Appendix A

CMSSL and LAPACK: Corresponding Routines

This appendix contains a list of LAPACK routines that have CMSSL equivalents. LAPACK is a library of Fortran 77 subroutines for solving numerical linear algebra problems.

In this appendix, each set of corresponding LAPACK and CMSSL routines appears along with a brief description of the routines' functionality. The descriptions are taken from the LAPACK index; restrictions or limitations of the CMSSL routines are indicated. The LAPACK routines are listed in the same order as in the LAPACK index.

The LAPACK index resides in the **`netlib`** file **`lapack/index`**.

Copyright © 1994 Thinking Machines Corporation

Table 8. Corresponding CMSSL and LAPACK Routines

LAPACK Routines	Corresponding CMSSL Routines
SIMPLE DRIVER ROUTINES	
{s|d|c|z}gesv	**gen_lu_factor**, **gen_lu_solve**
Solves a general system of linear equations $AX=B$.	
{s|d|c|z}gbsv	**gen_banded_factor**, **gen_banded_solve**
Solves a general banded system of linear equations $AX=B$.	
{s|d|c|z}gtsv	**gen_tridiag_factor**, **gen_tridiag_solve**
Solves a general tridiagonal system of linear equations $AX=B$.	
{s|d|c|z}posv	**gen_lu_factor**, **gen_lu_solve**
Solves a symmetric or Hermitian positive definite system of linear equations $AX=B$.	
{s|d|c|z}sysv **{c|z}hesv**	**gen_qr_factor**, **gen_qr_solve** (with pivoting)
Solves a real symmetric, complex symmetric, or complex Hermitian indefinite system of linear equations $AX=B$.	
{s|d|c|z}gels	**gen_qr_factor**, **gen_qr_solve**
Computes the least squares solution to an overdetermined system of linear equations, $AX=B$ or $A^{H}X=B$, or the minimum-norm solution of an underdetermined system, where A is a general rectangular matrix of full rank, using a QR or LQ factorization of A.	
{s|d|c|z}gelss	**gen_bidiag** (real or double in CMSSL 3.2), **bidiag_svd_singular_values** **gen_bidiag_apply_{u,v}{_tra}** **gen_bidiag_singular_system**
Computes the minimum-norm least squares solution to an over- or underdetermined system of linear equations $AX=B$ using the singular value decomposition of A.	

Copyright © 1994 Thinking Machines Corporation

Table 4 *(Continued)*

LAPACK Routines	Corresponding CMSSL Routines
{s|d}syev **{c|z}heev** Computes all eigenvalues and eigenvectors of a symmetric or Hermitian matrix.	**sym_tred_eigensystem**
sspev, **dspev**, **chpev**, **zhpev** Computes all eigenvalues and eigenvectors of a symmetric or Hermitian matrix in packed storage.	**sym_lanczos**
ssbev, **dsbev**, **chbev**, **zhbev** Computes all eigenvalues and eigenvectors of a symmetric or Hermitian banded matrix.	**sym_lanczos**
{s|d}stev Computes all eigenvalues and eigenvectors of a real symmetric tridiagonal matrix.	**sym_tridiag_eigenvalues**, **sym_tridiag_eigenvectors**
{s|d|c|z}geev Computes the eigenvalues and left and right eigenvectors of a general matrix.	**gen_arnoldi** (real or double)
{s|d|c|z}gesvd Computes the singular value decomposition of a general rectangular matrix.	**gen_bidiag** (real or double in CMSSL 3.2), **bidiag_svd_singular_values**
{s|d}sygv **{c|z}hegv** Computes all eigenvalues and the eigenvectors of a generalized symmetric- or Hermitian-definite generalized eigenproblem, $Ax = \lambda Bx$, $ABx = \lambda x$, or $BAx = \lambda x$.	**sym_tred_gen_eigensystem**
{s|d|c|z}ggsvd Computes the generalized singular value decomposition.	**gen_bidiag** (real or double in CMSSL 3.2), **bidiag_svd_singular_values**

