



भारतीय प्रौद्योगिकी संस्थान गुवाहाटी
INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI

MA 374: Financial Engineering Lab

Lab 10

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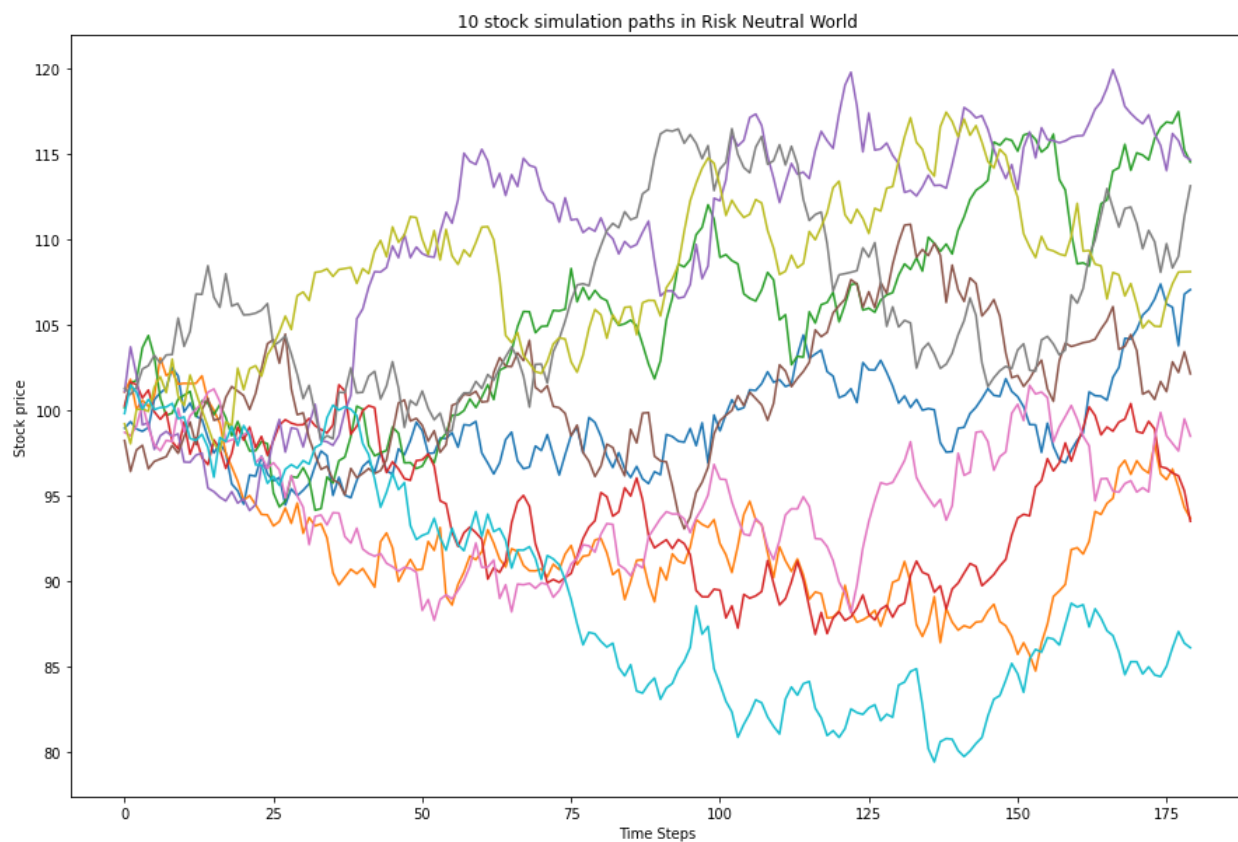
25th Mar 2021

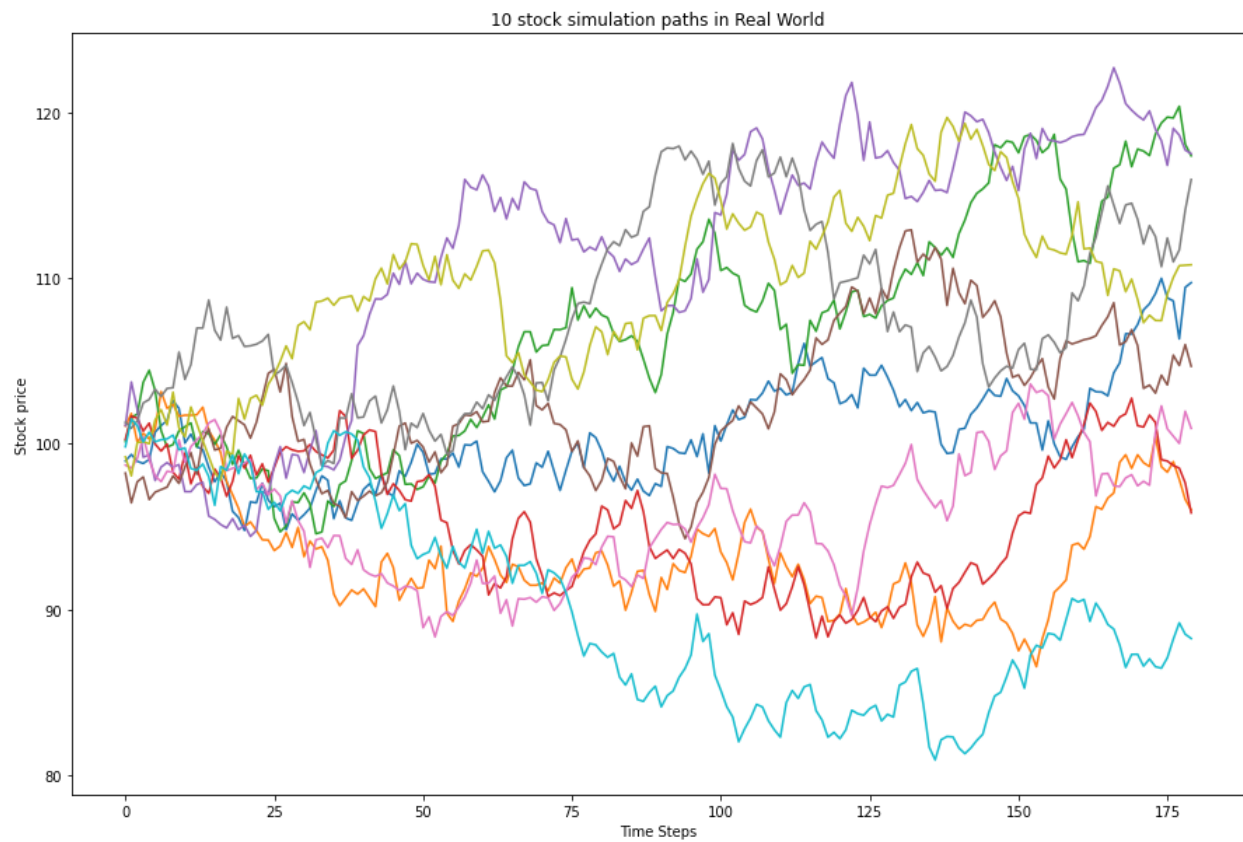
Note: 

1. Please wait for a little while for the simulations to run (~10 seconds)
2. Please run python programs using **python3**, i.e. **python3**
<filename>.py

