

## NAG Toolbox

### nag\_rand\_int\_log (g05tf)

#### 1 Purpose

nag\_rand\_int\_log (g05tf) generates a vector of pseudorandom integers from the discrete logarithmic distribution with parameter  $a$ .

#### 2 Syntax

```
[r, state, x, ifail] = nag_rand_int_log(mode, n, a, r, state)
```

```
[r, state, x, ifail] = g05tf(mode, n, a, r, state)
```

#### 3 Description

nag\_rand\_int\_log (g05tf) generates  $n$  integers  $x_i$  from a discrete logarithmic distribution, where the probability of  $x_i = I$  is

$$P(x_i = I) = -\frac{a^I}{I \times \log(1 - a)}, \quad I = 1, 2, \dots,$$

where  $0 < a < 1$ .

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\_log (g05tf) 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\_log (g05tf).

#### 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\_log (g05tf).

**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: **a** – REAL (KIND=nag\_wp)  
*a*, the parameter of the logarithmic distribution.  
 Constraint: 0.0 < **a** < 1.0.
- 4: **r**(*lr*) – REAL (KIND=nag\_wp) array  
*lr*, the dimension of the array, must satisfy the constraint  
     if **mode** = 0 or 2, *lr* must not be too small, but the lower limit is too complicated to specify;  
     if **mode** = 1, *lr* must remain unchanged from the previous call to nag\_rand\_int\_log (g05tf).  
 .  
 If **mode** = 1, the reference vector from the previous call to nag\_rand\_int\_log (g05tf).  
 If **mode** = 3, **r** is not referenced.
- 5: **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  
**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 logarithmic 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:  $0.0 < a < 1.0$ .

**ifail** = 4

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

**ifail** = 5

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

**ifail** = 6

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 10 pseudorandom integers from a logarithmic distribution with parameter  $a = 0.9999$ , generated by a single call to `nag_rand_int_log` (`g05tf`), after initialization by `nag_rand_init_repeat` (`g05kf`).

### 9.1 Program Text

```
function g05tf_example

fprintf('g05tf 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(10);

% Parameters
```

```
a = 0.9999;  
  
% Generate variates from logarithmic distribution without reference vector  
mode = nag_int(3);  
r = [0];  
[r, state, x, ifail] = g05tf( ...  
                             mode, n, a, r, state);  
  
disp('Variates');  
disp(double(x));
```

## 9.2 Program Results

g05tf example results

```
Variates  
      6  
     23  
    2765  
     30  
      3  
      1  
     299  
     968  
     166  
      4
```

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