

NAG Library Routine Document

G05SNF

Note: before using this routine, please read the Users' Note for your implementation to check the interpretation of ***bold italicised*** terms and other implementation-dependent details.

1 Purpose

G05SNF generates a vector of pseudorandom numbers taken from a Student's t -distribution with ν degrees of freedom.

2 Specification

```
SUBROUTINE G05SNF(N, DF, STATE, X, IFAIL)
INTEGER          N, DF, STATE(lstate), IFAIL
double precision X(N)
```

3 Description

The distribution has PDF (probability density function)

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

G05SNF calculates the values

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

where the y_i are generated by G05SKF from a Normal distribution with mean 0 and variance 1.0, and the z_i are generated by G05SJF from a gamma distribution with parameters $\frac{1}{2}\nu$ and 2 (i.e., from a χ^2 -distribution with ν degrees of freedom).

One of the initialization routines G05KFF (for a repeatable sequence if computed sequentially) or G05KGF (for a non-repeatable sequence) must be called prior to the first call to G05SNF.

4 References

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

5 Parameters

- 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(*lstate*) – INTEGER array *Communication Array*
Note: *lstate* = LSTATE, the dimension of STATE as supplied to the initialization routine G05KFF or G05KGF.
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 precision** array *Output*
On exit: the *n* pseudorandom numbers from the specified Student's *t*-distribution.
- 5: IFAIL – INTEGER *Input/Output*
On entry: IFAIL must be set to 0, -1 or 1. If you are unfamiliar with this parameter you should refer to Section 3.3 in the Essential Introduction for details.
On exit: IFAIL = 0 unless the routine detects an error (see Section 6).
 For environments where it might be inappropriate to halt program execution when an error is detected, the value -1 or 1 is recommended. If the output of error messages is undesirable, then the value 1 is recommended. Otherwise, if you are not familiar with this parameter, the recommended value is 0. **When the value -1 or 1 is used it is essential to test the value of IFAIL on exit.**

6 Error Indicators and Warnings

If on entry IFAIL = 0 or -1, explanatory error messages are output on the current error message unit (as defined by X04AAF).

Errors or warnings detected by the routine:

IFAIL = 1

On entry, $N < 0$.

IFAIL = 2

On entry, $DF < 1$.

IFAIL = 3

On entry, STATE vector was not initialized or has been corrupted.

7 Accuracy

Not applicable.

8 Further Comments

The time taken by G05SNF increases with ν .

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 G05SNF, after initialization by G05KFF.

9.1 Program Text

```

*      G05SNF Example Program Text
*      Mark 22 Release. NAG Copyright 2006.
*      .. Parameters ..
      INTEGER          NOUT
      PARAMETER        (NOUT=6)
      INTEGER          MSTATE, MSEED, N
      PARAMETER        (MSTATE=633,MSEED=1,N=5)
*      .. Local Scalars ..
      INTEGER          DF, GENID, I, IFAIL, LSEED, LSTATE, SUBID
*      .. Local Arrays ..
      DOUBLE PRECISION X(N)
      INTEGER          SEED(MSEED), STATE(MSTATE)
*      .. External Subroutines ..
      EXTERNAL         G05KFF, G05SNF
*      .. Executable Statements ..
      WRITE (NOUT,*) 'G05SNF Example Program Results'
      WRITE (NOUT,*)
*      Set the distribution parameter DF
      DF = 5
*      Initialize the seed to a repeatable sequence
      SEED(1) = 1762543
*      GENID and SUBID identify the base generator.
      GENID = 1
      SUBID = 1
*      Initialize the generator to a repeatable sequence
      LSTATE = MSTATE
      LSEED = MSEED
      IFAIL = 1
      CALL G05KFF(GENID,SUBID,SEED,LSEED,STATE,LSTATE,IFAIL)
      IF (IFAIL.NE.0) THEN
         WRITE (NOUT,99998) IFAIL
         GO TO 20
      END IF
*      Generate the variates
      IFAIL = 1
      CALL G05SNF(N,DF,STATE,X,IFAIL)
      IF (IFAIL.NE.0) THEN
         WRITE (NOUT,99997) IFAIL
         GO TO 20
      END IF
*      Display the variates
      WRITE (NOUT,99999) (X(I),I=1,N)
*
      20 CONTINUE
*
99999 FORMAT (1X,F10.4)
99998 FORMAT (1X,' ** G05KFF returned with IFAIL = ',I5)
99997 FORMAT (1X,' ** G05SNF returned with IFAIL = ',I5)
      END

```

9.2 Program Data

None.

9.3 Program Results

G05SNF Example Program Results

```

0.3849
-0.9461
-2.2814
0.1127
0.5272

```