Chapter X04

Input/Output Utilities

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1 Scope of the Chapter

This chapter contains utility routines concerned with input from and output to an external file.

2 Background to the Problems

2.1 Input/Output on Parallel Machines

Input/output on parallel machines is still a subject of intense research but some facilities are provided in the NAG Parallel Library. The problem is to read data in a form meaningful to the user into a distributed form required by NAG Parallel Library routines or to write distributed data into a form meaningful to the user.

The NAG Parallel Library assumes that many processes may open a file for reading simultaneously; each process reads the entire file. Writing to a file presents a greater difficulty since it is obviously necessary to enforce an ordering on the ability of each processor to write to a single file to prevent write conflicts.

The philosophy behind file input/output operations in the NAG Parallel Library can be summarised as follows:

> all processors may **read** a file simultaneously;
>
> a single processor is designated to **write** to a file and all data from other processors is communicated to the designated output processor in an order determined by the outputting processor.

On a network of workstations, input will ordinarily be taken from a file that is visible to all machines (i.e., on a network file system). However, this is not an essential requirement; the X04 input routines may read data from files that are local to each machine but the user **must** ensure that the local files contain identical data otherwise incorrect results may be produced.

Routines are provided for reading and writing real and complex dense matrices in the most common data distributions in the library, the cyclic two-dimensional block distribution (see Chapters F07 and F08), the column block distribution (see Chapter F02) and the row block distribution (see Chapter C06). Routines are also provided for writing dense real vectors distributed conformally to sparse matrices (see Chapter F11).

2.2 Output from NAG Parallel Library Routines

Output from NAG Parallel Library routines to an external file falls into two categories:

(a) **Error messages:**

which are always associated with an error exit from a routine, that is, with a non-zero value of IFAIL or INFO as specified in Section 5 of each routine document.

(b) **Advisory messages:**

which are not directly associated with an error condition; for example information about the NAG Parallel Library in use produced by A00AAFP.

Each category of output is written to its own Fortran output unit – the **error message unit** or the **advisory message unit**. In practice these may be the same unit number. Default unit numbers are provided for each implementation of the Library (see the Users' Note for your implementation); they may be changed by users through the routines X04AAF and X04ABF (X04AAF and X04ABF are identical to the equivalent routines in the NAG Fortran 77 Library and so retain the 6-character names). Output of error messages may be controlled by the setting of IFAIL (see the Essential Introduction of the NAG Parallel Library).

2.3 Matrix Output Routines

Routines are provided to allow formatted output of general matrices that are stored in a cyclic two-dimensional block or column block distribution in arrays of real or complex numbers.

The user can specify the format of individual matrix elements. All output is directed to a user specified unit number.

2.4 Matrix Input Routines

Routines are provided to allow the input of general real and complex matrices stored in an external file into two-dimensional arrays of real or complex numbers in a cyclic two-dimensional block distribution.

All input is taken from a user-specified unit number.

2.5 Vector Output Routines

Routines are provided to allow formatted output of real vectors that are distributed conformally to sparse matrices.

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.

Apart from the the matrix input/output routines, users of the NAG Parallel Library may need to call routines in Chapter X04 for the following purposes:

if the default unit number for error messages (given in the Users' Note for your implementation for your implementation) is not satisfactory, it may be changed to a new value NERR by the statement

```
CALL X04AAF(1,NERR)
```

Similarly the unit number for advisory messages may be changed to a new value NADV by the statement

```
CALL X04ABF(1,NADV)
```

Note that a dense vector may be input or output by regarding an n element vector as an n by 1, or a 1 by n matrix.

Please note that for reasons of compatibility and consistency, the argument FORMAT in the routines X04BSFP and X04BWFP have been slightly modified. FORMAT must now contain a valid Fortran format, not just a field descriptor for a floating point number. All other arguments for all other routines have not been changed.

3.1 Reading Matrices

X04BCFP Reads real general matrix, from external file, into array distributed in cyclic two-dimensional form, used with routines from Chapter F07 and Chapter F08

X04BGFP Reads general real matrix from external file into array distributed in cyclic two-dimensional block form, used with routines from Chapter F04 (Black Box)

X04BRFP Reads complex general matrix from an external file into array distributed in cyclic two-dimensional block form, used with routines from Chapter F07 and Chapter F08

X04BVFP Reads general complex matrix from an external file into an array distributed in cyclic two-dimensional block form, used with routines from Chapter F04 (Black Box)

3.2 Accessing Unit Numbers

X04AAF and X04ABF return, or set, the error and advisory message unit numbers respectively.

3.3 Printing Matrices

X04BDFP Outputs real general matrix, stored in cyclic two-dimensional block fashion, to an external file, used with routines from Chapter F07 and Chapter F08

X04BFFP Outputs set of real general matrices distributed on a two-dimensional logical processor grid, used with routines from Chapter F02

X04BHFP Outputs general real matrix, stored in cyclic two-dimensional block fashion, to external file, used with routines from Chapter F04 (Black Box)

X04BMFP Outputs a set of general integer matrices distributed on a two-dimensional logical processor grid

X04BSFP Outputs complex general matrix, stored in cyclic two-dimensional block fashion to an external file, used with routines from Chapter F07 and Chapter F08

X04BUFP Outputs set of complex general matrices distributed on a two-dimensional logical processor grid, used with routines from Chapter F02

X04BWFP Outputs general complex matrix, stored in cyclic two-dimensional block fashion, used with routines from Chapter F04 (Black Box)

X04BXFP Outputs real matrix stored in row block fashion

X04BZFP Outputs complex matrix stored in row block fashion (complex version of X04BXFP)

3.4 Printing Vectors

X04YAFP Outputs real dense vector, distributed conformally to a sparse matrix on a logical grid of processors, to an external file

X04YPFP Outputs complex vector, distributed conformally to sparse matrix to a sequential file

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