भारतीय प्रौद्योगिकी संस्थान गुवाहाटी
INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI

MA 374: Financial Engineering Lab

Lab 02

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Question 1.

Data given to determine the initial price of a European call and a European put option in the binomial model are:

$$S(0) = 100,\ K = 100,\ T = 1,\ M = 100,\ r = 8\%,\ \sigma = 20\%$$

Also given 2 sets of u and d:

a) $Set\ 1:\ u = e^{\sigma\sqrt{\Delta t}},\ d = e^{-\sigma\sqrt{\Delta t}}$

b) $Set\ 2:\ u = e^{\sigma\sqrt{\Delta t}+\left(r-\frac{1}{2}\sigma^2\right)\Delta t},\ d = e^{-\sigma\sqrt{\Delta t}+\left(r-\frac{1}{2}\sigma^2\right)\Delta t}$

Using them:

```
The Call price for set 1 is: 12.085380013710122
The Put price for set 1 is: 4.397014652374142
The Call price for set 2 is: 12.12304707401244
The Put price for set 2 is: 4.434681712676475
```

The **sensitivity analysis** of option price variance with **S(0), K, M, r,** σ has been done by plotting 2-D and 3-D plots .

Question 2.

The path-dependent derivative used for this question is the **Asian Option**.

The payoff for the Asian Call Option = $(S_{avg\ over\ path} - K)^+$

The payoff for the Asian Put Option = $(K - S_{avg\ over\ path})^+$

Here K is the strike price.

The data taken for this question is:

$$S(0) = 100,\ K = 100,\ T = 1,\ M = 10,\ r = 8\%,\ \sigma = 20\%$$

We have taken the value of **M as 10**. For an Asian option, we have to take all possible paths, which in our case will be **2^M**. So taking a value of M = 100, would be computationally infeasible. The initial option price (for call and put) can be found using,

$$H(0) = \frac{1}{e^{rT}} \sum_{over\ \ all\ paths} p^{ups}(1-p)^{M-ups} f(S_{avg})$$

Here **ups** represents the **number of ups** in the path, **f** denotes the **payoff for the Asian option,** and denotes **the average stock price over the path**, which is computed as:

$$S_{avg} = \frac{\sum_{i=0}^{i=M} S\left(\frac{T*i}{M}\right)}{M+1}$$

Using these formulae, we get:

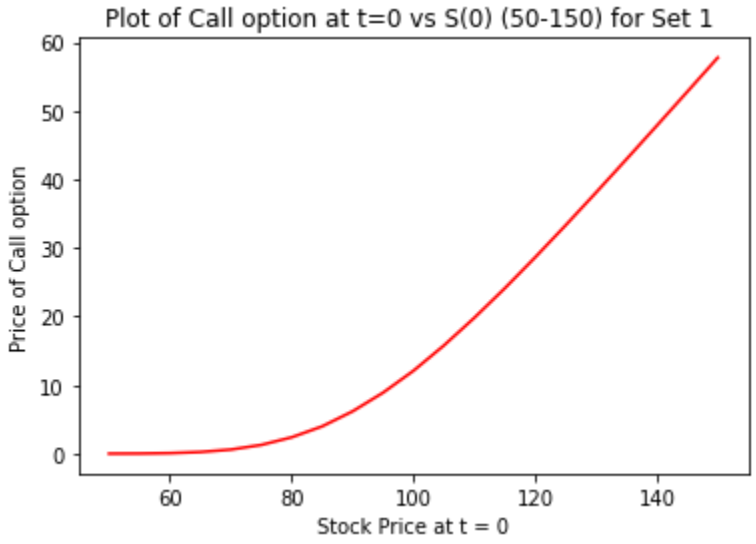
```
The Asian Call price for set 1 is: 6.476003047446573
The Asian Put price for set 1 is: 2.6779455899442306
The Asian Call price for set 2 is: 6.490029377643389
The Asian Put price for set 2 is: 2.691971920141049
```

