# Chapter F01

Matrix Operations and Distribution

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1 Scope of the Chapter

This Chapter includes a number of routines for the generation, gathering and scattering of distributed vectors and matrices and for carrying out element-wise operations on groups of matrices on the Library Grid.

2 Background to the Problems

The use of the routines in this Chapter is certainly not mandatory: they are designed to be of assistance to users of the Parallel Library to simplify the tasks inherent in the generation, gathering and scattering of matrices and vectors. The generation routines require a user-supplied procedure to generate blocks of a matrix or vector.

In particular, the routines of this Chapter can be used to:
- generate a three-dimensional array in row-block form for use by routines in Chapter C06;
- generate dense matrices and vectors distributed in column block fashion, in row block fashion and in cyclic two-dimensional block fashion, as required by routines in Chapter F02, Chapter F04, Chapter F07 and Chapter F08;
- generate tridiagonal and narrow banded matrices distributed in column block fashion, as required by routines in Chapter F04 and Chapter F07;
- generate sparse matrices, in coordinate storage format, distributed in row block fashion, as required by routines in Chapter F11;
- gather and scatter dense and sparse matrices and vectors using the distributions specified by the routines in Chapter F04, Chapter F07, Chapter F08, and Chapter F11, in particular to gather and scatter vectors distributed conformally to specified sparse matrices, as required by routines in Chapter F11;
- carry out element-wise operations; on the corresponding elements of a group of matrices, each matrix stored on a different processor.

3 Recommendations on Choice and Use of Available Routines

Note. Refer to the Users' Note for your implementation to check that a routine is available.

3.1 Generation of Matrices and Vectors

The routines in this section are concerned with the distribution of three-dimensional arrays, matrices and vectors. Each routine requires a user-supplied procedure to generate a specified block of the array. Note that, in many cases, a routine for distributing a matrix can also be used to distribute a vector simply by treating the vector as a one-dimensional matrix.

3.1.1 Three-dimensional arrays (for Chapter C06)

F01ZHFP Generates an \(l\) by \(m\) by \(n\) three-dimensional array \(A(i, j, k)\) on a grid of processors in \(i\)-block form.

3.1.2 Dense and banded matrices, column block distribution (for Chapters F02, F04 and F07)

F01ZRFP Generates and distributes real matrix in column block fashion, used with routines from Chapter F02 and Chapter F04.

F01ZWFP Generates and distributes complex matrix in column block fashion, used with routines from Chapter F02 and Chapter F04.

F01YXFP Generates and distributes real symmetric banded matrix in column block fashion, used with routines from Chapter F07.

F01YWFP Generates and distributes complex Hermitian banded matrix in column block fashion, used with routines from Chapter F07.
3.1.3 Dense matrices and vectors, row block distribution (for Chapters C06, F04 and F07)

F01ZMFP Generates and distributes real matrix in row block fashion, used with routines from Chapter C06 and Chapter F04.

F01ZNFP Generates and distributes complex matrix in row block fashion, used with routines from Chapter F04.

F01YYFP Generates and distributes real matrix in row block fashion on a one-dimensional grid of processors, used with routines from Chapter F07.

F01YZFP Generates and distributes complex matrix in row block fashion on a one-dimensional grid of processors, used with routines from Chapter F07.

F01ZZFP Generates and distributes real vector in column block fashion, used with routines from Chapter F07.

F01ZYFP Generates and distributes complex vector in column block fashion, used with routines from Chapter F07.

3.1.4 Dense matrices, cyclic two-dimensional block distribution (for Chapters F04, F07 and F08)

F01ZSFP Generates and distributes real matrix in cyclic two-dimensional block fashion, used with routines from Chapter F04 (Black Box).

F01ZXFP Generates and distributes complex matrix in cyclic two-dimensional block fashion, used with routines from Chapter F04 (Black Box).

F01ZQFP Generates and distributes real matrix in cyclic two-dimensional block fashion, used with routines from Chapter F07 and Chapter F08.

F01ZVFP Generates and distributes complex matrix in cyclic two-dimensional block fashion, used with routines from Chapter F07 and Chapter F08.

