
        (f2cl-lib:fref z-%data%
          ((f2cl-lib:int-add k 1))
          ((1 *))
          z-%offset%))))))
  (cond
    ((<
      (f2cl-lib:fref z
        ((f2cl-lib:int-add (f2cl-lib:int-mul 2 n)
          (f2cl-lib:int-sub 1)))
        ((1 *)))
      zero)
    (setf info
      (f2cl-lib:int-sub
        (f2cl-lib:int-sub
          (f2cl-lib:int-add 200 (f2cl-lib:int-mul 2 n))
          1)))
    (error
      " ** On entry to ~a parameter number ~a had an illegal value~%"
      "DLASQ2" 2)
    (go end_label)))
  (setf d
    (+ d

```

```

(f2cl-lib:fref z-%data%
  ((f2cl-lib:int-sub (f2cl-lib:int-mul 2 n) 1))
  ((1 *))
  z-%offset%)))
(setf qmax
  (max qmax
    (f2cl-lib:fref z-%data%
      ((f2cl-lib:int-sub (f2cl-lib:int-mul 2 n)
        1))
      ((1 *))
      z-%offset%)))
(setf zmax (max qmax zmax))
(cond
  ((= e zero)
    (f2cl-lib:fdo (k 2 (f2cl-lib:int-add k 1))
      (> k n) nil)
    (tagbody
      (setf (f2cl-lib:fref z-%data% (k) ((1 *)) z-%offset%)
        (f2cl-lib:fref z-%data%
          ((f2cl-lib:int-sub (f2cl-lib:int-mul 2 k)
            1))
          ((1 *))
          z-%offset%))))))
(multiple-value-bind (var-0 var-1 var-2 var-3)
  (dlasrt "D" n z iinfo)
  (declare (ignore var-0 var-1 var-2))
  (setf iinfo var-3))
(setf (f2cl-lib:fref z-%data%
  ((f2cl-lib:int-sub (f2cl-lib:int-mul 2 n) 1))
  ((1 *))
  z-%offset%)
  d)
(go end_label)))
(setf trace$ (+ d e))
(cond
  ((= trace$ zero)
    (setf (f2cl-lib:fref z-%data%
      ((f2cl-lib:int-sub (f2cl-lib:int-mul 2 n) 1))
      ((1 *))
      z-%offset%)
      zero)
    (go end_label)))
(setf ieee
  (and (= (ilaenv 10 "DLASQ2" "N" 1 2 3 4) 1)
    (= (ilaenv 11 "DLASQ2" "N" 1 2 3 4) 1)))
(f2cl-lib:fdo (k (f2cl-lib:int-mul 2 n)

```

```

        (f2cl-lib:int-add k (f2cl-lib:int-sub 2)))
      (> k 2) nil)
(tagbody
  (setf (f2cl-lib:fref z-%data%
                      ((f2cl-lib:int-mul 2 k))
                      ((1 *))
                      z-%offset%)
        zero)
  (setf (f2cl-lib:fref z-%data%
                      ((f2cl-lib:int-sub (f2cl-lib:int-mul 2 k) 1))
                      ((1 *))
                      z-%offset%)
        (f2cl-lib:fref z-%data% (k) ((1 *)) z-%offset%))
  (setf (f2cl-lib:fref z-%data%
                      ((f2cl-lib:int-sub (f2cl-lib:int-mul 2 k) 2))
                      ((1 *))
                      z-%offset%)
        zero)
  (setf (f2cl-lib:fref z-%data%
                      ((f2cl-lib:int-sub (f2cl-lib:int-mul 2 k) 3))
                      ((1 *))
                      z-%offset%)
        (f2cl-lib:fref z-%data%
                      ((f2cl-lib:int-sub k 1))
                      ((1 *))
                      z-%offset%))))
(setf i0 1)
(setf n0 n)
(cond
  ((<
    (* cbias
      (f2cl-lib:fref z
                    ((f2cl-lib:int-add (f2cl-lib:int-mul 4 i0)
                                         (f2cl-lib:int-sub 3)))
                    ((1 *))))
    (f2cl-lib:fref z
                  ((f2cl-lib:int-add (f2cl-lib:int-mul 4 n0)
                                       (f2cl-lib:int-sub 3)))
                  ((1 *))))
    (setf ipn4 (f2cl-lib:int-mul 4 (f2cl-lib:int-add i0 n0)))
    (f2cl-lib:fdo (i4 (f2cl-lib:int-mul 4 i0) (f2cl-lib:int-add i4 4))
      (> i4
        (f2cl-lib:int-mul 2
          (f2cl-lib:int-add i0
            n0
            (f2cl-lib:int-sub

```

```

1))))
      nil)
(tagbody
  (setf temp
    (f2cl-lib:fref z-%data%
      ((f2cl-lib:int-sub i4 3))
      ((1 *))
      z-%offset%))
    (setf (f2cl-lib:fref z-%data%
      ((f2cl-lib:int-sub i4 3))
      ((1 *))
      z-%offset%)
      (f2cl-lib:fref z-%data%
        ((f2cl-lib:int-sub ipn4 i4 3))
        ((1 *))
        z-%offset%))
    (setf (f2cl-lib:fref z-%data%
      ((f2cl-lib:int-sub ipn4 i4 3))
      ((1 *))
      z-%offset%)
      temp)
    (setf temp
      (f2cl-lib:fref z-%data%
        ((f2cl-lib:int-sub i4 1))
        ((1 *))
        z-%offset%))
      (setf (f2cl-lib:fref z-%data%
        ((f2cl-lib:int-sub i4 1))
        ((1 *))
        z-%offset%)
        (f2cl-lib:fref z-%data%
          ((f2cl-lib:int-sub ipn4 i4 5))
          ((1 *))
          z-%offset%))
      (setf (f2cl-lib:fref z-%data%
        ((f2cl-lib:int-sub ipn4 i4 5))
        ((1 *))
        z-%offset%)
        temp))))))
(setf pp 0)
(f2cl-lib:fdo (k 1 (f2cl-lib:int-add k 1))
  (> k 2) nil)
(tagbody
  (setf d
    (f2cl-lib:fref z-%data%
      ((f2cl-lib:int-sub

```

```

        (f2cl-lib:int-add (f2cl-lib:int-mul 4 n0)
                          pp)
      3))
    ((1 *))
    z-%offset%))
(f2cl-lib:fdo (i4
              (f2cl-lib:int-add
                (f2cl-lib:int-mul 4
                                  (f2cl-lib:int-add n0
                                                      (f2cl-lib:int-sub
                                                        1)))
              pp)
              (f2cl-lib:int-add i4 (f2cl-lib:int-sub 4)))
  (> i4 (f2cl-lib:int-add (f2cl-lib:int-mul 4 i0) pp))
  nil)
(tagbody
 (cond
  ((<=
    (f2cl-lib:fref z
                  ((f2cl-lib:int-add i4 (f2cl-lib:int-sub 1)))
                  ((1 *)))
   (* tol2 d))
  (setf (f2cl-lib:fref z-%data%
                      ((f2cl-lib:int-sub i4 1))
                      ((1 *))
                      z-%offset%)
    (- zero))
  (setf d
    (f2cl-lib:fref z-%data%
                  ((f2cl-lib:int-sub i4 3))
                  ((1 *))
                  z-%offset%)))
(t
 (setf d
  (*
   (f2cl-lib:fref z-%data%
                 ((f2cl-lib:int-sub i4 3))
                 ((1 *))
                 z-%offset%)
   (/ d
     (+ d
       (f2cl-lib:fref z-%data%
                     ((f2cl-lib:int-sub i4 1))
                     ((1 *))
                     z-%offset%))))))
(setf emin
```



```

(f2cl-lib:fref z-%data%
  ((f2cl-lib:int-add (f2cl-lib:int-mul 4 i0)
    pp
    1))
  ((1 *))
  z-%offset%))
(setf d
  (f2cl-lib:fref z-%data%
    ((f2cl-lib:int-sub
      (f2cl-lib:int-add (f2cl-lib:int-mul 4 i0)
        pp)
      3))
    ((1 *))
    z-%offset%))
(f2cl-lib:fdo (i4 (f2cl-lib:int-add (f2cl-lib:int-mul 4 i0) pp)
  (f2cl-lib:int-add i4 4))
  (> i4
    (f2cl-lib:int-add
      (f2cl-lib:int-mul 4
        (f2cl-lib:int-add n0
          (f2cl-lib:int-
            1)))
      pp))
  nil)
(tagbody
  (setf (f2cl-lib:fref z-%data%
    ((f2cl-lib:int-sub
      (f2cl-lib:int-add i4
        (f2cl-lib:int-mul -1
          2
          pp))
      2))
    ((1 *))
    z-%offset%))
    (+ d
      (f2cl-lib:fref z-%data%
        ((f2cl-lib:int-sub i4 1))
        ((1 *))
        z-%offset%)))
  (cond
    ((<=
      (f2cl-lib:fref z
        ((f2cl-lib:int-add i4 (f2cl-lib:int-sub 1)))
        ((1 *)))
      (* tol2 d))
      (setf (f2cl-lib:fref z-%data%

```

```

((f2cl-lib:int-sub i4 1))
((1 *))
z-%offset%)

(- zero))
(setf (f2cl-lib:fref z-%data%
  ((f2cl-lib:int-sub
    (f2cl-lib:int-add i4
      (f2cl-lib:int-mul
        -1
        2
        pp))
      2))
  ((1 *))
  z-%offset%)
  d)
(setf (f2cl-lib:fref z-%data%
  ((f2cl-lib:int-add i4
    (f2cl-lib:int-mul -1
      2
      pp)))
  ((1 *))
  z-%offset%)
  zero)
(setf d
  (f2cl-lib:fref z-%data%
    ((f2cl-lib:int-add i4 1))
    ((1 *))
    z-%offset%)))
((and
  (<
    (* safmin
      (f2cl-lib:fref z ((f2cl-lib:int-add i4 1)) ((1 *))))
    (f2cl-lib:fref z
      ((f2cl-lib:int-add i4
        (f2cl-lib:int-mul -1
          2
          pp)
        (f2cl-lib:int-sub 2)))
      ((1 *))))
  (<
    (* safmin
      (f2cl-lib:fref z
        ((f2cl-lib:int-add i4
          (f2cl-lib:int-mul -1
            2
            pp)

```

```

                                                    (f2cl-lib:int-sub
                                                    2)))
                                                    ((1 *)))
(f2cl-lib:fref z ((f2cl-lib:int-add i4 1)) ((1 *))))
(setf temp
  (/
    (f2cl-lib:fref z-%data%
      ((f2cl-lib:int-add i4 1))
      ((1 *))
      z-%offset%)
    (f2cl-lib:fref z-%data%
      ((f2cl-lib:int-sub
        (f2cl-lib:int-add i4
          (f2cl-lib:int-mul -1
            2
            pp))
          2))
      ((1 *))
      z-%offset%)))
(setf (f2cl-lib:fref z-%data%
  ((f2cl-lib:int-add i4
    (f2cl-lib:int-mul -1
      2
      pp))
    ((1 *))
    z-%offset%)
  (*
    (f2cl-lib:fref z-%data%
      ((f2cl-lib:int-sub i4 1))
      ((1 *))
      z-%offset%)
    temp))
(setf d (* d temp)))
(t
  (setf (f2cl-lib:fref z-%data%
    ((f2cl-lib:int-add i4
      (f2cl-lib:int-mul -1
        2
        pp))
      ((1 *))
      z-%offset%)
    (*
      (f2cl-lib:fref z-%data%
        ((f2cl-lib:int-add i4 1))
        ((1 *))

```

```

                                z-%offset%)
(/
(f2cl-lib:fref z-%data%
  ((f2cl-lib:int-sub i4 1))
  ((1 *))
  z-%offset%)
(f2cl-lib:fref z-%data%
  ((f2cl-lib:int-sub
    (f2cl-lib:int-add i4
      (f2cl-lib:int-mul
        -1
        2
        pp))
      2))
  ((1 *))
  z-%offset%))))))
(setf d
  (*
    (f2cl-lib:fref z-%data%
      ((f2cl-lib:int-add i4 1))
      ((1 *))
      z-%offset%)
    (/ d
      (f2cl-lib:fref z-%data%
        ((f2cl-lib:int-sub
          (f2cl-lib:int-add i4
            (f2cl-lib:int-mul
              -1
              2
              pp))
            2))
          ((1 *))
          z-%offset%))))))
(setf emin
  (min emin
    (f2cl-lib:fref z-%data%
      ((f2cl-lib:int-add i4
        (f2cl-lib:int-mul
          -1
          2
          pp))
        ((1 *))
        z-%offset%))))))
(setf (f2cl-lib:fref z-%data%
  ((f2cl-lib:int-sub (f2cl-lib:int-mul 4 n0)
    pp

```

```

                                2))
                                ((1 *))
                                z-%offset%)
d)
(setf qmax
  (f2cl-lib:fref z-%data%
    ((f2cl-lib:int-sub (f2cl-lib:int-mul 4 i0)
      pp
      2))
    ((1 *))
    z-%offset%))
(f2cl-lib:fdo (i4
  (f2cl-lib:int-add (f2cl-lib:int-mul 4 i0)
    (f2cl-lib:int-sub pp)
    2)
  (f2cl-lib:int-add i4 4))
  (> i4
    (f2cl-lib:int-add (f2cl-lib:int-mul 4 n0)
      (f2cl-lib:int-sub pp)
      (f2cl-lib:int-sub 2)))
  nil)
(tagbody
  (setf qmax
    (max qmax
      (f2cl-lib:fref z-%data% (i4) ((1 *)) z-%offset%))))
  (setf pp (f2cl-lib:int-sub 1 pp)))
(setf iter 2)
(setf nfail 0)
(setf ndiv (f2cl-lib:int-mul 2 (f2cl-lib:int-sub n0 i0)))
(f2cl-lib:fdo (iwhila 1 (f2cl-lib:int-add iwhila 1))
  (> iwhila (f2cl-lib:int-add n 1)) nil)
(tagbody
  (if (< n0 1) (go label150))
  (setf desig zero)
  (cond
    ((= n0 n)
      (setf sigma zero))
    (t
      (setf sigma
        (-
          (f2cl-lib:fref z-%data%
            ((f2cl-lib:int-sub
              (f2cl-lib:int-mul 4 n0)
              1))
            ((1 *))
            z-%offset%))))))

```

```

(cond
  ((< sigma zero)
   (setf info 1)
   (go end_label)))
(setf emax zero)
(cond
  ((> n0 i0)
   (setf emin
    (abs
     (f2cl-lib:fref z-%data%
                    ((f2cl-lib:int-sub
                     (f2cl-lib:int-mul 4 n0)
                     5))
                    ((1 *))
                    z-%offset%))))))
  (t
   (setf emin zero)))
(setf qmin
  (f2cl-lib:fref z-%data%
                ((f2cl-lib:int-sub (f2cl-lib:int-mul 4 n0)
                                    3))
                ((1 *))
                z-%offset%))
(setf qmax qmin)
(f2cl-lib:fdo (i4 (f2cl-lib:int-mul 4 n0)
                (f2cl-lib:int-add i4 (f2cl-lib:int-sub 4)))
              ((> i4 8) nil)
  (tagbody
   (if
    (<=
     (f2cl-lib:fref z-%data%
                    ((f2cl-lib:int-sub i4 5))
                    ((1 *))
                    z-%offset%)
     zero)
    (go label100)))
  (cond
   ((>= qmin (* four emax))
    (setf qmin
     (min qmin
      (f2cl-lib:fref z-%data%
                    ((f2cl-lib:int-sub i4 3))
                    ((1 *))
                    z-%offset%))))
   (setf emax
    (max emax

```

```

(f2cl-lib:fref z-%data%
  ((f2cl-lib:int-sub i4 5))
  ((1 *))
  z-%offset%))))))
(setf qmax
  (max qmax
    (+
      (f2cl-lib:fref z-%data%
        ((f2cl-lib:int-sub i4 7))
        ((1 *))
        z-%offset%)
      (f2cl-lib:fref z-%data%
        ((f2cl-lib:int-sub i4 5))
        ((1 *))
        z-%offset%))))))
(setf emin
  (min emin
    (f2cl-lib:fref z-%data%
      ((f2cl-lib:int-sub i4 5))
      ((1 *))
      z-%offset%))))))
(setf i4 4)
label100
(setf i0 (the fixnum (truncate i4 4)))
(setf (f2cl-lib:fref z-%data%
  ((f2cl-lib:int-sub (f2cl-lib:int-mul 4 n0) 1))
  ((1 *))
  z-%offset%)
  emin)
(setf dmin
  (-
    (max zero
      (+ qmin
        (* (- two)
          (f2cl-lib:fsqrt qmin)
          (f2cl-lib:fsqrt emax))))))
(setf pp 0)
(setf nbig
  (f2cl-lib:int-mul 30
    (f2cl-lib:int-add
      (f2cl-lib:int-sub n0 i0)
      1)))
(f2cl-lib:fdo (iwhilb 1 (f2cl-lib:int-add iwhilb 1))
  ((> iwhilb nbig) nil)
  (tagbody
    (if (> i0 n0) (go label130))

```

```

(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
   var-9 var-10 var-11)
  (dlasq3 i0 n0 z pp dmin sigma desig qmax nfail iter ndiv
   ieee)
  (declare (ignore var-0 var-2 var-3 var-11))
  (setf n0 var-1)
  (setf dmin var-4)
  (setf sigma var-5)
  (setf desig var-6)
  (setf qmax var-7)
  (setf nfail var-8)
  (setf iter var-9)
  (setf ndiv var-10))
(setf pp (f2cl-lib:int-sub 1 pp))
(cond
  ((and (= pp 0)
        (>= (f2cl-lib:int-add n0 (f2cl-lib:int-sub i0)) 3))
   (cond
     ((or
       (<= (f2cl-lib:fref z ((f2cl-lib:int-mul 4 n0)) ((1 *)))
          (* tol2 qmax))
        (<=
          (f2cl-lib:fref z
                        ((f2cl-lib:int-add
                          (f2cl-lib:int-mul 4 n0)
                          (f2cl-lib:int-sub 1)))
                        ((1 *)))
          (* tol2 sigma)))
      (setf splt (f2cl-lib:int-sub i0 1))
      (setf qmax
        (f2cl-lib:fref z-%data%
                        ((f2cl-lib:int-sub
                          (f2cl-lib:int-mul 4 i0)
                          3))
                        ((1 *))
                        z-%offset%))
      (setf emin
        (f2cl-lib:fref z-%data%
                        ((f2cl-lib:int-sub
                          (f2cl-lib:int-mul 4 i0)
                          1))
                        ((1 *))
                        z-%offset%))
      (setf oldemn
        (f2cl-lib:fref z-%data%

```



```

((f2cl-lib:int-mul 4 i0))
((1 *))
z-%offset%))
(f2cl-lib:fdo (i4 (f2cl-lib:int-mul 4 i0)
(f2cl-lib:int-add i4 4))
(> i4
(f2cl-lib:int-mul 4
(f2cl-lib:int-add n0
(f2cl-lib:
3)))
nil)
(tagbody
(cond
(or
(<= (f2cl-lib:fref z (i4) ((1 *)))
(* tol2
(f2cl-lib:fref z
(f2cl-lib:int-add i4
(f2cl-lib:
3)))
((1 *))))))
(<=
(f2cl-lib:fref z
(f2cl-lib:int-add i4
(f2cl-lib:int-su
1)))
((1 *)))
(* tol2 sigma)))
(setf (f2cl-lib:fref z-%data%
(f2cl-lib:int-sub i4 1))
((1 *))
z-%offset%)
(- sigma))
(setf splt (the fixnum (truncate i4 4)))
(setf qmax zero)
(setf emin
(f2cl-lib:fref z-%data%
(f2cl-lib:int-add i4 3))
((1 *))
z-%offset%))
(setf oldemn
(f2cl-lib:fref z-%data%
(f2cl-lib:int-add i4 4))
((1 *))
z-%offset%)))
(t

```

```

        (setf qmax
          (max qmax
            (f2cl-lib:fref z-%data%
                          ((f2cl-lib:int-add i4
                                                1))
                          ((1 *))
                          z-%offset%)))

        (setf emin
          (min emin
            (f2cl-lib:fref z-%data%
                          ((f2cl-lib:int-sub i4
                                                1))
                          ((1 *))
                          z-%offset%)))

        (setf oldemn
          (min oldemn
            (f2cl-lib:fref z-%data%
                          (i4)
                          ((1 *))
                          z-%offset%))))))

    (setf (f2cl-lib:fref z-%data%
                        ((f2cl-lib:int-sub
                          (f2cl-lib:int-mul 4 n0)
                          1))
                        ((1 *))
                        z-%offset%)
      emin)
    (setf (f2cl-lib:fref z-%data%
                        ((f2cl-lib:int-mul 4 n0))
                        ((1 *))
                        z-%offset%)
      oldemn)
    (setf i0 (f2cl-lib:int-add splt 1))))))

  (setf info 2)
  (go end_label)
label1130))
  (setf info 3)
  (go end_label)
label1150
  (f2cl-lib:fdo (k 2 (f2cl-lib:int-add k 1))
    ((> k n) nil)
    (tagbody
      (setf (f2cl-lib:fref z-%data% (k) ((1 *)) z-%offset%)
        (f2cl-lib:fref z-%data%
                      ((f2cl-lib:int-sub (f2cl-lib:int-mul 4 k)
                                          3))

```

```

((1 *))
z-%offset%)))
(multiple-value-bind (var-0 var-1 var-2 var-3)
  (dlasrt "D" n z iinfo)
  (declare (ignore var-0 var-1 var-2))
  (setf iinfo var-3))
(setf e zero)
(f2cl-lib:fdo (k n (f2cl-lib:int-add k (f2cl-lib:int-sub 1)))
  (> k 1) nil)
  (tagbody
    (setf e (+ e (f2cl-lib:fref z-%data% (k) ((1 *)) z-%offset%))))
  (setf (f2cl-lib:fref z-%data%
    ((f2cl-lib:int-add (f2cl-lib:int-mul 2 n) 1))
    ((1 *))
    z-%offset%)
    trace$)
  (setf (f2cl-lib:fref z-%data%
    ((f2cl-lib:int-add (f2cl-lib:int-mul 2 n) 2))
    ((1 *))
    z-%offset%)
    e)
  (setf (f2cl-lib:fref z-%data%
    ((f2cl-lib:int-add (f2cl-lib:int-mul 2 n) 3))
    ((1 *))
    z-%offset%)
    (coerce (realpart iter) 'double-float))
  (setf (f2cl-lib:fref z-%data%
    ((f2cl-lib:int-add (f2cl-lib:int-mul 2 n) 4))
    ((1 *))
    z-%offset%)
    (/ (coerce (realpart ndiv) 'double-float)
        (coerce (realpart (expt n 2)) 'double-float)))
  (setf (f2cl-lib:fref z-%data%
    ((f2cl-lib:int-add (f2cl-lib:int-mul 2 n) 5))
    ((1 *))
    z-%offset%)
    (/ (* hundred nfail)
        (coerce (realpart iter) 'double-float)))
  (go end_label)
end_label
(return (values nil nil info))))))

```

## 7.69 dlasq3 LAPACK

```
<dlasq3.input>≡  
  )set break resume  
  )sys rm -f dlasq3.output  
  )spool dlasq3.output  
  )set message test on  
  )set message auto off  
  )clear all  
  
  )spool  
  )lisp (bye)
```

`<dlasq3.help>`≡

```
=====
dlasq3 examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

DLASQ3 - for deflation, computes a shift (TAU) and calls dqds

#### SYNOPSIS

```
SUBROUTINE DLASQ3( IO, NO, Z, PP, DMIN, SIGMA, DESIG, QMAX, NFAIL,
                  ITER, NDIV, IEEE )
```

LOGICAL IEEE

INTEGER IO, ITER, NO, NDIV, NFAIL, PP

DOUBLE PRECISION DESIG, DMIN, QMAX, SIGMA

DOUBLE PRECISION Z( \* )

#### PURPOSE

DLASQ3 checks for deflation, computes a shift (TAU) and calls dqds. In case of failure it changes shifts, and tries again until output is positive.

#### ARGUMENTS

IO (input) INTEGER  
First index.

NO (input) INTEGER  
Last index.

Z (input) DOUBLE PRECISION array, dimension ( 4\*N )  
Z holds the qd array.

PP (input) INTEGER  
PP=0 for ping, PP=1 for pong.

DMIN (output) DOUBLE PRECISION  
Minimum value of d.

SIGMA (output) DOUBLE PRECISION  
Sum of shifts used in current segment.

DESIG (input/output) DOUBLE PRECISION  
Lower order part of SIGMA

QMAX (input) DOUBLE PRECISION  
Maximum value of q.

NFAIL (output) INTEGER  
Number of times shift was too big.

ITER (output) INTEGER  
Number of iterations.

NDIV (output) INTEGER  
Number of divisions.

TTYPE (output) INTEGER  
Shift type.

IEEE (input) LOGICAL  
Flag for IEEE or non IEEE arithmetic (passed to DLASQ5).

```

(LAPACK dlasq3)=
  (let* ((cbias 1.5)
        (zero 0.0)
        (qurtr 0.25)
        (half 0.5)
        (one 1.0)
        (two 2.0)
        (hundrd 100.0))
    (declare (type (double-float 1.5 1.5) cbias)
              (type (double-float 0.0 0.0) zero)
              (type (double-float 0.25 0.25) qurtr)
              (type (double-float 0.5 0.5) half)
              (type (double-float 1.0 1.0) one)
              (type (double-float 2.0 2.0) two)
              (type (double-float 100.0 100.0) hundrd))
    (let ((ttype 0)
          (f2cl-lib:dmin1 zero)
          (dmin2 zero)
          (dn zero)
          (dn1 zero)
          (dn2 zero)
          (tau zero))
      (declare (type (double-float) tau dn2 dn1 dn dmin2 f2cl-lib:dmin1)
                (type fixnum ttype))
      (defun dlasq3 (i0 n0 z pp dmin sigma desig qmax nfail iter ndiv ieee)
        (declare (type (member t nil) ieee)
                  (type (double-float) qmax desig sigma dmin)
                  (type (simple-array double-float (*)) z)
                  (type fixnum ndiv iter nfail pp n0 i0))
        (f2cl-lib:with-multi-array-data
          ((z double-float z-%data% z-%offset%))
          (prog ((eps 0.0) (s 0.0) (safmin 0.0) (temp 0.0) (tol 0.0) (tol2 0.0)
                 (ipn4 0) (j4 0) (n0in 0) (nn 0) (t$ 0.0))
            (declare (type (double-float) t$ eps s safmin temp tol tol2)
                      (type fixnum ipn4 j4 n0in nn))
            (setf n0in n0)
            (setf eps (dlamch "Precision"))
            (setf safmin (dlamch "Safe minimum"))
            (setf tol (* eps hundrd))
            (setf tol2 (expt tol 2))
            label110
            (if (< n0 i0) (go end_label))
            (if (= n0 i0) (go label20))
            (setf nn (f2cl-lib:int-add (f2cl-lib:int-mul 4 n0) pp))
            (if (= n0 (f2cl-lib:int-add i0 1)) (go label40))
            (if

```

```

      (and
      (>
      (f2cl-lib:fref z-%data%
                    ((f2cl-lib:int-sub nn 5))
                    ((1 *))
                    z-%offset%)

      (* tol2
      (+ sigma
      (f2cl-lib:fref z-%data%
                    ((f2cl-lib:int-sub nn 3))
                    ((1 *))
                    z-%offset%))))

      (>
      (f2cl-lib:fref z-%data%
                    ((f2cl-lib:int-sub
                     (f2cl-lib:int-add nn (f2cl-lib:int-mul -1 2 pp))
                     4))
                    ((1 *))
                    z-%offset%)

      (* tol2
      (f2cl-lib:fref z-%data%
                    ((f2cl-lib:int-sub nn 7))
                    ((1 *))
                    z-%offset%))))

      (go label30))
label20
      (setf (f2cl-lib:fref z-%data%
                        ((f2cl-lib:int-sub (f2cl-lib:int-mul 4 n0) 3))
                        ((1 *))
                        z-%offset%)

      (+
      (f2cl-lib:fref z-%data%
                    ((f2cl-lib:int-sub
                     (f2cl-lib:int-add (f2cl-lib:int-mul 4 n0)
                                         pp)
                     3))
                    ((1 *))
                    z-%offset%)

      sigma))
      (setf n0 (f2cl-lib:int-sub n0 1))
      (go label10)
label30
      (if
      (and
      (>
      (f2cl-lib:fref z-%data%

```



```

((f2cl-lib:int-sub nn 9))
((1 *))
z-%offset%)
(* tol2 sigma))
(>
(f2cl-lib:fref z-%data%
((f2cl-lib:int-sub
(f2cl-lib:int-add nn (f2cl-lib:int-mul -1 2 pp))
8))
((1 *))
z-%offset%)
(* tol2
(f2cl-lib:fref z-%data%
((f2cl-lib:int-sub nn 11))
((1 *))
z-%offset%))))
(go label150))
label140
(cond
((>
(f2cl-lib:fref z
((f2cl-lib:int-add nn (f2cl-lib:int-sub 3)))
((1 *)))
(f2cl-lib:fref z
((f2cl-lib:int-add nn (f2cl-lib:int-sub 7)))
((1 *)))
(setf s
(f2cl-lib:fref z-%data%
((f2cl-lib:int-sub nn 3))
((1 *))
z-%offset%))
(setf (f2cl-lib:fref z-%data%
((f2cl-lib:int-sub nn 3))
((1 *))
z-%offset%)
(f2cl-lib:fref z-%data%
((f2cl-lib:int-sub nn 7))
((1 *))
z-%offset%))
(setf (f2cl-lib:fref z-%data%
((f2cl-lib:int-sub nn 7))
((1 *))
z-%offset%)
s))))
(cond
((>

```

```

(f2cl-lib:fref z
  ((f2cl-lib:int-add nn (f2cl-lib:int-sub 5)))
  ((1 *)))
(*
  (f2cl-lib:fref z
    ((f2cl-lib:int-add nn (f2cl-lib:int-sub 3)))
    ((1 *)))
  tol2))
(setf t$
  (* half
    (+
      (-
        (f2cl-lib:fref z-%data%
          ((f2cl-lib:int-sub nn 7))
          ((1 *))
          z-%offset%)
        (f2cl-lib:fref z-%data%
          ((f2cl-lib:int-sub nn 3))
          ((1 *))
          z-%offset%))
        (f2cl-lib:fref z-%data%
          ((f2cl-lib:int-sub nn 5))
          ((1 *))
          z-%offset%))))))
(setf s
  (*
    (f2cl-lib:fref z-%data%
      ((f2cl-lib:int-sub nn 3))
      ((1 *))
      z-%offset%)
    (/
      (f2cl-lib:fref z-%data%
        ((f2cl-lib:int-sub nn 5))
        ((1 *))
        z-%offset%)
      t$)))
(cond
  ((<= s t$)
    (setf s
      (*
        (f2cl-lib:fref z-%data%
          ((f2cl-lib:int-sub nn 3))
          ((1 *))
          z-%offset%)
        (/
          (f2cl-lib:fref z-%data%
            ((f2cl-lib:int-sub nn 5))
            ((1 *))
            z-%offset%)
          t$)))
    )
  )

```

```

((f2cl-lib:int-sub nn 5))
((1 *))
z-%offset%)
(* t$ (+ one (f2cl-lib:fsqrt (+ one (/ s t$)))))))))
(t
(setf s
  (*
    (f2cl-lib:fref z-%data%
      ((f2cl-lib:int-sub nn 3))
      ((1 *))
      z-%offset%)
    (/
      (f2cl-lib:fref z-%data%
        ((f2cl-lib:int-sub nn 5))
        ((1 *))
        z-%offset%)
      (+ t$
        (* (f2cl-lib:fsqrt t$)
          (f2cl-lib:fsqrt (+ t$ s)))))))))
(setf t$
  (+
    (f2cl-lib:fref z-%data%
      ((f2cl-lib:int-sub nn 7))
      ((1 *))
      z-%offset%)
    (+ s
      (f2cl-lib:fref z-%data%
        ((f2cl-lib:int-sub nn 5))
        ((1 *))
        z-%offset%))))
(setf (f2cl-lib:fref z-%data%
  ((f2cl-lib:int-sub nn 3))
  ((1 *))
  z-%offset%)
  (*
    (f2cl-lib:fref z-%data%
      ((f2cl-lib:int-sub nn 3))
      ((1 *))
      z-%offset%)
    (/
      (f2cl-lib:fref z-%data%
        ((f2cl-lib:int-sub nn 7))
        ((1 *))
        z-%offset%)
      t$)))
(setf (f2cl-lib:fref z-%data%

```

```

((f2cl-lib:int-sub nn 7))
((1 *))
z-%offset%)
t$)))
(setf (f2cl-lib:fref z-%data%
((f2cl-lib:int-sub (f2cl-lib:int-mul 4 n0) 7))
((1 *))
z-%offset%)
(+
(f2cl-lib:fref z-%data%
((f2cl-lib:int-sub nn 7))
((1 *))
z-%offset%)
sigma))
(setf (f2cl-lib:fref z-%data%
((f2cl-lib:int-sub (f2cl-lib:int-mul 4 n0) 3))
((1 *))
z-%offset%)
(+
(f2cl-lib:fref z-%data%
((f2cl-lib:int-sub nn 3))
((1 *))
z-%offset%)
sigma))
(setf n0 (f2cl-lib:int-sub n0 2))
(go label10)
label150
(cond
((or (<= dmin zero) (< n0 n0in))
(cond
((<
(* cbias
(f2cl-lib:fref z
((f2cl-lib:int-add (f2cl-lib:int-mul 4 i0)
pp
(f2cl-lib:int-sub 3)))
((1 *))))
(f2cl-lib:fref z
((f2cl-lib:int-add (f2cl-lib:int-mul 4 n0)
pp
(f2cl-lib:int-sub 3)))
((1 *))))
(setf ipn4 (f2cl-lib:int-mul 4 (f2cl-lib:int-add i0 n0)))
(f2cl-lib:fdo (j4 (f2cl-lib:int-mul 4 i0)
(f2cl-lib:int-add j4 4))
(> j4

```

```

(f2cl-lib:int-mul 2
(f2cl-lib:int-add i0
n0
(f2cl-lib:i
1))))
nil)
(tagbody
(setf temp
(f2cl-lib:fref z-%data%
((f2cl-lib:int-sub j4 3))
((1 *))
z-%offset%))
(setf (f2cl-lib:fref z-%data%
((f2cl-lib:int-sub j4 3))
((1 *))
z-%offset%)
(f2cl-lib:fref z-%data%
((f2cl-lib:int-sub ipn4 j4 3))
((1 *))
z-%offset%))
(setf (f2cl-lib:fref z-%data%
((f2cl-lib:int-sub ipn4 j4 3))
((1 *))
z-%offset%)
temp)
(setf temp
(f2cl-lib:fref z-%data%
((f2cl-lib:int-sub j4 2))
((1 *))
z-%offset%))
(setf (f2cl-lib:fref z-%data%
((f2cl-lib:int-sub j4 2))
((1 *))
z-%offset%)
(f2cl-lib:fref z-%data%
((f2cl-lib:int-sub ipn4 j4 2))
((1 *))
z-%offset%))
(setf (f2cl-lib:fref z-%data%
((f2cl-lib:int-sub ipn4 j4 2))
((1 *))
z-%offset%)
temp)
(setf temp
(f2cl-lib:fref z-%data%
((f2cl-lib:int-sub j4 1))

```

```

((1 *))
z-%offset%))
(setf (f2cl-lib:fref z-%data%
((f2cl-lib:int-sub j4 1))
((1 *))
z-%offset%
(f2cl-lib:fref z-%data%
((f2cl-lib:int-sub ipn4 j4 5))
((1 *))
z-%offset%))
(setf (f2cl-lib:fref z-%data%
((f2cl-lib:int-sub ipn4 j4 5))
((1 *))
z-%offset%
temp)
(setf temp
(f2cl-lib:fref z-%data% (j4) ((1 *)) z-%offset%))
(setf (f2cl-lib:fref z-%data% (j4) ((1 *)) z-%offset%)
(f2cl-lib:fref z-%data%
((f2cl-lib:int-sub ipn4 j4 4))
((1 *))
z-%offset%))
(setf (f2cl-lib:fref z-%data%
((f2cl-lib:int-sub ipn4 j4 4))
((1 *))
z-%offset%
temp)))
(cond
((<= (f2cl-lib:int-add n0 (f2cl-lib:int-sub i0)) 4)
(setf (f2cl-lib:fref z-%data%
((f2cl-lib:int-sub
(f2cl-lib:int-add
(f2cl-lib:int-mul 4 n0)
pp)
1))
((1 *))
z-%offset%)
(f2cl-lib:fref z-%data%
((f2cl-lib:int-sub
(f2cl-lib:int-add
(f2cl-lib:int-mul 4 i0)
pp)
1))
((1 *))
z-%offset%))
(setf (f2cl-lib:fref z-%data%
```

```

((f2cl-lib:int-sub
  (f2cl-lib:int-mul 4 n0)
  pp))
((1 *))
z-%offset%)
(f2cl-lib:fref z-%data%
  ((f2cl-lib:int-sub
    (f2cl-lib:int-mul 4 i0)
    pp))
  ((1 *))
  z-%offset%)))
(setf dmin2
  (min dmin2
    (f2cl-lib:fref z-%data%
      ((f2cl-lib:int-sub
        (f2cl-lib:int-add
          (f2cl-lib:int-mul 4 n0)
          pp)
        1))
      ((1 *))
      z-%offset%)))
(setf (f2cl-lib:fref z-%data%
  ((f2cl-lib:int-sub
    (f2cl-lib:int-add
      (f2cl-lib:int-mul 4 n0)
      pp)
    1))
  ((1 *))
  z-%offset%)
  (min
    (f2cl-lib:fref z-%data%
      ((f2cl-lib:int-sub
        (f2cl-lib:int-add
          (f2cl-lib:int-mul 4 n0)
          pp)
        1))
      ((1 *))
      z-%offset%)
    (f2cl-lib:fref z-%data%
      ((f2cl-lib:int-sub
        (f2cl-lib:int-add
          (f2cl-lib:int-mul 4 i0)
          pp)
        1))
      ((1 *))
      z-%offset%)

```

```

(f2cl-lib:fref z-%data%
  ((f2cl-lib:int-add
    (f2cl-lib:int-mul 4 i0)
    pp
    3))
  ((1 *))
  z-%offset%)))
(setf (f2cl-lib:fref z-%data%
  ((f2cl-lib:int-sub (f2cl-lib:int-mul 4 n0)
    pp))
  ((1 *))
  z-%offset%)
(min
  (f2cl-lib:fref z-%data%
    ((f2cl-lib:int-sub
      (f2cl-lib:int-mul 4 n0)
      pp))
    ((1 *))
    z-%offset%)
  (f2cl-lib:fref z-%data%
    ((f2cl-lib:int-sub
      (f2cl-lib:int-mul 4 i0)
      pp))
    ((1 *))
    z-%offset%)
  (f2cl-lib:fref z-%data%
    ((f2cl-lib:int-add
      (f2cl-lib:int-sub
        (f2cl-lib:int-mul 4 i0)
        pp)
      4))
    ((1 *))
    z-%offset%)))
(setf qmax
  (max qmax
    (f2cl-lib:fref z-%data%
      ((f2cl-lib:int-sub
        (f2cl-lib:int-add
          (f2cl-lib:int-mul 4 i0)
          pp)
        3))
      ((1 *))
      z-%offset%)
    (f2cl-lib:fref z-%data%
      ((f2cl-lib:int-add
        (f2cl-lib:int-mul 4 i0)

```



```

                                pp
                                1))
                                ((1 *))
                                z-%offset%)))
    (setf dmin (- zero))))))
(cond
  ((or (< dmin zero)
        (< (* safmin qmax)
            (min
              (f2cl-lib:fref z
                ((f2cl-lib:int-add (f2cl-lib:int-mul 4 n0)
                                     pp
                                     (f2cl-lib:int-sub 1)))
                ((1 *)))
              (f2cl-lib:fref z
                ((f2cl-lib:int-add (f2cl-lib:int-mul 4 n0)
                                     pp
                                     (f2cl-lib:int-sub 9)))
                ((1 *)))
              (+ dmin2
                (f2cl-lib:fref z
                  ((f2cl-lib:int-add
                    (f2cl-lib:int-mul 4 n0)
                    (f2cl-lib:int-sub pp)))
                  ((1 *)))))))
    (tagbody
      (multiple-value-bind
        (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
         var-9 var-10 var-11 var-12)
        (dlasq4 i0 n0 z pp n0in dmin f2cl-lib:dmin1 dmin2 dn dn1 dn2
         tau ttype)
        (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                          var-7 var-8 var-9 var-10))
        (setf tau var-11)
        (setf ttype var-12))
      label80
      (multiple-value-bind
        (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
         var-9 var-10 var-11)
        (dlasq5 i0 n0 z pp tau dmin f2cl-lib:dmin1 dmin2 dn dn1 dn2
         ieee)
        (declare (ignore var-0 var-1 var-2 var-3 var-4 var-6 var-11))
        (setf dmin var-5)
        (setf dmin2 var-7)
        (setf dn var-8)
        (setf dn1 var-9)

```

```

      (setf dn2 var-10))
    (setf ndiv
      (f2cl-lib:int-add ndiv
        (f2cl-lib:int-add
          (f2cl-lib:int-sub n0 i0)
          2)))
    (setf iter (f2cl-lib:int-add iter 1))
    (cond
      ((and (>= dmin zero) (> f2cl-lib:dmin1 zero))
        (go label100))
      ((and (< dmin zero)
        (> f2cl-lib:dmin1 zero)
        (<
          (f2cl-lib:fref z
            ((f2cl-lib:int-add
              (f2cl-lib:int-mul 4
                (f2cl-lib:int-add n0
                  (f2cl-lib:int-sub
                    (f2cl-lib:int-sub pp)))
                    ((1 *)))
                (* tol (+ sigma dn1)))
                (< (abs dn) (* tol sigma)))
            (setf (f2cl-lib:fref z-%data%
              ((f2cl-lib:int-add
                (f2cl-lib:int-sub
                  (f2cl-lib:int-mul 4
                    (f2cl-lib:int-sub
                      n0
                      1))
                    pp)
                    2))
                ((1 *))
                z-%offset%)
              zero)
            (setf dmin zero)
            (go label100))
        (< dmin zero)
        (setf nfail (f2cl-lib:int-add nfail 1))
        (cond
          ((< ttype (f2cl-lib:int-sub 22))
            (setf tau zero))
          ((> f2cl-lib:dmin1 zero)
            (setf tau (* (+ tau dmin) (- one (* two eps)))))
          (setf ttype (f2cl-lib:int-sub ttype 11)))
        (t

```

```

        (setf tau (* qurtr tau))
        (setf ttype (f2cl-lib:int-sub ttype 12))))
      (go label80))
    ((/= dmin dmin)
     (setf tau zero)
     (go label80))
    (t
     (go label90))))))
label90
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9)
  (dlasq6 i0 n0 z pp dmin f2cl-lib:dmin1 dmin2 dn dn1 dn2)
  (declare (ignore var-0 var-1 var-2 var-3 var-5))
  (setf dmin var-4)
  (setf dmin2 var-6)
  (setf dn var-7)
  (setf dn1 var-8)
  (setf dn2 var-9))
(setf ndiv
  (f2cl-lib:int-add ndiv
    (f2cl-lib:int-add (f2cl-lib:int-sub n0 i0)
      2)))

(setf iter (f2cl-lib:int-add iter 1))
(setf tau zero)
label100
(cond
  ((< tau sigma)
   (setf desig (+ desig tau))
   (setf t$ (+ sigma desig))
   (setf desig (- desig (- t$ sigma))))
  (t
   (setf t$ (+ sigma tau))
   (setf desig (+ (- sigma (- t$ tau)) desig))))
(setf sigma t$)
end_label
(return
  (values nil
    n0
    nil
    nil
    dmin
    sigma
    desig
    qmax
    nfail
    iter

```

```
ndiv  
nil))))))
```

## 7.70 dlasq4 LAPACK

```
<dlasq4.input>≡  
  )set break resume  
  )sys rm -f dlasq4.output  
  )spool dlasq4.output  
  )set message test on  
  )set message auto off  
  )clear all  
  
  )spool  
  )lisp (bye)
```

`<dlasq4.help>`≡

```
=====
dlasq4 examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

DLASQ4 - an approximation TAU to the smallest eigenvalue using values of d from the previous transform

#### SYNOPSIS

```
SUBROUTINE DLASQ4( IO, NO, Z, PP, NOIN, DMIN, DMIN1, DMIN2, DN, DN1,
                  DN2, TAU, TTYPE )
```

```
      INTEGER      IO, NO, NOIN, PP, TTYPE
```

```
      DOUBLE      PRECISION DMIN, DMIN1, DMIN2, DN, DN1, DN2, TAU
```

```
      DOUBLE      PRECISION Z( * )
```

#### PURPOSE

DLASQ4 computes an approximation TAU to the smallest eigenvalue using values of d from the previous transform.

IO (input) INTEGER  
First index.

NO (input) INTEGER  
Last index.

Z (input) DOUBLE PRECISION array, dimension ( 4\*N )  
Z holds the qd array.

PP (input) INTEGER  
PP=0 for ping, PP=1 for pong.

NOIN (input) INTEGER  
The value of NO at start of EIGTEST.

DMIN (input) DOUBLE PRECISION  
Minimum value of d.

DMIN1 (input) DOUBLE PRECISION

Minimum value of  $d$ , excluding  $D( NO )$ .

DMIN2 (input) DOUBLE PRECISION  
Minimum value of  $d$ , excluding  $D( NO )$  and  $D( NO-1 )$ .

DN (input) DOUBLE PRECISION  
 $d(N)$

DN1 (input) DOUBLE PRECISION  
 $d(N-1)$

DN2 (input) DOUBLE PRECISION  
 $d(N-2)$

TAU (output) DOUBLE PRECISION  
This is the shift.

TTYPE (output) INTEGER  
Shift type.

