

## NAG Library Function Document

### nag\_rand\_init\_nonrepeatable (g05kgc)

#### 1 Purpose

nag\_rand\_init\_nonrepeatable (g05kgc) initializes the selected base generator to generate a non-repeatable sequence of variates. The base generator can then be used by the group of pseudorandom number functions (see g05khc–g05kjc, g05ncc, g05ndc, g05pdc–g05pjc, g05pxc–g05pzc, g05rcc, g05rdc, g05ryc, g05rzc and g05sac–g05tlc) and the quasi-random scrambled sequence initialization function, nag\_quasi\_init\_scrambled (g05ync).

#### 2 Specification

```
#include <nag.h>
#include <nagg05.h>

void nag_rand_init_nonrepeatable (Nag_BaseRNG genid, Integer subid,
    Integer state[], Integer *lstate, NagError *fail)
```

#### 3 Description

nag\_rand\_init\_nonrepeatable (g05kgc) selects a base generator through the input value of the arguments **genid** and **subid**, and then initializes it based on the values taken from the real-time clock, resulting in the same base generator yielding different sequences of random numbers each time the calling program is run. It should be noted that there is no guarantee of statistical properties between sequences, only within sequences.

A definition of some of the terms used in this description, along with details of the various base generators can be found in the g05 Chapter Introduction.

#### 4 References

L'Ecuyer P and Simard R (2002) *TestU01: a software library in ANSI C for empirical testing of random number generators* Departement d'Informatique et de Recherche Operationnelle, Universite de Montreal <http://www.iro.umontreal.ca/~lecuyer>

Maclaren N M (1989) The generation of multiple independent sequences of pseudorandom numbers *Appl. Statist.* **38** 351–359

Matsumoto M and Nishimura T (1998) Mersenne twister: a 623-dimensionally equidistributed uniform pseudorandom number generator *ACM Transactions on Modelling and Computer Simulations*

Wichmann B A and Hill I D (2006) Generating good pseudo-random numbers *Computational Statistics and Data Analysis* **51** 1614–1622

Wikramaratna R S (1989) ACORN - a new method for generating sequences of uniformly distributed pseudo-random numbers *Journal of Computational Physics* **83** 16–31

#### 5 Arguments

- 1: **genid** – Nag\_BaseRNG *Input*  
*On entry:* must contain the type of base generator to use.
- genid** = Nag\_Basic  
 NAG basic generator.
- genid** = Nag\_WichmannHill\_I  
 Wichmann Hill I generator.

**genid** = Nag\_MersenneTwister  
Mersenne Twister.

**genid** = Nag\_WichmannHill\_II  
Wichmann Hill II generator.

**genid** = Nag\_ACORN  
ACORN generator.

**genid** = Nag\_MRG32k3a  
L'Ecuyer MRG32k3a generator.

See the g05 Chapter Introduction for details of each of the base generators.

*Constraint:* **genid** = Nag\_Basic, Nag\_WichmannHill\_I, Nag\_MersenneTwister, Nag\_WichmannHill\_II, Nag\_ACORN or Nag\_MRG32k3a.

2: **subid** – Integer *Input*

*On entry:* if **genid** = Nag\_WichmannHill\_I, **subid** indicates which of the 273 sub-generators to use. In this case, the  $((|\mathbf{subid}| + 272) \bmod 273) + 1$  sub-generator is used.

If **genid** = Nag\_ACORN, **subid** indicates the values of  $k$  and  $p$  to use, where  $k$  is the order of the generator, and  $p$  controls the size of the modulus,  $M$ , with  $M = 2^{(p \times 30)}$ . If **subid** < 1, the default values of  $k = 10$  and  $p = 2$  are used, otherwise values for  $k$  and  $p$  are calculated from the formula,  $\mathbf{subid} = k + 1000(p - 1)$ .

If **genid** = Nag\_MRG32k3a and  $\mathbf{subid} \bmod 2 = 0$  the range of the generator is set to  $(0, 1]$ , otherwise the range is set to  $(0, 1)$ ; in this case the sequence is identical to the implementation of MRG32k3a in TestU01 (see L'Ecuyer and Simard (2002)) for identical seeds.

For all other values of **genid**, **subid** is not referenced.

3: **state**[**lstate**] – Integer *Communication Array*

*On exit:* contains information on the selected base generator and its current state. If **lstate** < 1 then **state** may be NULL.

4: **lstate** – Integer \* *Input/Output*

*On entry:* the dimension of the **state** array, or a value < 1. If the Mersenne Twister (**genid** = Nag\_MersenneTwister) is being used and the skip ahead function nag\_rand\_skip\_ahead (g05kjc) or nag\_rand\_skip\_ahead\_power2 (g05kkc) will be called subsequently, then you must ensure that **lstate** ≥ 1260.

