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 *Input*

On entry: the median, a, of the distribution.

2: **semiqr** – double *Input*

On entry: the semi-interquartile range, b, of the distribution.

Constraint: **semiqr** ≥ 0.0.

3: **n** – Integer *Input*

On entry: the number, n, of pseudo-random numbers to be generated.

Constraint: **n** ≥ 0.

4: **x**[dim] – double *Output*

Note: the dimension, dim, of the array **x** must be at least $\max(1, \mathbf{n})$.

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** = ⟨*value*⟩.
Constraint: **n** ≥ 0.

NE_REAL

On entry, **semiqr** = ⟨*value*⟩.
Constraint: **semiqr** ≥ 0.0.

NE_BAD_PARAM

On entry, parameter ⟨*value*⟩ 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
```