3.1.5 Sparse matrices, cyclic row block distributions (for Chapter F11)

F01YAFP In-place generation of real sparse matrix using cyclic row block distribution.

F01YBFP In-place generation of real sparse matrix using cyclic row block distribution (suitable for repeated sparsity pattern).

F01YPFP In-place generation of complex sparse matrix according to cyclic row block distribution.

F01YQFP In-place generation of complex sparse matrix according to cyclic row block distribution (suitable for repeated sparsity pattern).

3.1.6 Dense vectors, distributed conformally to specified sparse matrices (for Chapter F11)

An appropriate Chapter F11 routine must have been called prior to any of the following routines in order to set up auxiliary information about the sparse matrix $A$ in the array IAINFO. See Section 3.3 of the F11 Chapter Introduction for further information, particularly Section 3.3.2 of the F11 Chapter Introduction.

F01YEFP In-place generation of real dense vector distributed conformally to sparse matrix.

F01YTFP In-place generation of complex dense vector distributed conformally to sparse matrix.

3.2 Scattering (Distribution) of Matrices and Vectors

3.2.1 Dense matrices, cyclic two-dimensional block distribution (for Chapters F04, F07 and F08)

F01WPFP Scatter real matrix from the root processor to the Library Grid using cyclic two-dimensional block format, used with routines from Chapter F04.

F01WVFP Scatter complex matrix from the root processor to the Library Grid using cyclic two-dimensional block format, used with routines from Chapter F04.

F01WNFP Scatter real matrix from the root processor to the Library Grid using cyclic two-dimensional block format, used with routines from Chapter F07 and Chapter F08.

F01WUFP Scatter complex matrix from the root processor to the Library Grid using cyclic two-dimensional block format, used with routines from Chapter F07 and Chapter F08.
3.2.2 Sparse matrices, cyclic row block distributions (for Chapter F11)

F01XAFP Scatter real sparse matrix, stored in coordinate storage format, using cyclic row block distribution.

F01XPFP Scatter complex sparse matrix, stored in coordinate storage format, using cyclic row block distribution.

3.2.3 Dense vectors, conformally to specified sparse matrices (for Chapter F11)

An appropriate Chapter F11 routine must have been called prior to any of the following routines in order to set up auxiliary information about the sparse matrix A in the array IAINFO. See Section 3.3 of the F11 Chapter Introduction for further information, particularly Section 3.3.2 of the F11 Chapter Introduction.

F01XEFP Scatter real vector distributed conformally to sparse matrix.

F01XGFP Scatter integer vector distributed conformally to sparse matrix.

F01XTFP Scatter complex vector distributed conformally to sparse matrix.

3.3 Gathering of Matrices and Vectors

3.3.1 Dense matrices, two-dimensional block cyclic distribution (for Chapters F04, F07 and F08)

F01WBFP Gather real matrix distributed in cyclic two-dimensional block format, used with routines from Chapter F04.

F01WHFP Gather complex matrix distributed in cyclic two-dimensional block format, used with routines from Chapter F04.

F01WAFFP Gather real matrix, regarded as submatrix of matrix distributed in cyclic two-dimensional block format, used with routines from Chapter F07 and Chapter F08.

F01WGFP Gather complex matrix distributed in cyclic two-dimensional block format, used with routines from Chapter F07 and Chapter F08.

3.3.2 Dense vectors, cyclic row or column block distributions (for Chapter F08)

F01ZPFP Gather real vector distributed conformally to matrix, used with routines from Chapter F07 and Chapter F08.

3.3.3 Dense vectors, distributed conformally to specified sparse matrices (for Chapter F11)

An appropriate Chapter F11 routine must have been called prior to any of the following routines in order to set up auxiliary information about the sparse matrix A in the array IAINFO. See Section 3.3 of the F11 Chapter Introduction for further information, particularly Section 3.3.2 of the F11 Chapter Introduction.

F01XFPFP Gather real vector distributed conformally to sparse matrix.

F01XHFP Gather integer vector distributed conformally to sparse matrix.

F01XUFPP Gather complex vector distributed conformally to sparse matrix.

3.4 Element-wise Operations on Groups of Matrices (for Chapter F11)

F01CPFP Element-wise maximum or minimum in absolute value of integer matrices.