NAG Toolbox for MATLAB

g05le

1 Purpose

g05le generates a vector of pseudo-random numbers taken from a beta distribution with a and b.

2 Syntax

```
[x, iseed, ifail] = g05le(a, b, n, igen, iseed)
```

3 Description

The beta distribution has PDF (probability density function)

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

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:

(i) 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;

(ii) 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;

(iii) 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 $t = (1-\beta)/(\alpha+1-\beta)$;

(iv) 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.

One of the initialization functions g05kb (for a repeatable sequence if computed sequentially) or g05kc (for a non-repeatable sequence) must be called prior to the first call to g05le.

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: **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: $\mathbf{n} \geq 0$.

4: **igen – int32 scalar**

Must contain the identification number for the generator to be used to return a pseudo-random number and should remain unchanged following initialization by a prior call to g05kb or g05kc.

5: **iseed**(4) **– int32 array**

Contains values which define the current state of the selected generator.

5.2 Optional Input Parameters

None.

5.3 Input Parameters Omitted from the MATLAB Interface

None.

5.4 Output Parameters

1: **x**$(*)$ **– double array**

Note: the dimension of the array **x** must be at least $\max(1, \mathbf{n})$.

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

2: **iseed**(4) **– int32 array**

Contains updated values defining the new state of the selected generator.

3: **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, $\mathbf{a} \leq 0.0$.

ifail $= 2$

On entry, $\mathbf{b} \leq 0.0$.

ifail $= 3$

On entry, $\mathbf{n} < 0$.

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 g05le the transformation, $y = x/(1-x)$, may be used.

9 Example

```
a = 2;
b = 2;
n = int32(5);
igen = int32(1);
iseed = [int32(1762543);
         int32(9324783);
         int32(42344);
         int32(742355)];
[igen, iseed] = g05kb(igen, iseed);
[x, iseedOut, ifail] = g05le(a, b, n, igen, iseed)
```

```
x =
    0.4334
    0.8888
    0.5604
    0.3799
    0.5064
iseedOut =
     1333557
     3583480
     8535852
    10382072
ifail =
           0
```