G05FFF – NAG Fortran Library Routine Document

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

G05FFF generates a vector of pseudo-random variates from a gamma distribution with parameters a and b.

2 Specification

```
SUBROUTINE G05FFF(A, B, N, X, IFAIL)
INTEGER           N, IFAIL
real              A, B, X(N)
```

3 Description

The gamma distribution has PDF (probability density function):

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

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 [3] (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 [1] 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 [2] 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.

4 References

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

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

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

[4] Hastings N A J and Peacock J B (1975) *Statistical Distributions* Butterworths

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 ≥ 1.

4: X(N) — ***real*** array *Output*

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

5: IFAIL — INTEGER *Input/Output*

On entry: IFAIL must be set to 0, −1 or 1. For users not familiar with this parameter (described in Chapter P01) the recommended value is 0.

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

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 detected by the routine:

IFAIL = 1

On entry, A ≤ 0.0,
or B ≤ 0.0,
or N < 1.

7 Accuracy

Not applicable.

8 Further Comments

None.

9 Example

The example program prints a set of five pseudo-random variates from a gamma distribution with parameters $a = 5.0$ and $b = 1.0$, generated by G05FFF 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.

```
*     G05FFF Example Program Text
*     NAG Fortran SMP Library, Release 2.  NAG Copyright 2000.
*     .. Parameters ..
      INTEGER          NOUT
      PARAMETER        (NOUT=6)
      INTEGER          N
      PARAMETER        (N=5)
*     .. Local Scalars ..
      INTEGER          IFAIL, J
*     .. Local Arrays ..
```

```
      DOUBLE PRECISION X(N)
*     .. External Subroutines ..
      EXTERNAL         G05CBF, G05FFF, G05ZAF
*     .. Executable Statements ..
      CALL G05ZAF('O')
      WRITE (NOUT,*) 'G05FFF Example Program Results'
      WRITE (NOUT,*)
      IFAIL = 0
      CALL G05CBF(0)
      WRITE (NOUT,*) 'Gamma Dist --- A=5.0, B=1.0'
*
      CALL G05FFF(5.0D0,1.0D0,N,X,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

```
 G05FFF Example Program Results

 Gamma Dist --- A=5.0, B=1.0
     6.7603
     2.9943
     8.3800
     4.5740
     4.9672
```