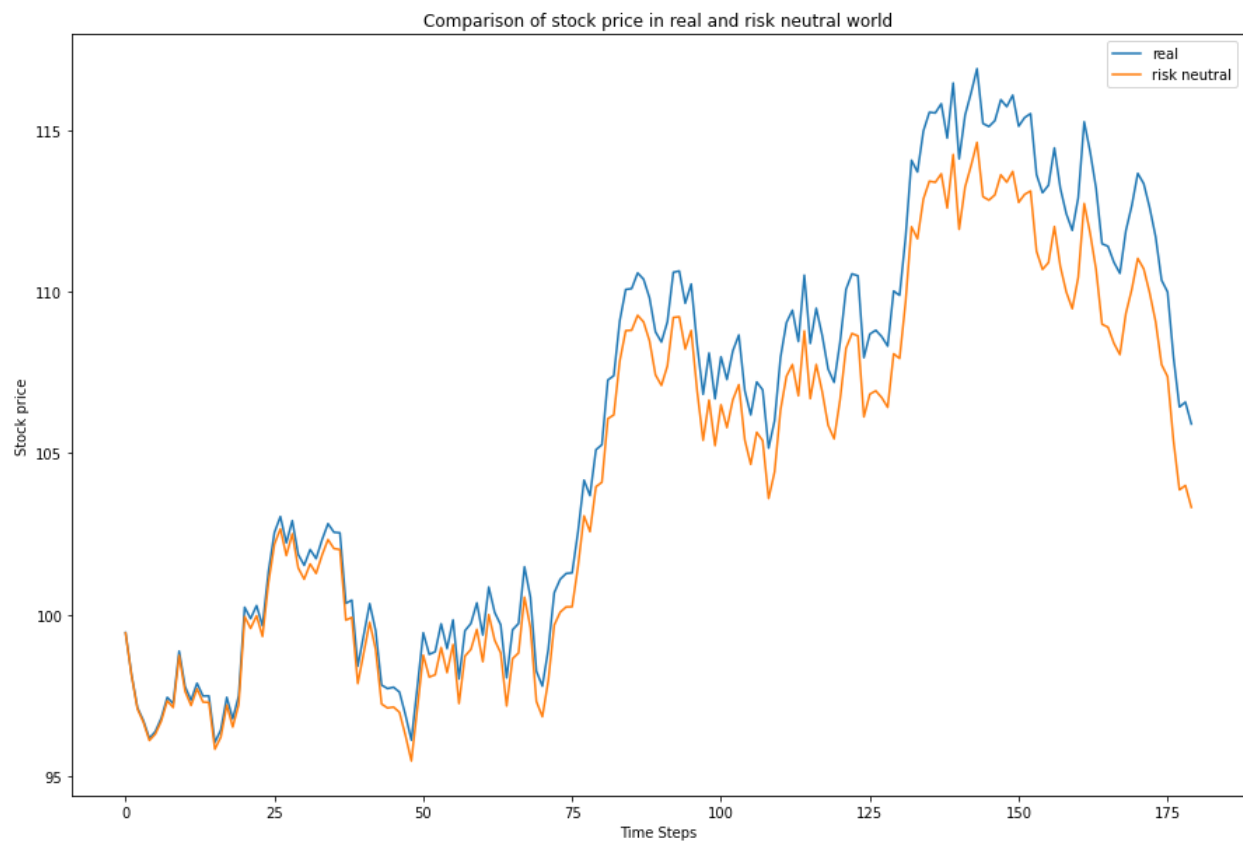
Question 01.

- In this question, we first simulate 10 different paths of the asset price making use of the GBM model for risk-free and real worlds. The plots are attached below.





- We then compare the stock prices for real and risk-free worlds.

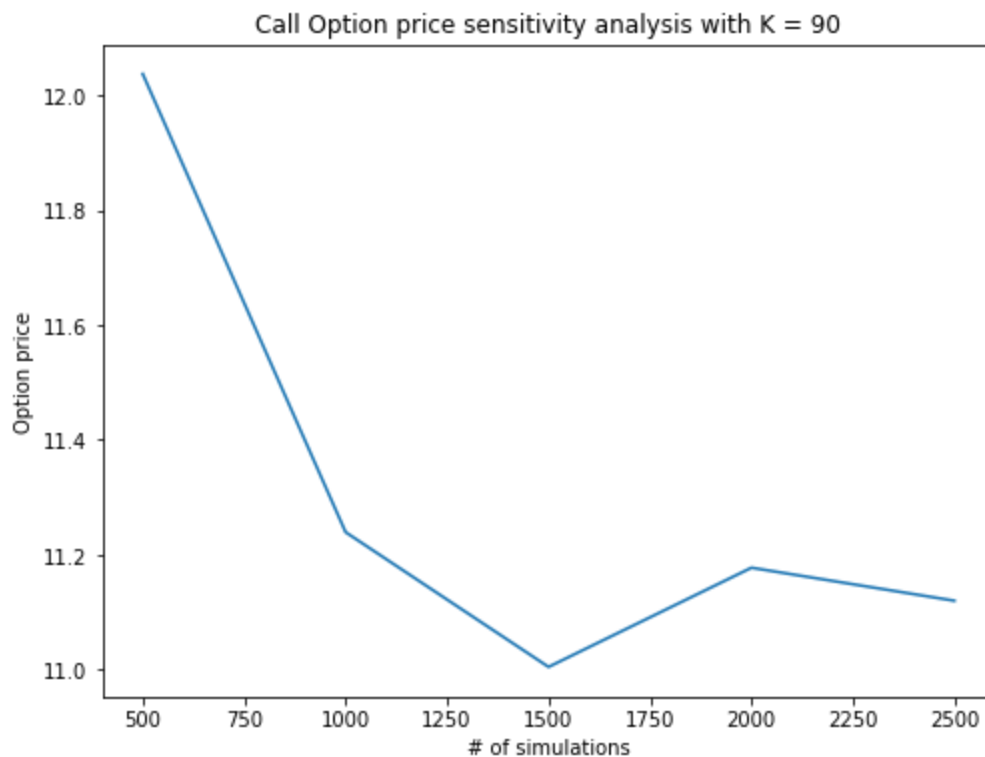


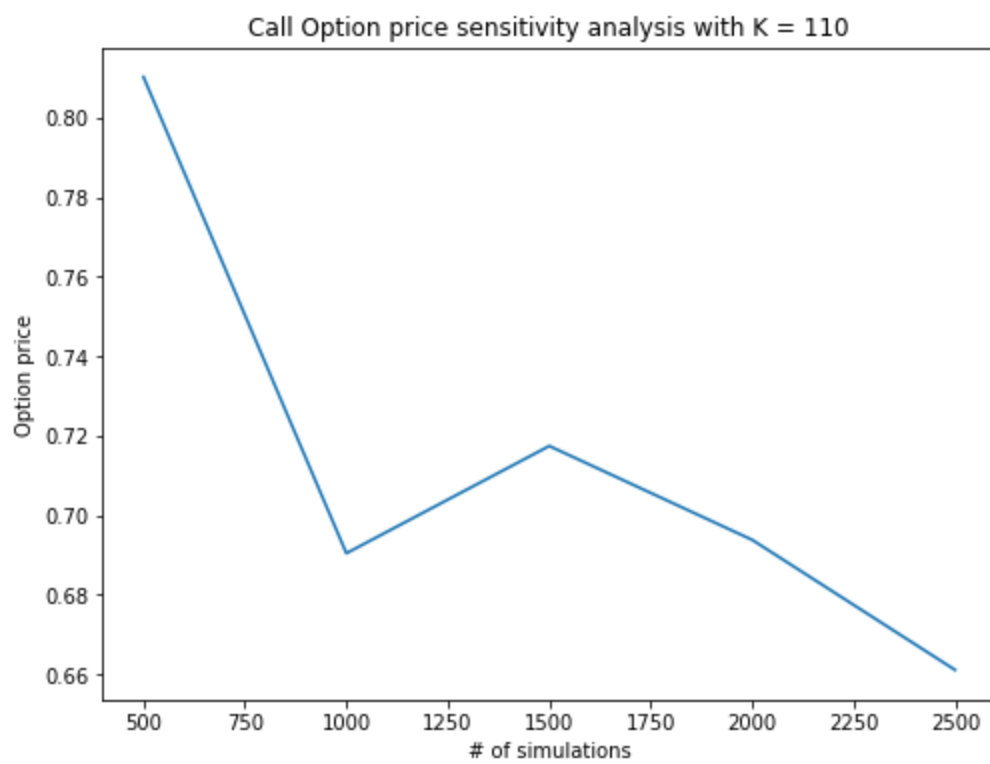
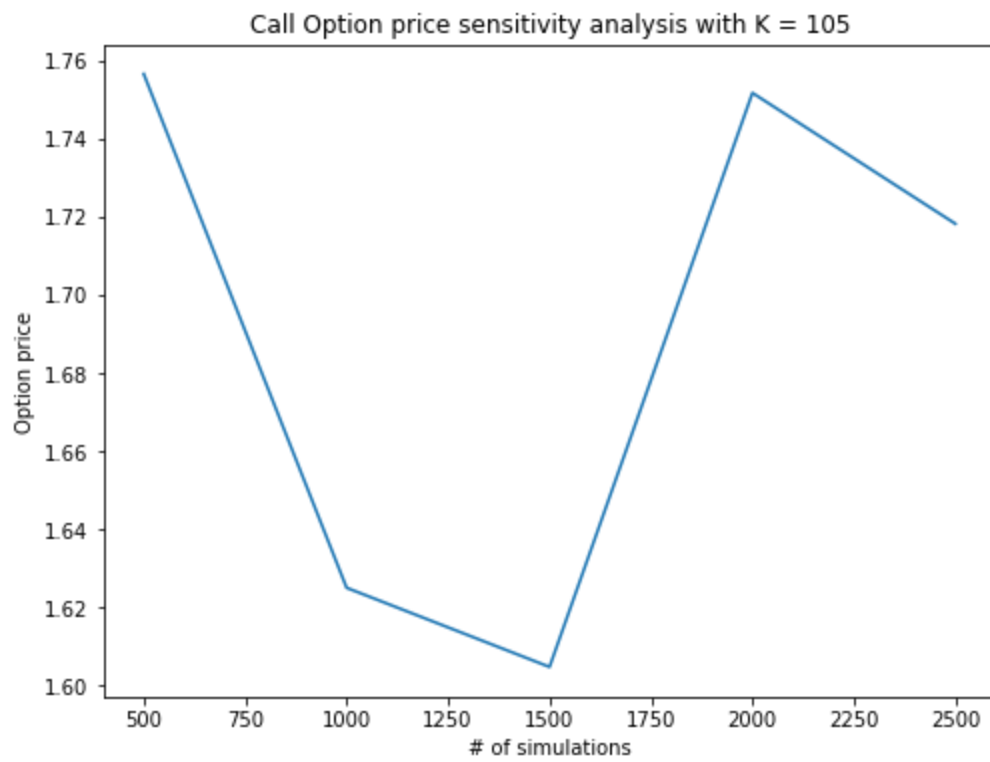
- The price of a 6 month fixed-strike Asian option with a strike price of 105 ($K = 105$) for both **call** and **put** options are computed. We also repeat the same for other values of K namely - $K = 90$ and $K = 110$.

