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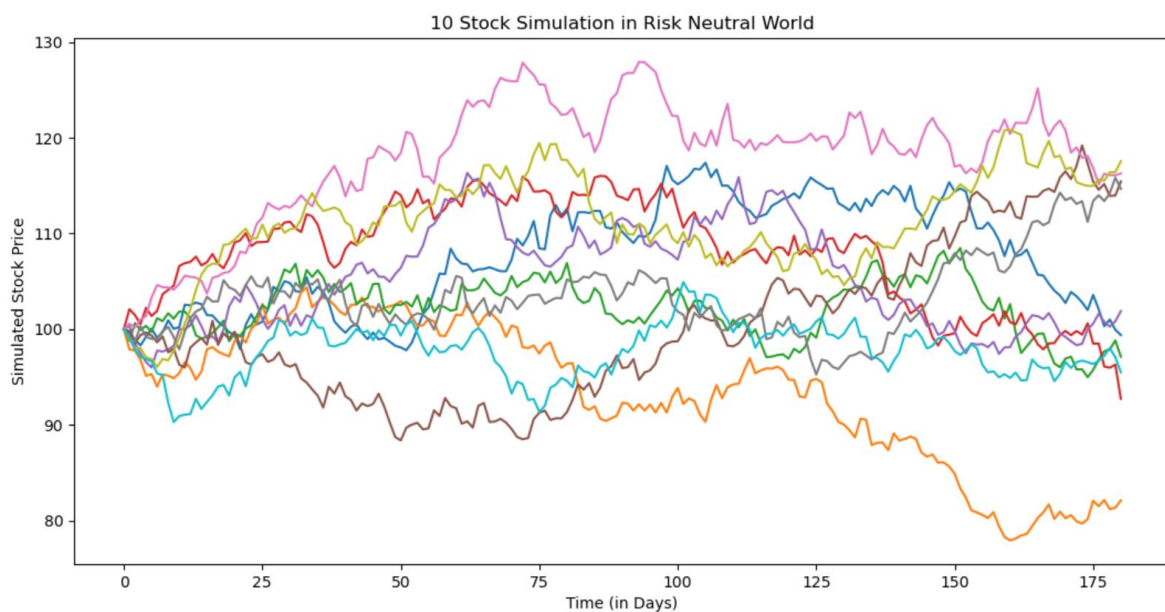
Q1.

The following parameters have been set (as given in question):

$\mu = 0.1, \sigma = 0.2, r = 0.05, t = 0, S_0 = 100, T = 180 \text{ days}$

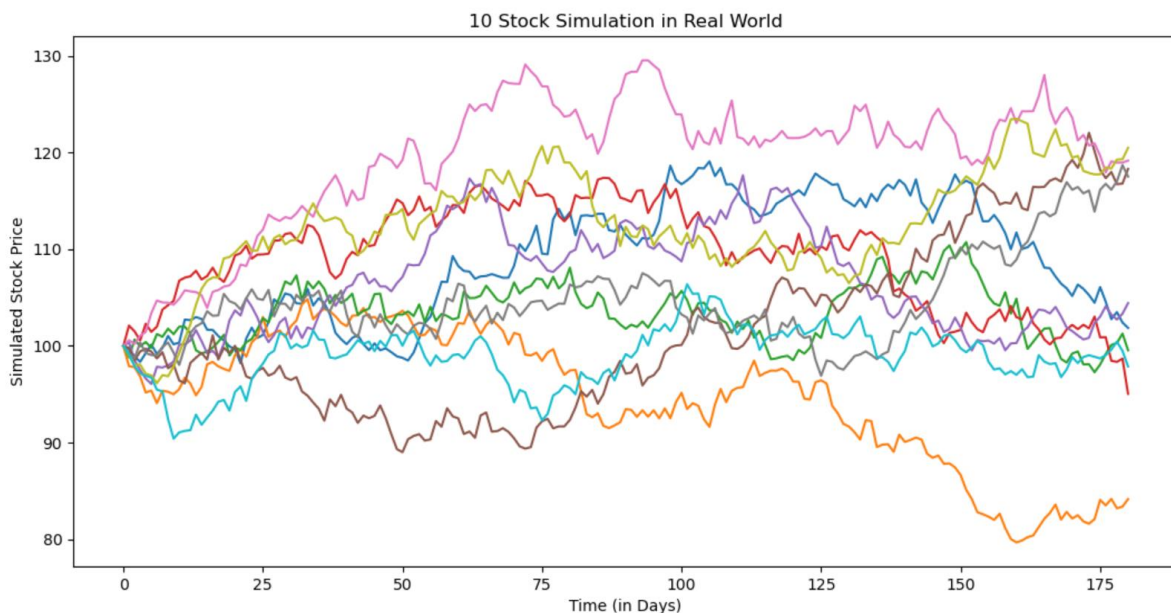
- **Stock Price** for **ten** different simulations (using **risk neutral** GBM equation):

$$S(t_{i+1}) = S(t_i) \exp\left(\left(r - \frac{1}{2}\sigma^2\right)(t_{i+1} - t_i) + \sigma\sqrt{t_{i+1} - t_i}Z_{i+1}\right)$$

