

NAG Library Routine Document

G05LLF

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

G05LLF generates a vector of pseudorandom numbers from a Cauchy distribution with median a and semi-interquartile range b .

2 Specification

```
SUBROUTINE G05LLF(XMED, SEMIQR, N, X, IGEN, ISEED, IFAIL)
INTEGER          N, IGEN, ISEED(4), IFAIL
double precision XMED, SEMIQR, X(N)
```

3 Description

The distribution has PDF (probability density function)

$$f(x) = \frac{1}{\pi b \left(1 + \left(\frac{x-a}{b}\right)^2\right)}.$$

G05LLF returns the value

$$a + b \frac{2y_1 - 1}{y_2},$$

where y_1 and y_2 are a pair of consecutive pseudorandom numbers from a uniform distribution over $(0, 1)$, such that

$$(2y_1 - 1)^2 + y_2^2 \leq 1.$$

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 G05LLF.

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: | XMED – <i>double precision</i>
<i>On entry:</i> a , the median of the distribution. | <i>Input</i> |
| 2: | SEMIQR – <i>double precision</i>
<i>On entry:</i> b , the semi-interquartile range of the distribution.
<i>Constraint:</i> SEMIQR ≥ 0.0 . | <i>Input</i> |
| 3: | N – INTEGER
<i>On entry:</i> n , the number of pseudorandom numbers to be generated.
<i>Constraint:</i> N ≥ 0 . | <i>Input</i> |

- 4: $X(N)$ – *double precision* array *Output*
On exit: the n pseudorandom numbers from the specified Cauchy 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: 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, $N < 0$.

IFAIL = 2

On entry, SEMIQR < 0.0 .

7 Accuracy

Not applicable.

8 Further Comments

None.

9 Example

This example prints the first five pseudorandom real numbers from a Cauchy distribution with median 1.0 and semi-interquartile range 2.0, generated by a single call to G05LLF, after initialization by G05KBF.

9.1 Program Text

```

*      G05LLF Example Program Text
*      Mark 20 Release. NAG Copyright 2001.
*      .. Parameters ..
      INTEGER          NOUT, N
      PARAMETER        (NOUT=6,N=5)
*      .. Local Scalars ..
      DOUBLE PRECISION SEMIQR, XMED
      INTEGER           IFAIL, IGEN
*      .. Local Arrays ..
      DOUBLE PRECISION X(N)
      INTEGER           ISEED(4)
*      .. External Subroutines ..
      EXTERNAL          G05KBF, G05LLF
*      .. Executable Statements ..
      WRITE (NOUT,*) 'G05LLF Example Program Results'
      WRITE (NOUT,*)
*      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)
*
      XMED = 1.0D0
      SEMIQR = 2.0D0
      IFAIL = 1
      CALL G05LLF(XMED,SEMIQR,N,X,IGEN,ISEED,IFAIL)
*
      IF (IFAIL.EQ.0) THEN
*
          WRITE (NOUT,99999) X
*
      ELSE
          WRITE (NOUT,99998) IFAIL
      END IF
*
99999 FORMAT (1X,F10.4)
99998 FORMAT (1X,' ** G05LLF returned with IFAIL = ',I5)
      END

```

9.2 Program Data

None.

9.3 Program Results

G05LLF Example Program Results

```

0.4962
1.8604
0.2698
1.0859
-3.9829

```
