

Many problems in physics—especially those involving the actions of large numbers of “actors”—require the use of statistical approaches whether they be attacked via analytic methods or numerical simulations. The numerical approaches make use of random—or, usually—pseudo random numbers generated by algorithms that are chosen for their ability to produce long strings of numbers that mimic the properties of truly random numbers especially including uniform coverage of some region of the number line and an effective absence of repetition.

In this assignment you will write a simple but effective pseudorandom number generator and use it to simulate a diffusion process by following a large number of random walkers (drunken Coast Guard sailors) who start out with infinite density at the origin.

Part 1—Pseudorandom number generator

Use the method shown in class to build your pseudorandom number generator and test it by examining (somehow!) the sequence of random numbers it produces.

Do the numbers seem to have the kind of properties one would expect of a *genuinely* random sequence?

Part 2—Diffusion (The migration of the drunken Coast Guard sailors)

Imagine that there are N drunken Coast Guard sailors, all starting at the bar (i.e., the origin) and undergoing random walks. Each step has the same unit length but has an equal probability of being in any given direction—that is, it is chosen from a uniform random distribution over the interval 0 to 2π .

- a) Write a program that plots the position of the N sailors on the computer screen. You should let the number of sailors N be an input. You can decide whether or not and how to use colors, how to update the display, etc. While the program is running and the sailors are walking, have the following information constantly displayed and updated in a corner of the screen:

average position (center of mass) of the group of sailors

rms radius of the group of sailors

How does the average position depend on time (i.e., with the number of steps)? How does the rms radius depend on time? Do these results make sense? Are there any theoretical predictions in these regards that you can compare your results to?

- b) Alter your program so that it uses the method developed in class to choose the step direction from a gaussian distribution centered about some specific direction that has an adjustable “width” in angular units.

Now how does the average position and the rms radius depend on time? How do they depend on the chosen width of the distribution? Do your results make sense? Why or why not?