

NAG Library Routine Document

G05MJF

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

G05MJF generates a vector of pseudorandom integers from the discrete binomial distribution with parameters m and p .

2 Specification

```
SUBROUTINE G05MJF(MODE, M, P, N, X, IGEN, ISEED, R, NR, IFAIL)
INTEGER          MODE, M, N, X(N), IGEN, ISEED(4), NR, IFAIL
double precision P, R(NR)
```

3 Description

G05MJF generates n integers x_i from a discrete binomial distribution, where the probability of $x_i = I$ is

$$P(x_i = I) = \frac{m!}{I!(m-I)!} p^I \times (1-p)^{m-I}, \quad I = 0, 1, \dots, m,$$

where $0 \leq m$ and $0 \leq p \leq 1$. This represents the probability of achieving I successes in m trials when the probability of success at a single trial is p .

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 G05MJF with the same parameter values 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 G05MJF.

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: 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 G05MJF.

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: M – INTEGER *Input*
On entry: m , the number of trials of the distribution.
Constraint: $M \geq 0$.
- 3: P – *double precision* *Input*
On entry: p , the probability of success of the binomial distribution.
Constraint: $0.0 \leq P \leq 1.0$.
- 4: N – INTEGER *Input*
On entry: n , the number of pseudorandom numbers to be generated.
Constraint: $N \geq 1$.
- 5: X(N) – INTEGER array *Output*
On exit: the n pseudorandom numbers from the specified binomial distribution.
- 6: 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.
- 7: 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.
- 8: R(NR) – *double precision* array *Communication Array*
On entry: if $\text{MODE} = 1$, the reference vector from the previous call to G05MJF.
 If $\text{MODE} = 3$, R is not referenced by G05MJF.
On exit: the reference vector.
- 9: NR – INTEGER *Input*
On entry: the dimension of the array R as declared in the (sub)program from which G05MJF is called.
Suggested value: $\text{NR} = 22 + 20\sqrt{M \times P(1 - P)}$.
Constraints:
 if $\text{MODE} = 0$ or 2 ,
 $\text{NR} > \min\left(M, \text{int}\left[M \times P + 7.15\sqrt{M \times P(1 - P)} + 1\right]\right) \max\left(0, \text{int}\left[M \times P - 7.15\sqrt{M \times P(1 - P)} - 7.15\right]\right) + 6$;
 if $\text{MODE} = 1$, NR should remain unchanged from the previous call to G05MJF;
 if $\text{MODE} = 3$, R is not referenced.
- 10: 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, $P < 0.0$,
or $P > 1.0$.

$IFAIL = 4$

On entry, $M < 0$.

$IFAIL = 5$

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

$IFAIL = 6$

M or P 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 20 pseudorandom integers from a binomial distribution with parameters $m = 6000$ and $p = 0.8$, generated by a single call to $G05MJF$, after initialization by $G05KBF$.

9.1 Program Text

```
*      G05MJF Example Program Text
*      Mark 20 Release. NAG Copyright 2001.
*      .. Parameters ..
      INTEGER          NOUT, N, NR
      PARAMETER        (NOUT=6,N=20,NR=6007)
*      .. Local Scalars ..
      DOUBLE PRECISION P
      INTEGER          I, IFAIL, IGEN, M
*      .. Local Arrays ..
      DOUBLE PRECISION R(NR)
      INTEGER          ISEED(4), X(N)
*      .. External Subroutines ..
      EXTERNAL        G05KBF, G05MJF
*      .. Executable Statements ..
      WRITE (NOUT,*) 'G05MJF Example Program Results'
      WRITE (NOUT,*)
*      Set the distribution parameters P and M
      P = 0.8D0
```

```
      M = 6000
*      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)
*      Choose MODE = 2
      IFAIL = 1
      CALL G05MJF(2,M,P,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,' ** G05MJF returned with IFAIL = ',I5)
      END
```

9.2 Program Data

None.

9.3 Program Results

G05MJF Example Program Results

```
4758
4851
4793
4820
4851
4795
4807
4792
4787
4842
4801
4794
4806
4878
4745
4790
4832
4789
4743
4812
```
