

RngStreams

Multiple independent streams of pseudo-random numbers

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This manual is for RngStreams, a package for generating multiple independent streams of pseudo-random numbers.

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1 Installing RngStreams

To install the RngStreams package type

```
./configure --prefix=<prefix_path>  
make
```

This should compile the library ('librngstreams.a') and an example program.

To install the library type:

```
make install
```

which installs

```
'<prefix_path>/lib/librngstreams.a',  
'<prefix_path>/lib/librngstreams.so',  
'<prefix_path>/include/Rngstream.h', and  
'<prefix_path>/info/rngstreams.info'.
```

If `--prefix` is omitted, then `/usr/local` is used as default.

It is possible to remove these files by

```
make uninstall
```

Documentation

A manual can be found in directory 'doc' in various formats, including PS, PDF, HTML, Info and plain text.

Profiling and Verification

To compile and run two test programs type

```
make check
```

2 Interface to the package RngStreams

RngStream

Data type

Contains the state of a stream from the present module. It is defined as

```
typedef struct RngStream_InfoState * RngStream;

struct RngStream_InfoState {
    double Cg[6], Bg[6], Ig[6];
    int Anti;
    int IncPrec;
    char *name;
};
```

The arrays *Ig*, *Bg*, and *Cg* contain the initial state, the starting point of the current substream, and the current state, respectively. This stream generates antithetic variates if *Anti* \neq 0. The precision of the output numbers is increased if *IncPrec* \neq 0.

void RngStream_SetPackageSeed (unsigned long *seed*[6]) Library Function

Sets the initial seed of the package **RngStreams** to the six integers in the vector *seed*. This will be the seed (initial state) of the first stream. If this procedure is not called, the default initial seed is {12345, 12345, 12345, 12345, 12345, 12345}. If it is called, the first 3 values of the seed must all be less than $m_1 = 4294967087$, and not all 0; and the last 3 values must all be less than $m_2 = 4294944443$, and not all 0.

RngStream RngStream_CreateStream (const char *name*[]) Library Function

Creates and returns a new stream with identifier *name*, whose state variable is of type **RngStream_InfoState**. This procedure reserves space to keep the information relative to the **RngStream**, initializes its seed *Ig*, sets *Bg* and *Cg* equal to *Ig*, sets its antithetic and precision switches to 0. The seed *Ig* is equal to the initial seed of the package given by **RngStream_SetPackageSeed** if this is the first stream created, otherwise it is *Z* steps ahead of that of the most recently created stream.

void RngStream_DeleteStream (RngStream **pg*) Library Function
Deletes the stream **pg* created previously by **RngStream_CreateStream**, and recovers its memory. Otherwise, does nothing.

void RngStream_ResetStartStream (RngStream *g*) Library Function
Reinitializes the stream *g* to its initial state: *Cg* and *Bg* are set to *Ig*.

void RngStream_ResetStartSubstream (RngStream *g*) Library Function
Reinitializes the stream *g* to the beginning of its current substream: *Cg* is set to *Bg*.

- void RngStream_ResetNextSubstream** (RngStream *g*) Library Function
 Reinitializes the stream *g* to the beginning of its next substream: *Ng* is computed, and *Cg* and *Bg* are set to *Ng*.
- void RngStream_SetAntithetic** (RngStream *g*, int *a*) Library Function
 If *a* $\neq 0$, the stream *g* will start generating antithetic variates, i.e., $1-U$ instead of U , until this method is called again with *a* = 0. By default, the streams are created with *a* = 0.
- void RngStream_IncreasedPrecis** (RngStream *g*, int *incp*) Library Function
 After calling this procedure with *incp* $\neq 0$, each call (direct or indirect) to **RngStream_RandU01** for stream *g* will advance the state of the stream by 2 steps instead of 1, and will return a number with (roughly) 53 bits of precision instead of 32 bits. More specifically, in the non-antithetic case, when the precision is increased, the instruction $x = \text{RngStream_RandU01}(g)$ is equivalent to $x = (\text{RngStream_RandU01}(g) + \text{RngStream_RandU01}(g) * \text{fact}) \% 1.0$ where the constant *fact* is equal to 2^{-24} . This also applies when calling **RngStream_RandU01** indirectly (e.g., by calling **RngStream_RandInt**, etc.). By default, or if this procedure is called again with *incp* = 0, each call to **RngStream_RandU01** for stream *g* advances the state by 1 step and returns a number with 32 bits of precision.
- void RngStream_SetSeed** (RngStream *g*, unsigned long *seed*[6]) Library Function
 Sets the initial seed *Ig* of stream *g* to the vector *seed*. This vector must satisfy the same conditions as in **RngStream_SetPackageSeed**. The stream is then reset to this initial seed. The states and seeds of the other streams are not modified. As a result, after calling this procedure, the initial seeds of the streams are no longer spaced *Z* values apart. We discourage the use of this procedure.
- void RngStream_AdvanceState** (RngStream *g*, long *e*, long *c*) Library Function
 Advances the state of stream *g* by *k* values, without modifying the states of other streams (as in **RngStream_SetSeed**), nor the values of *Bg* and *Ig* associated with this stream. If *e* > 0, then $k = 2^e + c$; if *e* < 0, then $k = -2^{-e} + c$; and if *e* = 0, then $k = c$. Note: *c* is allowed to take negative values. We discourage the use of this procedure.
- void RngStream_GetState** (RngStream *g*, unsigned long *seed*[6]) Library Function
 Returns in *seed*[] the current state *Cg* of stream *g*. This is convenient if we want to save the state for subsequent use.
- void RngStream_WriteState** (RngStream *g*) Library Function
 Prints (to standard output) the current state of stream *g*.
- void RngStream_WriteStateFull** (RngStream *g*) Library Function
 Prints (to standard output) the name of stream *g* and the values of all its internal variables.

double RngStream_RandU01 (RngStream *g*) Library Function

Returns a (pseudo)random number from the uniform distribution over the interval (0,1), using stream *g*, after advancing the state by one step. The returned number has 32 bits of precision in the sense that it is always a multiple of $1/(2^{32} - 208)$, unless `RngStream_IncreasedPrecis` has been called for this stream.

long RngStream_RandInt (RngStream *g*, long *i*, long *j*) Library Function

Returns a (pseudo)random number from the discrete uniform distribution over the integers $\{ i, i+1, \dots, j \}$, using stream *g*. Makes one call to `RngStream_RandU01`.

3 Example

```
#include <stdio.h>
#include "RngStream.h"

int main (void)
{
    double x;
    int i;
    RngStream gen;

    /* get a stream */
    gen = RngStream_CreateStream ("generator_1");

    /* sample from generator */
    for (i=0; i<10; i++) {
        x = RngStream_RandU01 (gen);
        printf ("%f\n", x );
    }

    return 0;
}
```