#### Level 1 BLAS

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     ) C \leftarrow \alpha op(A) op(B) + \beta C, op(X) = X, X^T, X^H, C - m \times n

) C \leftarrow \alpha AB + \beta C, C \leftarrow \alpha BA + \beta C, C - m \times n, A = A^T

) C \leftarrow \alpha AB + \beta C, C \leftarrow \alpha BA + \beta C, C - m \times n, A = A^H

) C \leftarrow \alpha AA^T + \beta C, C \leftarrow \alpha A^TA + \beta C, C - n \times n

) C \leftarrow \alpha AA^H + \beta C, C \leftarrow \alpha A^HA + \beta C, C - n \times n

) C \leftarrow \alpha AB^T + \overline{\alpha} BA^T + \beta C, C \leftarrow \alpha A^TB + \overline{\alpha} B^TA + \beta C, C - n \times n

) C \leftarrow \alpha AB^H + \overline{\alpha} BA^H + \beta C, C \leftarrow \alpha A^HB + \overline{\alpha} B^HA + \beta C, C - n \times n

B \leftarrow \alpha op(A)B, B \leftarrow \alpha Bop(A), op(A) = A, A^T, A^H, B - m \times n

B \leftarrow \alpha op(A^{-1})B, B \leftarrow \alpha Bop(A^{-1}), op(A) = A, A^T, A^H, B - m \times n
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                                                                                                                                                                                                                           \begin{array}{l} A \leftarrow \alpha x y^H + A, A - m \times n \\ A \leftarrow \alpha x x^H + A \end{array}
                                                                                                                                                                                                                                                 \begin{array}{l} A \leftarrow \alpha xy^T + A, A - m \times n \\ A \leftarrow \alpha xy^T + A, A - m \times n \end{array}
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                                                                                                                                                                                                                                                                                                                                                                                                                                   \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
                                                                                    \leftarrow \alpha o p(A) o p(B) + \beta C, o p(X) = X, X^T, X^H, C - m \times n
\sim R A + \beta C, C - m \times n, A = A^T
    \leftarrow \alpha o p(A)B, B \leftarrow \alpha B o p(A), o p(A) = A, A^T, A^H, B - m \times n \\ \leftarrow \alpha o p(A^{-1})B, B \leftarrow \alpha B o p(A^{-1}), o p(A) = A, A^T, A^H, B - m \times n
                                                                                                                                                                                                                                                                                    A^{-1}x, x \leftarrow A^{-T}x, x \leftarrow
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### Meaning of prefixes

D - DOUBLE PRECISION

C - COMPLEX\*16 by all machines) (this may not be supported

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

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

## Level 2 and Level 3 BLAS

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

Dummy options arguments are declared as CHARACTER\*1 Level 2 and Level 3 BLAS Options and may be passed as character strings.

TRANx= 'No transpose', 'Transpose'

DIAG UPLO = 'Non-unit triangular', 'Unit triangular' = 'Left', 'Right' (A or op(A) on the left, = 'Upper triangular', 'Lower triangular' 'Conjugate transpose'  $(X, X^T, X^H)$ 

or A or op(A) on the right)

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

#### 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

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

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

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

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

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

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

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

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

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

#### Basic

#### Linear

### $\mathbf{Algebra}$

# Subprograms

# University of Tennessee Oak Ridge National Laboratory

A Quick Reference Guide

Numerical Algorithms Group Ltd.

May 11, 1997