```

(LAPACK dlasq4)=
  (let* ((cnst1 0.563)
        (cnst2 1.01)
        (cnst3 1.05)
        (qurtr 0.25)
        (third$ 0.333)
        (half 0.5)
        (zero 0.0)
        (one 1.0)
        (two 2.0)
        (hundrd 100.0))
    (declare (type (double-float 0.563 0.563) cnst1)
             (type (double-float 1.01 1.01) cnst2)
             (type (double-float 1.05 1.05) cnst3)
             (type (double-float 0.25 0.25) qurtr)
             (type (double-float 0.333 0.333) third$)
             (type (double-float 0.5 0.5) half)
             (type (double-float 0.0 0.0) zero)
             (type (double-float 1.0 1.0) one)
             (type (double-float 2.0 2.0) two)
             (type (double-float 100.0 100.0) hundrd))
    (let ((g zero))
      (declare (type (double-float) g))
      (defun dlasq4
        (i0 n0 z pp n0in dmin f2cl-lib:dmin1 dmin2 dn dn1 dn2 tau ttype)
        (declare (type (double-float) tau dn2 dn1 dn dmin2 f2cl-lib:dmin1 dmin)
                 (type (simple-array double-float (*)) z)
                 (type fixnum ttype n0in pp n0 i0))
        (f2cl-lib:with-multi-array-data
          ((z double-float z-%data% z-%offset%))
          (prog ((a2 0.0) (b1 0.0) (b2 0.0) (gam 0.0) (gap1 0.0) (gap2 0.0)
                 (s 0.0) (i4 0) (nn 0) (np 0) (sqrt$ 0.0f0))
            (declare (type (single-float) sqrt$)
                    (type (double-float) a2 b1 b2 gam gap1 gap2 s)
                    (type fixnum i4 nn np))
            (cond
              ((<= dmin zero)
               (setf tau (- dmin))
               (setf ttype -1)
               (go end_label)))
            (setf nn (f2cl-lib:int-add (f2cl-lib:int-mul 4 n0) pp))
            (cond
              ((= n0in n0)
               (cond
                 ((or (= dmin dn) (= dmin dn1))
                  (setf b1

```

```

(*
  (f2cl-lib:fsqrt
    (f2cl-lib:fref z-%data%
      ((f2cl-lib:int-sub nn 3))
      ((1 *))
      z-%offset%))
  (f2cl-lib:fsqrt
    (f2cl-lib:fref z-%data%
      ((f2cl-lib:int-sub nn 5))
      ((1 *))
      z-%offset%)))
(setf b2
  (*
    (f2cl-lib:fsqrt
      (f2cl-lib:fref z-%data%
        ((f2cl-lib:int-sub nn 7))
        ((1 *))
        z-%offset%))
    (f2cl-lib:fsqrt
      (f2cl-lib:fref z-%data%
        ((f2cl-lib:int-sub nn 9))
        ((1 *))
        z-%offset%))))
(setf a2
  (+
    (f2cl-lib:fref z-%data%
      ((f2cl-lib:int-sub nn 7))
      ((1 *))
      z-%offset%)
    (f2cl-lib:fref z-%data%
      ((f2cl-lib:int-sub nn 5))
      ((1 *))
      z-%offset%)))
(cond
  ((and (= dmin dn) (= f2cl-lib:dmin1 dn1))
    (setf gap2 (- dmin2 a2 (* dmin2 qurtr)))
    (cond
      ((and (> gap2 zero) (> gap2 b2))
        (setf gap1 (- a2 dn (* (/ b2 gap2) b2))))
      (t
        (setf gap1 (- a2 dn (+ b1 b2)))))
    (cond
      ((and (> gap1 zero) (> gap1 b1))
        (setf s (max (- dn (* (/ b1 gap1) b1)) (* half dmin)))
        (setf ttype -2))
      (t

```



```

(setf s zero)
(if (> dn b1) (setf s (- dn b1)))
(if (> a2 (+ b1 b2)) (setf s (min s (- a2 (+ b1 b2)))))
(setf s (max s (* third$ dmin)))
(setf ttype -3)))
(t
 (tagbody
  (setf ttype -4)
  (setf s (* qurtr dmin))
  (cond
   ((= dmin dn)
    (setf gam dn)
    (setf a2 zero)
    (if
     (>
      (f2cl-lib:fref z-%data%
                     ((f2cl-lib:int-sub nn 5))
                     ((1 *))
                     z-%offset%)
      (f2cl-lib:fref z-%data%
                     ((f2cl-lib:int-sub nn 7))
                     ((1 *))
                     z-%offset%))
     (go end_label)))
   (setf b2
    (/
     (f2cl-lib:fref z-%data%
                     ((f2cl-lib:int-sub nn 5))
                     ((1 *))
                     z-%offset%)
     (f2cl-lib:fref z-%data%
                     ((f2cl-lib:int-sub nn 7))
                     ((1 *))
                     z-%offset%)))
    (setf np (f2cl-lib:int-sub nn 9)))
  (t
   (setf np (f2cl-lib:int-sub nn (f2cl-lib:int-mul 2 pp)))
   (setf b2
    (f2cl-lib:fref z-%data%
                     ((f2cl-lib:int-sub np 2))
                     ((1 *))
                     z-%offset%))
    (setf gam dn1)
    (if
     (>
      (f2cl-lib:fref z-%data%

```

```

((f2cl-lib:int-sub np 4))
((1 *))
z-%offset%)
(f2cl-lib:fref z-%data%
((f2cl-lib:int-sub np 2))
((1 *))
z-%offset%))
(go end_label))
(setf a2
(/
(f2cl-lib:fref z-%data%
((f2cl-lib:int-sub np 4))
((1 *))
z-%offset%)
(f2cl-lib:fref z-%data%
((f2cl-lib:int-sub np 2))
((1 *))
z-%offset%)))
(if
(>
(f2cl-lib:fref z-%data%
((f2cl-lib:int-sub nn 9))
((1 *))
z-%offset%)
(f2cl-lib:fref z-%data%
((f2cl-lib:int-sub nn 11))
((1 *))
z-%offset%))
(go end_label))
(setf b2
(/
(f2cl-lib:fref z-%data%
((f2cl-lib:int-sub nn 9))
((1 *))
z-%offset%)
(f2cl-lib:fref z-%data%
((f2cl-lib:int-sub nn 11))
((1 *))
z-%offset%)))
(setf np (f2cl-lib:int-sub nn 13)))
(setf a2 (+ a2 b2))
(f2cl-lib:fdo (i4 np
(f2cl-lib:int-add i4 (f2cl-lib:int-sub 4)))
(> i4
(f2cl-lib:int-add
(f2cl-lib:int-mul 4 i0)

```

```

(f2cl-lib:int-sub 1)
pp))
nil)
(tagbody
  (if (= b2 zero) (go label20))
  (setf b1 b2)
  (if
    (> (f2cl-lib:fref z-%data% (i4) ((1 *)) z-%offset%)
      (f2cl-lib:fref z-%data%
                    ((f2cl-lib:int-sub i4 2))
                    ((1 *))
                    z-%offset%)))
    (go end_label))
  (setf b2
    (* b2
      (/
        (f2cl-lib:fref z-%data%
                      (i4)
                      ((1 *))
                      z-%offset%)
        (f2cl-lib:fref z-%data%
                      ((f2cl-lib:int-sub i4 2))
                      ((1 *))
                      z-%offset%))))))
  (setf a2 (+ a2 b2))
  (if (or (< (* hundred (max b2 b1)) a2) (< cnst1 a2))
    (go label20)))

label20

(setf a2 (* cnst3 a2))
(if (< a2 cnst1)
  (setf s
    (/ (* gam (- one (f2cl-lib:fsqrt a2)))
      (+ one a2))))))

(= dmin dn2)
(setf ttype -5)
(setf s (* qurtr dmin))
(setf np (f2cl-lib:int-sub nn (f2cl-lib:int-mul 2 pp)))
(setf b1
  (f2cl-lib:fref z-%data%
                ((f2cl-lib:int-sub np 2))
                ((1 *))
                z-%offset%))

(setf b2
  (f2cl-lib:fref z-%data%
                ((f2cl-lib:int-sub np 6))
                ((1 *))

```

```

                                z-%offset%))
(setf gam dn2)
(if
  (or
    (>
      (f2cl-lib:fref z-%data%
        ((f2cl-lib:int-sub np 8))
        ((1 *))
        z-%offset%)

      b2)
    (>
      (f2cl-lib:fref z-%data%
        ((f2cl-lib:int-sub np 4))
        ((1 *))
        z-%offset%)

      b1))
  (go end_label))
(setf a2
  (*
    (/
      (f2cl-lib:fref z-%data%
        ((f2cl-lib:int-sub np 8))
        ((1 *))
        z-%offset%)

      b2)
    (+ one
      (/
        (f2cl-lib:fref z-%data%
          ((f2cl-lib:int-sub np 4))
          ((1 *))
          z-%offset%)

        b1))))))
(cond
  ((> (f2cl-lib:int-add n0 (f2cl-lib:int-sub i0)) 2)
    (tagbody
      (setf b2
        (/
          (f2cl-lib:fref z-%data%
            ((f2cl-lib:int-sub nn 13))
            ((1 *))
            z-%offset%)

          (f2cl-lib:fref z-%data%
            ((f2cl-lib:int-sub nn 15))
            ((1 *))
            z-%offset%)))

      (setf a2 (+ a2 b2))

```

```

(f2cl-lib:fdo (i4
  (f2cl-lib:int-add nn (f2cl-lib:int-sub 17))
  (f2cl-lib:int-add i4 (f2cl-lib:int-sub 4)))
  (> i4
    (f2cl-lib:int-add
      (f2cl-lib:int-mul 4 i0)
      (f2cl-lib:int-sub 1)
      pp))
    nil)
(tagbody
  (if (= b2 zero) (go label40))
  (setf b1 b2)
  (if
    (> (f2cl-lib:fref z-%data% (i4) ((1 *)) z-%offset%)
      (f2cl-lib:fref z-%data%
        ((f2cl-lib:int-sub i4 2))
        ((1 *))
        z-%offset%))
    (go end_label))
  (setf b2
    (* b2
      (/
        (f2cl-lib:fref z-%data%
          (i4)
          ((1 *))
          z-%offset%)
        (f2cl-lib:fref z-%data%
          ((f2cl-lib:int-sub i4 2))
          ((1 *))
          z-%offset%))))))
  (setf a2 (+ a2 b2))
  (if (or (< (* hundred (max b2 b1)) a2) (< cnst1 a2))
    (go label40)))

label40
  (setf a2 (* cnst3 a2))))
(if (< a2 cnst1)
  (setf s
    (/ (* gam (- one (f2cl-lib:fsqrt a2)))
      (+ one a2))))
(t
  (cond
    ((= ttype (f2cl-lib:int-sub 6))
      (setf g (+ g (* third$ (- one g)))))
    ((= ttype (f2cl-lib:int-sub 18))
      (setf g (* qurtr third$)))
    (t

```

```

      (setf g qurtr)))
      (setf s (* g dmin))
      (setf ttype -6))))
    ((= n0in (f2cl-lib:int-add n0 1))
     (cond
      ((and (= f2cl-lib:dmin1 dn1) (= dmin2 dn2))
       (tagbody
        (setf ttype -7)
        (setf s (* third$ f2cl-lib:dmin1))
        (if
         (>
          (f2cl-lib:fref z-%data%
                        ((f2cl-lib:int-sub nn 5))
                        ((1 *))
                        z-%offset%)
          (f2cl-lib:fref z-%data%
                        ((f2cl-lib:int-sub nn 7))
                        ((1 *))
                        z-%offset%))
         (go end_label)))
        (setf b1
         (/
          (f2cl-lib:fref z-%data%
                        ((f2cl-lib:int-sub nn 5))
                        ((1 *))
                        z-%offset%)
          (f2cl-lib:fref z-%data%
                        ((f2cl-lib:int-sub nn 7))
                        ((1 *))
                        z-%offset%)))
        (setf b2 b1)
        (if (= b2 zero) (go label60))
        (f2cl-lib:fdo (i4
                      (f2cl-lib:int-add (f2cl-lib:int-mul 4 n0)
                                           (f2cl-lib:int-sub 9)
                                           pp)
                      (f2cl-lib:int-add i4 (f2cl-lib:int-sub 4)))
          ((> i4
            (f2cl-lib:int-add (f2cl-lib:int-mul 4 i0)
                              (f2cl-lib:int-sub 1)
                              pp))
           nil)
         (tagbody
          (setf a2 b1)
          (if
           (> (f2cl-lib:fref z-%data% (i4) ((1 *)) z-%offset%)

```

```

(f2cl-lib:fref z-%data%
  ((f2cl-lib:int-sub i4 2))
  ((1 *))
  z-%offset%))
(go end_label))
(setf b1
  (* b1
    (/
      (f2cl-lib:fref z-%data%
        (i4)
        ((1 *))
        z-%offset%)
      (f2cl-lib:fref z-%data%
        ((f2cl-lib:int-sub i4 2))
        ((1 *))
        z-%offset%))))))
(setf b2 (+ b2 b1))
(if (< (* hundrd (max b1 a2)) b2) (go label60)))

label60
(setf b2 (f2cl-lib:fsqrt (* cnst3 b2)))
(setf a2 (/ f2cl-lib:dmin1 (+ one (expt b2 2))))
(setf gap2 (- (* half dmin2) a2))
(cond
  ((and (> gap2 zero) (> gap2 (* b2 a2)))
   (setf s
     (max s
       (* a2
         (+ one (* (- cnst2) a2 (/ b2 gap2) b2))))))
  (t
   (setf s (max s (* a2 (- one (* cnst2 b2)))))
   (setf ttype -8))))
(t
 (setf s (* qurtr f2cl-lib:dmin1))
 (if (= f2cl-lib:dmin1 dn1) (setf s (* half f2cl-lib:dmin1)))
 (setf ttype -9)))
(= n0in (f2cl-lib:int-add n0 2))
(cond
  ((and (= dmin2 dn2)
        (<
          (* two
            (f2cl-lib:fref z
              ((f2cl-lib:int-add nn
                (f2cl-lib:int-sub
                  5)))
              ((1 *))))
            (f2cl-lib:fref z

```

```

((f2cl-lib:int-add nn
(f2cl-lib:int-sub 7)))
((1 *))))
(tagbody
  (setf ttype -10)
  (setf s (* third$ dmin2))
  (if
    (>
      (f2cl-lib:fref z-%data%
        ((f2cl-lib:int-sub nn 5))
        ((1 *))
        z-%offset%)
      (f2cl-lib:fref z-%data%
        ((f2cl-lib:int-sub nn 7))
        ((1 *))
        z-%offset%))
    (go end_label))
  (setf b1
    (/
      (f2cl-lib:fref z-%data%
        ((f2cl-lib:int-sub nn 5))
        ((1 *))
        z-%offset%)
      (f2cl-lib:fref z-%data%
        ((f2cl-lib:int-sub nn 7))
        ((1 *))
        z-%offset%)))
  (setf b2 b1)
  (if (= b2 zero) (go label180))
  (f2cl-lib:fdo (i4
    (f2cl-lib:int-add (f2cl-lib:int-mul 4 n0)
      (f2cl-lib:int-sub 9)
      pp)
    (f2cl-lib:int-add i4 (f2cl-lib:int-sub 4)))
    (> i4
      (f2cl-lib:int-add (f2cl-lib:int-mul 4 i0)
        (f2cl-lib:int-sub 1)
        pp))
    nil)
  (tagbody
    (if
      (> (f2cl-lib:fref z-%data% (i4) ((1 *)) z-%offset%)
        (f2cl-lib:fref z-%data%
          ((f2cl-lib:int-sub i4 2))
          ((1 *))
          z-%offset%))

```



```

        (go end_label))
      (setf b1
        (* b1
          (/
            (f2cl-lib:fref z-%data%
                          (i4)
                          ((1 *))
                          z-%offset%)
            (f2cl-lib:fref z-%data%
                          ((f2cl-lib:int-sub i4 2))
                          ((1 *))
                          z-%offset%))))
        (setf b2 (+ b2 b1))
        (if (< (* hundred b1) b2) (go label180))))

label180
      (setf b2 (f2cl-lib:fsqrt (* cnst3 b2)))
      (setf a2 (/ dmin2 (+ one (expt b2 2))))
      (setf gap2
        (-
          (+
            (f2cl-lib:fref z-%data%
                          ((f2cl-lib:int-sub nn 7))
                          ((1 *))
                          z-%offset%)
            (f2cl-lib:fref z-%data%
                          ((f2cl-lib:int-sub nn 9))
                          ((1 *))
                          z-%offset%))
          (*
            (f2cl-lib:fsqrt
              (f2cl-lib:fref z-%data%
                            ((f2cl-lib:int-sub nn 11))
                            ((1 *))
                            z-%offset%))
            (f2cl-lib:fsqrt
              (f2cl-lib:fref z-%data%
                            ((f2cl-lib:int-sub nn 9))
                            ((1 *))
                            z-%offset%))))
          a2))
      (cond
        ((and (> gap2 zero) (> gap2 (* b2 a2)))
         (setf s
           (max s
             (* a2
               (+ one (* (- cnst2) a2 (/ b2 gap2) b2)))))))

```

```

                (t
                  (setf s (max s (* a2 (- one (* cnst2 b2))))))))))
      (t
        (setf s (* qurtr dmin2))
        (setf ttype -11)))
      ((> n0in (f2cl-lib:int-add n0 2))
       (setf s zero)
       (setf ttype -12)))
      (setf tau s)
    end_label
    (return
     (values nil nil nil nil nil nil nil nil nil nil tau ttype))))))

```

## 7.71 dlasq5 LAPACK

```

⟨dlasq5.input⟩≡
)set break resume
)sys rm -f dlasq5.output
)spool dlasq5.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)

```

`<dlasq5.help>`≡

```
=====
dlasq5 examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

DLASQ5 - one dqds transform in ping-pong form, one version for IEEE machines another for non IEEE machines

#### SYNOPSIS

```
SUBROUTINE DLASQ5( IO, NO, Z, PP, TAU, DMIN, DMIN1, DMIN2, DN, DNM1,
                  DNM2, IEEE )
```

LOGICAL IEEE

INTEGER IO, NO, PP

DOUBLE PRECISION DMIN, DMIN1, DMIN2, DN, DNM1, DNM2, TAU

DOUBLE PRECISION Z( \* )

#### PURPOSE

DLASQ5 computes one dqds transform in ping-pong form, one version for IEEE machines another for non IEEE machines.

#### ARGUMENTS

IO (input) INTEGER  
First index.

NO (input) INTEGER  
Last index.

Z (input) DOUBLE PRECISION array, dimension ( 4\*N )  
Z holds the qd array. EMIN is stored in Z(4\*NO) to avoid an extra argument.

PP (input) INTEGER  
PP=0 for ping, PP=1 for pong.

TAU (input) DOUBLE PRECISION  
This is the shift.

DMIN (output) DOUBLE PRECISION  
Minimum value of d.

DMIN1 (output) DOUBLE PRECISION Minimum value of d, excluding D(  
NO ).

DMIN2 (output) DOUBLE PRECISION Minimum value of d, excluding D(  
NO ) and D( NO-1 ).

DN (output) DOUBLE PRECISION  
d(NO), the last value of d.

DNM1 (output) DOUBLE PRECISION  
d(NO-1).

DNM2 (output) DOUBLE PRECISION  
d(NO-2).

IEEE (input) LOGICAL  
Flag for IEEE or non IEEE arithmetic.

```

(LAPACK dlasq5)=
  (let* ((zero 0.0))
    (declare (type (double-float 0.0 0.0) zero))
    (defun dlasq5 (i0 n0 z pp tau dmin f2cl-lib:dmin1 dmin2 dn dnm1 dnm2 ieee)
      (declare (type (member t nil) ieee)
        (type (double-float) dnm2 dnm1 dn dmin2 f2cl-lib:dmin1 dmin tau)
        (type (simple-array double-float (*)) z)
        (type fixnum pp n0 i0))
      (f2cl-lib:with-multi-array-data
        ((z double-float z-%data% z-%offset%))
        (prog ((d 0.0) (emin 0.0) (temp 0.0) (j4 0) (j4p2 0))
          (declare (type (double-float) d emin temp)
            (type fixnum j4 j4p2))
          (if (<= (f2cl-lib:int-sub n0 i0 1) 0) (go end_label))
          (setf j4
            (f2cl-lib:int-sub (f2cl-lib:int-add (f2cl-lib:int-mul 4 i0) pp)
              3))
          (setf emin
            (f2cl-lib:fref z-%data%
              ((f2cl-lib:int-add j4 4))
              ((1 *))
              z-%offset%))
          (setf d (- (f2cl-lib:fref z-%data% (j4) ((1 *)) z-%offset%) tau))
          (setf dmin d)
          (setf f2cl-lib:dmin1
            (- (f2cl-lib:fref z-%data% (j4) ((1 *)) z-%offset%)))
          (cond
            (ieee
              (cond
                ((= pp 0)
                  (f2cl-lib:fdo (j4 (f2cl-lib:int-mul 4 i0) (f2cl-lib:int-add j4 4))
                    ((> j4
                      (f2cl-lib:int-mul 4
                        (f2cl-lib:int-add n0
                          (f2cl-lib:int
                            3))))
                      nil)
                    (tagbody
                      (setf (f2cl-lib:fref z-%data%
                        ((f2cl-lib:int-sub j4 2))
                        ((1 *))
                        z-%offset%)
                        (+ d
                          (f2cl-lib:fref z-%data%
                            ((f2cl-lib:int-sub j4 1))
                            ((1 *))

```

```

                                z-%offset%)))
(setf temp
 (/
  (f2cl-lib:fref z-%data%
    ((f2cl-lib:int-add j4 1))
    ((1 *))
    z-%offset%)
  (f2cl-lib:fref z-%data%
    ((f2cl-lib:int-sub j4 2))
    ((1 *))
    z-%offset%)))
(setf d (- (* d temp) tau))
(setf dmin (min dmin d))
(setf (f2cl-lib:fref z-%data% (j4) ((1 *)) z-%offset%)
  (*
    (f2cl-lib:fref z-%data%
      ((f2cl-lib:int-sub j4 1))
      ((1 *))
      z-%offset%)
    temp))
(setf emin
  (min (f2cl-lib:fref z-%data% (j4) ((1 *)) z-%offset%)
    emin))))
(t
  (f2cl-lib:fdo (j4 (f2cl-lib:int-mul 4 i0) (f2cl-lib:int-add j4 4))
    (> j4
      (f2cl-lib:int-mul 4
        (f2cl-lib:int-add n0
          (f2cl-lib:int-sub
            3))))
    nil)
  (tagbody
    (setf (f2cl-lib:fref z-%data%
      ((f2cl-lib:int-sub j4 3))
      ((1 *))
      z-%offset%)
      (+ d
        (f2cl-lib:fref z-%data% (j4) ((1 *)) z-%offset%)))
    (setf temp
      (/
        (f2cl-lib:fref z-%data%
          ((f2cl-lib:int-add j4 2))
          ((1 *))
          z-%offset%)
        (f2cl-lib:fref z-%data%
          ((f2cl-lib:int-sub j4 3))
          ((1 *))
          z-%offset%)))
      (f2cl-lib:fref z-%data%
        ((f2cl-lib:int-add j4 1))
        ((1 *))
        z-%offset%)
      (f2cl-lib:fref z-%data%
        ((f2cl-lib:int-sub j4 2))
        ((1 *))
        z-%offset%)))
    (setf d (- (* d temp) tau))
    (setf dmin (min dmin d))
    (setf (f2cl-lib:fref z-%data% (j4) ((1 *)) z-%offset%)
      (*
        (f2cl-lib:fref z-%data%
          ((f2cl-lib:int-sub j4 1))
          ((1 *))
          z-%offset%)
        temp))
    (setf emin
      (min (f2cl-lib:fref z-%data% (j4) ((1 *)) z-%offset%)
        emin))))
  )

```

```

((1 *))
z-%offset%)))
(setf d (- (* d temp) tau))
(setf dmin (min dmin d))
(setf (f2cl-lib:fref z-%data%
                    ((f2cl-lib:int-sub j4 1))
                    ((1 *))
                    z-%offset%)
      (* (f2cl-lib:fref z-%data% (j4) ((1 *)) z-%offset%)
         temp))
(setf emin
  (min
    (f2cl-lib:fref z-%data%
                  ((f2cl-lib:int-sub j4 1))
                  ((1 *))
                  z-%offset%)
    emin))))))
(setf dnm2 d)
(setf dmin2 dmin)
(setf j4
  (f2cl-lib:int-sub
    (f2cl-lib:int-mul 4 (f2cl-lib:int-sub n0 2))
    pp))
(setf j4p2
  (f2cl-lib:int-sub
    (f2cl-lib:int-add j4 (f2cl-lib:int-mul 2 pp))
    1))
(setf (f2cl-lib:fref z-%data%
                    ((f2cl-lib:int-sub j4 2))
                    ((1 *))
                    z-%offset%)
      (+ dnm2 (f2cl-lib:fref z-%data% (j4p2) ((1 *)) z-%offset%)))
(setf (f2cl-lib:fref z-%data% (j4) ((1 *)) z-%offset%)
      (*
        (f2cl-lib:fref z-%data%
                      ((f2cl-lib:int-add j4p2 2))
                      ((1 *))
                      z-%offset%)
        (/ (f2cl-lib:fref z-%data% (j4p2) ((1 *)) z-%offset%)
           (f2cl-lib:fref z-%data%
                         ((f2cl-lib:int-sub j4 2))
                         ((1 *))
                         z-%offset%))))))
(setf dnm1
  (-
    (*

```

```

(f2cl-lib:fref z-%data%
  ((f2cl-lib:int-add j4p2 2))
  ((1 *))
  z-%offset%)
(/ dnm2
  (f2cl-lib:fref z-%data%
    ((f2cl-lib:int-sub j4 2))
    ((1 *))
    z-%offset%)))
tau))
(setf dmin (min dmin dnm1))
(setf f2cl-lib:dmin1 dmin)
(setf j4 (f2cl-lib:int-add j4 4))
(setf j4p2
  (f2cl-lib:int-sub
    (f2cl-lib:int-add j4 (f2cl-lib:int-mul 2 pp))
    1))
(setf (f2cl-lib:fref z-%data%
  ((f2cl-lib:int-sub j4 2))
  ((1 *))
  z-%offset%)
  (+ dnm1 (f2cl-lib:fref z-%data% (j4p2) ((1 *)) z-%offset%)))
(setf (f2cl-lib:fref z-%data% (j4) ((1 *)) z-%offset%)
  (*
    (f2cl-lib:fref z-%data%
      ((f2cl-lib:int-add j4p2 2))
      ((1 *))
      z-%offset%)
    (/ (f2cl-lib:fref z-%data% (j4p2) ((1 *)) z-%offset%)
      (f2cl-lib:fref z-%data%
        ((f2cl-lib:int-sub j4 2))
        ((1 *))
        z-%offset%))))))
(setf dn
  (-
    (*
      (f2cl-lib:fref z-%data%
        ((f2cl-lib:int-add j4p2 2))
        ((1 *))
        z-%offset%)
      (/ dnm1
        (f2cl-lib:fref z-%data%
          ((f2cl-lib:int-sub j4 2))
          ((1 *))
          z-%offset%))))
    tau))

```



```

(setf dmin (min dmin dn)))
(t
  (cond
    ((= pp 0)
      (f2cl-lib:fdo (j4 (f2cl-lib:int-mul 4 i0) (f2cl-lib:int-add j4 4))
        ((> j4
          (f2cl-lib:int-mul 4
            (f2cl-lib:int-add n0
              (f2cl-lib:int-3))))
          nil)
      (tagbody
        (setf (f2cl-lib:fref z-%data%
          ((f2cl-lib:int-sub j4 2))
          ((1 *))
          z-%offset%)
          (+ d
            (f2cl-lib:fref z-%data%
              ((f2cl-lib:int-sub j4 1))
              ((1 *))
              z-%offset%)))
        (cond
          ((< d zero)
            (go end_label))
          (t
            (setf (f2cl-lib:fref z-%data% (j4) ((1 *)) z-%offset%)
              (*
                (f2cl-lib:fref z-%data%
                  ((f2cl-lib:int-add j4 1))
                  ((1 *))
                  z-%offset%)
                (/
                  (f2cl-lib:fref z-%data%
                    ((f2cl-lib:int-sub j4 1))
                    ((1 *))
                    z-%offset%)
                  (f2cl-lib:fref z-%data%
                    ((f2cl-lib:int-sub j4 2))
                    ((1 *))
                    z-%offset%))))
            (setf d
              (-
                (*
                  (f2cl-lib:fref z-%data%
                    ((f2cl-lib:int-add j4 1))
                    ((1 *))

```

```

                                z-%offset%)
(/ d
  (f2cl-lib:fref z-%data%
    ((f2cl-lib:int-sub j4 2))
    ((1 *))
    z-%offset%)))
  tau)))
(setf dmin (min dmin d))
(setf emin
  (min emin
    (f2cl-lib:fref z-%data%
      (j4)
      ((1 *))
      z-%offset%))))))
(t
  (f2cl-lib:fdo (j4 (f2cl-lib:int-mul 4 i0) (f2cl-lib:int-add j4 4))
    (> j4
      (f2cl-lib:int-mul 4
        (f2cl-lib:int-add n0
          (f2cl-lib:int-sub
            3))))
    nil)
  (tagbody
    (setf (f2cl-lib:fref z-%data%
      ((f2cl-lib:int-sub j4 3))
      ((1 *))
      z-%offset%)
      (+ d
        (f2cl-lib:fref z-%data% (j4) ((1 *)) z-%offset%)))
    (cond
      ((< d zero)
        (go end_label))
      (t
        (setf (f2cl-lib:fref z-%data%
          ((f2cl-lib:int-sub j4 1))
          ((1 *))
          z-%offset%)
          (*
            (f2cl-lib:fref z-%data%
              ((f2cl-lib:int-add j4 2))
              ((1 *))
              z-%offset%)
            (/
              (f2cl-lib:fref z-%data% (j4) ((1 *)) z-%offset%)
              (f2cl-lib:fref z-%data%
                ((f2cl-lib:int-sub j4 3))

```

```

((1 *))
z-%offset%))))

(setf d
  (-
    (*
      (f2cl-lib:fref z-%data%
        ((f2cl-lib:int-add j4 2))
        ((1 *))
        z-%offset%)
      (/ d
        (f2cl-lib:fref z-%data%
          ((f2cl-lib:int-sub j4 3))
          ((1 *))
          z-%offset%)))
    tau))))
(setf dmin (min dmin d))
(setf emin
  (min emin
    (f2cl-lib:fref z-%data%
      ((f2cl-lib:int-sub j4 1))
      ((1 *))
      z-%offset%))))))

(setf dnm2 d)
(setf dmin2 dmin)
(setf j4
  (f2cl-lib:int-sub
    (f2cl-lib:int-mul 4 (f2cl-lib:int-sub n0 2))
    pp))
(setf j4p2
  (f2cl-lib:int-sub
    (f2cl-lib:int-add j4 (f2cl-lib:int-mul 2 pp))
    1))
(setf (f2cl-lib:fref z-%data%
  ((f2cl-lib:int-sub j4 2))
  ((1 *))
  z-%offset%)
  (+ dnm2 (f2cl-lib:fref z-%data% (j4p2) ((1 *)) z-%offset%)))
(cond
  ((< dnm2 zero)
    (go end_label))
  (t
    (setf (f2cl-lib:fref z-%data% (j4) ((1 *)) z-%offset%)
      (*
        (f2cl-lib:fref z-%data%
          ((f2cl-lib:int-add j4p2 2))
          ((1 *))

```

```

                                z-%offset%)
      (/ (f2cl-lib:fref z-%data% (j4p2) ((1 *)) z-%offset%)
         (f2cl-lib:fref z-%data%
                        ((f2cl-lib:int-sub j4 2))
                        ((1 *))
                        z-%offset%)))

(setf dnm1
  (-
    (*
      (f2cl-lib:fref z-%data%
                    ((f2cl-lib:int-add j4p2 2))
                    ((1 *))
                    z-%offset%)
      (/ dnm2
         (f2cl-lib:fref z-%data%
                        ((f2cl-lib:int-sub j4 2))
                        ((1 *))
                        z-%offset%)))
    tau))))
(setf dmin (min dmin dnm1))
(setf f2cl-lib:dmin1 dmin)
(setf j4 (f2cl-lib:int-add j4 4))
(setf j4p2
  (f2cl-lib:int-sub
   (f2cl-lib:int-add j4 (f2cl-lib:int-mul 2 pp))
   1))
(setf (f2cl-lib:fref z-%data%
                    ((f2cl-lib:int-sub j4 2))
                    ((1 *))
                    z-%offset%)
      (+ dnm1 (f2cl-lib:fref z-%data% (j4p2) ((1 *)) z-%offset%)))
(cond
  ((< dnm1 zero)
   (go end_label))
  (t
   (setf (f2cl-lib:fref z-%data% (j4) ((1 *)) z-%offset%)
         (*
          (f2cl-lib:fref z-%data%
                        ((f2cl-lib:int-add j4p2 2))
                        ((1 *))
                        z-%offset%)
          (/ (f2cl-lib:fref z-%data% (j4p2) ((1 *)) z-%offset%)
             (f2cl-lib:fref z-%data%
                            ((f2cl-lib:int-sub j4 2))
                            ((1 *))
                            z-%offset%))))))

```

```

      (setf dn
        (-
          (*
            (f2cl-lib:fref z-%data%
                          ((f2cl-lib:int-add j4p2 2))
                          ((1 *))
                          z-%offset%)
            (/ dnm1
              (f2cl-lib:fref z-%data%
                            ((f2cl-lib:int-sub j4 2))
                            ((1 *))
                            z-%offset%)))
          tau))))
      (setf dmin (min dmin dn)))
      (setf (f2cl-lib:fref z-%data%
                        ((f2cl-lib:int-add j4 2))
                        ((1 *))
                        z-%offset%)
        dn)
      (setf (f2cl-lib:fref z-%data%
                        ((f2cl-lib:int-sub (f2cl-lib:int-mul 4 n0) pp))
                        ((1 *))
                        z-%offset%)
        emin)
    end_label
  (return
    (values nil
            nil
            nil
            nil
            nil
            dmin
            f2cl-lib:dmin1
            dmin2
            dn
            dnm1
            dnm2
            nil))))))

```

**7.72 dlasq6 LAPACK**

```
<dlasq6.input>≡  
  )set break resume  
  )sys rm -f dlasq6.output  
  )spool dlasq6.output  
  )set message test on  
  )set message auto off  
  )clear all  
  
  )spool  
  )lisp (bye)
```

`<dlasq6.help>`≡

```
=====
dlasq6 examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

DLASQ6 - one dqd (shift equal to zero) transform in ping-pong form, with protection against underflow and overflow

#### SYNOPSIS

```
SUBROUTINE DLASQ6( IO, NO, Z, PP, DMIN, DMIN1, DMIN2, DN, DNM1, DNM2 )
```

```
      INTEGER      IO, NO, PP
```

```
      DOUBLE      PRECISION DMIN, DMIN1, DMIN2, DN, DNM1, DNM2
```

```
      DOUBLE      PRECISION Z( * )
```

#### PURPOSE

DLASQ6 computes one dqd (shift equal to zero) transform in ping-pong form, with protection against underflow and overflow.

#### ARGUMENTS

IO (input) INTEGER  
First index.

NO (input) INTEGER  
Last index.

Z (input) DOUBLE PRECISION array, dimension ( 4\*N )  
Z holds the qd array. EMIN is stored in Z(4\*NO) to avoid an extra argument.

PP (input) INTEGER  
PP=0 for ping, PP=1 for pong.

DMIN (output) DOUBLE PRECISION  
Minimum value of d.

DMIN1 (output) DOUBLE PRECISION Minimum value of d, excluding D( NO ).

DMIN2 (output) DOUBLE PRECISION Minimum value of  $d$ , excluding  $D(N0)$  and  $D(N0-1)$ .

DN (output) DOUBLE PRECISION  
 $d(N0)$ , the last value of  $d$ .

DNM1 (output) DOUBLE PRECISION  
 $d(N0-1)$ .

DNM2 (output) DOUBLE PRECISION  
 $d(N0-2)$ .



```

(LAPACK dlasq6)=
  (let* ((zero 0.0))
    (declare (type (double-float 0.0 0.0) zero))
    (defun dlasq6 (i0 n0 z pp dmin f2cl-lib:dmin1 dmin2 dn dnm1 dnm2)
      (declare (type (double-float) dnm2 dnm1 dn dmin2 f2cl-lib:dmin1 dmin)
        (type (simple-array double-float (*)) z)
        (type fixnum pp n0 i0))
      (f2cl-lib:with-multi-array-data
        ((z double-float z-%data% z-%offset%))
        (prog ((d 0.0) (emin 0.0) (safmin 0.0) (temp 0.0) (j4 0) (j4p2 0))
          (declare (type (double-float) d emin safmin temp)
            (type fixnum j4 j4p2))
          (if (<= (f2cl-lib:int-sub n0 i0 1) 0) (go end_label))
          (setf safmin (dlamch "Safe minimum"))
          (setf j4
            (f2cl-lib:int-sub (f2cl-lib:int-add (f2cl-lib:int-mul 4 i0) pp)
              3))
          (setf emin
            (f2cl-lib:fref z-%data%
              ((f2cl-lib:int-add j4 4))
              ((1 *))
              z-%offset%))
          (setf d (f2cl-lib:fref z-%data% (j4) ((1 *)) z-%offset%))
          (setf dmin d)
          (cond
            ((= pp 0)
              (f2cl-lib:fdo (j4 (f2cl-lib:int-mul 4 i0) (f2cl-lib:int-add j4 4))
                ((> j4
                  (f2cl-lib:int-mul 4
                    (f2cl-lib:int-add n0
                      (f2cl-lib:int-sub
                        (f2cl-lib:int-mul 4 i0)
                        3))))
                  nil)
              (tagbody
                (setf (f2cl-lib:fref z-%data%
                  ((f2cl-lib:int-sub j4 2))
                  ((1 *))
                  z-%offset%))
                  (+ d
                    (f2cl-lib:fref z-%data%
                      ((f2cl-lib:int-sub j4 1))
                      ((1 *))
                      z-%offset%)))
                (cond
                  ((=
                    (f2cl-lib:fref z

```

```

((f2cl-lib:int-add j4 (f2cl-lib:int-sub 2)))
((1 *)))

zero)
(setf (f2cl-lib:fref z-%data% (j4) ((1 *)) z-%offset%) zero)
(setf d
  (f2cl-lib:fref z-%data%
    ((f2cl-lib:int-add j4 1))
    ((1 *))
    z-%offset%))

(setf dmin d)
(setf emin zero))
((and
  (<
    (* safmin
      (f2cl-lib:fref z ((f2cl-lib:int-add j4 1)) ((1 *))))
    (f2cl-lib:fref z
      ((f2cl-lib:int-add j4 (f2cl-lib:int-sub 2)))
      ((1 *))))
  (<
    (* safmin
      (f2cl-lib:fref z
        ((f2cl-lib:int-add j4
          (f2cl-lib:int-sub 2)))
        ((1 *))))
    (f2cl-lib:fref z ((f2cl-lib:int-add j4 1)) ((1 *))))))
(setf temp
  (/
    (f2cl-lib:fref z-%data%
      ((f2cl-lib:int-add j4 1))
      ((1 *))
      z-%offset%)
    (f2cl-lib:fref z-%data%
      ((f2cl-lib:int-sub j4 2))
      ((1 *))
      z-%offset%)))
(setf (f2cl-lib:fref z-%data% (j4) ((1 *)) z-%offset%)
  (*
    (f2cl-lib:fref z-%data%
      ((f2cl-lib:int-sub j4 1))
      ((1 *))
      z-%offset%)
    temp))
(setf d (* d temp)))
(t
  (setf (f2cl-lib:fref z-%data% (j4) ((1 *)) z-%offset%)
    (*

```

```

(f2cl-lib:fref z-%data%
  ((f2cl-lib:int-add j4 1))
  ((1 *))
  z-%offset%)
(/
(f2cl-lib:fref z-%data%
  ((f2cl-lib:int-sub j4 1))
  ((1 *))
  z-%offset%)
(f2cl-lib:fref z-%data%
  ((f2cl-lib:int-sub j4 2))
  ((1 *))
  z-%offset%))))
(setf d
  (*
    (f2cl-lib:fref z-%data%
      ((f2cl-lib:int-add j4 1))
      ((1 *))
      z-%offset%)
    (/ d
      (f2cl-lib:fref z-%data%
        ((f2cl-lib:int-sub j4 2))
        ((1 *))
        z-%offset%))))))
(setf dmin (min dmin d))
(setf emin
  (min emin
    (f2cl-lib:fref z-%data% (j4) ((1 *)) z-%offset%))))
(t
  (f2cl-lib:fdo (j4 (f2cl-lib:int-mul 4 i0) (f2cl-lib:int-add j4 4))
    (> j4
      (f2cl-lib:int-mul 4
        (f2cl-lib:int-add n0
          (f2cl-lib:int-sub
            3))))
    nil)
  (tagbody
    (setf (f2cl-lib:fref z-%data%
      ((f2cl-lib:int-sub j4 3))
      ((1 *))
      z-%offset%)
      (+ d (f2cl-lib:fref z-%data% (j4) ((1 *)) z-%offset%)))
    (cond
      ((=
        (f2cl-lib:fref z
          ((f2cl-lib:int-add j4 (f2cl-lib:int-sub 3)))

```

```

                                ((1 *)))
    zero)
  (setf (f2cl-lib:fref z-%data%
                                ((f2cl-lib:int-sub j4 1))
                                ((1 *)))
                                z-%offset%)

    zero)
  (setf d
    (f2cl-lib:fref z-%data%
                                ((f2cl-lib:int-add j4 2))
                                ((1 *)))
                                z-%offset%))

  (setf dmin d)
  (setf emin zero))
  ((and
    (<
      (* safmin
        (f2cl-lib:fref z ((f2cl-lib:int-add j4 2)) ((1 *))))
        (f2cl-lib:fref z
          ((f2cl-lib:int-add j4 (f2cl-lib:int-sub 3)))
          ((1 *))))
      (<
        (* safmin
          (f2cl-lib:fref z
            ((f2cl-lib:int-add j4
              (f2cl-lib:int-sub 3)))
            ((1 *))))
          (f2cl-lib:fref z ((f2cl-lib:int-add j4 2)) ((1 *))))))
    (setf temp
      (/
        (f2cl-lib:fref z-%data%
          ((f2cl-lib:int-add j4 2))
          ((1 *)))
          z-%offset%)
        (f2cl-lib:fref z-%data%
          ((f2cl-lib:int-sub j4 3))
          ((1 *)))
          z-%offset%)))
    (setf (f2cl-lib:fref z-%data%
          ((f2cl-lib:int-sub j4 1))
          ((1 *)))
          z-%offset%)
      (* (f2cl-lib:fref z-%data% (j4) ((1 *)) z-%offset%)
        temp))
    (setf d (* d temp)))
  (t

```

```

(setf (f2cl-lib:fref z-%data%
                    ((f2cl-lib:int-sub j4 1))
                    ((1 *))
                    z-%offset%))
(*
 (f2cl-lib:fref z-%data%
                ((f2cl-lib:int-add j4 2))
                ((1 *))
                z-%offset%))
(/ (f2cl-lib:fref z-%data% (j4) ((1 *)) z-%offset%)
   (f2cl-lib:fref z-%data%
                  ((f2cl-lib:int-sub j4 3))
                  ((1 *))
                  z-%offset%))))))
(setf d
      (*
       (f2cl-lib:fref z-%data%
                       ((f2cl-lib:int-add j4 2))
                       ((1 *))
                       z-%offset%))
       (/ d
          (f2cl-lib:fref z-%data%
                          ((f2cl-lib:int-sub j4 3))
                          ((1 *))
                          z-%offset%))))))
(setf dmin (min dmin d))
(setf emin
      (min emin
            (f2cl-lib:fref z-%data%
                            ((f2cl-lib:int-sub j4 1))
                            ((1 *))
                            z-%offset%))))))
(setf dnm2 d)
(setf dmin2 dmin)
(setf j4
      (f2cl-lib:int-sub (f2cl-lib:int-mul 4 (f2cl-lib:int-sub n0 2))
                        pp))
(setf j4p2
      (f2cl-lib:int-sub (f2cl-lib:int-add j4 (f2cl-lib:int-mul 2 pp))
                        1))
(setf (f2cl-lib:fref z-%data%
                    ((f2cl-lib:int-sub j4 2))
                    ((1 *))
                    z-%offset%))
      (+ dnm2 (f2cl-lib:fref z-%data% (j4p2) ((1 *)) z-%offset%)))
(cond

```

```

(=
  (f2cl-lib:fref z
    ((f2cl-lib:int-add j4 (f2cl-lib:int-sub 2)))
    ((1 *)))
  zero)
(setf (f2cl-lib:fref z-%data% (j4) ((1 *)) z-%offset%) zero)
(setf dnm1
  (f2cl-lib:fref z-%data%
    ((f2cl-lib:int-add j4p2 2))
    ((1 *))
    z-%offset%))
(setf dmin dnm1)
(setf emin zero))
(and
  (< (* safmin (f2cl-lib:fref z ((f2cl-lib:int-add j4p2 2)) ((1 *))))
    (f2cl-lib:fref z
      ((f2cl-lib:int-add j4 (f2cl-lib:int-sub 2)))
      ((1 *))))
  (<
    (* safmin
      (f2cl-lib:fref z
        ((f2cl-lib:int-add j4 (f2cl-lib:int-sub 2)))
        ((1 *))))
      (f2cl-lib:fref z ((f2cl-lib:int-add j4p2 2)) ((1 *))))))
(setf temp
  (/
    (f2cl-lib:fref z-%data%
      ((f2cl-lib:int-add j4p2 2))
      ((1 *))
      z-%offset%)
    (f2cl-lib:fref z-%data%
      ((f2cl-lib:int-sub j4 2))
      ((1 *))
      z-%offset%)))
(setf (f2cl-lib:fref z-%data% (j4) ((1 *)) z-%offset%)
  (* (f2cl-lib:fref z-%data% (j4p2) ((1 *)) z-%offset%) temp))
(setf dnm1 (* dnm2 temp))
(t
  (setf (f2cl-lib:fref z-%data% (j4) ((1 *)) z-%offset%)
    (*
      (f2cl-lib:fref z-%data%
        ((f2cl-lib:int-add j4p2 2))
        ((1 *))
        z-%offset%)
      (/ (f2cl-lib:fref z-%data% (j4p2) ((1 *)) z-%offset%)
        (f2cl-lib:fref z-%data%
          ((f2cl-lib:int-add j4p2 2))
          ((1 *))
          z-%offset%)))))

```

```

((f2cl-lib:int-sub j4 2))
((1 *))
z-%offset%))))
(setf dnm1
  (*
    (f2cl-lib:fref z-%data%
      ((f2cl-lib:int-add j4p2 2))
      ((1 *))
      z-%offset%)
    (/ dnm2
      (f2cl-lib:fref z-%data%
        ((f2cl-lib:int-sub j4 2))
        ((1 *))
        z-%offset%))))))
(setf dmin (min dmin dnm1))
(setf f2cl-lib:dmin1 dmin)
(setf j4 (f2cl-lib:int-add j4 4))
(setf j4p2
  (f2cl-lib:int-sub (f2cl-lib:int-add j4 (f2cl-lib:int-mul 2 pp))
    1))
(setf (f2cl-lib:fref z-%data%
  ((f2cl-lib:int-sub j4 2))
  ((1 *))
  z-%offset%)
  (+ dnm1 (f2cl-lib:fref z-%data% (j4p2) ((1 *)) z-%offset%)))
(cond
  ((=
    (f2cl-lib:fref z
      ((f2cl-lib:int-add j4 (f2cl-lib:int-sub 2)))
      ((1 *)))
    zero)
    (setf (f2cl-lib:fref z-%data% (j4) ((1 *)) z-%offset%) zero)
    (setf dn
      (f2cl-lib:fref z-%data%
        ((f2cl-lib:int-add j4p2 2))
        ((1 *))
        z-%offset%))
    (setf dmin dn)
    (setf emin zero))
  ((and
    (< (* safmin (f2cl-lib:fref z ((f2cl-lib:int-add j4p2 2)) ((1 *))))
      (f2cl-lib:fref z
        ((f2cl-lib:int-add j4 (f2cl-lib:int-sub 2)))
        ((1 *))))
    (<
      (* safmin

```

```

(f2cl-lib:fref z
  ((f2cl-lib:int-add j4 (f2cl-lib:int-sub 2)))
  ((1 *)))
(f2cl-lib:fref z ((f2cl-lib:int-add j4p2 2)) ((1 *)))
(setf temp
  (/
    (f2cl-lib:fref z-%data%
      ((f2cl-lib:int-add j4p2 2))
      ((1 *))
      z-%offset%)
    (f2cl-lib:fref z-%data%
      ((f2cl-lib:int-sub j4 2))
      ((1 *))
      z-%offset%)))
(setf (f2cl-lib:fref z-%data% (j4) ((1 *)) z-%offset%)
  (* (f2cl-lib:fref z-%data% (j4p2) ((1 *)) z-%offset%) temp))
(setf dn (* dnm1 temp))
(t
  (setf (f2cl-lib:fref z-%data% (j4) ((1 *)) z-%offset%)
    (*
      (f2cl-lib:fref z-%data%
        ((f2cl-lib:int-add j4p2 2))
        ((1 *))
        z-%offset%)
      (/ (f2cl-lib:fref z-%data% (j4p2) ((1 *)) z-%offset%)
        (f2cl-lib:fref z-%data%
          ((f2cl-lib:int-sub j4 2))
          ((1 *))
          z-%offset%))))))
  (setf dn
    (*
      (f2cl-lib:fref z-%data%
        ((f2cl-lib:int-add j4p2 2))
        ((1 *))
        z-%offset%)
      (/ dnm1
        (f2cl-lib:fref z-%data%
          ((f2cl-lib:int-sub j4 2))
          ((1 *))
          z-%offset%))))))
  (setf dmin (min dmin dn))
  (setf (f2cl-lib:fref z-%data%
    ((f2cl-lib:int-add j4 2))
    ((1 *))
    z-%offset%)
    dn)

```



```

      (setf (f2cl-lib:fref z-%data%
                        ((f2cl-lib:int-sub (f2cl-lib:int-mul 4 n0) pp))
                        ((1 *))
                        z-%offset%)
            emin)
end_label
(return
 (values nil nil nil nil dmin f2cl-lib:dmin1 dmin2 dn dnm1 dnm2))))))

```

### 7.73 dlasr LAPACK

```

⟨dlasr.input⟩≡
)set break resume
)sys rm -f dlasr.output
)spool dlasr.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)

```

`<dlasr.help>=`

```
=====
dlasr examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

DLASR - a sequence of plane rotations to a real matrix A,

#### SYNOPSIS

```
SUBROUTINE DLASR( SIDE, PIVOT, DIRECT, M, N, C, S, A, LDA )
```

```
      CHARACTER      DIRECT, PIVOT, SIDE
```

```
      INTEGER        LDA, M, N
```

```
      DOUBLE         PRECISION A( LDA, * ), C( * ), S( * )
```

#### PURPOSE

DLASR applies a sequence of plane rotations to a real matrix A, from either the left or the right.

When SIDE = 'L', the transformation takes the form

$$A := P * A$$

and when SIDE = 'R', the transformation takes the form

$$A := A * P^{**T}$$

where P is an orthogonal matrix consisting of a sequence of z plane rotations, with z = M when SIDE = 'L' and z = N when SIDE = 'R', and P\*\*T is the transpose of P.

When DIRECT = 'F' (Forward sequence), then

$$P = P(z-1) * \dots * P(2) * P(1)$$

and when DIRECT = 'B' (Backward sequence), then

$$P = P(1) * P(2) * \dots * P(z-1)$$

where P(k) is a plane rotation matrix defined by the 2-by-2 rotation

$$\begin{aligned} R(k) &= \begin{pmatrix} c(k) & s(k) \\ -s(k) & c(k) \end{pmatrix} \\ &= \begin{pmatrix} c(k) & s(k) \\ -s(k) & c(k) \end{pmatrix}. \end{aligned}$$

When PIVOT = 'V' (Variable pivot), the rotation is performed for the plane (k,k+1), i.e., P(k) has the form

$$P(k) = \begin{pmatrix} 1 & & & & & & \\ & \dots & & & & & \\ & & 1 & & & & \\ & & & c(k) & s(k) & & \\ & & & -s(k) & c(k) & & \\ & & & & & 1 & \dots \\ & & & & & & \dots & 1 \end{pmatrix}$$

where R(k) appears as a rank-2 modification to the identity matrix in rows and columns k and k+1.

When PIVOT = 'T' (Top pivot), the rotation is performed for the plane (1,k+1), so P(k) has the form

$$P(k) = \begin{pmatrix} c(k) & & & s(k) & & & \\ & 1 & & & & & \\ & & \dots & & & & \\ & & & 1 & & & \\ -s(k) & & & & c(k) & & \\ & & & & & 1 & \dots \\ & & & & & & \dots & 1 \end{pmatrix}$$

where R(k) appears in rows and columns 1 and k+1.

Similarly, when PIVOT = 'B' (Bottom pivot), the rotation is performed for the plane (k,z), giving P(k) the form

$$P(k) = \begin{pmatrix} 1 & & & & & & \\ & \dots & & & & & \\ & & 1 & & & & \\ & & & c(k) & & & s(k) \\ & & & & 1 & & \\ & & & & & \dots & \\ & & & & & & 1 & \\ & & & -s(k) & & & & c(k) \end{pmatrix}$$

where R(k) appears in rows and columns k and z. The rotations are per-

formed without ever forming  $P(k)$  explicitly.

