NAG Fortran Library Routine Document

F08WWF (CGGBAK/ZGGBAK)

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

F08WWF (CGGBAK/ZGGBAK) forms the right or left eigenvectors of the real generalized eigenvalue problem $Ax = \lambda Bx$, by backward transformation on the computed eigenvectors given by F08YXF (CTGEVC/ZTGEVC). It is necessary to call this routine only if the optional balancing routine F08WVF (CGGBAL/ZGGBAL) was previously called to balance the matrix pair (A, B).

2 Specification

```
 SUBROUTINE F08WWF(JOB, SIDE, N, ILO, IHI, LSCALE, RSCALE, M, V, LDV,
1                  INFO)
 ENTRY      cggbak (JOB, SIDE, N, ILO, IHI, LSCALE, RSCALE, M, V, LDV,
1                  INFO)
 INTEGER            N, ILO, IHI, M, LDV, INFO
 real               LSCALE(*), RSCALE(*)
 complex            V(LDV,*)
 CHARACTER*1        JOB, SIDE
```

The ENTRY statement enables the routine to be called by its LAPACK name.

3 Description

If the matrix pair has been previously balanced using the routine F08WVF (CGGBAL/ZGGBAL) then F08WWF (CGGBAK/ZGGBAK) backtransforms the eigenvector solution given by F08YXF (CTGEVC/ZTGEVC). This is usually the sixth and last step in the solution of the generalized eigenvalue problem.

For a description of balancing, see the document for F08WVF (CGGBAL/ZGGBAL).

4 References

Ward R C (1981) Balancing the generalized eigenvalue problem *SIAM J. Sci. Stat. Comp.* **2** 141–152

5 Parameters

1: JOB – CHARACTER*1 *Input*

On entry: specifies the backtransformation step required:

if JOB = 'N', no transformations are done;

if JOB = 'P', only do backward transformations based on permutations;

if JOB = 'S', only do backward transformations based on scaling;

if JOB = 'B', do backward transformations for both permutations and scaling.

Note: this must be identical to the parameter JOB as supplied to F08WVF (CGGBAL/ZGGBAL).

Constraint: JOB = 'N', 'P', 'S' or 'B'.

2: SIDE – CHARACTER*1 *Input*

On entry: indicates whether left or right eigenvectors are to be transformed, as follows:

if SIDE = 'L', left eigenvectors are transformed;

if SIDE = 'R', right eigenvectors are transformed.

Constraint: SIDE = 'L' or 'R'.

3: N – INTEGER *Input*

On entry: n, the order of the matrices A and B of the generalized eigenvalue problem.

Constraint: N ≥ 0.

4: ILO – INTEGER *Input*

5: IHI – INTEGER *Input*

On entry: i_{lo} and i_{hi} as determined by a previous call to F08WVF (CGGBAL/ZGGBAL).

Constraints:

$1 \leq$ ILO $\leq$ IHI $\leq$ N if N > 0;
ILO $= 1$ and IHI $= 0$ if N $= 0$.

6: LSCALE(*) – ***real*** array *Input*

Note: the dimension of the array LSCALE must be at least $\max(1, \text{N})$.

On entry: details of the permutations and scaling factors applied to the left side of the matrices A and B, as returned by a previous call to F08WVF (CGGBAL/ZGGBAL).

7: RSCALE(*) – ***real*** array *Input*

Note: the dimension of the array RSCALE must be at least $\max(1, \text{N})$.

On entry: details of the permutations and scaling factors applied to the right side of the matrices A and B, as returned by a previous call to F08WVF (CGGBAL/ZGGBAL).

8: M – INTEGER *Input*

On entry: m, the required number of left or right eigenvectors.

Constraint: $0 \leq$ M $\leq$ N.

9: V(LDV,*) – ***complex*** array *Input/Output*

Note: the second dimension of the array V must be at least $\max(1, \text{M})$.

On entry: the matrix of right or left eigenvectors, as returned by F08WVF (CGGBAL/ZGGBAL).

On exit: the transformed right or left eigenvectors.

10: LDV – INTEGER *Input*

On entry: the first dimension of the array V as declared in the (sub)program from which F08WWF (CGGBAK/ZGGBAK) is called.

Constraint: LDV $\geq \max(1, \text{N})$.

11: INFO – INTEGER *Output*

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

6 Error Indicators and Warnings

Errors or warnings detected by the routine:

INFO < 0

If INFO $= -i$, the ith parameter had an illegal value. An explanatory message is output, and execution of the program is terminated.

7 Accuracy

The errors are negligible, compared with the previous computations.

8 Further Comments

The number of operations is proportional to n^2.

The real analogue of this routine is F08WJF (SGGBAK/DGGBAK).

9 Example

See Section 9 of the documents for F08XSF (CHGEQZ/ZHGEQZ) and F08YXF (CTGEVC/ZTGEVC).