# Lab 10 Output

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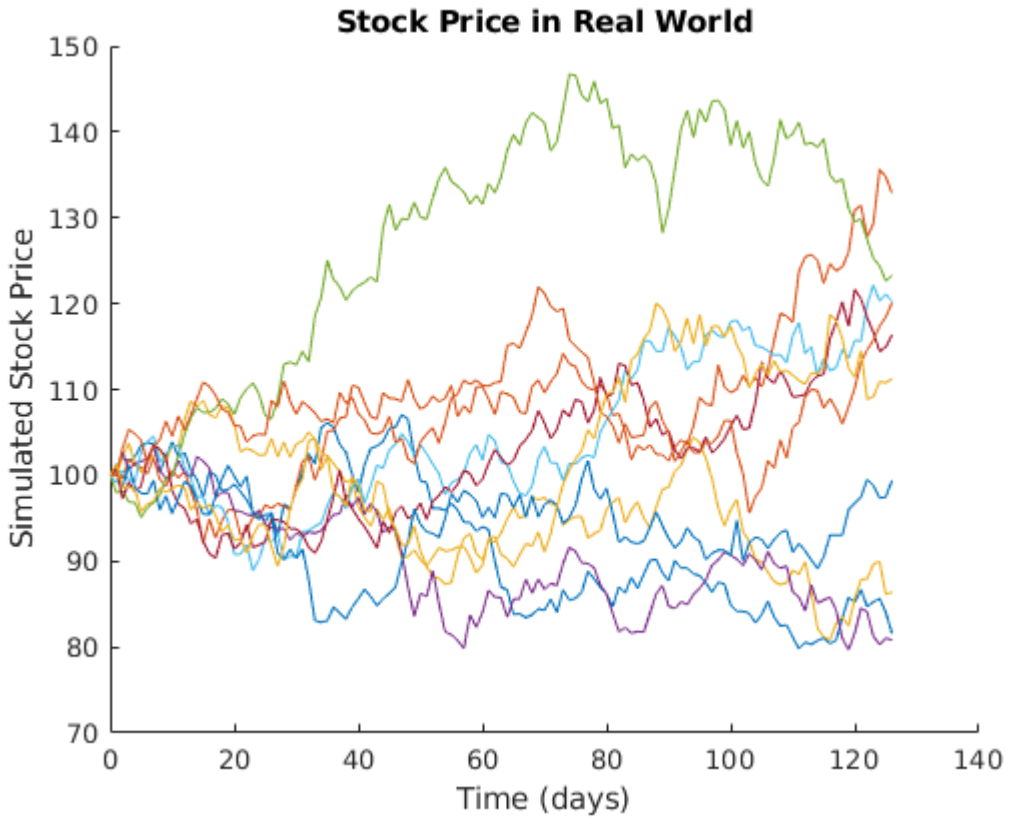
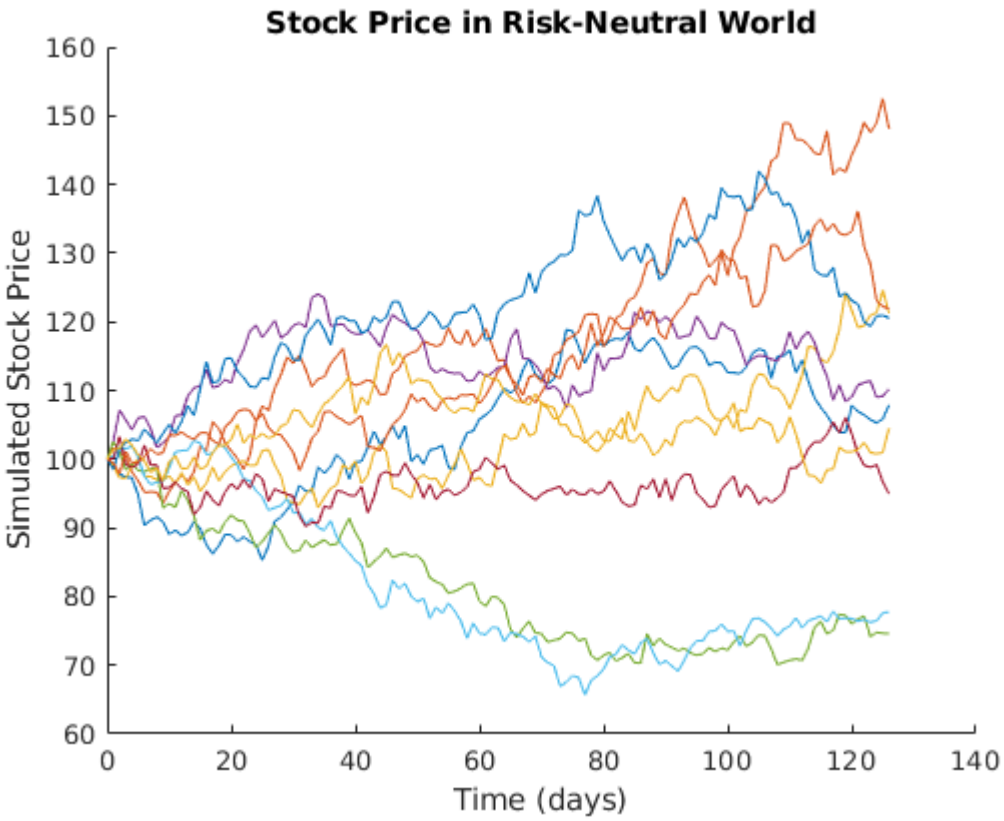
Roll no – 170123057