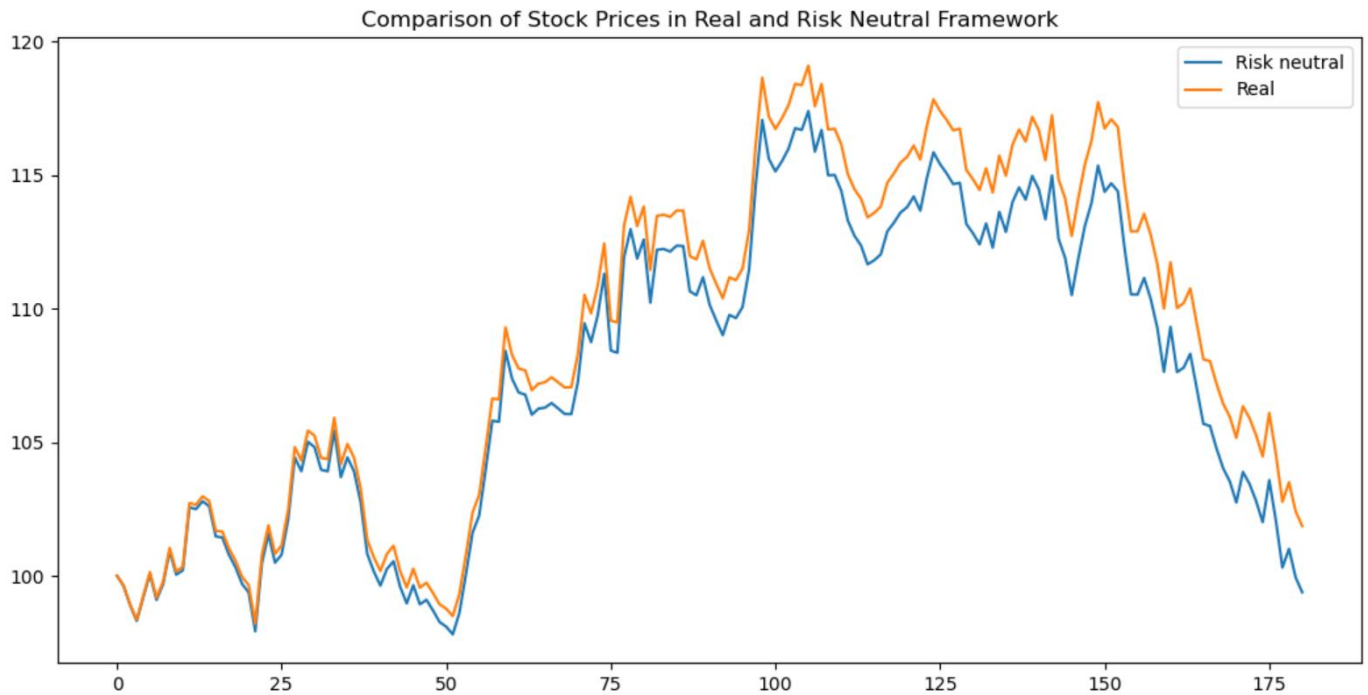


- **Stock Price** for ten different simulations (using real world GBM equation):

$$S(t_{i+1}) = S(t_i) \exp\left(\left(\mu - \frac{1}{2}\sigma^2\right)(t_{i+1} - t_i) + \sigma\sqrt{t_{i+1} - t_i}Z_{i+1}\right)$$



Here, we have compared the stock price values for risk neutral and real-world scenarios for one of the simulations.

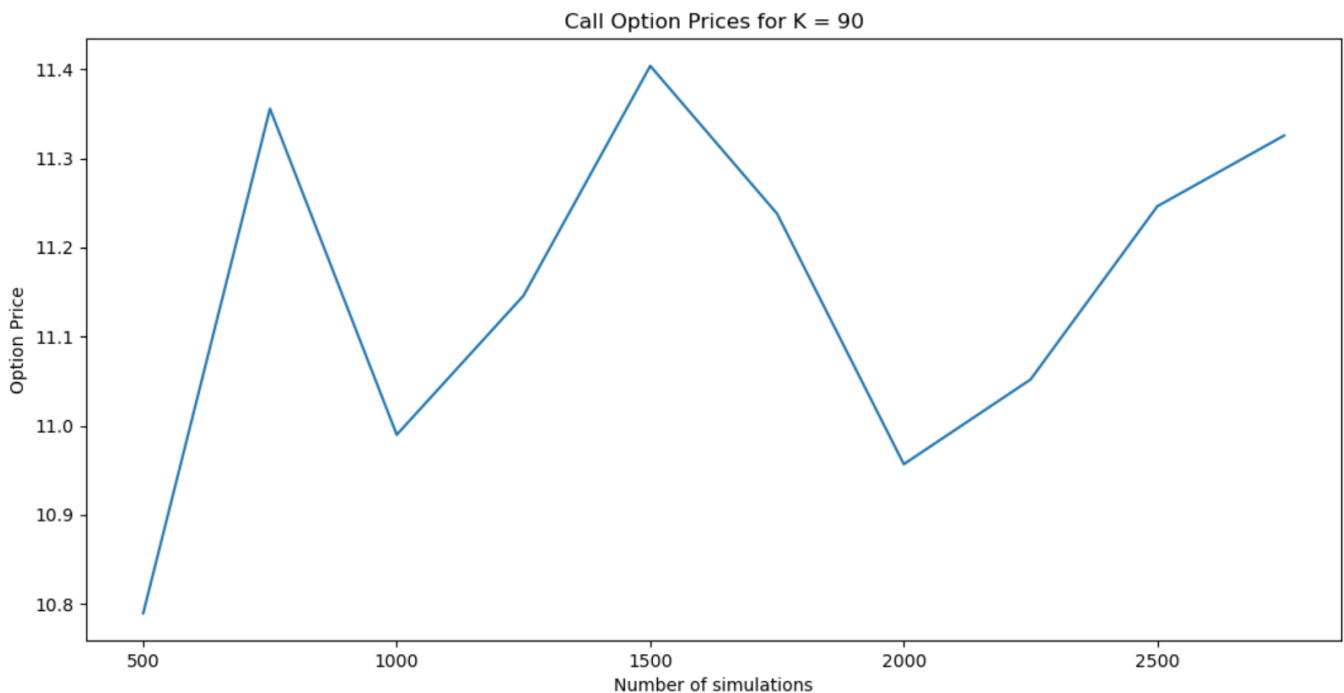


Six month fixed-strike Asian Option Price was calculated for Strike prices 90,105 and 110. To calculate the Asian Option Payoff, arithmetic mean (of the strike prices in the 6-month period) was used. The option price was calculated as follows:

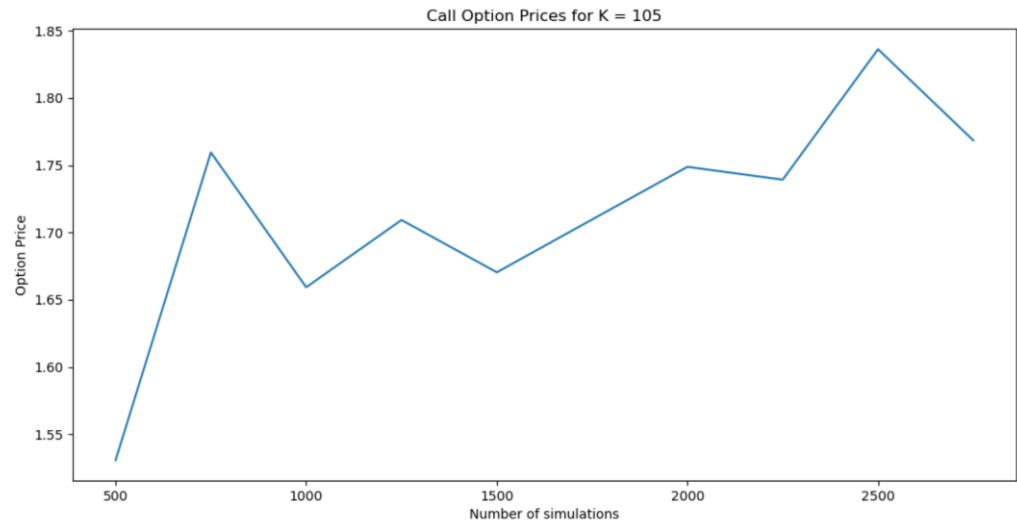
$$H(0) = e^{-rT} \sum_{i=0}^M \frac{1}{M} * (Payoff\ of\ Option)$$

The graphical plots of the Option Prices vs Number of Simulations are as follows:

