NAG Toolbox

nag_rand_dist_gamma (g05sj)

1 Purpose

nag_rand_dist_gamma (g05sj) generates a vector of pseudorandom numbers taken from a gamma distribution with parameters a and b.

2 Syntax

```
[state, x, ifail] = nag_rand_dist_gamma(n, a, b, state)
[state, x, ifail] = g05sj(n, a, b, state)
```

3 Description

The gamma distribution has PDF (probability density function)

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

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

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

(i) 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 argument, t, is taken as $1 - a$. This is similar to Ahrens and Dieter's GS algorithm (see Ahrens and Dieter (1974)) in which $t = 1$;

(ii) 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;

(iii) 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 initialization functions nag_rand_init_repeat (g05kf) (for a repeatable sequence if computed sequentially) or nag_rand_init_nonrepeat (g05kg) (for a non-repeatable sequence) must be called prior to the first call to nag_rand_dist_gamma (g05sj).

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.* **27** 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

5.1 Compulsory Input Parameters

1: **n** – INTEGER

n, the number of pseudorandom numbers to be generated.

Constraint: **n** ≥ 0.

2: **a** – REAL (KIND=nag_wp)

a, the parameter of the gamma distribution.

Constraint: **a** > 0.0.

3: **b** – REAL (KIND=nag_wp)

b, the parameter of the gamma distribution.

Constraint: **b** > 0.0.

4: **state**$(:)$ – INTEGER array

Note: the actual argument supplied **must** be the array **state** supplied to the initialization routines nag_rand_init_repeat (g05kf) or nag_rand_init_nonrepeat (g05kg).

Contains information on the selected base generator and its current state.

5.2 Optional Input Parameters

None.

5.3 Output Parameters

1: **state**$(:)$ – INTEGER array

Contains updated information on the state of the generator.

2: **x**$(\mathbf{n})$ – REAL (KIND=nag_wp) array

The n pseudorandom numbers from the specified gamma distribution.

3: **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 $= 1$

Constraint: **n** ≥ 0.

ifail $= 2$

Constraint: **a** > 0.0.

ifail $= 3$

Constraint: **b** > 0.0.

ifail $= 4$

On entry, **state** vector has been corrupted or not initialized.

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

Not applicable.

8 Further Comments

None.

9 Example

This example prints a set of five pseudorandom numbers from a gamma distribution with parameters $a = 5.0$ and $b = 1.0$, generated by a single call to nag_rand_dist_gamma (g05sj), after initialization by nag_rand_init_repeat (g05kf).

9.1 Program Text

```
function g05sj_example

fprintf('g05sj example results\n\n');

% Initialize the base generator to a repeatable sequence
seed  = [nag_int(1762543)];
genid = nag_int(1);
subid = nag_int(1);
[state, ifail] = g05kf( ...
                        genid, subid, seed);

% Number of variates
n = nag_int(5);

% Parameters
a = 5;
b = 1;

% Generate variates from Gamma distribution
[state, x, ifail] = g05sj( ...
                           n, a, b, state);

disp('Variates');
disp(x);
```

9.2 Program Results

```
g05sj example results

Variates
    5.0702
    6.1337
    3.1018
    3.9863
    4.9648
```