#### ARGUMENTS

- SIDE** (input) CHARACTER\*1  
 Specifies whether the plane rotation matrix  $P$  is applied to  $A$  on the left or the right. = 'L': Left, compute  $A := P*A$   
 = 'R': Right, compute  $A := A*P**T$
- PIVOT** (input) CHARACTER\*1  
 Specifies the plane for which  $P(k)$  is a plane rotation matrix.  
 = 'V': Variable pivot, the plane  $(k,k+1)$   
 = 'T': Top pivot, the plane  $(1,k+1)$   
 = 'B': Bottom pivot, the plane  $(k,z)$
- DIRECT** (input) CHARACTER\*1  
 Specifies whether  $P$  is a forward or backward sequence of plane rotations. = 'F': Forward,  $P = P(z-1)*...*P(2)*P(1)$   
 = 'B': Backward,  $P = P(1)*P(2)*...*P(z-1)$
- M** (input) INTEGER  
 The number of rows of the matrix  $A$ . If  $m \leq 1$ , an immediate return is effected.
- N** (input) INTEGER  
 The number of columns of the matrix  $A$ . If  $n \leq 1$ , an immediate return is effected.
- C** (input) DOUBLE PRECISION array, dimension  
 $(M-1)$  if  $SIDE = 'L'$   $(N-1)$  if  $SIDE = 'R'$  The cosines  $c(k)$  of the plane rotations.
- S** (input) DOUBLE PRECISION array, dimension  
 $(M-1)$  if  $SIDE = 'L'$   $(N-1)$  if  $SIDE = 'R'$  The sines  $s(k)$  of the plane rotations. The 2-by-2 plane rotation part of the matrix  $P(k)$ ,  $R(k)$ , has the form  $R(k) = \begin{pmatrix} c(k) & s(k) \\ -s(k) & c(k) \end{pmatrix}$ .
- A** (input/output) DOUBLE PRECISION array, dimension  $(LDA,N)$   
 The  $M$ -by- $N$  matrix  $A$ . On exit,  $A$  is overwritten by  $P*A$  if  $SIDE = 'R'$  or by  $A*P**T$  if  $SIDE = 'L'$ .
- LDA** (input) INTEGER  
 The leading dimension of the array  $A$ .  $LDA \geq \max(1,M)$ .

```

(LAPACK dlasr)≡
  (let* ((one 1.0) (zero 0.0))
    (declare (type (double-float 1.0 1.0) one)
              (type (double-float 0.0 0.0) zero))
    (defun dlasr (side pivot direct m n c s a lda)
      (declare (type (simple-array double-float (*)) a s c)
                (type fixnum lda n m)
                (type character direct pivot side))
      (f2cl-lib:with-multi-array-data
        ((side character side-%data% side-%offset%)
         (pivot character pivot-%data% pivot-%offset%)
         (direct character direct-%data% direct-%offset%)
         (c double-float c-%data% c-%offset%)
         (s double-float s-%data% s-%offset%)
         (a double-float a-%data% a-%offset%))
        (prog ((ctemp 0.0) (stemp 0.0) (temp 0.0) (i 0) (info 0) (j 0))
          (declare (type (double-float) ctemp stemp temp)
                    (type fixnum i info j))
          (setf info 0)
          (cond
            ((not (or (char-equal side #\L) (char-equal side #\R)))
              (setf info 1))
            ((not (or (char-equal pivot #\V) (char-equal pivot #\T) (char-equal piv
              (setf info 2))
            ((not (or (char-equal direct #\F) (char-equal direct #\B)))
              (setf info 3))
            ((< m 0)
              (setf info 4))
            ((< n 0)
              (setf info 5))
            ((< lda (max (the fixnum 1) (the fixnum m)))
              (setf info 9)))
          (cond
            ((/= info 0)
              (error
               " ** On entry to ~a parameter number ~a had an illegal value~%"
               "DLASR" info)
              (go end_label)))
          (if (or (= m 0) (= n 0)) (go end_label))
          (cond
            ((char-equal side #\L)
              (cond
                ((char-equal pivot #\V)
                  (cond
                    ((char-equal direct #\F)
                     (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))

```

```

        ((> j (f2cl-lib:int-add m (f2cl-lib:int-sub 1)))
         nil)
(tagbody
  (setf ctemp
        (f2cl-lib:fref c-%data% (j) ((1 *)) c-%offset%))
  (setf stemp
        (f2cl-lib:fref s-%data% (j) ((1 *)) s-%offset%))
  (cond
    ((or (/= ctemp one) (/= stemp zero))
     (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                   ((> i n) nil)
     (tagbody
      (setf temp
              (f2cl-lib:fref a-%data%
                            ((f2cl-lib:int-add j 1) i)
                            ((1 lda) (1 *))
                            a-%offset%))
      (setf (f2cl-lib:fref a-%data%
                          ((f2cl-lib:int-add j 1) i)
                          ((1 lda) (1 *))
                          a-%offset%)
            (- (* ctemp temp)
               (* stemp
                  (f2cl-lib:fref a-%data%
                                (j i)
                                ((1 lda) (1 *))
                                a-%offset%))))
      (setf (f2cl-lib:fref a-%data%
                          (j i)
                          ((1 lda) (1 *))
                          a-%offset%)
            (+ (* stemp temp)
               (* ctemp
                  (f2cl-lib:fref a-%data%
                                (j i)
                                ((1 lda) (1 *))
                                a-%offset%))))))))))
((char-equal direct #\B)
 (f2cl-lib:fdo (j (f2cl-lib:int-add m (f2cl-lib:int-sub 1))
               (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
               ((> j 1) nil)
  (tagbody
   (setf ctemp
         (f2cl-lib:fref c-%data% (j) ((1 *)) c-%offset%))
   (setf stemp
         (f2cl-lib:fref s-%data% (j) ((1 *)) s-%offset%))

```

```

(cond
  ((or (/= ctemp one) (/= stemp zero))
    (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
      ((> i n) nil)
      (tagbody
        (setf temp
          (f2cl-lib:fref a-%data%
            ((f2cl-lib:int-add j 1) i)
            ((1 lda) (1 *))
            a-%offset%))
          (setf (f2cl-lib:fref a-%data%
            ((f2cl-lib:int-add j 1) i)
            ((1 lda) (1 *))
            a-%offset%)
            (- (* ctemp temp)
              (* stemp
                (f2cl-lib:fref a-%data%
                  (j i)
                  ((1 lda) (1 *))
                  a-%offset%))))))
        (setf (f2cl-lib:fref a-%data%
          (j i)
          ((1 lda) (1 *))
          a-%offset%)
          (+ (* stemp temp)
            (* ctemp
              (f2cl-lib:fref a-%data%
                (j i)
                ((1 lda) (1 *))
                a-%offset%))))))))))
((char-equal pivot #\T)
  (cond
    ((char-equal direct #\F)
      (f2cl-lib:fdo (j 2 (f2cl-lib:int-add j 1))
        ((> j m) nil)
        (tagbody
          (setf ctemp
            (f2cl-lib:fref c-%data%
              ((f2cl-lib:int-sub j 1) i)
              ((1 *))
              c-%offset%))
            (setf stemp
              (f2cl-lib:fref s-%data%
                ((f2cl-lib:int-sub j 1) i)
                ((1 *))
                s-%offset%))

```

```

(cond
  ((or (/= ctemp one) (/= stemp zero))
    (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
      ((> i n) nil)
      (tagbody
        (setf temp
          (f2cl-lib:fref a-%data%
            (j i)
            ((1 lda) (1 *))
            a-%offset%))
          (setf (f2cl-lib:fref a-%data%
            (j i)
            ((1 lda) (1 *))
            a-%offset%)
            (- (* ctemp temp)
              (* stemp
                (f2cl-lib:fref a-%data%
                  (1 i)
                  ((1 lda) (1 *))
                  a-%offset%))))
            (setf (f2cl-lib:fref a-%data%
              (1 i)
              ((1 lda) (1 *))
              a-%offset%)
              (+ (* stemp temp)
                (* ctemp
                  (f2cl-lib:fref a-%data%
                    (1 i)
                    ((1 lda) (1 *))
                    a-%offset%))))))))))
  ((char-equal direct #\B)
    (f2cl-lib:fdo (j m (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
      ((> j 2) nil)
      (tagbody
        (setf ctemp
          (f2cl-lib:fref c-%data%
            ((f2cl-lib:int-sub j 1))
            ((1 *))
            c-%offset%))
          (setf stemp
            (f2cl-lib:fref s-%data%
              ((f2cl-lib:int-sub j 1))
              ((1 *))
              s-%offset%))
          (cond
            ((or (/= ctemp one) (/= stemp zero))

```



```

(f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
  (> i n) nil)
(tagbody
  (setf temp
    (f2cl-lib:fref a-%data%
      (j i)
      ((1 lda) (1 *))
      a-%offset%))
  (setf (f2cl-lib:fref a-%data%
    (j i)
    ((1 lda) (1 *))
    a-%offset%)
    (- (* ctemp temp)
      (* stemp
        (f2cl-lib:fref a-%data%
          (1 i)
          ((1 lda) (1 *))
          a-%offset%))))
  (setf (f2cl-lib:fref a-%data%
    (1 i)
    ((1 lda) (1 *))
    a-%offset%)
    (+ (* stemp temp)
      (* ctemp
        (f2cl-lib:fref a-%data%
          (1 i)
          ((1 lda) (1 *))
          a-%offset%))))))
((char-equal pivot #\B)
  (cond
    ((char-equal direct #\F)
      (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
        (> j (f2cl-lib:int-add m (f2cl-lib:int-sub 1)))
        nil)
      (tagbody
        (setf ctemp
          (f2cl-lib:fref c-%data% (j) ((1 *)) c-%offset%))
        (setf stemp
          (f2cl-lib:fref s-%data% (j) ((1 *)) s-%offset%))
        (cond
          ((or (/= ctemp one) (/= stemp zero))
            (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
              (> i n) nil)
            (tagbody
              (setf temp
                (f2cl-lib:fref a-%data%

```

```

                                (j i)
                                ((1 lda) (1 *))
                                a-%offset%)
(setf (f2cl-lib:fref a-%data%
                    (j i)
                    ((1 lda) (1 *))
                    a-%offset%)
      (+
        (* stemp
          (f2cl-lib:fref a-%data%
                        (m i)
                        ((1 lda) (1 *))
                        a-%offset%))
        (* ctemp temp)))
(setf (f2cl-lib:fref a-%data%
                    (m i)
                    ((1 lda) (1 *))
                    a-%offset%)
      (-
        (* ctemp
          (f2cl-lib:fref a-%data%
                        (m i)
                        ((1 lda) (1 *))
                        a-%offset%))
        (* stemp temp)))))))))
((char-equal direct #\B)
 (f2cl-lib:fdo (j (f2cl-lib:int-add m (f2cl-lib:int-sub 1))
               (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
               (> j 1) nil)
 (tagbody
  (setf ctemp
        (f2cl-lib:fref c-%data% (j) ((1 *)) c-%offset%))
  (setf stemp
        (f2cl-lib:fref s-%data% (j) ((1 *)) s-%offset%))
  (cond
   ((or (/= ctemp one) (/= stemp zero))
    (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                  (> i n) nil)
    (tagbody
     (setf temp
             (f2cl-lib:fref a-%data%
                           (j i)
                           ((1 lda) (1 *))
                           a-%offset%))
     (setf (f2cl-lib:fref a-%data%
                         (j i)

```

```

((1 lda) (1 *))
a-%offset%)

(+
(* stemp
  (f2cl-lib:fref a-%data%
    (m i)
    ((1 lda) (1 *))
    a-%offset%))
  (* ctemp temp)))
(setf (f2cl-lib:fref a-%data%
  (m i)
  ((1 lda) (1 *))
  a-%offset%))

(-
(* ctemp
  (f2cl-lib:fref a-%data%
    (m i)
    ((1 lda) (1 *))
    a-%offset%))
  (* stemp temp)))))))))

((char-equal side #\R)
(cond
  ((char-equal pivot #\V)
    (cond
      ((char-equal direct #\F)
        (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
          ((> j (f2cl-lib:int-add n (f2cl-lib:int-sub 1)))
            nil)
        (tagbody
          (setf ctemp
            (f2cl-lib:fref c-%data% (j) ((1 *)) c-%offset%))
          (setf stemp
            (f2cl-lib:fref s-%data% (j) ((1 *)) s-%offset%))
          (cond
            ((or (/= ctemp one) (/= stemp zero))
              (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                ((> i m) nil)
              (tagbody
                (setf temp
                  (f2cl-lib:fref a-%data%
                    (i (f2cl-lib:int-add j 1))
                    ((1 lda) (1 *))
                    a-%offset%))
                (setf (f2cl-lib:fref a-%data%
                  (i (f2cl-lib:int-add j 1))
                  ((1 lda) (1 *))

```

```

                                a-%offset%)
(- (* ctemp temp)
  (* stemp
    (f2cl-lib:fref a-%data%
      (i j)
      ((1 lda) (1 *))
      a-%offset%)))
(setf (f2cl-lib:fref a-%data%
  (i j)
  ((1 lda) (1 *))
  a-%offset%)
  (+ (* stemp temp)
    (* ctemp
      (f2cl-lib:fref a-%data%
        (i j)
        ((1 lda) (1 *))
        a-%offset%)))))))))
((char-equal direct #\B)
 (f2cl-lib:fdo (j (f2cl-lib:int-add n (f2cl-lib:int-sub 1))
  (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
  (> j 1) nil)
(tagbody
  (setf ctemp
    (f2cl-lib:fref c-%data% (j) ((1 *)) c-%offset%))
  (setf stemp
    (f2cl-lib:fref s-%data% (j) ((1 *)) s-%offset%))
  (cond
    ((or (/= ctemp one) (/= stemp zero))
     (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
       (> i m) nil)
     (tagbody
       (setf temp
         (f2cl-lib:fref a-%data%
           (i (f2cl-lib:int-add j 1))
           ((1 lda) (1 *))
           a-%offset%))
         (setf (f2cl-lib:fref a-%data%
           (i (f2cl-lib:int-add j 1))
           ((1 lda) (1 *))
           a-%offset%)
           (- (* ctemp temp)
             (* stemp
               (f2cl-lib:fref a-%data%
                 (i j)
                 ((1 lda) (1 *))
                 a-%offset%))))))

```

```

      (setf (f2cl-lib:fref a-%data%
        (i j)
        ((1 lda) (1 *))
        a-%offset%)
        (+ (* stemp temp)
          (* ctemp
            (f2cl-lib:fref a-%data%
              (i j)
              ((1 lda) (1 *))
              a-%offset%)))))))))
((char-equal pivot #\T)
 (cond
  ((char-equal direct #\F)
   (f2cl-lib:fdo (j 2 (f2cl-lib:int-add j 1))
    (> j n) nil)
   (tagbody
    (setf ctemp
      (f2cl-lib:fref c-%data%
        ((f2cl-lib:int-sub j 1))
        ((1 *))
        c-%offset%))
      (setf stemp
        (f2cl-lib:fref s-%data%
          ((f2cl-lib:int-sub j 1))
          ((1 *))
          s-%offset%))
      (cond
       ((or (/= ctemp one) (/= stemp zero))
        (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
         (> i m) nil)
        (tagbody
         (setf temp
           (f2cl-lib:fref a-%data%
             (i j)
             ((1 lda) (1 *))
             a-%offset%))
           (setf (f2cl-lib:fref a-%data%
             (i j)
             ((1 lda) (1 *))
             a-%offset%)
             (- (* ctemp temp)
               (* stemp
                 (f2cl-lib:fref a-%data%
                   (i 1)
                   ((1 lda) (1 *))
                   a-%offset%))))))

```

```

        (setf (f2cl-lib:fref a-%data%
                           (i 1)
                           ((1 lda) (1 *)))
              a-%offset%)
      (+ (* stemp temp)
         (* ctemp
            (f2cl-lib:fref a-%data%
                           (i 1)
                           ((1 lda) (1 *)))
            a-%offset%)))))))))
((char-equal direct #\B)
 (f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
               (> j 2) nil)
 (tagbody
  (setf ctemp
        (f2cl-lib:fref c-%data%
                        ((f2cl-lib:int-sub j 1))
                        ((1 *)))
        c-%offset%))
  (setf stemp
        (f2cl-lib:fref s-%data%
                        ((f2cl-lib:int-sub j 1))
                        ((1 *)))
        s-%offset%))
  (cond
   ((or (/= ctemp one) (/= stemp zero))
    (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                  (> i m) nil)
    (tagbody
     (setf temp
            (f2cl-lib:fref a-%data%
                            (i j)
                            ((1 lda) (1 *)))
            a-%offset%))
     (setf (f2cl-lib:fref a-%data%
                           (i j)
                           ((1 lda) (1 *)))
           a-%offset%)
     (- (* ctemp temp)
        (* stemp
           (f2cl-lib:fref a-%data%
                           (i 1)
                           ((1 lda) (1 *)))
           a-%offset%))))
  (setf (f2cl-lib:fref a-%data%
                        (i 1)
                        ((1 lda) (1 *)))
        a-%offset%)))

```

```

((1 lda) (1 *))
a-%offset%)
(+ (* stemp temp)
  (* ctemp
    (f2cl-lib:fref a-%data%
      (i 1)
      ((1 lda) (1 *))
      a-%offset%)))))))))
(char-equal pivot #\B)
(cond
  ((char-equal direct #\F)
    (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
      ((> j (f2cl-lib:int-add n (f2cl-lib:int-sub 1)))
        nil)
    (tagbody
      (setf ctemp
        (f2cl-lib:fref c-%data% (j) ((1 *)) c-%offset%))
      (setf stemp
        (f2cl-lib:fref s-%data% (j) ((1 *)) s-%offset%))
      (cond
        ((or (/= ctemp one) (/= stemp zero))
          (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
            ((> i m) nil)
          (tagbody
            (setf temp
              (f2cl-lib:fref a-%data%
                (i j)
                ((1 lda) (1 *))
                a-%offset%))
            (setf (f2cl-lib:fref a-%data%
              (i j)
              ((1 lda) (1 *))
              a-%offset%)
              (+
                (* stemp
                  (f2cl-lib:fref a-%data%
                    (i n)
                    ((1 lda) (1 *))
                    a-%offset%))
                (* ctemp temp)))
            (setf (f2cl-lib:fref a-%data%
              (i n)
              ((1 lda) (1 *))
              a-%offset%)
              (-
                (* ctemp

```

```

(f2cl-lib:fref a-%data%
  (i n)
  ((1 lda) (1 *))
  a-%offset%))
(* stemp temp))))))))))
((char-equal direct #\B)
 (f2cl-lib:fdo (j (f2cl-lib:int-add n (f2cl-lib:int-sub 1))
  (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
  (> j 1) nil)
(tagbody
  (setf ctemp
    (f2cl-lib:fref c-%data% (j) ((1 *)) c-%offset%))
  (setf stemp
    (f2cl-lib:fref s-%data% (j) ((1 *)) s-%offset%))
  (cond
    ((or (/= ctemp one) (/= stemp zero))
     (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
       (> i m) nil)
     (tagbody
       (setf temp
         (f2cl-lib:fref a-%data%
           (i j)
           ((1 lda) (1 *))
           a-%offset%))
         (setf (f2cl-lib:fref a-%data%
           (i j)
           ((1 lda) (1 *))
           a-%offset%)
           (+
            (* stemp
              (f2cl-lib:fref a-%data%
                (i n)
                ((1 lda) (1 *))
                a-%offset%))
              (* ctemp temp)))
           (setf (f2cl-lib:fref a-%data%
            (i n)
            ((1 lda) (1 *))
            a-%offset%)
            (-
             (* ctemp
               (f2cl-lib:fref a-%data%
                 (i n)
                 ((1 lda) (1 *))
                 a-%offset%))
               (* stemp temp))))))))))))))

```



```
end_label  
  (return (values nil nil nil nil nil nil nil nil nil)))))
```

## 7.74 dlasrt LAPACK

```
<dlasrt.input>≡  
  )set break resume  
  )sys rm -f dlasrt.output  
  )spool dlasrt.output  
  )set message test on  
  )set message auto off  
  )clear all  
  
  )spool  
  )lisp (bye)
```

`<dlasrt.help>`≡

```
=====
dlasrt examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

DLASRT - number in D in increasing order (if ID = 'I') or in decreasing order (if ID = 'D' )

#### SYNOPSIS

```
SUBROUTINE DLASRT( ID, N, D, INFO )
```

```
      CHARACTER      ID
      INTEGER        INFO, N
      DOUBLE         PRECISION D( * )
```

#### PURPOSE

Sort the numbers in D in increasing order (if ID = 'I') or in decreasing order (if ID = 'D' ).

Use Quick Sort, reverting to Insertion sort on arrays of size  $\leq 20$ . Dimension of STACK limits N to about  $2^{**}32$ .

#### ARGUMENTS

```
ID      (input) CHARACTER*1
        = 'I': sort D in increasing order;
        = 'D': sort D in decreasing order.

N        (input) INTEGER
        The length of the array D.

D        (input/output) DOUBLE PRECISION array, dimension (N)
        On entry, the array to be sorted. On exit, D has been sorted
        into increasing order (D(1) <= ... <= D(N) ) or into decreasing
        order (D(1) >= ... >= D(N) ), depending on ID.

INFO     (output) INTEGER
        = 0:  successful exit
        < 0:  if INFO = -i, the i-th argument had an illegal value
```



```

(LAPACK dlasrt)≡
  (let* ((select 20))
    (declare (type (fixnum 20 20) select))
    (defun dlasrt (id n d info)
      (declare (type (simple-array double-float (*)) d)
                (type fixnum info n)
                (type character id))
      (f2cl-lib:with-multi-array-data
        ((id character id-%data% id-%offset%)
         (d double-float d-%data% d-%offset%))
        (prog ((stack (make-array 64 :element-type 'fixnum)) (d1 0.0)
              (d2 0.0) (d3 0.0) (dmnmix 0.0) (tmp 0.0) (dir 0) (endd 0) (i 0)
              (j 0) (start 0) (stkpnt 0))
              (declare (type (simple-array fixnum (64)) stack)
                        (type (double-float) d1 d2 d3 dmnmix tmp)
                        (type fixnum dir endd i j start stkpnt))
              (setf info 0)
              (setf dir -1)
              (cond
                ((char-equal id #\D)
                 (setf dir 0))
                ((char-equal id #\I)
                 (setf dir 1)))
              (cond
                ((= dir (f2cl-lib:int-sub 1))
                 (setf info -1))
                ((< n 0)
                 (setf info -2)))
              (cond
                ((/= info 0)
                 (error
                  " ** On entry to ~a parameter number ~a had an illegal value~%"
                  "DLASRT" (f2cl-lib:int-sub info))
                 (go end_label)))
              (if (<= n 1) (go end_label))
              (setf stkpnt 1)
              (setf (f2cl-lib:fref stack (1 1) ((1 2) (1 32))) 1)
              (setf (f2cl-lib:fref stack (2 1) ((1 2) (1 32))) n)
label10
              (setf start (f2cl-lib:fref stack (1 stkpnt) ((1 2) (1 32))))
              (setf endd (f2cl-lib:fref stack (2 stkpnt) ((1 2) (1 32))))
              (setf stkpnt (f2cl-lib:int-sub stkpnt 1))
              (cond
                ((and (<= (f2cl-lib:int-add endd (f2cl-lib:int-sub start)) select)
                     (> (f2cl-lib:int-add endd (f2cl-lib:int-sub start)) 0))
                 (cond

```

```

(= dir 0)
(f2cl-lib:fdo (i (f2cl-lib:int-add start 1)
                 (f2cl-lib:int-add i 1))
              ((> i endd) nil)
(tagbody
 (f2cl-lib:fdo (j i (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
               ((> j (f2cl-lib:int-add start 1)) nil)
  (tagbody
   (cond
    ((> (f2cl-lib:fref d (j) ((1 *)))
        (f2cl-lib:fref d
                      ((f2cl-lib:int-add j
                                           (f2cl-lib:int-sub
                                            1)))
                      ((1 *))))
     (setf dmnmx
           (f2cl-lib:fref d-%data%
                          (j)
                          ((1 *))
                          d-%offset%))
     (setf (f2cl-lib:fref d-%data% (j) ((1 *)) d-%offset%)
           (f2cl-lib:fref d-%data%
                          ((f2cl-lib:int-sub j 1))
                          ((1 *))
                          d-%offset%))
     (setf (f2cl-lib:fref d-%data%
                          ((f2cl-lib:int-sub j 1))
                          ((1 *))
                          d-%offset%)
           dmnmx))
    (t
     (go label30))))))
label30)))
(t
 (f2cl-lib:fdo (i (f2cl-lib:int-add start 1)
                 (f2cl-lib:int-add i 1))
               ((> i endd) nil)
  (tagbody
   (f2cl-lib:fdo (j i (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
                 ((> j (f2cl-lib:int-add start 1)) nil)
    (tagbody
     (cond
      ((< (f2cl-lib:fref d (j) ((1 *)))
          (f2cl-lib:fref d
                        ((f2cl-lib:int-add j
                                           (f2cl-lib:int-sub
                                            1)
                                           (f2cl-lib:int-sub
                                             1)
                                           ((1 *)))
                        (f2cl-lib:int-sub
                         1)
                         ((1 *))))
       (setf dmnmx
             (f2cl-lib:fref d-%data%
                            (j)
                            ((1 *))
                            d-%offset%))
       (setf (f2cl-lib:fref d-%data% (j) ((1 *)) d-%offset%)
             (f2cl-lib:fref d-%data%
                            ((f2cl-lib:int-sub j 1))
                            ((1 *))
                            d-%offset%))
       (setf (f2cl-lib:fref d-%data%
                            ((f2cl-lib:int-sub j 1))
                            ((1 *))
                            d-%offset%)
             dmnmx))
      (t
       (go label30))))))
label30)))

```

```

1)))
((1 *)))
(setf dnmnx
  (f2cl-lib:fref d-%data%
    (j)
    ((1 *))
    d-%offset%))
(setf (f2cl-lib:fref d-%data% (j) ((1 *)) d-%offset%)
  (f2cl-lib:fref d-%data%
    ((f2cl-lib:int-sub j 1))
    ((1 *))
    d-%offset%))
(setf (f2cl-lib:fref d-%data%
  ((f2cl-lib:int-sub j 1))
  ((1 *))
  d-%offset%)
  dnmnx))
(t
  (go label50))))
label50))))
(> (f2cl-lib:int-add endd (f2cl-lib:int-sub start)) select)
(setf d1 (f2cl-lib:fref d-%data% (start) ((1 *)) d-%offset%))
(setf d2 (f2cl-lib:fref d-%data% (endd) ((1 *)) d-%offset%))
(setf i (the fixnum (truncate (+ start endd) 2)))
(setf d3 (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%))
(cond
  ((< d1 d2)
    (cond
      ((< d3 d1)
        (setf dnmnx d1))
      ((< d3 d2)
        (setf dnmnx d3))
      (t
        (setf dnmnx d2))))
    (t
      (cond
        ((< d3 d2)
          (setf dnmnx d2))
        ((< d3 d1)
          (setf dnmnx d3))
        (t
          (setf dnmnx d1))))))
(cond
  ((= dir 0)
    (tagbody
      (setf i (f2cl-lib:int-sub start 1))

```

```

label160      (setf j (f2cl-lib:int-add endd 1))

              (setf j (f2cl-lib:int-sub j 1))
              (if (< (f2cl-lib:fref d-%data% (j) ((1 *)) d-%offset%) dmnmx)
                  (go label160))

label180      (setf i (f2cl-lib:int-add i 1))
              (if (> (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%) dmnmx)
                  (go label180))
              (cond
                ((< i j)
                 (setf tmp (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%))
                 (setf (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%)
                       (f2cl-lib:fref d-%data% (j) ((1 *)) d-%offset%))
                 (setf (f2cl-lib:fref d-%data% (j) ((1 *)) d-%offset%) tmp)
                 (go label160)))
                (t
                 (cond
                   ((> (f2cl-lib:int-add j (f2cl-lib:int-sub start))
                      (f2cl-lib:int-add endd
                        (f2cl-lib:int-sub j)
                        (f2cl-lib:int-sub 1)))
                    (setf stkpnt (f2cl-lib:int-add stkpnt 1))
                    (setf (f2cl-lib:fref stack (1 stkpnt) ((1 2) (1 32))) start)
                    (setf (f2cl-lib:fref stack (2 stkpnt) ((1 2) (1 32))) j)
                    (setf stkpnt (f2cl-lib:int-add stkpnt 1))
                    (setf (f2cl-lib:fref stack (1 stkpnt) ((1 2) (1 32)))
                          (f2cl-lib:int-add j 1))
                    (setf (f2cl-lib:fref stack (2 stkpnt) ((1 2) (1 32))) endd))
                   (t
                    (setf stkpnt (f2cl-lib:int-add stkpnt 1))
                    (setf (f2cl-lib:fref stack (1 stkpnt) ((1 2) (1 32)))
                          (f2cl-lib:int-add j 1))
                    (setf (f2cl-lib:fref stack (2 stkpnt) ((1 2) (1 32))) endd)
                    (setf stkpnt (f2cl-lib:int-add stkpnt 1))
                    (setf (f2cl-lib:fref stack (1 stkpnt) ((1 2) (1 32))) start)
                    (setf (f2cl-lib:fref stack (2 stkpnt) ((1 2) (1 32))) j))))))
              (t
               (tagbody
                (setf i (f2cl-lib:int-sub start 1))
                (setf j (f2cl-lib:int-add endd 1))

label190      (setf j (f2cl-lib:int-sub j 1))
                (if (> (f2cl-lib:fref d-%data% (j) ((1 *)) d-%offset%) dmnmx)
                    (go label190))

label1110     (setf i (f2cl-lib:int-add i 1))

```

```

(if (< (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%) dnmnx)
  (go label110))
(cond
  ((< i j)
    (setf tmp (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%))
    (setf (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%)
          (f2cl-lib:fref d-%data% (j) ((1 *)) d-%offset%))
    (setf (f2cl-lib:fref d-%data% (j) ((1 *)) d-%offset%) tmp)
    (go label90)))
(cond
  ((> (f2cl-lib:int-add j (f2cl-lib:int-sub start))
    (f2cl-lib:int-add endd
      (f2cl-lib:int-sub j)
      (f2cl-lib:int-sub 1)))
    (setf stkpnt (f2cl-lib:int-add stkpnt 1))
    (setf (f2cl-lib:fref stack (1 stkpnt) ((1 2) (1 32))) start)
    (setf (f2cl-lib:fref stack (2 stkpnt) ((1 2) (1 32))) j)
    (setf stkpnt (f2cl-lib:int-add stkpnt 1))
    (setf (f2cl-lib:fref stack (1 stkpnt) ((1 2) (1 32)))
          (f2cl-lib:int-add j 1))
    (setf (f2cl-lib:fref stack (2 stkpnt) ((1 2) (1 32))) endd))
  (t
    (setf stkpnt (f2cl-lib:int-add stkpnt 1))
    (setf (f2cl-lib:fref stack (1 stkpnt) ((1 2) (1 32)))
          (f2cl-lib:int-add j 1))
    (setf (f2cl-lib:fref stack (2 stkpnt) ((1 2) (1 32))) endd)
    (setf stkpnt (f2cl-lib:int-add stkpnt 1))
    (setf (f2cl-lib:fref stack (1 stkpnt) ((1 2) (1 32))) start)
    (setf (f2cl-lib:fref stack (2 stkpnt) ((1 2) (1 32)))
          j))))))
(if (> stkpnt 0) (go label10))
end_label
(return (values nil nil nil info))))))

```



## 7.75 dlassq LAPACK

```
<dlassq.input>≡  
  )set break resume  
  )sys rm -f dlassq.output  
  )spool dlassq.output  
  )set message test on  
  )set message auto off  
  )clear all  
  
  )spool  
  )lisp (bye)
```

`<dlassq.help>`≡

```
=====
dlassq examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

DCLASSQ - the values scl and smsq such that  $(scl**2)*smsq = x(1)**2 + \dots + x(n)**2 + (scale**2)*sumsq$ ,

#### SYNOPSIS

```
SUBROUTINE DCLASSQ( N, X, INCX, SCALE, SUMSQ )
```

```
      INTEGER          INCX, N
```

```
      DOUBLE           PRECISION SCALE, SUMSQ
```

```
      DOUBLE           PRECISION X( * )
```

#### PURPOSE

DCLASSQ returns the values scl and smsq such that

where  $x(i) = X(1 + (i - 1)*INCX)$ . The value of sumsq is assumed to be non-negative and scl returns the value

$$scl = \max(scale, \text{abs}(x(i)))$$

scale and sumsq must be supplied in SCALE and SUMSQ and scl and smsq are overwritten on SCALE and SUMSQ respectively.

The routine makes only one pass through the vector x.

#### ARGUMENTS

N (input) INTEGER

The number of elements to be used from the vector X.

X (input) DOUBLE PRECISION array, dimension (N)

The vector for which a scaled sum of squares is computed.  $x(i) = X(1 + (i - 1)*INCX)$ ,  $1 \leq i \leq n$ .

INCX (input) INTEGER

The increment between successive values of the vector X. INCX

$> 0$ .

SCALE (input/output) DOUBLE PRECISION

On entry, the value `scale` in the equation above. On exit, SCALE is overwritten with `scl`, the scaling factor for the sum of squares.

SUMSQ (input/output) DOUBLE PRECISION

On entry, the value `sumsq` in the equation above. On exit, SUMSQ is overwritten with `smsq`, the basic sum of squares from which `scl` has been factored out.

```

(LAPACK dlassq)≡
  (let* ((zero 0.0))
    (declare (type (double-float 0.0 0.0) zero))
    (defun dlassq (n x incx scale sumsq)
      (declare (type (double-float) sumsq scale)
        (type (simple-array double-float (*)) x)
        (type fixnum incx n))
      (f2cl-lib:with-multi-array-data
        ((x double-float x-%data% x-%offset%))
        (prog ((absxi 0.0) (ix 0))
          (declare (type (double-float) absxi) (type fixnum ix))
          (cond
            ((> n 0)
              (f2cl-lib:fdo (ix 1 (f2cl-lib:int-add ix incx))
                (> ix
                  (f2cl-lib:int-add 1
                    (f2cl-lib:int-mul
                     (f2cl-lib:int-add n
                      (f2cl-lib:int-sub 1))
                     incx)))
                nil)
              (tagbody
                (cond
                  ((/= (f2cl-lib:fref x (ix) ((1 *))) zero)
                    (setf absxi
                      (abs
                       (f2cl-lib:fref x-%data% (ix) ((1 *)) x-%offset%)))
                    (cond
                      ((< scale absxi)
                       (setf sumsq (+ 1 (* sumsq (expt (/ scale absxi) 2))))
                       (setf scale absxi))
                      (t
                       (setf sumsq (+ sumsq (expt (/ absxi scale) 2))))))))
                  (return (values nil nil nil scale sumsq))))))

```

## 7.76 dlasv2 LAPACK

```
<dlasv2.input>≡  
  )set break resume  
  )sys rm -f dlasv2.output  
  )spool dlasv2.output  
  )set message test on  
  )set message auto off  
  )clear all  
  
  )spool  
  )lisp (bye)
```

`<dlasv2.help>=`

```
=====
dlasv2 examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

DLASV2 - the singular value decomposition of a 2-by-2 triangular matrix  
 $\begin{bmatrix} F & G \\ 0 & H \end{bmatrix}$

#### SYNOPSIS

```
SUBROUTINE DLASV2( F, G, H, SSMIN, SSMAX, SNR, CSR, SNL, CSL )
```

```
      DOUBLE          PRECISION CSL, CSR, F, G, H, SNL, SNR, SSMAX, SSMIN
```

#### PURPOSE

DLASV2 computes the singular value decomposition of a 2-by-2 triangular matrix

$\begin{bmatrix} F & G \\ 0 & H \end{bmatrix}$ . On return, `abs(SSMAX)` is the larger singular value, `abs(SSMIN)` is the smaller singular value, and `(CSL,SNL)` and `(CSR,SNR)` are the left and right singular vectors for `abs(SSMAX)`, giving the decomposition

$$\begin{bmatrix} \text{CSL} & \text{SNL} \\ -\text{SNL} & \text{CSL} \end{bmatrix} \begin{bmatrix} F & G \\ 0 & H \end{bmatrix} \begin{bmatrix} \text{CSR} & -\text{SNR} \\ \text{SNR} & \text{CSR} \end{bmatrix} = \begin{bmatrix} \text{SSMAX} & 0 \\ 0 & \text{SSMIN} \end{bmatrix}.$$

#### ARGUMENTS

**F** (input) DOUBLE PRECISION  
The (1,1) element of the 2-by-2 matrix.

**G** (input) DOUBLE PRECISION  
The (1,2) element of the 2-by-2 matrix.

**H** (input) DOUBLE PRECISION  
The (2,2) element of the 2-by-2 matrix.

**SSMIN** (output) DOUBLE PRECISION  
`abs(SSMIN)` is the smaller singular value.

**SSMAX** (output) DOUBLE PRECISION  
`abs(SSMAX)` is the larger singular value.

SNL        (output) DOUBLE PRECISION  
CSL        (output) DOUBLE PRECISION The vector (CSL, SNL) is a  
            unit left singular vector for the singular value abs(SSMAX).  
  
SNR        (output) DOUBLE PRECISION  
CSR        (output) DOUBLE PRECISION The vector (CSR, SNR) is a  
            unit right singular vector for the singular value abs(SSMAX).

#### FURTHER DETAILS

Any input parameter may be aliased with any output parameter.

Barring over/underflow and assuming a guard digit in subtraction, all output quantities are correct to within a few units in the last place (ulps).

In IEEE arithmetic, the code works correctly if one matrix element is infinite.

Overflow will not occur unless the largest singular value itself overflows or is within a few ulps of overflow. (On machines with partial overflow, like the Cray, overflow may occur if the largest singular value is within a factor of 2 of overflow.)

Underflow is harmless if underflow is gradual. Otherwise, results may correspond to a matrix modified by perturbations of size near the underflow threshold.

```

(LAPACK dlasv2)=
(let* ((zero 0.0) (half 0.5) (one 1.0) (two 2.0) (four 4.0))
  (declare (type (double-float 0.0 0.0) zero)
            (type (double-float 0.5 0.5) half)
            (type (double-float 1.0 1.0) one)
            (type (double-float 2.0 2.0) two)
            (type (double-float 4.0 4.0) four))
  (defun dlasv2 (f g h ssmin ssmax snr csr snl csl)
    (declare (type (double-float) csl snl csr snr ssmax ssmin h g f))
    (prog ((a 0.0) (clt 0.0) (crt 0.0) (d 0.0) (fa 0.0) (ft 0.0) (ga 0.0)
           (gt 0.0) (ha 0.0) (ht 0.0) (l 0.0) (m 0.0) (mm 0.0) (r 0.0) (s 0.0)
           (slt 0.0) (srt 0.0) (t$ 0.0) (temp 0.0) (tsign 0.0) (tt 0.0)
           (pmax 0) (gasmal nil) (swap nil))
      (declare (type (double-float) a clt crt d fa ft ga gt ha ht l m mm r s
                     slt srt t$ temp tsign tt)
                (type fixnum pmax)
                (type (member t nil) gasmal swap))
      (setf ft f)
      (setf fa (abs ft))
      (setf ht h)
      (setf ha (abs h))
      (setf pmax 1)
      (setf swap (> ha fa))
      (cond
        (swap
         (setf pmax 3)
         (setf temp ft)
         (setf ft ht)
         (setf ht temp)
         (setf temp fa)
         (setf fa ha)
         (setf ha temp)))
      (setf gt g)
      (setf ga (abs gt))
      (cond
        ((= ga zero)
         (setf ssmin ha)
         (setf ssmax fa)
         (setf clt one)
         (setf crt one)
         (setf slt zero)
         (setf srt zero))
      (t
       (setf gasmal t)
       (cond
        ((> ga fa)

```



```

(setf pmax 2)
(cond
  ((< (f2cl-lib:f2cl/ fa ga) (dlamch "EPS"))
    (setf gasmal nil)
    (setf ssmax ga)
    (cond
      ((> ha one)
        (setf ssmin (/ fa (/ ga ha))))
      (t
        (setf ssmin (* (/ fa ga) ha))))
    (setf clt one)
    (setf slt (/ ht gt))
    (setf srt one)
    (setf crt (/ ft gt))))))
(cond
  (gasmal
    (setf d (- fa ha))
    (cond
      ((= d fa)
        (setf l one))
      (t
        (setf l (/ d fa))))
    (setf m (/ gt ft))
    (setf t$ (- two l))
    (setf mm (* m m))
    (setf tt (* t$ t$))
    (setf s (f2cl-lib:fsqrt (+ tt mm)))
    (cond
      ((= l zero)
        (setf r (abs m)))
      (t
        (setf r (f2cl-lib:fsqrt (+ (* l l) mm))))
    (setf a (* half (+ s r)))
    (setf ssmin (/ ha a))
    (setf ssmax (* fa a))
    (cond
      ((= mm zero)
        (cond
          ((= l zero)
            (setf t$ (* (f2cl-lib:sign two ft) (f2cl-lib:sign one gt))))
          (t
            (setf t$ (+ (/ gt (f2cl-lib:sign d ft)) (/ m t$)))))
      (t
        (setf t$ (* (+ (/ m (+ s t$)) (/ m (+ r l))) (+ one a))))
    (setf l (f2cl-lib:fsqrt (+ (* t$ t$) four)))
    (setf crt (/ two l))

```

```

        (setf srt (/ t$ 1))
        (setf clt (/ (+ crt (* srt m)) a))
        (setf slt (/ (* (/ ht ft) srt) a))))))
(cond
  (swap
    (setf csl srt)
    (setf snl crt)
    (setf csr slt)
    (setf snr clt))
  (t
    (setf csl clt)
    (setf snl slt)
    (setf csr crt)
    (setf snr srt)))
(if (= pmax 1)
  (setf tsign
    (* (f2cl-lib:sign one csr)
       (f2cl-lib:sign one csl)
       (f2cl-lib:sign one f))))
(if (= pmax 2)
  (setf tsign
    (* (f2cl-lib:sign one snr)
       (f2cl-lib:sign one csl)
       (f2cl-lib:sign one g))))
(if (= pmax 3)
  (setf tsign
    (* (f2cl-lib:sign one snr)
       (f2cl-lib:sign one snl)
       (f2cl-lib:sign one h))))
(setf ssmax (f2cl-lib:sign ssmax tsign))
(setf ssmin
  (f2cl-lib:sign ssmin
    (* tsign
      (f2cl-lib:sign one f)
      (f2cl-lib:sign one h))))
(return (values nil nil nil ssmin ssmax snr csr snl csl))))

```

## 7.77 dlaswp LAPACK

```
<dlaswp.input>=  
  )set break resume  
  )sys rm -f dlaswp.output  
  )spool dlaswp.output  
  )set message test on  
  )set message auto off  
  )clear all  
  
  )spool  
  )lisp (bye)
```

*<dlaswp.help>*≡

```
=====
dlaswp examples
=====
```

```
=====
Man Page Details
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```

#### NAME

DLASWP - a series of row interchanges on the matrix A

#### SYNOPSIS

```
SUBROUTINE DLASWP( N, A, LDA, K1, K2, IPIV, INCX )
```

```
      INTEGER      INCX, K1, K2, LDA, N
```

```
      INTEGER      IPIV( * )
```

```
      DOUBLE      PRECISION A( LDA, * )
```

#### PURPOSE

DLASWP performs a series of row interchanges on the matrix A. One row interchange is initiated for each of rows K1 through K2 of A.

#### ARGUMENTS

N	(input) INTEGER The number of columns of the matrix A.
A	(input/output) DOUBLE PRECISION array, dimension (LDA,N) On entry, the matrix of column dimension N to which the row interchanges will be applied. On exit, the permuted matrix.
LDA	(input) INTEGER The leading dimension of the array A.
K1	(input) INTEGER The first element of IPIV for which a row interchange will be done.
K2	(input) INTEGER The last element of IPIV for which a row interchange will be done.
IPIV	(input) INTEGER array, dimension (K2*abs(INCX))

The vector of pivot indices. Only the elements in positions K1 through K2 of IPIV are accessed. IPIV(K) = L implies rows K and L are to be interchanged.

INCX (input) INTEGER

The increment between successive values of IPIV. If IPIV is negative, the pivots are applied in reverse order.

```

(LAPACK dlaswp)≡
(defun dlaswp (n a lda k1 k2 ipiv incx)
  (declare (type (simple-array fixnum (*)) ipiv)
            (type (simple-array double-float (*)) a)
            (type fixnum incx k2 k1 lda n))
  (f2cl-lib:with-multi-array-data
    ((a double-float a-%data% a-%offset%)
     (ipiv fixnum ipiv-%data% ipiv-%offset%))
    (prog ((temp 0.0) (i 0) (i1 0) (i2 0) (inc 0) (ip 0) (ix 0) (ix0 0) (j 0)
           (k 0) (n32 0))
      (declare (type fixnum n32 k j ix0 ix ip inc i2 i1 i)
                (type (double-float) temp))
      (cond
        ((> incx 0)
         (setf ix0 k1)
         (setf i1 k1)
         (setf i2 k2)
         (setf inc 1))
        ((< incx 0)
         (setf ix0
              (f2cl-lib:int-add 1
                                (f2cl-lib:int-mul (f2cl-lib:int-sub 1 k2)
                                                    incx)))
         (setf i1 k2)
         (setf i2 k1)
         (setf inc -1))
        (t
         (go end_label))))
    (setf n32 (* (the fixnum (truncate n 32)) 32))
    (cond
      ((/= n32 0)
       (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 32))
                     ((> j n32) nil)
       (tagbody
        (setf ix ix0)
        (f2cl-lib:fdo (i i1 (f2cl-lib:int-add i inc))
                      ((> i i2) nil)
        (tagbody
         (setf ip
                (f2cl-lib:fref ipiv-%data%
                               (ix)
                               ((1 *))
                               ipiv-%offset%))
         (cond
           ((/= ip i)
            (f2cl-lib:fdo (k j (f2cl-lib:int-add k 1))

```

```

                                (> k (f2cl-lib:int-add j 31)) nil)
(tagbody
  (setf temp
    (f2cl-lib:fref a-%data%
      (i k)
      ((1 lda) (1 *))
      a-%offset%))
  (setf (f2cl-lib:fref a-%data%
    (i k)
    ((1 lda) (1 *))
    a-%offset%)
    (f2cl-lib:fref a-%data%
      (ip k)
      ((1 lda) (1 *))
      a-%offset%))
  (setf (f2cl-lib:fref a-%data%
    (ip k)
    ((1 lda) (1 *))
    a-%offset%)
    temp))))
(setf ix (f2cl-lib:int-add ix incx))))))
(cond
  ((/= n32 n)
    (setf n32 (f2cl-lib:int-add n32 1))
    (setf ix ix0)
    (f2cl-lib:fdo (i i1 (f2cl-lib:int-add i inc))
      (> i i2) nil)
    (tagbody
      (setf ip (f2cl-lib:fref ipiv-%data% (ix) ((1 *)) ipiv-%offset%))
      (cond
        ((/= ip i)
          (f2cl-lib:fdo (k n32 (f2cl-lib:int-add k 1))
            (> k n) nil)
          (tagbody
            (setf temp
              (f2cl-lib:fref a-%data%
                (i k)
                ((1 lda) (1 *))
                a-%offset%))
            (setf (f2cl-lib:fref a-%data%
              (i k)
              ((1 lda) (1 *))
              a-%offset%)
              (f2cl-lib:fref a-%data%
                (ip k)
                ((1 lda) (1 *))
                a-%offset%)))
            (tagbody
              (setf temp
                (f2cl-lib:fref a-%data%
                  (i k)
                  ((1 lda) (1 *))
                  a-%offset%))
              (setf (f2cl-lib:fref a-%data%
                (ip k)
                ((1 lda) (1 *))
                a-%offset%)
                  temp))))
          (setf ip (f2cl-lib:fref ipiv-%data% (ix) ((1 *)) ipiv-%offset%)))
        (t)
          (setf ip (f2cl-lib:fref ipiv-%data% (ix) ((1 *)) ipiv-%offset%)))
      )
    )
  )
)

```

```

                                a-%offset%))
      (setf (f2cl-lib:fref a-%data%
                          (ip k)
                          ((1 lda) (1 *))
                          a-%offset%)
            temp))))
      (setf ix (f2cl-lib:int-add ix incx))))))
end_label
      (return (values nil nil nil nil nil nil nil))))

```

## 7.78 dlasy2 LAPACK

```

⟨dlasy2.input⟩≡
)set break resume
)sys rm -f dlasy2.output
)spool dlasy2.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)

```



`<dasy2.help>=`

```
=====
dasy2 examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

DLASY2 - for the N1 by N2 matrix X,  $1 \leq N1, N2 \leq 2$ , in  $op(TL)*X + ISGN*X*op(TR) = SCALE*B$ ,

#### SYNOPSIS

```
SUBROUTINE DLASY2( LTRANL, LTRANR, ISGN, N1, N2, TL, LDTL, TR, LDTR, B,
                  LDB, SCALE, X, LDX, XNORM, INFO )
```

LOGICAL        LTRANL, LTRANR

INTEGER        INFO, ISGN, LDB, LDTL, LDTR, LDX, N1, N2

DOUBLE         PRECISION SCALE, XNORM

DOUBLE        PRECISION B( LDB, \* ), TL( LDTL, \* ), TR( LDTR, \* ),  
X( LDX, \* )

#### PURPOSE

DLASY2 solves for the N1 by N2 matrix X,  $1 \leq N1, N2 \leq 2$ , in

where TL is N1 by N1, TR is N2 by N2, B is N1 by N2, and ISGN = 1 or -1.  $op(T) = T$  or  $T'$ , where  $T'$  denotes the transpose of T.

#### ARGUMENTS

LTRANL (input) LOGICAL

On entry, LTRANL specifies the  $op(TL) := .FALSE.$ ,  $op(TL) = TL$ ,  
=  $.TRUE.$ ,  $op(TL) = TL'$ .

LTRANR (input) LOGICAL

On entry, LTRANR specifies the  $op(TR) := .FALSE.$ ,  $op(TR) = TR$ ,  
=  $.TRUE.$ ,  $op(TR) = TR'$ .

ISGN (input) INTEGER

On entry, ISGN specifies the sign of the equation as described  
before. ISGN may only be 1 or -1.

N1 (input) INTEGER  
On entry, N1 specifies the order of matrix TL. N1 may only be 0, 1 or 2.

N2 (input) INTEGER  
On entry, N2 specifies the order of matrix TR. N2 may only be 0, 1 or 2.

TL (input) DOUBLE PRECISION array, dimension (LDTL,2)  
On entry, TL contains an N1 by N1 matrix.

LDTL (input) INTEGER  
The leading dimension of the matrix TL. LDTL  $\geq$  max(1,N1).

TR (input) DOUBLE PRECISION array, dimension (LDTR,2)  
On entry, TR contains an N2 by N2 matrix.

LDTR (input) INTEGER  
The leading dimension of the matrix TR. LDTR  $\geq$  max(1,N2).

B (input) DOUBLE PRECISION array, dimension (LDB,2)  
On entry, the N1 by N2 matrix B contains the right-hand side of the equation.

LDB (input) INTEGER  
The leading dimension of the matrix B. LDB  $\geq$  max(1,N1).

SCALE (output) DOUBLE PRECISION  
On exit, SCALE contains the scale factor. SCALE is chosen less than or equal to 1 to prevent the solution overflowing.

X (output) DOUBLE PRECISION array, dimension (LDX,2)  
On exit, X contains the N1 by N2 solution.

LDX (input) INTEGER  
The leading dimension of the matrix X. LDX  $\geq$  max(1,N1).

XNORM (output) DOUBLE PRECISION  
On exit, XNORM is the infinity-norm of the solution.

INFO (output) INTEGER  
On exit, INFO is set to 0: successful exit.  
1: TL and TR have too close eigenvalues, so TL or TR is perturbed to get a nonsingular equation. NOTE: In the interests of speed, this routine does not check the inputs for errors.

