NAG Library Function Document

nag_rand_f (g05shc)

1 Purpose

nag_rand_f (g05shc) generates a vector of pseudorandom numbers taken from an F (or Fisher's variance ratio) distribution with μ and ν degrees of freedom.

2 Specification

```
#include <nag.h>
#include <nagg05.h>
void nag_rand_f (Integer n, Integer df1, Integer df2, Integer state[],
     double x[], NagError *fail)
```

3 Description

The distribution has PDF (probability density function)

$$f(x) = \frac{\left(\frac{\mu+\nu-2}{2}\right)! x^{\frac{1}{2}\mu-1}}{\left(\frac{1}{2}\mu-1\right)!\left(\frac{1}{2}\nu-1\right)!\left(1+\frac{\mu}{\nu}x\right)^{\frac{1}{2}(\mu+\nu)}} \times \left(\frac{\mu}{\nu}\right)^{\frac{1}{2}\mu} \quad \text{if } x > 0,$$

$$f(x) = 0 \qquad \text{otherwise.}$$

nag_rand_f (g05shc) calculates the values

$$\frac{\nu y_i}{\mu z_i}, \quad i = 1, 2, \ldots, n,$$

where y_i and z_i are generated by nag_rand_gamma (g05sjc) from gamma distributions with parameters $\left(\frac{1}{2}\mu, 2\right)$ and $\left(\frac{1}{2}\nu, 2\right)$ respectively (i.e., from χ^2-distributions with μ and ν degrees of freedom).

One of the initialization functions nag_rand_init_repeatable (g05kfc) (for a repeatable sequence if computed sequentially) or nag_rand_init_nonrepeatable (g05kgc) (for a non-repeatable sequence) must be called prior to the first call to nag_rand_f (g05shc).

4 References

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

5 Arguments

1: **n** – Integer *Input*

On entry: n, the number of pseudorandom numbers to be generated.

Constraint: **n** ≥ 0.

2: **df1** – Integer *Input*

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

Constraint: **df1** ≥ 1.

3: **df2** – Integer *Input*

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

Constraint: **df2** ≥ 1.

4: **state**[dim] – Integer *Communication Array*

Note: the dimension, dim, of this array is dictated by the requirements of associated functions that must have been previously called. This array MUST be the same array passed as argument **state** in the previous call to nag_rand_init_repeatable (g05kfc) or nag_rand_init_nonrepeatable (g05kgc).

On entry: contains information on the selected base generator and its current state.

On exit: contains updated information on the state of the generator.

5: **x**[**n**] – double *Output*

On exit: the n pseudorandom numbers from the specified F-distribution.

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

The NAG error argument (see Section 2.7 in How to Use the NAG Library and its Documentation).

6 Error Indicators and Warnings

NE_ALLOC_FAIL

Dynamic memory allocation failed.
See Section 2.3.1.2 in How to Use the NAG Library and its Documentation for further information.

NE_BAD_PARAM

On entry, argument ⟨*value*⟩ had an illegal value.

NE_INT

On entry, **df1** = ⟨*value*⟩.
Constraint: **df1** ≥ 1.

On entry, **df2** = ⟨*value*⟩.
Constraint: **df2** ≥ 1.

On entry, **n** = ⟨*value*⟩.
Constraint: **n** ≥ 0.

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 contact NAG for assistance.

An unexpected error has been triggered by this function. Please contact NAG.
See Section 2.7.6 in How to Use the NAG Library and its Documentation for further information.

NE_INVALID_STATE

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

NE_NO_LICENCE

Your licence key may have expired or may not have been installed correctly.
See Section 2.7.5 in How to Use the NAG Library and its Documentation for further information.

7 Accuracy

Not applicable.

8 Parallelism and Performance

nag_rand_f (g05shc) is threaded by NAG for parallel execution in multithreaded implementations of the NAG Library.

Please consult the x06 Chapter Introduction for information on how to control and interrogate the OpenMP environment used within this function. Please also consult the Users' Note for your implementation for any additional implementation-specific information.

9 Further Comments

The time taken by nag_rand_f (g05shc) increases with μ and ν.

10 Example

This example prints five pseudorandom numbers from an F-distribution with two and three degrees of freedom, generated by a single call to nag_rand_f (g05shc), after initialization by nag_rand_init_repeatable (g05kfc).

10.1 Program Text

```
/* nag_rand_f (g05shc) Example Program.
 *
 * NAGPRODCODE Version.
 *
 * Copyright 2016 Numerical Algorithms Group.
 *
 * Mark 26, 2016.
 */
/* Pre-processor includes */
#include <stdio.h>
#include <math.h>
#include <nag.h>
#include <nag_stdlib.h>
#include <nagg05.h>

int main(void)
{
  /* Integer scalar and array declarations */
  Integer exit_status = 0;
  Integer i, lstate;
  Integer *state = 0;

  /* NAG structures */
  NagError fail;

  /* Double scalar and array declarations */
  double *x = 0;

  /* Set the distribution parameters */
  Integer df1 = 2;
  Integer df2 = 3;

  /* Set the sample size */
  Integer n = 5;

  /* Choose the base generator */
  Nag_BaseRNG genid = Nag_Basic;
  Integer subid = 0;

  /* Set the seed */
  Integer seed[] = { 1762543 };
```

```
  Integer lseed = 1;

  /* Initialize the error structure */
  INIT_FAIL(fail);

  printf("nag_rand_f (g05shc) Example Program Results\n\n");

  /* Get the length of the state array */
  lstate = -1;
  nag_rand_init_repeatable(genid, subid, seed, lseed, state, &lstate, &fail);
  if (fail.code != NE_NOERROR) {
    printf("Error from nag_rand_init_repeatable (g05kfc).\n%s\n",
           fail.message);
    exit_status = 1;
    goto END;
  }

  /* Allocate arrays */
  if (!(x = NAG_ALLOC(n, double)) || !(state = NAG_ALLOC(lstate, Integer)))
  {
    printf("Allocation failure\n");
    exit_status = -1;
    goto END;
  }

  /* Initialize the generator to a repeatable sequence */
  nag_rand_init_repeatable(genid, subid, seed, lseed, state, &lstate, &fail);
  if (fail.code != NE_NOERROR) {
    printf("Error from nag_rand_init_repeatable (g05kfc).\n%s\n",
           fail.message);
    exit_status = 1;
    goto END;
  }

  /* Generate the variates */
  nag_rand_f(n, df1, df2, state, x, &fail);
  if (fail.code != NE_NOERROR) {
    printf("Error from nag_rand_f (g05shc).\n%s\n", fail.message);
    exit_status = 1;
    goto END;
  }

  /* Display the variates */
  for (i = 0; i < n; i++)
    printf("%10.4f\n", x[i]);

END:
  NAG_FREE(x);
  NAG_FREE(state);

  return exit_status;
}
```

10.2 Program Data

None.

10.3 Program Results

```
nag_rand_f (g05shc) Example Program Results

    1.4401
    1.8083
    0.3638
    0.5464
    4.0895
```