

NAG Library Routine Document

G05NAF

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

G05NAF performs a pseudorandom permutation of a vector of integers.

2 Specification

```
SUBROUTINE G05NAF( INDEX, N, IGEN, ISEED, IFAIL)
INTEGER           INDEX(N), N, IGEN, ISEED(4), IFAIL
```

3 Description

G05NAF permutes the elements of an integer array without inspecting their values. Each of the $n!$ possible permutations of the n values may be regarded as being equally probable.

Even for modest values of n (greater than 25 say), it is theoretically impossible that all $n!$ permutations may occur, as $n!$ exceeds the cycle length of G05KAF for any valid value of IGEN. For practical purposes this is irrelevant, as the time necessary to generate all possible permutations is many millenia.

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 G05NAF.

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: INDEX(N) – INTEGER array *Input/Output*
On entry: the n integer values to be permuted.
On exit: the n permuted integer values.
- 2: N – INTEGER *Input*
On entry: the number of values to be permuted.
Constraint: $N \geq 1$.
- 3: 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.
- 4: 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.

5: 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, $N < 1$.

7 Accuracy

Not applicable.

8 Further Comments

None.

9 Example

In the example program a vector containing the first eight positive integers in ascending order is permuted by a call to G05NAF and the permutation is printed. This is repeated a total of ten times, after initialization by G05KBF.

9.1 Program Text

```
*      G05NAF Example Program Text
*      Mark 20 Release. NAG Copyright 2001.
*      .. Parameters ..
      INTEGER          NOUT, N
      PARAMETER        (NOUT=6,N=8)
*      .. Local Scalars ..
      INTEGER          I, IFAIL, IGEN, J, K, M
*      .. Local Arrays ..
      INTEGER          INDEX(N), ISEED(4)
*      .. External Subroutines ..
      EXTERNAL         G05KBF, G05NAF
*      .. Executable Statements ..
      WRITE (NOUT,*) 'G05NAF Example Program Results'
      WRITE (NOUT,*)
      M = 10
*      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)
      WRITE (NOUT,99998) M, ' Permutations of first ', N, ' integers'
      WRITE (NOUT,*)
```

```

      DO 40 J = 1, M
        DO 20 I = 1, N
          INDEX(I) = I
20      CONTINUE
        IFAIL = 1
        CALL G05NAF(INDEX,N,IGEN,ISEED,IFAIL)
*
        IF (IFAIL.EQ.0) THEN
          WRITE (NOUT,99999) (INDEX(K),K=1,N)
        ELSE
          WRITE (NOUT,99997) IFAIL
          GO TO 60
        END IF
*
40      CONTINUE
60      CONTINUE
*
99999 FORMAT (1X,8I3)
99998 FORMAT (1X,I2,A,I1,A)
99997 FORMAT (1X,' ** G05NAF returned with IFAIL = ',I5)
      END

```

9.2 Program Data

None.

9.3 Program Results

G05NAF Example Program Results

10 Permutations of first 8 integers

2	4	3	7	8	6	5	1
2	3	6	4	7	5	1	8
6	5	1	4	7	8	3	2
7	3	2	5	1	4	8	6
7	4	8	5	6	2	3	1
2	1	5	8	4	3	7	6
7	3	4	6	2	5	1	8
4	1	7	5	6	8	3	2
3	1	5	2	8	7	4	6
8	7	6	1	3	2	5	4