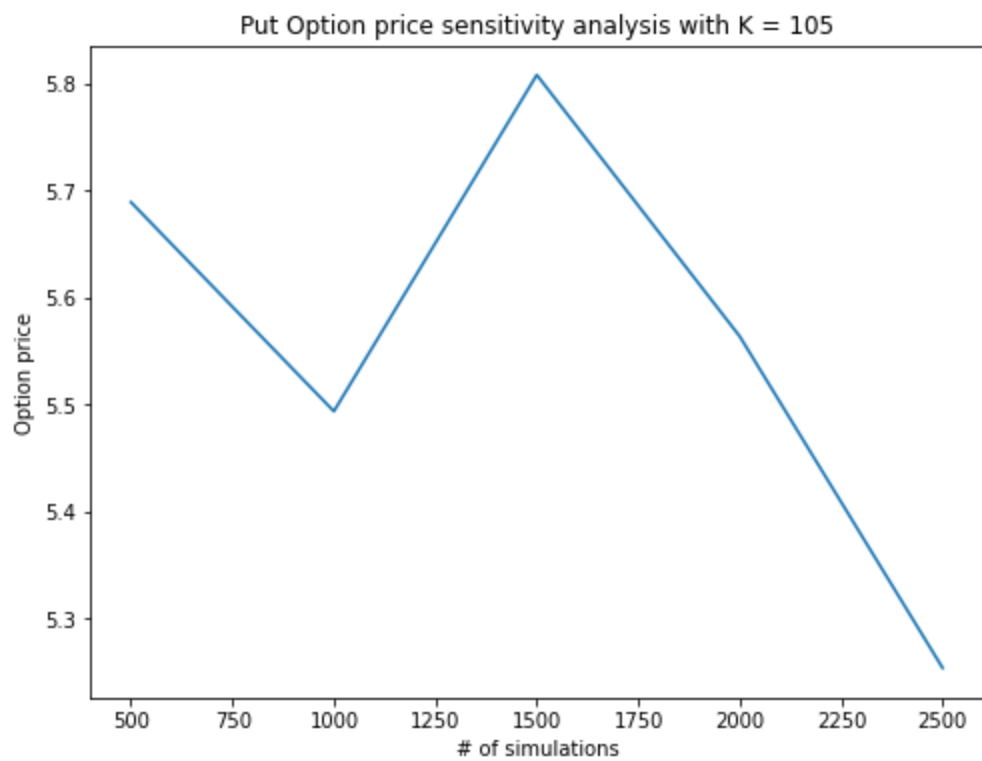
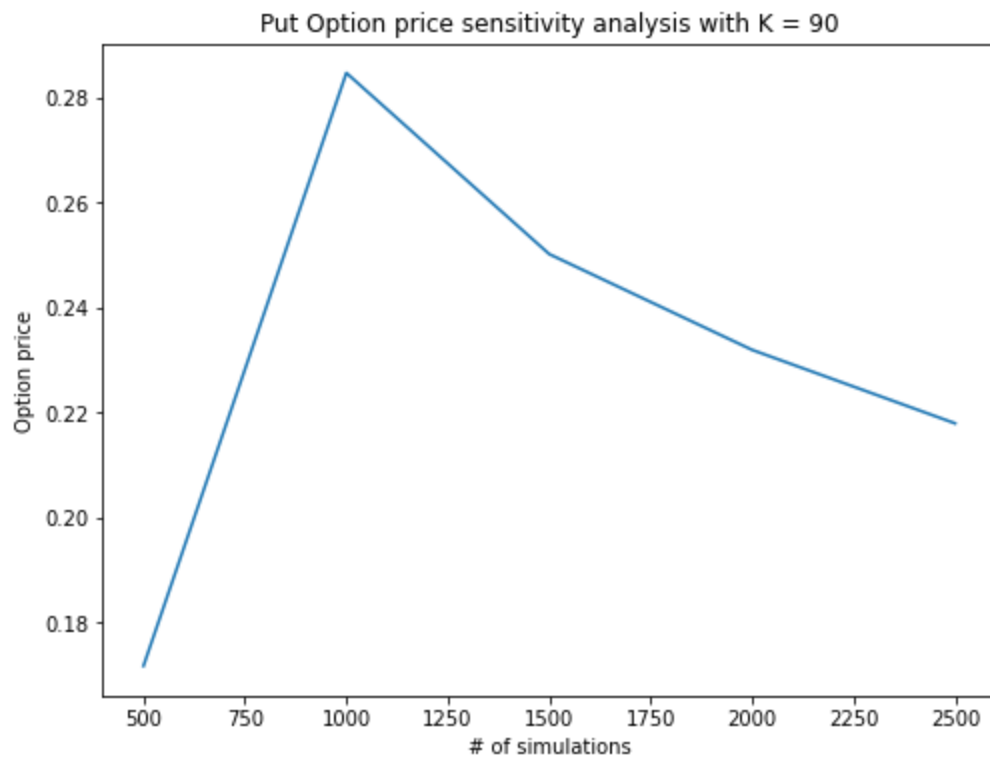
- The computed option prices are:

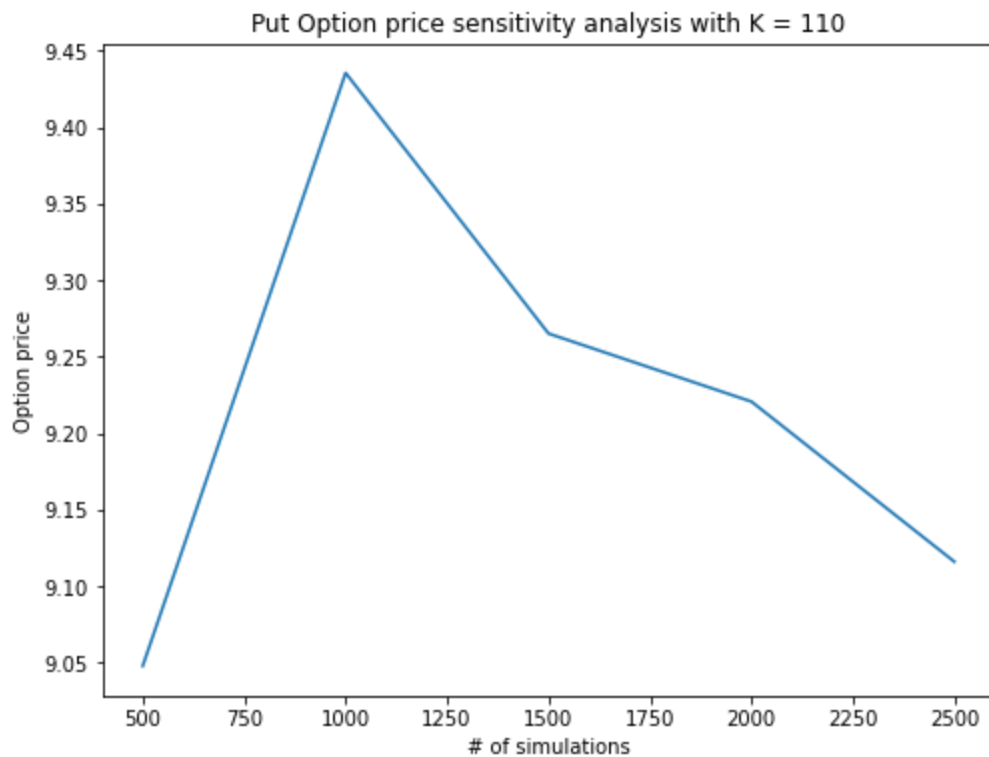
- ❖ Call Option price for $K = 90$ is 11.09926
- ❖ Call Option price for $K = 105$ is 1.71275
- ❖ Call Option price for $K = 110$ is 0.65917
- ❖ Put Option price for $K = 90$ is 0.26274
- ❖ Put Option price for $K = 105$ is 5.45548
- ❖ Put Option price for $K = 110$ is 9.24344

- We now plot these against the number of simulations and get the following graphs.



