NAG Fortran Library Routine Document

F11GCF

Note: before using this routine, please read the Users' Note for your implementation to check the interpretation of ***bold italicised*** terms and other implementation-dependent details.

1 Purpose

F11GCF is the third in a suite of three routines for the iterative solution of a symmetric system of simultaneous linear equations (Golub and van Loan (1996)). F11GCF returns information about the computations during an iteration and/or after this has been completed. The first routine of the suite, F11GAF, is a setup routine; the second routine, F11GBF, is the proper iterative solver.

These three routines are suitable for the solution of large sparse symmetric systems of equations.

2 Specification

```
SUBROUTINE F11GCF(ITN, STPLHS, STPRHS, ANORM, SIGMAX, ITS, SIGERR,
1                 IFAIL)
INTEGER           ITN, ITS, IFAIL
real              STPLHS, STPRHS, ANORM, SIGMAX, SIGERR
```

3 Description

F11GCF returns information about the solution process. It can be called either during a monitoring step of F11GBF or after F11GBF has completed its tasks. Calling F11GCF at any other time will result in an error condition being raised.

For further information you should read the documentation for F11GAF and F11GBF.

4 References

Golub G H and van Loan C F (1996) *Matrix Computations* (3rd Edition) Johns Hopkins University Press, Baltimore

5 Parameters

1: ITN – INTEGER *Output*

On exit: the number of iterations carried out by F11GBF.

2: STPLHS – ***real*** *Output*

On exit: the current value of the left-hand side of the termination criterion used by F11GBF.

3: STPRHS – ***real*** *Output*

On exit: the current value of the right-hand side of the termination criterion used by F11GBF.

4: ANORM – ***real*** *Output*

On exit: the norm $\|A\|_1 = \|A\|_\infty$ when either it has been supplied to F11GAF or it has been estimated by F11GBF (see also Sections 3 and 5 of the document for F11GAF).
Otherwise, ANORM $= 0.0$ is returned.

5: SIGMAX – ***real*** *Output*

On exit: the current estimate of the largest singular value $\sigma_1(\bar{A})$ of the preconditioned iteration matrix $\bar{A} = E^{-1}AE^{-T}$, when either it has been supplied to F11GAF or it has been estimated by

F11GBF (see also Sections 3 and 5 of the document for F11GAF). Note that if ITS $<$ ITN then SIGMAX contains the final estimate. If, on final exit from F11GBF, ITS $=$ ITN, then the estimation of $\sigma_1(\bar{A})$ may have not converged: in this case you should look at the value returned in SIGERR (see below).
Otherwise, SIGMAX $= 0.0$ is returned.

6: ITS – INTEGER *Output*

On exit: the number of iterations employed so far in the computation of the estimate of $\sigma_1(\bar{A})$, the largest singular value of the preconditioned matrix $\bar{A} = E^{-1}AE^{-T}$, when $\sigma_1(\bar{A})$ has been estimated by F11GBF using the bisection method (see also Sections 3, 5 and 8 of the document for F11GAF).
Otherwise, ITS $= 0$ is returned.

7: SIGERR – ***real*** *Output*

On exit: if $\sigma_1(\bar{A})$ has been estimated by F11GBF using bisection,

$$\text{SIGERR} = \max\left(\frac{|\sigma_1^{(k)} - \sigma_1^{(k-1)}|}{\sigma_1^{(k)}}, \frac{|\sigma_1^{(k)} - \sigma_1^{(k-2)}|}{\sigma_1^{(k)}}\right),$$

where $k =$ ITS denotes the iteration number. The estimation has converged if SIGERR $\leq$ SIGTOL where SIGTOL is an input parameter to F11GAF.
Otherwise, SIGERR $= 0.0$ is returned.

8: IFAIL – INTEGER *Input/Output*

On entry: IFAIL must be set to 0, -1 or 1. Users who are unfamiliar with this parameter should refer to Chapter P01 for details.

On exit: IFAIL $= 0$ unless the routine detects an error (see Section 6).

For environments where it might be inappropriate to halt program execution when an error is detected, the value -1 or 1 is recommended. If the output of error messages is undesirable, then the value 1 is recommended. Otherwise, for users not familiar with this parameter the recommended value is 0. **When the value -1 or 1 is used it is essential to test the value of IFAIL on exit.**

6 Error Indicators and Warnings

If on entry IFAIL $= 0$ or -1, explanatory error messages are output on the current error message unit (as defined by X04AAF).

Errors or warnings detected by the routine:

IFAIL $= 1$

F11GCF has been called out of sequence. For example, the last call to F11GBF did not return IREVCM $= 3$ or 4.

7 Accuracy

Not applicable.

8 Further Comments

None.

9 Example

See Section 9 of the document for F11GAF.