

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):

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

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

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:

If $\alpha < 0.5$

Jhnk's algorithm is used, see for example Dagpunar 1988. This generates the beta variate as $u_1^{1/a} / (u_1^{1/a} + u_2^{1/b})$, 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: $a > 0.0$.

2: **b – double scalar**

b , the parameter of the beta distribution.

Constraint: $b > 0.0$.

3: **n – int32 scalar**

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

Constraint: $n \geq 1$.

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, $a \leq 0.0$,
or $b \leq 0.0$,
or $n < 1$.

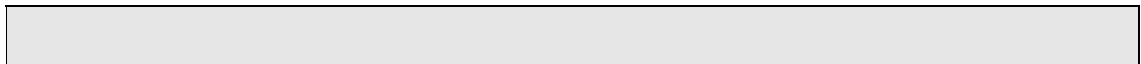
7 Accuracy

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
```
