NAG C Library Function Document

nag_rngs_chi_sq (g05lcc)

1 Purpose

nag_rngs_chi_sq (g05lcc) generates a vector of pseudo-random numbers taken from a χ^2 distribution with ν degrees of freedom.

2 Specification

```
void nag_rngs_chi_sq (Integer df, Integer n, double x[], Integer igen,
     Integer iseed[], NagError *fail)
```

3 Description

The distribution has PDF (probability density function)

$$\begin{aligned} f(x) &= \frac{x^{\frac{1}{2}\nu-1} \times e^{-x/2}}{2^{\frac{1}{2}\nu} \times (\frac{1}{2}\nu - 1)!} && \text{if } x > 0; \\ f(x) &= 0 && \text{otherwise.} \end{aligned}$$

This is the same as a gamma distribution with parameters $\frac{1}{2}\nu$ and 2.

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_chi_sq (g05lcc).

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: **df** – Integer *Input*

On entry: the number of degrees of freedom, ν, of the distribution.

Constraint: **df** ≥ 1.

2: **n** – Integer *Input*

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

Constraint: **n** ≥ 0.

3: **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 χ^2 distribution.

4: **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).

5: **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.

6: **fail** – NagError * *Input/Output*

The NAG error parameter (see the Essential Introduction).

6 Error Indicators and Warnings

NE_INT

On entry, $\mathbf{n} = \langle value \rangle$.
Constraint: $\mathbf{n} \geq 0$.

On entry, $\mathbf{df} = \langle value \rangle$.
Constraint: $\mathbf{df} \geq 1$.

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

The time taken by nag_rngs_chi_sq (g05lcc) increases with ν.

9 Example

The example program prints 5 pseudo-random numbers from a χ^2 distribution with five degrees of freedom, generated by a single call to nag_rngs_chi_sq (g05lcc), after initialisation by nag_rngs_init_repeatable (g05kbc).

9.1 Program Text

```
/* nag_rngs_chi_sq(g05lcc) 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   i, igen, n;
  Integer   exit_status=0;
  NagError fail;
  /* Arrays */
  double   *x=0;
  Integer  iseed[4];

  INIT_FAIL(fail);
  Vprintf("g05lcc Example Program Results\n\n");

  n = 5;
  /* Allocate memory */
  if ( !(x = NAG_ALLOC(n, 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);
  g05lcc(5, n, x, igen, iseed, &fail);
  if (fail.code != NE_NOERROR)
    {
      Vprintf("Error from g05lcc.\n%s\n", fail.message);
      exit_status = 1;
      goto END;
    }
  for (i = 0; i < n; ++i)
    {
      Vprintf("%10.4f\n",   x[i]);
    }
 END:
  if (x) NAG_FREE(x);
  return exit_status;
}
```

9.2 Program Data

None.

9.3 Program Results

```
g05lcc Example Program Results

    2.0097
   13.6994
    3.8964
    3.0941
    8.0579
```