

NAG Library Function Document

nag_rand_students_t (g05snc)

1 Purpose

nag_rand_students_t (g05snc) generates a vector of pseudorandom numbers taken from a Student's t -distribution with ν degrees of freedom.

2 Specification

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

3 Description

The distribution has PDF (probability density function)

$$f(x) = \frac{\left(\frac{\nu-1}{2}\right)!}{\left(\frac{1}{2}\nu - 1\right)! \sqrt{\pi\nu} \left(1 + \frac{x^2}{\nu}\right)^{\frac{1}{2}(\nu+1)}}.$$

nag_rand_students_t (g05snc) calculates the values

$$y_i \sqrt{\frac{\nu}{z_i}}, \quad i = 1, \dots, n$$

where the y_i are generated by nag_rand_normal (g05skc) with mean 0 and variance 1.0, and the z_i are generated by nag_rand_gamma (g05sjc) with parameters $\frac{1}{2}\nu$ and 2 (i.e., from a χ^2 -distribution with 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 (g05kge) (for a non-repeatable sequence) must be called prior to the first call to nag_rand_students_t (g05snc).

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: $n \geq 0$.
- 2: **df** – Integer *Input*
On entry: ν , the number of degrees of freedom of the distribution.
Constraint: $df \geq 1$.

- 3: **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.
- 4: **x**[*n*] – double *Output*
On exit: the *n* pseudorandom numbers from the specified Student's *t*-distribution.
- 5: **fail** – NagError * *Input/Output*
The NAG error argument (see Section 3.6 in the Essential Introduction).

6 Error Indicators and Warnings

NE_BAD_PARAM

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

NE_INT

On entry, **df** = $\langle value \rangle$.

Constraint: **df** ≥ 1 .

On entry, **n** = $\langle value \rangle$.

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.

NE_INVALID_STATE

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

7 Accuracy

Not applicable.

8 Parallelism and Performance

`nag_rand_students_t` (g05snc) is threaded by NAG for parallel execution in multithreaded implementations of the NAG Library.

Please consult the Users' Note for your implementation for any additional implementation-specific information.

9 Further Comments

The time taken by `nag_rand_students_t` (g05snc) increases with ν .

10 Example

This example prints five pseudorandom numbers from a Student's *t*-distribution with five degrees of freedom, generated by a single call to `nag_rand_students_t` (g05snc), after initialization by `nag_rand_init_repeatable` (g05kfc).

10.1 Program Text

```

/* nag_rand_students_t (g05snc) Example Program.
 *
 * Copyright 2008, Numerical Algorithms Group.
 *
 * Mark 9, 2009.
 */
/* 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    df = 5;

    /* 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;

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

    printf("nag_rand_students_t (g05snc) 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;
    }

    /* Initialise 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_students_t(n, df, state, x, &fail);
if (fail.code != NE_NOERROR)
{
    printf("Error from nag_rand_students_t (g05snc).\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_students_t (g05snc) Example Program Results

```
0.3849
-0.9461
-2.2814
0.1127
0.5272
```
