Lab Assignment 10: Monte Carlo Simulation
IC252 - IIT Mandi

In this assignment, you will learn to use Monte-Carlo method to estimate numbers and calculate integrals.

1. Continuation of the example in Slide 6 of Lecture 32: Approximate the value of the number π by generating samples of size 100, 1000 and 10000.

2. For the following integral
$$\int_0^1 \frac{2}{1+x^2}dx$$
numerically compute its approximation by generating samples of size 100, 1000 and 10000.

3. Let there be an array A of size n which contains all the integers in the range $[1, n]$. Array A is said be a derangement if $\forall i \in [0, n-1], A[i] \neq i + 1$.

   The total number of derangements which can be generated on an array of size n is denoted as $!n$ (a.k.a. subfactorial n). It is known that

   related to De Montmort's problem (Lecture 4)

$$\lim_{n\to\infty} \frac{n!}{!n} = e$$

   where e is the Euler's number.

   Generate a sample of size 10000 where each sample point is an arrays of size n. Use this random sample to estimate the value of e and output the estimate upto 5 decimal places. The correct value of e upto 5 decimal places is 2.71828. Estimate the value for three cases: $n = 100$, 1000 and 10000.

Notes:

1. While generating data sets, consider the numbers with three decimal places. That is, if the random number generated is 0.4789 then consider it as 0.478.

2. You may use in-built functions/library to generate samples or create random permutations from desired underlying distributions.

3. To learn more about **derangements** please check out the following links which contain short videos (lasting less than 15 minutes) on this topic.
   https://en.wikipedia.org/wiki/Derangement
   https://www.youtube.com/watch?v=pbXg5EI5t4c
   https://www.youtube.com/watch?v=qYAWjIVY7Zw