```

(LAPACK dlasy2)=
  (let* ((zero 0.0) (one 1.0) (two 2.0) (half 0.5) (eight 8.0))
    (declare (type (double-float 0.0 0.0) zero)
              (type (double-float 1.0 1.0) one)
              (type (double-float 2.0 2.0) two)
              (type (double-float 0.5 0.5) half)
              (type (double-float 8.0 8.0) eight))
    (let ((locu12
           (make-array 4
                        :element-type 'fixnum
                        :initial-contents '(3 4 1 2)))
          (loc121
           (make-array 4
                        :element-type 'fixnum
                        :initial-contents '(2 1 4 3)))
          (locu22
           (make-array 4
                        :element-type 'fixnum
                        :initial-contents '(4 3 2 1)))
          (xswpiv
           (make-array 4 :element-type 't :initial-contents '(nil nil t t)))
          (bswpiv
           (make-array 4 :element-type 't :initial-contents '(nil t nil t))))
      (declare (type (simple-array (member t nil) (4)) bswpiv xswpiv)
                (type (simple-array fixnum (4)) locu22 loc121 locu12))
      (defun dlasy2
        (ltranl ltranr isgn n1 n2 t1 ldt1 tr ldtr b ldb$ scale x ldx xnorm
         info)
        (declare (type (double-float) xnorm scale)
                  (type (simple-array double-float (*)) x b tr t1)
                  (type fixnum info ldx ldb$ ldtr ldt1 n2 n1 isgn)
                  (type (member t nil) ltranr ltranl))
        (f2cl-lib:with-multi-array-data
          ((t1 double-float t1-%data% t1-%offset%)
           (tr double-float tr-%data% tr-%offset%)
           (b double-float b-%data% b-%offset%)
           (x double-float x-%data% x-%offset%))
          (prog ((btmp (make-array 4 :element-type 'double-float))
                 (t16 (make-array 16 :element-type 'double-float))
                 (tmp (make-array 4 :element-type 'double-float))
                 (x2 (make-array 2 :element-type 'double-float))
                 (jpiv (make-array 4 :element-type 'fixnum)) (bet 0.0)
                 (eps 0.0) (gam 0.0) (l21 0.0) (sgn 0.0) (smin 0.0) (smlnum 0.0)
                 (tau1 0.0) (temp 0.0) (u11 0.0) (u12 0.0) (u22 0.0) (xmax 0.0)
                 (i 0) (ip 0) (ipiv 0) (ipsv 0) (j 0) (jp 0) (jpsv 0) (k 0)
                 (bswap nil) (xswap nil))

```

```

(declare (type (simple-array double-float (16)) t16)
  (type (simple-array double-float (4)) btmp tmp)
  (type (simple-array double-float (2)) x2)
  (type (simple-array fixnum (4)) jpiv)
  (type (double-float) bet eps gam l21 sgn smin smlnum tau1
        temp u11 u12 u22 xmax)
  (type fixnum i ip ipiv ipsv j jp jpsv k)
  (type (member t nil) bswap xswap))
(setf info 0)
(if (or (= n1 0) (= n2 0)) (go end_label))
(setf eps (dlamch "P"))
(setf smlnum (/ (dlamch "S") eps))
(setf sgn (coerce (the fixnum isgn) 'double-float))
(setf k (f2cl-lib:int-sub (f2cl-lib:int-add n1 n1 n2) 2))
(f2cl-lib:computed-goto (label10 label20 label30 label50) k)
label10
  (setf tau1
    (+
      (f2cl-lib:fref t1-%data% (1 1) ((1 ldtl) (1 *)) t1-%offset%)
      (* sgn
        (f2cl-lib:fref tr-%data%
          (1 1)
          ((1 ldtr) (1 *))
          tr-%offset%))))
  (setf bet (abs tau1))
  (cond
    ((<= bet smlnum)
      (setf tau1 smlnum)
      (setf bet smlnum)
      (setf info 1)))
  (setf scale one)
  (setf gam
    (abs
      (f2cl-lib:fref b-%data% (1 1) ((1 ldb$) (1 *)) b-%offset%)))
  (if (> (* smlnum gam) bet) (setf scale (/ one gam)))
  (setf (f2cl-lib:fref x-%data% (1 1) ((1 ldx) (1 *)) x-%offset%)
    (/
      (*
        (f2cl-lib:fref b-%data% (1 1) ((1 ldb$) (1 *)) b-%offset%)
        scale)
      tau1))
  (setf xnorm
    (abs
      (f2cl-lib:fref x-%data% (1 1) ((1 ldx) (1 *)) x-%offset%)))
  (go end_label)
label20

```

```

(setf smin
  (max
    (* eps
      (max
        (abs
          (f2cl-lib:fref tl-%data%
            (1 1)
            ((1 ldtr) (1 *))
            tl-%offset%))
        (abs
          (f2cl-lib:fref tr-%data%
            (1 1)
            ((1 ldtr) (1 *))
            tr-%offset%))
        (abs
          (f2cl-lib:fref tr-%data%
            (1 2)
            ((1 ldtr) (1 *))
            tr-%offset%))
        (abs
          (f2cl-lib:fref tr-%data%
            (2 1)
            ((1 ldtr) (1 *))
            tr-%offset%))
        (abs
          (f2cl-lib:fref tr-%data%
            (2 2)
            ((1 ldtr) (1 *))
            tr-%offset%))))
    smlnum))
(setf (f2cl-lib:fref tmp (1) ((1 4)))
  (+
    (f2cl-lib:fref tl-%data% (1 1) ((1 ldtr) (1 *)) tl-%offset%)
    (* sgn
      (f2cl-lib:fref tr-%data%
        (1 1)
        ((1 ldtr) (1 *))
        tr-%offset%))))
(setf (f2cl-lib:fref tmp (4) ((1 4)))
  (+
    (f2cl-lib:fref tl-%data% (1 1) ((1 ldtr) (1 *)) tl-%offset%)
    (* sgn
      (f2cl-lib:fref tr-%data%
        (2 2)
        ((1 ldtr) (1 *))
        tr-%offset%))))

```

```

(cond
  (ltranr
    (setf (f2cl-lib:fref tmp (2) ((1 4)))
      (* sgn
        (f2cl-lib:fref tr-%data%
          (2 1)
          ((1 ldtr) (1 *))
          tr-%offset%)))
    (setf (f2cl-lib:fref tmp (3) ((1 4)))
      (* sgn
        (f2cl-lib:fref tr-%data%
          (1 2)
          ((1 ldtr) (1 *))
          tr-%offset%))))
  (t
    (setf (f2cl-lib:fref tmp (2) ((1 4)))
      (* sgn
        (f2cl-lib:fref tr-%data%
          (1 2)
          ((1 ldtr) (1 *))
          tr-%offset%)))
    (setf (f2cl-lib:fref tmp (3) ((1 4)))
      (* sgn
        (f2cl-lib:fref tr-%data%
          (2 1)
          ((1 ldtr) (1 *))
          tr-%offset%))))))
(setf (f2cl-lib:fref btmp (1) ((1 4)))
  (f2cl-lib:fref b-%data% (1 1) ((1 ldb$) (1 *)) b-%offset%))
(setf (f2cl-lib:fref btmp (2) ((1 4)))
  (f2cl-lib:fref b-%data% (1 2) ((1 ldb$) (1 *)) b-%offset%))
(go label40)
label30
(setf smin
  (max
    (* eps
      (max
        (abs
          (f2cl-lib:fref tr-%data%
            (1 1)
            ((1 ldtr) (1 *))
            tr-%offset%))
        (abs
          (f2cl-lib:fref tl-%data%
            (1 1)
            ((1 ldtl) (1 *))
            tr-%offset%))
          ))))

```

```

                                tl-%offset%))
(abs
  (f2cl-lib:fref tl-%data%
    (1 2)
    ((1 ldtl) (1 *))
    tl-%offset%))
(abs
  (f2cl-lib:fref tl-%data%
    (2 1)
    ((1 ldtl) (1 *))
    tl-%offset%))
(abs
  (f2cl-lib:fref tl-%data%
    (2 2)
    ((1 ldtl) (1 *))
    tl-%offset%)))
smlnum))
(setf (f2cl-lib:fref tmp (1) ((1 4)))
  (+
    (f2cl-lib:fref tl-%data% (1 1) ((1 ldtl) (1 *)) tl-%offset%)
    (* sgn
      (f2cl-lib:fref tr-%data%
        (1 1)
        ((1 ldtr) (1 *))
        tr-%offset%))))
(setf (f2cl-lib:fref tmp (4) ((1 4)))
  (+
    (f2cl-lib:fref tl-%data% (2 2) ((1 ldtl) (1 *)) tl-%offset%)
    (* sgn
      (f2cl-lib:fref tr-%data%
        (1 1)
        ((1 ldtr) (1 *))
        tr-%offset%))))
(cond
  (ltranl
    (setf (f2cl-lib:fref tmp (2) ((1 4)))
      (f2cl-lib:fref tl-%data%
        (1 2)
        ((1 ldtl) (1 *))
        tl-%offset%))
    (setf (f2cl-lib:fref tmp (3) ((1 4)))
      (f2cl-lib:fref tl-%data%
        (2 1)
        ((1 ldtl) (1 *))
        tl-%offset%)))
  (t

```

```

      (setf (f2cl-lib:fref tmp (2) ((1 4)))
            (f2cl-lib:fref t1-%data%
                          (2 1)
                          ((1 ldt1) (1 *))
                          t1-%offset%))
      (setf (f2cl-lib:fref tmp (3) ((1 4)))
            (f2cl-lib:fref t1-%data%
                          (1 2)
                          ((1 ldt1) (1 *))
                          t1-%offset%))))
      (setf (f2cl-lib:fref btmp (1) ((1 4)))
            (f2cl-lib:fref b-%data% (1 1) ((1 ldb$) (1 *)) b-%offset%))
      (setf (f2cl-lib:fref btmp (2) ((1 4)))
            (f2cl-lib:fref b-%data% (2 1) ((1 ldb$) (1 *)) b-%offset%))
label40
      (setf ipiv (idamax 4 tmp 1))
      (setf u11 (f2cl-lib:fref tmp (ipiv) ((1 4))))
      (cond
        ((<= (abs u11) smin)
         (setf info 1)
         (setf u11 smin)))
      (setf u12
            (f2cl-lib:fref tmp
                          ((f2cl-lib:fref locu12 (ipiv) ((1 4))))
                          ((1 4))))
      (setf l21
            (/
             (f2cl-lib:fref tmp
                          ((f2cl-lib:fref locl21 (ipiv) ((1 4))))
                          ((1 4)))
             u11))
      (setf u22
            (-
             (f2cl-lib:fref tmp
                          ((f2cl-lib:fref locu22 (ipiv) ((1 4))))
                          ((1 4)))
             (* u12 l21)))
      (setf xswap (f2cl-lib:fref xswpiv (ipiv) ((1 4))))
      (setf bswap (f2cl-lib:fref bswpiv (ipiv) ((1 4))))
      (cond
        ((<= (abs u22) smin)
         (setf info 1)
         (setf u22 smin)))
      (cond
        (bswap
         (setf temp (f2cl-lib:fref btmp (2) ((1 4))))

```



```

(setf (f2cl-lib:fref btmp (2) ((1 4)))
      (- (f2cl-lib:fref btmp (1) ((1 4))) (* 121 temp)))
(setf (f2cl-lib:fref btmp (1) ((1 4))) temp))
(t
 (setf (f2cl-lib:fref btmp (2) ((1 4)))
       (- (f2cl-lib:fref btmp (2) ((1 4)))
          (* 121 (f2cl-lib:fref btmp (1) ((1 4)))))))
(setf scale one)
(cond
 ((or
  (> (* two smlnum (abs (f2cl-lib:fref btmp (2) ((1 4))))
      (abs u22))
  (> (* two smlnum (abs (f2cl-lib:fref btmp (1) ((1 4))))
      (abs u11)))
 (setf scale
        (/ half
           (max (abs (f2cl-lib:fref btmp (1) ((1 4)))
                    (abs (f2cl-lib:fref btmp (2) ((1 4))))))
 (setf (f2cl-lib:fref btmp (1) ((1 4)))
        (* (f2cl-lib:fref btmp (1) ((1 4))) scale))
 (setf (f2cl-lib:fref btmp (2) ((1 4)))
        (* (f2cl-lib:fref btmp (2) ((1 4))) scale))))
(setf (f2cl-lib:fref x2 (2) ((1 2)))
      (/ (f2cl-lib:fref btmp (2) ((1 4))) u22))
(setf (f2cl-lib:fref x2 (1) ((1 2)))
      (- (/ (f2cl-lib:fref btmp (1) ((1 4))) u11)
         (* (/ u12 u11) (f2cl-lib:fref x2 (2) ((1 2))))))
(cond
 (xswap
  (setf temp (f2cl-lib:fref x2 (2) ((1 2))))
  (setf (f2cl-lib:fref x2 (2) ((1 2)))
        (f2cl-lib:fref x2 (1) ((1 2))))
  (setf (f2cl-lib:fref x2 (1) ((1 2))) temp)))
(setf (f2cl-lib:fref x-%data% (1 1) ((1 ldx) (1 *))) x-%offset%)
      (f2cl-lib:fref x2 (1) ((1 2))))
(cond
 (= n1 1)
 (setf (f2cl-lib:fref x-%data% (1 2) ((1 ldx) (1 *))) x-%offset%)
      (f2cl-lib:fref x2 (2) ((1 2))))
(setf xnorm
  (+
   (abs
    (f2cl-lib:fref x-%data%
                   (1 1)
                   ((1 ldx) (1 *))
                   x-%offset%)))

```

```

        (abs
          (f2cl-lib:fref x-%data%
                        (1 2)
                        ((1 ldx) (1 *))
                        x-%offset%))))
      (t
        (setf (f2cl-lib:fref x-%data% (2 1) ((1 ldx) (1 *)) x-%offset%)
              (f2cl-lib:fref x2 (2) ((1 2))))
        (setf xnorm
              (max
                (abs
                  (f2cl-lib:fref x-%data%
                                (1 1)
                                ((1 ldx) (1 *))
                                x-%offset%))
                (abs
                  (f2cl-lib:fref x-%data%
                                (2 1)
                                ((1 ldx) (1 *))
                                x-%offset%))))))
      (go end_label)
label50
      (setf smin
            (max
              (abs
                (f2cl-lib:fref tr-%data%
                              (1 1)
                              ((1 ldtr) (1 *))
                              tr-%offset%))
              (abs
                (f2cl-lib:fref tr-%data%
                              (1 2)
                              ((1 ldtr) (1 *))
                              tr-%offset%))
              (abs
                (f2cl-lib:fref tr-%data%
                              (2 1)
                              ((1 ldtr) (1 *))
                              tr-%offset%))
              (abs
                (f2cl-lib:fref tr-%data%
                              (2 2)
                              ((1 ldtr) (1 *))
                              tr-%offset%))))
      (setf smin
            (max smin

```

```

(abs
  (f2cl-lib:fref tl-%data%
    (1 1)
    ((1 ldtl) (1 *))
    tl-%offset%))

(abs
  (f2cl-lib:fref tl-%data%
    (1 2)
    ((1 ldtl) (1 *))
    tl-%offset%))

(abs
  (f2cl-lib:fref tl-%data%
    (2 1)
    ((1 ldtl) (1 *))
    tl-%offset%))

(abs
  (f2cl-lib:fref tl-%data%
    (2 2)
    ((1 ldtl) (1 *))
    tl-%offset%)))
(setf smin (max (* eps smin) smlnum))
(setf (f2cl-lib:fref btmp (1) ((1 4))) zero)
(dcopy 16 btmp 0 t16 1)
(setf (f2cl-lib:fref t16 (1 1) ((1 4) (1 4)))
  (+
    (f2cl-lib:fref tl-%data% (1 1) ((1 ldtl) (1 *)) tl-%offset%)
    (* sgn
      (f2cl-lib:fref tr-%data%
        (1 1)
        ((1 ldtr) (1 *))
        tr-%offset%))))
(setf (f2cl-lib:fref t16 (2 2) ((1 4) (1 4)))
  (+
    (f2cl-lib:fref tl-%data% (2 2) ((1 ldtl) (1 *)) tl-%offset%)
    (* sgn
      (f2cl-lib:fref tr-%data%
        (1 1)
        ((1 ldtr) (1 *))
        tr-%offset%))))
(setf (f2cl-lib:fref t16 (3 3) ((1 4) (1 4)))
  (+
    (f2cl-lib:fref tl-%data% (1 1) ((1 ldtl) (1 *)) tl-%offset%)
    (* sgn
      (f2cl-lib:fref tr-%data%
        (2 2)
        ((1 ldtr) (1 *))

```

```

                                tr-%offset%))))
(setf (f2cl-lib:fref t16 (4 4) ((1 4) (1 4)))
      (+
        (f2cl-lib:fref t1-%data% (2 2) ((1 ldt1) (1 *)) t1-%offset%)
        (* sgn
          (f2cl-lib:fref tr-%data%
                        (2 2)
                        ((1 ldtr) (1 *))
                        tr-%offset%))))))
(cond
  (ltran1
    (setf (f2cl-lib:fref t16 (1 2) ((1 4) (1 4)))
          (f2cl-lib:fref t1-%data%
                        (2 1)
                        ((1 ldt1) (1 *))
                        t1-%offset%))
    (setf (f2cl-lib:fref t16 (2 1) ((1 4) (1 4)))
          (f2cl-lib:fref t1-%data%
                        (1 2)
                        ((1 ldt1) (1 *))
                        t1-%offset%))
    (setf (f2cl-lib:fref t16 (3 4) ((1 4) (1 4)))
          (f2cl-lib:fref t1-%data%
                        (2 1)
                        ((1 ldt1) (1 *))
                        t1-%offset%))
    (setf (f2cl-lib:fref t16 (4 3) ((1 4) (1 4)))
          (f2cl-lib:fref t1-%data%
                        (1 2)
                        ((1 ldt1) (1 *))
                        t1-%offset%)))
  (t
    (setf (f2cl-lib:fref t16 (1 2) ((1 4) (1 4)))
          (f2cl-lib:fref t1-%data%
                        (1 2)
                        ((1 ldt1) (1 *))
                        t1-%offset%))
    (setf (f2cl-lib:fref t16 (2 1) ((1 4) (1 4)))
          (f2cl-lib:fref t1-%data%
                        (2 1)
                        ((1 ldt1) (1 *))
                        t1-%offset%))
    (setf (f2cl-lib:fref t16 (3 4) ((1 4) (1 4)))
          (f2cl-lib:fref t1-%data%
                        (1 2)
                        ((1 ldt1) (1 *))
                        t1-%offset%)))

```

```

                                t1-%offset%))
  (setf (f2cl-lib:fref t16 (4 3) ((1 4) (1 4)))
        (f2cl-lib:fref t1-%data%
                        (2 1)
                        ((1 ldt1) (1 *))
                        t1-%offset%)))
(cond
 (ltranr
  (setf (f2cl-lib:fref t16 (1 3) ((1 4) (1 4)))
        (* sgn
          (f2cl-lib:fref tr-%data%
                        (1 2)
                        ((1 ldtr) (1 *))
                        tr-%offset%)))
  (setf (f2cl-lib:fref t16 (2 4) ((1 4) (1 4)))
        (* sgn
          (f2cl-lib:fref tr-%data%
                        (1 2)
                        ((1 ldtr) (1 *))
                        tr-%offset%)))
  (setf (f2cl-lib:fref t16 (3 1) ((1 4) (1 4)))
        (* sgn
          (f2cl-lib:fref tr-%data%
                        (2 1)
                        ((1 ldtr) (1 *))
                        tr-%offset%)))
  (setf (f2cl-lib:fref t16 (4 2) ((1 4) (1 4)))
        (* sgn
          (f2cl-lib:fref tr-%data%
                        (2 1)
                        ((1 ldtr) (1 *))
                        tr-%offset%))))
(t
 (setf (f2cl-lib:fref t16 (1 3) ((1 4) (1 4)))
        (* sgn
          (f2cl-lib:fref tr-%data%
                        (2 1)
                        ((1 ldtr) (1 *))
                        tr-%offset%)))
  (setf (f2cl-lib:fref t16 (2 4) ((1 4) (1 4)))
        (* sgn
          (f2cl-lib:fref tr-%data%
                        (2 1)
                        ((1 ldtr) (1 *))
                        tr-%offset%)))
  (setf (f2cl-lib:fref t16 (3 1) ((1 4) (1 4)))
        (* sgn
          (f2cl-lib:fref tr-%data%
                        (2 1)
                        ((1 ldtr) (1 *))
                        tr-%offset%))))

```

```

      (* sgn
        (f2cl-lib:fref tr-%data%
          (1 2)
          ((1 ldtr) (1 *))
          tr-%offset%)))
      (setf (f2cl-lib:fref t16 (4 2) ((1 4) (1 4)))
        (* sgn
          (f2cl-lib:fref tr-%data%
            (1 2)
            ((1 ldtr) (1 *))
            tr-%offset%))))
      (setf (f2cl-lib:fref btmp (1) ((1 4)))
        (f2cl-lib:fref b-%data% (1 1) ((1 ldb$) (1 *)) b-%offset%))
      (setf (f2cl-lib:fref btmp (2) ((1 4)))
        (f2cl-lib:fref b-%data% (2 1) ((1 ldb$) (1 *)) b-%offset%))
      (setf (f2cl-lib:fref btmp (3) ((1 4)))
        (f2cl-lib:fref b-%data% (1 2) ((1 ldb$) (1 *)) b-%offset%))
      (setf (f2cl-lib:fref btmp (4) ((1 4)))
        (f2cl-lib:fref b-%data% (2 2) ((1 ldb$) (1 *)) b-%offset%))
      (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
        (> i 3) nil)
      (tagbody
        (setf xmax zero)
        (f2cl-lib:fdo (ip i (f2cl-lib:int-add ip 1))
          (> ip 4) nil)
        (tagbody
          (f2cl-lib:fdo (jp i (f2cl-lib:int-add jp 1))
            (> jp 4) nil)
            (tagbody
              (cond
                ((>= (abs (f2cl-lib:fref t16 (ip jp) ((1 4) (1 4))))
                  xmax)
                  (setf xmax
                    (abs
                      (f2cl-lib:fref t16 (ip jp) ((1 4) (1 4)))))
                    (setf ipsv ip)
                    (setf jpsv jp))))))
              (cond
                ((/= ipsv i)
                  (dswap 4
                    (f2cl-lib:array-slice t16
                      double-float
                      (ipsv 1)
                      ((1 4) (1 4)))
                    4 (f2cl-lib:array-slice t16 double-float (i 1) ((1 4) (1 4)))
                    4)

```

```

(setf temp (f2cl-lib:fref btmp (i) ((1 4))))
(setf (f2cl-lib:fref btmp (i) ((1 4)))
      (f2cl-lib:fref btmp (ipsv) ((1 4))))
(setf (f2cl-lib:fref btmp (ipsv) ((1 4))) temp)))
(if (/= jpsv i)
    (dswap 4
      (f2cl-lib:array-slice t16
                            double-float
                            (1 jpsv)
                            ((1 4) (1 4)))

      1
      (f2cl-lib:array-slice t16 double-float (1 i) ((1 4) (1 4))
                            1))
  (setf (f2cl-lib:fref jpiv (i) ((1 4))) jpsv)
  (cond
    ((< (abs (f2cl-lib:fref t16 (i i) ((1 4) (1 4)))) smin)
      (setf info 1)
      (setf (f2cl-lib:fref t16 (i i) ((1 4) (1 4))) smin)))
    (f2cl-lib:fdo (j (f2cl-lib:int-add i 1) (f2cl-lib:int-add j 1))
      ((> j 4) nil)
    (tagbody
      (setf (f2cl-lib:fref t16 (j i) ((1 4) (1 4)))
            (/ (f2cl-lib:fref t16 (j i) ((1 4) (1 4)))
               (f2cl-lib:fref t16 (i i) ((1 4) (1 4)))))
      (setf (f2cl-lib:fref btmp (j) ((1 4)))
            (- (f2cl-lib:fref btmp (j) ((1 4)))
               (* (f2cl-lib:fref t16 (j i) ((1 4) (1 4)))
                  (f2cl-lib:fref btmp (i) ((1 4))))))
      (f2cl-lib:fdo (k (f2cl-lib:int-add i 1)
                      (f2cl-lib:int-add k 1))
        ((> k 4) nil)
      (tagbody
        (setf (f2cl-lib:fref t16 (j k) ((1 4) (1 4)))
              (- (f2cl-lib:fref t16 (j k) ((1 4) (1 4)))
                 (* (f2cl-lib:fref t16 (j i) ((1 4) (1 4)))
                    (f2cl-lib:fref t16 (i k) ((1 4) (1 4))))))))))
    (if (< (abs (f2cl-lib:fref t16 (4 4) ((1 4) (1 4)))) smin)
      (setf (f2cl-lib:fref t16 (4 4) ((1 4) (1 4))) smin))
  (setf scale one)
  (cond
    ((or
      (> (* eight smlnum (abs (f2cl-lib:fref btmp (1) ((1 4))))
          (abs (f2cl-lib:fref t16 (1 1) ((1 4) (1 4)))))
      (> (* eight smlnum (abs (f2cl-lib:fref btmp (2) ((1 4))))
          (abs (f2cl-lib:fref t16 (2 2) ((1 4) (1 4)))))
      (> (* eight smlnum (abs (f2cl-lib:fref btmp (3) ((1 4))))
          (abs (f2cl-lib:fref t16 (3 3) ((1 4) (1 4)))))))

```

```

      (abs (f2cl-lib:fref t16 (3 3) ((1 4) (1 4))))
    (> (* eight smlnum (abs (f2cl-lib:fref btmp (4) ((1 4))))
      (abs (f2cl-lib:fref t16 (4 4) ((1 4) (1 4)))))
    (setf scale
      (/ (/ one eight)
        (max (abs (f2cl-lib:fref btmp (1) ((1 4))))
              (abs (f2cl-lib:fref btmp (2) ((1 4))))
              (abs (f2cl-lib:fref btmp (3) ((1 4))))
              (abs (f2cl-lib:fref btmp (4) ((1 4)))))))
    (setf (f2cl-lib:fref btmp (1) ((1 4)))
      (* (f2cl-lib:fref btmp (1) ((1 4))) scale))
    (setf (f2cl-lib:fref btmp (2) ((1 4)))
      (* (f2cl-lib:fref btmp (2) ((1 4))) scale))
    (setf (f2cl-lib:fref btmp (3) ((1 4)))
      (* (f2cl-lib:fref btmp (3) ((1 4))) scale))
    (setf (f2cl-lib:fref btmp (4) ((1 4)))
      (* (f2cl-lib:fref btmp (4) ((1 4))) scale)))
  (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
    (> i 4) nil)
  (tagbody
    (setf k (f2cl-lib:int-sub 5 i))
    (setf temp (/ one (f2cl-lib:fref t16 (k k) ((1 4) (1 4)))))
    (setf (f2cl-lib:fref tmp (k) ((1 4)))
      (* (f2cl-lib:fref btmp (k) ((1 4))) temp))
    (f2cl-lib:fdo (j (f2cl-lib:int-add k 1) (f2cl-lib:int-add j 1))
      (> j 4) nil)
    (tagbody
      (setf (f2cl-lib:fref tmp (k) ((1 4)))
        (- (f2cl-lib:fref tmp (k) ((1 4)))
          (* temp
            (f2cl-lib:fref t16 (k j) ((1 4) (1 4)))
            (f2cl-lib:fref tmp (j) ((1 4)))))))
    (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
      (> i 3) nil)
  (tagbody
    (cond
      ((/=
        (f2cl-lib:fref jpiv
          ((f2cl-lib:int-add 4 (f2cl-lib:int-sub i)))
          ((1 4)))
        (f2cl-lib:int-add 4 (f2cl-lib:int-sub i)))
      (setf temp
        (f2cl-lib:fref tmp ((f2cl-lib:int-sub 4 i)) ((1 4))))
      (setf (f2cl-lib:fref tmp ((f2cl-lib:int-sub 4 i)) ((1 4)))
        (f2cl-lib:fref tmp
          ((f2cl-lib:fref jpiv

```



```

((f2cl-lib:int-sub 4
i))
((1 4)))
((1 4)))
(setf (f2cl-lib:fref tmp
      ((f2cl-lib:fref jpiv
        ((f2cl-lib:int-sub 4 i))
        ((1 4)))
      temp))))
(setf (f2cl-lib:fref x-%data% (1 1) ((1 ldx) (1 *)) x-%offset%)
      (f2cl-lib:fref tmp (1) ((1 4))))
(setf (f2cl-lib:fref x-%data% (2 1) ((1 ldx) (1 *)) x-%offset%)
      (f2cl-lib:fref tmp (2) ((1 4))))
(setf (f2cl-lib:fref x-%data% (1 2) ((1 ldx) (1 *)) x-%offset%)
      (f2cl-lib:fref tmp (3) ((1 4))))
(setf (f2cl-lib:fref x-%data% (2 2) ((1 ldx) (1 *)) x-%offset%)
      (f2cl-lib:fref tmp (4) ((1 4))))
(setf xnorm
      (max
        (+ (abs (f2cl-lib:fref tmp (1) ((1 4))))
           (abs (f2cl-lib:fref tmp (3) ((1 4))))
        (+ (abs (f2cl-lib:fref tmp (2) ((1 4))))
           (abs (f2cl-lib:fref tmp (4) ((1 4)))))))
end_label
(return
 (values nil
         nil
         nil
         nil
         nil
         nil
         nil
         nil
         nil
         nil
         nil
         scale
         nil
         nil
         xnorm
         info))))))

```

**7.79 dorg2r LAPACK**

```
(dorg2r.input)=  
  )set break resume  
  )sys rm -f dorg2r.output  
  )spool dorg2r.output  
  )set message test on  
  )set message auto off  
  )clear all  
  
  )spool  
  )lisp (bye)
```

`<dorg2r.help>=`

```
=====
dorg2r examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

DORG2R - an m by n real matrix Q with orthonormal columns,

#### SYNOPSIS

```
SUBROUTINE DORG2R( M, N, K, A, LDA, TAU, WORK, INFO )
```

```
      INTEGER          INFO, K, LDA, M, N
```

```
      DOUBLE           PRECISION A( LDA, * ), TAU( * ), WORK( * )
```

#### PURPOSE

DORG2R generates an m by n real matrix Q with orthonormal columns, which is defined as the first n columns of a product of k elementary reflectors of order m

$$Q = H(1) H(2) \dots H(k)$$

as returned by DGEQRF.

#### ARGUMENTS

M (input) INTEGER

The number of rows of the matrix Q.  $M \geq 0$ .

N (input) INTEGER

The number of columns of the matrix Q.  $M \geq N \geq 0$ .

K (input) INTEGER

The number of elementary reflectors whose product defines the matrix Q.  $N \geq K \geq 0$ .

A (input/output) DOUBLE PRECISION array, dimension (LDA,N)

On entry, the i-th column must contain the vector which defines the elementary reflector H(i), for  $i = 1, 2, \dots, k$ , as returned by DGEQRF in the first k columns of its array argument A. On exit, the m-by-n matrix Q.

LDA      (input) INTEGER  
          The first dimension of the array A. LDA  $\geq$  max(1,M).

TAU      (input) DOUBLE PRECISION array, dimension (K)  
          TAU(i) must contain the scalar factor of the elementary reflector H(i), as returned by DGEQRF.

WORK     (workspace) DOUBLE PRECISION array, dimension (N)

INFO     (output) INTEGER  
          = 0: successful exit  
          < 0: if INFO = -i, the i-th argument has an illegal value

```

(LAPACK dorg2r)≡
  (let* ((one 1.0) (zero 0.0))
    (declare (type (double-float 1.0 1.0) one)
              (type (double-float 0.0 0.0) zero))
    (defun dorg2r (m n k a lda tau work info)
      (declare (type (simple-array double-float (*)) work tau a)
                (type fixnum info lda k n m))
      (f2cl-lib:with-multi-array-data
        ((a double-float a-%data% a-%offset%)
         (tau double-float tau-%data% tau-%offset%)
         (work double-float work-%data% work-%offset%))
        (prog ((i 0) (j 0) (l 0))
          (declare (type fixnum i j l))
          (setf info 0)
          (cond
            ((< m 0)
             (setf info -1))
            ((or (< n 0) (> n m))
             (setf info -2))
            ((or (< k 0) (> k n))
             (setf info -3))
            ((< lda (max (the fixnum 1) (the fixnum m)))
             (setf info -5)))
          (cond
            ((/= info 0)
             (error
              " ** On entry to ~a parameter number ~a had an illegal value~%"
              "DORG2R" (f2cl-lib:int-sub info))
             (go end_label)))
          (if (<= n 0) (go end_label))
          (f2cl-lib:fdo (j (f2cl-lib:int-add k 1) (f2cl-lib:int-add j 1))
            (> j n) nil)
          (tagbody
            (f2cl-lib:fdo (l 1 (f2cl-lib:int-add 1 1))
              (> l m) nil)
            (tagbody
              (setf (f2cl-lib:fref a-%data% (l j) ((1 lda) (1 *)) a-%offset%)
                    zero)))
              (setf (f2cl-lib:fref a-%data% (j j) ((1 lda) (1 *)) a-%offset%)
                    one)))
          (f2cl-lib:fdo (i k (f2cl-lib:int-add i (f2cl-lib:int-sub 1)))
            (> i 1) nil)
          (tagbody
            (cond
              ((< i n)
               (setf (f2cl-lib:fref a-%data% (i i) ((1 lda) (1 *)) a-%offset%)

```

```

                                one)
(dlarf "Left" (f2cl-lib:int-add (f2cl-lib:int-sub m i) 1)
 (f2cl-lib:int-sub n i)
 (f2cl-lib:array-slice a double-float (i i) ((1 lda) (1 *))) 1
 (f2cl-lib:fref tau-%data% (i) ((1 *)) tau-%offset%)
 (f2cl-lib:array-slice a
                        double-float
                        (i (f2cl-lib:int-add i 1))
                        ((1 lda) (1 *)))

lda work)))
(if (< i m)
  (dscal (f2cl-lib:int-sub m i)
    (- (f2cl-lib:fref tau-%data% (i) ((1 *)) tau-%offset%)
      (f2cl-lib:array-slice a
                            double-float
                            ((+ i 1) i)
                            ((1 lda) (1 *)))

1))
(setf (f2cl-lib:fref a-%data% (i i) ((1 lda) (1 *)) a-%offset%)
  (- one
    (f2cl-lib:fref tau-%data% (i) ((1 *)) tau-%offset%)))
(f2cl-lib:fdo (1 1 (f2cl-lib:int-add 1 1))
  ((> 1 (f2cl-lib:int-add i (f2cl-lib:int-sub 1))) nil)
  (tagbody
    (setf (f2cl-lib:fref a-%data% (1 i) ((1 lda) (1 *)) a-%offset%)
      zero))))))
end_label
(return (values nil nil nil nil nil nil nil info))))))

```

## 7.80 dorgbr LAPACK

```

⟨dorgbr.input⟩≡
)set break resume
)sys rm -f dorgbr.output
)spool dorgbr.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)

```

*<dorgbr.help>*≡

```
=====
dorgbr examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

DORGBR - one of the real orthogonal matrices Q or P\*\*T determined by DGEBRD when reducing a real matrix A to bidiagonal form

#### SYNOPSIS

```
SUBROUTINE DORGBR( VECT, M, N, K, A, LDA, TAU, WORK, LWORK, INFO )
```

```
      CHARACTER      VECT
```

```
      INTEGER        INFO, K, LDA, LWORK, M, N
```

```
      DOUBLE         PRECISION A( LDA, * ), TAU( * ), WORK( * )
```

#### PURPOSE

DORGBR generates one of the real orthogonal matrices Q or P\*\*T determined by DGEBRD when reducing a real matrix A to bidiagonal form:  $A = Q * B * P^{**T}$ . Q and P\*\*T are defined as products of elementary reflectors H(i) or G(i) respectively.

If VECT = 'Q', A is assumed to have been an M-by-K matrix, and Q is of order M:

if  $m \geq k$ ,  $Q = H(1) H(2) \dots H(k)$  and DORGBR returns the first n columns of Q, where  $m \geq n \geq k$ ;

if  $m < k$ ,  $Q = H(1) H(2) \dots H(m-1)$  and DORGBR returns Q as an M-by-M matrix.

If VECT = 'P', A is assumed to have been a K-by-N matrix, and P\*\*T is of order N:

if  $k < n$ ,  $P^{**T} = G(k) \dots G(2) G(1)$  and DORGBR returns the first m rows of P\*\*T, where  $n \geq m \geq k$ ;

if  $k \geq n$ ,  $P^{**T} = G(n-1) \dots G(2) G(1)$  and DORGBR returns P\*\*T as an N-by-N matrix.

#### ARGUMENTS

VECT (input) CHARACTER\*1

Specifies whether the matrix Q or the matrix P\*\*T is required,

as defined in the transformation applied by DGEHRD:

= 'Q': generate Q;  
 = 'P': generate P\*\*T.

- M (input) INTEGER  
 The number of rows of the matrix Q or P\*\*T to be returned. M  $\geq$  0.
- N (input) INTEGER  
 The number of columns of the matrix Q or P\*\*T to be returned. N  $\geq$  0. If VECT = 'Q', M  $\geq$  N  $\geq$  min(M,K); if VECT = 'P', N  $\geq$  M  $\geq$  min(N,K).
- K (input) INTEGER  
 If VECT = 'Q', the number of columns in the original M-by-K matrix reduced by DGEHRD. If VECT = 'P', the number of rows in the original K-by-N matrix reduced by DGEHRD. K  $\geq$  0.
- A (input/output) DOUBLE PRECISION array, dimension (LDA,N)  
 On entry, the vectors which define the elementary reflectors, as returned by DGEHRD. On exit, the M-by-N matrix Q or P\*\*T.
- LDA (input) INTEGER  
 The leading dimension of the array A. LDA  $\geq$  max(1,M).
- TAU (input) DOUBLE PRECISION array, dimension (min(M,K)) if VECT = 'Q' (min(N,K)) if VECT = 'P' TAU(i) must contain the scalar factor of the elementary reflector H(i) or G(i), which determines Q or P\*\*T, as returned by DGEHRD in its array argument TAUQ or TAUP.
- WORK (workspace/output) DOUBLE PRECISION array, dimension (MAX(1,LWORK))  
 On exit, if INFO = 0, WORK(1) returns the optimal LWORK.
- LWORK (input) INTEGER  
 The dimension of the array WORK. LWORK  $\geq$  max(1,min(M,N)). For optimum performance LWORK  $\geq$  min(M,N)\*NB, where NB is the optimal blocksize.
- If LWORK = -1, then a workspace query is assumed; the routine only calculates the optimal size of the WORK array, returns this value as the first entry of the WORK array, and no error message related to LWORK is issued by XERBLA.
- INFO (output) INTEGER



= 0: successful exit  
< 0: if INFO = -i, the i-th argument had an illegal value

```

(LAPACK dorgbr)=
  (let* ((zero 0.0) (one 1.0))
    (declare (type (double-float 0.0 0.0) zero)
              (type (double-float 1.0 1.0) one))
    (defun dorgbr (vect m n k a lda tau work lwork info)
      (declare (type (simple-array double-float (*)) work tau a)
                (type fixnum info lwork lda k n m)
                (type character vect))
      (f2cl-lib:with-multi-array-data
        ((vect character vect-%data% vect-%offset%)
         (a double-float a-%data% a-%offset%)
         (tau double-float tau-%data% tau-%offset%)
         (work double-float work-%data% work-%offset%))
        (prog ((i 0) (iinfo 0) (j 0) (lwkopt 0) (mn 0) (nb 0) (lquery nil)
              (wantq nil))
          (declare (type fixnum i iinfo j lwkopt mn nb)
                    (type (member t nil) lquery wantq))
          (setf info 0)
          (setf wantq (char-equal vect #\Q))
          (setf mn (min (the fixnum m) (the fixnum n)))
          (setf lquery (coerce (= lwork -1) '(member t nil)))
          (cond
            ((and (not wantq) (not (char-equal vect #\P)))
              (setf info -1))
            ((< m 0)
              (setf info -2))
            ((or (< n 0)
                  (and wantq
                       (or (> n m)
                           (< n
                            (min (the fixnum m)
                                (the fixnum k))))))
              (and (not wantq)
                    (or (> m n)
                        (< m
                         (min (the fixnum n)
                             (the fixnum k))))))
              (setf info -3))
            ((< k 0)
              (setf info -4))
            ((< lda (max (the fixnum 1) (the fixnum m)))
              (setf info -6))
            ((and
              (< lwork
               (max (the fixnum 1) (the fixnum mn)))
              (not lquery))
              )
          )
    )
  )

```

```

        (setf info -9)))
(cond
  ((= info 0)
    (cond
      (wantq
        (setf nb (ilaenv 1 "DORGQR" " " m n k -1)))
      (t
        (setf nb (ilaenv 1 "DORGLQ" " " m n k -1))))
    (setf lwkopt
      (f2cl-lib:int-mul
        (max (the fixnum 1) (the fixnum mn))
        nb))
    (setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)
      (coerce (the fixnum lwkopt) 'double-float)))
p (cond
  ((/= info 0)
    (error
      " ** On entry to ~a parameter number ~a had an illegal value~%"
      "DORGQR" (f2cl-lib:int-sub info))
    (go end_label))
  (lquery
    (go end_label)))
(cond
  ((or (= m 0) (= n 0))
    (setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)
      (coerce (the fixnum 1) 'double-float))
    (go end_label)))
(cond
  (wantq
    (cond
      ((>= m k)
        (multiple-value-bind
          (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8)
          (dorgqr m n k a lda tau work lwork iinfo)
          (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
            var-7))
          (setf iinfo var-8)))
      (t
        (f2cl-lib:fdo (j m (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
          ((> j 2) nil)
          (tagbody
            (setf (f2cl-lib:fref a-%data%
              (1 j)
              ((1 lda) (1 *))
              a-%offset%)
              zero)
            (go end_label)))))))

```

```

(f2cl-lib:fdo (i (f2cl-lib:int-add j 1)
                (f2cl-lib:int-add i 1))
              (> i m) nil)
(tagbody
  (setf (f2cl-lib:fref a-%data%
                      (i j)
                      ((1 lda) (1 *))
                      a-%offset%)
        (f2cl-lib:fref a-%data%
                      (i (f2cl-lib:int-sub j 1))
                      ((1 lda) (1 *))
                      a-%offset%))))))
(setf (f2cl-lib:fref a-%data% (1 1) ((1 lda) (1 *)) a-%offset%
      one)
(f2cl-lib:fdo (i 2 (f2cl-lib:int-add i 1))
              (> i m) nil)
(tagbody
  (setf (f2cl-lib:fref a-%data%
                      (i 1)
                      ((1 lda) (1 *))
                      a-%offset%)
        zero))))
(cond
 (> m 1)
 (multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8)
  (dorgqr (f2cl-lib:int-sub m 1) (f2cl-lib:int-sub m 1)
          (f2cl-lib:int-sub m 1)
          (f2cl-lib:array-slice a
                                double-float
                                (2 2)
                                ((1 lda) (1 *)))
          lda tau work lwork iinfo)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                  var-7))
  (setf iinfo var-8))))))
(t
 (cond
 (< k n)
 (multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8)
  (dorglq m n k a lda tau work lwork iinfo)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                  var-7))
  (setf iinfo var-8)))
 (t

```

```

(setf (f2cl-lib:fref a-%data% (1 1) ((1 lda) (1 *)) a-%offset%)
      one)
(f2cl-lib:fdo (i 2 (f2cl-lib:int-add i 1))
              (> i n) nil)
  (tagbody
    (setf (f2cl-lib:fref a-%data%
                        (i 1)
                        ((1 lda) (1 *))
                        a-%offset%)
          zero)))
(f2cl-lib:fdo (j 2 (f2cl-lib:int-add j 1))
              (> j n) nil)
  (tagbody
    (f2cl-lib:fdo (i (f2cl-lib:int-add j (f2cl-lib:int-sub 1))
                  (f2cl-lib:int-add i (f2cl-lib:int-sub 1)))
                  (> i 2) nil)
      (tagbody
        (setf (f2cl-lib:fref a-%data%
                            (i j)
                            ((1 lda) (1 *))
                            a-%offset%)
              (f2cl-lib:fref a-%data%
                            ((f2cl-lib:int-sub i 1) j)
                            ((1 lda) (1 *))
                            a-%offset%))))
        (setf (f2cl-lib:fref a-%data%
                            (1 j)
                            ((1 lda) (1 *))
                            a-%offset%)
              zero)))
(cond
 (> n 1)
 (multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8)
  (dorglq (f2cl-lib:int-sub n 1) (f2cl-lib:int-sub n 1)
          (f2cl-lib:int-sub n 1)
          (f2cl-lib:array-slice a
                                double-float
                                (2 2)
                                ((1 lda) (1 *)))
          lda tau work lwork iinfo)
    (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                     var-7))
    (setf iinfo var-8))))))
(setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)
      (coerce (the fixnum lwkopt) 'double-float))

```

```
end_label  
  (return (values nil nil nil nil nil nil nil nil nil info))))))
```

## 7.81 dorghr LAPACK

```
<orghr.input>≡  
  )set break resume  
  )sys rm -f orghr.output  
  )spool orghr.output  
  )set message test on  
  )set message auto off  
  )clear all  
  
  )spool  
  )lisp (bye)
```

`<dorghr.help>=`

```
=====
dorghr examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

DORGHR - a real orthogonal matrix Q which is defined as the product of IHI-ILO elementary reflectors of order N, as returned by DGEHRD

#### SYNOPSIS

```
SUBROUTINE DORGHR( N, ILO, IHI, A, LDA, TAU, WORK, LWORK, INFO )
```

```
      INTEGER          IHI, ILO, INFO, LDA, LWORK, N
```

```
      DOUBLE           PRECISION A( LDA, * ), TAU( * ), WORK( * )
```

#### PURPOSE

DORGHR generates a real orthogonal matrix Q which is defined as the product of IHI-ILO elementary reflectors of order N, as returned by DGEHRD:

$$Q = H(i_{lo}) H(i_{lo}+1) \dots H(i_{hi}-1).$$

#### ARGUMENTS

N (input) INTEGER  
The order of the matrix Q. N >= 0.

ILO (input) INTEGER  
IHI (input) INTEGER ILO and IHI must have the same values as in the previous call of DGEHRD. Q is equal to the unit matrix except in the submatrix Q(i<sub>lo</sub>+1:i<sub>hi</sub>,i<sub>lo</sub>+1:i<sub>hi</sub>). 1 <= ILO <= IHI <= N, if N > 0; ILO=1 and IHI=0, if N=0.

A (input/output) DOUBLE PRECISION array, dimension (LDA,N)  
On entry, the vectors which define the elementary reflectors, as returned by DGEHRD. On exit, the N-by-N orthogonal matrix Q.

LDA (input) INTEGER  
The leading dimension of the array A. LDA >= max(1,N).

TAU (input) DOUBLE PRECISION array, dimension (N-1)  
TAU(i) must contain the scalar factor of the elementary reflector H(i), as returned by DGEHRD.

WORK (workspace/output) DOUBLE PRECISION array, dimension (MAX(1,LWORK))  
On exit, if INFO = 0, WORK(1) returns the optimal LWORK.

LWORK (input) INTEGER  
The dimension of the array WORK. LWORK  $\geq$  IHI-ILO. For optimum performance LWORK  $\geq$  (IHI-ILO)\*NB, where NB is the optimal blocksize.

If LWORK = -1, then a workspace query is assumed; the routine only calculates the optimal size of the WORK array, returns this value as the first entry of the WORK array, and no error message related to LWORK is issued by XERBLA.

INFO (output) INTEGER  
= 0: successful exit  
< 0: if INFO = -i, the i-th argument had an illegal value



```

(LAPACK dorghr)≡
  (let* ((zero 0.0) (one 1.0))
    (declare (type (double-float 0.0 0.0) zero)
              (type (double-float 1.0 1.0) one))
    (defun dorghr (n ilo ihi a lda tau work lwork info)
      (declare (type (simple-array double-float (*)) work tau a)
                (type fixnum info lwork lda ihi ilo n))
      (f2cl-lib:with-multi-array-data
        ((a double-float a-%data% a-%offset%)
         (tau double-float tau-%data% tau-%offset%)
         (work double-float work-%data% work-%offset%))
        (prog ((i 0) (iinfo 0) (j 0) (lwkopt 0) (nb 0) (nh 0) (lquery nil))
          (declare (type fixnum i iinfo j lwkopt nb nh)
                    (type (member t nil) lquery))
          (setf info 0)
          (setf nh (f2cl-lib:int-sub ihi ilo))
          (setf lquery (coerce (= lwork -1) '(member t nil)))
          (cond
            ((< n 0)
              (setf info -1))
            ((or (< ilo 1)
                  (> ilo
                    (max (the fixnum 1) (the fixnum n))))
              (setf info -2))
            ((or
              (< ihi (min (the fixnum ilo) (the fixnum n)))
              (> ihi n))
              (setf info -3))
            ((< lda (max (the fixnum 1) (the fixnum n)))
              (setf info -5))
            ((and
              (< lwork
                (max (the fixnum 1) (the fixnum nh)))
              (not lquery))
              (setf info -8)))
          (cond
            ((= info 0)
              (setf nb (ilaenv 1 "DORGQR" " " " nh nh nh -1))
              (setf lwkopt
                (f2cl-lib:int-mul
                  (max (the fixnum 1) (the fixnum nh))
                  nb))
              (setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)
                (coerce (the fixnum lwkopt) 'double-float))))
            (t
              (setf info 1))))))
  )

```

```

(error
  " ** On entry to ~a parameter number ~a had an illegal value~%"
  "DORGHR" (f2cl-lib:int-sub info))
(go end_label))
(lquery
  (go end_label)))
(cond
  ((= n 0)
    (setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)
          (coerce (the fixnum 1) 'double-float))
    (go end_label)))
(f2cl-lib:fdo (j ihi (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
  ((> j (f2cl-lib:int-add ilo 1)) nil)
  (tagbody
    (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
      ((> i (f2cl-lib:int-add j (f2cl-lib:int-sub 1))) nil)
      (tagbody
        (setf (f2cl-lib:fref a-%data% (i j) ((1 lda) (1 *)) a-%offset%)
              zero)))
    (f2cl-lib:fdo (i (f2cl-lib:int-add j 1) (f2cl-lib:int-add i 1))
      ((> i ihi) nil)
      (tagbody
        (setf (f2cl-lib:fref a-%data% (i j) ((1 lda) (1 *)) a-%offset%)
              (f2cl-lib:fref a-%data%
                            (i (f2cl-lib:int-sub j 1))
                            ((1 lda) (1 *))
                            a-%offset%))))
    (f2cl-lib:fdo (i (f2cl-lib:int-add ihi 1) (f2cl-lib:int-add i 1))
      ((> i n) nil)
      (tagbody
        (setf (f2cl-lib:fref a-%data% (i j) ((1 lda) (1 *)) a-%offset%)
              zero))))))
(f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
  ((> j ilo) nil)
  (tagbody
    (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
      ((> i n) nil)
      (tagbody
        (setf (f2cl-lib:fref a-%data% (i j) ((1 lda) (1 *)) a-%offset%)
              zero)))
    (setf (f2cl-lib:fref a-%data% (j j) ((1 lda) (1 *)) a-%offset%)
          one)))
(f2cl-lib:fdo (j (f2cl-lib:int-add ihi 1) (f2cl-lib:int-add j 1))
  ((> j n) nil)
  (tagbody
    (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))

```

```

                                ((> i n) nil)
      (tagbody
        (setf (f2cl-lib:fref a-%data% (i j) ((1 lda) (1 *)) a-%offset%)
              zero)))
      (setf (f2cl-lib:fref a-%data% (j j) ((1 lda) (1 *)) a-%offset%)
            one)))
    (cond
      ((> nh 0)
       (multiple-value-bind
         (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8)
         (dorgqr nh nh nh
          (f2cl-lib:array-slice a
                                double-float
                                ((+ ilo 1) (f2cl-lib:int-add ilo 1))
                                ((1 lda) (1 *)))
          lda (f2cl-lib:array-slice tau double-float (ilo) ((1 *))) work
          lwork iinfo)
         (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7))
         (setf iinfo var-8))))
      (setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)
            (coerce (the fixnum lwkopt) 'double-float)))
    end_label
    (return (values nil nil nil nil nil nil nil nil info))))))

```

## 7.82 dorgl2 LAPACK

```

⟨dorgl2.input⟩≡
)set break resume
)sys rm -f dorgl2.output
)spool dorgl2.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)

```

`<dorgl2.help>=`

```
=====
dorgl2 examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

DORGL2 - an m by n real matrix Q with orthonormal rows,

#### SYNOPSIS

```
SUBROUTINE DORGL2( M, N, K, A, LDA, TAU, WORK, INFO )
```

```
      INTEGER          INFO, K, LDA, M, N
```

```
      DOUBLE          PRECISION A( LDA, * ), TAU( * ), WORK( * )
```

#### PURPOSE

DORGL2 generates an m by n real matrix Q with orthonormal rows, which is defined as the first m rows of a product of k elementary reflectors of order n

$$Q = H(k) \dots H(2) H(1)$$

as returned by DGELQF.

#### ARGUMENTS

M (input) INTEGER

The number of rows of the matrix Q. M >= 0.

N (input) INTEGER

The number of columns of the matrix Q. N >= M.

K (input) INTEGER

The number of elementary reflectors whose product defines the matrix Q. M >= K >= 0.

A (input/output) DOUBLE PRECISION array, dimension (LDA,N)

On entry, the i-th row must contain the vector which defines the elementary reflector H(i), for i = 1,2,...,k, as returned by DGELQF in the first k rows of its array argument A. On exit, the m-by-n matrix Q.

LDA      (input) INTEGER  
The first dimension of the array A.  $LDA \geq \max(1, M)$ .

TAU      (input) DOUBLE PRECISION array, dimension (K)  
TAU(i) must contain the scalar factor of the elementary reflector  $H(i)$ , as returned by DGELQF.

WORK      (workspace) DOUBLE PRECISION array, dimension (M)

INFO      (output) INTEGER  
= 0: successful exit  
< 0: if  $INFO = -i$ , the  $i$ -th argument has an illegal value

```

(LAPACK dorgl2)=
  (let* ((one 1.0) (zero 0.0))
    (declare (type (double-float 1.0 1.0) one)
              (type (double-float 0.0 0.0) zero))
    (defun dorgl2 (m n k a lda tau work info)
      (declare (type (simple-array double-float (*)) work tau a)
                (type fixnum info lda k n m))
      (f2cl-lib:with-multi-array-data
        ((a double-float a-%data% a-%offset%)
         (tau double-float tau-%data% tau-%offset%)
         (work double-float work-%data% work-%offset%))
        (prog ((i 0) (j 0) (l 0))
          (declare (type fixnum i j l))
          (setf info 0)
          (cond
            ((< m 0)
              (setf info -1))
            ((< n m)
              (setf info -2))
            ((or (< k 0) (> k m))
              (setf info -3))
            ((< lda (max (the fixnum 1) (the fixnum m)))
              (setf info -5)))
          (cond
            ((/= info 0)
              (error
               " ** On entry to ~a parameter number ~a had an illegal value~%"
               "DORGL2" (f2cl-lib:int-sub info))
              (go end_label)))
          (if (<= m 0) (go end_label))
          (cond
            ((< k m)
              (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                            ((> j n) nil)
              (tagbody
                (f2cl-lib:fdo (l 1 (f2cl-lib:int-add k 1) (f2cl-lib:int-add l 1))
                              ((> l m) nil)
                (tagbody
                  (setf (f2cl-lib:fref a-%data%
                                       (l j)
                                       ((1 lda) (1 *))
                                       a-%offset%)
                        zero)))
                  (if (and (> j k) (<= j m))
                      (setf (f2cl-lib:fref a-%data%
                                             (j j)

```

```

                                ((1 lda) (1 *))
                                a-%offset%)
                                one))))))
(f2cl-lib:fdo (i k (f2cl-lib:int-add i (f2cl-lib:int-sub 1)))
              ((> i 1) nil)
(tagbody
 (cond
  ((< i n)
   (cond
    ((< i m)
     (setf (f2cl-lib:fref a-%data%
                          (i i)
                          ((1 lda) (1 *))
                          a-%offset%)
            one)
     (dlarf "Right" (f2cl-lib:int-sub m i)
             (f2cl-lib:int-add (f2cl-lib:int-sub n i) 1)
             (f2cl-lib:array-slice a double-float (i i) ((1 lda) (1 *)))
             lda (f2cl-lib:fref tau-%data% (i) ((1 *)) tau-%offset%)
             (f2cl-lib:array-slice a
                                   double-float
                                   ((+ i 1) i)
                                   ((1 lda) (1 *)))
             lda work)))
    (dscal (f2cl-lib:int-sub n i)
            (- (f2cl-lib:fref tau-%data% (i) ((1 *)) tau-%offset%)
              (f2cl-lib:array-slice a
                                    double-float
                                    (i (f2cl-lib:int-add i 1))
                                    ((1 lda) (1 *)))
              lda)))
    (setf (f2cl-lib:fref a-%data% (i i) ((1 lda) (1 *)) a-%offset%)
          (- one
            (f2cl-lib:fref tau-%data% (i) ((1 *)) tau-%offset%)))
    (f2cl-lib:fdo (1 1 (f2cl-lib:int-add 1 1))
                  ((> 1 (f2cl-lib:int-add i (f2cl-lib:int-sub 1))) nil)
                  (tagbody
                   (setf (f2cl-lib:fref a-%data% (i 1) ((1 lda) (1 *)) a-%offset%)
                         zero))))))
end_label
(return (values nil nil nil nil nil nil nil info))))))

```

## 7.83 dorglq LAPACK

```
<dorglq.input>≡  
  )set break resume  
  )sys rm -f dorglq.output  
  )spool dorglq.output  
  )set message test on  
  )set message auto off  
  )clear all  
  
  )spool  
  )lisp (bye)
```



`<dorglq.help>≡`

```
=====
dorglq examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

DORGLQ - an M-by-N real matrix Q with orthonormal rows,

#### SYNOPSIS

```
SUBROUTINE DORGLQ( M, N, K, A, LDA, TAU, WORK, LWORK, INFO )
```

```
      INTEGER          INFO, K, LDA, LWORK, M, N
```

```
      DOUBLE           PRECISION A( LDA, * ), TAU( * ), WORK( * )
```

#### PURPOSE

DORGLQ generates an M-by-N real matrix Q with orthonormal rows, which is defined as the first M rows of a product of K elementary reflectors of order N

$$Q = H(k) \dots H(2) H(1)$$

as returned by DGELQF.

