

## NAG Library Function Document

### nag\_real\_symm\_banded\_sparse\_eigensystem\_init (f12ffc)

#### 1 Purpose

nag\_real\_symm\_banded\_sparse\_eigensystem\_init (f12ffc) is a setup function for nag\_real\_symm\_banded\_sparse\_eigensystem\_sol (f12fgc) which can be used to find some eigenvalues (and optionally the corresponding eigenvectors) of a standard or generalized eigenvalue problem defined by real, banded, symmetric matrices. The banded matrix must be stored using the LAPACK storage format for real banded nonsymmetric matrices.

#### 2 Specification

```
#include <nag.h>
#include <nagf12.h>

void nag_real_symm_banded_sparse_eigensystem_init (Integer n, Integer nev,
    Integer ncv, Integer icomm[], Integer licomm, double comm[],
    Integer lcomm, NagError *fail)
```

#### 3 Description

The pair of functions nag\_real\_symm\_banded\_sparse\_eigensystem\_init (f12ffc) and nag\_real\_symm\_banded\_sparse\_eigensystem\_sol (f12fgc) together with the option setting function nag\_real\_symm\_sparse\_eigensystem\_option (f12fdc) are designed to calculate some of the eigenvalues,  $\lambda$ , (and optionally the corresponding eigenvectors,  $x$ ) of a standard eigenvalue problem  $Ax = \lambda x$ , or of a generalized eigenvalue problem  $Ax = \lambda Bx$  of order  $n$ , where  $n$  is large and the coefficient matrices  $A$  and  $B$  are banded real and symmetric.

nag\_real\_symm\_banded\_sparse\_eigensystem\_init (f12ffc) is a setup function which must be called before the option setting function nag\_real\_symm\_sparse\_eigensystem\_option (f12fdc) and the solver function nag\_real\_symm\_banded\_sparse\_eigensystem\_sol (f12fgc). Internally, nag\_real\_symm\_banded\_sparse\_eigensystem\_sol (f12fgc) makes calls to nag\_real\_symm\_sparse\_eigensystem\_iter (f12fbc) and nag\_real\_symm\_sparse\_eigensystem\_sol (f12fcc); the function documents for nag\_real\_symm\_sparse\_eigensystem\_iter (f12fbc) and nag\_real\_symm\_sparse\_eigensystem\_sol (f12fcc) should be consulted for details of the algorithm used.

This setup function initializes the communication arrays, sets (to their default values) all options that can be set by you via the option setting function nag\_real\_symm\_sparse\_eigensystem\_option (f12fdc), and checks that the lengths of the communication arrays as passed by you are of sufficient length. For details of the options available and how to set them, see Section 11.1 in nag\_real\_symm\_sparse\_eigensystem\_option (f12fdc).

#### 4 References

Lehoucq R B (2001) Implicitly restarted Arnoldi methods and subspace iteration *SIAM Journal on Matrix Analysis and Applications* **23** 551–562

Lehoucq R B and Scott J A (1996) An evaluation of software for computing eigenvalues of sparse nonsymmetric matrices *Preprint MCS-P547-1195* Argonne National Laboratory

Lehoucq R B and Sorensen D C (1996) Deflation techniques for an implicitly restarted Arnoldi iteration *SIAM Journal on Matrix Analysis and Applications* **17** 789–821

Lehoucq R B, Sorensen D C and Yang C (1998) *ARPACK Users' Guide: Solution of Large-scale Eigenvalue Problems with Implicitly Restarted Arnoldi Methods* SIAM, Philadelphia

