

## NAG C Library Function Document

### nag\_rngs\_geom (g05mbc)

#### 1 Purpose

nag\_rngs\_geom (g05mbc) generates a vector of pseudo-random integers from the discrete geometric distribution with probability  $p$  of success at a trial.

#### 2 Specification

```
void nag_rngs_geom (Integer mode, double p, Integer n, Integer x[], Integer igen,
  Integer iseed[], double r[], NagError *fail)
```

#### 3 Description

nag\_rngs\_geom (g05mbc) generates  $n$  integers  $x_I$  from a discrete geometric distribution, where the probability of  $x_i = I$  (a first success after  $I$  trials) is

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

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 nag\_rngs\_geom (g05mbc) 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 initialisation functions nag\_rngs\_init\_repeatable (g05kbc) (for a repeatable sequence if computed sequentially) or nag\_rngs\_init\_nonrepeatable (g05kcc) (for a non-repeatable sequence) must be called prior to the first call to nag\_rngs\_geom (g05mbc).

#### 4 References

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

#### 5 Parameters

1: **mode** – Integer *Input*

*On entry:* 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 nag\_rngs\_geom (g05mbc).

**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 *Input*

*On entry:* 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** – Integer *Input*  
*On entry:* the number,  $n$ , of pseudo-random numbers to be generated.  
*Constraint:*  $n \geq 1$ .
- 4: **x[n]** – Integer *Output*  
*On exit:* the  $n$  pseudo-random numbers from the specified geometric distribution.
- 5: **igen** – Integer *Input*  
*On entry:* must contain the identification number for the generator to be used to return a pseudo-random number and should remain unchanged following initialisation by a prior call to one of the functions `nag_rngs_init_repeatable` (g05kbc) or `nag_rngs_init_nonrepeatable` (g05kcc).
- 6: **iseed[4]** – Integer *Input/Output*  
*On entry:* contains values which define the current state of the selected generator.  
*On exit:* contains updated values defining the new state of the selected generator.
- 7: **r[dim]** – double *Input/Output*  
**Note:** the dimension,  $dim$ , of the array **r** must be at least  $6 + 42/p$  when **mode** < 3 and at least 1 otherwise.  
*On exit:* the reference vector.
- 8: **fail** – NagError \* *Input/Output*  
The NAG error parameter (see the Essential Introduction).

## 6 Error Indicators and Warnings

### NE\_INT

On entry, **mode** =  $\langle value \rangle$ .  
Constraint:  $0 \leq \mathbf{mode} \leq 3$ .

On entry, **n** =  $\langle value \rangle$ .  
Constraint:  $n \geq 1$ .

### NE\_DIM\_INFEASIBLE

**p** is so small that the reference vector length would exceed integer range We recommend setting **mode** = 3. **p** =  $\langle value \rangle$ .

### NE\_PREV\_CALL

**p** is not the same as when **r** was set up in a previous call. Previous value =  $\langle value \rangle$ , **p** =  $\langle value \rangle$ .

### NE\_REAL

On entry, **p** < *machine precision* or **p** > 1.0: **p** =  $\langle value \rangle$ .

### NE\_BAD\_PARAM

On entry, parameter  $\langle value \rangle$  had an illegal value.

### NE\_INTERNAL\_ERROR

An internal error has occurred in this function. Check the function call and any array sizes. If the call is correct then please consult NAG for assistance.

## 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

The example program prints five pseudo-random integers from a geometric distribution with parameter  $p = 0.001$ , generated by a single call to `nag_rngs_geom(g05mbc)`, after initialisation by `nag_rngs_init_repeatabl(g05kbc)`.

### 9.1 Program Text

```

/* nag_rngs_geom(g05mbc) Example Program.
 *
 * Copyright 2001 Numerical Algorithms Group.
 *
 * Mark 7, 2001.
 */

#include <stdio.h>
#include <nag.h>
#include <nag_stdlib.h>
#include <nagg05.h>

int main(void)
{
    /* Scalars */
    double p;
    Integer igen, j, n, nr;
    Integer exit_status=0;
    NagError fail;

    /* Arrays */
    double *r=0;
    Integer *x=0;
    Integer iseed[4];

    INIT_FAIL(fail);
    Vprintf("g05mbc Example Program Results\n\n");

    nr = 40000;
    n = 10;
    /* Allocate memory */
    if ( !(r = NAG_ALLOC(nr, double)) ||
        !(x = NAG_ALLOC(n, Integer)) )
    {
        Vprintf("Allocation failure\n");
        exit_status = -1;
        goto END;
    }

    /* Set the distribution parameter P */
    p = 0.001;
    /* Initialise the seed to a repeatable sequence */

```

```
iseed[0] = 1762543;
iseed[1] = 9324783;
iseed[2] = 423441;
iseed[3] = 742355;
/* igen identifies the stream. */
igen = 1;
g05kbc(&igen, iseed);

/* Choose MODE = 3 because P is close to 0 */
g05mbc(3, p, n, x, igen, iseed, r, &fail);
if (fail.code != NE_NOERROR)
{
    Vprintf("Error from g05mbc.\n%s\n", fail.message);
    exit_status = 1;
    goto END;
}
for (j = 0; j < n; ++j)
{
    Vprintf("%12ld\n", x[j]);
}
END:
if (r) NAG_FREE(r);
if (x) NAG_FREE(x);
return exit_status;
}
```

## 9.2 Program Data

None.

## 9.3 Program Results

g05mbc Example Program Results

```
3699
631
29
1228
481
341
1394
915
332
487
```

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