NAG C Library Function Document

nag_rngs_exp_mix (g05lqc)

1 Purpose

nag_rngs_exp_mix (g05lqc) generates a vector of pseudo-random numbers from an exponential mix distribution composed of \( m \) exponential distributions each having a mean \( a_i \) and weight \( w_i \).

2 Specification

```c
void nag_rngs_exp_mix (Integer nmix, const double a[], const double wgt[],
                      Integer n, double x[], Integer igen, Integer iseed[], NagError *fail)
```

3 Description

The distribution has PDF (probability density function)

\[
f(x) = \begin{cases} 
  \sum_{i=1}^{m} \frac{1}{a_i} w_i e^{-x/a_i} & \text{if } x > 0, \\
  0 & \text{otherwise},
\end{cases}
\]

where \( \sum_{i=1}^{m} w_i = 1 \) and \( a_i > 0, w_i \geq 0 \).

nag_rngs_exp_mix (g05lqc) returns the values \( x_i \) by selecting, with probability \( w_j \), random variates from an exponential distribution with parameter \( a_j \).

One of the initialisation functions nag_rngs_init_repeatable (g05kbc) (for a repeatable sequence if computed sequentially) or nag_rngs_init_nonrepeatable (g05kcc) (for a non-repeatable sequence) must be called prior to the first call to nag_rngs_exp_mix (g05lqc).

4 References


5 Parameters

1: \( \text{nmix} \) – Integer \( \quad \text{Input} \)
   
   On entry: the number, \( m \), of exponential distributions in the mix.

   Constraint: \( \text{nmix} \geq 1 \).

2: \( a[\text{nmix}] \) – const double \( \quad \text{Input} \)
   
   On entry: the \( m \) parameters \( a_i \) for the \( m \) exponential distributions in the mix.

   Constraint: \( a[i] > 0.0 \) for \( i = 0, 1, \ldots, \text{nmix} - 1 \).

3: \( \text{wgt[\text{nmix}]} \) – double \( \quad \text{Input/Output} \)
   
   On entry: the \( m \) weights \( w_i \) for the \( m \) exponential distributions in the mix.

   On exit: used as internal workspace prior to being restored and hence is unchanged.

   Constraints:

   \[
   \sum_{i=1}^{\text{nmix}} \text{wgt}[i] = 1.0; \\
   \text{wgt}[i] \geq 0.0 \text{ for } i = 0, 1, \ldots, \text{nmix} - 1.
   \]
4: \( n \) – Integer

\( n \) on entry: the number, \( n \), of pseudo-random numbers to be generated.

\( n \) is an integer.

\( n \) on exit: the \( n \) pseudo-random numbers from the specified exponential mix distribution.

5: \( x[\text{dim}] \) – double

\( x \) on entry: the dimension, \( \text{dim} \), of the array \( x \) must be at least \( \max(1, n) \).

\( x \) on exit: the \( n \) pseudo-random numbers from the specified exponential mix distribution.

6: \( \text{igen} \) – Integer

\( \text{igen} \) on entry: must contain the identification number for the generator to be used to return a pseudo-random number and should remain unchanged following initialisation by a prior call to one of the functions \( \text{nag\_rngs\_init\_repeatable (g05kbc)} \) or \( \text{nag\_rngs\_init\_nonrepeatable (g05kcc)} \).

7: \( \text{iseed}[4] \) – Integer

\( \text{iseed} \) on entry: contains values which define the current state of the selected generator.

\( \text{iseed} \) on exit: contains updated values defining the new state of the selected generator.

8: \( \text{fail} \) – NagError *

\( \text{fail} \) on entry: contains the NAG error parameter (see the Essential Introduction).

6 Error Indicators and Warnings

\textbf{NE_INT}

On entry, \( n = \langle \text{value} \rangle \).

Constraint: \( n \geq 0 \).

On entry, \( nmix = \langle \text{value} \rangle \).

Constraint: \( nmix \geq 1 \).

\textbf{NE_REAL}

On entry, sum of weights \( wgt \) is not equal to 1.0: \( \text{sum} = \langle \text{value} \rangle \).

\textbf{NE_REAL_ARRAY_ELEM_CONS}

On entry, \( wgt[i - 1] < 0 \): \( i = \langle \text{value} \rangle \), \( wgt[i - 1] = \langle \text{value} \rangle \).

On entry, \( a[i - 1] \leq 0 \): \( i = \langle \text{value} \rangle \), \( a[i - 1] = \langle \text{value} \rangle \).

\textbf{NE_ALLOC_FAIL}

Memory allocation failed.

\textbf{NE_BAD_PARAM}

On entry, parameter \( \langle \text{value} \rangle \) had an illegal value.

\textbf{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 consult NAG for assistance.

7 Accuracy

Not applicable.
8 Further Comments

None.

9 Example

The example program prints the first five pseudo-random real numbers from an exponential mix distribution comprising three exponential distributions with parameters \(a_1 = 1.0\), \(a_2 = 5.0\) and \(a_3 = 2.0\), and with respective weights 0.5, 0.3 and 0.2. The numbers are generated by a single call to nag_rngs_exp_mix (g05lqc), after initialisation by nag_rngs_init_repeatable (g05kbc).

9.1 Program Text

```c
/* nag_rngs_exp_mix(g05lqc) Example Program.
 *
 * Copyright 2001 Numerical Algorithms Group.
 *
 */

#include <stdio.h>
#include <nag.h>
#include <nag_stdlib.h>
#include <nagg05.h>

int main(void)
{
    /* Scalars */
    Integer igen, j, m, nmix;
    Integer exit_status=0;
    NagError fail;

    /* Arrays */
    double *a=0, *wgt=0, *x=0;
    Integer iseed[4];

    INIT_FAIL(fail);
    Vprintf("g05lqc Example Program Results\n\n");
    m = 5;
    nmix = 3;
    /* Allocate memory */
    if ( !(a = NAG_ALLOC(nmix, double)) ||
        !(wgt = NAG_ALLOC(nmix, double)) ||
        !(x = NAG_ALLOC(m, double)) )
    {
        Vprintf("Allocation failure\n");
        exit_status = -1;
        goto END;
    }

    /* Initialise the seed to a repeatable sequence */
    iseed[0] = 1762543;
    iseed[1] = 9324783;
    iseed[2] = 42344;
    iseed[3] = 742355;
    /* igen identifies the stream. */
    igen = 1;
    g05kbc(&igen, iseed);

    a[0] = 1.0;
    a[1] = 5.0;
    a[2] = 2.0;

    wgt[0] = 0.5;
    wgt[1] = 0.3;
    wgt[2] = 0.2;
```

[NP3645/7]
g05lqc(nmix, a, wgt, m, x, igen, iseed, &fail);
if (fail.code != NE_NOERROR)
{
    Vprintf("Error from g05lqc.\n%s\n", fail.message);
    exit_status = 1;
    goto END;
}
for (j = 0; j < m; ++j)
{
    Vprintf("%10.4f
", x[j]);
}
END:
if (a) NAG_FREE(a);
if (wgt) NAG_FREE(wgt);
if (x) NAG_FREE(x);
return exit_status;

9.2 Program Data
None.

9.3 Program Results

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<tr>
<th>g05lqc Example Program Results</th>
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<tbody>
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<td>1.0723</td>
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<tr>
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<td>0.1827</td>
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