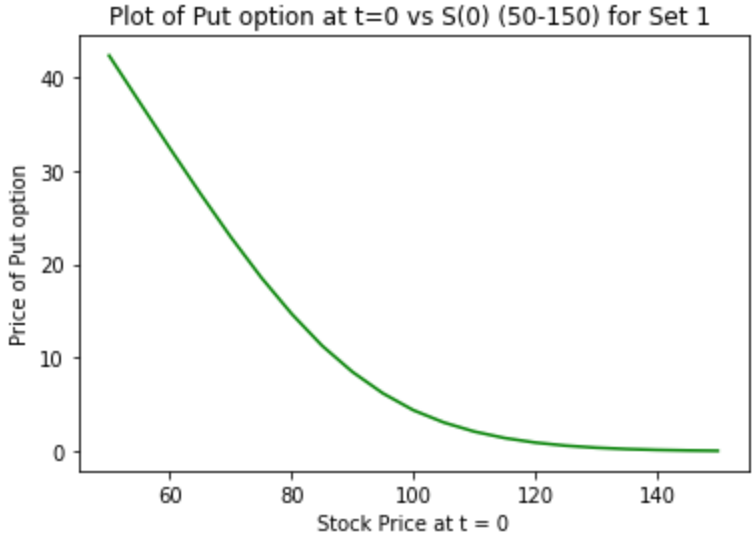
The **sensitivity analysis** of option price variance with **S(0), K, M, r,** σ has been done by plotting 2-D and 3-D plots.

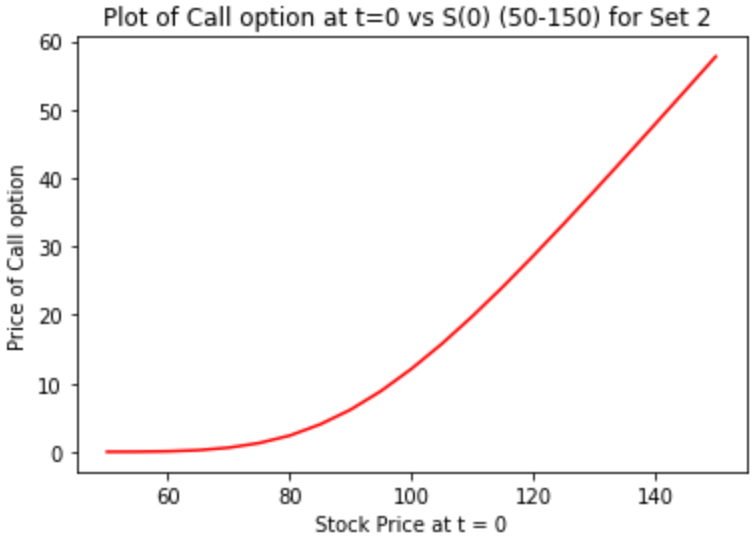
Question 1 Plots -

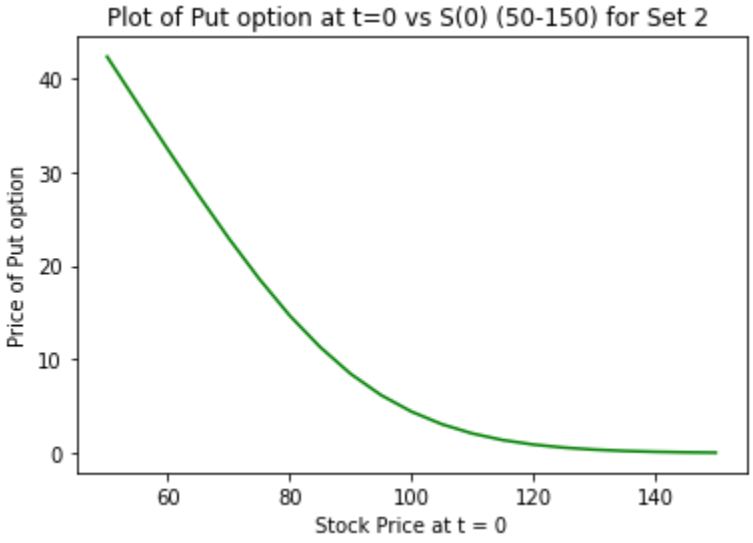
2D Plots (1 param at a time)

