

nag_real_cholesky (f03aec)

1. Purpose

nag_real_cholesky (f03aec) computes a Cholesky factorization of a real symmetric positive-definite matrix, and evaluates the determinant.

2. Specification

```
#include <nag.h>
#include <nagf03.h>

void nag_real_cholesky(Integer n, double a[], Integer tda, double p[],
    double *detf, Integer *dete, NagError *fail)
```

3. Description

This function computes the Cholesky factorization of a real symmetric positive-definite matrix $A = LL^T$ where L is lower triangular. The determinant is the product of the squares of the diagonal elements of L .

4. Parameters

n

Input: n , the order of the matrix A .
Constraint: $n \geq 1$.

a[n][tda]

Input: 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.
Output: the sub-diagonal elements of the lower triangular matrix L . The upper triangle of A is unchanged.

tda

Input: the second dimension of the array **a** as declared in the function from which **nag_real_cholesky** is called.
Constraint: **tda** \geq **n**.

p[n]

Output: the reciprocals of the diagonal elements of L .

detf

dete

Output: the determinant of A is given by **detf** \times 2.0^{dete} . It is given in this form to avoid overflow or underflow.

fail

The NAG error parameter, see the Essential Introduction to the NAG C Library.

5. Error Indications and Warnings

NE_NOT_POS_DEF

The matrix is not positive-definite, possibly due to rounding errors. The factorization could not be completed. **detf** and **dete** are set to zero.

NE_INT_ARG_LT

On entry, **n** must not be less than 1: **n** = *<value>*.

NE_2_INT_ARG_LT

On entry, **tda** = *<value>* while **n** = *<value>*. These parameters must satisfy **tda** \geq **n**.

6. Further Comments

The time taken by the function is approximately proportional to n^3 .

6.1. Accuracy

The accuracy of the determinant depends on the conditioning of the original matrix. For a detailed error analysis see Wilkinson and Reinsch (1971) p 25.

6.2. References

Wilkinson J H and Reinsch C (1971) *Handbook for Automatic Computation (Vol II, Linear Algebra)* Springer-Verlag pp 9–30.

7. See Also

nag_real_cholesky_solve_mult_rhs (f04agc)

8. Example

To compute a Cholesky factorization and calculate the determinant of the real symmetric positive-definite matrix

$$\begin{pmatrix} 6 & 7 & 6 & 5 \\ 7 & 11 & 8 & 7 \\ 6 & 8 & 11 & 9 \\ 5 & 7 & 9 & 11 \end{pmatrix}.$$

8.1. Program Text

```

/* nag_real_cholesky(f03aec) Example Program
 *
 * Copyright 1990 Numerical Algorithms Group.
 *
 * Mark 1, 1990.
 */

#include <nag.h>
#include <math.h>
#include <stdio.h>
#include <nag_stdlib.h>
#include <nagf03.h>

#define NMAX 8
#define TDA NMAX

main()
{
    double detf, determ, a[NMAX][TDA], p[NMAX];
    Integer i, dete, j, n;
    static NagError fail;

    Vprintf("f03aec Example Program Results\n");
    /* Skip heading in data file */
    Vscanf("%*[^\\n]");
    Vscanf("%ld\\n",&n);
    if (n<1 || n>NMAX)
    {
        Vfprintf(stderr,"n is out of range: n = %5ld\\n",n);
        exit(EXIT_FAILURE);
    }
    for (i=0; i<n; i++)
        for (j=0; j<n; j++)
            Vscanf("%lf",&a[i][j]);
    fail.print = TRUE;
    f03aec(n, (double *)a, (Integer)TDA, p, &detf, &dete, &fail);
    if (fail.code != NE_NOERROR)
        exit(EXIT_FAILURE);
    Vprintf("Array A after factorization\n");
    for (i=0; i<n; i++)
        for (j=0; j<n; j++)
            Vprintf("%9.4f%s", a[i][j], (j%8==7 || j==n-1) ? "\\n" : " ");

```

```

Vprintf("\nArray p\n");
for (i=0; i<n; i++)
    Vprintf("%9.4f%s", p[i], (i%8==7 || i==n-1) ? "\n" : " ");
Vprintf("\ndetf = %9.4f      dete = %2ld\n\n", detf, dete);
determ = detf*pow(2.0,(double)dete);
Vprintf("Value of determinant = %9.4f\n", determ);
exit(EXIT_SUCCESS);
}

```

8.2. Program Data

f03aec Example Program Data

```

4
 6   7   6   5
 7  11   8   7
 6   8  11   9
 5   7   9  11

```

8.3. Program Results

f03aec Example Program Results

Array A after factorization

6.0000	7.0000	6.0000	5.0000
2.8577	11.0000	8.0000	7.0000
2.4495	0.5941	11.0000	9.0000
2.0412	0.6931	1.6645	11.0000

Array p

0.4082	0.5941	0.4639	0.5283
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detf = 0.0691 dete = 12

Value of determinant = 283.0000