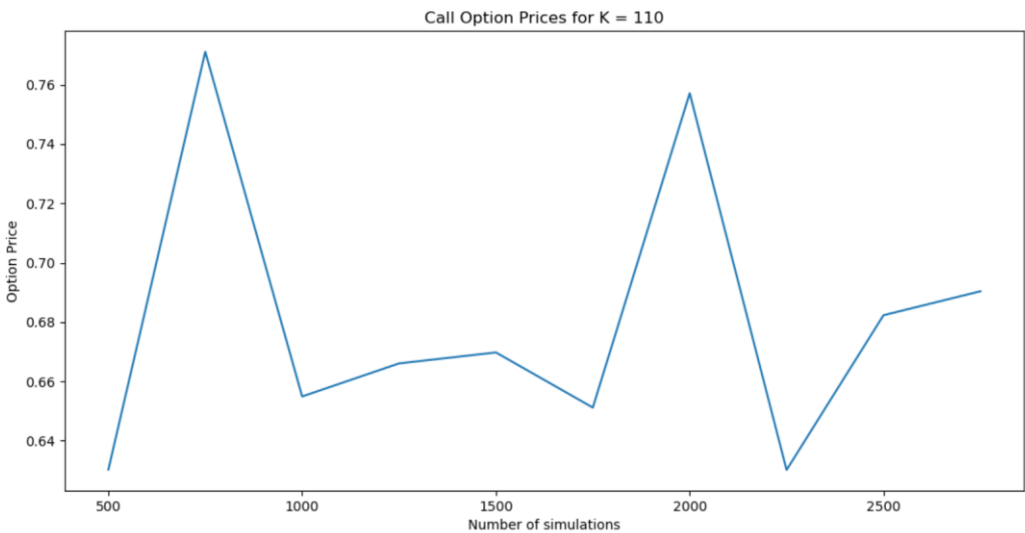
Average Call option price for K = 90 is 11.32566



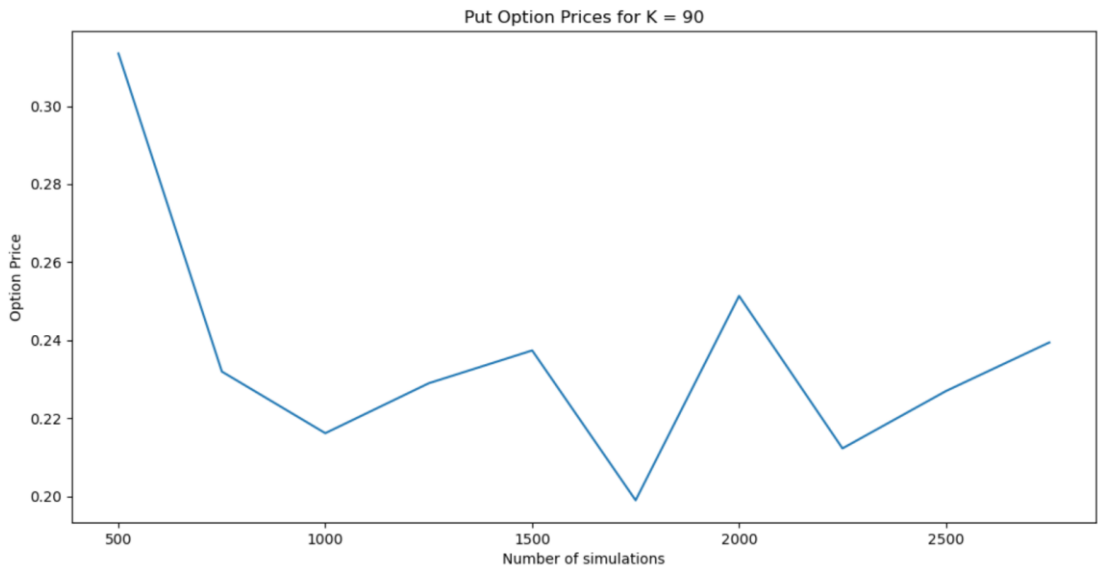
Average Call option price for K = 105 is 1.76843



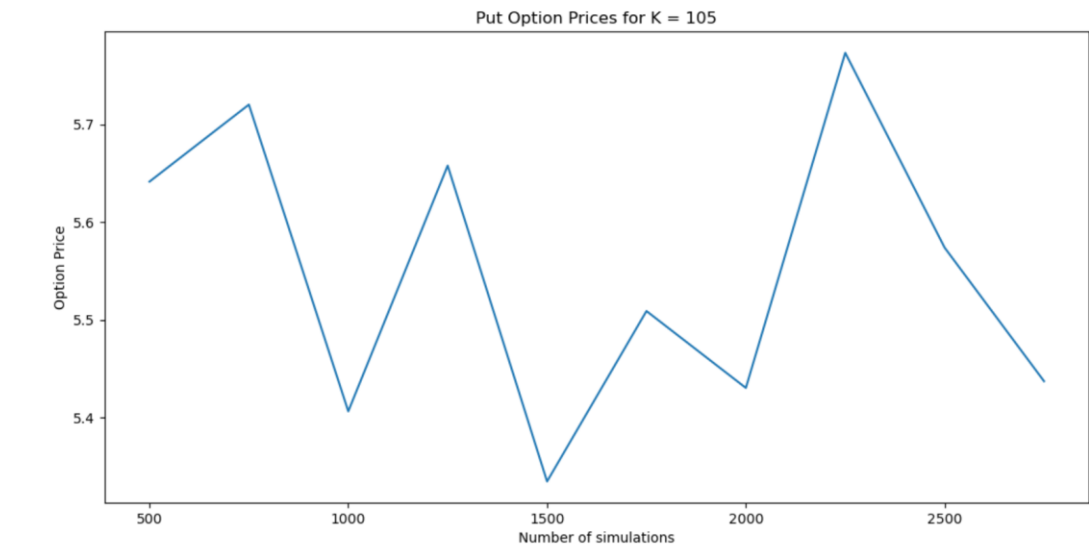
Average Call option price for K = 110 is 0.69037



