

Level 1 BLAS

	dim	scalar	vector	vector	scalars	5-element array
SUBROUTINE xROTG (					A, B, C, S)	
SUBROUTINE xROTMG(					D1, D2, A, B,	PARAM)
SUBROUTINE xROT (N,			X, INCX, Y, INCY,		C, S)	
SUBROUTINE xROTM (N,			X, INCX, Y, INCY,			PARAM)
SUBROUTINE xSWAP (N,			X, INCX, Y, INCY)			
SUBROUTINE xSCAL (N,	ALPHA,		X, INCX)			
SUBROUTINE xCOPY (N,			X, INCX, Y, INCY)			
SUBROUTINE xAXPY (N,	ALPHA,		X, INCX, Y, INCY)			
FUNCTION xDOT (N,			X, INCX, Y, INCY)			
FUNCTION xDOTU (N,			X, INCX, Y, INCY)			
FUNCTION xDOTC (N,			X, INCX, Y, INCY)			
FUNCTION xxDOT (N,			X, INCX, Y, INCY)			
FUNCTION xNRM2 (N,			X, INCX)			
FUNCTION xASUM (N,			X, INCX)			
FUNCTION IxAMAX(N,			X, INCX)			

Generate plane rotation	S, D
Generate modified plane rotation	S, D
Apply plane rotation	S, D
Apply modified plane rotation	S, D
$x \leftrightarrow y$	S, D, C, Z
$x \leftarrow \alpha x$	S, D, C, Z, CS, ZD
$y \leftarrow x$	S, D, C, Z
$y \leftarrow \alpha x + y$	S, D, C, Z
$dot \leftarrow x^T y$	S, D, DS
$dot \leftarrow x^T y$	C, Z
$dot \leftarrow x^H y$	C, Z
$dot \leftarrow \alpha + x^T y$	SDS
$nrm2 \leftarrow ||x||_2$	S, D, SC, DZ
$asum \leftarrow ||re(x)||_1 + ||im(x)||_1$	S, D, SC, DZ
$amax \leftarrow 1^{st} k \ni |re(x_k)| + |im(x_k)|$ $= max(|re(x_i)| + |im(x_i)|)$	S, D, C, Z

Level 2 BLAS

	options	dim	b-width	scalar	matrix	vector	scalar	vector
xGEMV (	TRANS,	M, N,		ALPHA, A, LDA, X, INCX, BETA, Y, INCY)				
xGBMV (	TRANS,	M, N, KL, KU,		ALPHA, A, LDA, X, INCX, BETA, Y, INCY)				
xHEMV (UPLO,		N,		ALPHA, A, LDA, X, INCX, BETA, Y, INCY)				
xHEMV (UPLO,		N, K,		ALPHA, A, LDA, X, INCX, BETA, Y, INCY)				
xHPMV (UPLO,		N,		ALPHA, AP, X, INCX, BETA, Y, INCY)				
xSYMV (UPLO,		N,		ALPHA, A, LDA, X, INCX, BETA, Y, INCY)				
xSBMV (UPLO,		N, K,		ALPHA, A, LDA, X, INCX, BETA, Y, INCY)				
xSPMV (UPLO,		N,		ALPHA, AP, X, INCX, BETA, Y, INCY)				
xTRMV (UPLO, TRANS, DIAG,		N,		A, LDA, X, INCX)				
xTBMV (UPLO, TRANS, DIAG,		N, K,		A, LDA, X, INCX)				
xTPMV (UPLO, TRANS, DIAG,		N,		AP, X, INCX)				
xTRSV (UPLO, TRANS, DIAG,		N,		A, LDA, X, INCX)				
xTBSV (UPLO, TRANS, DIAG,		N, K,		A, LDA, X, INCX)				
xTPSV (UPLO, TRANS, DIAG,		N,		AP, X, INCX)				
	options	dim	scalar	vector	vector	matrix		
xGER (		M, N,	ALPHA, X, INCX, Y, INCY, A, LDA)					
xGERU (		M, N,	ALPHA, X, INCX, Y, INCY, A, LDA)					
xGERC (		M, N,	ALPHA, X, INCX, Y, INCY, A, LDA)					
xHER (UPLO,		N,	ALPHA, X, INCX,		A, LDA)			
xHPR (UPLO,		N,	ALPHA, X, INCX,		AP)			
xHER2 (UPLO,		N,	ALPHA, X, INCX, Y, INCY, A, LDA)					
xHPR2 (UPLO,		N,	ALPHA, X, INCX, Y, INCY, AP)					
xSYR (UPLO,		N,	ALPHA, X, INCX,		A, LDA)			
xSPR (UPLO,		N,	ALPHA, X, INCX,		AP)			
xSYR2 (UPLO,		N,	ALPHA, X, INCX, Y, INCY, A, LDA)					
xSPR2 (UPLO,		N,	ALPHA, X, INCX, Y, INCY, AP)					