- Using Cos-Rubeinstein formula, it is evident that the Call Option price has positive dependence on S(0), and then using Put-Call Parity shows that the Put Option price has negative dependence on S(0).

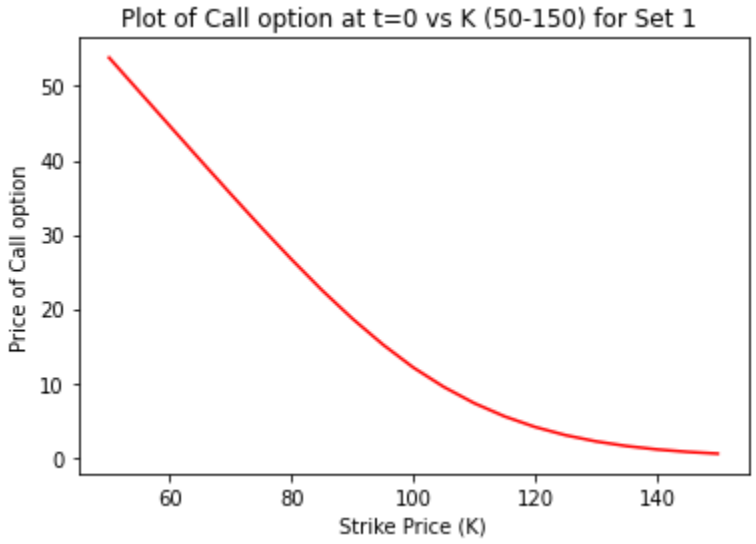


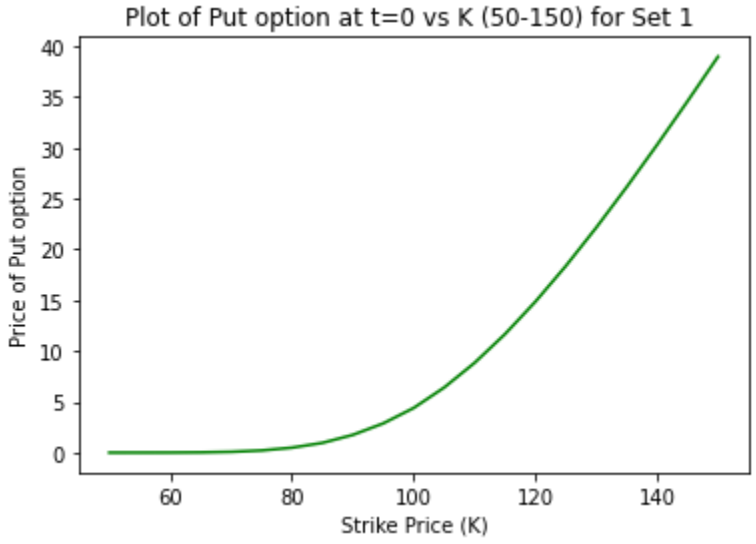


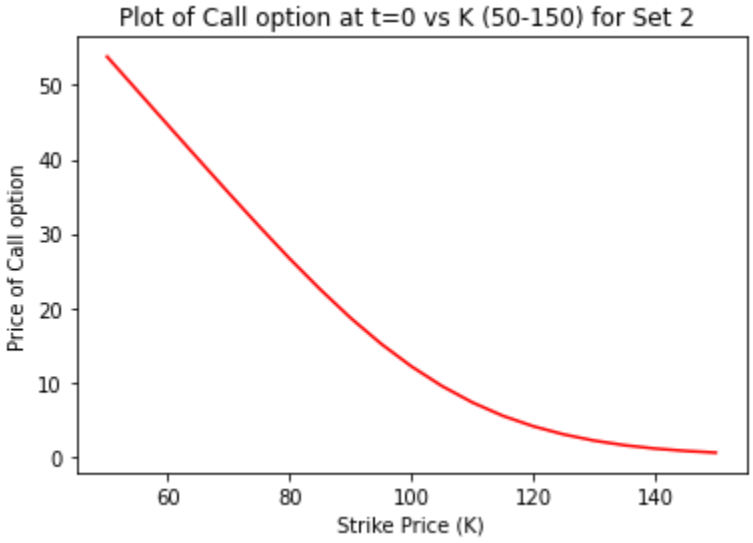

Plot of Call option at t=0 vs S(0) (50-150) for Set 2
Price of Call option
