NAG Toolbox

nag_rand_int_poisson_varmean (g05tk)

1 Purpose

nag_rand_int_poisson_varmean (g05tk) generates a vector of pseudorandom integers, each from a discrete Poisson distribution with differing parameter.

2 Syntax

```
[state, x, ifail] = nag_rand_int_poisson_varmean(vlamda, state, 'm', m)
[state, x, ifail] = g05tk(vlamda, state, 'm', m)
```

3 Description

nag_rand_int_poisson_varmean (g05tk) generates m integers x_j, each from a discrete Poisson distribution with mean λ_j, where the probability of $x_j = I$ is

$$P\left(x_j = I\right) = \frac{\lambda_j^I \times e^{-\lambda_j}}{I!}, \quad I = 0, 1, \ldots,$$

where

$$\lambda_j \geq 0, \quad j = 1, 2, \ldots, m.$$

The methods used by this function have low set up times and are designed for efficient use when the value of the parameter λ changes during the simulation. For large samples from a distribution with fixed λ using nag_rand_int_poisson (g05tj) to set up and use a reference vector may be more efficient.

When $\lambda < 7.5$ the product of uniforms method is used, see for example Dagpunar (1988). For larger values of λ an envelope rejection method is used with a target distribution:

$$f(x) = \tfrac{1}{3} \qquad \text{if } |x| \leq 1,$$

$$f(x) = \tfrac{1}{3}|x|^{-3} \quad \text{otherwise.}$$

This distribution is generated using a ratio of uniforms method. A similar approach has also been suggested by Ahrens and Dieter (1989). The basic method is combined with quick acceptance and rejection tests given by Maclaren (1990). For values of $\lambda \geq 87$ Stirling's approximation is used in the computation of the Poisson distribution function, otherwise tables of factorials are used as suggested by Maclaren (1990).

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_varmean (g05tk).

4 References

Ahrens J H and Dieter U (1989) A convenient sampling method with bounded computation times for Poisson distributions *Amer. J. Math. Management Sci.* 1–13

Dagpunar J (1988) *Principles of Random Variate Generation* Oxford University Press

Maclaren N M (1990) A Poisson random number generator *Personal Communication*

5 Parameters

5.1 Compulsory Input Parameters

1: **vlamda**(**m**) – REAL (KIND=nag_wp) array

The means, λ_j, for $j = 1, 2, \ldots, \mathbf{m}$, of the Poisson distributions.

Constraint: $0.0 \leq \mathbf{vlamda}(j) \leq$ x02bb/2.0, for $j = 1, 2, \ldots, \mathbf{m}$.

2: **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: **m** – INTEGER

Default: the dimension of the array **vlamda**.

m, the number of Poisson distributions for which pseudorandom variates are required.

Constraint: $\mathbf{m} \geq 1$.

5.3 Output Parameters

1: **state**(:) – INTEGER array

Contains updated information on the state of the generator.

2: **x**(**m**) – INTEGER array

The m pseudorandom numbers from the specified Poisson distributions.

3: **ifail** – INTEGER

$\mathbf{ifail} = 0$ unless the function detects an error (see Section 5).

6 Error Indicators and Warnings

Errors or warnings detected by the function:

$\mathbf{ifail} = 1$

Constraint: $\mathbf{m} \geq 1$.

$\mathbf{ifail} = 2$

On entry, at least one element of **vlamda** is less than zero.

On entry, at least one element of **vlamda** is too large.

$\mathbf{ifail} = 3$

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

$\mathbf{ifail} = -99$

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

$\mathbf{ifail} = -399$

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 ten pseudorandom integers from five Poisson distributions with means $\lambda_1 = 0.5$, $\lambda_2 = 5$, $\lambda_3 = 10$, $\lambda_4 = 500$ and $\lambda_5 = 1000$. These are generated by ten calls to nag_rand_int_poisson_varmean (g05tk), after initialization by nag_rand_init_repeat (g05kf).

9.1 Program Text

```
function g05tk_example

fprintf('g05tk 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 sets of variates
n = 10;
% Parameters
vlamda = [0.5; 5; 10; 500; 1000];
m = numel(vlamda);

x = zeros(n, m, nag_int_name);

% Generate n sets of the m variates
for i = 1:n
  [state, x(i, :), ifail] = g05tk( ...
                                   vlamda, state);
end

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

9.2 Program Results

```
g05tk example results

Variates
           1           6          12         507        1003
           0           9          11         520        1028
           1           3           7         483        1041
           0           3          11         513        1012
           1           5           9         496         940
           0           6          17         548         990
           1           9           8         512        1035
           0           4          10         458        1029
           1           6          13         523         971
           0           9          16         519         999
```