

NAG Library Routine Document

G05TFF

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

G05TFF generates a vector of pseudorandom integers from the discrete logarithmic distribution with parameter a .

2 Specification

```
SUBROUTINE G05TFF (MODE, N, A, R, LR, STATE, X, IFAIL)
INTEGER          MODE, N, LR, STATE(*), X(N), IFAIL
REAL (KIND=nag_wp) A, R(LR)
```

3 Description

G05TFF 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 G05TFF with the same parameter value can then use this reference vector to generate further variates.

One of the initialization routines G05KFF (for a repeatable sequence if computed sequentially) or G05KGF (for a non-repeatable sequence) must be called prior to the first call to G05TFF.

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 G05TFF.

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: N – INTEGER *Input*
On entry: n , the number of pseudorandom numbers to be generated.
Constraint: $N \geq 0$.
- 3: A – REAL (KIND=nag_wp) *Input*
On entry: a , the parameter of the logarithmic distribution.
Constraint: $0.0 < A < 1.0$.
- 4: R(LR) – REAL (KIND=nag_wp) array *Communication Array*
On entry: if MODE = 1, the reference vector from the previous call to G05TFF.
 If MODE = 3, R is not referenced by G05TFF.
On exit: the reference vector.
- 5: LR – INTEGER *Input*
On entry: the dimension of the array R as declared in the (sub)program from which G05TFF is called.
Suggested value:
 if MODE \neq 3, $LR = 18 + \frac{40}{1-A}$;
 otherwise LR = 1.
Constraints:
 if MODE = 0 or 2, LR must not be too small, but the lower limit is too complicated to specify;
 if MODE = 1, LR must remain unchanged from the previous call to G05TFF.
- 6: STATE(*) – INTEGER array *Communication Array*
Note: the actual argument supplied must be the array STATE supplied to the initialization routines G05KFF or G05KGF.
On entry: contains information on the selected base generator and its current state.
On exit: contains updated information on the state of the generator.
- 7: X(N) – INTEGER array *Output*
On exit: the n pseudorandom numbers from the specified logarithmic distribution.
- 8: 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.
 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.**
On exit: IFAIL = 0 unless the routine detects an error or a warning has been flagged (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 or warnings detected by the routine:

$IFAIL = 1$

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

$IFAIL = 2$

On entry, $N < 0$.

$IFAIL = 3$

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

$IFAIL = 4$

On entry, A is not the same as when R was set up in a previous call to G05TFF with $MODE = 0$ or 2 .

On entry, the R vector was not initialized correctly, or has been corrupted.

$IFAIL = 5$

On entry, LR is too small when $MODE = 0$ or 2 .

$IFAIL = 6$

On entry, $STATE$ vector was not initialized or has been corrupted.

7 Accuracy

Not applicable.

8 Further Comments

None.

9 Example

This example prints 10 pseudorandom integers from a logarithmic distribution with parameter $a = 0.9999$, generated by a single call to G05TFF, after initialization by G05KFF.

9.1 Program Text

```

Program g05tffe
!      G05TFF Example Program Text
!      Mark 24 Release. NAG Copyright 2012.
!
!      .. Use Statements ..
!      Use nag_library, Only: g05kff, g05tff, nag_wp, x02amf
!      .. Implicit None Statement ..
!      Implicit None
!      .. Parameters ..
!      Integer, Parameter          :: lseed = 1, maxlr = 5000, nin = 5,      &
!                                   nout = 6
!      .. Local Scalars ..
!      Real (Kind=nag_wp)         :: a

```

```

Integer                                :: genid, ifail, lr, lstate, mode, n,   &
                                         subid
! .. Local Arrays ..
Real (Kind=nag_wp), Allocatable        :: r(:)
Integer                                 :: seed(lseed)
Integer, Allocatable                    :: state(:), x(:)
! .. Intrinsic Procedures ..
Intrinsic                               :: int
! .. Executable Statements ..
Write (nout,*) 'G05TFF Example Program Results'
Write (nout,*)

! Skip heading in data file
Read (nin,*)

! Read in the base generator information and seed
Read (nin,*) genid, subid, seed(1)

! Initial call to initialiser to get size of STATE array
lstate = 0
Allocate (state(lstate))
ifail = 0
Call g05kff(genid,subid,seed,lseed,state,lstate,ifail)

! Reallocate STATE
Deallocate (state)
Allocate (state(lstate))

! Initialize the generator to a repeatable sequence
ifail = 0
Call g05kff(genid,subid,seed,lseed,state,lstate,ifail)

! Read in sample size
Read (nin,*) n

! Read in the distribution parameters
Read (nin,*) a

! Use suggested value for LR
If (1.0E0_nag_wp-a<x02amf()) Then
!   A is too close to 1.0 to calculate LR, so
!   set to MAXLR, which means we will use MODE = 3
  lr = maxlr
Else
  lr = int(1.8E1_nag_wp+4.0E1_nag_wp/(1.0E0_nag_wp-a))
End If

  lr = maxlr
! If R is a reasonable size use MODE = 2
! else do not reference R and use MODE = 3
If (lr<maxlr) Then
  mode = 2
Else
  mode = 3
  lr = 0
End If

Allocate (x(n),r(lr))

! Generate the variates
ifail = 0
Call g05tff(mode,n,a,r,lr,state,x,ifail)

! Display the variates
Write (nout,99999) x(1:n)

99999 Format (1X,I12)
End Program g05tffe

```

9.2 Program Data

G05TFF Example Program Data

```
1 1 1762543      :: GENID,SUBID,SEED(1)
10              :: N
0.9999          :: A
```

9.3 Program Results

G05TFF Example Program Results

```
6
23
2765
30
3
1
299
968
166
4
```