Stock Price at t = 0
0
10
20
30
40
50
60
60
80
100
120
140

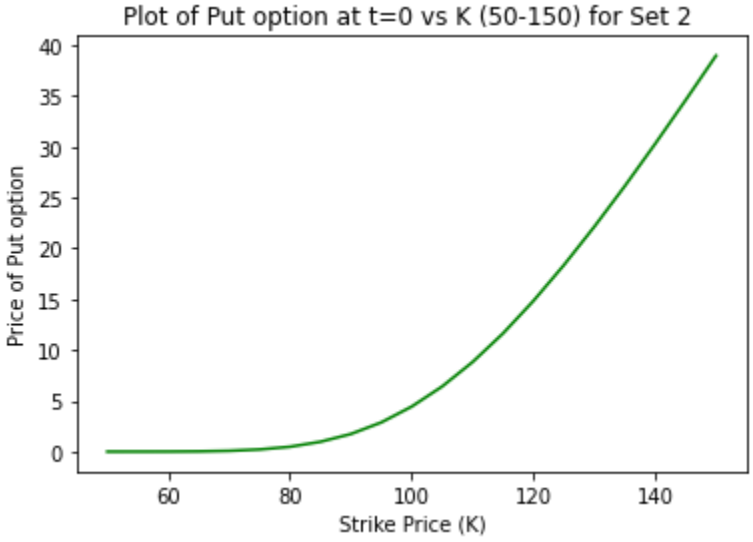

Plot of Put option at t=0 vs S(0) (50-150) for Set 2
Price of Put option
Stock Price at t = 0
0
10
20
30
40
60
80
100
120
140

- Using Cos-Rubeinstein formula, it is evident that the Call Option price has negative dependence on K, and then using Put-Call Parity shows that the Put Option price has positive dependence on K.