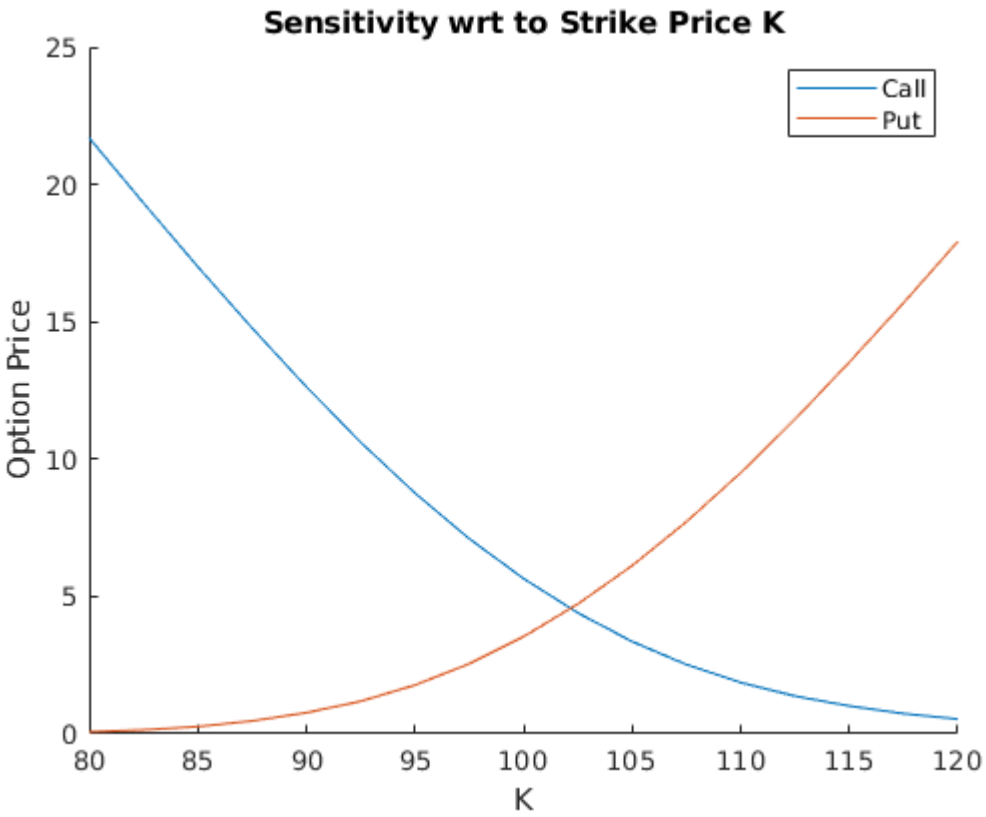
Q1. Using monte Carlo methods without variance reduction techniques