Copyright © 1994 Thinking Machines Corporation

Table 4 *(Continued)*

LAPACK Routines	Corresponding CMSSL Routines
EXPERT DRIVER ROUTINES	
{s|d|c|z}gesvx	**gen_lu_factor**, **gen_lu_solve**, **gen_lu_infinity_norm_inv** (for condition number; no error bounds provided)
Solves a general system of linear equations $AX = B$, $A^{\mathrm{T}}X = B$, or $A^{\mathrm{H}}X = B$, and provides an estimate of the condition number and error bounds on the solution.	
{s|d|c|z}gbsvx	**gen_banded_factor**, **gen_banded_solve** (No equivalent for condition estimation or error bounds)
Solves a general banded system of linear equations $AX = B$, $A^{\mathrm{T}}X = B$, or $A^{\mathrm{H}}X = B$, and provides an estimate of the condition number and error bounds on the solution.	
{s|d|c|z}gtsvx	**gen_tridiag_factor**, **gen_tridiag_solve** (No equivalent for condition estimation or error bounds)
Solves a general tridiagonal system of linear equations $AX = B$, $A^{\mathrm{T}}X = B$, or $A^{\mathrm{H}}X = B$, and provides an estimate of the condition number and error bounds on the solution.	
{s|d|c|z}posvx	**gen_lu_factor**, **gen_lu_solve**, **gen_lu_infinity_norm_inv** (for condition number; no error bounds provided)
Solves a symmetric or Hermitian positive definite system of linear equations $AX = B$, and provides an estimate of the condition number and error bounds on the solution.	

Copyright © 1994 Thinking Machines Corporation

Table 4 *(Continued)*

LAPACK Routines	Corresponding CMSSL Routines
{s|d|c|z}sysvx **{c|z}hesvx**	**gen_qr_factor**, **gen_qr_solve** (with pivoting), **gen_qr_infinity_norm_inv**, **gen_qr_r_infinity_norm_inv** (for condition estimation; no error bounds provided)
Solves a real symmetric, complex symmetric, or complex Hermitian indefinite system of linear equations $AX = B$, and provides an estimate of the condition number and error bounds on the solution.	
{s|d|c|z}gelsx	**gen_qr_factor**, **gen_qr_solve**, **gen_qr_infinity_norm_inv**, **gen_qr_r_infinity_norm_inv** (for condition estimation)
Computes the minimum-norm least squares solution to an over- or underdetermined system of linear equations $AX = B$ using a complete orthogonal factorization of A.	
{s|d}syevx **{c|z}heevx**	**sym_tred** **sym_tridiag_eigenvalues** **sym_tridiag_eigenvectors** **tridiag_to_sym**
Computes selected eigenvalues and eigenvectors of a symmetric or Hermitian matrix.	
{s|d}spevx **{c|z}hpevx**	**sym_lanczos**
Computes selected eigenvalues and eigenvectors of a symmetric or Hermitian matrix in packed storage.	
{s|d}sbevx **{c|z}hbevx**	**sym_lanczos**
Computes selected eigenvalues and eigenvectors of a symmetric or Hermitian banded matrix.	

Copyright © 1994 Thinking Machines Corporation

Table 4 *(Continued)*

LAPACK Routines	Corresponding CMSSL Routines
{s|d}stevx	**sym_tridiag_eigenvalues** (all eigenvalues), **sym_tridiag_eigenvectors** (selected eigenvectors)
Computes selected eigenvalues and eigenvectors of a real symmetric tridiagonal matrix.	
COMPUTATIONAL ROUTINES	
{s|d|c|z}bdsqr	**bidiag_svd_singular_values** (real or double in CMSSL 3.2)
Computes the singular value decomposition of a real bidiagonal matrix using the bidiagonal *QR* algorithm.	
{s|d|c|z}gbtrf	**gen_banded_factor**
Computes an *LU* factorization of a general banded matrix using partial pivoting with row interchanges.	
{s|d|c|z}gbtrs	**gen_banded_solve**
Solves a general banded system of linear equations $AX = B$, $A^{\mathrm{T}}X = B$, or $A^{\mathrm{H}}X = B$ using the *LU* factorization computed by **sgbtrf** / **cgbtrf**.	
{s|d|c|z}gebrd	**gen_bidiag** (real or double in CMSSL 3.2)
Reduces a general rectangular matrix to real bidiagonal form by an orthogonal or unitary transformation.	
{s|d|c|z}gecon	**gen_lu_infinity_norm_inv**
Estimates the reciprocal of the condition number of a general matrix, in either the 1-norm or the infinity norm, using the *LU* factorization computed by **sgetrf** / **cgetrf**.	
{s|d|c|z}geqpf	**gen_qr_factor**
Computes a *QR* factorization, with column pivoting, of a general rectangular matrix.	
{s|d|c|z}geqrf	**gen_qr_factor**
Computes a *QR* factorization of a general rectangular matrix.	

