

NAG Toolbox

nag_rand_int_general (g05td)

1 Purpose

nag_rand_int_general (g05td) generates a vector of pseudorandom integers from a discrete distribution with a given PDF (probability density function) or CDF (cumulative distribution function) p .

2 Syntax

```
[r, state, x, ifail] = nag_rand_int_general(mode, n, p, ip1, itype, r, state,
'np', np)
[r, state, x, ifail] = g05td(mode, n, p, ip1, itype, r, state, 'np', np)
```

3 Description

nag_rand_int_general (g05td) generates a sequence of n integers x_i , from a discrete distribution defined by information supplied in \mathbf{p} . This may either be the PDF or CDF of the distribution. A reference vector is first set up to contain the CDF of the distribution in its higher elements, followed by an index.

Setting up the reference vector and subsequent generation of variates can each be performed by separate calls to nag_rand_int_general (g05td) or may be combined in a single call.

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_general (g05td).

4 References

Kendall M G and Stuart A (1969) *The Advanced Theory of Statistics (Volume 1)* (3rd Edition) Griffin
 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_general (g05td).

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: **p(np)** – REAL (KIND=nag_wp) array
 The PDF or CDF of the distribution.
 Constraints:
 $0.0 \leq \mathbf{p}(i) \leq 1.0$, for $i = 1, 2, \dots, \mathbf{np}$;
 if **itype** = 1, $\sum_{i=1}^{\mathbf{np}} \mathbf{p}(i) = 1.0$;
 if **itype** = 2, $\mathbf{p}(i) < \mathbf{p}(j)$, $i < j$ and $\mathbf{p}(\mathbf{np}) = 1.0$.
- 4: **ip1** – INTEGER
 The value of the variate, a whole number, to which the probability in **p**(1) corresponds.
- 5: **itype** – INTEGER
 Indicates the type of information contained in **p**.
itype = 1
p contains a probability distribution function (PDF).
itype = 2
p contains a cumulative distribution function (CDF).
 Constraint: **itype** = 1 or 2.
- 6: **r(lr)** – REAL (KIND=nag_wp) array
lr, the dimension of the array, must satisfy the constraint
 if **mode** = 0 or 2, $lr \geq \mathbf{np} + 8$;
 if **mode** = 1, *lr* should remain unchanged from the previous call to nag_rand_int_general (g05td).
 .
 If **mode** = 1, the reference vector from the previous call to nag_rand_int_general (g05td).
- 7: **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

- 1: **np** – INTEGER
 Default: the dimension of the array **p**.
 The number of values supplied in **p** defining the PDF or CDF of the discrete distribution.
 Constraint: **np** > 0.

5.3 Output Parameters

- 1: **r(lr)** – REAL (KIND=nag_wp) array
 The reference vector.

- 2: **state**(:) – INTEGER array
Contains updated information on the state of the generator.
- 3: **x**(**n**) – INTEGER array
Contains n pseudorandom numbers from the specified discrete 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 or 2.

ifail = 2

Constraint: **n** \geq 0.

ifail = 3

Constraint: if **itype** = 2, **p**(**np**) = 1.0.

On entry, at least one element of the vector **p** is less than 0.0 or greater than 1.0.

On entry, **itype** = 1 and the sum of the elements of **p** do not equal one.

On entry, **itype** = 2 and the values of **p** are not all in strictly ascending order.

ifail = 4

Constraint: **np** > 0.

ifail = 6

Constraint: **itype** = 1 or 2.

ifail = 7

On entry, some of the elements of the array **r** have been corrupted or have not been initialized.

The value of **np** or **ip1** is not the same as when **r** was set up in a previous call.

ifail = 8

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

ifail = 9

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 variates from a discrete distribution whose PDF, p , is defined as follows:

n	p
-5	0.01
-4	0.02
-3	0.04
-2	0.08
-1	0.20
0	0.30
1	0.20
2	0.08
3	0.04
4	0.02
5	0.01

The reference vector is set up and the variates are generated by a single call to `nag_rand_int_general` (g05td), after initialization by `nag_rand_init_repeat` (g05kf).

9.1 Program Text

```
function g05td_example

fprintf('g05td 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 (PDF)
p = [0.01;    0.02;    0.04;    0.08;    0.2;    0.3;
     0.2;    0.08;    0.04;    0.02;    0.01];
ip1 = nag_int(-5);
itype = nag_int(1);

% Generate variates from PDF defined by p and ip1
mode = nag_int(2);
r = zeros(60, 1);
[r, state, x, ifail] = g05td( ...
    mode, n, p, ip1, itype, r, state);

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

9.2 Program Results

g05td example results

Variates

0
-2
1
1
-2
0
0
1
0
1
-3
-1
0
-3
0
-1
-1
5
2
0