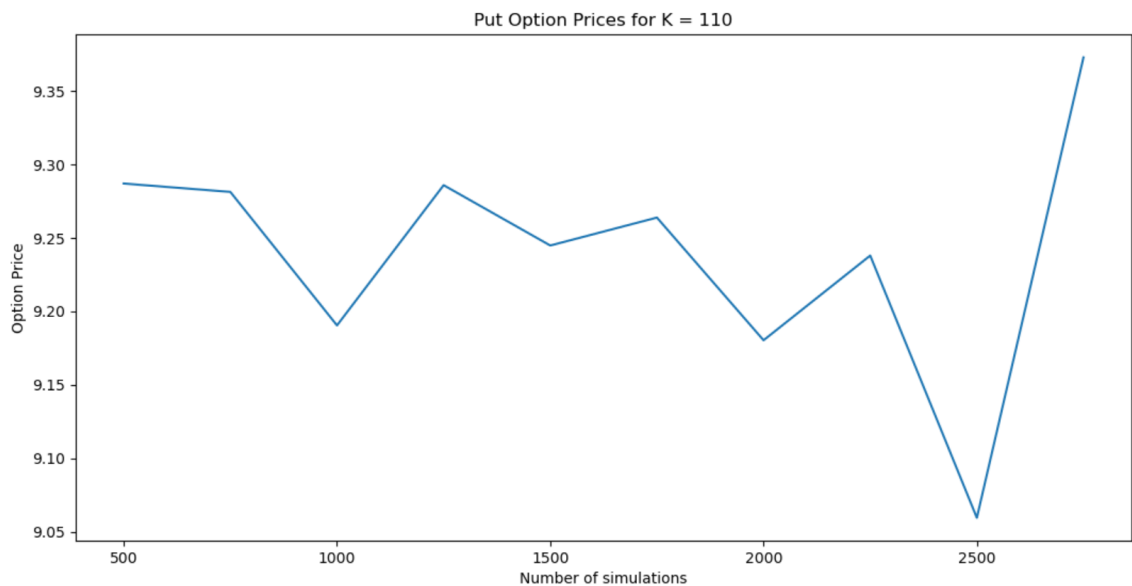
Average Put option price for K = 90 is 0.23942



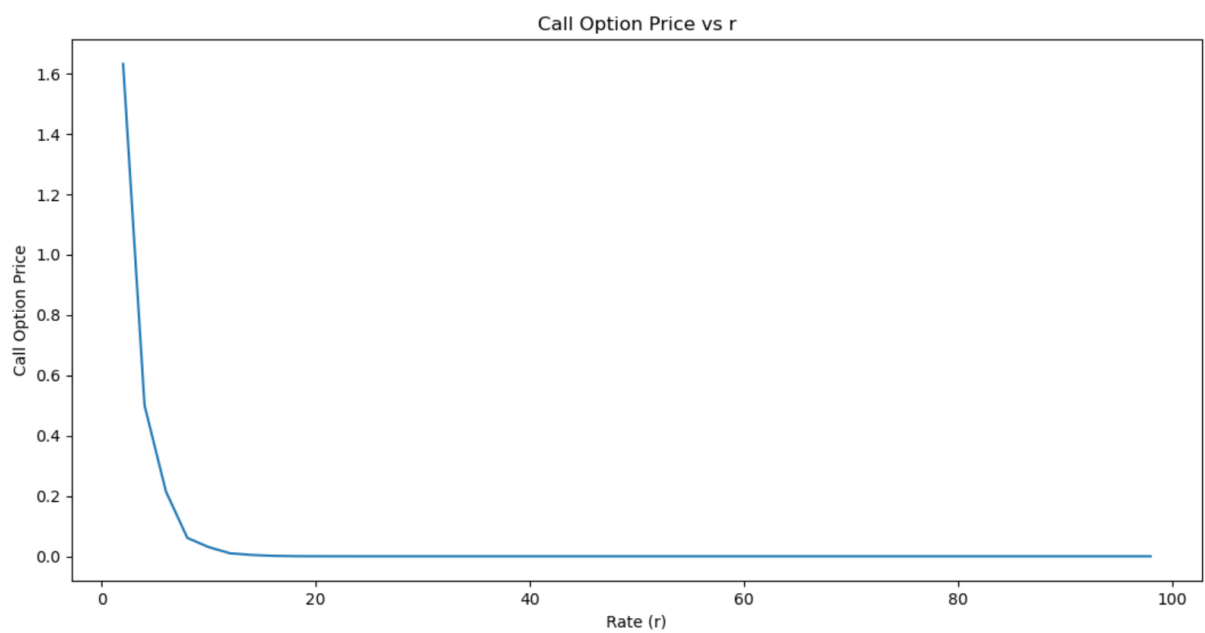
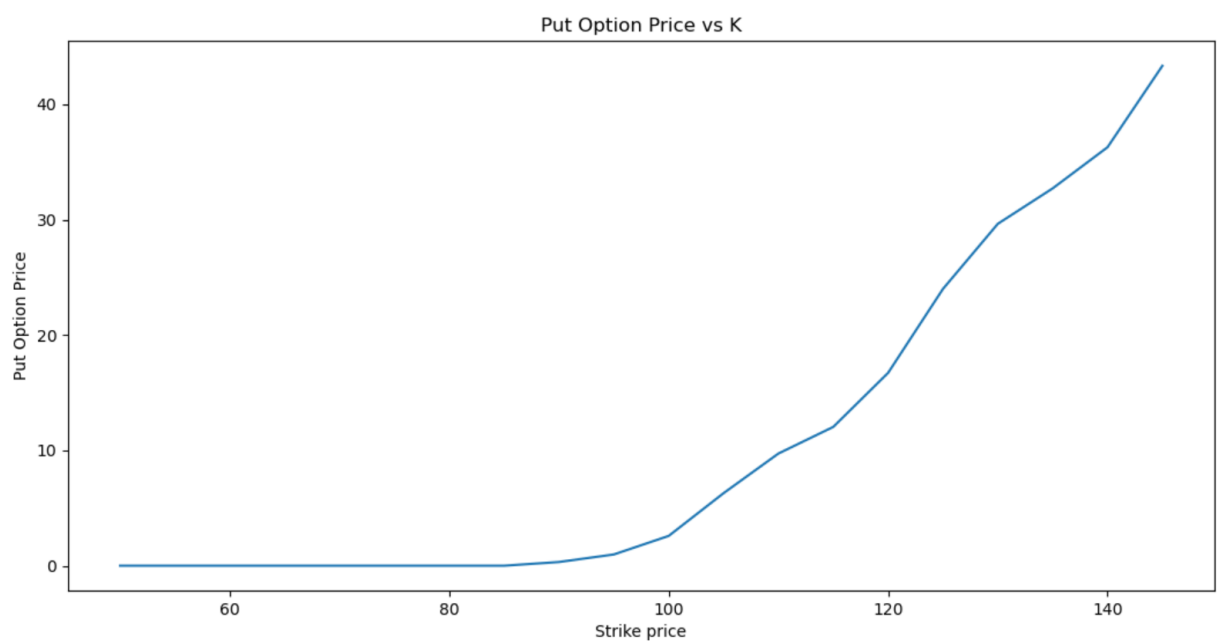
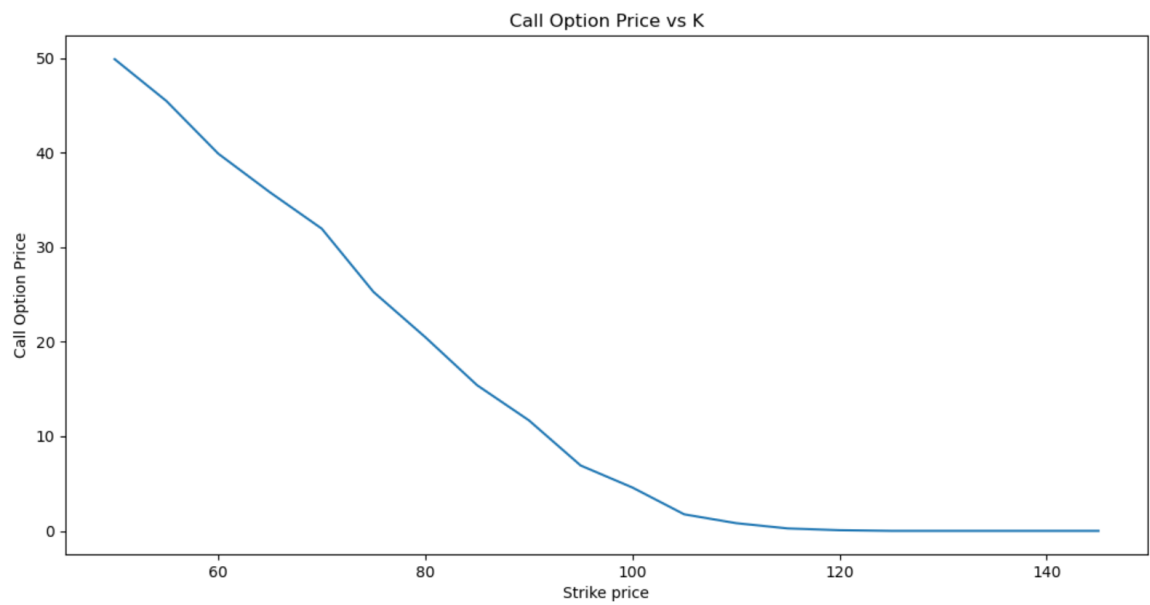
Average Put option price for $K = 105$ is 5.43707

