NAG Fortran Library Routine Document

G05LFF

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

G05LFF generates a vector of pseudo-random numbers taken from a gamma distribution with a and b.

2 Specification

```
SUBROUTINE G05LFF(A, B, N, X, IGEN, ISEED, IFAIL)
INTEGER           N, IGEN, ISEED(4), IFAIL
real              A, B, X(*)
```

3 Description

The beta distribution has PDF (probability density function)

$$f(x) = \frac{1}{b^a \Gamma(a)} x^{a-1} e^{-x/b} \quad \text{if } 0 \leq x; \quad a, b > 0.0$$

$$f(x) = 0 \qquad \text{otherwise.}$$

One of three algorithms is used to generate the variates depending upon the value of a:

If $a < 1$, a switching algorithm described by Dagpunar (1988) (called G6) is used. The target distributions are $f_1(x) = cax^{a-1}/t^a$ and $f_2(x) = (1-c)e^{-(x-t)}$, where $c = t(t + ae^{-t})$, and the switching parameter, t, is taken as $1 - a$. This is similar to Ahrens and Dieter's GS algorithm (see Ahrens and Dieter (1974)) in which $t = 1$;

If $a = 1$, the gamma distribution reduces to the exponential distribution and the method based on the logarithmic transformation of a uniform random variate is used;

If $a > 1$, the algorithm given by Best (1978) is used. This is based on using a Student's t-distribution with two degrees of freedom as the target distribution in an envelope rejection method.

One of the initialisation routines G05KBF (for a repeatable sequence if computed sequentially) or G05KCF (for a non-repeatable sequence) must be called prior to the first call to G05LFF.

4 References

Ahrens J H and Dieter U (1974) Computer methods for sampling from gamma, beta, Poisson and binomial distributions *Computing* **12** 223–46

Best D J (1978) Letter to the Editor *Appl. Statist.* **29** 181

Dagpunar J (1988) *Principles of Random Variate Generation* Oxford University Press

Hastings N A J and Peacock J B (1975) *Statistical Distributions* Butterworth

5 Parameters

1: A – ***real*** *Input*

On entry: the parameter, a, of the gamma distribution.

Constraint: A > 0.0.

2: B – ***real*** *Input*

On entry: the parameter, b, of the gamma distribution.

Constraint: B > 0.0.

3: N – INTEGER *Input*

On entry: the number, n, of pseudo-random numbers to be generated.

Constraint: N ≥ 0.

4: X(*) – ***real*** array *Output*

Note: the dimension of the array X must be at least $\max(1, \mathrm{N})$.

On exit: the n pseudo-random numbers from the specified gamma distribution.

5: IGEN – INTEGER *Input*

On entry: must contain the identification number for the generator to be used to return a pseudo-random number and should remain unchanged following initialisation by a prior call to one of the routines G05KBF or G05KCF.

6: ISEED(4) – INTEGER array *Input/Output*

On entry: contains values which define the current state of the selected generator.

On exit: contains updated values defining the new state of the selected generator.

7: 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, A ≤ 0.0.

IFAIL $= 2$

On entry, B ≤ 0.0.

IFAIL $= 3$

On entry, N < 0.

7 Accuracy

Not applicable.

8 Further Comments

None.

9 Example

The example program prints a set of five pseudo-random numbers from a gamma distribution with parameters $a = 5.0$ and $b = 1.0$, generated by a single call to G05LFF, after initialisation by G05KBF.

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.

```
*     G05LFF Example Program Text
*     Mark 20 Release. NAG Copyright 2001.
*     .. Parameters ..
      INTEGER          NOUT
      PARAMETER        (NOUT=6)
      INTEGER          N
      PARAMETER        (N=5)
*     .. Local Scalars ..
      INTEGER          IFAIL, IGEN, J
*     .. Local Arrays ..
      real             X(N)
      INTEGER          ISEED(4)
*     .. External Subroutines ..
      EXTERNAL         G05KBF, G05LFF
*     .. Executable Statements ..
      WRITE (NOUT,*) 'G05LFF Example Program Results'
      WRITE (NOUT,*)
*     Initialise the seed to a repeatable sequence
      ISEED(1) = 1762543
      ISEED(2) = 9324783
      ISEED(3) = 42344
      ISEED(4) = 742355
*     IGEN identifies the stream.
      IGEN = 1
      CALL G05KBF(IGEN,ISEED)
*
      IFAIL = 0
      WRITE (NOUT,*) 'Gamma Dist --- A=5.0, B=1.0'
*
      CALL G05LFF(5.0e0,1.0e0,N,X,IGEN,ISEED,IFAIL)
*
      WRITE (NOUT,99999) (X(J),J=1,N)
      STOP
*
99999 FORMAT (1X,F10.4)
      END
```

9.2 Program Data

None.

9.3 Program Results

```
 G05LFF Example Program Results

 Gamma Dist --- A=5.0, B=1.0
     3.2806
     4.6512
     4.0683
     4.6252
     7.6745
```