Copyright © 1994 Thinking Machines Corporation

Table 4 *(Continued)*

LAPACK Routines	Corresponding CMSSL Routines
{s|d|c|z}getrf	**gen_lu_factor**
Computes an *LU* factorization of a general matrix using partial pivoting with row interchanges.	
{s|d|c|z}getri	**gen_lu_solve**
Computes the inverse of a general matrix using the *LU* factorization computed by **sgetrf** / **cgetrf**.	
{s|d|c|z}getrs	**gen_lu_solve**
Solves a general system of linear equations $AX = B$, $A^{\mathrm{T}}X = B$, or $A^{\mathrm{H}}X = B$, using the *LU* factorization computed by **sgetrf** / **cgetrf**.	
{s|d|c|z}gttrf	**gen_tridiag_factor**
Computes an *LU* factorization of a general tridiagonal matrix using partial pivoting with row interchanges.	
{s|d|c|z}gttrs	**gen_tridiag_solve**
Solves a general tridiagonal system of linear equations $AX = B$, $A^{\mathrm{T}}X = \mathrm{B}$, or $A^{\mathrm{H}}X = B$ using the *LU* factorization computed by **sgttrf** / **cgttrf**.	
{s|d}opgtr **{c|z}upgtr**	**sym_to_tridiag**, **tridiag_to_sym**
Generates the orthogonal or unitary transformation matrix from a reduction to tridiagonal form determined by **ssptrd** / **chptrd**.	
{s|d}opmtr **{c|z}upmtr**	**sym_to_tridiag**, **tridiag_to_sym**
Multiplies a general matrix by the orthogonal or unitary transformation matrix from a reduction to tridiagonal form determined by **ssptrd** / **chptrd**.	
{s|d}orgbr **{c|z}ungbr**	**bidiag_to_gen_left**, **bidiag_to_gen_right**, **gen_to_bidiag_left**, **gen_to_bidiag_right**
Generates the orthogonal or unitary transformation matrices from a reduction to bidiagonal form determined by **sgebrd** / **cgebrd**.	

Copyright © 1994 Thinking Machines Corporation

Table 4 *(Continued)*

LAPACK Routines	Corresponding CMSSL Routines
{s|d}orgqr **{c|z}ungqr**	**gen_qr_apply_q**, **gen_qr_apply_q_tra**
Generates all or part of the orthogonal or unitary matrix *Q* from a *QR* factorization determined by **sgeqrf** / **cgeqrf**.	
{s|d}orgtr **{c|z}ungtr**	**sym_to_tridiag**, **tridiag_to_sym**
Generates the orthogonal or unitary transformation matrix from a reduction to tridiagonal form determined by **ssytrd** / **chetrd**.	
{s|d}ormbr **{c|z}unmbr**	**gen_bidiag_apply_u**, **gen_bidiag_apply_v**, **gen_bidiag_apply_u_tra**, **gen_bidiag_apply_v_tra**
Multiplies a general matrix by one of the orthogonal or unitary transformation matrices from a reduction to bidiagonal form determined by **sgebrd** / **cgebrd**.	
{s|d}ormqr **{c|z}unmqr**	**gen_qr_apply_q**, **gen_qr_apply_q_tra**
Multiplies a general matrix by the orthogonal or unitary matrix from a *QR* factorization determined by **sgeqrf** / **cgeqrf**.	
{s|d}ormtr **{c|z}unmtr**	**sym_to_tridiag**, **tridiag_to_sym**
Multiplies a general matrix by the orthogonal or unitary transformation matrix from a reduction to tridiagonal form determined by **ssytrd** / **chetrd**.	
{s|d}stebz	**sym_tridiag_eigenvalues** (all eigenvalues)
Computes selected eigenvalues of a real symmetric tridiagonal matrix by bisection.	

Copyright © 1994 Thinking Machines Corporation

Table 4 *(Continued)*

LAPACK Routines	Corresponding CMSSL Routines
{s|d|c|z}stein	**sym_tridiag_eigenvectors**
Computes selected eigenvectors of a real symmetric tridiagonal matrix by inverse iteration.	
{s|d}sytrd	**sym_tred**
{c|z}hetrd	
Reduces a symmetric or Hermitian matrix to real symmetric tridiagonal form by an orthogonal or unitary similarity transformation.	

Copyright © 1994 Thinking Machines Corporation