#### ARGUMENTS

M (input) INTEGER

The number of rows of the matrix Q.  $M \geq 0$ .

N (input) INTEGER

The number of columns of the matrix Q.  $N \geq M$ .

K (input) INTEGER

The number of elementary reflectors whose product defines the matrix Q.  $M \geq K \geq 0$ .

A (input/output) DOUBLE PRECISION array, dimension (LDA,N)

On entry, the i-th row must contain the vector which defines the elementary reflector  $H(i)$ , for  $i = 1, 2, \dots, k$ , as returned by DGELQF in the first k rows of its array argument A. On exit, the M-by-N matrix Q.

LDA        (input) INTEGER  
            The first dimension of the array A.  $LDA \geq \max(1, M)$ .

TAU        (input) DOUBLE PRECISION array, dimension (K)  
            TAU(i) must contain the scalar factor of the elementary reflector H(i), as returned by DGELQF.

WORK       (workspace/output) DOUBLE PRECISION array, dimension  
            (MAX(1,LWORK))  
            On exit, if INFO = 0, WORK(1) returns the optimal LWORK.

LWORK      (input) INTEGER  
            The dimension of the array WORK.  $LWORK \geq \max(1, M)$ . For optimum performance  $LWORK \geq M \cdot NB$ , where NB is the optimal block-size.

            If LWORK = -1, then a workspace query is assumed; the routine only calculates the optimal size of the WORK array, returns this value as the first entry of the WORK array, and no error message related to LWORK is issued by XERBLA.

INFO       (output) INTEGER  
            = 0: successful exit  
            < 0: if INFO = -i, the i-th argument has an illegal value

```

(LAPACK dorglq)≡
  (let* ((zero 0.0))
    (declare (type (double-float 0.0 0.0) zero))
    (defun dorglq (m n k a lda tau work lwork info)
      (declare (type (simple-array double-float (*)) work tau a)
        (type fixnum info lwork lda k n m))
      (f2cl-lib:with-multi-array-data
        ((a double-float a-%data% a-%offset%)
         (tau double-float tau-%data% tau-%offset%)
         (work double-float work-%data% work-%offset%))
        (prog ((i 0) (ib 0) (iinfo 0) (iws 0) (j 0) (ki 0) (kk 0) (l 0)
              (ldwork 0) (lwkopt 0) (nb 0) (nbmin 0) (nx 0) (lquery nil))
              (declare (type fixnum i ib iinfo iws j ki kk l ldwork
                            lwkopt nb nbmin nx)
                        (type (member t nil) lquery))
              (setf info 0)
              (setf nb (ilaenv 1 "DORGLQ" " " m n k -1))
              (setf lwkopt
                (f2cl-lib:int-mul
                  (max (the fixnum 1) (the fixnum m))
                  nb))
              (setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)
                (coerce (the fixnum lwkopt) 'double-float))
              (setf lquery (coerce (= lwork -1) '(member t nil)))
              (cond
                ((< m 0)
                 (setf info -1))
                ((< n m)
                 (setf info -2))
                ((or (< k 0) (> k m))
                 (setf info -3))
                ((< lda (max (the fixnum 1) (the fixnum m)))
                 (setf info -5))
                ((and
                  (< lwork (max (the fixnum 1) (the fixnum m)))
                  (not lquery))
                 (setf info -8)))
              (cond
                ((/= info 0)
                 (error
                  " ** On entry to ~a parameter number ~a had an illegal value~%"
                  "DORGLQ" (f2cl-lib:int-sub info))
                 (go end_label))
                (lquery
                 (go end_label))))
              (cond

```

```

    ((<= m 0)
      (setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)
        (coerce (the fixnum 1) 'double-float))
      (go end_label)))
  (setf nbmin 2)
  (setf nx 0)
  (setf iws m)
  (cond
    ((and (> nb 1) (< nb k))
      (setf nx
        (max (the fixnum 0)
              (the fixnum
                (ilaenv 3 "DORGLQ" " " m n k -1)))))
    (cond
      ((< nx k)
        (setf ldwork m)
        (setf iws (f2cl-lib:int-mul ldwork nb))
        (cond
          ((< lwork iws)
            (setf nb (the fixnum (truncate lwork ldwork)))
            (setf nbmin
              (max (the fixnum 2)
                    (the fixnum
                      (ilaenv 2 "DORGLQ" " " m n k -1))))))))))
    (cond
      ((and (>= nb nbmin) (< nb k) (< nx k))
        (setf ki (* (the fixnum (truncate (- k nx 1) nb)) nb))
        (setf kk
          (min (the fixnum k)
                (the fixnum (f2cl-lib:int-add ki nb))))
        (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
          ((> j kk) nil)
          (tagbody
            (f2cl-lib:fdo (i (f2cl-lib:int-add kk 1) (f2cl-lib:int-add i 1))
              ((> i m) nil)
              (tagbody
                (setf (f2cl-lib:fref a-%data%
                                      (i j)
                                      ((1 lda) (1 *))
                                      a-%offset%)
                  zero))))))
        (t
          (setf kk 0)))
    (if (< kk m)
      (multiple-value-bind
        (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7)

```

```

(dorgl2 (f2cl-lib:int-sub m kk) (f2cl-lib:int-sub n kk)
  (f2cl-lib:int-sub k kk)
  (f2cl-lib:array-slice a
    double-float
    ((+ kk 1) (f2cl-lib:int-add kk 1))
    ((1 lda) (1 *)))
  lda (f2cl-lib:array-slice tau double-float ((+ kk 1)) ((1 *)))
  work iinfo)
(declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6))
(setf iinfo var-7)))
(cond
  (> kk 0)
  (f2cl-lib:fdo (i (f2cl-lib:int-add ki 1)
    (f2cl-lib:int-add i (f2cl-lib:int-sub nb)))
    (> i 1) nil)
  (tagbody
    (setf ib
      (min (the fixnum nb)
        (the fixnum
          (f2cl-lib:int-add (f2cl-lib:int-sub k i) 1))))
    (cond
      ((<= (f2cl-lib:int-add i ib) m)
        (dlarft "Forward" "Rowwise"
          (f2cl-lib:int-add (f2cl-lib:int-sub n i) 1) ib
          (f2cl-lib:array-slice a double-float (i i) ((1 lda) (1 *)))
          lda (f2cl-lib:array-slice tau double-float (i) ((1 *))) work
          ldwork)
        (dlarfb "Right" "Transpose" "Forward" "Rowwise"
          (f2cl-lib:int-add (f2cl-lib:int-sub m i ib) 1)
          (f2cl-lib:int-add (f2cl-lib:int-sub n i) 1) ib
          (f2cl-lib:array-slice a double-float (i i) ((1 lda) (1 *)))
          lda work ldwork
          (f2cl-lib:array-slice a
            double-float
            ((+ i ib) i)
            ((1 lda) (1 *)))
          lda
          (f2cl-lib:array-slice work double-float ((+ ib 1)) ((1 *)))
          ldwork)))
      (multiple-value-bind
        (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7)
        (dorgl2 ib (f2cl-lib:int-add (f2cl-lib:int-sub n i) 1) ib
          (f2cl-lib:array-slice a double-float (i i) ((1 lda) (1 *)))
          lda (f2cl-lib:array-slice tau double-float (i) ((1 *)))
          work iinfo)
        (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6))

```

```

      (setf iinfo var-7))
    (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
      ((> j (f2cl-lib:int-add i (f2cl-lib:int-sub 1)))
       nil)
      (tagbody
        (f2cl-lib:fdo (l i (f2cl-lib:int-add l 1))
          ((> l
            (f2cl-lib:int-add i
              ib
              (f2cl-lib:int-sub 1)))
           nil)
          (tagbody
            (setf (f2cl-lib:fref a-%data%
                                (l j)
                                ((1 lda) (1 *))
                                a-%offset%)
                  zero))))))
    (setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)
      (coerce (the fixnum iws) 'double-float))
  end_label
  (return (values nil nil nil nil nil nil nil nil info))))

```

## 7.84 dorgqr LAPACK

```

<dorgqr.input>≡
)set break resume
)sys rm -f dorgqr.output
)spool dorgqr.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)

```

`<dorgqr.help>=`

```
=====
dorgqr examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

DORGQR - an M-by-N real matrix Q with orthonormal columns,

#### SYNOPSIS

```
SUBROUTINE DORGQR( M, N, K, A, LDA, TAU, WORK, LWORK, INFO )
```

```
      INTEGER          INFO, K, LDA, LWORK, M, N
```

```
      DOUBLE           PRECISION A( LDA, * ), TAU( * ), WORK( * )
```

#### PURPOSE

DORGQR generates an M-by-N real matrix Q with orthonormal columns, which is defined as the first N columns of a product of K elementary reflectors of order M

$$Q = H(1) H(2) \dots H(k)$$

as returned by DGEQRF.

#### ARGUMENTS

M (input) INTEGER

The number of rows of the matrix Q.  $M \geq 0$ .

N (input) INTEGER

The number of columns of the matrix Q.  $M \geq N \geq 0$ .

K (input) INTEGER

The number of elementary reflectors whose product defines the matrix Q.  $N \geq K \geq 0$ .

A (input/output) DOUBLE PRECISION array, dimension (LDA,N)

On entry, the i-th column must contain the vector which defines the elementary reflector H(i), for  $i = 1, 2, \dots, k$ , as returned by DGEQRF in the first k columns of its array argument A. On exit, the M-by-N matrix Q.

LDA (input) INTEGER  
The first dimension of the array A.  $LDA \geq \max(1, M)$ .

TAU (input) DOUBLE PRECISION array, dimension (K)  
TAU(i) must contain the scalar factor of the elementary reflector  $H(i)$ , as returned by DGEQRF.

WORK (workspace/output) DOUBLE PRECISION array, dimension (MAX(1,LWORK))  
On exit, if INFO = 0, WORK(1) returns the optimal LWORK.

LWORK (input) INTEGER  
The dimension of the array WORK.  $LWORK \geq \max(1, N)$ . For optimum performance  $LWORK \geq N \cdot NB$ , where NB is the optimal block-size.

If LWORK = -1, then a workspace query is assumed; the routine only calculates the optimal size of the WORK array, returns this value as the first entry of the WORK array, and no error message related to LWORK is issued by XERBLA.

INFO (output) INTEGER  
= 0: successful exit  
< 0: if INFO = -i, the i-th argument has an illegal value



```

(LAPACK dorgqr)=
  (let* ((zero 0.0))
    (declare (type (double-float 0.0 0.0) zero))
    (defun dorgqr (m n k a lda tau work lwork info)
      (declare (type (simple-array double-float (*)) work tau a)
        (type fixnum info lwork lda k n m))
      (f2cl-lib:with-multi-array-data
        ((a double-float a-%data% a-%offset%)
         (tau double-float tau-%data% tau-%offset%)
         (work double-float work-%data% work-%offset%))
        (prog ((i 0) (ib 0) (iinfo 0) (iws 0) (j 0) (ki 0) (kk 0) (l 0)
              (ldwork 0) (lwkopt 0) (nb 0) (nbmin 0) (nx 0) (lquery nil))
          (declare (type fixnum i ib iinfo iws j ki kk l ldwork
                        lwkopt nb nbmin nx)
                    (type (member t nil) lquery))
          (setf info 0)
          (setf nb (ilaenv 1 "DORGQR" " " m n k -1))
          (setf lwkopt
            (f2cl-lib:int-mul
              (max (the fixnum 1) (the fixnum n))
              nb))
          (setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)
            (coerce (the fixnum lwkopt) 'double-float))
          (setf lquery (coerce (= lwork -1) '(member t nil)))
          (cond
            ((< m 0)
              (setf info -1))
            ((or (< n 0) (> n m))
              (setf info -2))
            ((or (< k 0) (> k n))
              (setf info -3))
            ((< lda (max (the fixnum 1) (the fixnum m)))
              (setf info -5))
            ((and
              (< lwork (max (the fixnum 1) (the fixnum n)))
              (not lquery))
              (setf info -8)))
          (cond
            ((/= info 0)
              (error
                " ** On entry to ~a parameter number ~a had an illegal value~%"
                "DORGQR" (f2cl-lib:int-sub info))
              (go end_label))
            (lquery
              (go end_label))))
          (cond

```

```

      ((<= n 0)
      (setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)
            (coerce (the fixnum 1) 'double-float))
      (go end_label)))
    (setf nbmin 2)
    (setf nx 0)
    (setf iws n)
    (cond
      ((and (> nb 1) (< nb k))
      (setf nx
            (max (the fixnum 0)
                  (the fixnum
                    (ilaenv 3 "DORGQR" " " m n k -1))))))
      (cond
        ((< nx k)
        (setf ldwork n)
        (setf iws (f2cl-lib:int-mul ldwork nb))
        (cond
          ((< lwork iws)
          (setf nb (the fixnum (truncate lwork ldwork)))
          (setf nbmin
                (max (the fixnum 2)
                      (the fixnum
                        (ilaenv 2 "DORGQR" " " m n k -1))))))))))
      (cond
        ((and (>= nb nbmin) (< nb k) (< nx k))
        (setf ki (* (the fixnum (truncate (- k nx 1) nb)) nb))
        (setf kk
              (min (the fixnum k)
                    (the fixnum (f2cl-lib:int-add ki nb))))
        (f2cl-lib:fdo (j (f2cl-lib:int-add kk 1) (f2cl-lib:int-add j 1))
                      ((> j n) nil)
          (tagbody
            (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                          ((> i kk) nil)
              (tagbody
                (setf (f2cl-lib:fref a-%data%
                                      (i j)
                                      ((1 lda) (1 *))
                                      a-%offset%)
                      zero))))))
        (t
        (setf kk 0)))
      (if (< kk n)
          (multiple-value-bind
            (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7)

```

```

(dorg2r (f2cl-lib:int-sub m kk) (f2cl-lib:int-sub n kk)
  (f2cl-lib:int-sub k kk)
  (f2cl-lib:array-slice a
    double-float
    ((+ kk 1) (f2cl-lib:int-add kk 1))
    ((1 lda) (1 *)))
  lda (f2cl-lib:array-slice tau double-float ((+ kk 1)) ((1 *)))
  work iinfo)
(declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6))
(setf iinfo var-7)))
(cond
  (> kk 0)
  (f2cl-lib:fdo (i (f2cl-lib:int-add ki 1)
    (f2cl-lib:int-add i (f2cl-lib:int-sub nb)))
    (> i 1) nil)
  (tagbody
    (setf ib
      (min (the fixnum nb)
        (the fixnum
          (f2cl-lib:int-add (f2cl-lib:int-sub k i) 1))))
    (cond
      ((<= (f2cl-lib:int-add i ib) n)
        (dlarft "Forward" "Columnwise"
          (f2cl-lib:int-add (f2cl-lib:int-sub m i) 1) ib
          (f2cl-lib:array-slice a double-float (i i) ((1 lda) (1 *)))
          lda (f2cl-lib:array-slice tau double-float (i) ((1 *))) work
          ldwork)
        (dlarfb "Left" "No transpose" "Forward" "Columnwise"
          (f2cl-lib:int-add (f2cl-lib:int-sub m i) 1)
          (f2cl-lib:int-add (f2cl-lib:int-sub n i ib) 1) ib
          (f2cl-lib:array-slice a double-float (i i) ((1 lda) (1 *)))
          lda work ldwork
          (f2cl-lib:array-slice a
            double-float
            (i (f2cl-lib:int-add i ib))
            ((1 lda) (1 *)))
          lda
          (f2cl-lib:array-slice work double-float ((+ ib 1)) ((1 *)))
          ldwork)))
      (multiple-value-bind
        (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7)
        (dorg2r (f2cl-lib:int-add (f2cl-lib:int-sub m i) 1) ib ib
          (f2cl-lib:array-slice a double-float (i i) ((1 lda) (1 *)))
          lda (f2cl-lib:array-slice tau double-float (i) ((1 *)))
          work iinfo)
        (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6))

```

```

        (setf iinfo var-7))
      (f2cl-lib:fdo (j i (f2cl-lib:int-add j 1))
        (> j
          (f2cl-lib:int-add i ib (f2cl-lib:int-sub 1)))
        nil)
      (tagbody
        (f2cl-lib:fdo (l 1 (f2cl-lib:int-add l 1))
          (> l
            (f2cl-lib:int-add i (f2cl-lib:int-sub 1)))
          nil)
        (tagbody
          (setf (f2cl-lib:fref a-%data%
                                (l j)
                                ((1 lda) (1 *))
                                a-%offset%)
                zero))))))
      (setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)
        (coerce (the fixnum iws) 'double-float))
    end_label
    (return (values nil nil nil nil nil nil nil nil info))))

```

## 7.85 dorm2r LAPACK

```

⟨dorm2r.input⟩≡
)set break resume
)sys rm -f dorm2r.output
)spool dorm2r.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)

```

`<dorm2r.help>`≡

```
=====
dorm2r examples
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Man Page Details
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```

#### NAME

DORM2R - the general real  $m$  by  $n$  matrix  $C$  with  $Q * C$  if  $SIDE = 'L'$  and  $TRANS = 'N'$ , or  $Q' * C$  if  $SIDE = 'L'$  and  $TRANS = 'T'$ , or  $C * Q$  if  $SIDE = 'R'$  and  $TRANS = 'N'$ , or  $C * Q'$  if  $SIDE = 'R'$  and  $TRANS = 'T'$ ,

#### SYNOPSIS

```
SUBROUTINE DORM2R( SIDE, TRANS, M, N, K, A, LDA, TAU, C, LDC, WORK,
                  INFO )
```

```
CHARACTER      SIDE, TRANS
```

```
INTEGER        INFO, K, LDA, LDC, M, N
```

```
DOUBLE         PRECISION A( LDA, * ), C( LDC, * ), TAU( * ), WORK(
* )
```

#### PURPOSE

DORM2R overwrites the general real  $m$  by  $n$  matrix  $C$  with

where  $Q$  is a real orthogonal matrix defined as the product of  $k$  elementary reflectors

$$Q = H(1) H(2) \dots H(k)$$

as returned by DGEQRF.  $Q$  is of order  $m$  if  $SIDE = 'L'$  and of order  $n$  if  $SIDE = 'R'$ .

#### ARGUMENTS

SIDE (input) CHARACTER\*1  
 = 'L': apply  $Q$  or  $Q'$  from the Left  
 = 'R': apply  $Q$  or  $Q'$  from the Right

TRANS (input) CHARACTER\*1  
 = 'N': apply  $Q$  (No transpose)  
 = 'T': apply  $Q'$  (Transpose)

M (input) INTEGER  
The number of rows of the matrix C.  $M \geq 0$ .

N (input) INTEGER  
The number of columns of the matrix C.  $N \geq 0$ .

K (input) INTEGER  
The number of elementary reflectors whose product defines the matrix Q. If SIDE = 'L',  $M \geq K \geq 0$ ; if SIDE = 'R',  $N \geq K \geq 0$ .

A (input) DOUBLE PRECISION array, dimension (LDA,K)  
The i-th column must contain the vector which defines the elementary reflector H(i), for  $i = 1, 2, \dots, k$ , as returned by DGEQRF in the first k columns of its array argument A. A is modified by the routine but restored on exit.

LDA (input) INTEGER  
The leading dimension of the array A. If SIDE = 'L',  $LDA \geq \max(1, M)$ ; if SIDE = 'R',  $LDA \geq \max(1, N)$ .

TAU (input) DOUBLE PRECISION array, dimension (K)  
TAU(i) must contain the scalar factor of the elementary reflector H(i), as returned by DGEQRF.

C (input/output) DOUBLE PRECISION array, dimension (LDC,N)  
On entry, the m by n matrix C. On exit, C is overwritten by  $Q^*C$  or  $Q^*C$  or  $CQ^*$  or  $CQ$ .

LDC (input) INTEGER  
The leading dimension of the array C.  $LDC \geq \max(1, M)$ .

WORK (workspace) DOUBLE PRECISION array, dimension (N) if SIDE = 'L', (M) if SIDE = 'R'

INFO (output) INTEGER  
= 0: successful exit  
< 0: if INFO = -i, the i-th argument had an illegal value

```

(LAPACK dorm2r)≡
  (let* ((one 1.0))
    (declare (type (double-float 1.0 1.0) one))
    (defun dorm2r (side trans m n k a lda tau c ldc work info)
      (declare (type (simple-array double-float (*)) work c tau a)
        (type fixnum info ldc lda k n m)
        (type character trans side))
      (f2cl-lib:with-multi-array-data
        ((side character side-%data% side-%offset%)
         (trans character trans-%data% trans-%offset%)
         (a double-float a-%data% a-%offset%)
         (tau double-float tau-%data% tau-%offset%)
         (c double-float c-%data% c-%offset%)
         (work double-float work-%data% work-%offset%))
        (prog ((aii 0.0) (i 0) (i1 0) (i2 0) (i3 0) (ic 0) (jc 0) (mi 0) (ni 0)
              (nq 0) (left nil) (notran nil))
          (declare (type (double-float) aii)
            (type fixnum i i1 i2 i3 ic jc mi ni nq)
            (type (member t nil) left notran))
          (setf info 0)
          (setf left (char-equal side #\L))
          (setf notran (char-equal trans #\N))
          (cond
            (left
              (setf nq m))
            (t
              (setf nq n)))
          (cond
            ((and (not left) (not (char-equal side #\R)))
              (setf info -1))
            ((and (not notran) (not (char-equal trans #\T)))
              (setf info -2))
            ((< m 0)
              (setf info -3))
            ((< n 0)
              (setf info -4))
            ((or (< k 0) (> k nq))
              (setf info -5))
            ((< lda (max (the fixnum 1) (the fixnum nq)))
              (setf info -7))
            ((< ldc (max (the fixnum 1) (the fixnum m)))
              (setf info -10)))
          (cond
            ((/= info 0)
              (error
                " ** On entry to ~a parameter number ~a had an illegal value~%"

```

```

        "DORM2R" (f2cl-lib:int-sub info))
      (go end_label)))
    (if (or (= m 0) (= n 0) (= k 0)) (go end_label))
    (cond
      ((or (and left (not notran)) (and (not left) notran))
        (setf i1 1)
        (setf i2 k)
        (setf i3 1))
      (t
        (setf i1 k)
        (setf i2 1)
        (setf i3 -1)))
    (cond
      (left
        (setf ni n)
        (setf jc 1))
      (t
        (setf mi m)
        (setf ic 1)))
    (f2cl-lib:fdo (i i1 (f2cl-lib:int-add i i3))
      (> i i2) nil)
    (tagbody
      (cond
        (left
          (setf mi (f2cl-lib:int-add (f2cl-lib:int-sub m i) 1))
          (setf ic i))
        (t
          (setf ni (f2cl-lib:int-add (f2cl-lib:int-sub n i) 1))
          (setf jc i)))
      (setf aii
        (f2cl-lib:fref a-%data% (i i) ((1 lda) (1 *)) a-%offset%))
      (setf (f2cl-lib:fref a-%data% (i i) ((1 lda) (1 *)) a-%offset%)
        one)
      (dlarf side mi ni
        (f2cl-lib:array-slice a double-float (i i) ((1 lda) (1 *))) 1
        (f2cl-lib:fref tau-%data% (i) ((1 *)) tau-%offset%)
        (f2cl-lib:array-slice c double-float (ic jc) ((1 ldc) (1 *))) ldc
        work)
      (setf (f2cl-lib:fref a-%data% (i i) ((1 lda) (1 *)) a-%offset%)
        aii)))
  end_label
  (return (values nil nil nil nil nil nil nil nil nil nil info))))))

```



## 7.86 dormbr LAPACK

```
<dormbr.input>≡  
  )set break resume  
  )sys rm -f dormbr.output  
  )spool dormbr.output  
  )set message test on  
  )set message auto off  
  )clear all  
  
  )spool  
  )lisp (bye)
```

`<dormbr.help>`≡

```
=====
dormbr examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

DORMBR - = 'Q', DORMBR overwrites the general real M-by-N matrix C with  
SIDE = 'L' SIDE = 'R' TRANS = 'N'

#### SYNOPSIS

```
SUBROUTINE DORMBR( VECT, SIDE, TRANS, M, N, K, A, LDA, TAU, C, LDC,
                  WORK, LWORK, INFO )
```

CHARACTER SIDE, TRANS, VECT

INTEGER INFO, K, LDA, LDC, LWORK, M, N

DOUBLE PRECISION A( LDA, \* ), C( LDC, \* ), TAU( \* ), WORK( \* )

#### PURPOSE

If VECT = 'Q', DORMBR overwrites the general real M-by-N matrix C with  
SIDE = 'L' SIDE = 'R' TRANS = 'N': Q \* C  
C \* Q TRANS = 'T': Q\*\*T \* C C \* Q\*\*T

If VECT = 'P', DORMBR overwrites the general real M-by-N matrix C with  
SIDE = 'L' SIDE = 'R'  
TRANS = 'N': P \* C C \* P  
TRANS = 'T': P\*\*T \* C C \* P\*\*T

Here Q and P\*\*T are the orthogonal matrices determined by DGEHRD when reducing a real matrix A to bidiagonal form:  $A = Q * B * P^{**T}$ . Q and P\*\*T are defined as products of elementary reflectors H(i) and G(i) respectively.

Let  $n_q = m$  if SIDE = 'L' and  $n_q = n$  if SIDE = 'R'. Thus  $n_q$  is the order of the orthogonal matrix Q or P\*\*T that is applied.

If VECT = 'Q', A is assumed to have been an NQ-by-K matrix: if  $n_q \geq k$ ,  
Q = H(1) H(2) . . . H(k);  
if  $n_q < k$ , Q = H(1) H(2) . . . H( $n_q-1$ ).

If VECT = 'P', A is assumed to have been a K-by-NQ matrix: if  $k < nq$ ,  $P = G(1) \ G(2) \ . \ . \ . \ G(k)$ ;  
 if  $k \geq nq$ ,  $P = G(1) \ G(2) \ . \ . \ . \ G(nq-1)$ .

#### ARGUMENTS

VECT (input) CHARACTER\*1  
 = 'Q': apply Q or Q\*\*T;  
 = 'P': apply P or P\*\*T.

SIDE (input) CHARACTER\*1  
 = 'L': apply Q, Q\*\*T, P or P\*\*T from the Left;  
 = 'R': apply Q, Q\*\*T, P or P\*\*T from the Right.

TRANS (input) CHARACTER\*1  
 = 'N': No transpose, apply Q or P;  
 = 'T': Transpose, apply Q\*\*T or P\*\*T.

M (input) INTEGER  
 The number of rows of the matrix C.  $M \geq 0$ .

N (input) INTEGER  
 The number of columns of the matrix C.  $N \geq 0$ .

K (input) INTEGER  
 If VECT = 'Q', the number of columns in the original matrix reduced by DGEHRD. If VECT = 'P', the number of rows in the original matrix reduced by DGEHRD.  $K \geq 0$ .

A (input) DOUBLE PRECISION array, dimension  
 (LDA,min(nq,K)) if VECT = 'Q' (LDA,nq) if VECT = 'P' The  
 vectors which define the elementary reflectors H(i) and G(i),  
 whose products determine the matrices Q and P, as returned by  
 DGEHRD.

LDA (input) INTEGER  
 The leading dimension of the array A. If VECT = 'Q',  $LDA \geq \max(1,nq)$ ; if VECT = 'P',  $LDA \geq \max(1,\min(nq,K))$ .

TAU (input) DOUBLE PRECISION array, dimension (min(nq,K))  
 TAU(i) must contain the scalar factor of the elementary reflector H(i) or G(i) which determines Q or P, as returned by DGEHRD in the array argument TAUQ or TAU.

C (input/output) DOUBLE PRECISION array, dimension (LDC,N)  
 On entry, the M-by-N matrix C. On exit, C is overwritten by

Q\*C or Q\*\*T\*C or C\*Q\*\*T or C\*Q or P\*C or P\*\*T\*C or C\*P or C\*P\*\*T.

LDC (input) INTEGER  
The leading dimension of the array C.  $LDC \geq \max(1, M)$ .

WORK (workspace/output) DOUBLE PRECISION array, dimension  $(\max(1, LWORK))$   
On exit, if INFO = 0, WORK(1) returns the optimal LWORK.

LWORK (input) INTEGER  
The dimension of the array WORK. If SIDE = 'L',  $LWORK \geq \max(1, N)$ ; if SIDE = 'R',  $LWORK \geq \max(1, M)$ . For optimum performance  $LWORK \geq N \cdot NB$  if SIDE = 'L', and  $LWORK \geq M \cdot NB$  if SIDE = 'R', where NB is the optimal blocksize.

If LWORK = -1, then a workspace query is assumed; the routine only calculates the optimal size of the WORK array, returns this value as the first entry of the WORK array, and no error message related to LWORK is issued by XERBLA.

INFO (output) INTEGER  
= 0: successful exit  
< 0: if INFO = -i, the i-th argument had an illegal value

```

(LAPACK dormbr)≡
(defun dormbr (vect side trans m n k lda tau c ldc work lwork info)
  (declare (type (simple-array double-float (*)) work c tau a)
    (type fixnum info lwork ldc lda k n m)
    (type character trans side vect))
  (f2cl-lib:with-multi-array-data
    ((vect character vect-%data% vect-%offset%)
     (side character side-%data% side-%offset%)
     (trans character trans-%data% trans-%offset%)
     (a double-float a-%data% a-%offset%)
     (tau double-float tau-%data% tau-%offset%)
     (c double-float c-%data% c-%offset%)
     (work double-float work-%data% work-%offset%))
    (prog ((i1 0) (i2 0) (iinfo 0) (lwkopt 0) (mi 0) (nb 0) (ni 0) (nq 0)
      (nw 0)
      (transt
        (make-array '(1) :element-type 'character :initial-element #\ ))
        (applyq nil) (left nil) (lquery nil) (notran nil))
      (declare (type (member t nil) notran lquery left applyq)
        (type (simple-array character (1)) transt)
        (type fixnum nw nq ni nb mi lwkopt iinfo i2 i1))
      (setf info 0)
      (setf applyq (char-equal vect #\Q))
      (setf left (char-equal side #\L))
      (setf notran (char-equal trans #\N))
      (setf lquery (coerce (= lwork -1) '(member t nil)))
      (cond
        (left
          (setf nq m)
          (setf nw n))
        (t
          (setf nq n)
          (setf nw m)))
      (cond
        ((and (not applyq) (not (char-equal vect #\P)))
          (setf info -1))
        ((and (not left) (not (char-equal side #\R)))
          (setf info -2))
        ((and (not notran) (not (char-equal trans #\T)))
          (setf info -3))
        ((< m 0)
          (setf info -4))
        ((< n 0)
          (setf info -5))
        ((< k 0)
          (setf info -6))

```

```

((or
  (and applyq
    (< lda
      (max (the fixnum 1) (the fixnum nq))))
  (and (not applyq)
    (< lda
      (max (the fixnum 1)
        (the fixnum
          (min (the fixnum nq)
            (the fixnum k)))))))
  (setf info -8))
(< ldc (max (the fixnum 1) (the fixnum m)))
(setf info -11))
((and
  (< lwork (max (the fixnum 1) (the fixnum nw)))
  (not lquery))
  (setf info -13)))
(cond
  ((= info 0)
    (cond
      (applyq
        (cond
          (left
            (setf nb
              (ilaenv 1 "DORMQR" (f2cl-lib:f2cl-// side trans)
                (f2cl-lib:int-sub m 1) n (f2cl-lib:int-sub m 1) -1)))
            (t
              (setf nb
                (ilaenv 1 "DORMQR" (f2cl-lib:f2cl-// side trans) m
                  (f2cl-lib:int-sub n 1) (f2cl-lib:int-sub n 1) -1))))))
          (t
            (cond
              (left
                (setf nb
                  (ilaenv 1 "DORMLQ" (f2cl-lib:f2cl-// side trans)
                    (f2cl-lib:int-sub m 1) n (f2cl-lib:int-sub m 1) -1)))
                (t
                  (setf nb
                    (ilaenv 1 "DORMLQ" (f2cl-lib:f2cl-// side trans) m
                      (f2cl-lib:int-sub n 1) (f2cl-lib:int-sub n 1) -1))))))
              (setf lwkopt
                (f2cl-lib:int-mul
                  (max (the fixnum 1) (the fixnum nw))
                  nb))
              (setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)
                (coerce (the fixnum lwkopt) 'double-float))))
    )
  )

```

```

(cond
  ((/= info 0)
    (error
      " ** On entry to ~a parameter number ~a had an illegal value~%"
      "DORMBR" (f2cl-lib:int-sub info))
    (go end_label))
  (lquery
    (go end_label)))
(setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)
      (coerce (the fixnum 1) 'double-float))
(if (or (= m 0) (= n 0)) (go end_label))
(cond
  (applyq
    (cond
      ((>= nq k)
        (multiple-value-bind
          (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9
           var-10 var-11 var-12)
            (dormqr side trans m n k a lda tau c ldc work lwork iinfo)
          (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
                        var-8 var-9 var-10 var-11))
            (setf iinfo var-12))))
      ((> nq 1)
        (cond
          (left
            (setf mi (f2cl-lib:int-sub m 1))
            (setf ni n)
            (setf i1 2)
            (setf i2 1))
          (t
            (setf mi m)
            (setf ni (f2cl-lib:int-sub n 1))
            (setf i1 1)
            (setf i2 2)))
        (multiple-value-bind
          (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9
           var-10 var-11 var-12)
            (dormqr side trans mi ni (f2cl-lib:int-sub nq 1)
              (f2cl-lib:array-slice a double-float (2 1) ((1 lda) (1 *)))
              lda tau
              (f2cl-lib:array-slice c double-float (i1 i2) ((1 ldc) (1 *)))
              ldc work lwork iinfo)
          (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
                        var-8 var-9 var-10 var-11))
            (setf iinfo var-12))))))
  (t

```

```

(cond
  (notran
    (f2cl-lib:f2cl-set-string transt "T" (string 1)))
  (t
    (f2cl-lib:f2cl-set-string transt "N" (string 1))))
(cond
  (> nq k)
    (multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9
       var-10 var-11 var-12)
      (dormlq side transt m n k a lda tau c ldc work lwork iinfo)
      (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
                       var-8 var-9 var-10 var-11))
      (setf iinfo var-12)))
  (> nq 1)
    (cond
      (left
        (setf mi (f2cl-lib:int-sub m 1))
        (setf ni n)
        (setf i1 2)
        (setf i2 1))
      (t
        (setf mi m)
        (setf ni (f2cl-lib:int-sub n 1))
        (setf i1 1)
        (setf i2 2)))
      (multiple-value-bind
        (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9
         var-10 var-11 var-12)
        (dormlq side transt mi ni (f2cl-lib:int-sub nq 1)
          (f2cl-lib:array-slice a double-float (1 2) ((1 lda) (1 *)))
          lda tau
          (f2cl-lib:array-slice c double-float (i1 i2) ((1 ldc) (1 *)))
          ldc work lwork iinfo)
        (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
                         var-8 var-9 var-10 var-11))
        (setf iinfo var-12))))))
(setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)
      (coerce (the fixnum lwkopt) 'double-float))
end_label
(return
  (values nil nil nil nil nil nil nil nil nil nil nil nil info))))

```



## 7.87 dorml2 LAPACK

```
<dorml2.input>=  
  )set break resume  
  )sys rm -f dorml2.output  
  )spool dorml2.output  
  )set message test on  
  )set message auto off  
  )clear all  
  
  )spool  
  )lisp (bye)
```

<dorml2.help>≡

```
=====
dorml2 examples
=====
```

```
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Man Page Details
=====
```

#### NAME

DORML2 - the general real  $m$  by  $n$  matrix  $C$  with  $Q * C$  if  $SIDE = 'L'$  and  $TRANS = 'N'$ , or  $Q' * C$  if  $SIDE = 'L'$  and  $TRANS = 'T'$ , or  $C * Q$  if  $SIDE = 'R'$  and  $TRANS = 'N'$ , or  $C * Q'$  if  $SIDE = 'R'$  and  $TRANS = 'T'$ ,

#### SYNOPSIS

```
SUBROUTINE DORML2( SIDE, TRANS, M, N, K, A, LDA, TAU, C, LDC, WORK,
                  INFO )
```

```
      CHARACTER    SIDE, TRANS
```

```
      INTEGER      INFO, K, LDA, LDC, M, N
```

```
      DOUBLE       PRECISION  A( LDA, * ), C( LDC, * ), TAU( * ), WORK(
      * )
```

#### PURPOSE

DORML2 overwrites the general real  $m$  by  $n$  matrix  $C$  with

where  $Q$  is a real orthogonal matrix defined as the product of  $k$  elementary reflectors

$$Q = H(k) \dots H(2) H(1)$$

as returned by DGELQF.  $Q$  is of order  $m$  if  $SIDE = 'L'$  and of order  $n$  if  $SIDE = 'R'$ .

#### ARGUMENTS

```
SIDE      (input) CHARACTER*1
           = 'L': apply Q or Q' from the Left
           = 'R': apply Q or Q' from the Right
```

```
TRANS     (input) CHARACTER*1
           = 'N': apply Q  (No transpose)
           = 'T': apply Q' (Transpose)
```

M (input) INTEGER  
The number of rows of the matrix C.  $M \geq 0$ .

N (input) INTEGER  
The number of columns of the matrix C.  $N \geq 0$ .

K (input) INTEGER  
The number of elementary reflectors whose product defines the matrix Q. If SIDE = 'L',  $M \geq K \geq 0$ ; if SIDE = 'R',  $N \geq K \geq 0$ .

A (input) DOUBLE PRECISION array, dimension  
(LDA,M) if SIDE = 'L', (LDA,N) if SIDE = 'R' The i-th row must contain the vector which defines the elementary reflector H(i), for  $i = 1, 2, \dots, k$ , as returned by DGELQF in the first k rows of its array argument A. A is modified by the routine but restored on exit.

LDA (input) INTEGER  
The leading dimension of the array A.  $LDA \geq \max(1, K)$ .

TAU (input) DOUBLE PRECISION array, dimension (K)  
TAU(i) must contain the scalar factor of the elementary reflector H(i), as returned by DGELQF.

C (input/output) DOUBLE PRECISION array, dimension (LDC,N)  
On entry, the m by n matrix C. On exit, C is overwritten by  $Q^*C$  or  $Q^*C$  or  $C^*Q^*$  or  $C^*Q^*$ .

LDC (input) INTEGER  
The leading dimension of the array C.  $LDC \geq \max(1, M)$ .

WORK (workspace) DOUBLE PRECISION array, dimension  
(N) if SIDE = 'L', (M) if SIDE = 'R'

INFO (output) INTEGER  
= 0: successful exit  
< 0: if INFO = -i, the i-th argument had an illegal value

```

(LAPACK dorml2)=
  (let* ((one 1.0))
    (declare (type (double-float 1.0 1.0) one))
    (defun dorml2 (side trans m n k a lda tau c ldc work info)
      (declare (type (simple-array double-float (*)) work c tau a)
        (type fixnum info ldc lda k n m)
        (type character trans side))
      (f2cl-lib:with-multi-array-data
        ((side character side-%data% side-%offset%)
         (trans character trans-%data% trans-%offset%)
         (a double-float a-%data% a-%offset%)
         (tau double-float tau-%data% tau-%offset%)
         (c double-float c-%data% c-%offset%)
         (work double-float work-%data% work-%offset%))
        (prog ((aii 0.0) (i 0) (i1 0) (i2 0) (i3 0) (ic 0) (jc 0) (mi 0) (ni 0)
              (nq 0) (left nil) (notran nil))
          (declare (type (double-float) aii)
            (type fixnum i i1 i2 i3 ic jc mi ni nq)
            (type (member t nil) left notran))
          (setf info 0)
          (setf left (char-equal side #\L))
          (setf notran (char-equal trans #\N))
          (cond
            (left
              (setf nq m))
            (t
              (setf nq n)))
          (cond
            ((and (not left) (not (char-equal side #\R)))
              (setf info -1))
            ((and (not notran) (not (char-equal trans #\T)))
              (setf info -2))
            ((< m 0)
              (setf info -3))
            ((< n 0)
              (setf info -4))
            ((or (< k 0) (> k nq))
              (setf info -5))
            ((< lda (max (the fixnum 1) (the fixnum k)))
              (setf info -7))
            ((< ldc (max (the fixnum 1) (the fixnum m)))
              (setf info -10)))
          (cond
            ((/= info 0)
              (error
                " ** On entry to ~a parameter number ~a had an illegal value~%"

```

```

        "DORML2" (f2cl-lib:int-sub info))
      (go end_label)))
    (if (or (= m 0) (= n 0) (= k 0)) (go end_label))
    (cond
      ((or (and left notran) (and (not left) (not notran)))
        (setf i1 1)
        (setf i2 k)
        (setf i3 1))
      (t
        (setf i1 k)
        (setf i2 1)
        (setf i3 -1)))
    (cond
      (left
        (setf ni n)
        (setf jc 1))
      (t
        (setf mi m)
        (setf ic 1)))
    (f2cl-lib:fdo (i i1 (f2cl-lib:int-add i i3))
      (> i i2) nil)
    (tagbody
      (cond
        (left
          (setf mi (f2cl-lib:int-add (f2cl-lib:int-sub m i) 1))
          (setf ic i))
        (t
          (setf ni (f2cl-lib:int-add (f2cl-lib:int-sub n i) 1))
          (setf jc i)))
      (setf aii
        (f2cl-lib:fref a-%data% (i i) ((1 lda) (1 *)) a-%offset%))
      (setf (f2cl-lib:fref a-%data% (i i) ((1 lda) (1 *)) a-%offset%)
        one)
      (dlarf side mi ni
        (f2cl-lib:array-slice a double-float (i i) ((1 lda) (1 *))) lda
        (f2cl-lib:fref tau-%data% (i) ((1 *)) tau-%offset%)
        (f2cl-lib:array-slice c double-float (ic jc) ((1 ldc) (1 *))) ldc
        work)
      (setf (f2cl-lib:fref a-%data% (i i) ((1 lda) (1 *)) a-%offset%)
        aii)))
    end_label
    (return (values nil nil nil nil nil nil nil nil nil nil info))))))

```

**7.88 dormlq LAPACK**

```
<dormlq.input>=  
  )set break resume  
  )sys rm -f dormlq.output  
  )spool dormlq.output  
  )set message test on  
  )set message auto off  
  )clear all  
  
  )spool  
  )lisp (bye)
```

`<dormlq.help>`≡

```
=====
dormlq examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

DORMLQ - the general real M-by-N matrix C with SIDE = 'L' SIDE = 'R'  
TRANS = 'N'

#### SYNOPSIS

```
SUBROUTINE DORMLQ( SIDE, TRANS, M, N, K, A, LDA, TAU, C, LDC, WORK,
                  LWORK, INFO )
```

CHARACTER SIDE, TRANS

INTEGER INFO, K, LDA, LDC, LWORK, M, N

DOUBLE PRECISION A( LDA, \* ), C( LDC, \* ), TAU( \* ), WORK( \* )

#### PURPOSE

DORMLQ overwrites the general real M-by-N matrix C with TRANS = 'T':  
Q\*\*T \* C C \* Q\*\*T

where Q is a real orthogonal matrix defined as the product of k elementary reflectors

$$Q = H(k) \dots H(2) H(1)$$

as returned by DGELQF. Q is of order M if SIDE = 'L' and of order N if SIDE = 'R'.

#### ARGUMENTS

SIDE (input) CHARACTER\*1  
= 'L': apply Q or Q\*\*T from the Left;  
= 'R': apply Q or Q\*\*T from the Right.

TRANS (input) CHARACTER\*1  
= 'N': No transpose, apply Q;  
= 'T': Transpose, apply Q\*\*T.

- M** (input) INTEGER  
The number of rows of the matrix C.  $M \geq 0$ .
- N** (input) INTEGER  
The number of columns of the matrix C.  $N \geq 0$ .
- K** (input) INTEGER  
The number of elementary reflectors whose product defines the matrix Q. If  $SIDE = 'L'$ ,  $M \geq K \geq 0$ ; if  $SIDE = 'R'$ ,  $N \geq K \geq 0$ .
- A** (input) DOUBLE PRECISION array, dimension  $(LDA, M)$  if  $SIDE = 'L'$ ,  $(LDA, N)$  if  $SIDE = 'R'$  The  $i$ -th row must contain the vector which defines the elementary reflector  $H(i)$ , for  $i = 1, 2, \dots, k$ , as returned by DGELQF in the first  $k$  rows of its array argument A. A is modified by the routine but restored on exit.
- LDA** (input) INTEGER  
The leading dimension of the array A.  $LDA \geq \max(1, K)$ .
- TAU** (input) DOUBLE PRECISION array, dimension  $(K)$   
 $TAU(i)$  must contain the scalar factor of the elementary reflector  $H(i)$ , as returned by DGELQF.
- C** (input/output) DOUBLE PRECISION array, dimension  $(LDC, N)$   
On entry, the  $M$ -by- $N$  matrix C. On exit, C is overwritten by  $Q^*C$  or  $Q^{**T}C$  or  $C^*Q^{**T}$  or  $C^*Q$ .
- LDC** (input) INTEGER  
The leading dimension of the array C.  $LDC \geq \max(1, M)$ .
- WORK** (workspace/output) DOUBLE PRECISION array, dimension  $(MAX(1, LWORK))$   
On exit, if  $INFO = 0$ ,  $WORK(1)$  returns the optimal LWORK.
- LWORK** (input) INTEGER  
The dimension of the array WORK. If  $SIDE = 'L'$ ,  $LWORK \geq \max(1, N)$ ; if  $SIDE = 'R'$ ,  $LWORK \geq \max(1, M)$ . For optimum performance  $LWORK \geq N \cdot NB$  if  $SIDE = 'L'$ , and  $LWORK \geq M \cdot NB$  if  $SIDE = 'R'$ , where  $NB$  is the optimal blocksize.

If  $LWORK = -1$ , then a workspace query is assumed; the routine only calculates the optimal size of the WORK array, returns this value as the first entry of the WORK array, and no error message related to LWORK is issued by XERBLA.



