Random numbers

PH456 Lab 1

Semester 2, 2021–2022

1 Aim

The aims the exercise this week is to produce and test random numbers and then apply them to a simple partitioned box problem, similar to the case discussed in class.

2 Tasks

1. Using different initial seeds and at least *two* different pseudo-random generators, produce sequences of uniformly distributed random numbers. Test these values for a) uniformity and b) lack of sequential correlation. Present your analysis as graphically as possible.

2. Write a program to simulate a partitioned box containing N particles, initially all on one side of the partition, with an equal probability of any *one* particle moving from one side of the partition to the other in unit time. Present your results graphically as well as textually.

3. Test any properties you calculate in task 2 using sequences from both random number generators in task 1. Discuss whether your results are compatible.

4. Change the probability so that there is, say, a 75% chance of any particle from one side of the partition travelling to the other, but only a 25% chance of any particle going the other way. Discuss your findings and provide numerical evidence if possible.

3 Computational hints for the tasks

1. An *autocorrelation function* is an additional method to detect patterns in data, which is not discussed in the lecture notes.
   The `numpy.correlate` function can calculate autocorrelations.

2. Two common ways to keep track of the particles are either 1) an array consisting of a list of the location of each particle, or 2) A total count of the number of particles on each side. Which is more efficient?

3. `BitGenerators` control the various types of random number generators of `numpy.random`. You might also want to time generation of random values using `time.perf_counter()`.

4 Evaluation

You should hand in *at least* the following:

- A short report ($\sim$ 2 pages) detailing what you did and discussing the results of the tasks.
- Code listings with adequate documentation. Ideally, this should be as a reference to an accessible git repository.
- Plots demonstrating the uniformity (or otherwise) of your random numbers in tasks 1 and 2.
- Plots demonstrating evidence for or against sequential correlation of your chosen uniform random number generators in task 1.
- Plots of the number of particles on each side of the box for tasks 2 and 4.