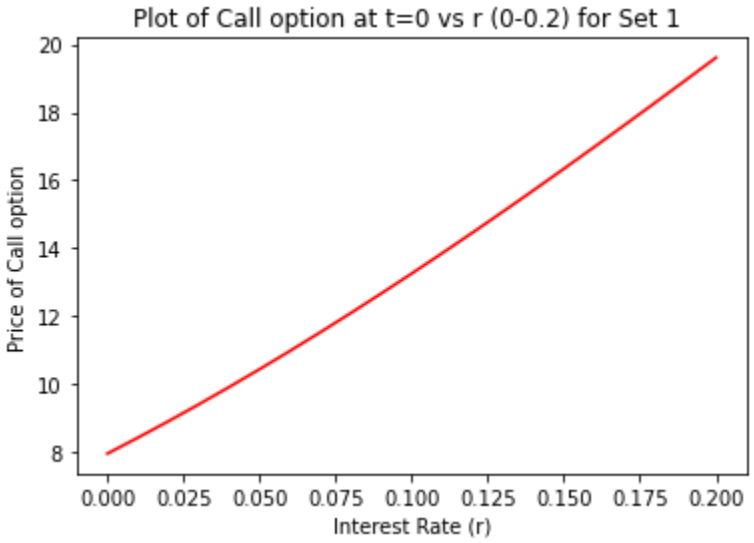


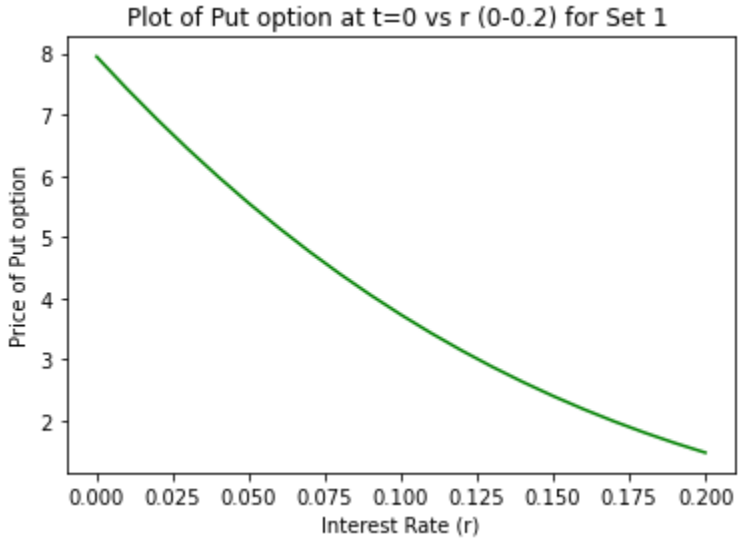


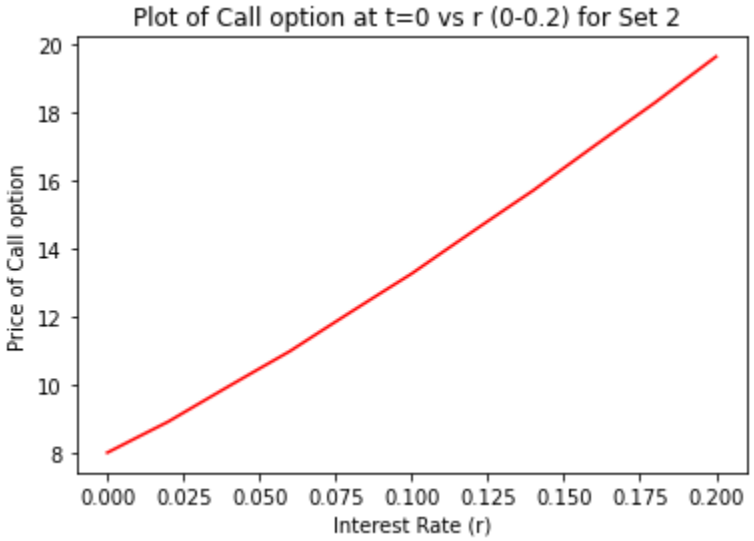

Plot of Call option at t=0 vs K (50-150) for Set 2
Price of Call option
Strike Price (K)
0
10
20
30
40
50
60
80
100
120
140

