

NAG C Library Function Document

nag_rngs_cauchy (g05llc)

1 Purpose

nag_rngs_cauchy (g05llc) generates a vector of pseudo-random numbers from a Cauchy distribution with median a and semi-interquartile range b .

2 Specification

```
void nag_rngs_cauchy (double xmed, double semiqr, Integer n, double x[],
                    Integer igen, Integer iseed[], NagError *fail)
```

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_rngs_cauchy (g05llc) returns the value

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

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

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

One of the initialisation functions nag_rngs_init_repeatable (g05kbc) (for a repeatable sequence if computed sequentially) or nag_rngs_init_nonrepeatable (g05kcc) (for a non-repeatable sequence) must be called prior to the first call to nag_rngs_cauchy (g05llc).

4 References

Knuth D E (1981) *The Art of Computer Programming (Volume 2)* (2nd Edition) Addison–Wesley

Kendall M G and Stuart A (1969) *The Advanced Theory of Statistics (Volume 1)* (3rd Edition) Griffin

5 Parameters

- | | | |
|----|--|---------------|
| 1: | xmed – double | <i>Input</i> |
| | <i>On entry:</i> the median, a , of the distribution. | |
| 2: | semiqr – double | <i>Input</i> |
| | <i>On entry:</i> the semi-interquartile range, b , of the distribution. | |
| | <i>Constraint:</i> semiqr \geq 0.0. | |
| 3: | n – Integer | <i>Input</i> |
| | <i>On entry:</i> the number, n , of pseudo-random numbers to be generated. | |
| | <i>Constraint:</i> n \geq 0. | |
| 4: | x [<i>dim</i>] – double | <i>Output</i> |
| | Note: the dimension, <i>dim</i> , of the array x must be at least max(1, n). | |

On exit: the n pseudo-random numbers from the specified Cauchy distribution.

- 5: **igen** – Integer *Input*
On entry: must contain the identification number for the generator to be used to return a pseudo-random number and should remain unchanged following initialisation by a prior call to one of the functions `nag_rngs_init_repeatable` (g05kbc) or `nag_rngs_init_nonrepeatable` (g05kcc).
- 6: **iseed**[4] – Integer *Input/Output*
On entry: contains values which define the current state of the selected generator.
On exit: contains updated values defining the new state of the selected generator.
- 7: **fail** – NagError * *Input/Output*
The NAG error parameter (see the Essential Introduction).

6 Error Indicators and Warnings

NE_INT

On entry, **n** = $\langle value \rangle$.
Constraint: **n** ≥ 0 .

NE_REAL

On entry, **semiqr** = $\langle value \rangle$.
Constraint: **semiqr** ≥ 0.0 .

NE_BAD_PARAM

On entry, parameter $\langle value \rangle$ had an illegal value.

NE_INTERNAL_ERROR

An internal error has occurred in this function. Check the function call and any array sizes. If the call is correct then please consult NAG for assistance.

7 Accuracy

Not applicable.

8 Further Comments

None.

9 Example

The example program prints the first five pseudo-random real numbers from a Cauchy distribution with median 1.0 and semi-interquartile range 2.0, generated by a single call to `nag_rngs_cauchy` (g05llc), after initialisation by `nag_rngs_init_repeatable` (g05kbc).

9.1 Program Text

```
/* nag_rngs_cauchy(g05llc) Example Program.
 *
 * Copyright 2001 Numerical Algorithms Group.
 *
 * Mark 7, 2001.
 */
#include <stdio.h>
```

```

#include <nag.h>
#include <nag_stdlib.h>
#include <nagg05.h>

int main(void)
{
    /* Scalars */
    Integer  igen, j, m;
    Integer  exit_status=0;
    NagError fail;

    /* Arrays */
    double  *x=0;
    Integer  iseed[4];

    INIT_FAIL(fail);
    Vprintf("g05llc Example Program Results\n\n");

    m = 5;
    /* Allocate memory */
    if ( !(x = NAG_ALLOC(m, double)) )
    {
        Vprintf("Allocation failure\n");
        exit_status = -1;
        goto END;
    }

    /* Initialise the seed to a repeatable sequence */
    iseed[0] = 1762543;
    iseed[1] = 9324783;
    iseed[2] = 42344;
    iseed[3] = 742355;
    /* igen identifies the stream. */
    igen = 1;
    g05kbc(&igen, iseed);

    g05llc(1.0, 2.0, m, x, igen, iseed, &fail);
    if (fail.code != NE_NOERROR)
    {
        Vprintf("Error from g05llc.\n%s\n", fail.message);
        exit_status = 1;
        goto END;
    }
    for (j = 0; j < m; ++j)
    {
        Vprintf("%10.4f\n", x[j]);
    }
    END:
    if (x) NAG_FREE(x);
    return exit_status;
}

```

9.2 Program Data

None.

9.3 Program Results

g05llc Example Program Results

```

0.4962
1.8604
0.2698
1.0859
-3.9829

```
