

## G05FSF – NAG Fortran Library Routine Document

**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  $\kappa$ .

### 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,  $\kappa$ , can be written as:

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

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

The  $n$  variates,  $\theta_1, \theta_2, \dots, \theta_n$ , are generated using an envelope rejection method with a wrapped Cauchy target distribution as proposed by Best and Fisher [1] and described by Dagpunar [2].

### 4 References

- [1] Best D J and Fisher N I (1979) Efficient simulation of the von Mises distribution *Appl. Statist.* **28** 152–157
- [2] Dagpunar J (1988) *Principles of Random Variate Generation* Oxford University Press
- [3] Mardia K V (1972) *Statistics of Directional Data* Academic Press

### 5 Parameters

- 1: VK — *real* *Input*  
*On entry:* the concentration parameter,  $\kappa$ , 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,  $\theta_1, \theta_2, \dots, \theta_n$ .
- 4: IFAIL — INTEGER *Input/Output*  
*On entry:* IFAIL must be set to 0, -1 or 1. For users not familiar with this parameter (described in Chapter P01) the recommended value is 0.  
*On exit:* IFAIL = 0 unless the routine detects an error (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 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  $\kappa$ .

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

## 9 Example

A set of 4 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
*      NAG Fortran SMP Library, Release 2.  NAG Copyright 2000.
*      .. Parameters ..
      INTEGER          NOUT
      PARAMETER       (NOUT=6)
      INTEGER          N
      PARAMETER       (N=10)
*      .. Local Scalars ..
      INTEGER          I, IFAIL
*      .. Local Arrays ..
      DOUBLE PRECISION X(N)
*      .. External Subroutines ..
      EXTERNAL         G05CBF, G05FSF, G05ZAF
*      .. Executable Statements ..
      CALL G05ZAF('0')
      WRITE (NOUT,*) 'G05FSF Example Program Results'
      WRITE (NOUT,*)
      IFAIL = 0
*
      CALL G05CBF(0)
*
      WRITE (NOUT,*) 'Von Mises Dist --- VK = 2.0'
*
      CALL G05FSF(2.0D0,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
```

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