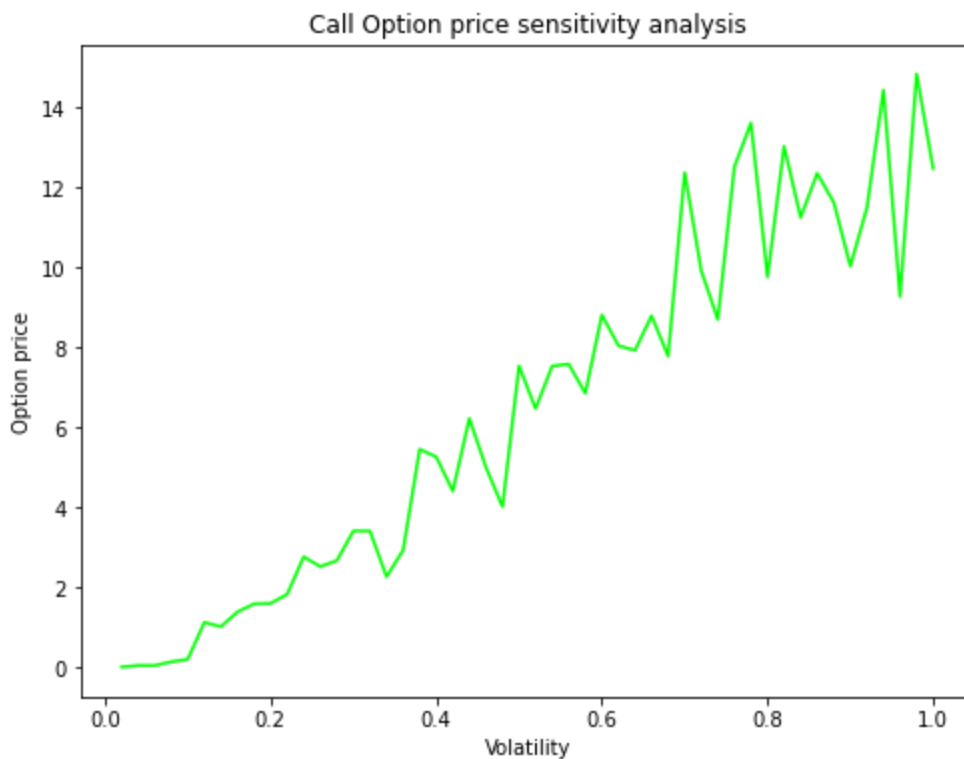
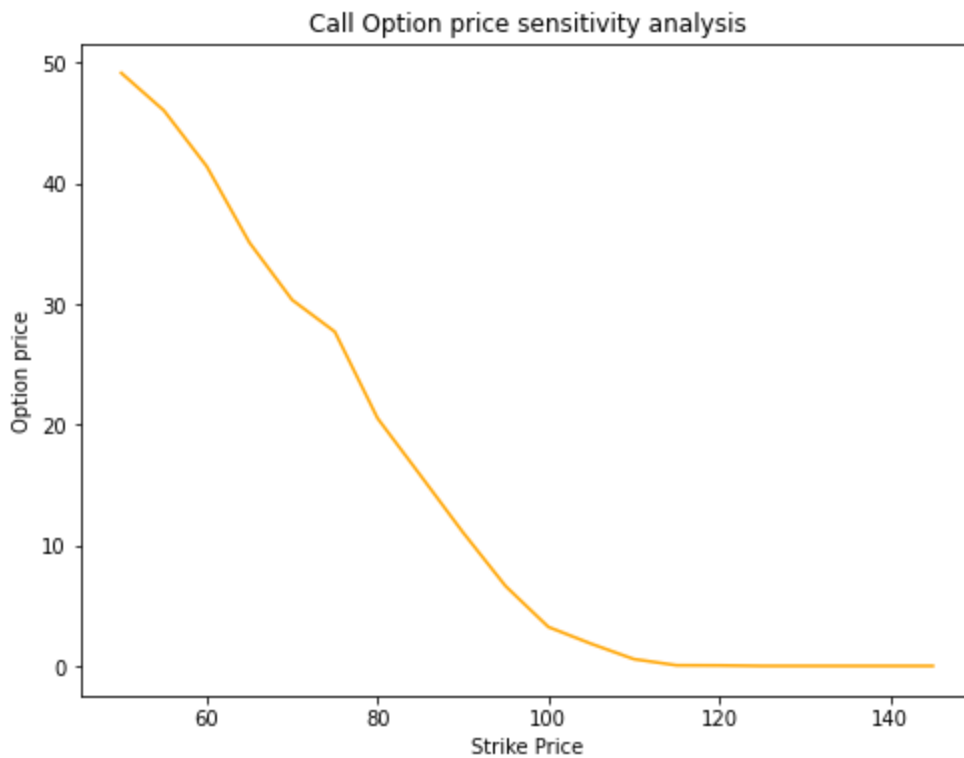


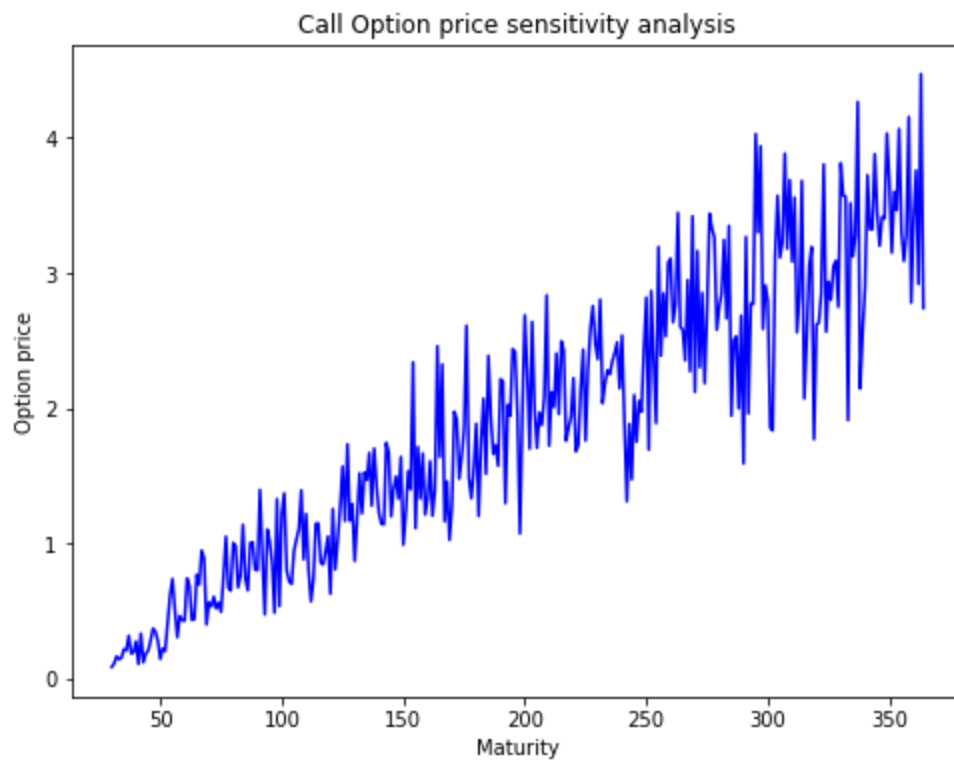
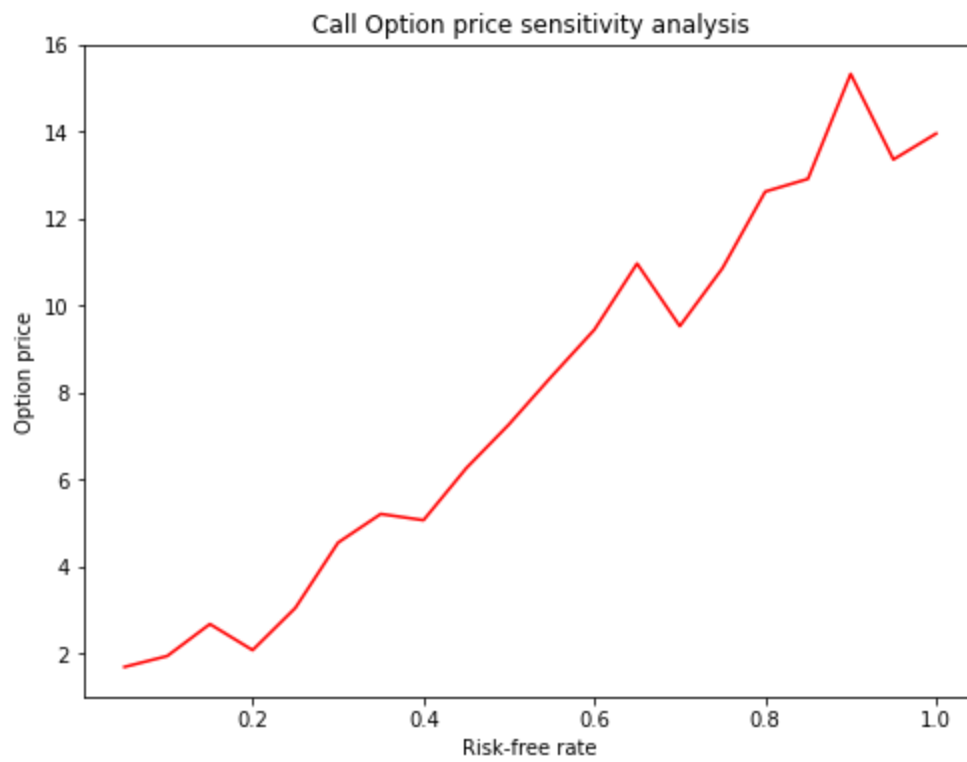


