NAG Fortran Library Routine Document

G05FSF

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

G05FSF generates a vector of pseudo-random variates from a von Mises distribution with concentration parameter κ.

2 Specification

```
SUBROUTINE G05FSF(VK, N, T, IFAIL)
INTEGER           N, IFAIL
real              VK, T(N)
```

3 Description

The von Mises distribution is a symmetric distribution used in the analysis of circular data. The probability density function of this distribution on the circle with mean direction $\mu_0 = 0$ and concentration parameter kappa, κ, can be written as:

$$f(\theta) = \frac{e^{\kappa \cos \theta}}{2\pi I_0(\kappa)},$$

where θ is reduced modulo 2π so that $-\pi \leq \theta < \pi$ and $\kappa \geq 0$. For very small κ the distribution is almost the uniform distribution, whereas for $\kappa \rightarrow \infty$ all the probability is concentrated at one point.

The n variates, θ_1, θ_2,..., θ_n, are generated using an envelope rejection method with a wrapped Cauchy target distribution as proposed by Best and Fisher (1979) and described by Dagpunar (1988).

4 References

Best D J and Fisher N I (1979) Efficient simulation of the von Mises distribution *Appl. Statist.* **28** 152–157

Dagpunar J (1988) *Principles of Random Variate Generation* Oxford University Press

Mardia K V (1972) *Statistics of Directional Data* Academic Press

5 Parameters

1: VK – ***real*** *Input*

On entry: the concentration parameter, κ, of the required von Mises distribution.

Constraint: VK > 0.0.

2: N – INTEGER *Input*

On entry: the number of random variates required, n.

Constraint: N ≥ 1.

3: T(N) – ***real*** array *Output*

On exit: the n random variates from the specified von Mises distribution, $\theta_1, \theta_2, \ldots, \theta_n$.

4: IFAIL – INTEGER *Input/Output*

On entry: IFAIL must be set to 0, −1 or 1. Users who are unfamiliar with this parameter should refer to Chapter P01 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, for users 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, VK $\leq$ 0.0,
or N $<$ 1.

7 Accuracy

Not applicable.

8 Further Comments

For a given number of random variates the generation time increases slightly with increasing κ.

If VK is supplied too large (i.e., VK > SQRT(X02ALF())) then floating point overflow will occur in internal calculation.

9 Example

A set of four random variates from a von Mises distribution with $\kappa = 2.0$ are generated and printed.

The generator mechanism used is selected by an initial call to G05ZAF.

9.1 Program Text

Note: the listing of the example program presented below uses ***bold italicised*** terms to denote precision-dependent details. Please read the Users' Note for your implementation to check the interpretation of these terms. As explained in the Essential Introduction to this manual, the results produced may not be identical for all implementations.

```
*     G05FSF Example Program Text
*     Mark 20 Revised. NAG Copyright 2001.
*     .. Parameters ..
      INTEGER          NOUT
      PARAMETER        (NOUT=6)
      INTEGER          N
      PARAMETER        (N=10)
*     .. Local Scalars ..
      INTEGER          I, IFAIL
*     .. Local Arrays ..
      real             X(N)
*     .. External Subroutines ..
      EXTERNAL         G05CBF, G05FSF, G05ZAF
*     .. Executable Statements ..
      CALL G05ZAF('O')
      WRITE (NOUT,*) 'G05FSF Example Program Results'
      WRITE (NOUT,*)
      IFAIL = 0
*
```

```
      CALL G05CBF(0)
*
      WRITE (NOUT,*) 'Von Mises Dist --- VK = 2.0'
*
      CALL G05FSF(2.0e0,N,X,IFAIL)
*
      WRITE (NOUT,99999) (X(I),I=1,N)
      STOP
*
99999 FORMAT (1X,F10.4)
      END
```

9.2 Program Data

None.

9.3 Program Results

```
 G05FSF Example Program Results

 Von Mises Dist --- VK = 2.0
    -1.6218
    -0.2575
    -0.2038
     0.8379
    -1.0074
    -0.6629
    -0.0986
     0.0252
     0.2702
    -0.5739
```