NAG Toolbox for MATLAB

g05fe

1 Purpose

g05fe generates a vector of pseudo-random variates from a beta distribution with parameters a and b.

2 Syntax

```
[x, ifail] = g05fe(a, b, n)
```

3 Description

The beta distribution has PDF (probability density function):

$$\begin{array}{ll} f(x) = \frac{\Gamma(a+b)}{\Gamma(a)\Gamma(b)} x^{a-1}(1-x)^{b-1} & \text{if } 0 \leq x \leq 1; a, b > 0.0 \\ f(x) = 0 & \text{otherwise.} \end{array}$$

One of four algorithms is used to generate the variates depending on the values of a and b. Let α be the maximum and β be the minimum of a and b. Then the algorithms are as follows:

If $\alpha < 0.5$

Jhnk's algorithm is used, see for example Dagpunar 1988. This generates the beta variate as $u_1^{1/a} / \left(u_1^{1/a} + u_2^{1/b} \right)$, where u_1 and u_2 are uniformly distributed random variates.

If $\beta > 1$

The algorithm BB given by Cheng 1978 is used. This involves the generation of an observation from a beta distribution of the second kind by the envelope rejection method using a log-logistic target distribution and then transforming it to a beta variate.

If $\alpha > 1$ and $\beta < 1$

The switching algorithm given by Atkinson 1979 is used. The two target distributions used are $f_1(x) = \beta x^{\beta}$ and $f_2(x) = \alpha(1-x)^{\beta-1}$, along with the approximation to the switching parameter of $t = (1-\beta)/(\alpha+1-\beta)$.

In all other cases

Cheng's BC algorithm, see Cheng 1978, is used with modifications suggested by Dagpunar 1988. This algorithm is similar to BB, used when $\beta > 1$, but is tuned for small values of a and b.

4 References

Atkinson A C 1979 A family of switching algorithms for the computer generation of beta random variates *Biometrika* **66** 141–5

Cheng R C H 1978 Generating beta variates with nonintegral shape parameters *Comm. ACM* **21** 317–322

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

Hastings N A J and Peacock J B 1975 *Statistical Distributions* Butterworths

5 Parameters

5.1 Compulsory Input Parameters

1: **a – double scalar**

a, the parameter of the beta distribution.

Constraint: $\mathbf{a} > 0.0$.

2: **b – double scalar**

b, the parameter of the beta distribution.

Constraint: $\mathbf{b} > 0.0$.

3: **n – int32 scalar**

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

Constraint: $\mathbf{n} \geq 1$.

5.2 Optional Input Parameters

None.

5.3 Input Parameters Omitted from the MATLAB Interface

None.

5.4 Output Parameters

1: **x(n) – double array**

The n pseudo-random variates from the specified beta distribution.

2: **ifail – int32 scalar**

0 unless the function detects an error (see Section 6).

6 Error Indicators and Warnings

Errors or warnings detected by the function:

ifail $= 1$

On entry, $\mathbf{a} \leq 0.0$,
or $\mathbf{b} \leq 0.0$,
or $\mathbf{n} < 1$.

7 Accuracy

Not applicable.

8 Further Comments

To generate an observation, y, from the beta distribution of the second kind from an observation, x, generated by g05fe the transformation, $y = x/(1 - x)$, may be used.

9 Example

```
a = 2;
b = 2;
n = int32(5);
g05za('O');
g05cb(int32(0));
[x, ifail] = g05fe(a, b, n)
```

```
x =
    0.7229
    0.4079
    0.8023
    0.2555
    0.0946
ifail =
           0
```