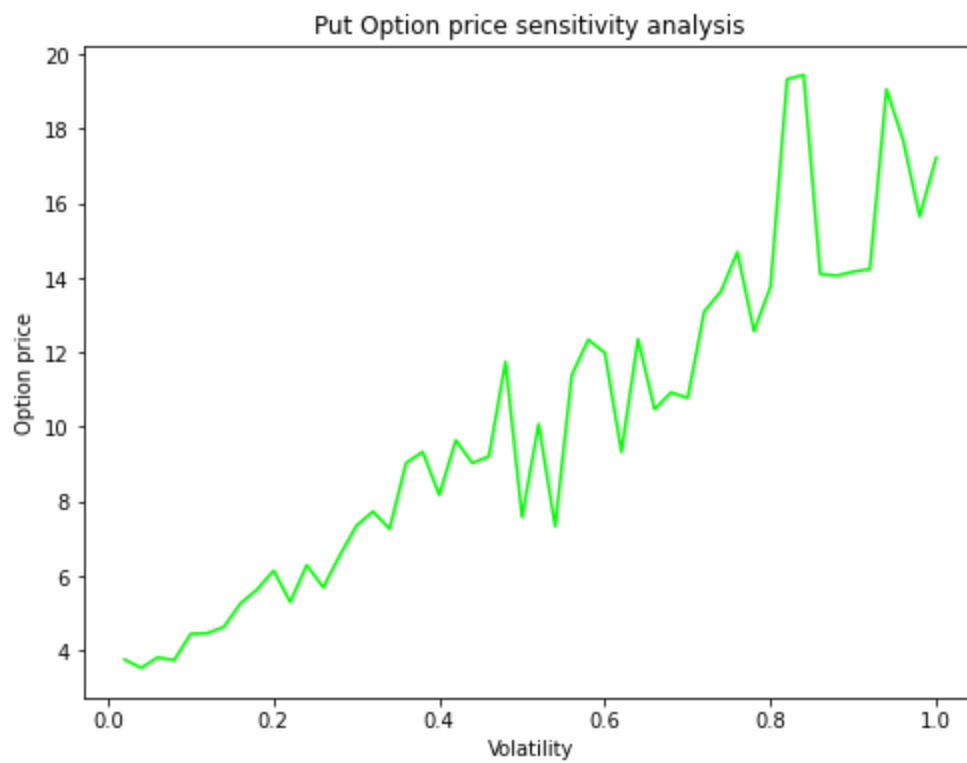
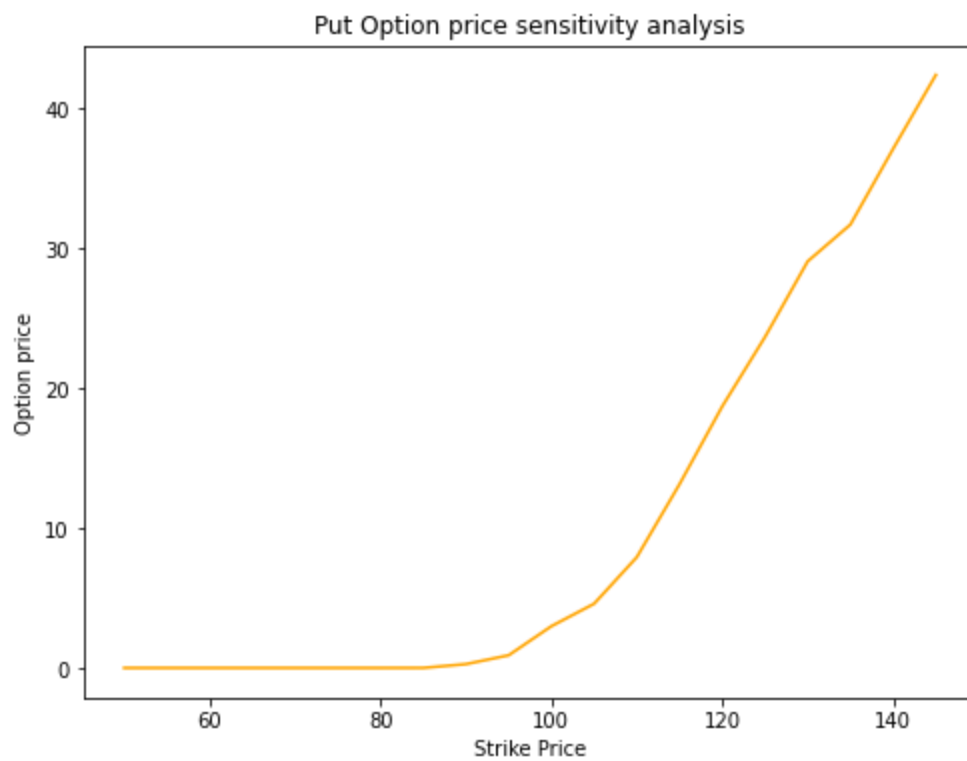


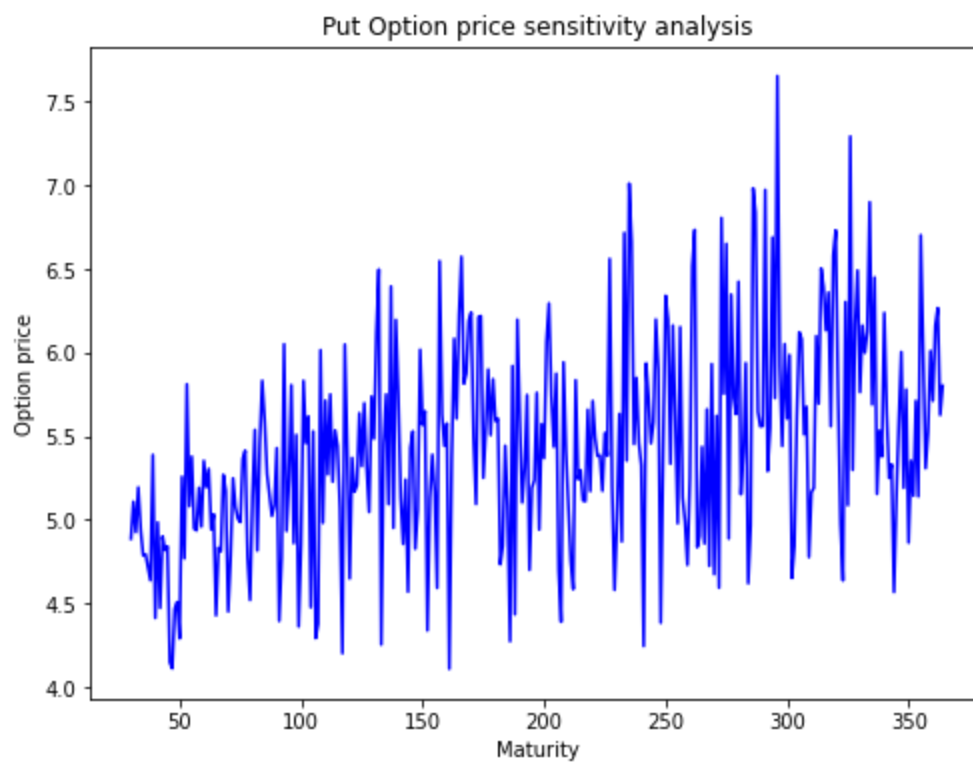
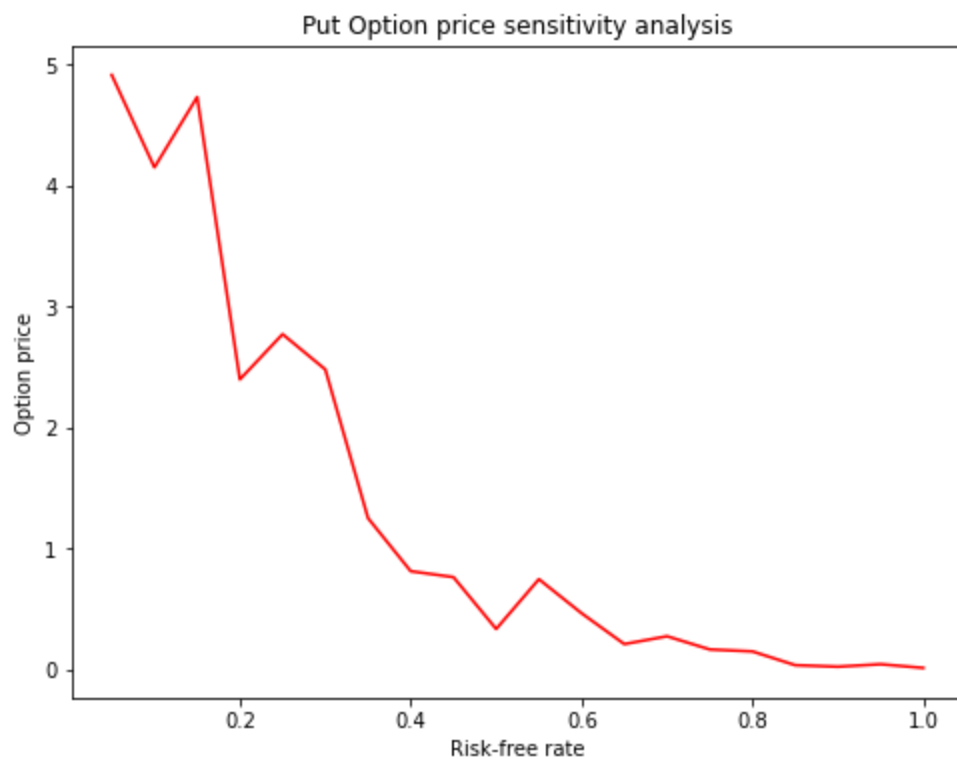
- From the data we can quickly observe that:
 - **Asian call option price decreases with increase in K from 90-110.**
 - **Asian put option price increases with increase in K from 90-110**
- The observation is in accordance with the expected behavior.
- This behavior is more clearly seen in the sensitivity analysis of option prices versus K .

