

# NAG Library Routine Document

## G05MDF

**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

G05MDF generates a vector of pseudorandom integers from the discrete logarithmic distribution with parameter  $a$ .

### 2 Specification

```
SUBROUTINE G05MDF(MODE, A, N, X, IGEN, ISEED, R, NR, IFAIL)
INTEGER          MODE, N, X(N), IGEN, ISEED(4), NR, IFAIL
double precision A, R(NR)
```

### 3 Description

G05MDF generates  $n$  integers  $x_i$  from a discrete logarithmic distribution, where the probability of  $x_i = I$  is

$$P(x_i = I) = -\frac{(a^I)}{(I \times \log(1 - a))} \quad I = 1, 2, \dots,$$

where  $0 < a < 1$ .

The variates can be generated with or without using a search table and index. If a search table is used then it is stored with the index in a reference vector and subsequent calls to G05MDF with the same parameter value can then use this reference vector to generate further variates.

One of the initialization routines G05KBF (for a repeatable sequence if computed sequentially) or G05KCF (for a non-repeatable sequence) must be called prior to the first call to G05MDF.

### 4 References

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

### 5 Parameters

1: MODE – INTEGER *Input*

*On entry:* a code for selecting the operation to be performed by the routine.

MODE = 0

Set up reference vector only.

MODE = 1

Generate variates using reference vector set up in a prior call to G05MDF.

MODE = 2

Set up reference vector and generate variates.

MODE = 3

Generate variates without using the reference vector.

*Constraint:* MODE = 0, 1, 2 or 3.

- 2:    A – *double precision* *Input*  
       *On entry:* a, the parameter of the logarithmic distribution.  
       *Constraint:*  $0.0 < A < 1.0$ .
- 3:    N – INTEGER *Input*  
       *On entry:* n, the number of pseudorandom numbers to be generated.  
       *Constraint:*  $N \geq 1$ .
- 4:    X(N) – INTEGER array *Output*  
       *On exit:* the n pseudorandom numbers from the specified logarithmic distribution.
- 5:    IGEN – INTEGER *Input*  
       *On entry:* must contain the identification number for the generator to be used to return a pseudorandom number and should remain unchanged following initialization by a prior call to G05KBF or G05KCF.
- 6:    ISEED(4) – INTEGER array *Communication Array*  
       *On entry:* contains values which define the current state of the selected generator.  
       *On exit:* contains updated values defining the new state of the selected generator.
- 7:    R(NR) – *double precision* array *Communication Array*  
       *On entry:* if MODE = 1, the reference vector from the previous call to G05MDF.  
       If MODE = 3, R is not referenced by G05MDF.  
       *On exit:* the reference vector.
- 8:    NR – INTEGER *Input*  
       *On entry:* the dimension of the array R as declared in the (sub)program from which G05MDF is called.  
       *Suggested value:*  
           if  $\text{MODE} \neq 3$ ,  $\text{NR} = 10 + \frac{40}{1-A}$ ;  
           otherwise NR = 1.  
       *Constraints:*  
           if MODE = 0 or 2, NR must not be too small, but the lower limit is too complicated to specify;  
           if MODE = 1, NR should remain unchanged from the previous call to G05MDF;  
           if MODE = 3, R is not referenced.
- 9:    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,  $N < 1$ .

$IFAIL = 2$

On entry,  $NR$  is too small when  $MODE = 0$  or  $2$  (see Section 5).

$IFAIL = 3$

On entry,  $A \leq 0.0$ ,  
or  $A \geq 1.0$ .

$IFAIL = 4$

On entry,  $MODE \neq 0, 1, 2$  or  $3$ .

$IFAIL = 5$

$MODE = 0$  or  $2$  and  $A$  is so close to  $1$  that  $NR$  would have to be larger than the largest representable integer. Use  $MODE = 3$  in this case.

$IFAIL = 6$

$A$  is not the same as when  $R$  was set up in a previous call with  $MODE = 0$  or  $2$ .

## 7 Accuracy

Not applicable.

## 8 Further Comments

None.

## 9 Example

This example prints five pseudorandom integers from a logarithmic distribution with parameter  $a = 0.999$ , generated by a single call to G05MDF, after initialization by G05KBF.

### 9.1 Program Text

```
*      G05MDF Example Program Text
*      Mark 20 Release. NAG Copyright 2001.
*      .. Parameters ..
      INTEGER          NOUT, N, NR
      PARAMETER        (NOUT=6,N=10,NR=1)
*      .. Local Scalars ..
      DOUBLE PRECISION A
      INTEGER          I, IFAIL, IGEN
*      .. Local Arrays ..
      DOUBLE PRECISION R(NR)
      INTEGER          ISEED(4), X(N)
*      .. External Subroutines ..
      EXTERNAL        G05KBF, G05MDF
*      .. Executable Statements ..
      WRITE (NOUT,*) 'G05MDF Example Program Results'
      WRITE (NOUT,*)
*      Set the distribution parameter A
```

```
      A = 0.9999D0
*      Initialize the seed to a repeatable sequence
      ISEED(1) = 1762543
      ISEED(2) = 9324783
      ISEED(3) = 42344
      ISEED(4) = 742355
*      IGEN identifies the stream.
      IGEN = 1
      CALL G05KBF(IGEN,ISEED)
      IFAIL = 1
*      Generate integers and store in X
*      Use MODE=3 because A > 0.95
      CALL G05MDF(3,A,N,X,IGEN,ISEED,R,NR,IFAIL)
*
      IF (IFAIL.EQ.0) THEN
*
          WRITE (NOUT,99999) (X(I),I=1,N)
*
      ELSE
          WRITE (NOUT,99998) IFAIL
      END IF
*
99999 FORMAT (1X,I12)
99998 FORMAT (1X,' ** G05MDF returned with IFAIL = ',I5)
      END
```

## 9.2 Program Data

None.

## 9.3 Program Results

G05MDF Example Program Results

```
      262
      21
      8546
      737
      1
      1
      16
      197
      53
      3
```

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