NAG Fortran Library Routine Document

G05EFF

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

G05EFF sets up a reference vector R for a hypergeometric distribution of the number of specified items in a sample of size l, taken from a population of size n with m specified items in it.

2 Specification

```
SUBROUTINE G05EFF(L, M, N, R, NR, IFAIL)
INTEGER           L, M, N, NR, IFAIL
real              R(NR)
```

3 Description

G05EFF sets up a reference vector for use in G05EYF. Together these routines produce random numbers from the distribution defined by:

$$P(I=i) = \frac{l!m!(n-l)!(n-m)!}{i!(l-i)!(m-i)!(n-m-l+i)!n!} \quad \text{if} \quad i = \max(0, m+l-n), \ldots, \min(l, m),$$

$$P(I=i) = 0 \qquad \text{otherwise.}$$

The reference array is generated by a recurrence relation if $lm(n-l)(n-m) < 50n^3$, otherwise Stirling's approximation is used.

4 References

Knuth D E (1981) *The Art of Computer Programming (Volume 2)* (2nd Edition) Addison-Wesley

5 Parameters

1: L – INTEGER *Input*

On entry: the parameter (sample size) l of the distribution.

Constraint: $0 \leq \text{L} \leq \text{N}$.

2: M – INTEGER *Input*

On entry: the parameter (number of specified items) m of the distribution.

Constraint: $0 \leq \text{M} \leq \text{N}$.

3: N – INTEGER *Input*

On entry: the parameter (population size) n of the distribution.

Constraint: $\text{N} \geq 0$.

4: R(NR) – ***real*** array *Output*

On exit: the reference vector.

5: NR – INTEGER *Input*

On entry: the dimension of the array R as declared in the (sub)program from which G05EFF is called.

Suggested value: NR $= 20 + \sqrt{(\mathrm{L} \times \mathrm{M} \times (\mathrm{N} - \mathrm{M}) \times (\mathrm{N} - \mathrm{L}))/\mathrm{N}^3}$ approximately (for optimum efficiency in G05EYF).

Constraint: NR must not be too small, but the limit is too complicated to specify. The suggested value will always be big enough.

6: IFAIL – INTEGER *Input/Output*

On entry: IFAIL must be set to 0, -1 or 1. Users who are unfamiliar with this parameter should refer to Chapter P01 for details.

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

For environments where it might be inappropriate to halt program execution when an error is detected, the value -1 or 1 is recommended. If the output of error messages is undesirable, then the value 1 is recommended. Otherwise, for users not familiar with this parameter the recommended value is 0. **When the value -1 or 1 is used it is essential to test the value of IFAIL on exit.**

6 Error Indicators and Warnings

If on entry IFAIL $= 0$ or -1, explanatory error messages are output on the current error message unit (as defined by X04AAF).

Errors or warnings detected by the routine:

IFAIL $= 1$

On entry, N is negative.

IFAIL $= 2$

On entry, L < 0,
or L $>$ N.

IFAIL $= 3$

On entry, M < 0,
or M $>$ N.

IFAIL $= 4$

On entry, NR is too small (see Section 5).

7 Accuracy

Not applicable.

8 Further Comments

The time taken by the routine increases with NR.

9 Example

The example program sets up a reference vector for a hypergeometric distribution with $l = 100$, $m = 50$ and $n = 1000$; it then prints the first five pseudo-random numbers generated by G05EYF, after initialisation by G05CBF.

The generator mechanism used is selected by an initial call to G05ZAF.

9.1 Program Text

Note: the listing of the example program presented below uses ***bold italicised*** terms to denote precision-dependent details. Please read the Users' Note for your implementation to check the interpretation of these terms. As explained in the Essential Introduction to this manual, the results produced may not be identical for all implementations.

```
*     G05EFF Example Program Text
*     Mark 20 Revised. NAG Copyright 2001.
*     .. Parameters ..
      INTEGER          L, M, N, NR
      PARAMETER        (L=100,M=50,N=1000,NR=62)
      INTEGER          NOUT
      PARAMETER        (NOUT=6)
*     .. Local Scalars ..
      INTEGER          I, IFAIL, IX
*     .. Local Arrays ..
      real             R(NR)
*     .. External Functions ..
      INTEGER          G05EYF
      EXTERNAL         G05EYF
*     .. External Subroutines ..
      EXTERNAL         G05CBF, G05EFF, G05ZAF
*     .. Executable Statements ..
      CALL G05ZAF('O')
      WRITE (NOUT,*) 'G05EFF Example Program Results'
      WRITE (NOUT,*)
      CALL G05CBF(0)
      IFAIL = 0
*
      CALL G05EFF(L,M,N,R,NR,IFAIL)
*
      DO 20 I = 1, 5
         IX = G05EYF(R,NR)
         WRITE (NOUT,99999) IX
   20 CONTINUE
      STOP
*
99999 FORMAT (1X,I5)
      END
```

9.2 Program Data

None.

9.3 Program Results

```
 G05EFF Example Program Results

     7
     3
     4
     3
     7
```