- We now carry out a **sensitivity analysis**. For this we vary **K (strike price)**, **r (risk-free rate)**, **sigma (volatility)**, and **T (maturity)** and plot 2D graphs.







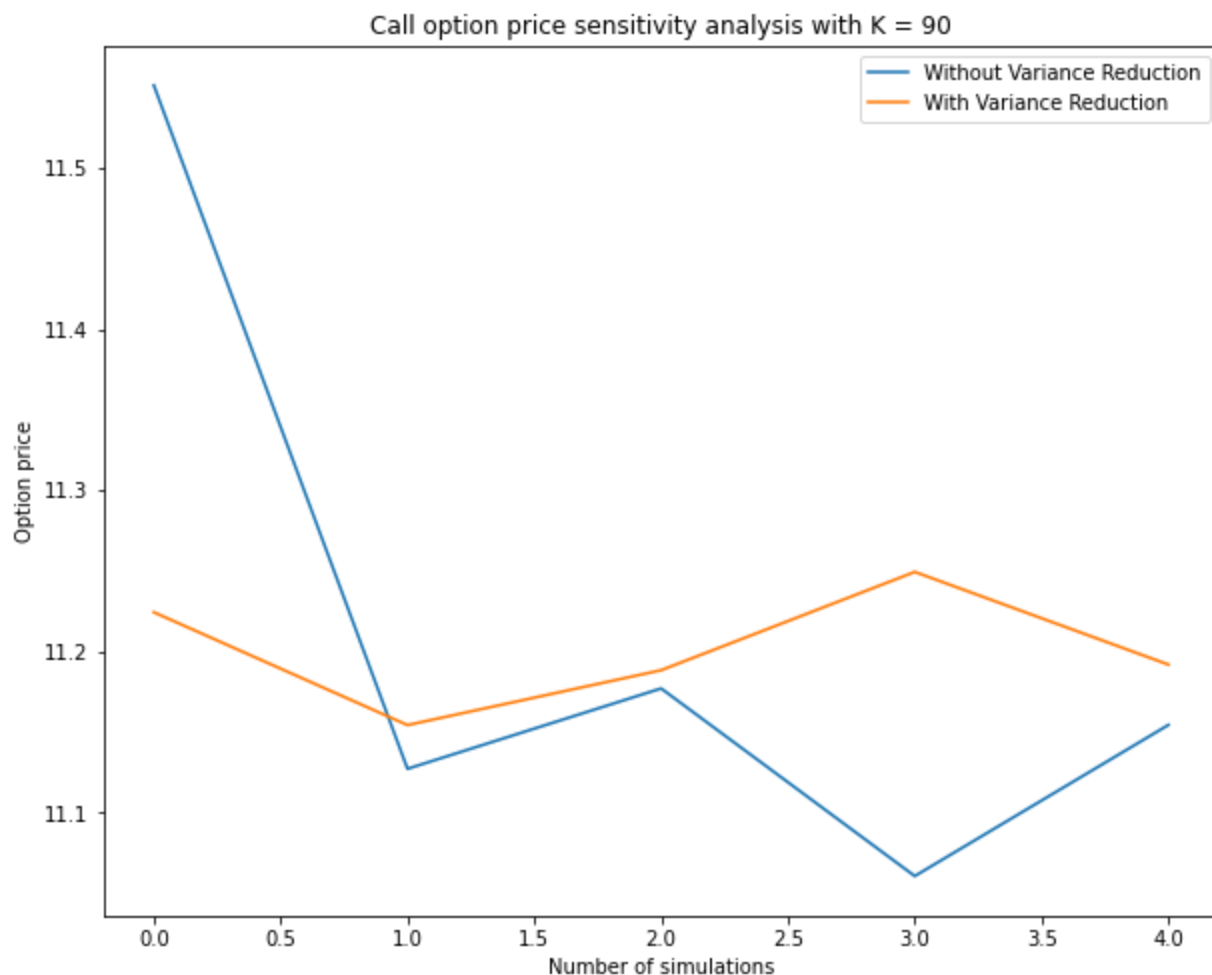


Question 2.

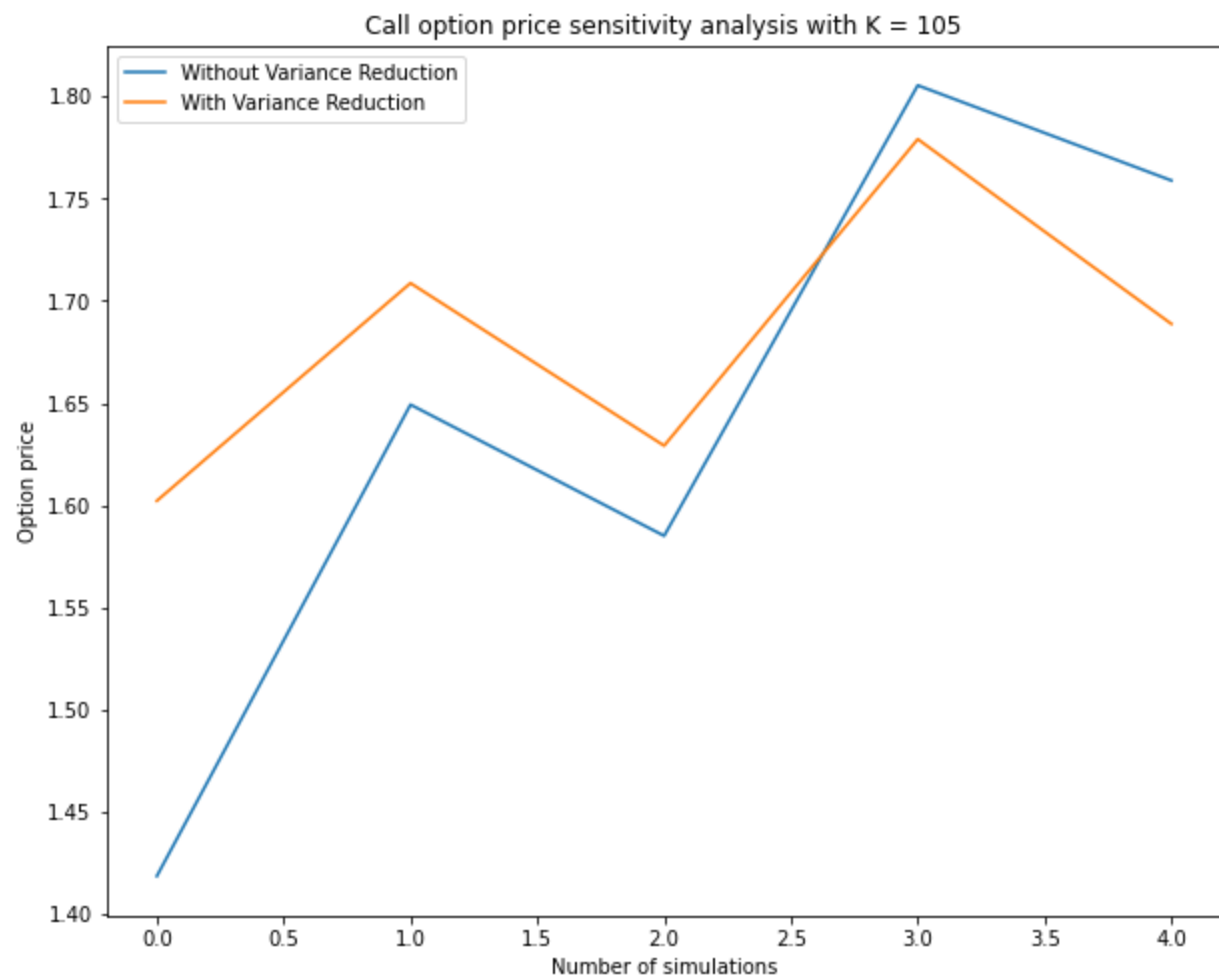
- In this question, we employ the variance reduction techniques and repeat the above exercise.
- We most definitely observe a reduction in variance as we note down the variance for call and put option prices for $K = 90$, 105 and 110.