## 5 Arguments

- 1: **n** – Integer *Input*  
*On entry:* the order of the matrix *A* (and the order of the matrix *B* for the generalized problem) that defines the eigenvalue problem.  
*Constraint:*  $n > 0$ .
- 2: **nev** – Integer *Input*  
*On entry:* the number of eigenvalues to be computed.  
*Constraint:*  $0 < nev < n - 1$ .
- 3: **ncv** – Integer *Input*  
*On entry:* the number of Lanczos basis vectors to use during the computation.  
 At present there is no *a priori* analysis to guide the selection of **ncv** relative to **nev**. However, it is recommended that  $ncv \geq 2 \times nev + 1$ . If many problems of the same type are to be solved, you should experiment with increasing **ncv** while keeping **nev** fixed for a given test problem. This will usually decrease the required number of matrix-vector operations but it also increases the work and storage required to maintain the orthogonal basis vectors. The optimal ‘cross-over’ with respect to CPU time is problem dependent and must be determined empirically.  
*Constraint:*  $nev < ncv \leq n$ .
- 4: **icomm**[**max(1, licomm)**] – Integer *Communication Array*  
*On exit:* contains data to be communicated to nag\_real\_symm\_banded\_sparse\_eigensystem\_sol (f12fgc).
- 5: **licomm** – Integer *Input*  
*On entry:* the dimension of the array **icomm**.  
 If **licomm** = -1, a workspace query is assumed and the function only calculates the required dimensions of **icomm** and **comm**, which it returns in **icomm**[0] and **comm**[0] respectively.  
*Constraint:*  $licomm \geq 140$  or **licomm** = -1.
- 6: **comm**[**max(1, licomm)**] – double *Communication Array*  
*On exit:* contains data to be communicated to nag\_real\_symm\_banded\_sparse\_eigensystem\_sol (f12fgc).
- 7: **lcomm** – Integer *Input*  
*On entry:* the dimension of the array **comm**.  
 If **lcomm** = -1, a workspace query is assumed and the function only calculates the dimensions of **icomm** and **comm** required by nag\_real\_symm\_banded\_sparse\_eigensystem\_sol (f12fgc), which it returns in **icomm**[0] and **comm**[0] respectively.  
*Constraint:*  $lcomm \geq 60$  or **lcomm** = -1.
- 8: **fail** – NagError \* *Input/Output*  
 The NAG error argument (see Section 3.6 in the Essential Introduction).

## 6 Error Indicators and Warnings

### NE\_ALLOC\_FAIL

Dynamic memory allocation failed.  
See Section 3.2.1.2 in the Essential Introduction for further information.

### NE\_BAD\_PARAM

On entry, argument  $\langle value \rangle$  had an illegal value.

### NE\_INT

On entry,  $\mathbf{n} = \langle value \rangle$ .  
Constraint:  $\mathbf{n} > 0$ .

On entry,  $\mathbf{nev} = \langle value \rangle$ .  
Constraint:  $\mathbf{nev} > 0$ .

### NE\_INT\_2

The length of the integer array  $\mathbf{comm}$  is too small  $\mathbf{lcomm} = \langle value \rangle$ , but must be at least  $\langle value \rangle$ .

The length of the integer array  $\mathbf{icomm}$  is too small  $\mathbf{licomm} = \langle value \rangle$ , but must be at least  $\langle value \rangle$ .

### NE\_INT\_3

On entry,  $\mathbf{ncv} = \langle value \rangle$ ,  $\mathbf{nev} = \langle value \rangle$  and  $\mathbf{n} = \langle value \rangle$ .  
Constraint:  $\mathbf{ncv} > \mathbf{nev} + 1$  and  $\mathbf{ncv} \leq \mathbf{n}$ .

### NE\_INTERNAL\_ERROR

An internal error has occurred in this function. Check the function call and any array sizes. If the call is correct then please contact NAG for assistance.

An unexpected error has been triggered by this function. Please contact NAG.  
See Section 3.6.6 in the Essential Introduction for further information.

### NE\_NO\_LICENCE

Your licence key may have expired or may not have been installed correctly.  
See Section 3.6.5 in the Essential Introduction for further information.

## 7 Accuracy

Not applicable.

## 8 Parallelism and Performance

Not applicable.

## 9 Further Comments

None.

## 10 Example

The use of `nag_real_symm_banded_sparse_eigensystem_init` (f12ffc) is illustrated by the example program of `nag_real_symm_banded_sparse_eigensystem_sol` (f12fgc) (see Section 10 in `nag_real_symm_banded_sparse_eigensystem_sol` (f12fgc)).

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