In this lab, we will use R to perform some more simulations.

Exercise 1: An application of the Central Limit Theorem
We will see how the Central Limit Theorem works by the following exercise:

1. First, write a function which inputs two parameters n and p, and generates a Binomial random variable. Run this routine a sufficiently large number of times and plot the histogram.
2. Now, write another function which takes the parameters n and p, generates n independent Bernoulli random variables and outputs the sum of these random variables. Run this routine a sufficiently large number of times and plot the histogram.
3. [**R**] Compare the two histograms above for values of n = 10, 100, 1000 and p = 0.1, 0.5 and 0.6.
4. [**R**] Can we, therefore, approximate the binomial distribution by another suitable distribution? If so, what should the parameters be?

Exercise 2: Checking defects
Gulmohar Toys has set up a manufacturing unit recently. In a particular department, two operations are carried out: shape-molding and painting. A machine first molds the product into a tube. The machine gives the tube a certain radius. Due to machine characteristics, the radius is normally distributed with mean 10cm and standard deviation 0.2cm. A second machine then paints it. There is 99.5% chance that it paints the correct shade. After this step, testing is conducted randomly. There is a 30% chance that a product will be selected for a test. In the first test the radius is tested. If the radius is between 9.7cm and 10.3cm, then there is 0.1% chance that the testing machine will classify it as defective and throw it out. If the radius is outside this range, then there is a 95% chance that the testing machine will throw it out. If the product passes first test, it is checked for color. If the correct shade was painted, there is a 0.5% chance that the testing machine will classify it as defective and throw it out. If it is a wrong shade, then there is a 99% chance that it will be caught as a defective piece. If a product is not selected for testing, it is accepted (sometimes wrongly) as 'defect-free'. Your task is to simulate this system and analyze it.

1. Write an R routine qCheck(N) where N is the number of products for which we run the simulation. Your routine should display
   - the fraction of products that were thrown out as defective,
   - the fraction of products that either had wrong paint or did not have radius between 9.6cm and 10.4cm.
   - the fraction of products that had the right paint and radius between 9.6cm and 10.4cm, but were still classified as defective.
   - the fraction of products that had either wrong paint or wrong radius but were not thrown out.
2. [**R**] Report the values for $N = 1000$ and $N = 10000$. What is a reasonable value for N?
3. [**R**] Suppose we start checking all products (instead of 30%). What are the above four values?
4. [**R**] Are there any other important metrics besides the four above that we should consider?