Variance of Call option price without variance reduction for $K = 90$ is 0.02995

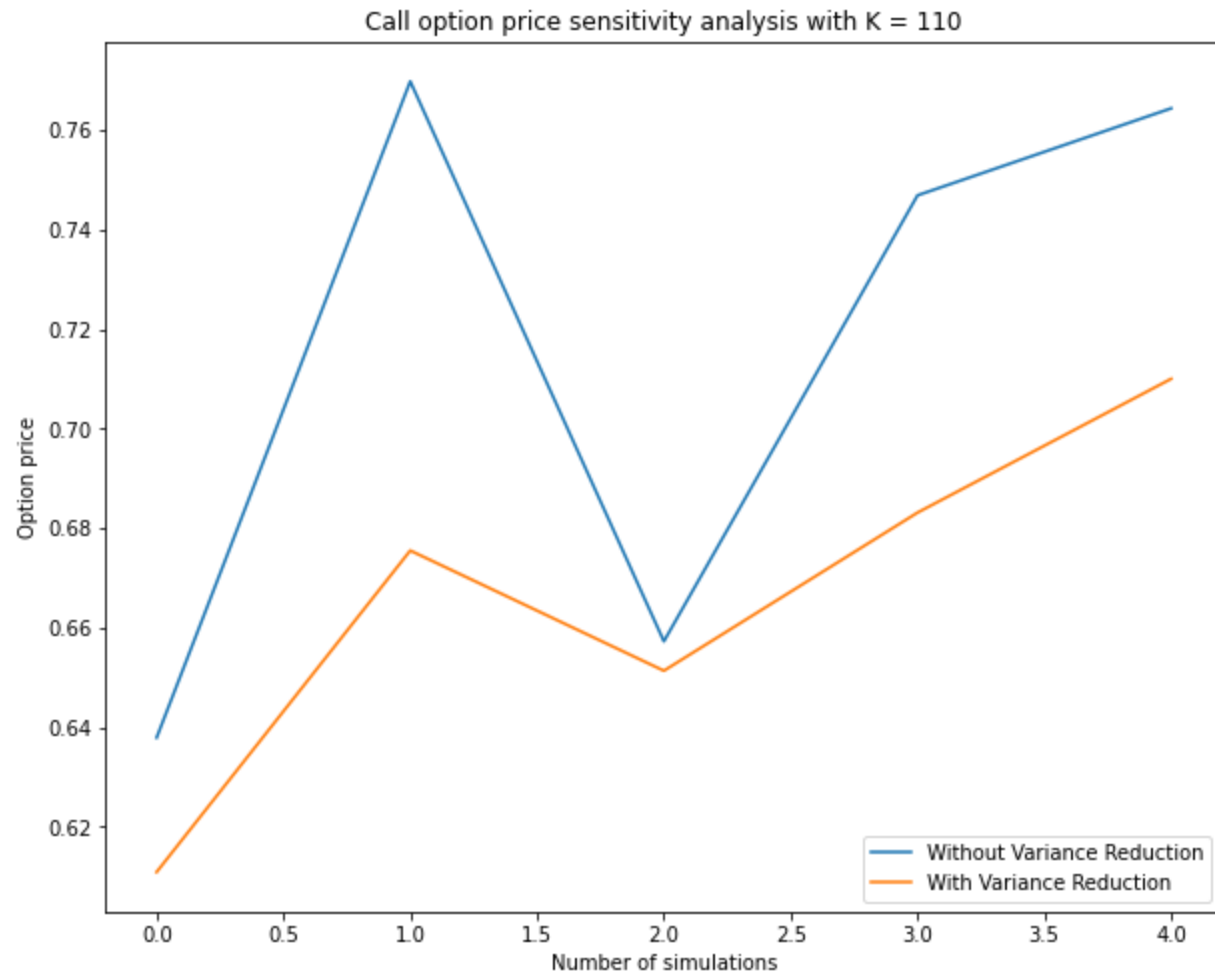
Variance of Call option price with variance reduction for $K = 90$ is 0.00106



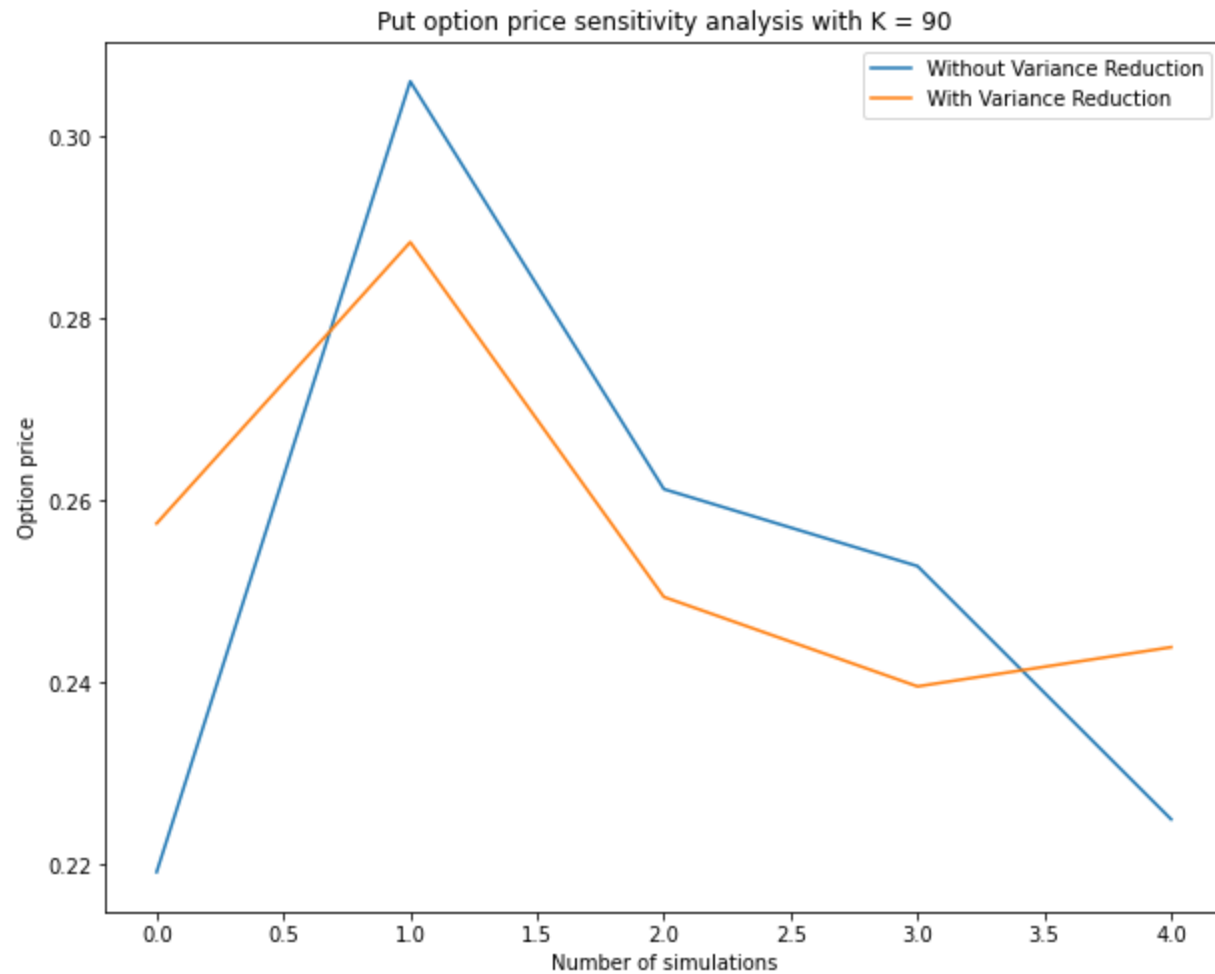
Variance of Call option price without variance reduction for $K = 105$ is 0.01869
Variance of Call option price with variance reduction for $K = 105$ is 0.00387



