

1. Assess random number generators in Mathematica and Python, to see if they perform as expected
 - (a) uniformly-distributed random numbers.
 - (b) Gaussian-distributed random numbers.
 - (c) Poisson-distributed random numbers.

For the following problems, do at least two of them using Mathematica, and at least two using Python.

2. Consider rolling N fair dice, each with f faces, with the outcome being the total of the numbers shown by each of the dice. The result will be between N (if all ones are showing) and $N \cdot f$ (if all f 's are showing). For example, if 3 six-sided dice are rolled, the total can be as low as 3 and as high as 18.
 - (a) Consider 2 six-sided fair dice. Use random numbers to predict the probabilities of each outcome.
 - i. Plot your results.
 - ii. Does a triangular-shaped probability density function fit your results well?
 - iii. Does a Gaussian fit well?
 - (b) Repeat for 4 six-sided dice.
 - (c) repeat for 10 six-sided dice.
 - (d) Try some other situations, such as 6 four-sided dice, or 3 ten-sided dice.
3. Use your results from Problem 2 to calculate the probability of getting between
 - (a) 6 and 8, when using 2 fair six-sided dice.
 - (b) 12 and 16 when using 4 fair six-sided dice.
4. Rework Problem 2 using unfair dice that have probabilities $P(4) = P(5) = P(6)$ and $P(1) = 4P(6)$, $P(2) = 3P(6)$, and $P(3) = 2P(6)$.
5. Consider a radiation counting experiment where the time interval is short enough that $\mu = 1.0$, and for this case 1000 measurements are made. For μ this small, a significant number of the results will be zero. Model this process using random numbers to investigate the following questions.
 - (a) How many of the 1000 results are expected to be zero?
 - (b) What is the probability of 5 consecutive zeros?

- (c) How many sequences of at least 5 consecutive zero results are expected?
 - (d) How many 1's are expected? Do the number of 1's follow a Gaussian distribution?
6. Simulate an ideal gas in a container of volume V_{total} , and determine the fraction of atoms that are within some subvolume $V < V_{total}$
- (a) in one dimension.
 - (b) in two dimensions.
 - (c) in three dimensions.
 - (d) Comment on your results.
7. Invent a situation and generate some simulated data for it.