Name: Somya Khandelwal

Roll Number: 200123056

Department: Mathematics and Computing

Course: MA 323 - Monte Carlo Simulation

Lab: 06

In [1]:

```
import matplotlib.pyplot as plt
import seaborn as sns
import numpy as np
import math
import time
```

In [2]:

```
M=[100,1000,10000,100000]
D = np.array([])
```

Im is basicaly the mean of obtained numpy array D.

Now, we need to calculate the delta. Which is calculated using the following:

For a 95% confidence interval, set $2\Phi(-\Delta) - 1 = 0.95$. Then $\Delta = \Phi^{-1}(0.975) = 1.96$, yielding the familiar 95% confidence interval $\left(\hat{\mu}_n - 1.96\frac{s}{\sqrt{n}}, \hat{\mu}_n + 1.96\frac{s}{\sqrt{n}}\right)$. Similarly 99% confidence interval

Now, we will find the Confidence interval, which has the formula:

$$\hat{\mu}_n - \frac{\Delta s}{\sqrt{n}} \leq \mu \leq \hat{\mu}_n + \frac{\Delta s}{\sqrt{n}}$$

In [4]:

```
for m in M:
  D = np.array([])
  for i in range(m):
    ui=np.random.uniform(0,1)
    val = math.exp(math.sqrt(ui))
    D=np.insert(D,len(D),val)

  Im = np.average(D)
  Std = np.std(D)
  Delta = 1.96
  CI_min = Im - Delta*Std/math.sqrt(m)
  CI_max = Im + Delta*Std/math.sqrt(m)
  print("Confidence interval for M=",m," is [",CI_min,",",CI_max,"]")
```

```
Confidence interval for M= 100  is [ 1.9316692945418266 , 2.0958437882451584 ]
Confidence interval for M= 1000  is [ 1.9551140085364622 , 2.0101359214145025 ]
Confidence interval for M= 10000  is [ 1.9873537988806238 , 2.004710165701991 ]
```

```
Confidence interval for M= 100000  is [ 1.99685450858497 , 2.002333087499452 ]
```

We have the following observations:

1) As M increases, the lenght of the interval decreases.

2) The interval converges to value 2

3) The Experimental value of I is 2

Theoritical value of I is calculated as:

$$\int_0^1 e^{x^{0.5}}\, dx = 2.$$

We can clearly see that the experimental value of I matches with the theoritical value of I.