1 Purpose

nag_rand_compd_poisson (g05tkc) generates a vector of pseudorandom integers, each from a discrete Poisson distribution with differing parameter.

2 Specification

```c
#include <nag.h>
#include <nag05.h>

void nag_rand_compd_poisson (Integer m, const double vlamda[],
                            Integer state[], Integer x[], NagError *fail)
```

3 Description

nag_rand_compd_poisson (g05tkc) generates \( m \) integers \( x_j \), each from a discrete Poisson distribution with mean \( \lambda_j \), where the probability of \( x_j = I \) is

\[
P(x_j = I) = \frac{\lambda_j^I e^{-\lambda_j}}{I!}, \quad I = 0, 1, \ldots,
\]

where

\[
\lambda_j \geq 0, \quad j = 1, 2, \ldots, m.
\]

The methods used by this function have low set up times and are designed for efficient use when the value of the parameter \( \lambda \) changes during the simulation. For large samples from a distribution with fixed \( \lambda \) using nag_rand_poisson (g05tjc) to set up and use a reference vector may be more efficient.

When \( \lambda < 7.5 \) the product of uniforms method is used, see for example Dagpunar (1988). For larger values of \( \lambda \) an envelope rejection method is used with a target distribution:

\[
f(x) = \begin{cases} 
\frac{1}{3} & \text{if } |x| \leq 1, \\
\frac{1}{3}|x|^{-3} & \text{otherwise.}
\end{cases}
\]

This distribution is generated using a ratio of uniforms method. A similar approach has also been suggested by Ahrens and Dieter (1989). The basic method is combined with quick acceptance and rejection tests given by Maclaren (1990). For values of \( \lambda \geq 87 \) Stirling’s approximation is used in the computation of the Poisson distribution function, otherwise tables of factorials are used as suggested by Maclaren (1990).

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_compd_poisson (g05tkc).

4 References


Maclaren N M (1990) A Poisson random number generator Personal Communication

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5 Arguments

1: \( m \) – Integer  
   \textit{Input}  
   \textit{On entry:} \( m \), the number of Poisson distributions for which pseudorandom variates are required.  
   \textit{Constraint:} \( m \geq 1 \).

2: \( \text{vlamda}[m] \) – const double  
   \textit{Input}  
   \textit{On entry:} the means, \( \lambda_j \), for \( j = 1,2,\ldots,m \), of the Poisson distributions.  
   \textit{Constraint:} \( 0.0 \leq \text{vlamda}[j - 1] \leq \text{nag}_\text{max}_\text{integer}/2.0 \), for \( j = 1,2,\ldots,m \).

3: \( \text{state}[\text{dim}] \) – Integer  
   \textit{Communication Array}  
   \textit{Note:} the dimension, \( \text{dim} \), 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 \( \text{state} \) in the previous call to \text{nag}_\text{rand}_\text{init}_\text{repeatable} (g05kfc) or \text{nag}_\text{rand}_\text{init}_\text{nonrepeatable} (g05kgc).  
   \textit{On entry:} contains information on the selected base generator and its current state.  
   \textit{On exit:} contains updated information on the selected base generator and its current state.

4: \( x[m] \) – Integer  
   \textit{Output}  
   \textit{On exit:} the \( m \) pseudorandom numbers from the specified Poisson distributions.

5: \( \text{fail} \) – NagError *  
   \textit{Input/Output}  
   The NAG error argument (see Section 3.6 in the Essential Introduction).

6 Error Indicators and Warnings

\textbf{NE_ALLOC_FAIL}  
Dynamic memory allocation failed.  
See Section 3.2.1.2 in the Essential Introduction for further information.

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

\textbf{NE_INT}  
On entry, \( m = \langle \text{value} \rangle \).  
Constraint: \( m \geq 1 \).

\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 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.

\textbf{NE_INVALID_STATE}  
On entry, \( \text{state} \) vector has been corrupted or not initialized.

\textbf{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_ARRAY

On entry, at least one element of \texttt{vlamda} is less than zero.

On entry, at least one element of \texttt{vlamda} is too large.

7 Accuracy

Not applicable.

8 Parallelism and Performance

Not applicable.

9 Further Comments

None.

10 Example

This example prints ten pseudorandom integers from five Poisson distributions with means $\lambda_1 = 0.5$, $\lambda_2 = 5$, $\lambda_3 = 10$, $\lambda_4 = 500$ and $\lambda_5 = 1000$. These are generated by ten calls to nag_rand_compd_poisson (g05tkc), after initialization by nag_rand_init_repeatable (g05kfc).

10.1 Program Text

```c
/* nag_rand_compd_poisson (g05tkc) 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, j, lstate;
    Integer *state = 0, *x = 0;

    /* NAG structures */
    NagError fail;

    /* Set the distribution parameters */
    Integer m = 5;
    double lambda[] = { 0.5e0, 5.0e0, 10.0e0, 500.0e0, 1000.0e0 };

    /* Set the sample size */
    Integer n = 10;

    /* 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 */
```

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init_fail(fail);

printf("nag_rand_compd_poisson (g05tkc) Example Program Results
\n\n");

/* Get the length of the state array */
lstate = -1;
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\n",
    fail.message);
    exit_status = 1;
    goto END;
}

/* Allocate arrays */
if (!(state = NAG_ALLOC(lstate, Integer)) ||
    !(x = NAG_ALLOC(m, 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\n",
    fail.message);
    exit_status = 1;
    goto END;
}

/* Generate and display n sets of the m variates*/
for (i = 0; i < n; i++)
{
    /* Generate the variates */
nag_rand_compd_poisson(m, lambda, state, x, &fail);
    if (fail.code != NE_NOERROR)
    {
        printf("Error from nag_rand_compd_poisson (g05tkc).\n\n",
        fail.message);
        exit_status = 1;
        goto END;
    }

    /* Display the variates*/
    printf("%12\n", i+1);
    for (j = 0; j < m; j++)
        printf("%12\n", x[j]);
    printf("\n");
}

END:
NAG_FREE(state);
NAG_FREE(x);
return exit_status;

10.2 Program Data
None.
## 10.3 Program Results

nag_rand_compd_poisson (g05tkc) Example Program Results

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