INFO      (output) INTEGER  
= 0:    successful exit  
< 0:    if INFO = -i, the i-th argument had an illegal value

```

(LAPACK dormlq)≡
  (let* ((nbmax 64) (ldt (+ nbmax 1)))
    (declare (type (fixnum 64 64) nbmax)
              (type fixnum ldt))
    (defun dormlq (side trans m n k a lda tau c ldc work lwork info)
      (declare (type (simple-array double-float (*)) work c tau a)
                (type fixnum info lwork ldc lda k n m)
                (type character trans side))
      (f2cl-lib:with-multi-array-data
        ((side character side-%data% side-%offset%)
         (trans character trans-%data% trans-%offset%)
         (a double-float a-%data% a-%offset%)
         (tau double-float tau-%data% tau-%offset%)
         (c double-float c-%data% c-%offset%)
         (work double-float work-%data% work-%offset%))
        (prog ((i 0) (i1 0) (i2 0) (i3 0) (ib 0) (ic 0) (iinfo 0) (iws 0) (jc 0)
              (ldwork 0) (lwkopt 0) (mi 0) (nb 0) (nbmin 0) (ni 0) (nq 0) (nw 0)
              (transt
                (make-array '(1) :element-type 'character :initial-element #\ )
                (left nil) (lquery nil) (notran nil)
                t$
                (make-array (the fixnum (reduce #'* (list ldt nbmax)))
                            :element-type 'double-float)))
              (declare (type (simple-array double-float (*)) t$)
                        (type fixnum i i1 i2 i3 ib ic iinfo iws jc ldwork
                                lwkopt mi nb nbmin ni nq nw)
                        (type (simple-array character (1)) transt)
                        (type (member t nil) left lquery notran))
              (setf info 0)
              (setf left (char-equal side #\L))
              (setf notran (char-equal trans #\N))
              (setf lquery (coerce (= lwork -1) '(member t nil)))
              (cond
                (left
                 (setf nq m)
                 (setf nw n))
                (t
                 (setf nq n)
                 (setf nw m)))
              (cond
                ((and (not left) (not (char-equal side #\R)))
                 (setf info -1))
                ((and (not notran) (not (char-equal trans #\T)))
                 (setf info -2))
                ((< m 0)
                 (setf info -3))

```

```

((< n 0)
 (setf info -4))
((or (< k 0) (> k nq))
 (setf info -5))
((< lda (max (the fixnum 1) (the fixnum k)))
 (setf info -7))
((< ldc (max (the fixnum 1) (the fixnum m)))
 (setf info -10))
((and
 (< lwork
  (max (the fixnum 1) (the fixnum nw)))
 (not lquery))
 (setf info -12)))
(cond
 ((= info 0)
  (setf nb
   (min (the fixnum nbmax)
        (the fixnum
         (ilaenv 1 "DORMLQ" (f2cl-lib:f2cl-// side trans) m
                  n k -1)))))
  (setf lwkopt
   (f2cl-lib:int-mul
    (max (the fixnum 1) (the fixnum nw))
    nb))
  (setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)
   (coerce (the fixnum lwkopt) 'double-float))))
(cond
 ((/= info 0)
  (error
   " ** On entry to ~a parameter number ~a had an illegal value~%"
   "DORMLQ" (f2cl-lib:int-sub info))
  (go end_label))
 (lquery
  (go end_label)))
(cond
 ((or (= m 0) (= n 0) (= k 0))
  (setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)
   (coerce (the fixnum 1) 'double-float))
  (go end_label)))
(setf nbmin 2)
(setf ldwork nw)
(cond
 ((and (> nb 1) (< nb k))
  (setf iws (f2cl-lib:int-mul nw nb))
  (cond
   ((< lwork iws)

```

```

      (setf nb (the fixnum (truncate lwork ldwork)))
      (setf nbmin
        (max (the fixnum 2)
              (the fixnum
                (ilaenv 2 "DORMLQ"
                  (f2cl-lib:f2cl-// side trans) m n k -1))))))
    (t
      (setf iws nw)))
  (cond
    ((or (< nb nbmin) (>= nb k))
      (multiple-value-bind
        (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9
         var-10 var-11)
        (dorml2 side trans m n k a lda tau c ldc work iinfo)
        (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
          var-8 var-9 var-10))
        (setf iinfo var-11)))
      (t
        (cond
          ((or (and left notran) (and (not left) (not notran)))
            (setf i1 1)
            (setf i2 k)
            (setf i3 nb))
          (t
            (setf i1
              (+ (* (the fixnum (truncate (- k 1) nb)) nb)
                1))
              (setf i2 1)
              (setf i3 (f2cl-lib:int-sub nb))))))
        (cond
          (left
            (setf ni n)
            (setf jc 1))
          (t
            (setf mi m)
            (setf ic 1)))
        (cond
          (notran
            (f2cl-lib:f2cl-set-string transt "T" (string 1)))
          (t
            (f2cl-lib:f2cl-set-string transt "N" (string 1))))
        (f2cl-lib:fdo (i i1 (f2cl-lib:int-add i i3))
          ((> i i2) nil)
          (tagbody
            (setf ib
              (min (the fixnum nb)

```

```

                                (the fixnum
                                (f2cl-lib:int-add (f2cl-lib:int-sub k i) 1))))
(dlarft "Forward" "Rowwise"
  (f2cl-lib:int-add (f2cl-lib:int-sub nq i) 1) ib
  (f2cl-lib:array-slice a double-float (i i) ((1 lda) (1 *))) lda
  (f2cl-lib:array-slice tau double-float (i) ((1 *))) t$ ldt)
(cond
  (left
    (setf mi (f2cl-lib:int-add (f2cl-lib:int-sub m i) 1))
    (setf ic i))
  (t
    (setf ni (f2cl-lib:int-add (f2cl-lib:int-sub n i) 1))
    (setf jc i)))
(dlarfb side transt "Forward" "Rowwise" mi ni ib
  (f2cl-lib:array-slice a double-float (i i) ((1 lda) (1 *))) lda
  t$ ldt
  (f2cl-lib:array-slice c double-float (ic jc) ((1 ldc) (1 *)))
  ldc work ldwork))))
(setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)
  (coerce (the fixnum lwkopt) 'double-float))
end_label
(return
  (values nil nil nil nil nil nil nil nil nil nil nil nil info))))))

```

## 7.89 dormqr LAPACK

```

⟨dormqr.input⟩≡
)set break resume
)sys rm -f dormqr.output
)spool dormqr.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)

```

`<dormqr.help>`≡

```
=====
dormqr examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

DORMQR - the general real M-by-N matrix C with SIDE = 'L' SIDE = 'R'  
TRANS = 'N'

#### SYNOPSIS

```
SUBROUTINE DORMQR( SIDE, TRANS, M, N, K, A, LDA, TAU, C, LDC, WORK,
                  LWORK, INFO )
```

CHARACTER SIDE, TRANS

INTEGER INFO, K, LDA, LDC, LWORK, M, N

DOUBLE PRECISION A( LDA, \* ), C( LDC, \* ), TAU( \* ), WORK( \* )

#### PURPOSE

DORMQR overwrites the general real M-by-N matrix C with TRANS = 'T':  
Q\*\*T \* C        C \* Q\*\*T

where Q is a real orthogonal matrix defined as the product of k elementary reflectors

$$Q = H(1) H(2) \dots H(k)$$

as returned by DGEQRF. Q is of order M if SIDE = 'L' and of order N if SIDE = 'R'.

#### ARGUMENTS

SIDE (input) CHARACTER\*1  
= 'L': apply Q or Q\*\*T from the Left;  
= 'R': apply Q or Q\*\*T from the Right.

TRANS (input) CHARACTER\*1  
= 'N': No transpose, apply Q;  
= 'T': Transpose, apply Q\*\*T.

- M** (input) INTEGER  
The number of rows of the matrix C.  $M \geq 0$ .
- N** (input) INTEGER  
The number of columns of the matrix C.  $N \geq 0$ .
- K** (input) INTEGER  
The number of elementary reflectors whose product defines the matrix Q. If  $SIDE = 'L'$ ,  $M \geq K \geq 0$ ; if  $SIDE = 'R'$ ,  $N \geq K \geq 0$ .
- A** (input) DOUBLE PRECISION array, dimension (LDA,K)  
The  $i$ -th column must contain the vector which defines the elementary reflector  $H(i)$ , for  $i = 1, 2, \dots, k$ , as returned by DGEQRF in the first  $k$  columns of its array argument A. A is modified by the routine but restored on exit.
- LDA** (input) INTEGER  
The leading dimension of the array A. If  $SIDE = 'L'$ ,  $LDA \geq \max(1, M)$ ; if  $SIDE = 'R'$ ,  $LDA \geq \max(1, N)$ .
- TAU** (input) DOUBLE PRECISION array, dimension (K)  
 $TAU(i)$  must contain the scalar factor of the elementary reflector  $H(i)$ , as returned by DGEQRF.
- C** (input/output) DOUBLE PRECISION array, dimension (LDC,N)  
On entry, the  $M$ -by- $N$  matrix C. On exit, C is overwritten by  $Q^*C$  or  $Q^{**T}C$  or  $CQ^{**T}$  or  $CQ$ .
- LDC** (input) INTEGER  
The leading dimension of the array C.  $LDC \geq \max(1, M)$ .
- WORK** (workspace/output) DOUBLE PRECISION array, dimension (MAX(1,LWORK))  
On exit, if  $INFO = 0$ ,  $WORK(1)$  returns the optimal LWORK.
- LWORK** (input) INTEGER  
The dimension of the array WORK. If  $SIDE = 'L'$ ,  $LWORK \geq \max(1, N)$ ; if  $SIDE = 'R'$ ,  $LWORK \geq \max(1, M)$ . For optimum performance  $LWORK \geq N \cdot NB$  if  $SIDE = 'L'$ , and  $LWORK \geq M \cdot NB$  if  $SIDE = 'R'$ , where  $NB$  is the optimal blocksize.
- If  $LWORK = -1$ , then a workspace query is assumed; the routine only calculates the optimal size of the WORK array, returns this value as the first entry of the WORK array, and no error message related to LWORK is issued by XERBLA.

INFO     (output) INTEGER  
      = 0:  successful exit  
      < 0:  if INFO = -i, the i-th argument had an illegal value



```

(LAPACK dormqr)≡
  (let* ((nbmax 64) (ldt (+ nbmax 1)))
    (declare (type (fixnum 64 64) nbmax)
              (type fixnum ldt))
    (defun dormqr (side trans m n k a lda tau c ldc work lwork info)
      (declare (type (simple-array double-float (*)) work c tau a)
                (type fixnum info lwork ldc lda k n m)
                (type character trans side))
      (f2cl-lib:with-multi-array-data
        ((side character side-%data% side-%offset%)
         (trans character trans-%data% trans-%offset%)
         (a double-float a-%data% a-%offset%)
         (tau double-float tau-%data% tau-%offset%)
         (c double-float c-%data% c-%offset%)
         (work double-float work-%data% work-%offset%))
        (prog ((i 0) (i1 0) (i2 0) (i3 0) (ib 0) (ic 0) (iinfo 0) (iws 0) (jc 0)
              (ldwork 0) (lwkopt 0) (mi 0) (nb 0) (nbmin 0) (ni 0) (nq 0) (nw 0)
              (left nil) (lquery nil) (notran nil)
              (t$
                (make-array (the fixnum (reduce #'* (list ldt nbmax)))
                           :element-type 'double-float)))
              (declare (type (simple-array double-float (*)) t$)
                        (type fixnum i i1 i2 i3 ib ic iinfo iws jc ldwork
                                lwkopt mi nb nbmin ni nq nw)
                        (type (member t nil) left lquery notran))
              (setf info 0)
              (setf left (char-equal side #\L))
              (setf notran (char-equal trans #\N))
              (setf lquery (coerce (= lwork -1) '(member t nil)))
              (cond
                (left
                 (setf nq m)
                 (setf nw n))
                (t
                 (setf nq n)
                 (setf nw m)))
              (cond
                ((and (not left) (not (char-equal side #\R)))
                 (setf info -1))
                ((and (not notran) (not (char-equal trans #\T)))
                 (setf info -2))
                ((< m 0)
                 (setf info -3))
                ((< n 0)
                 (setf info -4))
                ((or (< k 0) (> k nq))

```

```

      (setf info -5))
    ((< lda (max (the fixnum 1) (the fixnum nq)))
     (setf info -7))
    ((< ldc (max (the fixnum 1) (the fixnum m)))
     (setf info -10))
    ((and
      (< lwork
        (max (the fixnum 1) (the fixnum nw)))
      (not lquery))
     (setf info -12)))
  (cond
    ((= info 0)
     (setf nb
      (min (the fixnum nbmax)
        (the fixnum
          (ilaenv 1 "DORMQR" (f2cl-lib:f2cl-// side trans) m
            n k -1))))
     (setf lwkopt
      (f2cl-lib:int-mul
        (max (the fixnum 1) (the fixnum nw))
        nb))
     (setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)
      (coerce (the fixnum lwkopt) 'double-float)))
    (cond
      ((/= info 0)
       (error
        " ** On entry to ~a parameter number ~a had an illegal value~%"
        "DORMQR" (f2cl-lib:int-sub info))
       (go end_label))
      (lquery
       (go end_label)))
    (cond
      ((or (= m 0) (= n 0) (= k 0))
       (setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)
        (coerce (the fixnum 1) 'double-float))
       (go end_label)))
    (setf nbmin 2)
    (setf ldwork nw)
    (cond
      ((and (> nb 1) (< nb k))
       (setf iws (f2cl-lib:int-mul nw nb))
       (cond
         ((< lwork iws)
          (setf nb (the fixnum (truncate lwork ldwork)))
          (setf nbmin
            (max (the fixnum 2)

```

```

                                (the fixnum
                                (ilaenv 2 "DORMQR"
                                (f2cl-lib:f2cl-// side trans) m n k -1))))))
(t
  (setf iws nw)))
(cond
  ((or (< nb nbmin) (>= nb k))
    (multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9
       var-10 var-11)
      (dorm2r side trans m n k a lda tau c ldc work iinfo)
      (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
                       var-8 var-9 var-10))
      (setf iinfo var-11)))
  (t
    (cond
      ((or (and left (not notran)) (and (not left) notran))
        (setf i1 1)
        (setf i2 k)
        (setf i3 nb))
      (t
        (setf i1
          (+ (* (the fixnum (truncate (- k 1) nb)) nb)
            1))
          (setf i2 1)
          (setf i3 (f2cl-lib:int-sub nb))))
      (cond
        (left
          (setf ni n)
          (setf jc 1))
        (t
          (setf mi m)
          (setf ic 1)))
      (f2cl-lib:fdo (i i1 (f2cl-lib:int-add i i3))
        ((> i i2) nil)
      (tagbody
        (setf ib
          (min (the fixnum nb)
              (the fixnum
                (f2cl-lib:int-add (f2cl-lib:int-sub k i) 1))))
        (dlarft "Forward" "Columnwise"
          (f2cl-lib:int-add (f2cl-lib:int-sub nq i) 1) ib
          (f2cl-lib:array-slice a double-float (i i) ((1 lda) (1 *))) lda
          (f2cl-lib:array-slice tau double-float (i) ((1 *))) t$ ldt)
        (cond
          (left

```

```

        (setf mi (f2cl-lib:int-add (f2cl-lib:int-sub m i) 1))
        (setf ic i))
      (t
        (setf ni (f2cl-lib:int-add (f2cl-lib:int-sub n i) 1))
        (setf jc i)))
      (dlarfb side trans "Forward" "Columnwise" mi ni ib
        (f2cl-lib:array-slice a double-float (i i) ((1 lda) (1 *))) lda
        t$ ldt
        (f2cl-lib:array-slice c double-float (ic jc) ((1 ldc) (1 *)))
        ldc work ldwork))))
      (setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)
        (coerce (the fixnum lwkopt) 'double-float))
    end_label
    (return
      (values nil nil nil nil nil nil nil nil nil nil nil info))))))

```

## 7.90 dtrevc LAPACK

```

<dtrevc.input>≡
)set break resume
)sys rm -f dtrevc.output
)spool dtrevc.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)

```

`<dtrevc.help>`≡

```
=====
dtrevc examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

DTREVC - some or all of the right and/or left eigenvectors of a real upper quasi-triangular matrix T

#### SYNOPSIS

```
SUBROUTINE DTREVC( SIDE, HOWMNY, SELECT, N, T, LDT, VL, LDVL, VR, LDVR,
                  MM, M, WORK, INFO )
```

CHARACTER        HOWMNY, SIDE

INTEGER         INFO, LDT, LDVL, LDVR, M, MM, N

LOGICAL         SELECT( \* )

DOUBLE          PRECISION T( LDT, \* ), VL( LDVL, \* ), VR( LDVR, \* ),  
WORK( \* )

#### PURPOSE

DTREVC computes some or all of the right and/or left eigenvectors of a real upper quasi-triangular matrix T. Matrices of this type are produced by the Schur factorization of a real general matrix:  $A = Q^*TQ$ , as computed by DHSEQR.

The right eigenvector x and the left eigenvector y of T corresponding to an eigenvalue w are defined by:

$$T^*x = wx, \quad (y^*H)^*T = w^*(y^*H)$$

where  $y^*H$  denotes the conjugate transpose of y.

The eigenvalues are not input to this routine, but are read directly from the diagonal blocks of T.

This routine returns the matrices X and/or Y of right and left eigenvectors of T, or the products  $Q^*X$  and/or  $Q^*Y$ , where Q is an input matrix. If Q is the orthogonal factor that reduces a matrix A to Schur form T, then  $Q^*X$  and  $Q^*Y$  are the matrices of right and left eigenvectors of A.

## ARGUMENTS

- SIDE** (input) CHARACTER\*1  
 = 'R': compute right eigenvectors only;  
 = 'L': compute left eigenvectors only;  
 = 'B': compute both right and left eigenvectors.
- HOWMNY** (input) CHARACTER\*1  
 = 'A': compute all right and/or left eigenvectors;  
 = 'B': compute all right and/or left eigenvectors, backtransformed by the matrices in VR and/or VL; = 'S': compute selected right and/or left eigenvectors, as indicated by the logical array SELECT.
- SELECT** (input/output) LOGICAL array, dimension (N)  
 If HOWMNY = 'S', SELECT specifies the eigenvectors to be computed. If  $w(j)$  is a real eigenvalue, the corresponding real eigenvector is computed if SELECT(j) is .TRUE.. If  $w(j)$  and  $w(j+1)$  are the real and imaginary parts of a complex eigenvalue, the corresponding complex eigenvector is computed if either SELECT(j) or SELECT(j+1) is .TRUE., and on exit SELECT(j) is set to .TRUE. and SELECT(j+1) is set to Not referenced if HOWMNY = 'A' or 'B'.
- N** (input) INTEGER  
 The order of the matrix T.  $N \geq 0$ .
- T** (input) DOUBLE PRECISION array, dimension (LDT,N)  
 The upper quasi-triangular matrix T in Schur canonical form.
- LDT** (input) INTEGER  
 The leading dimension of the array T.  $LDT \geq \max(1, N)$ .
- VL** (input/output) DOUBLE PRECISION array, dimension (LDVL,MM)  
 On entry, if SIDE = 'L' or 'B' and HOWMNY = 'B', VL must contain an N-by-N matrix Q (usually the orthogonal matrix Q of Schur vectors returned by DHSEQR). On exit, if SIDE = 'L' or 'B', VL contains: if HOWMNY = 'A', the matrix Y of left eigenvectors of T; if HOWMNY = 'B', the matrix  $Q*Y$ ; if HOWMNY = 'S', the left eigenvectors of T specified by SELECT, stored consecutively in the columns of VL, in the same order as their eigenvalues. A complex eigenvector corresponding to a complex eigenvalue is stored in two consecutive columns, the first holding the real part, and the second the imaginary part. Not referenced if SIDE = 'R'.

- LDVL** (input) INTEGER  
The leading dimension of the array VL. LDVL  $\geq 1$ , and if SIDE = 'L' or 'B', LDVL  $\geq N$ .
- VR** (input/output) DOUBLE PRECISION array, dimension (LDVR,MM)  
On entry, if SIDE = 'R' or 'B' and HOWMNY = 'B', VR must contain an N-by-N matrix Q (usually the orthogonal matrix Q of Schur vectors returned by DHSEQR). On exit, if SIDE = 'R' or 'B', VR contains: if HOWMNY = 'A', the matrix X of right eigenvectors of T; if HOWMNY = 'B', the matrix Q\*X; if HOWMNY = 'S', the right eigenvectors of T specified by SELECT, stored consecutively in the columns of VR, in the same order as their eigenvalues. A complex eigenvector corresponding to a complex eigenvalue is stored in two consecutive columns, the first holding the real part and the second the imaginary part. Not referenced if SIDE = 'L'.
- LDVR** (input) INTEGER  
The leading dimension of the array VR. LDVR  $\geq 1$ , and if SIDE = 'R' or 'B', LDVR  $\geq N$ .
- MM** (input) INTEGER  
The number of columns in the arrays VL and/or VR. MM  $\geq M$ .
- M** (output) INTEGER  
The number of columns in the arrays VL and/or VR actually used to store the eigenvectors. If HOWMNY = 'A' or 'B', M is set to N. Each selected real eigenvector occupies one column and each selected complex eigenvector occupies two columns.
- WORK** (workspace) DOUBLE PRECISION array, dimension (3\*N)
- INFO** (output) INTEGER  
= 0: successful exit  
< 0: if INFO = -i, the i-th argument had an illegal value

#### FURTHER DETAILS

The algorithm used in this program is basically backward (forward) substitution, with scaling to make the code robust against possible overflow.

Each eigenvector is normalized so that the element of largest magnitude has magnitude 1; here the magnitude of a complex number (x,y) is taken to be  $|x| + |y|$ .

```

(LAPACK dtrevc)=
  (let* ((zero 0.0) (one 1.0))
    (declare (type (double-float 0.0 0.0) zero)
              (type (double-float 1.0 1.0) one))
    (defun dtrevc (side howmny select n t$ ldt vl ldvl vr ldvr mm m work info)
      (declare (type (simple-array double-float (*)) work vr vl t$)
                (type fixnum info m mm ldvr ldvl ldt n)
                (type (simple-array (member t nil) (*)) select)
                (type character howmny side))
      (f2cl-lib:with-multi-array-data
        ((side character side-%data% side-%offset%)
         (howmny character howmny-%data% howmny-%offset%)
         (select (member t nil) select-%data% select-%offset%)
         (t$ double-float t$-%data% t$-%offset%)
         (vl double-float vl-%data% vl-%offset%)
         (vr double-float vr-%data% vr-%offset%)
         (work double-float work-%data% work-%offset%))
        (prog ((x (make-array 4 :element-type 'double-float)) (beta 0.0)
              (bignum 0.0) (emax 0.0) (ovfl 0.0) (rec 0.0) (remax 0.0)
              (scale 0.0) (smin 0.0) (smlnum 0.0) (ulp 0.0) (unfl 0.0)
              (vcrit 0.0) (vmax 0.0) (wi 0.0) (wr 0.0) (xnorm 0.0) (i 0)
              (ierr 0) (ii 0) (ip 0) (is 0) (j 0) (j1 0) (j2 0) (jnxt 0) (k 0)
              (ki 0) (n2 0) (allv nil) (bothv nil) (leftv nil) (over nil)
              (pair nil) (rightv nil) (somev nil) (sqrt$ 0.0f0))
              (declare (type (single-float) sqrt$)
                        (type (simple-array double-float (4)) x)
                        (type (double-float) beta bignum emax ovfl rec remax scale
                               smin smlnum ulp unfl vcrit vmax wi wr
                               xnorm)
                        (type fixnum i ierr ii ip is j j1 j2 jnxt k ki
                               n2)
                        (type (member t nil) allv bothv leftv over pair rightv
                               somev))
              (setf bothv (char-equal side #\B))
              (setf rightv (or (char-equal side #\R) bothv))
              (setf leftv (or (char-equal side #\L) bothv))
              (setf allv (char-equal howmny #\A))
              (setf over (char-equal howmny #\B))
              (setf somev (char-equal howmny #\S))
              (setf info 0)
              (cond
                ((and (not rightv) (not leftv))
                 (setf info -1))
                ((and (not allv) (not over) (not somev))
                 (setf info -2))
                ((< n 0)

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(setf info -4))
((< ldt (max (the fixnum 1) (the fixnum n)))
 (setf info -6))
((or (< ldvl 1) (and leftv (< ldvl n)))
 (setf info -8))
((or (< ldvr 1) (and rightv (< ldvr n)))
 (setf info -10))
(t
 (cond
  (somev
   (setf m 0)
   (setf pair nil)
   (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
    ((> j n) nil)

    (tagbody
     (cond
      (pair
       (setf pair nil)
       (setf (f2cl-lib:fref select-%data%
                           (j)
                           ((1 *))
                           select-%offset%)
              nil))

      (t
       (cond
        ((< j n)
         (cond
          ((=
            (f2cl-lib:fref t$
                          ((f2cl-lib:int-add j 1) j)
                          ((1 ldt) (1 *)))
             zero)
           (if
            (f2cl-lib:fref select-%data%
                          (j)
                          ((1 *))
                          select-%offset%)
            (setf m (f2cl-lib:int-add m 1))))
          (t
           (setf pair t)
           (cond
            ((or (f2cl-lib:fref select (j) ((1 *)))
                  (f2cl-lib:fref select
                                ((f2cl-lib:int-add j 1))
                                ((1 *))))
             (setf (f2cl-lib:fref select-%data%

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                                (j)
                                ((1 *))
                                select-%offset%)
                                t)
                                (setf m (f2cl-lib:int-add m 2))))))
(t
  (if
    (f2cl-lib:fref select-%data%
                     (n)
                     ((1 *))
                     select-%offset%)
    (setf m (f2cl-lib:int-add m 1))))))
(t
  (setf m n))
(cond
  ((< mm m)
   (setf info -11))))
(cond
  ((/= info 0)
   (error
    " ** On entry to ~a parameter number ~a had an illegal value~%"
    "DTREVC" (f2cl-lib:int-sub info))
   (go end_label)))
(if (= n 0) (go end_label))
(setf unfl (dlamch "Safe minimum"))
(setf ovfl (/ one unfl))
(multiple-value-bind (var-0 var-1)
  (dlabad unfl ovfl)
  (declare (ignore))
  (setf unfl var-0)
  (setf ovfl var-1))
(setf ulp (dlamch "Precision"))
(setf smlnum (* unfl (/ n ulp)))
(setf bignum (/ (- one ulp) smlnum))
(setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%) zero)
(f2cl-lib:fdo (j 2 (f2cl-lib:int-add j 1))
  (> j n) nil)
(tagbody
  (setf (f2cl-lib:fref work-%data% (j) ((1 *)) work-%offset%) zero)
  (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
    (> i (f2cl-lib:int-add j (f2cl-lib:int-sub 1))) nil)
  (tagbody
    (setf (f2cl-lib:fref work-%data% (j) ((1 *)) work-%offset%)
      (+
        (f2cl-lib:fref work-%data% (j) ((1 *)) work-%offset%)
        (abs

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(f2cl-lib:fref t$-%data%
              (i j)
              ((1 ldt) (1 *))
              t$-%offset%))))))
(setf n2 (f2cl-lib:int-mul 2 n))
(cond
  (rightv
   (setf ip 0)
   (setf is m)
   (f2cl-lib:fdo (ki n (f2cl-lib:int-add ki (f2cl-lib:int-sub 1)))
                 ((> ki 1) nil)
   (tagbody
    (if (= ip 1) (go label130))
    (if (= ki 1) (go label40))
    (if
     (=
      (f2cl-lib:fref t$-%data%
                    (ki (f2cl-lib:int-sub ki 1))
                    ((1 ldt) (1 *))
                    t$-%offset%)
      zero)
     (go label40))
    (setf ip -1)
label40
    (cond
      (somev
       (cond
        ((= ip 0)
         (if
          (not
           (f2cl-lib:fref select-%data%
                         (ki)
                         ((1 *))
                         select-%offset%))
          (go label130)))
        (t
         (if
          (not
           (f2cl-lib:fref select-%data%
                         ((f2cl-lib:int-sub ki 1))
                         ((1 *))
                         select-%offset%))
          (go label130))))))
    (setf wr
      (f2cl-lib:fref t$-%data%
                    (ki ki)

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((1 ldt) (1 *))
t$-%offset%))

(setf wi zero)
(if (/= ip 0)
  (setf wi
    (*
      (f2cl-lib:fsqrt
        (abs
          (f2cl-lib:fref t$-%data%
            (ki (f2cl-lib:int-sub ki 1))
            ((1 ldt) (1 *))
            t$-%offset%)))
      (f2cl-lib:fsqrt
        (abs
          (f2cl-lib:fref t$-%data%
            ((f2cl-lib:int-sub ki 1) ki)
            ((1 ldt) (1 *))
            t$-%offset%))))))
(setf smin (max (* ulp (+ (abs wr) (abs wi))) smlnum))
(cond
  ((= ip 0)
    (setf (f2cl-lib:fref work-%data%
      ((f2cl-lib:int-add ki n))
      ((1 *))
      work-%offset%))
      one)
  (f2cl-lib:fdo (k 1 (f2cl-lib:int-add k 1))
    ((> k
      (f2cl-lib:int-add ki (f2cl-lib:int-sub 1)))
      nil)
    (tagbody
      (setf (f2cl-lib:fref work-%data%
        ((f2cl-lib:int-add k n))
        ((1 *))
        work-%offset%))
        (-
          (f2cl-lib:fref t$-%data%
            (k ki)
            ((1 ldt) (1 *))
            t$-%offset%))))))
(setf jnxt (f2cl-lib:int-sub ki 1))
(f2cl-lib:fdo (j (f2cl-lib:int-add ki (f2cl-lib:int-sub 1))
  (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
  ((> j 1) nil)
  (tagbody
    (if (> j jnxt) (go label60))

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(setf j1 j)
(setf j2 j)
(setf jnxt (f2cl-lib:int-sub j 1))
(cond
  (> j 1)
    (cond
      (/=
        (f2cl-lib:fref t$
          (j
            (f2cl-lib:int-add j
              (f2cl-lib:int-sub
                1)))
          ((1 ldt) (1 *)))
        zero)
      (setf j1 (f2cl-lib:int-sub j 1))
      (setf jnxt (f2cl-lib:int-sub j 2))))))
(cond
  (= j1 j2)
    (multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8 var-9 var-10 var-11 var-12 var-13 var-14
       var-15 var-16 var-17)
      (dlaln2 nil 1 1 smin one
        (f2cl-lib:array-slice t$
          double-float
          (j j)
          ((1 ldt) (1 *)))
        ldt one one
        (f2cl-lib:array-slice work
          double-float
          ((+ j n))
          ((1 *)))
        n wr zero x 2 scale xnorm ierr)
      (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
        var-6 var-7 var-8 var-9 var-10
        var-11 var-12 var-13 var-14))
      (setf scale var-15)
      (setf xnorm var-16)
      (setf ierr var-17))
    (cond
      (> xnorm one)
        (cond
          (> (f2cl-lib:fref work (j) ((1 *)))
            (f2cl-lib:f2cl/ bignum xnorm))
          (setf (f2cl-lib:fref x (1 1) ((1 2) (1 2)))
            (/ (f2cl-lib:fref x (1 1) ((1 2) (1 2)))

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                                xnorm))
      (setf scale (/ scale xnorm))))))
(if (/= scale one)
  (dscal ki scale
    (f2cl-lib:array-slice work
                          double-float
                          ((+ 1 n))
                          ((1 *)))
    1))
(setf (f2cl-lib:fref work-%data%
                    ((f2cl-lib:int-add j n))
                    ((1 *))
                    work-%offset%)
      (f2cl-lib:fref x (1 1) ((1 2) (1 2))))
(daxpy (f2cl-lib:int-sub j 1)
      (- (f2cl-lib:fref x (1 1) ((1 2) (1 2))))
      (f2cl-lib:array-slice t$
                            double-float
                            (1 j)
                            ((1 ldt) (1 *)))
      1
      (f2cl-lib:array-slice work
                            double-float
                            ((+ 1 n))
                            ((1 *)))
      1))
(t
  (multiple-value-bind
    (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
     var-8 var-9 var-10 var-11 var-12 var-13 var-14
     var-15 var-16 var-17)
    (dlaln2 nil 2 1 smin one
      (f2cl-lib:array-slice t$
                            double-float
                            ((+ j (f2cl-lib:int-sub 1))
                             (f2cl-lib:int-sub j 1))
                            ((1 ldt) (1 *)))
      ldt one one
      (f2cl-lib:array-slice work
                            double-float
                            ((+ j
                              (f2cl-lib:int-sub 1)
                              n))
                            ((1 *)))
      n wr zero x 2 scale xnorm ierr)
    (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5

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var-6 var-7 var-8 var-9 var-10
var-11 var-12 var-13 var-14))
(setf scale var-15)
(setf xnorm var-16)
(setf ierr var-17))
(cond
  (> xnorm one)
    (setf beta
      (max
        (f2cl-lib:fref work-%data%
          ((f2cl-lib:int-sub j 1))
          ((1 *))
          work-%offset%)
        (f2cl-lib:fref work-%data%
          (j)
          ((1 *))
          work-%offset%)))
    (cond
      (> beta (f2cl-lib:f2cl/ bignum xnorm))
        (setf (f2cl-lib:fref x (1 1) ((1 2) (1 2)))
          (/ (f2cl-lib:fref x (1 1) ((1 2) (1 2)))
            xnorm))
        (setf (f2cl-lib:fref x (2 1) ((1 2) (1 2)))
          (/ (f2cl-lib:fref x (2 1) ((1 2) (1 2)))
            xnorm))
        (setf scale (/ scale xnorm))))))
(if (/= scale one)
  (dscal ki scale
    (f2cl-lib:array-slice work
      double-float
      ((+ 1 n))
      ((1 *)))
    1))
(setf (f2cl-lib:fref work-%data%
  ((f2cl-lib:int-add
    (f2cl-lib:int-sub j 1)
    n))
  ((1 *))
  work-%offset%)
  (f2cl-lib:fref x (1 1) ((1 2) (1 2))))
(setf (f2cl-lib:fref work-%data%
  ((f2cl-lib:int-add j n))
  ((1 *))
  work-%offset%)
  (f2cl-lib:fref x (2 1) ((1 2) (1 2))))
(daxpy (f2cl-lib:int-sub j 2)

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```

      (- (f2cl-lib:fref x (1 1) ((1 2) (1 2))))
      (f2cl-lib:array-slice t$
        double-float
        (1 (f2cl-lib:int-sub j 1))
        ((1 ldt) (1 *)))
    1
    (f2cl-lib:array-slice work
      double-float
      ((+ 1 n))
      ((1 *)))
  1)
  (daxpy (f2cl-lib:int-sub j 2)
    (- (f2cl-lib:fref x (2 1) ((1 2) (1 2))))
    (f2cl-lib:array-slice t$
      double-float
      (1 j)
      ((1 ldt) (1 *)))
    1
    (f2cl-lib:array-slice work
      double-float
      ((+ 1 n))
      ((1 *)))
  1)))
label60))

(cond
  ((not over)
   (dcopy ki
    (f2cl-lib:array-slice work
      double-float
      ((+ 1 n))
      ((1 *)))
    1
    (f2cl-lib:array-slice vr
      double-float
      (1 is)
      ((1 ldvr) (1 *)))
    1)
   (setf ii
    (idamax ki
     (f2cl-lib:array-slice vr
      double-float
      (1 is)
      ((1 ldvr) (1 *)))
    1))
   (setf remax
    (/ one

```



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      (abs
        (f2cl-lib:fref vr-%data%
          (ii is)
          ((1 ldvr) (1 *))
          vr-%offset%)))
(dscal ki remax
  (f2cl-lib:array-slice vr
    double-float
    (1 is)
    ((1 ldvr) (1 *)))
  1)
(f2cl-lib:fdo (k (f2cl-lib:int-add ki 1)
  (f2cl-lib:int-add k 1))
  (> k n) nil)
(tagbody
  (setf (f2cl-lib:fref vr-%data%
    (k is)
    ((1 ldvr) (1 *))
    vr-%offset%)
    zero))))
(t
  (if (> ki 1)
    (dgemv "N" n (f2cl-lib:int-sub ki 1) one vr ldvr
      (f2cl-lib:array-slice work
        double-float
        ((+ 1 n))
        ((1 *)))
      1
      (f2cl-lib:fref work-%data%
        ((f2cl-lib:int-add ki n))
        ((1 *))
        work-%offset%)
      (f2cl-lib:array-slice vr
        double-float
        (1 ki)
        ((1 ldvr) (1 *)))
      1))
  (setf ii
    (idamax n
      (f2cl-lib:array-slice vr
        double-float
        (1 ki)
        ((1 ldvr) (1 *)))
      1))
  (setf remax
    (/ one

```

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                                (abs
                                (f2cl-lib:fref vr-%data%
                                    (ii ki)
                                    ((1 ldvr) (1 *)))
                                vr-%offset%)))
(dscal n remax
 (f2cl-lib:array-slice vr
                        double-float
                        (1 ki)
                        ((1 ldvr) (1 *)))
 1))))
(t
 (cond
  ((>=
   (abs
    (f2cl-lib:fref t$
                    ((f2cl-lib:int-add ki
                                         (f2cl-lib:int-sub 1))
                    ki)
                    ((1 ldt) (1 *))))
   (abs
    (f2cl-lib:fref t$
                    (ki
                     (f2cl-lib:int-add ki
                                         (f2cl-lib:int-sub 1)))
                    ((1 ldt) (1 *))))))
  (setf (f2cl-lib:fref work-%data%
                      ((f2cl-lib:int-add
                        (f2cl-lib:int-sub ki 1)
                        n))
                      ((1 *))
                      work-%offset%)
    one)
  (setf (f2cl-lib:fref work-%data%
                      ((f2cl-lib:int-add ki n2))
                      ((1 *))
                      work-%offset%)
    (/ wi
       (f2cl-lib:fref t$-%data%
                       ((f2cl-lib:int-sub ki 1) ki)
                       ((1 ldt) (1 *))
                       t$-%offset%)))
  (t
   (setf (f2cl-lib:fref work-%data%
                       ((f2cl-lib:int-add
                        (f2cl-lib:int-sub ki 1)

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n))
((1 *))
work-%offset%)
(/ (- wi)
(f2cl-lib:fref t$-%data%
(ki (f2cl-lib:int-sub ki 1))
((1 ldt) (1 *))
t$-%offset%)))
(setf (f2cl-lib:fref work-%data%
((f2cl-lib:int-add ki n2))
((1 *))
work-%offset%)
one)))
(setf (f2cl-lib:fref work-%data%
((f2cl-lib:int-add ki n))
((1 *))
work-%offset%)
zero)
(setf (f2cl-lib:fref work-%data%
((f2cl-lib:int-add
(f2cl-lib:int-sub ki 1)
n2))
((1 *))
work-%offset%)
zero)
(f2cl-lib:fdo (k 1 (f2cl-lib:int-add k 1))
(> k
(f2cl-lib:int-add ki (f2cl-lib:int-sub 2)))
nil)
(tagbody
(setf (f2cl-lib:fref work-%data%
((f2cl-lib:int-add k n))
((1 *))
work-%offset%)
(*
(-
(f2cl-lib:fref work-%data%
((f2cl-lib:int-add
(f2cl-lib:int-sub ki 1)
n))
((1 *))
work-%offset%))
(f2cl-lib:fref t$-%data%
(k (f2cl-lib:int-sub ki 1))
((1 ldt) (1 *))
t$-%offset%)))

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```

(setf (f2cl-lib:fref work-%data%
                    ((f2cl-lib:int-add k n2))
                    ((1 *))
                    work-%offset%))

(*
  (-
    (f2cl-lib:fref work-%data%
                  ((f2cl-lib:int-add ki n2))
                  ((1 *))
                  work-%offset%))
    (f2cl-lib:fref t$-%data%
                  (k ki)
                  ((1 ldt) (1 *))
                  t$-%offset%))))))
(setf jnxt (f2cl-lib:int-sub ki 2))
(f2cl-lib:fd0 (j (f2cl-lib:int-add ki (f2cl-lib:int-sub 2))
               (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
              ((> j 1) nil))
(tagbody
  (if (> j jnxt) (go label90))
  (setf j1 j)
  (setf j2 j)
  (setf jnxt (f2cl-lib:int-sub j 1))
  (cond
    ((> j 1)
     (cond
       ((/=
         (f2cl-lib:fref t$
                       (j
                         (f2cl-lib:int-add j
                                           (f2cl-lib:int-sub
                                             1)))
                       ((1 ldt) (1 *)))
          zero)
        (setf j1 (f2cl-lib:int-sub j 1))
        (setf jnxt (f2cl-lib:int-sub j 2))))))
    (cond
      ((= j1 j2)
       (multiple-value-bind
         (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
          var-8 var-9 var-10 var-11 var-12 var-13 var-14
          var-15 var-16 var-17)
         (dlaln2 nil 1 2 smin one
                  (f2cl-lib:array-slice t$
                                         double-float
                                         (j j)

```

```

                                ((1 ldt) (1 *)))
ldt one one
(f2cl-lib:array-slice work
  double-float
  ((+ j n))
  ((1 *)))
n wr wi x 2 scale xnorm ierr)
(declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
  var-6 var-7 var-8 var-9 var-10
  var-11 var-12 var-13 var-14))
(setf scale var-15)
(setf xnorm var-16)
(setf ierr var-17))
(cond
  (> xnorm one)
  (cond
    (> (f2cl-lib:fref work (j) ((1 *)))
      (f2cl-lib:f2cl/ bignum xnorm))
    (setf (f2cl-lib:fref x (1 1) ((1 2) (1 2)))
      (/ (f2cl-lib:fref x (1 1) ((1 2) (1 2)))
        xnorm))
    (setf (f2cl-lib:fref x (1 2) ((1 2) (1 2)))
      (/ (f2cl-lib:fref x (1 2) ((1 2) (1 2)))
        xnorm))
    (setf scale (/ scale xnorm))))))
(cond
  (/= scale one)
  (dscal ki scale
    (f2cl-lib:array-slice work
      double-float
      ((+ 1 n))
      ((1 *)))
    1)
  (dscal ki scale
    (f2cl-lib:array-slice work
      double-float
      ((+ 1 n2))
      ((1 *)))
    1)))
(setf (f2cl-lib:fref work-%data%
  ((f2cl-lib:int-add j n))
  ((1 *))
  work-%offset%)
  (f2cl-lib:fref x (1 1) ((1 2) (1 2))))
(setf (f2cl-lib:fref work-%data%
  ((f2cl-lib:int-add j n2))

```

```

                                ((1 *))
                                work-%offset%)
                                (f2cl-lib:fref x (1 2) ((1 2) (1 2))))
(daxpy (f2cl-lib:int-sub j 1)
  (- (f2cl-lib:fref x (1 1) ((1 2) (1 2))))
  (f2cl-lib:array-slice t$
    double-float
    (1 j)
    ((1 ldt) (1 *)))
1
(f2cl-lib:array-slice work
  double-float
  ((+ 1 n))
  ((1 *)))
1)
(daxpy (f2cl-lib:int-sub j 1)
  (- (f2cl-lib:fref x (1 2) ((1 2) (1 2))))
  (f2cl-lib:array-slice t$
    double-float
    (1 j)
    ((1 ldt) (1 *)))
1
(f2cl-lib:array-slice work
  double-float
  ((+ 1 n2))
  ((1 *)))
1))
(t
  (multiple-value-bind
    (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
     var-8 var-9 var-10 var-11 var-12 var-13 var-14
     var-15 var-16 var-17)
    (dlaln2 nil 2 2 smin one
      (f2cl-lib:array-slice t$
        double-float
        ((+ j (f2cl-lib:int-sub 1))
         (f2cl-lib:int-sub j 1))
        ((1 ldt) (1 *)))
      ldt one one
      (f2cl-lib:array-slice work
        double-float
        ((+ j
          (f2cl-lib:int-sub 1)
          n))
        ((1 *)))
      n wr wi x 2 scale xnorm ierr)

```

```

(declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
            var-6 var-7 var-8 var-9 var-10
            var-11 var-12 var-13 var-14))
(setf scale var-15)
(setf xnorm var-16)
(setf ierr var-17))
(cond
  ((> xnorm one)
   (setf beta
    (max
      (f2cl-lib:fref work-%data%
                      ((f2cl-lib:int-sub j 1))
                      ((1 *))
                      work-%offset%)
      (f2cl-lib:fref work-%data%
                      (j)
                      ((1 *))
                      work-%offset%)))
   (cond
     ((> beta (f2cl-lib:f2cl/ bignum xnorm))
      (setf rec (/ one xnorm))
      (setf (f2cl-lib:fref x (1 1) ((1 2) (1 2)))
        (* (f2cl-lib:fref x (1 1) ((1 2) (1 2)))
           rec))
      (setf (f2cl-lib:fref x (1 2) ((1 2) (1 2)))
        (* (f2cl-lib:fref x (1 2) ((1 2) (1 2)))
           rec))
      (setf (f2cl-lib:fref x (2 1) ((1 2) (1 2)))
        (* (f2cl-lib:fref x (2 1) ((1 2) (1 2)))
           rec))
      (setf (f2cl-lib:fref x (2 2) ((1 2) (1 2)))
        (* (f2cl-lib:fref x (2 2) ((1 2) (1 2)))
           rec))
      (setf scale (* scale rec))))))
  (cond
    ((/= scale one)
     (dscal ki scale
      (f2cl-lib:array-slice work
                            double-float
                            ((+ 1 n))
                            ((1 *)))
      1)
     (dscal ki scale
      (f2cl-lib:array-slice work
                            double-float
                            ((+ 1 n2))

```

```

((1 *)))
1)))
(setf (f2cl-lib:fref work-%data%
  ((f2cl-lib:int-add
    (f2cl-lib:int-sub j 1)
    n))
  ((1 *))
  work-%offset%
  (f2cl-lib:fref x (1 1) ((1 2) (1 2)))))
(setf (f2cl-lib:fref work-%data%
  ((f2cl-lib:int-add j n)
  ((1 *))
  work-%offset%
  (f2cl-lib:fref x (2 1) ((1 2) (1 2)))))
(setf (f2cl-lib:fref work-%data%
  ((f2cl-lib:int-add
    (f2cl-lib:int-sub j 1)
    n2))
  ((1 *))
  work-%offset%
  (f2cl-lib:fref x (1 2) ((1 2) (1 2)))))
(setf (f2cl-lib:fref work-%data%
  ((f2cl-lib:int-add j n2)
  ((1 *))
  work-%offset%
  (f2cl-lib:fref x (2 2) ((1 2) (1 2)))))
(daxpy (f2cl-lib:int-sub j 2)
  (- (f2cl-lib:fref x (1 1) ((1 2) (1 2)))))
(f2cl-lib:array-slice t$
  double-float
  (1 (f2cl-lib:int-sub j 1))
  ((1 ldt) (1 *)))
1
(f2cl-lib:array-slice work
  double-float
  ((+ 1 n))
  ((1 *)))
1)
(daxpy (f2cl-lib:int-sub j 2)
  (- (f2cl-lib:fref x (2 1) ((1 2) (1 2)))))
(f2cl-lib:array-slice t$
  double-float
  (1 j)
  ((1 ldt) (1 *)))
1
(f2cl-lib:array-slice work

```



```

double-float
((+ 1 n))
((1 *)))

1)
(daxpy (f2cl-lib:int-sub j 2)
(- (f2cl-lib:fref x (1 2) ((1 2) (1 2))))
(f2cl-lib:array-slice t$
double-float
(1 (f2cl-lib:int-sub j 1))
((1 ldt) (1 *)))

1
(f2cl-lib:array-slice work
double-float
((+ 1 n2))
((1 *)))

1)
(daxpy (f2cl-lib:int-sub j 2)
(- (f2cl-lib:fref x (2 2) ((1 2) (1 2))))
(f2cl-lib:array-slice t$
double-float
(1 j)
((1 ldt) (1 *)))

1
(f2cl-lib:array-slice work
double-float
((+ 1 n2))
((1 *)))

1)))

label90))

(cond
((not over)
(dcopy ki
(f2cl-lib:array-slice work
double-float
((+ 1 n))
((1 *)))

1
(f2cl-lib:array-slice vr
double-float
(1 (f2cl-lib:int-sub is 1))
((1 ldvr) (1 *)))

1)
(dcopy ki
(f2cl-lib:array-slice work
double-float
((+ 1 n2))

```

```

                                ((1 *)))
1
(f2cl-lib:array-slice vr
  double-float
  (1 is)
  ((1 ldvr) (1 *)))
1)
(setf emax zero)
(f2cl-lib:fdo (k 1 (f2cl-lib:int-add k 1))
  (> k ki) nil)
(tagbody
  (setf emax
    (max emax
      (+
        (abs
          (f2cl-lib:fref vr-%data%
            (k
              (f2cl-lib:int-sub is
                1))
              ((1 ldvr) (1 *))
              vr-%offset%))
        (abs
          (f2cl-lib:fref vr-%data%
            (k is)
              ((1 ldvr) (1 *))
              vr-%offset%)))))))
(setf remax (/ one emax))
(dscal ki remax
  (f2cl-lib:array-slice vr
    double-float
    (1 (f2cl-lib:int-sub is 1))
    ((1 ldvr) (1 *)))
  1)
(dscal ki remax
  (f2cl-lib:array-slice vr
    double-float
    (1 is)
    ((1 ldvr) (1 *)))
  1)
(f2cl-lib:fdo (k (f2cl-lib:int-add ki 1)
  (f2cl-lib:int-add k 1))
  (> k n) nil)
(tagbody
  (setf (f2cl-lib:fref vr-%data%
    (k (f2cl-lib:int-sub is 1))
    ((1 ldvr) (1 *))

```

```

                                vr-%offset%)
                                zero)
(setf (f2cl-lib:fref vr-%data%
                    (k is)
                    ((1 ldvr) (1 *)))
      vr-%offset%)
                                zero))))
(t
 (cond
  (> ki 2)
  (dgemv "N" n (f2cl-lib:int-sub ki 2) one vr ldvr
    (f2cl-lib:array-slice work
                          double-float
                          ((+ 1 n))
                          ((1 *)))
    1
    (f2cl-lib:fref work-%data%
                    ((f2cl-lib:int-add
                      (f2cl-lib:int-sub ki 1)
                      n))
                    ((1 *)))
                    work-%offset%)
    (f2cl-lib:array-slice vr
                          double-float
                          (1 (f2cl-lib:int-sub ki 1))
                          ((1 ldvr) (1 *)))
    1)
  (dgemv "N" n (f2cl-lib:int-sub ki 2) one vr ldvr
    (f2cl-lib:array-slice work
                          double-float
                          ((+ 1 n2))
                          ((1 *)))
    1
    (f2cl-lib:fref work-%data%
                    ((f2cl-lib:int-add ki n2))
                    ((1 *)))
                    work-%offset%)
    (f2cl-lib:array-slice vr
                          double-float
                          (1 ki)
                          ((1 ldvr) (1 *)))
    1))
(t
 (dscal n
  (f2cl-lib:fref work-%data%
                  ((f2cl-lib:int-add

```

```

                (f2cl-lib:int-sub ki 1)
                n))
            ((1 *))
            work-%offset%)
(f2cl-lib:array-slice vr
    double-float
    (1 (f2cl-lib:int-sub ki 1))
    ((1 ldvr) (1 *)))
1)
(dscal n
  (f2cl-lib:fref work-%data%
    ((f2cl-lib:int-add ki n2))
    ((1 *))
    work-%offset%)
  (f2cl-lib:array-slice vr
    double-float
    (1 ki)
    ((1 ldvr) (1 *)))
  1)))
(setf emax zero)
(f2cl-lib:fdo (k 1 (f2cl-lib:int-add k 1))
  (> k n) nil)
(tagbody
  (setf emax
    (max emax
      (+
        (abs
          (f2cl-lib:fref vr-%data%
            (k
              (f2cl-lib:int-sub ki
                1))
            ((1 ldvr) (1 *)))
          vr-%offset%))
        (abs
          (f2cl-lib:fref vr-%data%
            (k ki)
            ((1 ldvr) (1 *)))
          vr-%offset%))))))
(setf remax (/ one emax))
(dscal n remax
  (f2cl-lib:array-slice vr
    double-float
    (1 (f2cl-lib:int-sub ki 1))
    ((1 ldvr) (1 *)))
  1)
(dscal n remax

```

```

(f2cl-lib:array-slice vr
  double-float
  (1 ki)
  ((1 ldvr) (1 *)))
1))))
(setf is (f2cl-lib:int-sub is 1))
(if (/= ip 0) (setf is (f2cl-lib:int-sub is 1)))
label130
  (if (= ip 1) (setf ip 0))
  (if (= ip -1) (setf ip 1))))))
(cond
  (leftv
    (setf ip 0)
    (setf is 1)
    (f2cl-lib:fdo (ki 1 (f2cl-lib:int-add ki 1))
      (> ki n) nil)
    (tagbody
      (if (= ip -1) (go label250))
      (if (= ki n) (go label150))
      (if
        (=
          (f2cl-lib:fref t$-%data%
            ((f2cl-lib:int-add ki 1) ki)
            ((1 ldt) (1 *))
            t$-%offset%)
          zero)
        (go label150))
      (setf ip 1)
label150
      (cond
        (somev
          (if
            (not
              (f2cl-lib:fref select-%data% (ki) ((1 *)) select-%offset%))
            (go label250))))
        (setf wr
          (f2cl-lib:fref t$-%data%
            (ki ki)
            ((1 ldt) (1 *))
            t$-%offset%))
          (setf wi zero)
          (if (/= ip 0)
            (setf wi
              (*
                (f2cl-lib:fsqrt
                  (abs

