

NAG Toolbox

nag_rand_dist_cauchy (g05sc)

1 Purpose

nag_rand_dist_cauchy (g05sc) generates a vector of pseudorandom numbers from a Cauchy distribution with median a and semi-interquartile range b .

2 Syntax

```
[state, x, ifail] = nag_rand_dist_cauchy(n, xmed, semiqr, state)
[state, x, ifail] = g05sc(n, xmed, semiqr, state)
```

3 Description

The distribution has PDF (probability density function)

$$f(x) = \frac{1}{\pi b \left(1 + \left(\frac{x-a}{b}\right)^2\right)}.$$

nag_rand_dist_cauchy (g05sc) returns the value

$$a + b \frac{2y_1 - 1}{y_2},$$

where y_1 and y_2 are a pair of consecutive pseudorandom numbers from a uniform distribution over $(0, 1)$, such that

$$(2y_1 - 1)^2 + y_2^2 \leq 1.$$

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_cauchy (g05sc).

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: **n** – INTEGER
 n , the number of pseudorandom numbers to be generated.
Constraint: $n \geq 0$.
- 2: **xmed** – REAL (KIND=nag_wp)
 a , the median of the distribution.

3: **semiqr** – REAL (KIND=nag_wp)

b , the semi-interquartile range of the distribution.

Constraint: **semiqr** ≥ 0.0 .

4: **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: **state**(:) – INTEGER array

Contains updated information on the state of the generator.

2: **x**(**n**) – REAL (KIND=nag_wp) array

The n pseudorandom numbers from the specified Cauchy distribution.

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: **n** ≥ 0 .

ifail = 3

Constraint: **semiqr** ≥ 0.0 .

ifail = 4

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 the first five pseudorandom real numbers from a Cauchy distribution with median 1.0 and semi-interquartile range 2.0, generated by a single call to `nag_rand_dist_cauchy` (g05sc), after initialization by `nag_rand_init_repeat` (g05kf).

9.1 Program Text

```
function g05sc_example

fprintf('g05sc 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
xmed = 1;
semiqr = 2;

% Generate variates from Cauchy distribution
[state, x, ifail] = g05sc( ...
                    n, xmed, semiqr, state);

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

9.2 Program Results

```
g05sc example results

Variates
    6.1229
    2.2328
   -2.2118
    0.4118
    0.9892
```
