

## NAG Toolbox

### nag\_rand\_dist\_students\_t (g05sn)

#### 1 Purpose

nag\_rand\_dist\_students\_t (g05sn) generates a vector of pseudorandom numbers taken from a Student's  $t$ -distribution with  $\nu$  degrees of freedom.

#### 2 Syntax

```
[state, x, ifail] = nag_rand_dist_students_t(n, df, state)
[state, x, ifail] = g05sn(n, df, state)
```

#### 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\_dist\_students\_t (g05sn) calculates the values

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

where the  $y_i$  are generated by nag\_rand\_dist\_normal (g05sk) from a Normal distribution with mean 0 and variance 1.0, and the  $z_i$  are generated by nag\_rand\_dist\_gamma (g05sj) from a gamma distribution with parameters  $\frac{1}{2}\nu$  and 2 (i.e., from a  $\chi^2$ -distribution with  $\nu$  degrees of freedom).

One of the initialization functions nag\_rand\_init\_repeat (g05kf) (for a repeatable sequence if computed sequentially) or nag\_rand\_init\_nonrepeat (g05kg) (for a non-repeatable sequence) must be called prior to the first call to nag\_rand\_dist\_students\_t (g05sn).

#### 4 References

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

#### 5 Parameters

##### 5.1 Compulsory Input Parameters

1: **n** – INTEGER

$n$ , the number of pseudorandom numbers to be generated.

*Constraint:* **n**  $\geq$  0.

2: **df** – INTEGER

$\nu$ , the number of degrees of freedom of the distribution.

*Constraint:* **df**  $\geq$  1.

3: **state**(:) – INTEGER array

**Note:** the actual argument supplied **must** be the array **state** supplied to the initialization routines nag\_rand\_init\_repeat (g05kf) or nag\_rand\_init\_nonrepeat (g05kg).

Contains information on the selected base generator and its current state.

## 5.2 Optional Input Parameters

None.

## 5.3 Output Parameters

- 1: **state**(:) – INTEGER array  
Contains updated information on the state of the generator.
- 2: **x**(**n**) – REAL (KIND=nag\_wp) array  
The  $n$  pseudorandom numbers from the specified Student's  $t$ -distribution.
- 3: **ifail** – INTEGER  
**ifail** = 0 unless the function detects an error (see Section 5).

## 6 Error Indicators and Warnings

Errors or warnings detected by the function:

**ifail** = 1

Constraint:  $\mathbf{n} \geq 0$ .

**ifail** = 2

Constraint:  $\mathbf{df} \geq 1$ .

**ifail** = 3

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

**ifail** = -99

An unexpected error has been triggered by this routine. Please contact NAG.

**ifail** = -399

Your licence key may have expired or may not have been installed correctly.

**ifail** = -999

Dynamic memory allocation failed.

## 7 Accuracy

Not applicable.

## 8 Further Comments

The time taken by `nag_rand_dist_students_t` (g05sn) increases with  $\nu$ .

## 9 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_dist_students_t` (g05sn), after initialization by `nag_rand_init_repeat` (g05kf).

## 9.1 Program Text

```
function g05sn_example
fprintf('g05sn example results\n\n');

% Initialize the base generator to a repeatable sequence
seed = [nag_int(1762543)];
genid = nag_int(1);
subid = nag_int(1);
[state, ifail] = g05kf( ...
                    genid, subid, seed);

% Number of variates
n = nag_int(5);

% Parameters
df = nag_int(5);

% Generate variates from a Student t distribution
[state, x, ifail] = g05sn( ...
                    n, df, state);

disp('Variates');
disp(x);
```

## 9.2 Program Results

```
g05sn example results

Variates
  0.3849
 -0.9461
 -2.2814
  0.1127
  0.5272
```

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