

NAG Toolbox

nag_rand_int_negbin (g05th)

1 Purpose

nag_rand_int_negbin (g05th) generates a vector of pseudorandom integers from the discrete negative binomial distribution with parameter m and probability p of success at a trial.

2 Syntax

```
[r, state, x, ifail] = nag_rand_int_negbin(mode, n, m, p, r, state)
[r, state, x, ifail] = g05th(mode, n, m, p, r, state)
```

3 Description

nag_rand_int_negbin (g05th) generates n integers x_i from a discrete negative binomial distribution, where the probability of $x_i = I$ (I successes before m failures) is

$$P(x_i = I) = \frac{(m + I - 1)!}{I!(m - 1)!} \times p^I \times (1 - p)^m, \quad I = 0, 1, \dots$$

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_rand_int_negbin (g05th) with the same parameter value can then use this reference vector to generate further variates.

One of the initialization functions nag_rand_init_repeat (g05kf) (for a repeatable sequence if computed sequentially) or nag_rand_init_nonrepeat (g05kg) (for a non-repeatable sequence) must be called prior to the first call to nag_rand_int_negbin (g05th).

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** – INTEGER

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_rand_int_negbin (g05th).

mode = 2

Set up reference vector and generate variates.

mode = 3

Generate variates without using the reference vector.

Constraint: **mode** = 0, 1, 2 or 3.

- 2: **n** – INTEGER
n, the number of pseudorandom numbers to be generated.
 Constraint: **n** ≥ 0.
- 3: **m** – INTEGER
m, the number of failures of the distribution.
 Constraint: **m** ≥ 0.
- 4: **p** – REAL (KIND=nag_wp)
p, the parameter of the negative binomial distribution representing the probability of success at a single trial.
 Constraint: 0.0 ≤ **p** < 1.0.
- 5: **r**(*lr*) – REAL (KIND=nag_wp) array
lr, the dimension of the array, must satisfy the constraint
 if **mode** = 0 or 2,

$$lr > \text{int}\left(\frac{m \times p + 7.15 \times \sqrt{m \times p} + 20.15 \times p}{1-p} + 8.5\right) - \max\left(0, \text{int}\left(\frac{m \times p - 7.15 \times \sqrt{m \times p}}{1-p}\right)\right) + 9;$$

 if **mode** = 1, *lr* must remain unchanged from the previous call to nag_rand_int_negbin (g05th).
 .
 If **mode** = 1, the reference vector from the previous call to nag_rand_int_negbin (g05th).
 If **mode** = 3, **r** is not referenced.
- 6: **state**(:) – INTEGER array
Note: the actual argument supplied **must** be the array **state** supplied to the initialization routines nag_rand_init_repeat (g05kf) or nag_rand_init_nonrepeat (g05kg).
 Contains information on the selected base generator and its current state.

5.2 Optional Input Parameters

None.

5.3 Output Parameters

- 1: **r**(*lr*) – REAL (KIND=nag_wp) array
 If **mode** ≠ 3, the reference vector.
- 2: **state**(:) – INTEGER array
 Contains updated information on the state of the generator.
- 3: **x**(**n**) – INTEGER array
 The *n* pseudorandom numbers from the specified negative binomial distribution.
- 4: **ifail** – INTEGER
ifail = 0 unless the function detects an error (see Section 5).

6 Error Indicators and Warnings

Errors or warnings detected by the function:

ifail = 1

Constraint: **mode** = 0, 1, 2 or 3.

ifail = 2

Constraint: **n** \geq 0.

ifail = 3

Constraint: **m** \geq 0.

ifail = 4

Constraint: $0.0 \leq \mathbf{p} < 1.0$.

ifail = 5

On entry, some of the elements of the array **r** have been corrupted or have not been initialized.
p or **m** is not the same as when **r** was set up in a previous call.

ifail = 6

On entry, *lr* is too small when **mode** = 0 or 2.

ifail = 7

On entry, **state** vector has been corrupted or not initialized.

ifail = -99

An unexpected error has been triggered by this routine. Please contact NAG.

ifail = -399

Your licence key may have expired or may not have been installed correctly.

ifail = -999

Dynamic memory allocation failed.

7 Accuracy

Not applicable.

8 Further Comments

None.

9 Example

This example prints 20 pseudorandom integers from a negative binomial distribution with parameters $m = 60$ and $p = 0.999$, generated by a single call to `nag_rand_int_negbin` (g05th), after initialization by `nag_rand_init_repeat` (g05kf).

9.1 Program Text

```
function g05th_example

fprintf('g05th example results\n\n');

% Initialize the base generator to a repeatable sequence
seed = [nag_int(1762543)];
genid = nag_int(1);
subid = nag_int(1);
[state, ifail] = g05kf( ...
    genid, subid, seed);

% Number of variates
n = nag_int(20);

% Parameters
m = nag_int(60);
p = 0.999;

% Generate variates from a negative binomial distribution
% without reference vector
mode = nag_int(3);
r = [0];
[r, state, x, ifail] = g05th( ...
    mode, n, m, p, r, state);

disp('Variates');
disp(double(x));
```

9.2 Program Results

```
g05th example results

Variates
 62339
 50505
 64863
 66289
 50434
 59461
 57365
 65965
 59572
 63104
 47833
 54735
 62075
 48018
 61458
 55190
 54263
 80995
 70129
 60200
```