$y \leftarrow \alpha Ax + \beta y, y \leftarrow \alpha A^T x + \beta y, y \leftarrow \alpha A^H x + \beta y, A - m \times n$	S, D, C, Z
$y \leftarrow \alpha Ax + \beta y, y \leftarrow \alpha A^T x + \beta y, y \leftarrow \alpha A^H x + \beta y, A - m \times n$	S, D, C, Z
$y \leftarrow \alpha Ax + \beta y$	C, Z
$y \leftarrow \alpha Ax + \beta y$	C, Z
$y \leftarrow \alpha Ax + \beta y$	C, Z
$y \leftarrow \alpha Ax + \beta y$	S, D
$y \leftarrow \alpha Ax + \beta y$	S, D
$y \leftarrow \alpha Ax + \beta y$	S, D
$x \leftarrow Ax, x \leftarrow A^T x, x \leftarrow A^H x$	S, D, C, Z
$x \leftarrow Ax, x \leftarrow A^T x, x \leftarrow A^H x$	S, D, C, Z
$x \leftarrow Ax, x \leftarrow A^T x, x \leftarrow A^H x$	S, D, C, Z
$x \leftarrow A^{-1} x, x \leftarrow A^{-T} x, x \leftarrow A^{-H} x$	S, D, C, Z
$x \leftarrow A^{-1} x, x \leftarrow A^{-T} x, x \leftarrow A^{-H} x$	S, D, C, Z
$x \leftarrow A^{-1} x, x \leftarrow A^{-T} x, x \leftarrow A^{-H} x$	S, D, C, Z

$A \leftarrow \alpha xy^T + A, A - m \times n$	S, D
$A \leftarrow \alpha xy^T + A, A - m \times n$	C, Z
$A \leftarrow \alpha xy^H + A, A - m \times n$	C, Z
$A \leftarrow \alpha xx^H + A$	C, Z
$A \leftarrow \alpha xx^H + A$	C, Z
$A \leftarrow \alpha xy^H + y(\alpha x)^H + A$	C, Z
$A \leftarrow \alpha xy^H + y(\alpha x)^H + A$	C, Z
$A \leftarrow \alpha xx^T + A$	S, D
$A \leftarrow \alpha xx^T + A$	S, D
$A \leftarrow \alpha xy^T + \alpha yx^T + A$	S, D
$A \leftarrow \alpha xy^T + \alpha yx^T + A$	S, D

Level 3 BLAS

	options	dim	scalar	matrix	matrix	scalar	matrix
xGEMM (	TRANSA, TRANSB,	M, N, K,	ALPHA, A, LDA, B, LDB, BETA, C, LDC)				
xSYMM (SIDE, UPLO,		M, N,	ALPHA, A, LDA, B, LDB, BETA, C, LDC)				
xHEMM (SIDE, UPLO,		M, N,	ALPHA, A, LDA, B, LDB, BETA, C, LDC)				
xSYRK (UPLO, TRANS,		N, K,	ALPHA, A, LDA,		BETA, C, LDC)		
xHERK (UPLO, TRANS,		N, K,	ALPHA, A, LDA,		BETA, C, LDC)		
xSYR2K(UPLO, TRANS,		N, K,	ALPHA, A, LDA, B, LDB, BETA, C, LDC)				
xHER2K(UPLO, TRANS,		N, K,	ALPHA, A, LDA, B, LDB, BETA, C, LDC)				
xTRMM (SIDE, UPLO, TRANSA,	DIAG, M, N,		ALPHA, A, LDA, B, LDB)				
xTRSM (SIDE, UPLO, TRANSA,	DIAG, M, N,		ALPHA, A, LDA, B, LDB)				