```

```

(f2cl-lib:fref t$-%data%
  (ki (f2cl-lib:int-add ki 1))
  ((1 ldt) (1 *)))
  t$-%offset%)))
(f2cl-lib:fsqrt
  (abs
    (f2cl-lib:fref t$-%data%
      ((f2cl-lib:int-add ki 1) ki)
      ((1 ldt) (1 *)))
      t$-%offset%))))))
(setf smin (max (* ulp (+ (abs wr) (abs wi))) smlnum))
(cond
  ((= ip 0)
    (setf (f2cl-lib:fref work-%data%
      ((f2cl-lib:int-add ki n))
      ((1 *)))
      work-%offset%))
    one)
  (f2cl-lib:fdo (k (f2cl-lib:int-add ki 1)
    (f2cl-lib:int-add k 1))
    ((> k n) nil)
    (tagbody
      (setf (f2cl-lib:fref work-%data%
        ((f2cl-lib:int-add k n))
        ((1 *)))
        work-%offset%)
        (-
          (f2cl-lib:fref t$-%data%
            (ki k)
            ((1 ldt) (1 *)))
            t$-%offset%))))))
(setf vmax one)
(setf vcrit bignum)
(setf jnxt (f2cl-lib:int-add ki 1))
(f2cl-lib:fdo (j (f2cl-lib:int-add ki 1)
  (f2cl-lib:int-add j 1))
  ((> j n) nil)
  (tagbody
    (if (< j jnxt) (go label170))
    (setf j1 j)
    (setf j2 j)
    (setf jnxt (f2cl-lib:int-add j 1))
    (cond
      ((< j n)
        (cond
          ((/=

```

```

(f2cl-lib:fref t$
  ((f2cl-lib:int-add j 1) j)
  ((1 ldt) (1 *)))

zero)
(setf j2 (f2cl-lib:int-add j 1))
(setf jnxt (f2cl-lib:int-add j 2))))))
(cond
  ((= j1 j2)
    (cond
      ((> (f2cl-lib:fref work (j) ((1 *))) vcrit)
        (setf rec (/ one vmax))
        (dscal (f2cl-lib:int-add (f2cl-lib:int-sub n ki) 1)
          rec
          (f2cl-lib:array-slice work
            double-float
            ((+ ki n))
            ((1 *)))

          1)
        (setf vmax one)
        (setf vcrit bignum)))
      (setf (f2cl-lib:fref work-%data%
        ((f2cl-lib:int-add j n))
        ((1 *))
        work-%offset%)
        (-
          (f2cl-lib:fref work-%data%
            ((f2cl-lib:int-add j n))
            ((1 *))
            work-%offset%)
          (ddot (f2cl-lib:int-sub j ki 1)
            (f2cl-lib:array-slice t$
              double-float
              ((+ ki 1) j)
              ((1 ldt) (1 *)))

            1
            (f2cl-lib:array-slice work
              double-float
              ((+ ki 1 n))
              ((1 *)))

            1))))
    (multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8 var-9 var-10 var-11 var-12 var-13 var-14
       var-15 var-16 var-17)
      (dlaln2 nil 1 1 smin one
        (f2cl-lib:array-slice t$

```

```

                                double-float
                                (j j)
                                ((1 ldt) (1 *)))

ldt one one
(f2cl-lib:array-slice work
                        double-float
                        ((+ j n))
                        ((1 *)))

n wr zero x 2 scale xnorm ierr)
(declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                var-6 var-7 var-8 var-9 var-10
                var-11 var-12 var-13 var-14))
(setf scale var-15)
(setf xnorm var-16)
(setf ierr var-17))
(if (/= scale one)
    (dscal
     (f2cl-lib:int-add (f2cl-lib:int-sub n ki) 1)
     scale
     (f2cl-lib:array-slice work
                            double-float
                            ((+ ki n))
                            ((1 *)))

     1))
(setf (f2cl-lib:fref work-%data%
                     ((f2cl-lib:int-add j n))
                     ((1 *))
                     work-%offset%)
      (f2cl-lib:fref x (1 1) ((1 2) (1 2))))
(setf vmax
      (max
       (abs
        (f2cl-lib:fref work-%data%
                        ((f2cl-lib:int-add j n))
                        ((1 *))
                        work-%offset%))
       vmax))
(setf vcrit (/ bignum vmax)))
(t
 (setf beta
          (max
           (f2cl-lib:fref work-%data%
                           (j)
                           ((1 *))
                           work-%offset%)
           (f2cl-lib:fref work-%data%
                           (j)
                           ((1 *))
                           work-%offset%)))

```



```

((f2cl-lib:int-add j 1))
((1 *))
work-%offset%)))

(cond
  (> beta vcrit)
  (setf rec (/ one vmax))
  (dscal (f2cl-lib:int-add (f2cl-lib:int-sub n ki) 1)
    rec
    (f2cl-lib:array-slice work
      double-float
      ((+ ki n))
      ((1 *)))

  1)
  (setf vmax one)
  (setf vcrit bignum)))
(setf (f2cl-lib:fref work-%data%
  ((f2cl-lib:int-add j n))
  ((1 *))
  work-%offset%)

  (-
    (f2cl-lib:fref work-%data%
      ((f2cl-lib:int-add j n))
      ((1 *))
      work-%offset%)
    (ddot (f2cl-lib:int-sub j ki 1)
      (f2cl-lib:array-slice t$
        double-float
        ((+ ki 1) j)
        ((1 ldt) (1 *)))

      1
      (f2cl-lib:array-slice work
        double-float
        ((+ ki 1 n))
        ((1 *)))

      1)))
(setf (f2cl-lib:fref work-%data%
  ((f2cl-lib:int-add j 1 n))
  ((1 *))
  work-%offset%)

  (-
    (f2cl-lib:fref work-%data%
      ((f2cl-lib:int-add j 1 n))
      ((1 *))
      work-%offset%)
    (ddot (f2cl-lib:int-sub j ki 1)
      (f2cl-lib:array-slice t$

```

```

double-float
((+ ki 1)
 (f2cl-lib:int-add j
                    1))
((1 ldt) (1 *)))

1
(f2cl-lib:array-slice work
 double-float
 ((+ ki 1 n))
 ((1 *)))

1)))
(multiple-value-bind
 (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
  var-8 var-9 var-10 var-11 var-12 var-13 var-14
  var-15 var-16 var-17)
 (dlaln2 t 2 1 smin one
  (f2cl-lib:array-slice t$
    double-float
    (j j)
    ((1 ldt) (1 *)))

  ldt one one
  (f2cl-lib:array-slice work
    double-float
    ((+ j n))
    ((1 *)))

  n wr zero x 2 scale xnorm ierr)
(declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
  var-6 var-7 var-8 var-9 var-10
  var-11 var-12 var-13 var-14))
(setf scale var-15)
(setf xnorm var-16)
(setf ierr var-17))
(if (/= scale one)
  (dscal
   (f2cl-lib:int-add (f2cl-lib:int-sub n ki) 1)
   scale
   (f2cl-lib:array-slice work
     double-float
     ((+ ki n))
     ((1 *)))

   1))
(setf (f2cl-lib:fref work-%data%
  ((f2cl-lib:int-add j n))
  ((1 *))
  work-%offset%)
  (f2cl-lib:fref x (1 1) ((1 2) (1 2))))

```

```

(setf (f2cl-lib:fref work-%data%
                    ((f2cl-lib:int-add j 1 n))
                    ((1 *))
                    work-%offset%))
(f2cl-lib:fref x (2 1) ((1 2) (1 2))))
(setf vmax
  (max
    (abs
      (f2cl-lib:fref work-%data%
                    ((f2cl-lib:int-add j n))
                    ((1 *))
                    work-%offset%))
    (abs
      (f2cl-lib:fref work-%data%
                    ((f2cl-lib:int-add j 1 n))
                    ((1 *))
                    work-%offset%))
    vmax))
(setf vcrit (/ bignum vmax))))

label170))

(cond
  ((not over)
    (dcopy (f2cl-lib:int-add (f2cl-lib:int-sub n ki) 1)
      (f2cl-lib:array-slice work
        double-float
        ((+ ki n))
        ((1 *)))
      1
      (f2cl-lib:array-slice vl
        double-float
        (ki is)
        ((1 ldvl) (1 *)))
      1)
    (setf ii
      (f2cl-lib:int-sub
        (f2cl-lib:int-add
          (idamax
            (f2cl-lib:int-add (f2cl-lib:int-sub n ki) 1)
            (f2cl-lib:array-slice vl
              double-float
              (ki is)
              ((1 ldvl) (1 *)))
            1)
          ki)
        1))
    (setf remax

```

```

(/ one
  (abs
    (f2cl-lib:fref vl-%data%
      (ii is)
      ((1 ldvl) (1 *)))
    vl-%offset%)))
(dscal (f2cl-lib:int-add (f2cl-lib:int-sub n ki) 1) remax
  (f2cl-lib:array-slice vl
    double-float
    (ki is)
    ((1 ldvl) (1 *))))
1)
(f2cl-lib:fdo (k 1 (f2cl-lib:int-add k 1))
  (> k
    (f2cl-lib:int-add ki
      (f2cl-lib:int-sub 1)))
    nil)
(tagbody
  (setf (f2cl-lib:fref vl-%data%
    (k is)
    ((1 ldvl) (1 *)))
    vl-%offset%)
    zero))))
(t
  (if (< ki n)
    (dgemv "N" n (f2cl-lib:int-sub n ki) one
      (f2cl-lib:array-slice vl
        double-float
        (1 (f2cl-lib:int-add ki 1))
        ((1 ldvl) (1 *)))
      ldvl
      (f2cl-lib:array-slice work
        double-float
        ((+ ki 1 n))
        ((1 *)))
      1
      (f2cl-lib:fref work-%data%
        ((f2cl-lib:int-add ki n))
        ((1 *)))
        work-%offset%)
      (f2cl-lib:array-slice vl
        double-float
        (1 ki)
        ((1 ldvl) (1 *)))
      1))
  (setf ii

```

```

(idamax n
  (f2cl-lib:array-slice vl
    double-float
    (1 ki)
    ((1 ldvl) (1 *)))
  1))
(setf remax
  (/ one
    (abs
      (f2cl-lib:fref vl-%data%
        (ii ki)
        ((1 ldvl) (1 *))
        vl-%offset%))))
(dscal n remax
  (f2cl-lib:array-slice vl
    double-float
    (1 ki)
    ((1 ldvl) (1 *)))
  1))))
(t
  (tagbody
    (cond
      ((>=
        (abs
          (f2cl-lib:fref t$
            (ki (f2cl-lib:int-add ki 1))
            ((1 ldt) (1 *))))
          (abs
            (f2cl-lib:fref t$
              ((f2cl-lib:int-add ki 1) ki)
              ((1 ldt) (1 *))))))
        (setf (f2cl-lib:fref work-%data%
          ((f2cl-lib:int-add ki n))
          ((1 *))
          work-%offset%)
          (/ wi
            (f2cl-lib:fref t$-%data%
              (ki (f2cl-lib:int-add ki 1))
              ((1 ldt) (1 *))
              t$-%offset%)))
        (setf (f2cl-lib:fref work-%data%
          ((f2cl-lib:int-add ki 1 n2))
          ((1 *))
          work-%offset%)
          one))
    (t

```

```

(setf (f2cl-lib:fref work-%data%
                    ((f2cl-lib:int-add ki n))
                    ((1 *))
                    work-%offset%))

one)
(setf (f2cl-lib:fref work-%data%
                    ((f2cl-lib:int-add ki 1 n2))
                    ((1 *))
                    work-%offset%))

(/ (- wi)
   (f2cl-lib:fref t$-%data%
                  ((f2cl-lib:int-add ki 1) ki)
                  ((1 ldt) (1 *))
                  t$-%offset%))))))
(setf (f2cl-lib:fref work-%data%
                    ((f2cl-lib:int-add ki 1 n))
                    ((1 *))
                    work-%offset%))

zero)
(setf (f2cl-lib:fref work-%data%
                    ((f2cl-lib:int-add ki n2))
                    ((1 *))
                    work-%offset%))

zero)
(f2cl-lib:fdo (k (f2cl-lib:int-add ki 2)
               (f2cl-lib:int-add k 1))
              (> k n) nil)
(tagbody
 (setf (f2cl-lib:fref work-%data%
                     ((f2cl-lib:int-add k n))
                     ((1 *))
                     work-%offset%))

      (*
      (-
      (f2cl-lib:fref work-%data%
                    ((f2cl-lib:int-add ki n))
                    ((1 *))
                    work-%offset%))
      (f2cl-lib:fref t$-%data%
                    (ki k)
                    ((1 ldt) (1 *))
                    t$-%offset%))))
(setf (f2cl-lib:fref work-%data%
                    ((f2cl-lib:int-add k n2))
                    ((1 *))
                    work-%offset%))

```

```

(*)
(-
  (f2cl-lib:fref work-%data%
    ((f2cl-lib:int-add ki 1 n2))
    ((1 *))
    work-%offset%))
  (f2cl-lib:fref t$-%data%
    ((f2cl-lib:int-add ki 1) k)
    ((1 ldt) (1 *))
    t$-%offset%))))
(setf vmax one)
(setf vcrit bignum)
(setf jnxt (f2cl-lib:int-add ki 2))
(f2cl-lib:fdo (j (f2cl-lib:int-add ki 2)
  (f2cl-lib:int-add j 1))
  (> j n) nil)
(tagbody
  (if (< j jnxt) (go label200))
  (setf j1 j)
  (setf j2 j)
  (setf jnxt (f2cl-lib:int-add j 1))
  (cond
    ((< j n)
      (cond
        ((/=
          (f2cl-lib:fref t$
            ((f2cl-lib:int-add j 1) j)
            ((1 ldt) (1 *)))
          zero)
          (setf j2 (f2cl-lib:int-add j 1))
          (setf jnxt (f2cl-lib:int-add j 2))))))
    (cond
      ((= j1 j2)
        (cond
          ((> (f2cl-lib:fref work (j) ((1 *))) vcrit)
            (setf rec (/ one vmax))
            (dscal
              (f2cl-lib:int-add (f2cl-lib:int-sub n ki) 1) rec
              (f2cl-lib:array-slice work
                double-float
                ((+ ki n))
                ((1 *)))
              1)
            (dscal
              (f2cl-lib:int-add (f2cl-lib:int-sub n ki) 1) rec
              (f2cl-lib:array-slice work

```

```

double-float
((+ ki n2))
((1 *)))

1)
(setf vmax one)
(setf vcrit bignum)))
(setf (f2cl-lib:fref work-%data%
  ((f2cl-lib:int-add j n))
  ((1 *))
  work-%offset%)
  (-
    (f2cl-lib:fref work-%data%
      ((f2cl-lib:int-add j n))
      ((1 *))
      work-%offset%)
    (ddot (f2cl-lib:int-sub j ki 2)
      (f2cl-lib:array-slice t$
        double-float
        ((+ ki 2) j)
        ((1 ldt) (1 *)))
      1
      (f2cl-lib:array-slice work
        double-float
        ((+ ki 2 n))
        ((1 *)))
      1)))
(setf (f2cl-lib:fref work-%data%
  ((f2cl-lib:int-add j n2))
  ((1 *))
  work-%offset%)
  (-
    (f2cl-lib:fref work-%data%
      ((f2cl-lib:int-add j n2))
      ((1 *))
      work-%offset%)
    (ddot (f2cl-lib:int-sub j ki 2)
      (f2cl-lib:array-slice t$
        double-float
        ((+ ki 2) j)
        ((1 ldt) (1 *)))
      1
      (f2cl-lib:array-slice work
        double-float
        ((+ ki 2 n2))
        ((1 *)))
      1)))
1)))

```



```

(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6
   var-7 var-8 var-9 var-10 var-11 var-12 var-13
   var-14 var-15 var-16 var-17)
  (dlaln2 nil 1 2 smin one
   (f2cl-lib:array-slice t$
    double-float
    (j j)
    ((1 ldt) (1 *)))

   ldt one one
   (f2cl-lib:array-slice work
    double-float
    ((+ j n))
    ((1 *)))

   n wr (- wi) x 2 scale xnorm ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4
    var-5 var-6 var-7 var-8 var-9
    var-10 var-11 var-12 var-13
    var-14))
  (setf scale var-15)
  (setf xnorm var-16)
  (setf ierr var-17))
(cond
  ((/= scale one)
   (dscal
    (f2cl-lib:int-add (f2cl-lib:int-sub n ki) 1)
    scale
    (f2cl-lib:array-slice work
     double-float
     ((+ ki n))
     ((1 *)))

    1)
   (dscal
    (f2cl-lib:int-add (f2cl-lib:int-sub n ki) 1)
    scale
    (f2cl-lib:array-slice work
     double-float
     ((+ ki n2))
     ((1 *)))

    1)))
  (setf (f2cl-lib:fref work-%data%
    ((f2cl-lib:int-add j n))
    ((1 *))
    work-%offset%)
    (f2cl-lib:fref x (1 1) ((1 2) (1 2))))
  (setf (f2cl-lib:fref work-%data%

```

```

((f2cl-lib:int-add j n2))
((1 *))
work-%offset%)
(f2cl-lib:fref x (1 2) ((1 2) (1 2)))
(setf vmax
  (max
    (abs
      (f2cl-lib:fref work-%data%
        ((f2cl-lib:int-add j n))
        ((1 *))
        work-%offset%))
    (abs
      (f2cl-lib:fref work-%data%
        ((f2cl-lib:int-add j n2))
        ((1 *))
        work-%offset%))
    vmax))
(setf vcrit (/ bignum vmax))
(t
  (setf beta
    (max
      (f2cl-lib:fref work-%data%
        (j)
        ((1 *))
        work-%offset%)
      (f2cl-lib:fref work-%data%
        ((f2cl-lib:int-add j 1))
        ((1 *))
        work-%offset%)))
    (cond
      ((> beta vcrit)
        (setf rec (/ one vmax))
        (dscal
          (f2cl-lib:int-add (f2cl-lib:int-sub n ki) 1) rec
          (f2cl-lib:array-slice work
            double-float
            ((+ ki n))
            ((1 *)))
          1)
        (dscal
          (f2cl-lib:int-add (f2cl-lib:int-sub n ki) 1) rec
          (f2cl-lib:array-slice work
            double-float
            ((+ ki n2))
            ((1 *)))
          1)
      (t
        1)
    )
  )

```

```

(setf vmax one)
(setf vcrit bignum)))
(setf (f2cl-lib:fref work-%data%
                    ((f2cl-lib:int-add j n))
                    ((1 *))
                    work-%offset%))
(-
  (f2cl-lib:fref work-%data%
                ((f2cl-lib:int-add j n))
                ((1 *))
                work-%offset%))
  (ddot (f2cl-lib:int-sub j ki 2)
        (f2cl-lib:array-slice t$
                              double-float
                              ((+ ki 2) j)
                              ((1 ldt) (1 *))))
  1
  (f2cl-lib:array-slice work
                        double-float
                        ((+ ki 2 n))
                        ((1 *)))
  1)))
(setf (f2cl-lib:fref work-%data%
                    ((f2cl-lib:int-add j n2))
                    ((1 *))
                    work-%offset%))
(-
  (f2cl-lib:fref work-%data%
                ((f2cl-lib:int-add j n2))
                ((1 *))
                work-%offset%))
  (ddot (f2cl-lib:int-sub j ki 2)
        (f2cl-lib:array-slice t$
                              double-float
                              ((+ ki 2) j)
                              ((1 ldt) (1 *))))
  1
  (f2cl-lib:array-slice work
                        double-float
                        ((+ ki 2 n2))
                        ((1 *)))
  1)))
(setf (f2cl-lib:fref work-%data%
                    ((f2cl-lib:int-add j 1 n))
                    ((1 *))
                    work-%offset%))

```

```

(-
  (f2cl-lib:fref work-%data%
    ((f2cl-lib:int-add j 1 n))
    ((1 *))
    work-%offset%)
  (ddot (f2cl-lib:int-sub j ki 2)
    (f2cl-lib:array-slice t$
      double-float
      ((+ ki 2)
        (f2cl-lib:int-add j
          1))
      ((1 ldt) (1 *)))
    1
    (f2cl-lib:array-slice work
      double-float
      ((+ ki 2 n))
      ((1 *)))
    1)))
(setf (f2cl-lib:fref work-%data%
  ((f2cl-lib:int-add j 1 n2))
  ((1 *))
  work-%offset%)
(-
  (f2cl-lib:fref work-%data%
    ((f2cl-lib:int-add j 1 n2))
    ((1 *))
    work-%offset%)
  (ddot (f2cl-lib:int-sub j ki 2)
    (f2cl-lib:array-slice t$
      double-float
      ((+ ki 2)
        (f2cl-lib:int-add j
          1))
      ((1 ldt) (1 *)))
    1
    (f2cl-lib:array-slice work
      double-float
      ((+ ki 2 n2))
      ((1 *)))
    1)))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6
   var-7 var-8 var-9 var-10 var-11 var-12 var-13
   var-14 var-15 var-16 var-17)
  (dlaln2 t 2 2 smin one
    (f2cl-lib:array-slice t$

```

```

                                double-float
                                (j j)
                                ((1 ldt) (1 *)))

ldt one one
(f2cl-lib:array-slice work
  double-float
  ((+ j n))
  ((1 *)))

n wr (- wi) x 2 scale xnorm ierr)
(declare (ignore var-0 var-1 var-2 var-3 var-4
  var-5 var-6 var-7 var-8 var-9
  var-10 var-11 var-12 var-13
  var-14))
(setf scale var-15)
(setf xnorm var-16)
(setf ierr var-17))
(cond
  ((/= scale one)
    (dscal
      (f2cl-lib:int-add (f2cl-lib:int-sub n ki) 1)
      scale
      (f2cl-lib:array-slice work
        double-float
        ((+ ki n))
        ((1 *)))

      1)
    (dscal
      (f2cl-lib:int-add (f2cl-lib:int-sub n ki) 1)
      scale
      (f2cl-lib:array-slice work
        double-float
        ((+ ki n2))
        ((1 *)))

      1)))
(setf (f2cl-lib:fref work-%data%
  ((f2cl-lib:int-add j n))
  ((1 *))
  work-%offset%)
  (f2cl-lib:fref x (1 1) ((1 2) (1 2))))
(setf (f2cl-lib:fref work-%data%
  ((f2cl-lib:int-add j n2))
  ((1 *))
  work-%offset%)
  (f2cl-lib:fref x (1 2) ((1 2) (1 2))))
(setf (f2cl-lib:fref work-%data%
  ((f2cl-lib:int-add j 1 n))

```

```

((1 *))
work-%offset%)
(f2cl-lib:fref x (2 1) ((1 2) (1 2)))
(setf (f2cl-lib:fref work-%data%
((f2cl-lib:int-add j 1 n2))
((1 *))
work-%offset%)
(f2cl-lib:fref x (2 2) ((1 2) (1 2)))
(setf vmax
(max
(abs (f2cl-lib:fref x (1 1) ((1 2) (1 2))))
(abs (f2cl-lib:fref x (1 2) ((1 2) (1 2))))
(abs (f2cl-lib:fref x (2 1) ((1 2) (1 2))))
(abs (f2cl-lib:fref x (2 2) ((1 2) (1 2))))
vmax))
(setf vcrit (/ bignum vmax)))

label200))
label210

(cond
((not over)
(dcopy (f2cl-lib:int-add (f2cl-lib:int-sub n ki) 1)
(f2cl-lib:array-slice work
double-float
(+ ki n)
(1 *)))
1
(f2cl-lib:array-slice vl
double-float
(ki is)
(1 ldvl) (1 *)))
1)
(dcopy (f2cl-lib:int-add (f2cl-lib:int-sub n ki) 1)
(f2cl-lib:array-slice work
double-float
(+ ki n2)
(1 *)))
1
(f2cl-lib:array-slice vl
double-float
(ki (f2cl-lib:int-add is 1))
(1 ldvl) (1 *)))
1)
(setf emax zero)
(f2cl-lib:fdo (k ki (f2cl-lib:int-add k 1))
(> k n) nil)
(tagbody

```

```

(setf emax
  (max emax
    (+
      (abs
        (f2cl-lib:fref vl-%data%
          (k is)
          ((1 ldvl) (1 *))
          vl-%offset%))
      (abs
        (f2cl-lib:fref vl-%data%
          (k
            (f2cl-lib:int-add is
              1))
          ((1 ldvl) (1 *))
          vl-%offset%))))))
(setf remax (/ one emax))
(dscal (f2cl-lib:int-add (f2cl-lib:int-sub n ki) 1)
  remax
  (f2cl-lib:array-slice vl
    double-float
    (ki is)
    ((1 ldvl) (1 *)))
  1)
(dscal (f2cl-lib:int-add (f2cl-lib:int-sub n ki) 1)
  remax
  (f2cl-lib:array-slice vl
    double-float
    (ki (f2cl-lib:int-add is 1))
    ((1 ldvl) (1 *)))
  1)
(f2cl-lib:fdo (k 1 (f2cl-lib:int-add k 1))
  (> k
    (f2cl-lib:int-add ki
      (f2cl-lib:int-sub
        1)))
  nil)
(tagbody
  (setf (f2cl-lib:fref vl-%data%
    (k is)
    ((1 ldvl) (1 *))
    vl-%offset%)
    zero)
  (setf (f2cl-lib:fref vl-%data%
    (k (f2cl-lib:int-add is 1))
    ((1 ldvl) (1 *))
    vl-%offset%)
    zero)

```

```

                                zero))))
(t
  (cond
    ((< ki (f2cl-lib:int-add n (f2cl-lib:int-sub 1)))
      (dgemv "N" n (f2cl-lib:int-sub n ki 1) one
        (f2cl-lib:array-slice vl
          double-float
          (1 (f2cl-lib:int-add ki 2))
          ((1 ldvl) (1 *)))

        ldvl
        (f2cl-lib:array-slice work
          double-float
          ((+ ki 2 n))
          ((1 *)))

        1
        (f2cl-lib:fref work-%data%
          ((f2cl-lib:int-add ki n))
          ((1 *))
          work-%offset%)
        (f2cl-lib:array-slice vl
          double-float
          (1 ki)
          ((1 ldvl) (1 *)))

        1)
      (dgemv "N" n (f2cl-lib:int-sub n ki 1) one
        (f2cl-lib:array-slice vl
          double-float
          (1 (f2cl-lib:int-add ki 2))
          ((1 ldvl) (1 *)))

        ldvl
        (f2cl-lib:array-slice work
          double-float
          ((+ ki 2 n2))
          ((1 *)))

        1
        (f2cl-lib:fref work-%data%
          ((f2cl-lib:int-add ki 1 n2))
          ((1 *))
          work-%offset%)
        (f2cl-lib:array-slice vl
          double-float
          (1 (f2cl-lib:int-add ki 1))
          ((1 ldvl) (1 *)))

        1))
    (t
      (dscal n

```



```

(f2cl-lib:fref work-%data%
  ((f2cl-lib:int-add ki n))
  ((1 *))
  work-%offset%)
(f2cl-lib:array-slice vl
  double-float
  (1 ki)
  ((1 ldvl) (1 *)))
1)
(dscal n
  (f2cl-lib:fref work-%data%
    ((f2cl-lib:int-add ki 1 n2))
    ((1 *))
    work-%offset%)
  (f2cl-lib:array-slice vl
    double-float
    (1 (f2cl-lib:int-add ki 1))
    ((1 ldvl) (1 *)))
  1)))
(setf emax zero)
(f2cl-lib:fdo (k 1 (f2cl-lib:int-add k 1))
  (> k n) nil)
(tagbody
  (setf emax
    (max emax
      (+
        (abs
          (f2cl-lib:fref vl-%data%
            (k ki)
            ((1 ldvl) (1 *))
            vl-%offset%))
        (abs
          (f2cl-lib:fref vl-%data%
            (k
              (f2cl-lib:int-add ki
                1))
            ((1 ldvl) (1 *))
            vl-%offset%))))))
  (setf remax (/ one emax))
  (dscal n remax
    (f2cl-lib:array-slice vl
      double-float
      (1 ki)
      ((1 ldvl) (1 *)))
    1)
  (dscal n remax

```

```

                                (f2cl-lib:array-slice vl
                                double-float
                                (1 (f2cl-lib:int-add ki 1))
                                ((1 ldvl) (1 *)))
                                1))))))
    (setf is (f2cl-lib:int-add is 1))
    (if (/= ip 0) (setf is (f2cl-lib:int-add is 1)))
label250
    (if (= ip -1) (setf ip 0))
    (if (= ip 1) (setf ip -1))))))
end_label
  (return
    (values nil nil nil nil nil nil nil nil nil nil m nil info))))))

```

## 7.91 dtrexc LAPACK

```

<dtrexc.input>≡
)set break resume
)sys rm -f dtrexc.output
)spool dtrexc.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)

```

`<dtrexc.help>≡`

```
=====
dtrexc examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

DTREXC - the real Schur factorization of a real matrix  $A = Q^*TQ$ , so that the diagonal block of  $T$  with row index IFST is moved to row ILST

#### SYNOPSIS

```
SUBROUTINE DTREXC( COMPQ, N, T, LDT, Q, LDQ, IFST, ILST, WORK, INFO )
```

```
      CHARACTER      COMPQ
```

```
      INTEGER        IFST, ILST, INFO, LDQ, LDT, N
```

```
      DOUBLE         PRECISION Q( LDQ, * ), T( LDT, * ), WORK( * )
```

#### PURPOSE

DTREXC reorders the real Schur factorization of a real matrix  $A = Q^*TQ$ , so that the diagonal block of  $T$  with row index IFST is moved to row ILST.

The real Schur form  $T$  is reordered by an orthogonal similarity transformation  $Z^*T^*Z$ , and optionally the matrix  $Q$  of Schur vectors is updated by postmultiplying it with  $Z$ .

$T$  must be in Schur canonical form (as returned by DHSEQR), that is, block upper triangular with 1-by-1 and 2-by-2 diagonal blocks; each 2-by-2 diagonal block has its diagonal elements equal and its off-diagonal elements of opposite sign.

#### ARGUMENTS

```
COMPQ  (input) CHARACTER*1
        = 'V':  update the matrix Q of Schur vectors;
        = 'N':  do not update Q.
```

```
N      (input) INTEGER
        The order of the matrix T. N >= 0.
```

```
T      (input/output) DOUBLE PRECISION array, dimension (LDT,N)
```

On entry, the upper quasi-triangular matrix T, in Schur canonical form. On exit, the reordered upper quasi-triangular matrix, again in Schur canonical form.

- LDT (input) INTEGER  
The leading dimension of the array T.  $LDT \geq \max(1, N)$ .
- Q (input/output) DOUBLE PRECISION array, dimension (LDQ,N)  
On entry, if  $COMPQ = 'V'$ , the matrix Q of Schur vectors. On exit, if  $COMPQ = 'V'$ , Q has been postmultiplied by the orthogonal transformation matrix Z which reorders T. If  $COMPQ = 'N'$ , Q is not referenced.
- LDQ (input) INTEGER  
The leading dimension of the array Q.  $LDQ \geq \max(1, N)$ .
- IFST (input/output) INTEGER  
ILST (input/output) INTEGER Specify the reordering of the diagonal blocks of T. The block with row index IFST is moved to row ILST, by a sequence of transpositions between adjacent blocks. On exit, if IFST pointed on entry to the second row of a 2-by-2 block, it is changed to point to the first row; ILST always points to the first row of the block in its final position (which may differ from its input value by +1 or -1).  $1 \leq IFST \leq N$ ;  $1 \leq ILST \leq N$ .
- WORK (workspace) DOUBLE PRECISION array, dimension (N)
- INFO (output) INTEGER  
= 0: successful exit  
< 0: if  $INFO = -i$ , the i-th argument had an illegal value  
= 1: two adjacent blocks were too close to swap (the problem is very ill-conditioned); T may have been partially reordered, and ILST points to the first row of the current position of the block being moved.

```

(LAPACK dtrexc)=
  (let* ((zero 0.0))
    (declare (type (double-float 0.0 0.0) zero))
    (defun dtrexc (compq n t$ ldt q ldq ifst ilst work info)
      (declare (type (simple-array double-float (*)) work q t$)
        (type fixnum info ilst ifst ldq ldt n)
        (type character compq))
      (f2cl-lib:with-multi-array-data
        ((compq character compq-%data% compq-%offset%)
         (t$ double-float t$-%data% t$-%offset%)
         (q double-float q-%data% q-%offset%)
         (work double-float work-%data% work-%offset%))
        (prog ((here 0) (nbf 0) (nbl 0) (nbnext 0) (wantq nil))
          (declare (type fixnum here nbf nbl nbnext)
            (type (member t nil) wantq))
          (setf info 0)
          (setf wantq (char-equal compq #\V))
          (cond
            ((and (not wantq) (not (char-equal compq #\N)))
              (setf info -1))
            ((< n 0)
              (setf info -2))
            ((< ldt (max (the fixnum 1) (the fixnum n)))
              (setf info -4))
            ((or (< ldq 1)
              (and wantq
                (< ldq
                  (max (the fixnum 1)
                     (the fixnum n))))))
              (setf info -6))
            ((or (< ifst 1) (> ifst n))
              (setf info -7))
            ((or (< ilst 1) (> ilst n))
              (setf info -8)))
          (cond
            ((/= info 0)
              (error
                "** On entry to ~a parameter number ~a had an illegal value~%"
                "DTREXC" (f2cl-lib:int-sub info))
              (go end_label)))
            (if (<= n 1) (go end_label))
            (cond
              ((> ifst 1)
                (if
                  (/=
                    (f2cl-lib:fref t$-%data%

```

```

                                (ifst (f2cl-lib:int-sub ifst 1))
                                ((1 ldt) (1 *))
                                t$-%offset%)
                                zero)
                                (setf ifst (f2cl-lib:int-sub ifst 1))))))
(setf nbf 1)
(cond
  ((< ifst n)
    (if
      (/=
        (f2cl-lib:fref t$-%data%
                        ((f2cl-lib:int-add ifst 1) ifst)
                        ((1 ldt) (1 *))
                        t$-%offset%)
          zero)
      (setf nbf 2))))))
(cond
  ((> ilst 1)
    (if
      (/=
        (f2cl-lib:fref t$-%data%
                        (ilst (f2cl-lib:int-sub ilst 1))
                        ((1 ldt) (1 *))
                        t$-%offset%)
          zero)
      (setf ilst (f2cl-lib:int-sub ilst 1))))))
(setf nbl 1)
(cond
  ((< ilst n)
    (if
      (/=
        (f2cl-lib:fref t$-%data%
                        ((f2cl-lib:int-add ilst 1) ilst)
                        ((1 ldt) (1 *))
                        t$-%offset%)
          zero)
      (setf nbl 2))))))
(if (= ifst ilst) (go end_label))
(cond
  ((< ifst ilst)
    (tagbody
      (if (and (= nbf 2) (= nbl 1))
          (setf ilst (f2cl-lib:int-sub ilst 1)))
      (if (and (= nbf 1) (= nbl 2))
          (setf ilst (f2cl-lib:int-add ilst 1)))
      (setf here ifst)

```

```
(cond
  ((or (= nbf 1) (= nbf 2))
    (setf nbnext 1)
    (cond
      ((<= (f2cl-lib:int-add here nbf 1) n)
        (if
          (/=
            (f2cl-lib:fref t$-%data%
                          ((f2cl-lib:int-add here nbf 1)
                           (f2cl-lib:int-add here nbf))
                          ((1 ldt) (1 *)))
            t$-%offset%)
          zero)
        (setf nbnext 2))))
    (multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
       var-9 var-10)
      (dlaexc wantq n t$ ldt q ldq here nbf nbnext work info)
      (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                        var-7 var-8 var-9))
      (setf info var-10))
    (cond
      ((/= info 0)
        (setf ilst here)
        (go end_label)))
    (setf here (f2cl-lib:int-add here nbnext))
    (cond
      ((= nbf 2)
        (if
          (=
            (f2cl-lib:fref t$-%data%
                          ((f2cl-lib:int-add here 1) here)
                          ((1 ldt) (1 *)))
            t$-%offset%)
          zero)
        (setf nbf 3))))))
(t
  (setf nbnext 1)
  (cond
    ((<= (f2cl-lib:int-add here 3) n)
      (if
        (/=
          (f2cl-lib:fref t$-%data%
                        ((f2cl-lib:int-add here 3)
                         (f2cl-lib:int-add here 2))
```

```

                                ((1 ldt) (1 *))
                                t$-%offset%)
                                zero)
                                (setf nbnext 2))))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
   var-9 var-10)
  (dlaexc wantq n t$ ldt q ldq (f2cl-lib:int-add here 1) 1
   nbnext work info)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                  var-7 var-8 var-9))
  (setf info var-10))
(cond
  ((/= info 0)
   (setf ilst here)
   (go end_label)))
(cond
  ((= nbnext 1)
   (multiple-value-bind
     (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
      var-9 var-10)
     (dlaexc wantq n t$ ldt q ldq here 1 nbnext work info)
     (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                     var-7 var-8 var-9))
     (setf info var-10))
   (setf here (f2cl-lib:int-add here 1)))
  (t
   (if
    (=
     (f2cl-lib:fref t$-%data%
                    ((f2cl-lib:int-add here 2)
                     (f2cl-lib:int-add here 1))
                    ((1 ldt) (1 *))
                    t$-%offset%)
     zero)
    (setf nbnext 1))
    (cond
      ((= nbnext 2)
       (multiple-value-bind
         (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
          var-8 var-9 var-10)
         (dlaexc wantq n t$ ldt q ldq here 1 nbnext work info)
         (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                         var-6 var-7 var-8 var-9))
         (setf info var-10))
        (cond

```



```

        ((/= info 0)
         (setf ilst here)
         (go end_label)))
      (setf here (f2cl-lib:int-add here 2)))
    (t
     (multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8 var-9 var-10)
      (dlaexc wantq n t$ ldt q ldq here 1 1 work info)
      (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                       var-6 var-7 var-8 var-9))
      (setf info var-10))
     (multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8 var-9 var-10)
      (dlaexc wantq n t$ ldt q ldq
        (f2cl-lib:int-add here 1) 1 1 work info)
      (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                       var-6 var-7 var-8 var-9))
      (setf info var-10))
     (setf here (f2cl-lib:int-add here 2))))))
    (if (< here ilst) (go label10)))
  (t
   (tagbody
    (setf here ifst)
label120
    (cond
     ((or (= nbf 1) (= nbf 2))
      (setf nbnext 1)
      (cond
       ((>= here 3)
        (if
         (/=
          (f2cl-lib:fref t$-%data%
                        ((f2cl-lib:int-sub here 1)
                         (f2cl-lib:int-sub here 2))
                        ((1 ldt) (1 *)))
          t$-%offset%)
         zero)
        (setf nbnext 2))))
     (multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
       var-9 var-10)
      (dlaexc wantq n t$ ldt q ldq (f2cl-lib:int-sub here nbnext)
              nbnext nbf work info)
      (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6

```

```

        var-7 var-8 var-9))
    (setf info var-10))
  (cond
    ((/= info 0)
     (setf ilst here)
     (go end_label)))
  (setf here (f2cl-lib:int-sub here nbnext))
  (cond
    ((= nbf 2)
     (if
      (=
       (f2cl-lib:fref t$-%data%
                      ((f2cl-lib:int-add here 1) here)
                      ((1 ldt) (1 *)))
       t$-%offset%)
      zero)
     (setf nbf 3))))))
(t
 (setf nbnext 1)
 (cond
  ((>= here 3)
   (if
    (/=
     (f2cl-lib:fref t$-%data%
                    ((f2cl-lib:int-sub here 1)
                     (f2cl-lib:int-sub here 2))
                    ((1 ldt) (1 *)))
     t$-%offset%)
    zero)
   (setf nbnext 2))))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
   var-9 var-10)
  (dlaexc wantq n t$ ldt q ldq (f2cl-lib:int-sub here nbnext)
   nbnext 1 work info)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                   var-7 var-8 var-9))
  (setf info var-10))
(cond
  ((/= info 0)
   (setf ilst here)
   (go end_label)))
(cond
  ((= nbnext 1)
   (multiple-value-bind
    (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
     var-9 var-10)

```

```

        var-9 var-10)
        (dlaexc wantq n t$ ldt q ldq here nbnext 1 work info)
        (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                    var-7 var-8 var-9))
        (setf info var-10))
    (setf here (f2cl-lib:int-sub here 1)))
(t
 (if
  (=
   (f2cl-lib:fref t$-%data%
                  (here (f2cl-lib:int-sub here 1))
                  ((1 ldt) (1 *)))
   t$-%offset%)
   zero)
  (setf nbnext 1))
(cond
 ((= nbnext 2)
  (multiple-value-bind
   (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
    var-8 var-9 var-10)
    (dlaexc wantq n t$ ldt q ldq
              (f2cl-lib:int-sub here 1) 2 1 work info)
    (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                    var-6 var-7 var-8 var-9))
    (setf info var-10))
  (cond
   ((/= info 0)
    (setf ilst here)
    (go end_label)))
  (setf here (f2cl-lib:int-sub here 2)))
(t
 (multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
   var-8 var-9 var-10)
    (dlaexc wantq n t$ ldt q ldq here 1 1 work info)
    (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                    var-6 var-7 var-8 var-9))
    (setf info var-10))
  (multiple-value-bind
   (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
    var-8 var-9 var-10)
    (dlaexc wantq n t$ ldt q ldq
              (f2cl-lib:int-sub here 1) 1 1 work info)
    (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                    var-6 var-7 var-8 var-9))
    (setf info var-10))

```

```
                (setf here (f2cl-lib:int-sub here 2)))))))))
            (if (> here ilst) (go label20))))))
        (setf ilst here)
    end_label
    (return (values nil nil nil nil nil nil ifst ilst nil info))))))
```

## 7.92 dtrsna LAPACK

```
<dtrsna.input>≡
)set break resume
)sys rm -f dtrsna.output
)spool dtrsna.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

```
=====
dtrsna examples
=====

=====
Man Page Details
=====
```

DTRSNA - reciprocal condition numbers for specified eigenvalues and/or right eigenvectors of a real upper quasi-triangular matrix T (or of any matrix  $Q^*T^*Q$  with Q orthogonal)

```
SUBROUTINE DTRSNA( JOB, HOWMNY, SELECT, N, T, LDT, VL, LDVL, VR, LDVR,  
                  S, SEP, MM, M, WORK, LDWORK, IWORK, INFO )
```

```
DOUBLE      PRECISION S( * ), SEP( * ), T( LDT, * ), VL( LDVL, *
), VR( LDVR, * ), WORK( LDWORK, * )
```

DTRSNA estimates reciprocal condition numbers for specified eigenvalues and/or right eigenvectors of a real upper quasi-triangular matrix T (or of any matrix  $Q^*TQ$  with Q orthogonal).

T must be in Schur canonical form (as returned by DHSEQR), that is, block upper triangular with 1-by-1 and 2-by-2 diagonal blocks; each 2-by-2 diagonal block has its diagonal elements equal and its off-diagonal elements of opposite sign.

JOB (input) CHARACTER\*1  
Specifies whether condition numbers are required for eigenvalues (S) or eigenvectors (SEP):  
= 'E': for eigenvalues only (S);  
= 'V': for eigenvectors only (SEP);

= 'B': for both eigenvalues and eigenvectors (S and SEP).

HOWMNY (input) CHARACTER\*1  
 = 'A': compute condition numbers for all eigenpairs;  
 = 'S': compute condition numbers for selected eigenpairs specified by the array SELECT.

SELECT (input) LOGICAL array, dimension (N)  
 If HOWMNY = 'S', SELECT specifies the eigenpairs for which condition numbers are required. To select condition numbers for the eigenpair corresponding to a real eigenvalue  $w(j)$ , SELECT(j) must be set to .TRUE.. To select condition numbers corresponding to a complex conjugate pair of eigenvalues  $w(j)$  and  $w(j+1)$ , either SELECT(j) or SELECT(j+1) or both, must be set to .TRUE.. If HOWMNY = 'A', SELECT is not referenced.

N (input) INTEGER  
 The order of the matrix T.  $N \geq 0$ .

T (input) DOUBLE PRECISION array, dimension (LDT,N)  
 The upper quasi-triangular matrix T, in Schur canonical form.

LDT (input) INTEGER  
 The leading dimension of the array T.  $LDT \geq \max(1,N)$ .

VL (input) DOUBLE PRECISION array, dimension (LDVL,M)  
 If JOB = 'E' or 'B', VL must contain left eigenvectors of T (or of any  $Q^*TQ$  with Q orthogonal), corresponding to the eigenpairs specified by HOWMNY and SELECT. The eigenvectors must be stored in consecutive columns of VL, as returned by DHSEIN or DTREVC. If JOB = 'V', VL is not referenced.

LDVL (input) INTEGER  
 The leading dimension of the array VL.  $LDVL \geq 1$ ; and if JOB = 'E' or 'B',  $LDVL \geq N$ .

VR (input) DOUBLE PRECISION array, dimension (LDVR,M)  
 If JOB = 'E' or 'B', VR must contain right eigenvectors of T (or of any  $Q^*TQ$  with Q orthogonal), corresponding to the eigenpairs specified by HOWMNY and SELECT. The eigenvectors must be stored in consecutive columns of VR, as returned by DHSEIN or DTREVC. If JOB = 'V', VR is not referenced.

LDVR (input) INTEGER  
 The leading dimension of the array VR.  $LDVR \geq 1$ ; and if JOB = 'E' or 'B',  $LDVR \geq N$ .

- S** (output) DOUBLE PRECISION array, dimension (MM)  
 If JOB = 'E' or 'B', the reciprocal condition numbers of the selected eigenvalues, stored in consecutive elements of the array. For a complex conjugate pair of eigenvalues two consecutive elements of S are set to the same value. Thus S(j), SEP(j), and the j-th columns of VL and VR all correspond to the same eigenpair (but not in general the j-th eigenpair, unless all eigenpairs are selected). If JOB = 'V', S is not referenced.
- SEP** (output) DOUBLE PRECISION array, dimension (MM)  
 If JOB = 'V' or 'B', the estimated reciprocal condition numbers of the selected eigenvectors, stored in consecutive elements of the array. For a complex eigenvector two consecutive elements of SEP are set to the same value. If the eigenvalues cannot be reordered to compute SEP(j), SEP(j) is set to 0; this can only occur when the true value would be very small anyway. If JOB = 'E', SEP is not referenced.
- MM** (input) INTEGER  
 The number of elements in the arrays S (if JOB = 'E' or 'B') and/or SEP (if JOB = 'V' or 'B'). MM  $\geq$  M.
- M** (output) INTEGER  
 The number of elements of the arrays S and/or SEP actually used to store the estimated condition numbers. If HOWMNY = 'A', M is set to N.
- WORK** (workspace) DOUBLE PRECISION array, dimension (LDWORK,N+6)  
 If JOB = 'E', WORK is not referenced.
- LDWORK** (input) INTEGER  
 The leading dimension of the array WORK. LDWORK  $\geq$  1; and if JOB = 'V' or 'B', LDWORK  $\geq$  N.
- IWORK** (workspace) INTEGER array, dimension (2\*(N-1))  
 If JOB = 'E', IWORK is not referenced.
- INFO** (output) INTEGER  
 = 0: successful exit  
 < 0: if INFO = -i, the i-th argument had an illegal value

#### FURTHER DETAILS

The reciprocal of the condition number of an eigenvalue  $\lambda$  is defined as

$$S(\text{lambda}) = |v' * u| / (\text{norm}(u) * \text{norm}(v))$$

where  $u$  and  $v$  are the right and left eigenvectors of  $T$  corresponding to  $\text{lambda}$ ;  $v'$  denotes the conjugate-transpose of  $v$ , and  $\text{norm}(u)$  denotes the Euclidean norm. These reciprocal condition numbers always lie between zero (very badly conditioned) and one (very well conditioned). If  $n = 1$ ,  $S(\text{lambda})$  is defined to be 1.

An approximate error bound for a computed eigenvalue  $W(i)$  is given by

$$\text{EPS} * \text{norm}(T) / S(i)$$

where  $\text{EPS}$  is the machine precision.

The reciprocal of the condition number of the right eigenvector  $u$  corresponding to  $\text{lambda}$  is defined as follows. Suppose

$$T = \begin{pmatrix} \text{lambda} & c \\ 0 & T22 \end{pmatrix}$$

Then the reciprocal condition number is

$$\text{SEP}(\text{lambda}, T22) = \text{sigma-min}(T22 - \text{lambda} * I)$$

where  $\text{sigma-min}$  denotes the smallest singular value. We approximate the smallest singular value by the reciprocal of an estimate of the one-norm of the inverse of  $T22 - \text{lambda} * I$ . If  $n = 1$ ,  $\text{SEP}(1)$  is defined to be  $\text{abs}(T(1,1))$ .