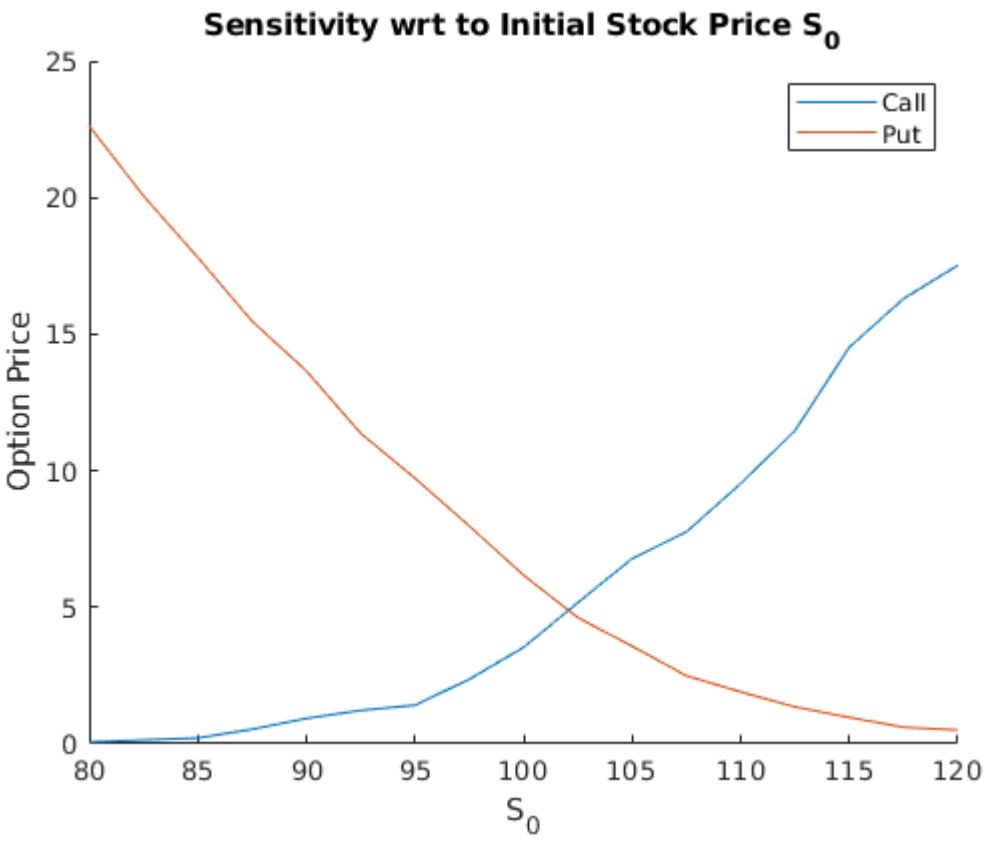


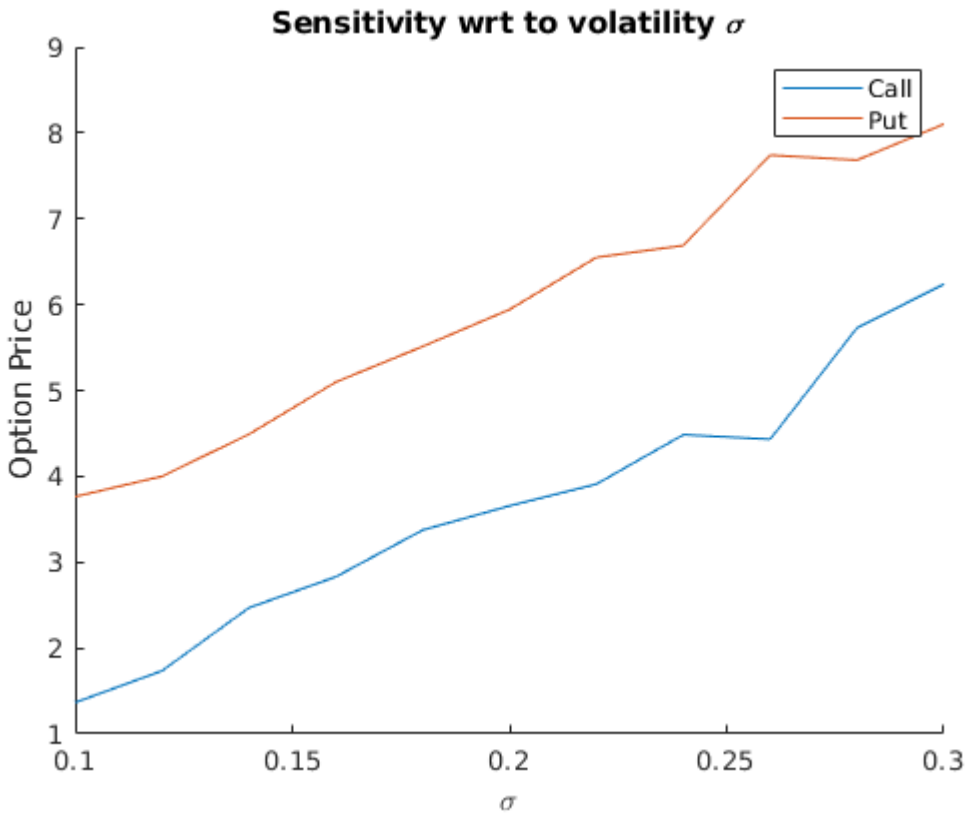



Asian call options with S0 = 100, r = 0.05, σ= 0.2,number of trials = 1000

| K | Call Option | Put Option |
|---|---|---|
| 90 | 12.6367 | 0.7690 |
| 105 | 3.3614 | 6.1233 |
| 110 | 1.8670 | 9.5054 |


Sensitivity wrt to Strike Price K
Call
Put
Option Price
K
0
5
10
15
20
25
80
85
90
95
100
105
110
115
120


Sensitivity wrt to Initial Stock Price S0
Call
Put
Option Price
S0
0
5
10
15
20
25
80
85
90
95
100
105
110
115
120




Q2 . Using antithetic variance reduction

$\theta = E[Y] = E[g(X)]$

where $\theta$ is the quantity we want to estimate ,

we can generate two sample $Y_1$ and $Y_2$ s.t. the new unbiased estimator of $\theta$ is

