NAG Toolbox

nag_rand_dist_dirichlet (g05se)

1 Purpose

nag_rand_dist_dirichlet (g05se) generates a vector of pseudorandom numbers taken from a Dirichlet distribution.

2 Syntax

```
[state, x, ifail] = nag_rand_dist_dirichlet(n, a, state, 'm', m)
[state, x, ifail] = g05se(n, a, state, 'm', m)
```

3 Description

The distribution has PDF (probability density function)

$$f(x) = \frac{1}{B(\alpha)}\prod_{i=1}^{m} x_i^{\alpha_i - 1} \quad \text{and}$$

$$B(\alpha) = \frac{\prod_{i=1}^{m}\Gamma(\alpha_i)}{\Gamma\left(\sum_{i=1}^{m}\alpha_i\right)}$$

where $x = \{x_1, x_2, \ldots, x_m\}$ is a vector of dimension m, such that $x_i > 0$ for all i and $\sum_{i=1}^{m} x_i = 1$.

nag_rand_dist_dirichlet (g05se) generates a draw from a Dirichlet distribution by first drawing m independent samples, $y_i \sim \text{gamma}(\alpha_i, 1)$, i.e., independent draws from a gamma distribution with parameters $\alpha_i > 0$ and one, and then setting $x_i = y_i / \sum_{j=1}^{m} y_j$.

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_dist_dirichlet (g05se).

4 References

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

Hastings N A J and Peacock J B (1975) *Statistical Distributions* Butterworth

5 Parameters

5.1 Compulsory Input Parameters

1: **n** – INTEGER

n, the number of pseudorandom numbers to be generated.

Constraint: **n** ≥ 0.

2: **a**(**m**) – REAL (KIND=nag_wp) array

The parameter vector for the distribution.

Constraint: $\mathbf{a}(i) > 0.0$, for $i = 1, 2, \ldots, \mathbf{m}$.

3: **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 **a**.

m, the number of dimensions of the distribution.

Constraint: $\mathbf{m} > 0$.

5.3 Output Parameters

1: **state**(:) – INTEGER array

Contains updated information on the state of the generator.

2: $\mathbf{x}(ldx, \mathbf{m})$ – REAL (KIND=nag_wp) array

The n pseudorandom numbers from the specified Dirichlet distribution, with $\mathbf{x}(i, j)$ holding the jth dimension for the ith variate.

3: **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: $\mathbf{n} \geq 0$.

ifail $= 2$

Constraint: $\mathbf{m} > 0$.

ifail $= 3$

On entry, at least one $\mathbf{a}(i) \leq 0$.

ifail $= 4$

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

ifail $= 6$

Constraint: $ldx \geq \mathbf{n}$.

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 a set of five pseudorandom numbers from a Dirichlet distribution with parameters $m = 4$ and $\alpha = \{2.0, 2.0, 2.0, 2.0\}$, generated by a single call to nag_rand_dist_dirichlet (g05se), after initialization by nag_rand_init_repeat (g05kf).

9.1 Program Text

```
     function g05se_example

fprintf('g05se 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(5);
% Parameters
a = [2; 2; 2; 2];

% Generate variates from Dirichlet distribution
[state, x, ifail] = g05se( ...
                           n, a, state);

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

9.2 Program Results

```
     g05se example results

Variates
    0.3600    0.3138    0.0837    0.2426
    0.2874    0.5121    0.1497    0.0509
    0.2286    0.2190    0.3959    0.1566
    0.1744    0.3961    0.2764    0.1530
    0.1522    0.2845    0.2074    0.3559
```