*On exit:* if **lstate** < 1 on entry, then the required length of the **state** array for the chosen base generator, otherwise **lstate** is unchanged. When **genid** = Nag\_MersenneTwister (Mersenne Twister) a value of 1260 is returned, allowing for the skip ahead function to be subsequently called. In all other cases the minimum length, as documented in the constraints below, is returned.

*Constraints:*

if **genid** = Nag\_Basic, **lstate** ≥ 17;  
if **genid** = Nag\_WichmannHill\_I, **lstate** ≥ 21;  
if **genid** = Nag\_MersenneTwister, **lstate** ≥ 633;  
if **genid** = Nag\_WichmannHill\_II, **lstate** ≥ 29;  
if **genid** = Nag\_ACORN, **lstate** ≥  $\max((k + 1) \times p + 9, 14) + 3$ , where  $k$  and  $p$  are defined by **subid**;  
if **genid** = Nag\_MRG32k3a, **lstate** ≥ 61;  
otherwise **lstate** < 1.

5: **fail** – NagError \* *Input/Output*

The NAG error argument (see Section 3.6 in the Essential Introduction).

## 6 Error Indicators and Warnings

### NE\_ALLOC\_FAIL

Dynamic memory allocation failed.  
See Section 3.2.1.2 in the Essential Introduction for further information.

### NE\_BAD\_PARAM

On entry, argument  $\langle value \rangle$  had an illegal value.

### NE\_INT

On entry,  $lstate = \langle value \rangle$ .  
Constraint:  $lstate \leq 0$  or  $lstate \geq \langle value \rangle$ .

### NE\_INTERNAL\_ERROR

An internal error has occurred in this function. Check the function call and any array sizes. If the call is correct then please contact NAG for assistance.

An unexpected error has been triggered by this function. Please contact NAG.  
See Section 3.6.6 in the Essential Introduction for further information.

### NE\_NO\_LICENCE

Your licence key may have expired or may not have been installed correctly.  
See Section 3.6.5 in the Essential Introduction for further information.

## 7 Accuracy

Not applicable.

## 8 Parallelism and Performance

Not applicable.

## 9 Further Comments

None.

## 10 Example

This example prints the first five pseudorandom real numbers from a uniform distribution between 0 and 1, generated by `nag_rand_basic` (g05sac) after initialization by `nag_rand_init_nonrepeatable` (g05kgc).

### 10.1 Program Text

```
/* nag_rand_init_nonrepeatable (g05kgc) Example Program.
 *
 * Copyright 2014 Numerical Algorithms Group.
 *
 * Mark 9, 2009.
 */
/* Pre-processor includes */
#include <stdio.h>
#include <math.h>
#include <nag.h>
#include <nag_stdlib.h>
#include <nagg05.h>

int main(void)
{
```

```

/* Integer scalar and array declarations */
Integer      exit_status = 0;
Integer      i, lstate;
Integer      *state = 0;
/* NAG structures */
NagError     fail;
/* Double scalar and array declarations */
double       *x = 0;
/* Set the sample size */
Integer      n = 5;
/* Choose the base generator */
Nag_BaseRNG genid = Nag_Basic;
Integer      subid = 0;

/* Initialise the error structure */
INIT_FAIL(fail);

printf(
    "nag_rand_init_nonrepeatable (g05kgc) Example Program Results\n\n");

/* Get the length of the state array */
lstate = -1;
nag_rand_init_nonrepeatable(genid, subid, state, &lstate, &fail);
if (fail.code != NE_NOERROR)
{
    printf("Error from nag_rand_init_nonrepeatable (g05kgc).\n%s\n",
        fail.message);
    exit_status = 1;
    goto END;
}

/* Allocate arrays */
if (!(x = NAG_ALLOC(n, double)) ||
    !(state = NAG_ALLOC(lstate, Integer)))
{
    printf("Allocation failure\n");
    exit_status = -1;
    goto END;
}

/* Initialise the generator to a repeatable sequence */
nag_rand_init_nonrepeatable(genid, subid, state, &lstate, &fail);

if (fail.code != NE_NOERROR)
{
    printf("Error from nag_rand_init_nonrepeatable (g05kgc).\n%s\n",
        fail.message);
    exit_status = 1;
    goto END;
}

/* Generate the variates*/
nag_rand_basic(n, state, x, &fail);
if (fail.code != NE_NOERROR)
{
    printf("Error from nag_rand_basic (g05kgc).\n%s\n", fail.message);
    exit_status = 1;
    goto END;
}

/* Display the variates */
for (i = 0; i < n; i++)
{
    printf("%10.4f\n", x[i]);
}

END:

```

```
NAG_FREE(x);  
NAG_FREE(state);  
  
return exit_status;  
}
```

## **10.2 Program Data**

None.

## **10.3 Program Results**

nag\_rand\_init\_nonrepeatable (g05kgc) Example Program Results

```
0.9234  
0.4207  
0.8461  
0.3662  
0.8180
```

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