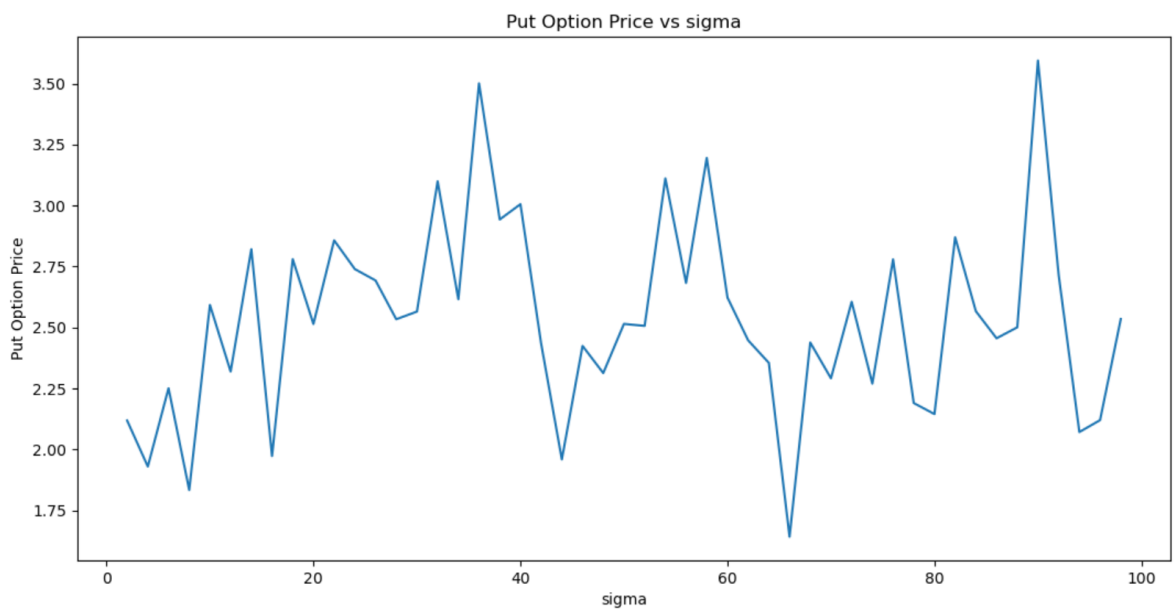
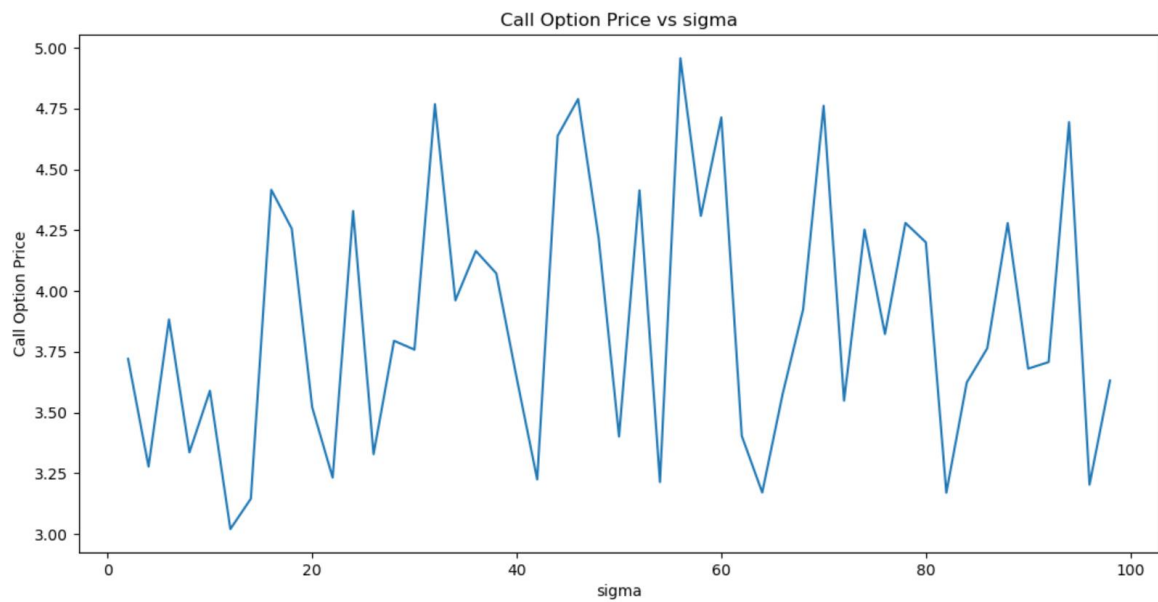
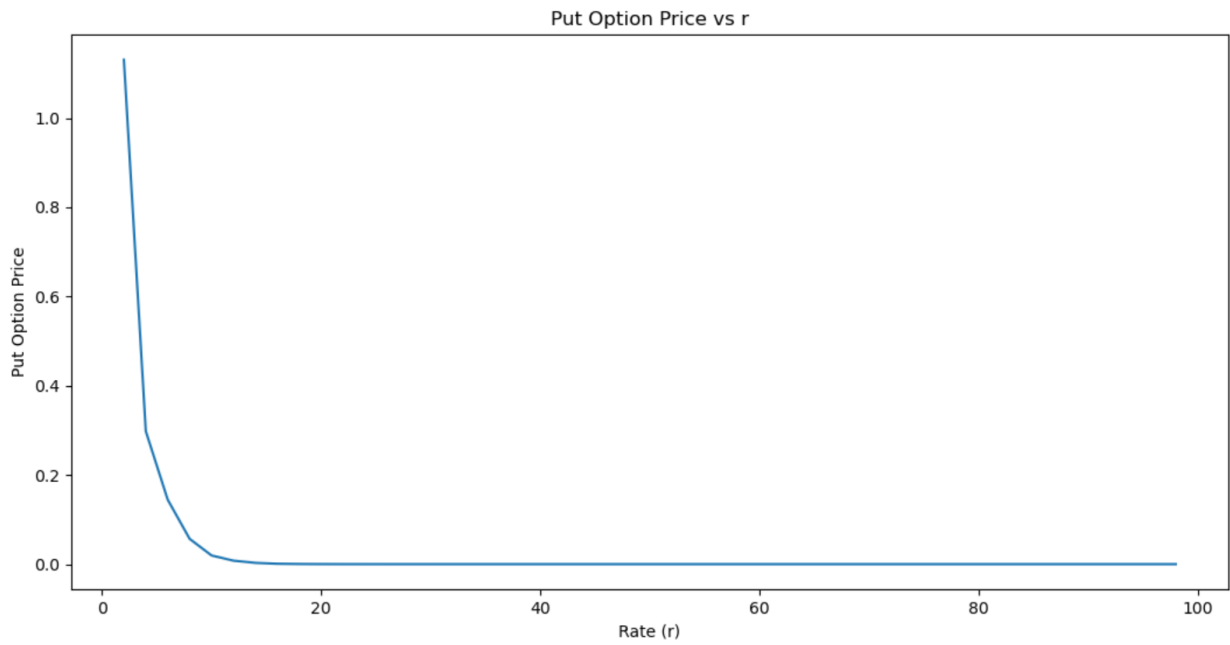


