

NAG Toolbox

nag_matop_real_symm_posdef_inv_noref (f01ad)

1 Purpose

nag_matop_real_symm_posdef_inv_noref (f01ad) calculates the approximate inverse of a real symmetric positive definite matrix, using a Cholesky factorization.

2 Syntax

```
[a, ifail] = nag_matop_real_symm_posdef_inv_noref(a, 'n', n)
[a, ifail] = f01ad(a, 'n', n)
```

3 Description

To compute the inverse X of a real symmetric positive definite matrix A , nag_matop_real_symm_posdef_inv_noref (f01ad) first computes a Cholesky factorization of A as $A = LL^T$, where L is lower triangular. It then computes L^{-1} and finally forms X as the product $L^{-T}L^{-1}$.

4 References

Wilkinson J H and Reinsch C (1971) *Handbook for Automatic Computation II, Linear Algebra* Springer-Verlag

5 Parameters

5.1 Compulsory Input Parameters

1: **a**(lda,:) – REAL (KIND=nag_wp) array

The first dimension of the array **a** must be at least $n + 1$.

The second dimension of the array **a** must be at least $\max(1, n)$.

The upper triangle of the n by n positive definite symmetric matrix A . The elements of the array below the diagonal need not be set.

5.2 Optional Input Parameters

1: **n** – INTEGER

Default: the second dimension of the array **a**.

n , the order of the matrix A .

Constraint: $n \geq 0$.

5.3 Output Parameters

1: **a**(lda,:) – REAL (KIND=nag_wp) array

The first dimension of the array **a** will be $n + 1$.

The second dimension of the array **a** will be $\max(1, n)$.

The lower triangle of the inverse matrix X is stored in the elements of the array below the diagonal, in rows 2 to $n + 1$; x_{ij} is stored in **a**($i + 1, j$) for $i \geq j$. The upper triangle of the original matrix is unchanged.

2: **ifail** – INTEGER

ifail = 0 unless the function detects an error (see Section 5).

6 Error Indicators and Warnings

Errors or warnings detected by the function:

ifail = 1

The matrix A is not positive definite, possibly due to rounding errors.

ifail = 2

On entry, $\mathbf{n} < 0$,
or $lda < \mathbf{n} + 1$.

ifail = -99

An unexpected error has been triggered by this routine. Please contact NAG.

ifail = -399

Your licence key may have expired or may not have been installed correctly.

ifail = -999

Dynamic memory allocation failed.

7 Accuracy

The accuracy of the computed inverse depends on the conditioning of the original matrix. For a detailed error analysis see page 39 of Wilkinson and Reinsch (1971).

8 Further Comments

The time taken by `nag_matop_real_symm_posdef_inv_noref` (f01ad) is approximately proportional to n^3 . `nag_matop_real_symm_posdef_inv_noref` (f01ad) calls functions `nag_lapack_dpotrf` (f07fd) and `nag_lapack_dpotri` (f07fj) from LAPACK.

9 Example

This example finds the inverse of the 4 by 4 matrix:

$$\begin{pmatrix} 5 & 7 & 6 & 5 \\ 7 & 10 & 8 & 7 \\ 6 & 8 & 10 & 9 \\ 5 & 7 & 9 & 10 \end{pmatrix}.$$

9.1 Program Text

```
function f01ad_example
fprintf('f01ad example results\n\n');
a = [ 5, 7, 6, 5;
      7, 10, 8, 7;
      6, 8, 10, 9;
      5, 7, 9, 10];
% add row for storing updates.
a = [a; 0 0 0 0];
```

```
[X, ifail] = f01ad(a);  
  
L = X(2:end,:);  
matrix = 'Lower';  
diag   = 'Non-unit';  
xtitl  = 'Lower triangle of inverse:';  
[ifail] = x04ca( ...  
              matrix, diag, L, xtitl);
```

9.2 Program Results

f01ad example results

```
Lower triangle of inverse:  
      1      2      3      4  
1      68.0000  
2     -41.0000     25.0000  
3     -17.0000     10.0000     5.0000  
4      10.0000     -6.0000     -3.0000     2.0000
```
