

NAG Toolbox for MATLAB

g05mb

1 Purpose

g05mb generates a vector of pseudo-random integers from the discrete geometric distribution with probability p of success at a trial.

2 Syntax

```
[x, iseed, r, ifail] = g05mb(mode, p, n, igen, iseed, r)
```

3 Description

g05mb generates n integers x_i from a discrete geometric distribution, where the probability of $x_i = I$ (a first success after I trials) is

$$P(x_i = I) = p \times \left[(1 - p)^{(I-1)} \right], \quad I = 1, 2, \dots$$

The variates can be generated with or without using a search table and index. If a search table is used then it is stored with the index in a reference vector and subsequent calls to g05mb with the same parameter value can then use this reference vector to generate further variates. If the search table is not used (as recommended for small values of p) then a direct transformation of uniform variates is used.

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 g05mb.

4 References

Knuth D E 1981 *The Art of Computer Programming (Volume 2)* (2nd Edition) Addison–Wesley

5 Parameters

5.1 Compulsory Input Parameters

1: **mode** – int32 scalar

A code for selecting the operation to be performed by the function:

mode = 0

Set up reference vector only.

mode = 1

Generate variates using reference vector set up in a prior call to g05mb.

mode = 2

Set up reference vector and generate variates.

mode = 3

Generate variates without using the reference vector.

Constraint: $0 \leq \mathbf{mode} \leq 3$.

2: **p** – double scalar

The parameter p of the geometric distribution representing the probability of success at a single trial.

Constraint: **machine precision** $\leq \mathbf{p} \leq 1.0$.

- 3: **n** – **int32 scalar**
 n , the number of pseudo-random numbers to be generated.
Constraint: $n \geq 1$.
- 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.
- 6: **r(nr)** – **double array**
 If **mode** = 1, the reference vector from the previous call to g05mb.

5.2 Optional Input Parameters

None.

5.3 Input Parameters Omitted from the MATLAB Interface

nr

5.4 Output Parameters

- 1: **x(n)** – **int32 array**
 The n pseudo-random numbers from the specified geometric distribution.
- 2: **iseed(4)** – **int32 array**
 Contains updated values defining the new state of the selected generator.
- 3: **r(nr)** – **double array**
 The reference vector.
- 4: **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, $n < 1$.

ifail = 2

On entry, $nr < 30/p + 6$ and **mode** = 0 or 2.

ifail = 3

On entry, $p < \textit{machine precision}$,
 or $p > 1.0$.

ifail = 4

On entry, **mode** < 0,
or **mode** > 3.

ifail = 5

mode = 0 or 2 and **p** is so small that **nr** would have to be larger than the largest representable integer. Use **mode** = 3 in this case.

ifail = 6

p is not the same as when **r** was set up in a previous call with **mode** = 0 or 2.

7 Accuracy

Not applicable.

8 Further Comments

The time taken to set up the reference vector, if used, increases with the length of array **r**. However, if the reference vector is used, the time taken to generate numbers decreases as the space allotted to the index part of **r** increases. There is a point, depending on the distribution, where this improvement becomes very small and the recommended values for the length of array **r** in other functions are designed to approximate this point.

If **p** is very small then the storage requirements for the reference vector and the time taken to set up the reference vector becomes prohibitive. In this case it is recommended that the reference vector is not used. This is achieved by selecting **mode** = 3.

9 Example

```
mode = int32(3);
p = 0.001;
n = int32(10);
igen = int32(1);
iseed = [int32(1762543);
         int32(9324783);
         int32(423441);
         int32(742355)];
r = zeros(42006, 1);
[x, iseedOut, rOut, ifail] = g05mb(mode, p, n, igen, iseed, r)
```

```
x =
    3699
     631
      29
    1228
     481
     341
    1394
     915
     332
     487
iseedOut =
    8821714
   11238271
    9072904
   10872611
rOut =
   array elided
ifail =
      0
```