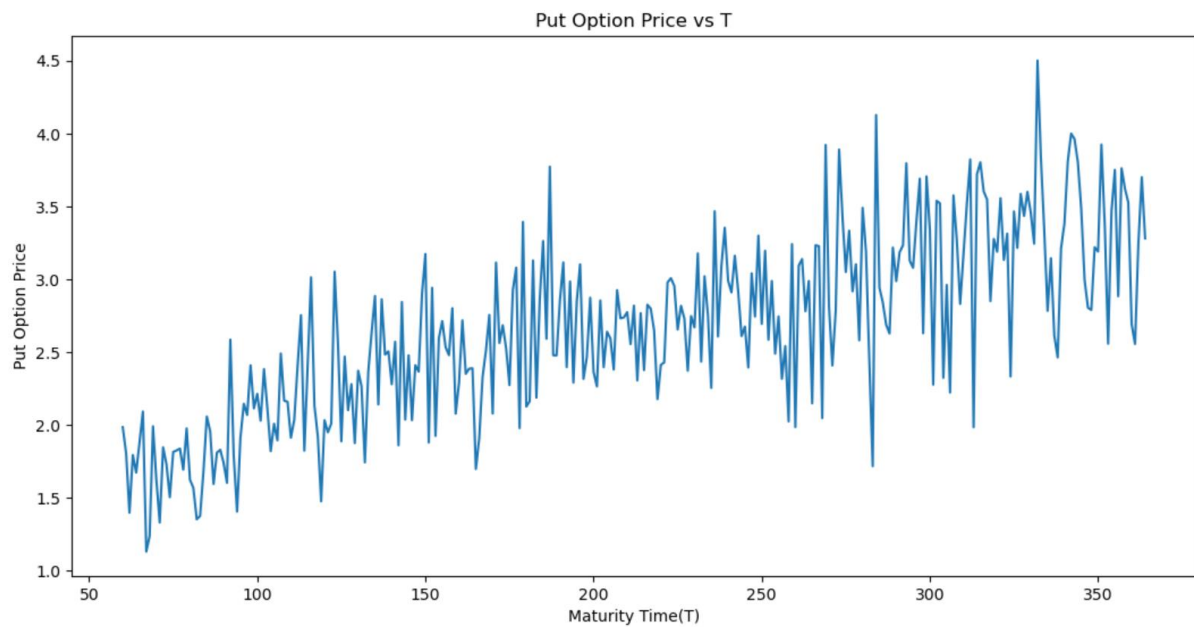
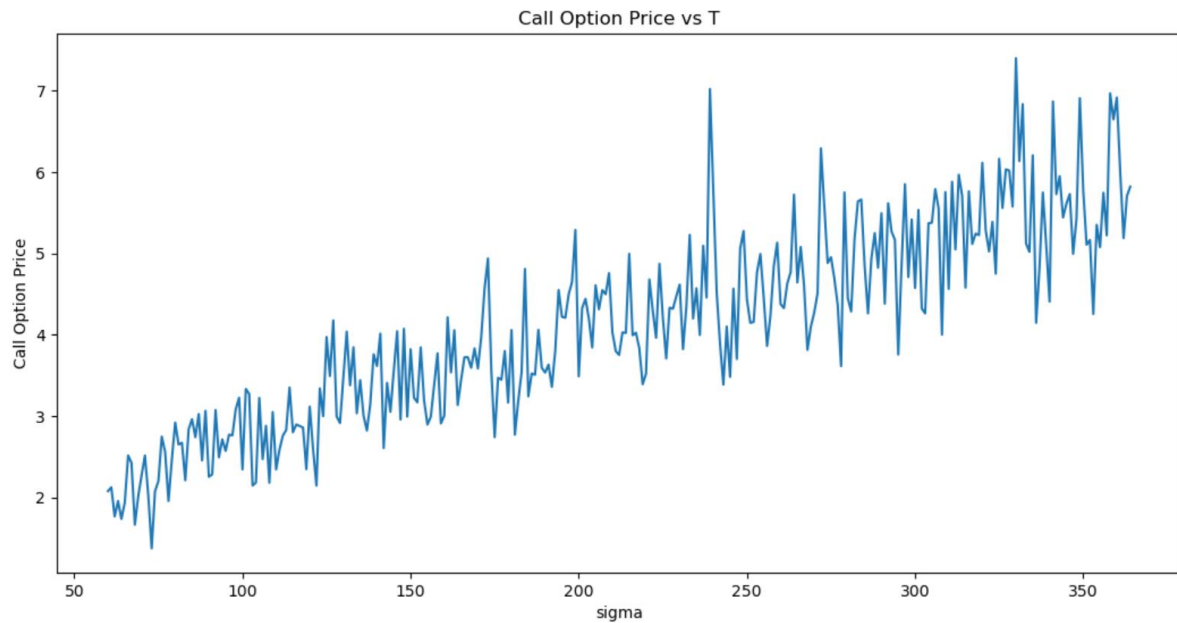
Average Put option price for $K = 110$ is 9.37288



Sensitivity analysis of the option prices was done (on the model parameters T , K , r , σ).