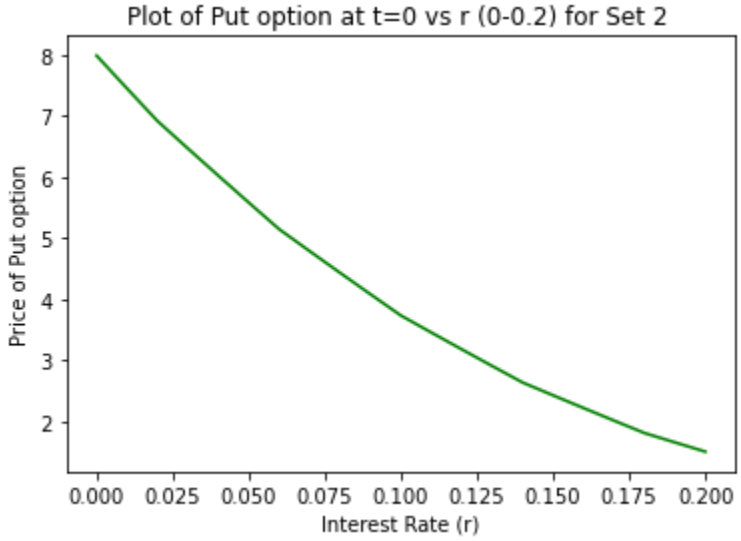

Plot of Put option at t=0 vs K (50-150) for Set 2
Price of Put option
Strike Price (K)
0
5
10
15
20
25
30
35
40
60
80
100
120
140

- Using Cos-Rubeinstein formula, it is evident that the Call Option price has positive dependence on r, and then using Put-Call Parity shows that the Put Option price has negative dependence on r.

