

# NAG Library Routine Document

## F08NJF (DGEBAK)

**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

F08NJF (DGEBAK) transforms eigenvectors of a balanced matrix to those of the original real nonsymmetric matrix.

### 2 Specification

```
SUBROUTINE F08NJF (JOB, SIDE, N, ILO, IHI, SCALE, M, V, LDV, INFO)
  INTEGER          N, ILO, IHI, M, LDV, INFO
  REAL (KIND=nag_wp) SCALE(*), V(LDV,*)
  CHARACTER(1)    JOB, SIDE
```

The routine may be called by its LAPACK name *dgebak*.

### 3 Description

F08NJF (DGEBAK) is intended to be used after a real nonsymmetric matrix  $A$  has been balanced by F08NHF (DGEBAL), and eigenvectors of the balanced matrix  $A''_{22}$  have subsequently been computed.

For a description of balancing, see the document for F08NHF (DGEBAL). The balanced matrix  $A''$  is obtained as  $A'' = DPAP^T D^{-1}$ , where  $P$  is a permutation matrix and  $D$  is a diagonal scaling matrix. This routine transforms left or right eigenvectors as follows:

if  $x$  is a right eigenvector of  $A''$ ,  $P^T D^{-1} x$  is a right eigenvector of  $A$ ;

if  $y$  is a left eigenvector of  $A''$ ,  $P^T D y$  is a left eigenvector of  $A$ .

### 4 References

None.

### 5 Arguments

- 1: JOB – CHARACTER(1) *Input*  
*On entry:* this **must** be the same argument JOB as supplied to F08NHF (DGEBAL).  
*Constraint:* JOB = 'N', 'P', 'S' or 'B'.
- 2: SIDE – CHARACTER(1) *Input*  
*On entry:* indicates whether left or right eigenvectors are to be transformed.  
 SIDE = 'L'  
     The left eigenvectors are transformed.  
 SIDE = 'R'  
     The right eigenvectors are transformed.  
*Constraint:* SIDE = 'L' or 'R'.

- 3: N – INTEGER *Input*  
*On entry:*  $n$ , the number of rows of the matrix of eigenvectors.  
*Constraint:*  $N \geq 0$ .
- 4: ILO – INTEGER *Input*  
5: IHI – INTEGER *Input*  
*On entry:* the values  $i_{lo}$  and  $i_{hi}$ , as returned by F08NHF (DGEBAL).  
*Constraints:*  
if  $N > 0$ ,  $1 \leq ILO \leq IHI \leq N$ ;  
if  $N = 0$ ,  $ILO = 1$  and  $IHI = 0$ .
- 6: SCALE(\*) – REAL (KIND=nag\_wp) array *Input*  
**Note:** the dimension of the array SCALE must be at least  $\max(1, N)$ .  
*On entry:* details of the permutations and/or the scaling factors used to balance the original real nonsymmetric matrix, as returned by F08NHF (DGEBAL).
- 7: M – INTEGER *Input*  
*On entry:*  $m$ , the number of columns of the matrix of eigenvectors.  
*Constraint:*  $M \geq 0$ .
- 8: V(LDV,\*) – REAL (KIND=nag\_wp) array *Input/Output*  
**Note:** the second dimension of the array V must be at least  $\max(1, M)$ .  
*On entry:* the matrix of left or right eigenvectors to be transformed.  
*On exit:* the transformed eigenvectors.
- 9: LDV – INTEGER *Input*  
*On entry:* the first dimension of the array V as declared in the (sub)program from which F08NHF (DGEBAK) is called.  
*Constraint:*  $LDV \geq \max(1, N)$ .
- 10: INFO – INTEGER *Output*  
*On exit:*  $INFO = 0$  unless the routine detects an error (see Section 6).

## 6 Error Indicators and Warnings

INFO < 0

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

## 7 Accuracy

The errors are negligible.

## 8 Parallelism and Performance

F08NHF (DGEBAK) makes calls to BLAS and/or LAPACK routines, which may be threaded within the vendor library used by this implementation. Consult the documentation for the vendor library for further information.

Please consult the X06 Chapter Introduction for information on how to control and interrogate the OpenMP environment used within this routine. Please also consult the Users' Note for your implementation for any additional implementation-specific information.

## **9 Further Comments**

The total number of floating-point operations is approximately proportional to  $nm$ .

The complex analogue of this routine is F08NWF (ZGEBAK).

## **10 Example**

See Section 10 in F08NHF (DGEBAL).

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