$$\hat{\theta} = \frac{Y_1 + Y_2}{2}$$

Hence we have

$$Var(\theta) = \frac{var(Y_1) + var(Y_2) + 2Cov(Y_1, Y_2)}{4}$$

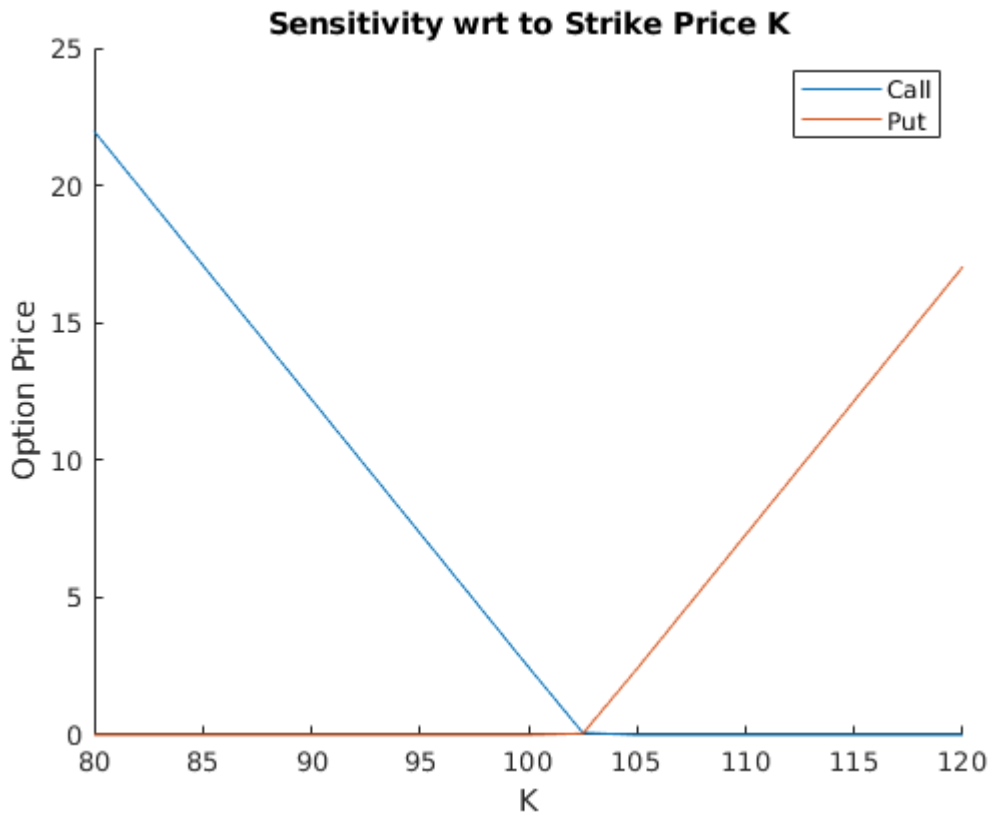
It is obvious that we could get a variance reduction if we have the two samples negatively correlated.

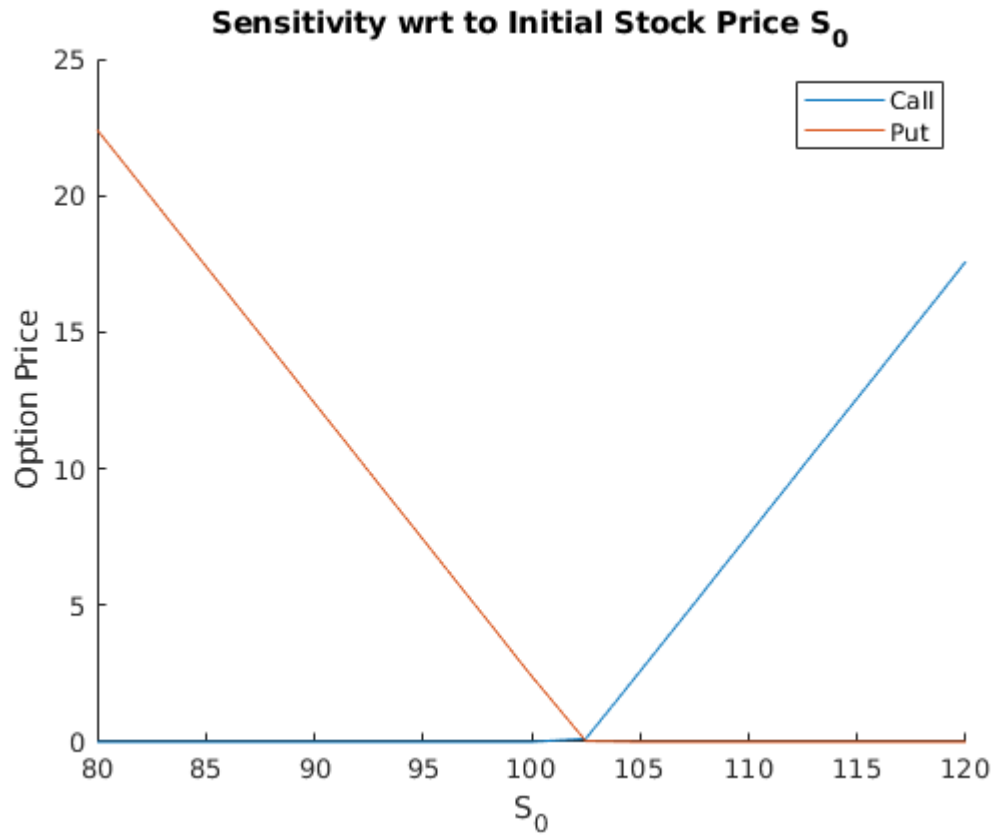
If $X \sim \mathcal{N}(0,1)$ then we can apply the following algorithm