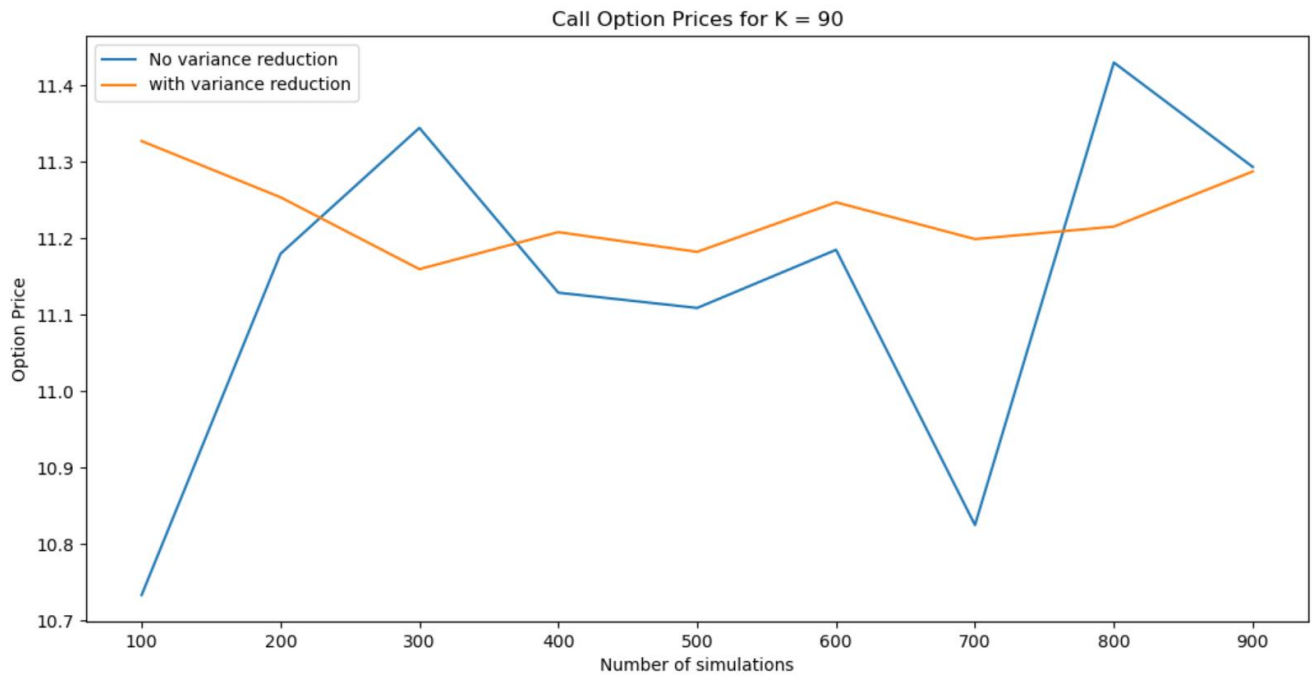


Q2:

Variance reduction techniques was done using **antithetic variables**. (In this technique, the variance is reduced using an antithetic variable (negative value for every corresponding positive value.))The reduction in variance is evident from the following graphs:

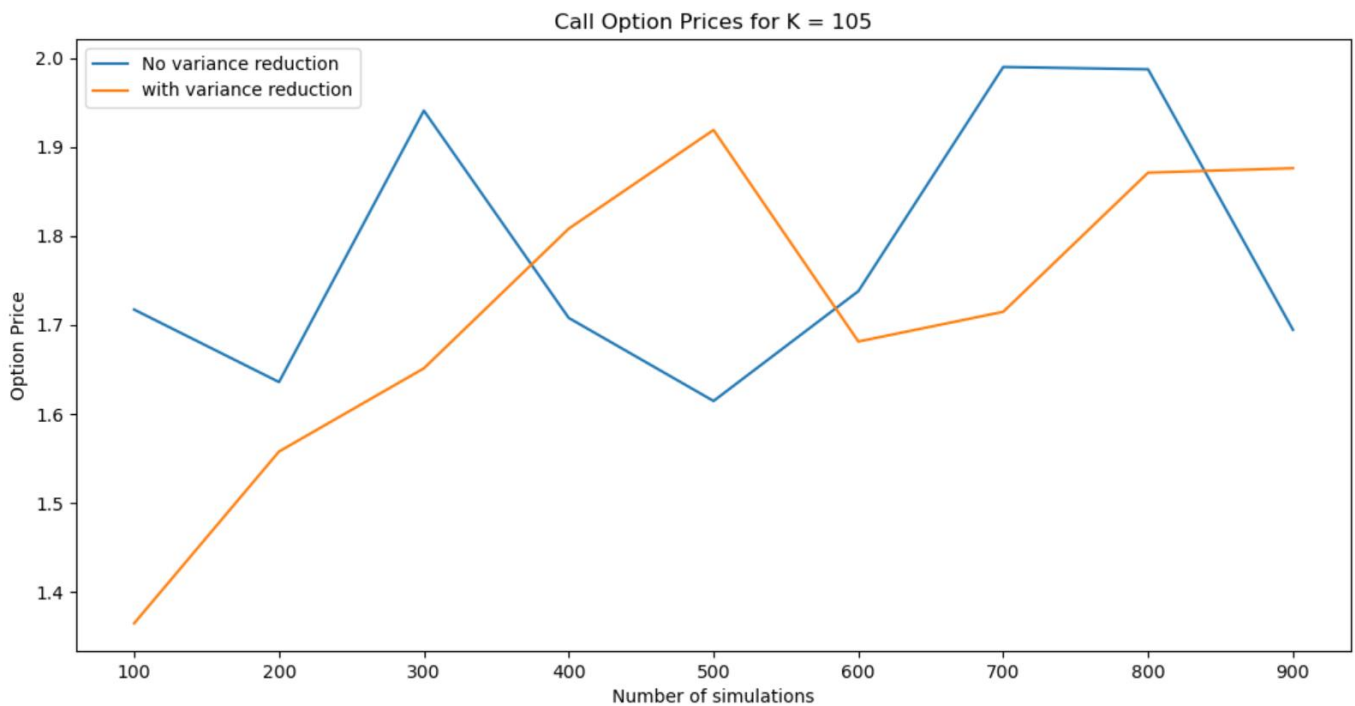
Variance of Call option price without variance reduction for $K = 90$ is **0.0465**

Variance of Call option price with variance reduction for $K = 90$ is **0.0025**



Variance of Call option price without variance reduction for K = 105 is **0.01992**

