NAG Library Routine Document

G05SMF

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

G05SMF generates a vector of pseudorandom numbers from a log-normal distribution with parameters μ and σ^2.

2 Specification

```
SUBROUTINE G05SMF (N, XMU, VAR, STATE, X, IFAIL)
INTEGER           N, STATE(*), IFAIL
REAL (KIND=nag_wp) XMU, VAR, X(N)
```

3 Description

The distribution has PDF (probability density function)

$$f(x) = \frac{1}{x\sigma\sqrt{2\pi}}\exp\left(-\frac{(\ln x - \mu)^2}{2\sigma^2}\right) \quad \text{if } x > 0,$$

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

i.e., $\ln x$ is normally distributed with mean μ and variance σ^2. G05SMF evaluates $\exp y_i$, where the y_i are generated by G05SKF from a Normal distribution with mean μ and variance σ^2, for $i = 1, 2, \ldots, n$.

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 G05SMF.

4 References

Kendall M G and Stuart A (1969) *The Advanced Theory of Statistics (Volume 1)* (3rd Edition) Griffin

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:   XMU – REAL (KIND=nag_wp)   *Input*

   On entry: μ, the mean of the distribution of $\ln x$.

3:   VAR – REAL (KIND=nag_wp)   *Input*

   On entry: σ^2, the variance of the distribution of $\ln x$.

   Constraint: $VAR \geq 0.0$.

4: STATE(∗) – INTEGER array   *Communication Array*

   Note: the actual argument supplied **must** be the array STATE supplied to the initialization routines 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.

5: X(N) – REAL (KIND=nag_wp) array   *Output*

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

6: 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.

   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.**

   On exit: IFAIL = 0 unless the routine detects an error or a warning has been flagged (see Section 6).

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 = $\langle value \rangle$.
   Constraint: N ≥ 0.

IFAIL = 2

   On entry, XMU is too large to take the exponential of XMU = $\langle value \rangle$.

IFAIL = 3

   On entry, VAR = $\langle value \rangle$.
   Constraint: VAR ≥ 0.0.

IFAIL = 4

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

IFAIL = −99

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

   See Section 3.8 in the Essential Introduction for further information.

IFAIL = −399

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

   See Section 3.7 in the Essential Introduction for further information.

IFAIL = −999

    Dynamic memory allocation failed.

    See Section 3.6 in the Essential Introduction for further information.

7   Accuracy

Not applicable.

8   Parallelism and Performance

G05SMF 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 routine. Please also consult the Users' Note for your implementation for any additional implementation-specific information.

9   Further Comments

None.

10   Example

This example prints five pseudorandom numbers from a log-normal distribution with mean 1.0 and variance 2.0, generated by a single call to G05SMF, after initialization by G05KFF.

10.1 Program Text

```
    Program g05smfe

!     G05SMF Example Program Text

!     Mark 25 Release. NAG Copyright 2014.

!     .. Use Statements ..
      Use nag_library, Only: g05kff, g05smf, nag_wp
!     .. Implicit None Statement ..
      Implicit None
!     .. Parameters ..
      Integer, Parameter              :: lseed = 1, nin = 5, nout = 6
!     .. Local Scalars ..
      Real (Kind=nag_wp)              :: var, xmu
      Integer                         :: genid, ifail, lstate, n, subid
!     .. Local Arrays ..
      Real (Kind=nag_wp), Allocatable :: x(:)
      Integer                         :: seed(lseed)
      Integer, Allocatable            :: state(:)
!     .. Executable Statements ..
      Write (nout,*) 'G05SMF Example Program Results'
      Write (nout,*)

!     Skip heading in data file
      Read (nin,*)

!     Read in the base generator information and seed
      Read (nin,*) genid, subid, seed(1)

!     Initial call to initialiser to get size of STATE array
      lstate = 0
      Allocate (state(lstate))
      ifail = 0
      Call g05kff(genid,subid,seed,lseed,state,lstate,ifail)
```

```
!       Reallocate STATE
        Deallocate (state)
        Allocate (state(lstate))

!       Initialize the generator to a repeatable sequence
        ifail = 0
        Call g05kff(genid,subid,seed,lseed,state,lstate,ifail)

!       Read in sample size
        Read (nin,*) n

        Allocate (x(n))

!       Read in the distribution parameters
        Read (nin,*) xmu, var

!       Generate the variates
        ifail = 0
        Call g05smf(n,xmu,var,state,x,ifail)

!       Display the variates
        Write (nout,99999) x(1:n)

99999 Format (1X,F10.4)
    End Program g05smfe
```

10.2 Program Data

```
G05SMF Example Program Data
1  1  1762543      :: GENID,SUBID,SEED(1)
5 3                :: N,NMIX
1.0 2.0            :: XMU,VAR
```

10.3 Program Results

```
 G05SMF Example Program Results

      4.4515
      0.4670
      6.9331
      8.8597
      0.4603
```