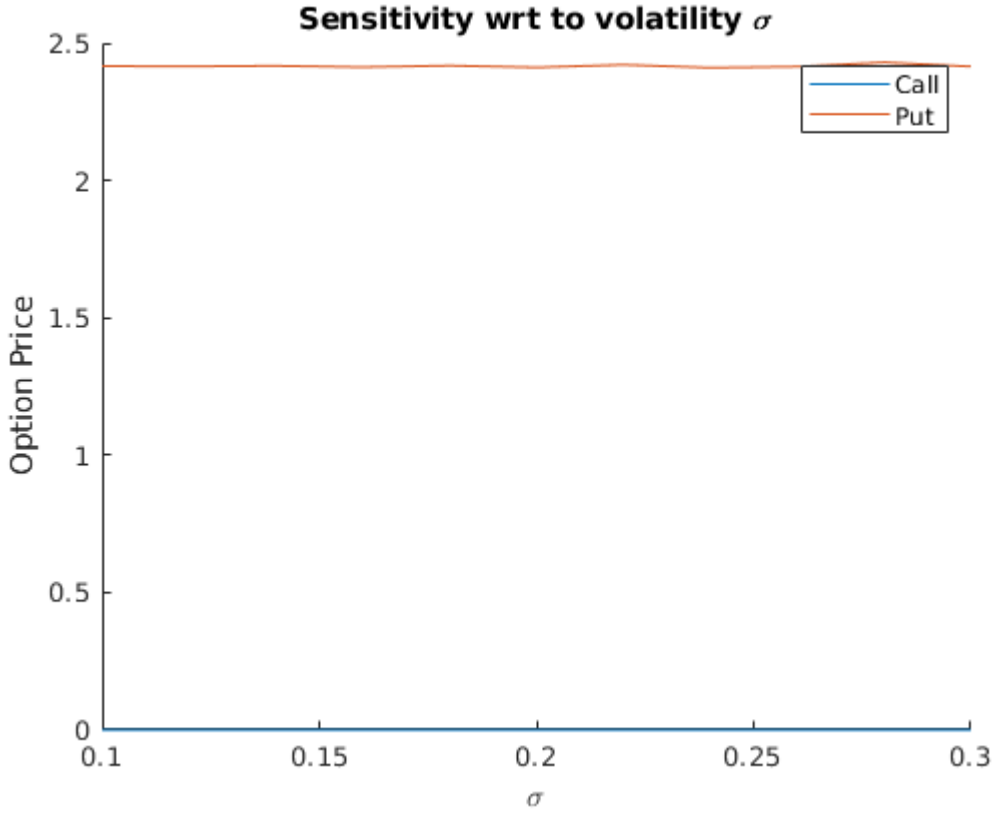
$$\hat{\theta} = \frac{1}{n}\sum_{i=1}^{N} \frac{g(X_i) + g(-X_i)}{2} \text{ with i.i.d. } X_i \sim \mathcal{N}(0,1)$$

Asian call options with S0 = 100, r = 0.05, σ= 0.2,number of trials = 1000

| K | Call Option | Put Option |
|---|---|---|
| 90 | 12.2192 | 0.0000 |
| 105 | 0.0000 | 2.4104 |
| 110 | 0.0000 | 7.2870 |




Sensitivity wrt to Initial Stock Price $S_0$
Call
Put
Option Price
25
20
15
10
5
0
80
85
90
95
100
105
110
115
120
$S_0$


Sensitivity wrt to volatility $\sigma$
Call
Put
Option Price
2.5
2
1.5
1
0.5
0
0.1
0.15
0.2
0.25
0.3
$\sigma$