

NAG Library Routine Document

G05SGF

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

G05SGF generates a vector of pseudorandom numbers from an exponential mix distribution composed of m exponential distributions each having a mean a_i and weight w_i .

2 Specification

```
SUBROUTINE G05SGF (N, NMIX, A, WGT, STATE, X, IFAIL)
```

```
INTEGER          N, NMIX, STATE(*), IFAIL
REAL (KIND=nag_wp) A(NMIX), WGT(NMIX), X(N)
```

3 Description

The distribution has PDF (probability density function)

$$f(x) = \sum_{i=1}^m \frac{1}{a_i} w_i e^{-x/a_i} \quad \text{if } x \geq 0,$$

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

where $\sum_{i=1}^m w_i = 1$ and $a_i > 0$, $w_i \geq 0$.

G05SGF returns the values x_i by selecting, with probability w_j , random variates from an exponential distribution with parameter a_j .

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 G05SGF.

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: NMIX – INTEGER *Input*
On entry: m , the number of exponential distributions in the mix.
Constraint: $NMIX \geq 1$.

- 3: A(NMIX) – REAL (KIND=nag_wp) array Input
On entry: the m parameters a_i for the m exponential distributions in the mix.
Constraint: $A(i) > 0.0$, for $i = 1, 2, \dots, \text{NMIX}$.
- 4: WGT(NMIX) – REAL (KIND=nag_wp) array Input
On entry: the m weights w_i for the m exponential distributions in the mix.
Constraints:
- $$\sum_{i=1}^m \text{WGT}(i) = 1.0;$$
- $$\text{WGT}(i) \geq 0.0, \text{ for } i = 1, 2, \dots, m.$$
- 5: 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.
- 6: X(N) – REAL (KIND=nag_wp) array Output
On exit: the n pseudorandom numbers from the specified exponential mix distribution.
- 7: 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, $N < 0$.

IFAIL = 2

On entry, $\text{NMIX} \leq 0$.

IFAIL = 3

On entry, $A(i) \leq 0.0$ for at least one $A(i)$.

IFAIL = 4

On entry, $\text{WGT}(i) < 0.0$ for at least one $\text{WGT}(i)$.

On entry, $\sum_{i=1}^{\text{NMIX}} \text{WGT}(i) \neq 1.0$.

IFAIL = 5

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

7 Accuracy

Not applicable.

8 Further Comments

None.

9 Example

This example prints the first five pseudorandom numbers from an exponential mix distribution comprising three exponential distributions with parameters $a_1 = 1.0$, $a_2 = 5.0$ and $a_3 = 2.0$, and with respective weights 0.5, 0.3 and 0.2. The numbers are generated by a single call to G05SGF, after initialization by G05KFF.

9.1 Program Text

```

Program g05sgfe

!      G05SGF Example Program Text
!
!      Mark 24 Release. NAG Copyright 2012.
!
!      .. Use Statements ..
!      Use nag_library, Only: g05kff, g05sgf, nag_wp
!      .. Implicit None Statement ..
!      Implicit None
!      .. Parameters ..
!      Integer, Parameter          :: lseed = 1, nin = 5, nout = 6
!      .. Local Scalars ..
!      Integer                    :: genid, ifail, lstate, n, nmix, subid
!      .. Local Arrays ..
!      Real (Kind=nag_wp), Allocatable :: a(:), wgt(:), x(:)
!      Integer                    :: seed(lseed)
!      Integer, Allocatable       :: state(:)
!
!      .. Executable Statements ..
!      Write (nout,*) 'G05SGF 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 and number of mixtures
      Read (nin,*) n, nmix

      Allocate (x(n),a(nmix),wgt(nmix))

!      Read in the distribution parameters
      Read (nin,*) a(1:nmix)
      Read (nin,*) wgt(1:nmix)

!      Generate the variates
      ifail = 0
      Call g05sgf(n,nmix,a,wgt,state,x,ifail)

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

99999 Format (1X,F10.4)
      End Program g05sgfe
```

9.2 Program Data

```
G05SGF Example Program Data
1 1 1762543      :: GENID,SUBID,SEED(1)
5 3              :: N,NMIX
1.0 5.0 2.0     :: A
0.5 0.3 0.2     :: WGT
```

9.3 Program Results

```
G05SGF Example Program Results
```

```
0.4520
2.2398
1.4649
0.2253
11.2884
```