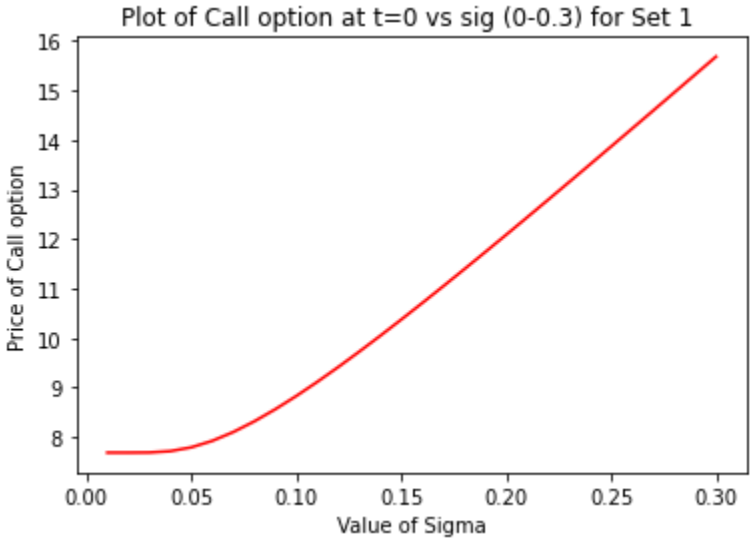


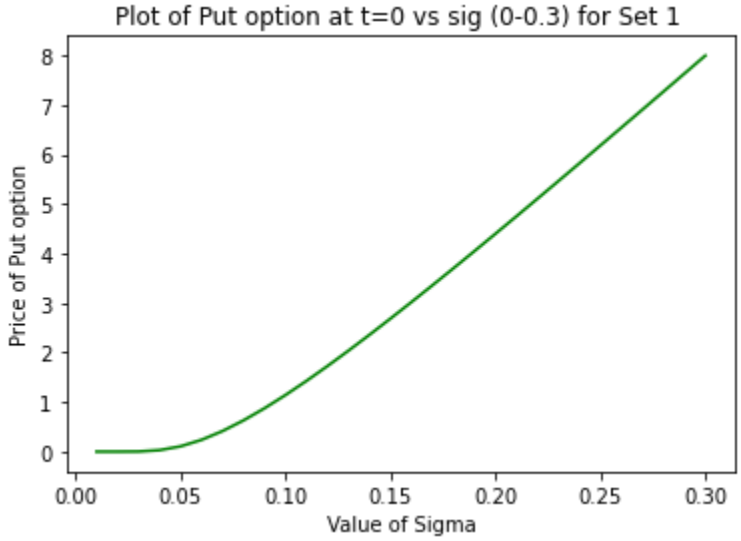


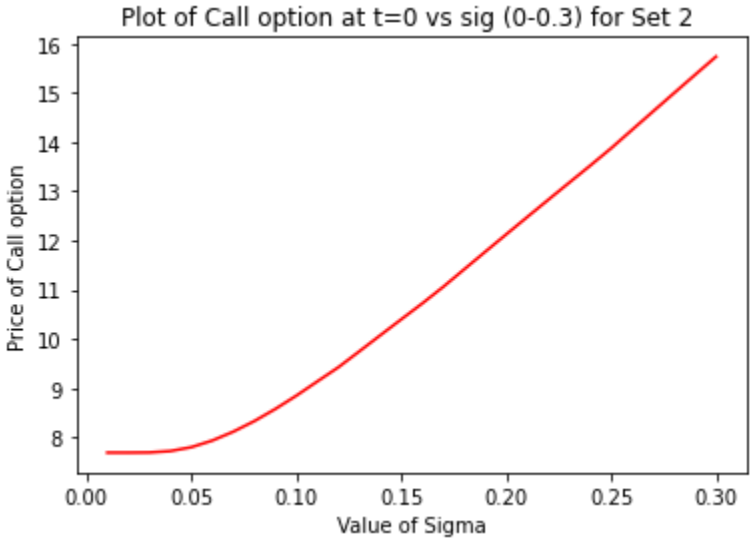

Plot of Call option at t=0 vs r (0-0.2) for Set 2
Price of Call option
Interest Rate (r)
20
18
16
14
12
10
8
0.000
0.025
0.050
0.075
0.100
0.125
0.150
0.175
0.200

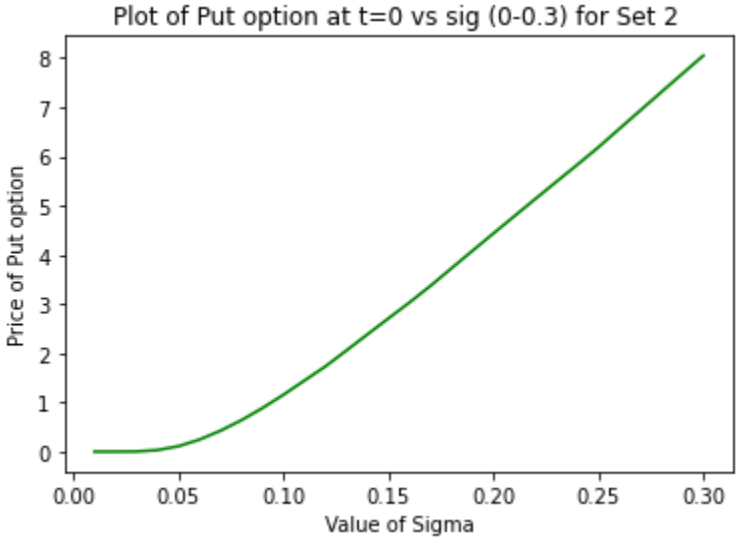

Plot of Put option at t=0 vs r (0-0.2) for Set 2
Price of Put option
Interest Rate (r)
8
7
6
5
4
3
2
0.000
0.025
0.050
0.075
0.100
0.125
0.150
0.175
0.200