$C \leftarrow \alpha op(A)op(B) + \beta C, op(X) = X, X^T, X^H, C - m \times n$	S, D, C, Z
$C \leftarrow \alpha AB + \beta C, C \leftarrow \alpha BA + \beta C, C - m \times n, A = A^T$	S, D, C, Z
$C \leftarrow \alpha AB + \beta C, C \leftarrow \alpha BA + \beta C, C - m \times n, A = A^H$	C, Z
$C \leftarrow \alpha AA^T + \beta C, C \leftarrow \alpha A^T A + \beta C, C - n \times n$	S, D, C, Z
$C \leftarrow \alpha AA^H + \beta C, C \leftarrow \alpha A^H A + \beta C, C - n \times n$	C, Z
$C \leftarrow \alpha AB^T + \bar{\alpha} BA^T + \beta C, C \leftarrow \alpha A^T B + \bar{\alpha} B^T A + \beta C, C - n \times n$	S, D, C, Z
$C \leftarrow \alpha AB^H + \bar{\alpha} BA^H + \beta C, C \leftarrow \alpha A^H B + \bar{\alpha} B^H A + \beta C, C - n \times n$	C, Z
$B \leftarrow \alpha op(A)B, B \leftarrow \alpha Bop(A), op(A) = A, A^T, A^H, B - m \times n$	S, D, C, Z
$B \leftarrow \alpha op(A^{-1})B, B \leftarrow \alpha Bop(A^{-1}), op(A) = A, A^T, A^H, B - m \times n$	S, D, C, Z

Meaning of prefixes

S - REAL	C - COMPLEX
D - DOUBLE PRECISION	Z - COMPLEX*16

(this may not be supported by all machines)

For the Level 2 BLAS a set of extended-precision routines with the prefixes ES, ED, EC, EZ may also be available.

Level 1 BLAS

In addition to the listed routines there are two further extended-precision dot product routines DQDOTI and DQDOTA.

Level 2 and Level 3 BLAS

Matrix types:

GE - GEneral	GB - General Band	
SY - SYmmetric	SB - Sym. Band	SP - Sum. Packed
HE - HERmitian	HB - Herm. Band	HP - Herm. Packed
TR - TRiangular	TB - Triang. Band	TP - Triang. Packed

Level 2 and Level 3 BLAS Options

Dummy options arguments are declared as CHARACTER*1 and may be passed as character strings.

TRANx	= 'N'No 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', 'R'ight' (A or op(A) on the left, or 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.

References

C. Lawson, R. Hanson, D. Kincaid, and F. Krogh, "Basic Linear Algebra Subprograms for Fortran Usage," *ACM Trans. on Math. Soft.* 5 (1979) 308-325

J.J. Dongarra, J. DuCroz, S. Hammarling, and R. Hanson, "An Extended Set of Fortran Basic Linear Algebra Subprograms," *ACM Trans. on Math. Soft.* 14,1 (1988) 1-32

J.J. Dongarra, I. Duff, J. DuCroz, and S. Hammarling, "A Set of Level 3 Basic Linear Algebra Subprograms," *ACM Trans. on Math. Soft.* (1989)

Obtaining the Software via netlib@ornl.gov

To receive a copy of the single-precision software, type in a mail message:

```
send sblas from blas
send sblas2 from blas
send sblas3 from blas
```

To receive a copy of the double-precision software, type in a mail message:

```
send dblas from blas
send dblas2 from blas
send dblas3 from blas
```

To receive a copy of the complex single-precision software, type in a mail message:

```
send cblas from blas
send cblas2 from blas
send cblas3 from blas
```

To receive a copy of the complex double-precision software, type in a mail message:

```
send zblas from blas
send zblas2 from blas
send zblas3 from blas
```

Send comments and questions to lapack@cs.utk.edu .

Basic

Linear

Algebra

Subprograms

A Quick Reference Guide

University of Tennessee
Oak Ridge National Laboratory
Numerical Algorithms Group Ltd.

May 11, 1997