

NAG Library Function Document

nag_rand_von_mises (g05src)

1 Purpose

nag_rand_von_mises (g05src) generates a vector of pseudorandom numbers from a von Mises distribution with concentration parameter κ .

2 Specification

```
#include <nag.h>
#include <nagg05.h>
void nag_rand_von_mises (Integer n, double vk, Integer state[], double x[],
                        NagError *fail)
```

3 Description

The von Mises distribution is a symmetric distribution used in the analysis of circular data. The PDF (probability density function) of this distribution on the circle with mean direction $\mu_0 = 0$ and concentration parameter κ , can be written as:

$$f(\theta) = \frac{e^{\kappa \cos \theta}}{2\pi I_0(\kappa)},$$

where θ is reduced modulo 2π so that $-\pi \leq \theta < \pi$ and $\kappa \geq 0$. For very small κ the distribution is almost the uniform distribution, whereas for $\kappa \rightarrow \infty$ all the probability is concentrated at one point.

The n variates, $\theta_1, \theta_2, \dots, \theta_n$, are generated using an envelope rejection method with a wrapped Cauchy target distribution as proposed by Best and Fisher (1979) and described by Dagpunar (1988).

One of the initialization functions nag_rand_init_repeatable (g05kfc) (for a repeatable sequence if computed sequentially) or nag_rand_init_nonrepeatable (g05kgc) (for a non-repeatable sequence) must be called prior to the first call to nag_rand_von_mises (g05src).

4 References

Best D J and Fisher N I (1979) Efficient simulation of the von Mises distribution *Appl. Statist.* **28** 152–157

Dagpunar J (1988) *Principles of Random Variate Generation* Oxford University Press

Mardia K V (1972) *Statistics of Directional Data* Academic Press

5 Arguments

- 1: **n** – Integer *Input*
On entry: n , the number of pseudorandom numbers to be generated.
Constraint: $n \geq 0$.
- 2: **vk** – double *Input*
On entry: κ , the concentration parameter of the required von Mises distribution.
Constraint: $0.0 < \mathbf{vk} \leq \sqrt{\text{nag_real_largest_number}}/2.0$.

- 3: **state**[*dim*] – Integer *Communication Array*
Note: the dimension, *dim*, of this array is dictated by the requirements of associated functions that must have been previously called. This array **MUST** be the same array passed as argument **state** in the previous call to nag_rand_init_repeatable (g05kfc) or nag_rand_init_nonrepeatable (g05kgc).
On entry: contains information on the selected base generator and its current state.
On exit: contains updated information on the state of the generator.
- 4: **x**[**n**] – double *Output*
On exit: the *n* pseudorandom numbers from the specified von Mises distribution.
- 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 *<value>* had an illegal value.

NE_INT

On entry, **n** = *<value>*.
Constraint: **n** ≥ 0.

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_INVALID_STATE

On entry, **state** vector has been corrupted or not initialized.

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.

NE_REAL

On entry, **vk** ≤ 0.0 or **vk** too large: **vk** = *<value>*.

7 Accuracy

Not applicable.

8 Parallelism and Performance

nag_rand_von_mises (g05src) is threaded by NAG for parallel execution in multithreaded implementations of the NAG Library.

Please consult the X06 Chapter Introduction for information on how to control and interrogate the OpenMP environment used within this function. Please also consult the Users' Note for your implementation for any additional implementation-specific information.

9 Further Comments

For a given number of random variates the generation time increases slightly with increasing κ .

10 Example

This example prints the first five pseudorandom numbers from a von Mises distribution with $\kappa = 1.0$, generated by a single call to `nag_rand_von_mises` (g05src), after initialization by `nag_rand_init_repeatabl` (g05kfc).

10.1 Program Text

```

/* nag_rand_von_mises (g05src) 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 distribution parameters */
    double       vk = 1.0e0;

    /* Set the sample size */
    Integer      n = 5;

    /* Choose the base generator */
    Nag_BaseRNG genid = Nag_Basic;
    Integer      subid = 0;

    /* Set the seed */
    Integer      seed[] = { 1762543 };
    Integer      lseed = 1;

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

    printf("nag_rand_von_mises (g05src) Example Program Results\n\n");

    /* Get the length of the state array */
    lstate = -1;
    nag_rand_init_repeatabl(genid, subid, seed, lseed, state, &lstate, &fail);
    if (fail.code != NE_NOERROR)
    {
        printf("Error from nag_rand_init_repeatabl (g05kfc).\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_repeatable(genid, subid, seed, lseed, state, &lstate, &fail);
if (fail.code != NE_NOERROR)
{
    printf("Error from nag_rand_init_repeatable (g05kfc).\n%s\n",
        fail.message);
    exit_status = 1;
    goto END;
}

/* Generate the variates*/
nag_rand_von_mises(n, vk, state, x, &fail);
if (fail.code != NE_NOERROR)
{
    printf("Error from nag_rand_von_mises (g05src).\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_von_mises (g05src) Example Program Results

```

1.2947
-1.9542
-0.6464
-1.4172
1.2536

```
