NAG Toolbox

nag_rand_int_poisson (g05tj)

1 Purpose

nag_rand_int_poisson (g05tj) generates a vector of pseudorandom integers from the discrete Poisson distribution with mean λ.

2 Syntax

```
[r, state, x, ifail] = nag_rand_int_poisson(mode, n, lambda, r, state)
[r, state, x, ifail] = g05tj(mode, n, lambda, r, state)
```

3 Description

nag_rand_int_poisson (g05tj) generates n integers x_i from a discrete Poisson distribution with mean λ, where the probability of $x_i = I$ is

$$P(x_i = I) = \frac{\lambda^I \times e^{-\lambda}}{I!}, \quad I = 0, 1, \ldots,$$

where $\lambda \geq 0$.

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_poisson (g05tj) with the same parameter values can then use this reference vector to generate further variates. The reference array is found using a recurrence relation if λ is less than 50 and by Stirling's formula otherwise.

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_poisson (g05tj).

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_poisson (g05tj).

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: **lambda** – REAL (KIND=nag_wp)

λ, the mean of the Poisson distribution.

Constraint: **lambda** ≥ 0.0.

4: **r**(lr) – REAL (KIND=nag_wp) array

lr, the dimension of the array, must satisfy the constraint

if **mode** $= 0$ or 2,

if $\sqrt{\textbf{lambda}} > 7.15$, $lr > 9 + \text{int}\left(8.5 + 14.3 \times \sqrt{\textbf{lambda}}\right)$;
otherwise $lr > 9 + \text{int}\left(\textbf{lambda} + 7.15 \times \sqrt{\textbf{lambda}} + 8.5\right)$.;
if **mode** $= 1$, lr must remain unchanged from the previous call to nag_rand_int_poisson (g05tj).

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If **mode** $= 1$, the reference vector from the previous call to nag_rand_int_poisson (g05tj).

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

If **mode** $\neq 3$, the reference vector.

2: **state**$(:)$ – INTEGER array

Contains updated information on the state of the generator.

3: **x**$(\textbf{n})$ – INTEGER array

The n pseudorandom numbers from the specified Poisson 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** ≥ 0.

ifail $= 3$

Constraint: **lambda** ≥ 0.0.

lambda is such that lr would have to be larger than the largest representable integer.

ifail $= 4$

lambda is not the same as when **r** was set up in a previous call.

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

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 Poisson distribution with mean $\lambda = 20$, generated by a single call to nag_rand_int_poisson (g05tj), after initialization by nag_rand_init_repeat (g05kf).

9.1 Program Text

```
function g05tj_example

fprintf('g05tj 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
lambda = 20;

% Generate variates from a Poisson distribution
mode = nag_int(2);
r = zeros(120, 1);
[r, state, x, ifail] = g05tj( ...
                              mode, n, lambda, r, state);

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

9.2 Program Results

```
g05tj example results

Variates
    21
    15
    23
    24
    14
    20
    19
    23
    20
    22
```