Variance of Call option price with variance reduction for K = 105 is **0.02815**



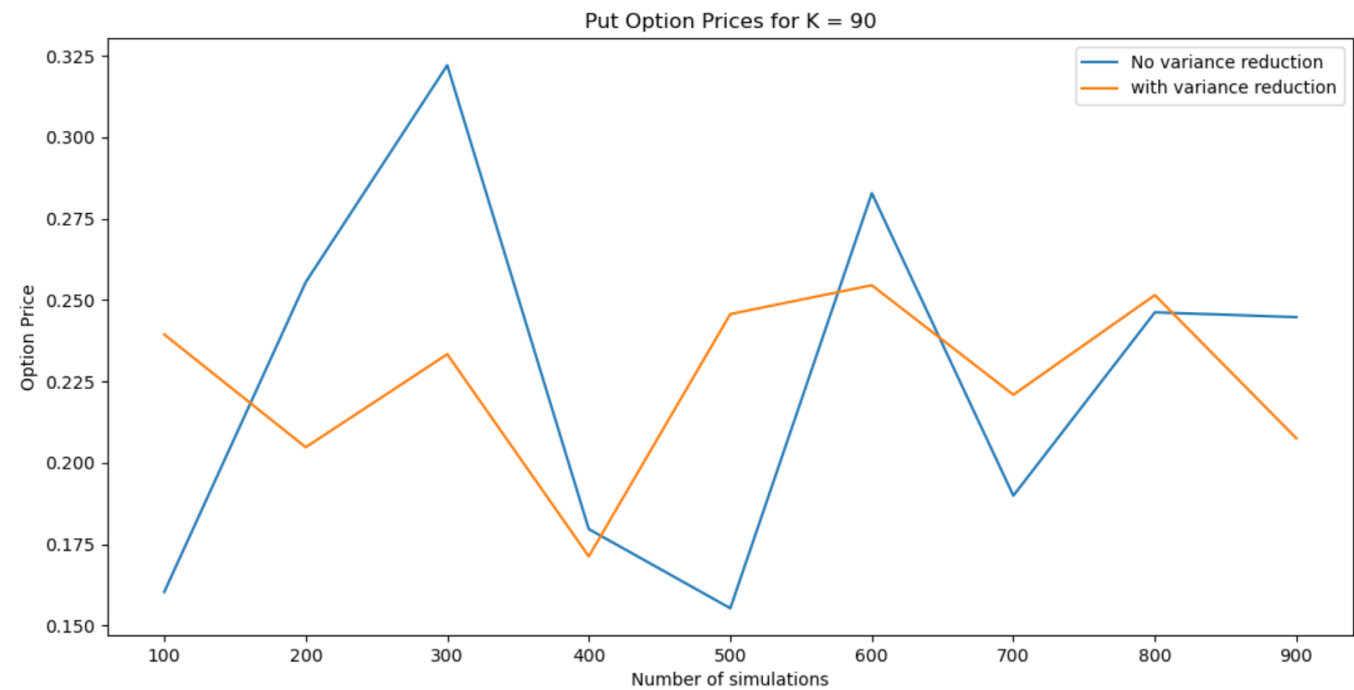
Variance of Call option price without variance reduction for $K = 110$ is **0.00487**

Variance of Call option price with variance reduction for $K = 110$ is **0.01234**



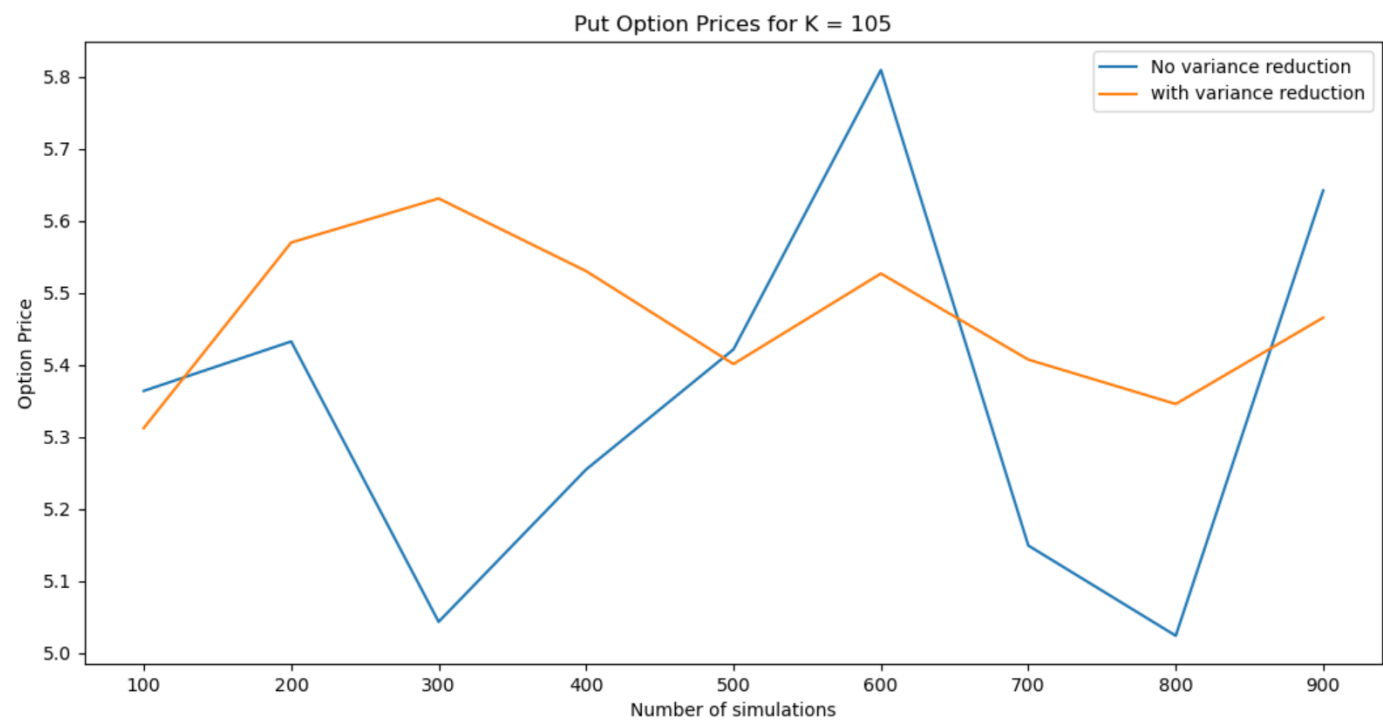
Variance of Put option price without variance reduction for $K = 90$ is **0.00298**

Variance of Put option price with variance reduction for $K = 90$ is **0.00066**



Variance of Put option price without variance reduction for $K = 105$ is **0.0619**

Variance of Put option price with variance reduction for $K = 105$ is **0.01016**



Variance of Put option price without variance reduction for $K = 110$ is **0.09944**

Variance of Put option price with variance reduction for $K = 110$ is **0.00177**