An approximate error bound for a computed right eigenvector  $VR(i)$  is given by

$$\text{EPS} * \text{norm}(T) / \text{SEP}(i)$$



```

(LAPACK dtrsna)=
  (let* ((zero 0.0) (one 1.0) (two 2.0))
    (declare (type (double-float 0.0 0.0) zero)
              (type (double-float 1.0 1.0) one)
              (type (double-float 2.0 2.0) two))
    (defun dtrsna
      (job howmny select n t$ ldt vl ldvl vr ldvr s sep mm m work ldwork
        iwork info)
      (declare (type (simple-array fixnum (*)) iwork)
                (type (simple-array double-float (*)) work sep s vr vl t$)
                (type fixnum info ldwork m mm ldvl ldt n)
                (type (simple-array (member t nil) (*)) select)
                (type character howmny job))
      (f2cl-lib:with-multi-array-data
        ((job character job-%data% job-%offset%)
         (howmny character howmny-%data% howmny-%offset%)
         (select (member t nil) select-%data% select-%offset%)
         (t$ double-float t$-%data% t$-%offset%)
         (vl double-float vl-%data% vl-%offset%)
         (vr double-float vr-%data% vr-%offset%)
         (s double-float s-%data% s-%offset%)
         (sep double-float sep-%data% sep-%offset%)
         (work double-float work-%data% work-%offset%)
         (iwork fixnum iwork-%data% iwork-%offset%))
        (prog ((dummy (make-array 1 :element-type 'double-float)) (bignum 0.0)
              (cond$ 0.0) (cs 0.0) (delta 0.0) (dumm 0.0) (eps 0.0) (est 0.0)
              (lnrm 0.0) (mu 0.0) (prod 0.0) (prod1 0.0) (prod2 0.0) (rnrm 0.0)
              (scale 0.0) (smlnum 0.0) (sn 0.0) (i 0) (ierr 0) (ifst 0) (ilst 0)
              (j 0) (k 0) (kase 0) (ks 0) (n2 0) (nn 0) (pair nil) (somcon nil)
              (wantbh nil) (wants nil) (wantsp nil) (/=$ 0.0f0))
              (declare (type (single-float) /=)
                        (type (simple-array double-float (1)) dummy)
                        (type (double-float) bignum cond$ cs delta dumm eps est lnrm
                              mu prod prod1 prod2 rnrm scale smlnum sn)
                        (type fixnum i ierr ifst ilst j k kase ks n2 nn)
                        (type (member t nil) pair somcon wantbh wants wantsp))
              (setf wantbh (char-equal job #\B))
              (setf wants (or (char-equal job #\E) wantbh))
              (setf wantsp (or (char-equal job #\V) wantbh))
              (setf somcon (char-equal howmny #\S))
              (setf info 0)
              (cond
                ((and (not wants) (not wantsp))
                 (setf info -1))
                ((and (not (char-equal howmny #\A)) (not somcon))
                 (setf info -2))

```

```

((< n 0)
 (setf info -4))
((< ldt (max (the fixnum 1) (the fixnum n)))
 (setf info -6))
((or (< ldvl 1) (and wants (< ldvl n)))
 (setf info -8))
((or (< ldvr 1) (and wants (< ldvr n)))
 (setf info -10))
(t
 (cond
  (somcon
   (setf m 0)
   (setf pair nil)
   (f2cl-lib:fdo (k 1 (f2cl-lib:int-add k 1))
    (> k n) nil)

   (tagbody
    (cond
     (pair
      (setf pair nil))
     (t
      (cond
       (< k n)
       (cond
        (=
         (f2cl-lib:fref t$
                        ((f2cl-lib:int-add k 1) k)
                        ((1 ldt) (1 *)))
         zero)
        (if
         (f2cl-lib:fref select-%data%
                        (k)
                        ((1 *))
                        select-%offset%)
         (setf m (f2cl-lib:int-add m 1))))
       (t
        (setf pair t)
        (if
         (or
          (f2cl-lib:fref select-%data%
                        (k)
                        ((1 *))
                        select-%offset%)
          (f2cl-lib:fref select-%data%
                        ((f2cl-lib:int-add k 1))
                        ((1 *))
                        select-%offset%)))

```

```

                (setf m (f2cl-lib:int-add m 2))))))
(t
  (if
    (f2cl-lib:fref select-%data%
      (n)
      ((1 *))
      select-%offset%)
    (setf m (f2cl-lib:int-add m 1)))))))))
(t
  (setf m n)))
(cond
  ((< mm m)
    (setf info -13))
  ((or (< ldwork 1) (and wantsp (< ldwork n)))
    (setf info -16))))
(cond
  ((/= info 0)
    (error
      " ** On entry to ~a parameter number ~a had an illegal value~%"
      "DTRSNA" (f2cl-lib:int-sub info))
    (go end_label)))
(if (= n 0) (go end_label))
(cond
  ((= n 1)
    (cond
      (somcon
        (if
          (not (f2cl-lib:fref select-%data% (1) ((1 *)) select-%offset%))
          (go end_label))))
      (if wants (setf (f2cl-lib:fref s-%data% (1) ((1 *)) s-%offset%) one))
      (if wantsp
        (setf (f2cl-lib:fref sep-%data% (1) ((1 *)) sep-%offset%)
          (abs
            (f2cl-lib:fref t$-%data%
              (1 1)
              ((1 ldt) (1 *))
              t$-%offset%))))
        (go end_label)))
    (setf eps (dlamch "P"))
    (setf smlnum (/ (dlamch "S") eps))
    (setf bignum (/ one smlnum))
    (multiple-value-bind (var-0 var-1)
      (dlabad smlnum bignum)
      (declare (ignore))
      (setf smlnum var-0)
      (setf bignum var-1))

```

```

(setf ks 0)
(setf pair nil)
(f2cl-lib:fdo (k 1 (f2cl-lib:int-add k 1))
              (> k n) nil)
(tagbody
 (cond
  (pair
   (setf pair nil)
   (go label60))
  (t
   (if (< k n)
       (setf pair
              (coerce
               (/=
                (f2cl-lib:fref t$-%data%
                              ((f2cl-lib:int-add k 1) k)
                              ((1 ldt) (1 *))
                              t$-%offset%)
                zero)
              '(member t nil))))))
 (cond
  (somcon
   (cond
    (pair
     (if
      (and
       (not
        (f2cl-lib:fref select-%data% (k) ((1 *)) select-%offset%))
       (not
        (f2cl-lib:fref select-%data%
                        ((f2cl-lib:int-add k 1)
                         ((1 *))
                         select-%offset%)))
      (go label60))))
    (t
     (if
      (not
       (f2cl-lib:fref select-%data% (k) ((1 *)) select-%offset%))
      (go label60))))))
 (setf ks (f2cl-lib:int-add ks 1))
 (cond
  (wants
   (cond
    ((not pair)
     (setf prod
              (ddot n

```

```

(f2cl-lib:array-slice vr
  double-float
  (1 ks)
  ((1 ldvr) (1 *)))
1
(f2cl-lib:array-slice vl
  double-float
  (1 ks)
  ((1 ldvl) (1 *)))
1))
(setf rnmr
  (dnrm2 n
    (f2cl-lib:array-slice vr
      double-float
      (1 ks)
      ((1 ldvr) (1 *)))
    1))
(setf lnmr
  (dnrm2 n
    (f2cl-lib:array-slice vl
      double-float
      (1 ks)
      ((1 ldvl) (1 *)))
    1))
(setf (f2cl-lib:fref s-%data% (ks) ((1 *)) s-%offset%)
  (/ (abs prod) (* rnmr lnmr)))
(t
  (setf prod1
    (ddot n
      (f2cl-lib:array-slice vr
        double-float
        (1 ks)
        ((1 ldvr) (1 *)))
      1
      (f2cl-lib:array-slice vl
        double-float
        (1 ks)
        ((1 ldvl) (1 *)))
      1))
  (setf prod1
    (+ prod1
      (ddot n
        (f2cl-lib:array-slice vr
          double-float
          (1 (f2cl-lib:int-add ks 1))
          ((1 ldvr) (1 *)))

```

```

1
(f2cl-lib:array-slice vl
double-float
(1 (f2cl-lib:int-add ks 1))
((1 ldvl) (1 *)))
1)))
(setf prod2
(ddot n
(f2cl-lib:array-slice vl
double-float
(1 ks)
((1 ldvl) (1 *)))
1
(f2cl-lib:array-slice vr
double-float
(1 (f2cl-lib:int-add ks 1))
((1 ldvr) (1 *)))
1))
(setf prod2
(- prod2
(ddot n
(f2cl-lib:array-slice vl
double-float
(1 (f2cl-lib:int-add ks 1))
((1 ldvl) (1 *)))
1
(f2cl-lib:array-slice vr
double-float
(1 ks)
((1 ldvr) (1 *)))
1)))
(setf rnorm
(dlapy2
(dnrm2 n
(f2cl-lib:array-slice vr
double-float
(1 ks)
((1 ldvr) (1 *)))
1)
(dnrm2 n
(f2cl-lib:array-slice vr
double-float
(1 (f2cl-lib:int-add ks 1))
((1 ldvr) (1 *)))
1)))
(setf lnorm

```

```

(dlapy2
  (dnrm2 n
    (f2cl-lib:array-slice vl
      double-float
      (1 ks)
      ((1 ldvl) (1 *)))
    1)
  (dnrm2 n
    (f2cl-lib:array-slice vl
      double-float
      (1 (f2cl-lib:int-add ks 1))
      ((1 ldvl) (1 *)))
    1)))
(setf cond$ (/ (dlapy2 prod1 prod2) (* rnrm lnrm)))
(setf (f2cl-lib:fref s-%data% (ks) ((1 *)) s-%offset%) cond$)
(setf (f2cl-lib:fref s-%data%
  ((f2cl-lib:int-add ks 1))
  ((1 *))
  s-%offset%)
  cond$))))))
(cond
  (wantsp
    (dlacpy "Full" n n t$ ldt work ldwork)
    (setf ifst k)
    (setf ilst 1)
    (multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
       var-9)
      (dtrexc "No Q" n work ldwork dummy 1 ifst ilst
        (f2cl-lib:array-slice work
          double-float
          (1 (f2cl-lib:int-add n 1))
          ((1 ldwork) (1 *)))
        ierr)
      (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-8))
      (setf ifst var-6)
      (setf ilst var-7)
      (setf ierr var-9))
    (cond
      ((or (= ierr 1) (= ierr 2))
        (setf scale one)
        (setf est bignum))
      (t
        (tagbody
          (cond
            ((= (f2cl-lib:fref work (2 1) ((1 ldwork) (1 *))) zero)

```

```

(f2cl-lib:fdo (i 2 (f2cl-lib:int-add i 1))
  (> i n) nil)
(tagbody
  (setf (f2cl-lib:fref work-%data%
    (i i)
    ((1 ldwork) (1 *))
    work-%offset%)
    (-
      (f2cl-lib:fref work-%data%
        (i i)
        ((1 ldwork) (1 *))
        work-%offset%)
      (f2cl-lib:fref work-%data%
        (1 1)
        ((1 ldwork) (1 *))
        work-%offset%))))))
(setf n2 1)
(setf nn (f2cl-lib:int-sub n 1)))
(t
  (setf mu
    (*
      (f2cl-lib:fsqrt
        (abs
          (f2cl-lib:fref work-%data%
            (1 2)
            ((1 ldwork) (1 *))
            work-%offset%)))
      (f2cl-lib:fsqrt
        (abs
          (f2cl-lib:fref work-%data%
            (2 1)
            ((1 ldwork) (1 *))
            work-%offset%))))))
  (setf delta
    (dlapy2 mu
      (f2cl-lib:fref work-%data%
        (2 1)
        ((1 ldwork) (1 *))
        work-%offset%)))
  (setf cs (/ mu delta))
  (setf sn
    (/
      (-
        (f2cl-lib:fref work-%data%
          (2 1)
          ((1 ldwork) (1 *))

```



```

                                work-%offset%))
                                delta))
(f2cl-lib:fdo (j 3 (f2cl-lib:int-add j 1))
              (> j n) nil)
(tagbody
  (setf (f2cl-lib:fref work-%data%
                      (2 j)
                      ((1 ldwork) (1 *))
                      work-%offset%))
        (* cs
          (f2cl-lib:fref work-%data%
                        (2 j)
                        ((1 ldwork) (1 *))
                        work-%offset%)))
  (setf (f2cl-lib:fref work-%data%
                      (j j)
                      ((1 ldwork) (1 *))
                      work-%offset%))
        (-
          (f2cl-lib:fref work-%data%
                        (j j)
                        ((1 ldwork) (1 *))
                        work-%offset%)
          (f2cl-lib:fref work-%data%
                        (1 1)
                        ((1 ldwork) (1 *))
                        work-%offset%))))
  (setf (f2cl-lib:fref work-%data%
                      (2 2)
                      ((1 ldwork) (1 *))
                      work-%offset%)
        zero)
  (setf (f2cl-lib:fref work-%data%
                      (1 (f2cl-lib:int-add n 1))
                      ((1 ldwork) (1 *))
                      work-%offset%)
        (* two mu))
(f2cl-lib:fdo (i 2 (f2cl-lib:int-add i 1))
              (> i
                (f2cl-lib:int-add n
                                  (f2cl-lib:int-sub
                                   1))))
  nil)
(tagbody
  (setf (f2cl-lib:fref work-%data%
                      (i (f2cl-lib:int-add n 1))

```

```

((1 ldwork) (1 *))
work-%offset%)

(* sn
  (f2cl-lib:fref work-%data%
    (1 (f2cl-lib:int-add i 1))
    ((1 ldwork) (1 *))
    work-%offset%))))

(setf n2 2)
(setf nn (f2cl-lib:int-mul 2 (f2cl-lib:int-sub n 1))))
(setf est zero)
(setf kase 0)

label50
(multiple-value-bind (var-0 var-1 var-2 var-3 var-4 var-5)
  (dlacon nn
    (f2cl-lib:array-slice work
      double-float
      (1 (f2cl-lib:int-add n 2))
      ((1 ldwork) (1 *)))
    (f2cl-lib:array-slice work
      double-float
      (1 (f2cl-lib:int-add n 4))
      ((1 ldwork) (1 *)))

    iwork est kase)
  (declare (ignore var-0 var-1 var-2 var-3))
  (setf est var-4)
  (setf kase var-5))
(cond
  ((/= kase 0)
    (cond
      ((= kase 1)
        (cond
          ((= n2 1)
            (multiple-value-bind
              (var-0 var-1 var-2 var-3 var-4 var-5 var-6
               var-7 var-8 var-9 var-10)
              (dlaqtr t t
                (f2cl-lib:int-sub n 1)
                (f2cl-lib:array-slice work
                  double-float
                  (2 2)
                  ((1 ldwork) (1 *)))

                ldwork dummy dumm scale
                (f2cl-lib:array-slice work
                  double-float
                  (1
                    (f2cl-lib:int-add n

```

```

                                                    4))
                                                    ((1 ldwork) (1 *)))
(f2cl-lib:array-slice work
 double-float
 (1
  (f2cl-lib:int-add n
   6))
                                                    ((1 ldwork) (1 *)))
ierr)
(declare (ignore var-0 var-1 var-2 var-3 var-4
               var-5 var-6 var-8 var-9))
(setf scale var-7)
(setf ierr var-10)))
(t
 (multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6
   var-7 var-8 var-9 var-10)
  (dlaqtr t nil
   (f2cl-lib:int-sub n 1)
   (f2cl-lib:array-slice work
    double-float
    (2 2)
    ((1 ldwork) (1 *)))
   ldwork
   (f2cl-lib:array-slice work
    double-float
    (1
     (f2cl-lib:int-add n
      1))
    ((1 ldwork) (1 *)))
   mu scale
   (f2cl-lib:array-slice work
    double-float
    (1
     (f2cl-lib:int-add n
      4))
    ((1 ldwork) (1 *)))
   (f2cl-lib:array-slice work
    double-float
    (1
     (f2cl-lib:int-add n
      6))
    ((1 ldwork) (1 *)))
   ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4
                   var-5 var-6 var-8 var-9))

```

```

        (setf scale var-7)
        (setf ierr var-10))))))
(t
  (cond
    ((= n2 1)
      (multiple-value-bind
        (var-0 var-1 var-2 var-3 var-4 var-5 var-6
         var-7 var-8 var-9 var-10)
        (dlaqtr nil t
          (f2cl-lib:int-sub n 1)
          (f2cl-lib:array-slice work
                                double-float
                                (2 2)
                                ((1 ldwork) (1 *)))
          ldwork dummy dumm scale
          (f2cl-lib:array-slice work
                                double-float
                                (1
                                 (f2cl-lib:int-add n
                                                    4))
                                ((1 ldwork) (1 *)))
          (f2cl-lib:array-slice work
                                double-float
                                (1
                                 (f2cl-lib:int-add n
                                                    6))
                                ((1 ldwork) (1 *)))
          ierr)
        (declare (ignore var-0 var-1 var-2 var-3 var-4
                          var-5 var-6 var-8 var-9))
        (setf scale var-7)
        (setf ierr var-10))))
  (t
    (multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6
       var-7 var-8 var-9 var-10)
      (dlaqtr nil nil
        (f2cl-lib:int-sub n 1)
        (f2cl-lib:array-slice work
                              double-float
                              (2 2)
                              ((1 ldwork) (1 *)))
        ldwork
        (f2cl-lib:array-slice work
                              double-float
                              (1
                               (f2cl-lib:int-add n
                                                  4))
                               ((1 ldwork) (1 *)))
        ierr)
      (declare (ignore var-0 var-1 var-2 var-3 var-4
                        var-5 var-6 var-8 var-9))
      (setf scale var-7)
      (setf ierr var-10))))

```

```
(f2cl-lib:int-add n
1))
((1 ldwork) (1 *)))
mu scale
(f2cl-lib:array-slice work
double-float
(1
(f2cl-lib:int-add n
4))
((1 ldwork) (1 *)))
(f2cl-lib:array-slice work
double-float
(1
(f2cl-lib:int-add n
6))
((1 ldwork) (1 *)))
(ierr)
(declare (ignore var-0 var-1 var-2 var-3 var-4
var-5 var-6 var-8 var-9))
(setf scale var-7)
(setf ierr var-10))))))
(go label50))))))
(setf (f2cl-lib:fref sep-%data% (ks) ((1 *)) sep-%offset%)
(/ scale (max est smlnum)))
(if pair
(setf (f2cl-lib:fref sep-%data%
((f2cl-lib:int-add ks 1))
((1 *))
sep-%offset%)
(f2cl-lib:fref sep-%data%
(ks)
((1 *))
sep-%offset%))))))
(if pair (setf ks (f2cl-lib:int-add ks 1)))
label60))
end_label
(return
(values nil
nil
nil
nil
nil
nil
nil
nil
nil
nil
nil
```

```
nil
nil
nil
nil
m
nil
nil
nil
info))))))
```

### 7.93 *ieeeck* LAPACK

```
<ieeeck.input>≡
)set break resume
)sys rm -f ieeeck.output
)spool ieeeck.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

*<ieeeck.help>*≡

```
=====
ieeeck examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

IEEECK - called from the ILAENV to verify that Infinity and possibly NaN arithmetic is safe (i.e

#### SYNOPSIS

```
INTEGER FUNCTION IEEECK( ISPEC, ZERO, ONE )
```

```
INTEGER      ISPEC
```

```
REAL         ONE, ZERO
```

#### PURPOSE

IEEECK is called from the ILAENV to verify that Infinity and possibly NaN arithmetic is safe (i.e. will not trap).

#### ARGUMENTS

ISPEC (input) INTEGER

Specifies whether to test just for infinity arithmetic or whether to test for infinity and NaN arithmetic. = 0: Verify infinity arithmetic only.  
= 1: Verify infinity and NaN arithmetic.

ZERO (input) REAL

Must contain the value 0.0 This is passed to prevent the compiler from optimizing away this code.

ONE (input) REAL

Must contain the value 1.0 This is passed to prevent the compiler from optimizing away this code.

RETURN VALUE: INTEGER = 0: Arithmetic failed to produce the correct answers

= 1: Arithmetic produced the correct answers

Return if we were only asked to check infinity arithmetic



```

(LAPACK ieeeck)=
  (defun ieeeck (ispec zero one)
    (declare (type (single-float) one zero) (type fixnum ispec))
    (prog ((nan1 0.0f0) (nan2 0.0f0) (nan3 0.0f0) (nan4 0.0f0) (nan5 0.0f0)
           (nan6 0.0f0) (neginf 0.0f0) (negzro 0.0f0) (newzro 0.0f0)
           (posinf 0.0f0) (ieeeck 0))
      (declare (type fixnum ieeeck)
                (type (single-float) posinf newzro negzro neginf nan6 nan5 nan4
                                nan3 nan2 nan1))

      (setf ieeeck 1)
      (setf posinf (/ one zero))
      (cond
        ((<= posinf one)
         (setf ieeeck 0)
         (go end_label)))
      (setf neginf (/ (- one) zero))
      (cond
        ((>= neginf zero)
         (setf ieeeck 0)
         (go end_label)))
      (setf negzro (/ one (+ neginf one)))
      (cond
        ((/= negzro zero)
         (setf ieeeck 0)
         (go end_label)))
      (setf neginf (/ one negzro))
      (cond
        ((>= neginf zero)
         (setf ieeeck 0)
         (go end_label)))
      (setf newzro (+ negzro zero))
      (cond
        ((/= newzro zero)
         (setf ieeeck 0)
         (go end_label)))
      (setf posinf (/ one newzro))
      (cond
        ((<= posinf one)
         (setf ieeeck 0)
         (go end_label)))
      (setf neginf (* neginf posinf))
      (cond
        ((>= neginf zero)
         (setf ieeeck 0)
         (go end_label)))
      (setf posinf (* posinf posinf))

```

```

(cond
  ((<= posinf one)
   (setf ieeeck 0)
   (go end_label)))
(if (= ispec 0) (go end_label))
(setf nan1 (+ posinf neginf))
(setf nan2 (/ posinf neginf))
(setf nan3 (/ posinf posinf))
(setf nan4 (* posinf zero))
(setf nan5 (* neginf negzro))
(setf nan6 (* nan5 0.0f0))
(cond
  ((= nan1 nan1)
   (setf ieeeck 0)
   (go end_label)))
(cond
  ((= nan2 nan2)
   (setf ieeeck 0)
   (go end_label)))
(cond
  ((= nan3 nan3)
   (setf ieeeck 0)
   (go end_label)))
(cond
  ((= nan4 nan4)
   (setf ieeeck 0)
   (go end_label)))
(cond
  ((= nan5 nan5)
   (setf ieeeck 0)
   (go end_label)))
(cond
  ((= nan6 nan6)
   (setf ieeeck 0)
   (go end_label)))
end_label
(return (values ieeeck nil nil nil)))

```

## 7.94 ilaenv LAPACK

```
<ilaenv.input>≡  
  )set break resume  
  )sys rm -f ilaenv.output  
  )spool ilaenv.output  
  )set message test on  
  )set message auto off  
  )clear all  
  
  )spool  
  )lisp (bye)
```

*<ilaenv.help>*≡

```
=====
ilaenv examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

ILAENV - called from the LAPACK routines to choose problem-dependent parameters for the local environment

#### SYNOPSIS

```
INTEGER FUNCTION ILAENV( ISPEC, NAME, OPTS, N1, N2, N3, N4 )
```

```
CHARACTER*( * ) NAME, OPTS
```

```
INTEGER      ISPEC, N1, N2, N3, N4
```

#### PURPOSE

ILAENV is called from the LAPACK routines to choose problem-dependent parameters for the local environment. See ISPEC for a description of the parameters.

ILAENV returns an INTEGER

if ILAENV >= 0: ILAENV returns the value of the parameter specified by ISPEC if ILAENV < 0: if ILAENV = -k, the k-th argument had an illegal value.

This version provides a set of parameters which should give good, but not optimal, performance on many of the currently available computers. Users are encouraged to modify this subroutine to set the tuning parameters for their particular machine using the option and problem size information in the arguments.

This routine will not function correctly if it is converted to all lower case. Converting it to all upper case is allowed.

#### ARGUMENTS

ISPEC (input) INTEGER

Specifies the parameter to be returned as the value of ILAENV.  
 = 1: the optimal blocksize; if this value is 1, an unblocked algorithm will give the best performance. = 2: the minimum block size for which the block routine should be used; if the

usable block size is less than this value, an unblocked routine should be used. = 3: the crossover point (in a block routine, for  $N$  less than this value, an unblocked routine should be used) = 4: the number of shifts, used in the nonsymmetric eigenvalue routines (DEPRECATED) = 5: the minimum column dimension for blocking to be used; rectangular blocks must have dimension at least  $k$  by  $m$ , where  $k$  is given by `ILAENV(2,...)` and  $m$  by `ILAENV(5,...)` = 6: the crossover point for the SVD (when reducing an  $m$  by  $n$  matrix to bidiagonal form, if  $\max(m,n)/\min(m,n)$  exceeds this value, a QR factorization is used first to reduce the matrix to a triangular form.) = 7: the number of processors  
 = 8: the crossover point for the multishift QR method for nonsymmetric eigenvalue problems (DEPRECATED) = 9: maximum size of the subproblems at the bottom of the computation tree in the divide-and-conquer algorithm (used by `xGELSD` and `xGESDD`) = 10: IEEE NaN arithmetic can be trusted not to trap  
 = 11: infinity arithmetic can be trusted not to trap  
 12 <= ISPEC <= 16: `xHSEQR` or one of its subroutines, see `IPARMQ` for detailed explanation

**NAME** (input) CHARACTER\*(\*)  
 The name of the calling subroutine, in either upper case or lower case.

**OPTS** (input) CHARACTER\*(\*)  
 The character options to the subroutine **NAME**, concatenated into a single character string. For example, `UPLO = 'U'`, `TRANS = 'T'`, and `DIAG = 'N'` for a triangular routine would be specified as `OPTS = 'UTN'`.

**N1** (input) INTEGER  
**N2** (input) INTEGER **N3** (input) INTEGER **N4** (input) INTEGER  
 Problem dimensions for the subroutine **NAME**; these may not all be required.

#### FURTHER DETAILS

The following conventions have been used when calling `ILAENV` from the LAPACK routines:

- 1) **OPTS** is a concatenation of all of the character options to subroutine **NAME**, in the same order that they appear in the argument list for **NAME**, even if they are not used in determining the value of the parameter specified by **ISPEC**.
- 2) The problem dimensions **N1**, **N2**, **N3**, **N4** are specified in the order that they appear in the argument list for **NAME**. **N1** is used first, **N2** second, and so on, and unused problem dimensions are

passed a value of -1.

- 3) The parameter value returned by ILAENV is checked for validity in the calling subroutine. For example, ILAENV is used to retrieve the optimal blocksize for STRTRI as follows:

```
NB = ILAENV( 1, 'STRTRI', UPLO // DIAG, N, -1, -1, -1 )  
IF( NB.LE.1 ) NB = MAX( 1, N )
```

```

(LAPACK ilaenv)≡
(defun ilaenv (ispec name opts n1 n2 n3 n4)
  (declare (type character opts name)
            (type fixnum n4 n3 n2 n1 ispec))
  (f2cl-lib:with-multi-array-data
    ((name character name-%data% name-%offset%)
     (opts character opts-%data% opts-%offset%))
    (prog ((i 0) (ic 0) (iz 0) (nb 0) (nbmin 0) (nx 0)
           (subnam
            (make-array '(6) :element-type 'character :initial-element #\ ))
            (c3 (make-array '(3) :element-type 'character :initial-element #\ ))
            (c2 (make-array '(2) :element-type 'character :initial-element #\ ))
            (c4 (make-array '(2) :element-type 'character :initial-element #\ ))
            (c1 (make-array '(1) :element-type 'character :initial-element #\ ))
            (cname nil) (sname nil) (ilaenv 0) (char$ 0.0f0))
           (declare (type (single-float) char$)
                     (type (member t nil) sname cname)
                     (type (simple-array character (1)) c1)
                     (type (simple-array character (2)) c4 c2)
                     (type (simple-array character (3)) c3)
                     (type (simple-array character (6)) subnam)
                     (type fixnum ilaenv nx nbmin nb iz ic i))
           (f2cl-lib:computed-goto
            (label100 label100 label100 label1400 label1500 label1600 label1700 label1800
             label1900 label11000 label11100)
            ispec)
           (setf ilaenv -1)
           (go end_label)
           label100
           (setf ilaenv 1)
           (f2cl-lib:f2cl-set-string subnam name (string 6))
           (setf ic (f2cl-lib:ichar (f2cl-lib:fref-string subnam (1 1))))
           (setf iz (f2cl-lib:ichar "Z"))
           (cond
            ((or (= iz 90) (= iz 122))
             (cond
              ((and (>= ic 97) (<= ic 122))
               (f2cl-lib:fset-string (f2cl-lib:fref-string subnam (1 1))
                                     (code-char (f2cl-lib:int-sub ic 32)))
               (f2cl-lib:fdo (i 2 (f2cl-lib:int-add i 1))
                            ((> i 6) nil)
               (tagbody
                (setf ic (f2cl-lib:ichar (f2cl-lib:fref-string subnam (i i))))
                (if (and (>= ic 97) (<= ic 122))
                    (f2cl-lib:fset-string (f2cl-lib:fref-string subnam (i i))
                                           (code-char

```

```

(f2cl-lib:int-sub ic 32)))))))))
((or (= iz 233) (= iz 169))
 (cond
  ((or (and (>= ic 129) (<= ic 137))
        (and (>= ic 145) (<= ic 153))
        (and (>= ic 162) (<= ic 169)))
   (f2cl-lib:fset-string (f2cl-lib:fref-string subnam (1 1))
                        (code-char (f2cl-lib:int-add ic 64)))
   (f2cl-lib:fdo (i 2 (f2cl-lib:int-add i 1))
                 (> i 6) nil)
   (tagbody
    (setf ic (f2cl-lib:ichar (f2cl-lib:fref-string subnam (i i))))
    (if
     (or (and (>= ic 129) (<= ic 137))
         (and (>= ic 145) (<= ic 153))
         (and (>= ic 162) (<= ic 169)))
     (f2cl-lib:fset-string (f2cl-lib:fref-string subnam (i i))
                           (code-char
                            (f2cl-lib:int-add ic 64)))))))))
((or (= iz 218) (= iz 250))
 (cond
  ((and (>= ic 225) (<= ic 250))
   (f2cl-lib:fset-string (f2cl-lib:fref-string subnam (1 1))
                        (code-char (f2cl-lib:int-sub ic 32)))
   (f2cl-lib:fdo (i 2 (f2cl-lib:int-add i 1))
                 (> i 6) nil)
   (tagbody
    (setf ic (f2cl-lib:ichar (f2cl-lib:fref-string subnam (i i))))
    (if (and (>= ic 225) (<= ic 250))
        (f2cl-lib:fset-string (f2cl-lib:fref-string subnam (i i))
                              (code-char
                               (f2cl-lib:int-sub ic 32)))))))))
(f2cl-lib:f2cl-set-string c1
                          (f2cl-lib:fref-string subnam (1 1))
                          (string 1))
(setf sname (or (f2cl-lib:fstring-= c1 "S") (f2cl-lib:fstring-= c1 "D")))
(setf cname (or (f2cl-lib:fstring-= c1 "C") (f2cl-lib:fstring-= c1 "Z")))
(if (not (or cname sname)) (go end_label))
(f2cl-lib:f2cl-set-string c2
                          (f2cl-lib:fref-string subnam (2 3))
                          (string 2))
(f2cl-lib:f2cl-set-string c3
                          (f2cl-lib:fref-string subnam (4 6))
                          (string 3))
(f2cl-lib:f2cl-set-string c4 (f2cl-lib:fref-string c3 (2 3)) (string 2))
(f2cl-lib:computed-goto (label110 label200 label300) ispec)

```



```

label110
  (setf nb 1)
  (cond
    ((f2cl-lib:fstring-= c2 "GE")
      (cond
        ((f2cl-lib:fstring-= c3 "TRF")
          (cond
            (sname
              (setf nb 64))
            (t
              (setf nb 64))))
          ((or (f2cl-lib:fstring-= c3 "QRF")
              (f2cl-lib:fstring-= c3 "RQF")
              (f2cl-lib:fstring-= c3 "LQF")
              (f2cl-lib:fstring-= c3 "QLF"))
            (cond
              (sname
                (setf nb 32))
              (t
                (setf nb 32))))
          ((f2cl-lib:fstring-= c3 "HRD")
            (cond
              (sname
                (setf nb 32))
              (t
                (setf nb 32))))
          ((f2cl-lib:fstring-= c3 "BRD")
            (cond
              (sname
                (setf nb 32))
              (t
                (setf nb 32))))
          ((f2cl-lib:fstring-= c3 "TRI")
            (cond
              (sname
                (setf nb 64))
              (t
                (setf nb 64))))))
    ((f2cl-lib:fstring-= c2 "P0")
      (cond
        ((f2cl-lib:fstring-= c3 "TRF")
          (cond
            (sname
              (setf nb 64))
            (t
              (setf nb 64))))))

```

```

((f2cl-lib:fstring== c2 "SY")
  (cond
    ((f2cl-lib:fstring== c3 "TRF")
      (cond
        (sname
          (setf nb 64))
        (t
          (setf nb 64))))
    ((and sname (f2cl-lib:fstring== c3 "TRD"))
      (setf nb 32))
    ((and sname (f2cl-lib:fstring== c3 "GST"))
      (setf nb 64))))
((and cname (f2cl-lib:fstring== c2 "HE"))
  (cond
    ((f2cl-lib:fstring== c3 "TRF")
      (setf nb 64))
    ((f2cl-lib:fstring== c3 "TRD")
      (setf nb 32))
    ((f2cl-lib:fstring== c3 "GST")
      (setf nb 64))))
((and sname (f2cl-lib:fstring== c2 "OR"))
  (cond
    ((f2cl-lib:fstring== (f2cl-lib:fref-string c3 (1 1)) "G")
      (cond
        ((or (f2cl-lib:fstring== c4 "QR")
              (f2cl-lib:fstring== c4 "RQ")
              (f2cl-lib:fstring== c4 "LQ")
              (f2cl-lib:fstring== c4 "QL")
              (f2cl-lib:fstring== c4 "HR")
              (f2cl-lib:fstring== c4 "TR")
              (f2cl-lib:fstring== c4 "BR"))
          (setf nb 32))))
    ((f2cl-lib:fstring== (f2cl-lib:fref-string c3 (1 1)) "M")
      (cond
        ((or (f2cl-lib:fstring== c4 "QR")
              (f2cl-lib:fstring== c4 "RQ")
              (f2cl-lib:fstring== c4 "LQ")
              (f2cl-lib:fstring== c4 "QL")
              (f2cl-lib:fstring== c4 "HR")
              (f2cl-lib:fstring== c4 "TR")
              (f2cl-lib:fstring== c4 "BR"))
          (setf nb 32))))))
((and cname (f2cl-lib:fstring== c2 "UN"))
  (cond
    ((f2cl-lib:fstring== (f2cl-lib:fref-string c3 (1 1)) "G")
      (cond

```

```

      ((or (f2cl-lib:fstring== c4 "QR")
            (f2cl-lib:fstring== c4 "RQ")
            (f2cl-lib:fstring== c4 "LQ")
            (f2cl-lib:fstring== c4 "QL")
            (f2cl-lib:fstring== c4 "HR")
            (f2cl-lib:fstring== c4 "TR")
            (f2cl-lib:fstring== c4 "BR")))
      (setf nb 32))))
((f2cl-lib:fstring== (f2cl-lib:fref-string c3 (1 1)) "M")
 (cond
  ((or (f2cl-lib:fstring== c4 "QR")
        (f2cl-lib:fstring== c4 "RQ")
        (f2cl-lib:fstring== c4 "LQ")
        (f2cl-lib:fstring== c4 "QL")
        (f2cl-lib:fstring== c4 "HR")
        (f2cl-lib:fstring== c4 "TR")
        (f2cl-lib:fstring== c4 "BR")))
   (setf nb 32))))))
((f2cl-lib:fstring== c2 "GB")
 (cond
  ((f2cl-lib:fstring== c3 "TRF")
   (cond
    (sname
     (cond
      ((<= n4 64)
       (setf nb 1))
      (t
       (setf nb 32))))))
   (t
    (cond
     ((<= n4 64)
      (setf nb 1))
     (t
      (setf nb 32))))))))))
((f2cl-lib:fstring== c2 "PB")
 (cond
  ((f2cl-lib:fstring== c3 "TRF")
   (cond
    (sname
     (cond
      ((<= n2 64)
       (setf nb 1))
      (t
       (setf nb 32))))))
   (t
    (cond

```

```

        ((<= n2 64)
         (setf nb 1))
        (t
         (setf nb 32)))))))))
((f2cl-lib:fstring-= c2 "TR")
 (cond
  ((f2cl-lib:fstring-= c3 "TRI")
   (cond
    (sname
     (setf nb 64))
    (t
     (setf nb 64))))))
((f2cl-lib:fstring-= c2 "LA")
 (cond
  ((f2cl-lib:fstring-= c3 "UUM")
   (cond
    (sname
     (setf nb 64))
    (t
     (setf nb 64))))))
((and sname (f2cl-lib:fstring-= c2 "ST"))
 (cond
  ((f2cl-lib:fstring-= c3 "EBZ")
   (setf nb 1))))))
(setf ilaenv nb)
(go end_label)
label200
(setf nbmin 2)
(cond
 ((f2cl-lib:fstring-= c2 "GE")
  (cond
   ((or (f2cl-lib:fstring-= c3 "QRF")
        (f2cl-lib:fstring-= c3 "RQF")
        (f2cl-lib:fstring-= c3 "LQF")
        (f2cl-lib:fstring-= c3 "QLF"))
    (cond
     (sname
      (setf nbmin 2))
     (t
      (setf nbmin 2))))
   ((f2cl-lib:fstring-= c3 "HRD")
    (cond
     (sname
      (setf nbmin 2))
     (t
      (setf nbmin 2))))))

```

```

((f2cl-lib:fstring== c3 "BRD")
  (cond
    (sname
      (setf nbmin 2))
    (t
      (setf nbmin 2))))
((f2cl-lib:fstring== c3 "TRI")
  (cond
    (sname
      (setf nbmin 2))
    (t
      (setf nbmin 2))))))
((f2cl-lib:fstring== c2 "SY")
  (cond
    ((f2cl-lib:fstring== c3 "TRF")
      (cond
        (sname
          (setf nbmin 8))
        (t
          (setf nbmin 8))))
    ((and sname (f2cl-lib:fstring== c3 "TRD"))
      (setf nbmin 2))))
((and cname (f2cl-lib:fstring== c2 "HE"))
  (cond
    ((f2cl-lib:fstring== c3 "TRD")
      (setf nbmin 2))))
((and sname (f2cl-lib:fstring== c2 "OR"))
  (cond
    ((f2cl-lib:fstring== (f2cl-lib:fref-string c3 (1 1)) "G")
      (cond
        ((or (f2cl-lib:fstring== c4 "QR")
              (f2cl-lib:fstring== c4 "RQ")
              (f2cl-lib:fstring== c4 "LQ")
              (f2cl-lib:fstring== c4 "QL")
              (f2cl-lib:fstring== c4 "HR")
              (f2cl-lib:fstring== c4 "TR")
              (f2cl-lib:fstring== c4 "BR"))
          (setf nbmin 2))))
    ((f2cl-lib:fstring== (f2cl-lib:fref-string c3 (1 1)) "M")
      (cond
        ((or (f2cl-lib:fstring== c4 "QR")
              (f2cl-lib:fstring== c4 "RQ")
              (f2cl-lib:fstring== c4 "LQ")
              (f2cl-lib:fstring== c4 "QL")
              (f2cl-lib:fstring== c4 "HR")
              (f2cl-lib:fstring== c4 "TR"))

```

```

        (f2cl-lib:fstring== c4 "BR"))
      (setf nbmin 2))))))
((and cname (f2cl-lib:fstring== c2 "UN"))
 (cond
  ((f2cl-lib:fstring== (f2cl-lib:fref-string c3 (1 1)) "G")
   (cond
    ((or (f2cl-lib:fstring== c4 "QR")
         (f2cl-lib:fstring== c4 "RQ")
         (f2cl-lib:fstring== c4 "LQ")
         (f2cl-lib:fstring== c4 "QL")
         (f2cl-lib:fstring== c4 "HR")
         (f2cl-lib:fstring== c4 "TR")
         (f2cl-lib:fstring== c4 "BR"))
     (setf nbmin 2))))
   ((f2cl-lib:fstring== (f2cl-lib:fref-string c3 (1 1)) "M")
    (cond
     ((or (f2cl-lib:fstring== c4 "QR")
          (f2cl-lib:fstring== c4 "RQ")
          (f2cl-lib:fstring== c4 "LQ")
          (f2cl-lib:fstring== c4 "QL")
          (f2cl-lib:fstring== c4 "HR")
          (f2cl-lib:fstring== c4 "TR")
          (f2cl-lib:fstring== c4 "BR"))
      (setf nbmin 2)))))))
(setf ilaenv nbmin)
(go end_label)
label300
(setf nx 0)
(cond
 ((f2cl-lib:fstring== c2 "GE")
  (cond
   ((or (f2cl-lib:fstring== c3 "QRF")
        (f2cl-lib:fstring== c3 "RQF")
        (f2cl-lib:fstring== c3 "LQF")
        (f2cl-lib:fstring== c3 "QLF"))
    (cond
     (sname
      (setf nx 128))
     (t
      (setf nx 128))))
   ((f2cl-lib:fstring== c3 "HRD")
    (cond
     (sname
      (setf nx 128))
     (t
      (setf nx 128))))))

```

```

      ((f2cl-lib:fstring== c3 "BRD")
      (cond
        (sname
         (setf nx 128))
        (t
         (setf nx 128))))))
    ((f2cl-lib:fstring== c2 "SY")
    (cond
      ((and sname (f2cl-lib:fstring== c3 "TRD"))
       (setf nx 32))))
    ((and cname (f2cl-lib:fstring== c2 "HE"))
    (cond
      ((f2cl-lib:fstring== c3 "TRD")
       (setf nx 32))))
    ((and sname (f2cl-lib:fstring== c2 "OR"))
    (cond
      ((f2cl-lib:fstring== (f2cl-lib:fref-string c3 (1 1)) "G")
      (cond
        ((or (f2cl-lib:fstring== c4 "QR")
              (f2cl-lib:fstring== c4 "RQ")
              (f2cl-lib:fstring== c4 "LQ")
              (f2cl-lib:fstring== c4 "QL")
              (f2cl-lib:fstring== c4 "HR")
              (f2cl-lib:fstring== c4 "TR")
              (f2cl-lib:fstring== c4 "BR"))
         (setf nx 128))))))
    ((and cname (f2cl-lib:fstring== c2 "UN"))
    (cond
      ((f2cl-lib:fstring== (f2cl-lib:fref-string c3 (1 1)) "G")
      (cond
        ((or (f2cl-lib:fstring== c4 "QR")
              (f2cl-lib:fstring== c4 "RQ")
              (f2cl-lib:fstring== c4 "LQ")
              (f2cl-lib:fstring== c4 "QL")
              (f2cl-lib:fstring== c4 "HR")
              (f2cl-lib:fstring== c4 "TR")
              (f2cl-lib:fstring== c4 "BR"))
         (setf nx 128))))))
    (setf ilaenv nx)
    (go end_label)
label400
    (setf ilaenv 6)
    (go end_label)
label500
    (setf ilaenv 2)
    (go end_label)

```

```

label600
  (setf ilaenv
    (f2cl-lib:int
      (*
        (coerce (realpart
          (min (the fixnum n1) (the fixnum n2))) 'single-float)
          1.6f0)))
    (go end_label)
label700
  (setf ilaenv 1)
  (go end_label)
label800
  (setf ilaenv 50)
  (go end_label)
label900
  (setf ilaenv 25)
  (go end_label)
label1000
  (setf ilaenv 0)
  (cond
    ((= ilaenv 1)
      (setf ilaenv (ieeeck 0 0.0f0 1.0f0))))
  (go end_label)
label1100
  (setf ilaenv 0)
  (cond
    ((= ilaenv 1)
      (setf ilaenv (ieeeck 1 0.0f0 1.0f0))))
end_label
  (return (values ilaenv nil nil nil nil nil nil nil))))

```

## 7.95 zlange LAPACK

```

⟨zlange.input⟩≡
)set break resume
)sys rm -f zlange.output
)spool zlange.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)

```



`<zlange.help>=`

```
=====
zlange examples
=====
```

```
=====
Man Page Details
=====
```

#### NAME

ZLANGE - the value of the one norm, or the Frobenius norm, or the infinity norm, or the element of largest absolute value of a complex matrix A

#### SYNOPSIS

```
DOUBLE PRECISION FUNCTION ZLANGE( NORM, M, N, A, LDA, WORK )
```

```
CHARACTER    NORM
```

```
INTEGER      LDA, M, N
```

```
DOUBLE       PRECISION WORK( * )
```

```
COMPLEX*16   A( LDA, * )
```

#### PURPOSE

ZLANGE returns the value of the one norm, or the Frobenius norm, or the infinity norm, or the element of largest absolute value of a complex matrix A.

#### DESCRIPTION

ZLANGE returns the value

```
ZLANGE = ( max(abs(A(i,j))), NORM = 'M' or 'm'
(
( norm1(A),          NORM = '1', 'O' or 'o'
(
( normI(A),          NORM = 'I' or 'i'
(
( normF(A),          NORM = 'F', 'f', 'E' or 'e'
```

where norm1 denotes the one norm of a matrix (maximum column sum), normI denotes the infinity norm of a matrix (maximum row sum) and normF denotes the Frobenius norm of a matrix (square root of sum of squares). Note that max(abs(A(i,j))) is not a consistent matrix

norm.

#### ARGUMENTS

- NORM** (input) CHARACTER\*1  
Specifies the value to be returned in ZLANGE as described above.
- M** (input) INTEGER  
The number of rows of the matrix A.  $M \geq 0$ . When  $M = 0$ , ZLANGE is set to zero.
- N** (input) INTEGER  
The number of columns of the matrix A.  $N \geq 0$ . When  $N = 0$ , ZLANGE is set to zero.
- A** (input) COMPLEX\*16 array, dimension (LDA,N)  
The m by n matrix A.
- LDA** (input) INTEGER  
The leading dimension of the array A.  $LDA \geq \max(M,1)$ .
- WORK** (workspace) DOUBLE PRECISION array, dimension (MAX(1,LWORK)),  
where LWORK  $\geq M$  when NORM = 'I'; otherwise, WORK is not referenced.

```

(LAPACK zlange)=
  (let* ((one 1.0) (zero 0.0))
    (declare (type (double-float 1.0 1.0) one)
              (type (double-float 0.0 0.0) zero))
    (defun zlange (norm m n a lda work)
      (declare (type (simple-array double-float (*)) work)
                (type (simple-array (complex double-float) (*)) a)
                (type fixnum lda n m)
                (type character norm))
      (f2cl-lib:with-multi-array-data
        ((norm character norm-%data% norm-%offset%)
         (a (complex double-float) a-%data% a-%offset%)
         (work double-float work-%data% work-%offset%))
        (prog ((scale 0.0) (sum 0.0) (value 0.0) (i 0) (j 0) (zlange 0.0))
          (declare (type fixnum i j)
                    (type (double-float) scale sum value zlange))
          (cond
            ((= (min (the fixnum m) (the fixnum n)) 0)
              (setf value zero))
            ((char-equal norm #\M)
              (setf value zero)
              (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                            ((> j n) nil)
                (tagbody
                  (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                                ((> i m) nil)
                    (tagbody
                      (setf value
                            (max value
                                (abs
                                  (f2cl-lib:fref a-%data%
                                                    (i j)
                                                    ((1 lda) (1 *))
                                                    a-%offset%))))))))))
            ((or (char-equal norm #\0) (f2cl-lib:fstring-= norm "1"))
              (setf value zero)
              (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                            ((> j n) nil)
                (tagbody
                  (setf sum zero)
                  (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                                ((> i m) nil)
                    (tagbody
                      (setf sum
                            (+ sum
                                (abs
                                  (f2cl-lib:fref a-%data%
                                                    (i j)
                                                    ((1 lda) (1 *))
                                                    a-%offset%))))))))))
          (return value)))

```

```

                                (f2cl-lib:fref a-%data%
                                  (i j)
                                  ((1 lda) (1 *))
                                  a-%offset%))))))
      (setf value (max value sum))))))
((char-equal norm #\I)
 (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
               (> i m) nil)
  (tagbody
    (setf (f2cl-lib:fref work-%data% (i) ((1 *)) work-%offset%)
          zero)))
(f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
              (> j n) nil)
  (tagbody
    (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                  (> i m) nil)
      (tagbody
        (setf (f2cl-lib:fref work-%data% (i) ((1 *)) work-%offset%)
              (+
                (f2cl-lib:fref work-%data%
                              (i)
                              ((1 *))
                              work-%offset%)
                (abs
                 (f2cl-lib:fref a-%data%
                               (i j)
                               ((1 lda) (1 *))
                               a-%offset%))))))))
(setf value zero)
(f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
              (> i m) nil)
  (tagbody
    (setf value
          (max value
            (f2cl-lib:fref work-%data%
                          (i)
                          ((1 *))
                          work-%offset%))))))
((or (char-equal norm #\F) (char-equal norm #\E))
 (setf scale zero)
 (setf sum one)
 (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
               (> j n) nil)
  (tagbody
    (multiple-value-bind (var-0 var-1 var-2 var-3 var-4)
      (zlassq m

```

```

(f2cl-lib:array-slice a
  (complex double-float)
  (1 j)
  ((1 lda) (1 *)))
  1 scale sum)
(declare (ignore var-0 var-1 var-2))
(setf scale var-3)
(setf sum var-4))))
(setf value (* scale (f2cl-lib:fsqrt sum))))
(setf zlange value)
(return (values zlange nil nil nil nil nil nil))))))

```

## 7.96 zlassq LAPACK

```

<zlassq.input>≡
)set break resume
)sys rm -f zlassq.output
)spool zlassq.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)

```

`<zlassq.help>`≡

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zlassq examples

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Man Page Details

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#### NAME

ZLASSQ - the values scl and ssq such that  $(scl**2)*ssq = x(1)**2 + \dots + x(n)**2 + (scale**2)*sumsq$ ,

#### SYNOPSIS

SUBROUTINE ZLASSQ( N, X, INCX, SCALE, SUMSQ )

INTEGER INCX, N

DOUBLE PRECISION SCALE, SUMSQ

COMPLEX\*16 X( \* )

#### PURPOSE

ZLASSQ returns the values scl and ssq such that

where  $x(i) = \text{abs}(X(1 + (i - 1)*INCX))$ . The value of sumsq is assumed to be at least unity and the value of ssq will then satisfy

$$1.0 \leq ssq \leq (sumsq + 2*n).$$

scale is assumed to be non-negative and scl returns the value

$$scl = \max_i (scale, \text{abs}(\text{real}(x(i))), \text{abs}(\text{aimag}(x(i))))$$

scale and sumsq must be supplied in SCALE and SUMSQ respectively. SCALE and SUMSQ are overwritten by scl and ssq respectively.

The routine makes only one pass through the vector X.

#### ARGUMENTS

N (input) INTEGER

The number of elements to be used from the vector X.

X (input) COMPLEX\*16 array, dimension (N)

The vector  $x$  as described above.  $x(i) = X(1 + (i - 1) * INCX)$ ,  $1 \leq i \leq n$ .

**INCX** (input) INTEGER  
The increment between successive values of the vector  $X$ .  $INCX > 0$ .

**SCALE** (input/output) DOUBLE PRECISION  
On entry, the value  $scale$  in the equation above. On exit, **SCALE** is overwritten with the value  $scl$ .

**SUMSQ** (input/output) DOUBLE PRECISION  
On entry, the value  $sumsq$  in the equation above. On exit, **SUMSQ** is overwritten with the value  $ssq$ .

```

(LAPACK zlassq)≡
  (let* ((zero 0.0))
    (declare (type (double-float 0.0 0.0) zero))
    (defun zlassq (n x incx scale sumsq)
      (declare (type (double-float) sumsq scale)
        (type (simple-array (complex double-float) (*)) x)
        (type fixnum incx n))
      (f2cl-lib:with-multi-array-data
        ((x (complex double-float) x-%data% x-%offset%))
        (prog ((temp1 0.0) (ix 0))
          (declare (type (double-float) temp1) (type fixnum ix))
          (cond
            ((> n 0)
              (f2cl-lib:fdo (ix 1 (f2cl-lib:int-add ix incx))
                ((> ix
                  (f2cl-lib:int-add 1
                    (f2cl-lib:int-mul
                      (f2cl-lib:int-add n
                        (f2cl-lib:int-sub 1))
                      incx)))
                nil)
              (tagbody
                (cond
                  ((/= (coerce (realpart (f2cl-lib:fref x (ix) ((1 *))) 'double-float) zero)
                    (setf temp1
                      (abs
                        (coerce (realpart
                          (f2cl-lib:fref x-%data% (ix) ((1 *)) x-%offset%) 'double-float)
                        scale temp1)
                      (setf sumsq (+ 1 (* sumsq (expt (/ scale temp1) 2))))
                      (setf scale temp1))
                    (t
                      (setf sumsq (+ sumsq (expt (/ temp1 scale) 2))))))
                  (cond
                    ((/= (f2cl-lib:dimag (f2cl-lib:fref x (ix) ((1 *))) zero)
                      (setf temp1
                        (abs
                          (f2cl-lib:dimag
                            (f2cl-lib:fref x-%data% (ix) ((1 *)) x-%offset%)))
                        scale temp1)
                      (setf sumsq (+ 1 (* sumsq (expt (/ scale temp1) 2))))
                      (setf scale temp1))
                    (t
                      (setf sumsq (+ sumsq (expt (/ temp1 scale) 2))))))))))

```



```
(return (values nil nil nil scale sumsq))))))
```

## Chapter 8

# Chunk collections

$\langle \text{Numerics} \rangle \equiv$   
(in-package "BOOT")

$\langle \text{BLAS } dcabs1 \rangle$   
 $\langle \text{BLAS } 1 \text{ } dasum \rangle$   
 $\langle \text{BLAS } 1 \text{ } daxpy \rangle$   
 $\langle \text{BLAS } 1 \text{ } dcopy \rangle$

$\langle \text{untested} \rangle \equiv$   
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*⟨LAPACK zlassq⟩*



# Bibliography

- [1] documentation source `ftp://ftp.netlib.org/lapack/manpages.tgz`
- [2] documentation source `http://www.math.utah.edu/software/lapack/lapack-blas.html`
- [3] documentation source Written on 22-October-1986. Jack Dongarra, Argonne National Lab. Jeremy Du Croz, Nag Central Office. Sven Hammarling, Nag Central Office. Richard Hanson, Sandia National Labs.
- [4] Householder, Alston S. “Principles of Numerical Analysis” Dover Publications, Mineola, NY ISBN 0-486-45312-X (1981)
- [5] Golub, Gene H. and Van Loan, Charles F. “Matrix Computations” Johns Hopkins University Press ISBN 0-8018-3772-3 (1989)
- [6] Higham, Nicholas J. “Accuracy and stability of numerical algorithms” SIAM Philadelphia, PA ISBN 0-89871-521-0 (2002)





## Chapter 9

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