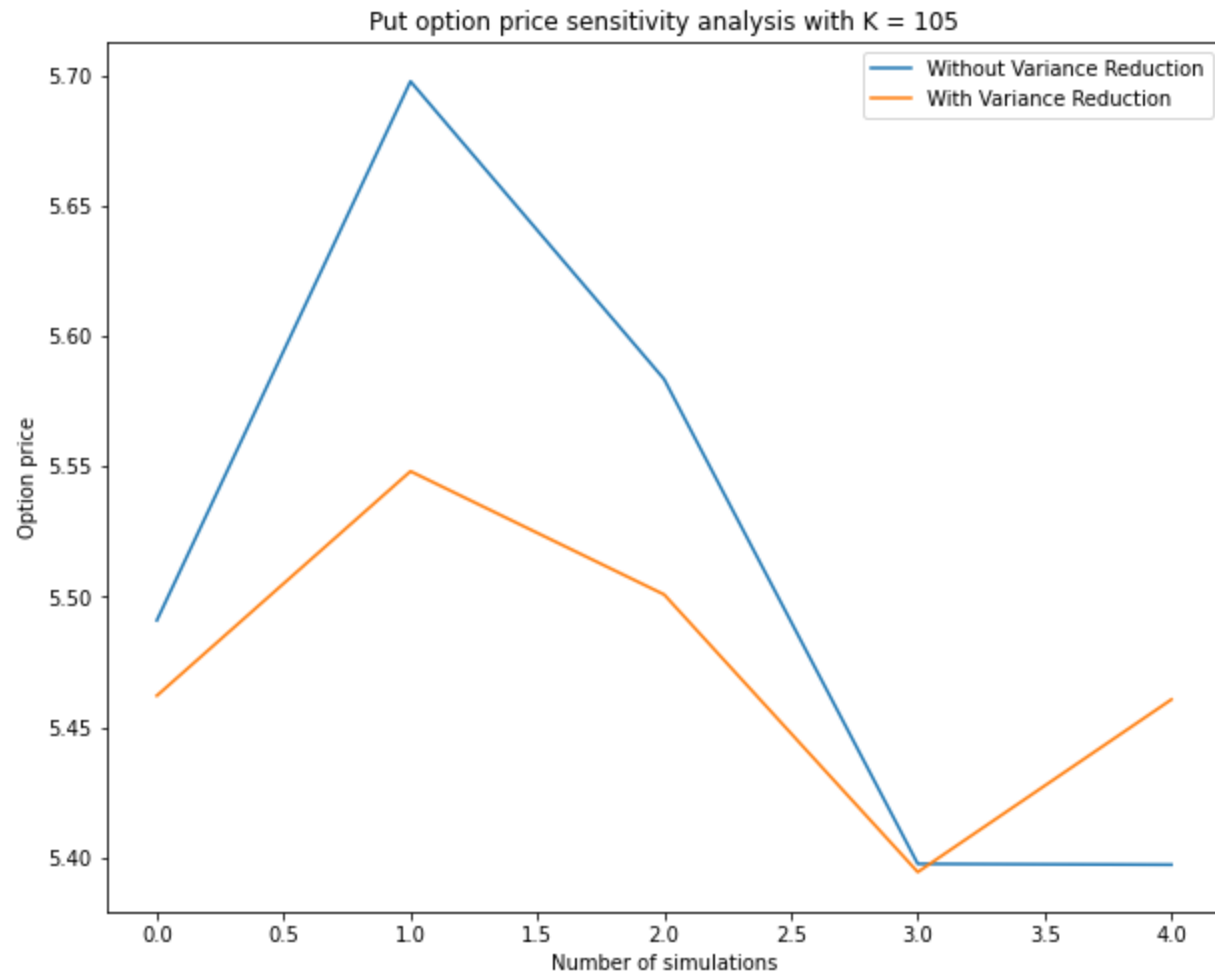
Variance of Call option price without variance reduction for $K = 110$ is 0.00314
Variance of Call option price with variance reduction for $K = 110$ is 0.00111



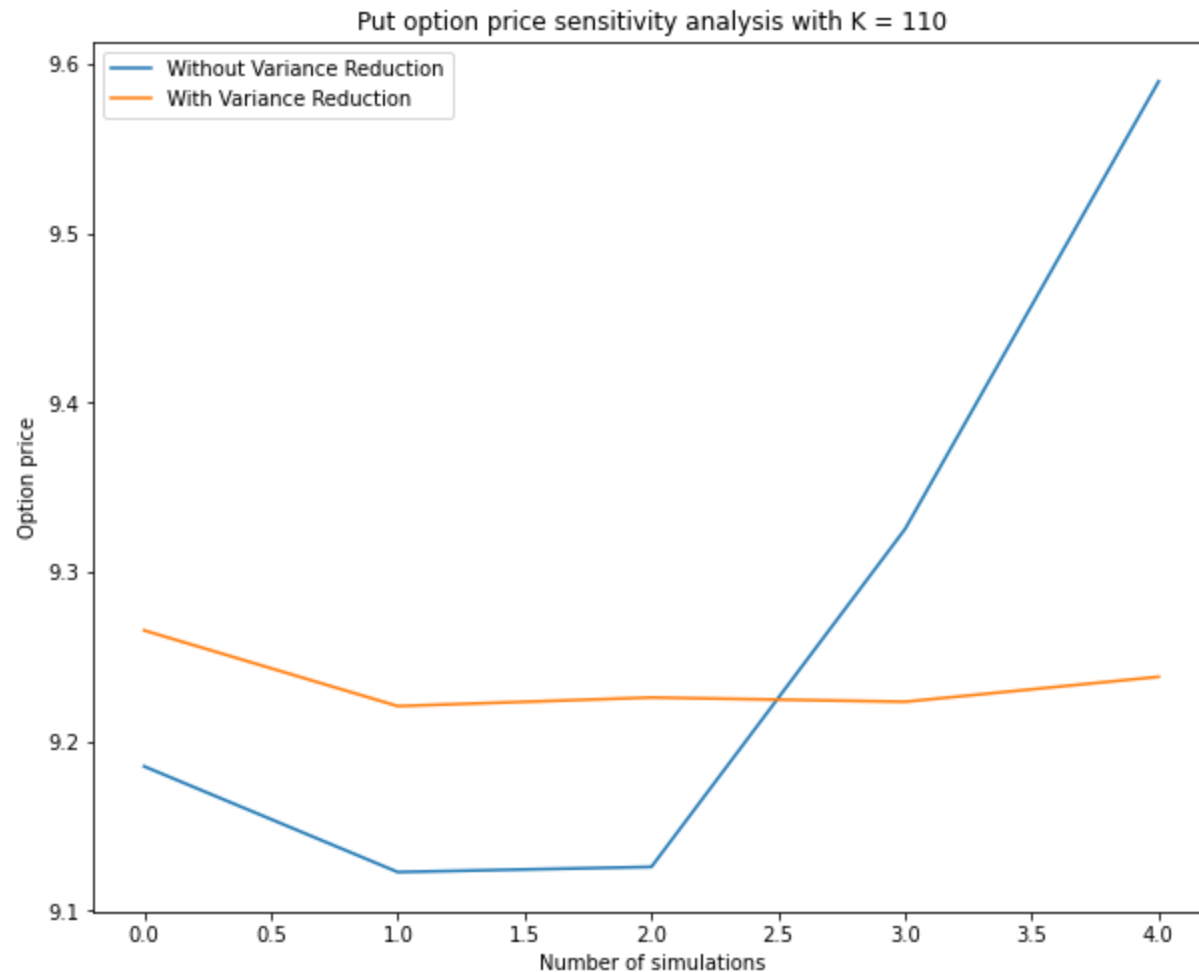
Variance of Put option price without variance reduction for $K = 90$ is 0.00096
Variance of Put option price with variance reduction for $K = 90$ is 0.0003



Variance of Put option price without variance reduction for $K = 105$ is 0.01324
Variance of Put option price with variance reduction for $K = 105$ is 0.00257



Variance of Put option price without variance reduction for $K = 110$ is 0.03098
Variance of Put option price with variance reduction for $K = 110$ is 0.00027



- As is clearly seen in each case, using variance reduction techniques has helped us reduce the variance in the respective option prices.

Extras...

The following packages need to be installed for this lab.

Kindly use pip3 since the code must be run in python-3 as mentioned previously.

```
Numpy - pip3 install numpy  
Matplotlib - pip3 install matplotlib
```