- Call Option price and Put Option has positive dependence on sigma

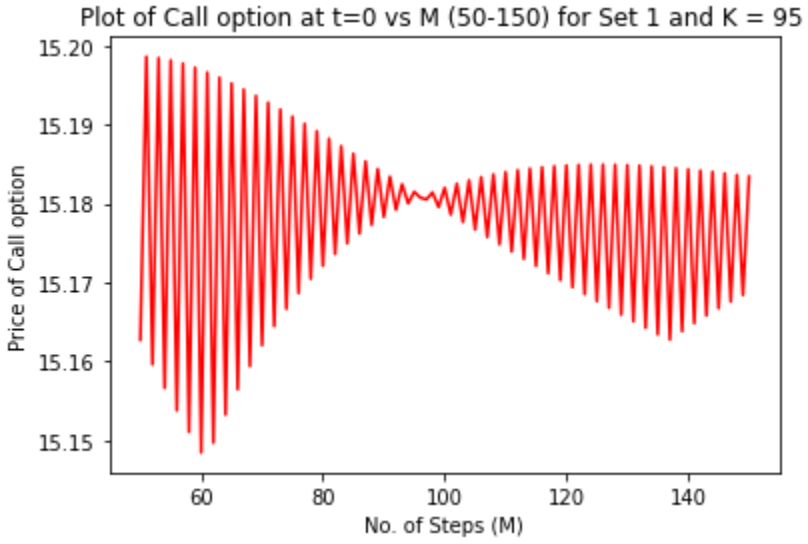


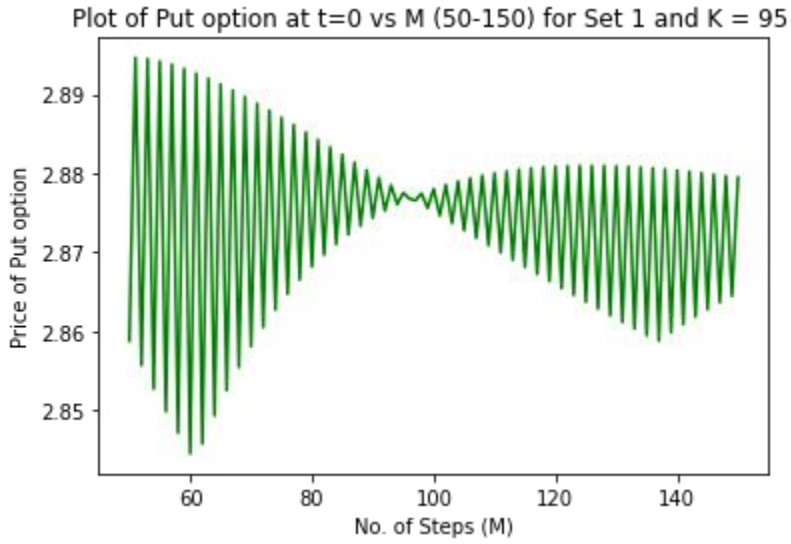



Plot of Call option at t=0 vs sig (0-0.3) for Set 2
Price of Call option
Value of Sigma
16
15
14
13
12
11
10
9
8
0.00
0.05
0.10
0.15
0.20
0.25
0.30

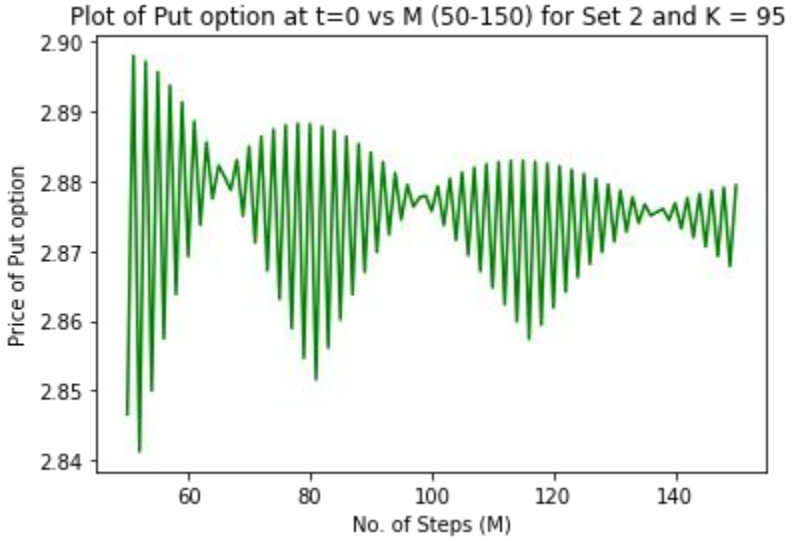

Plot of Put option at t=0 vs sig (0-0.3) for Set 2
Price of Put option
Value of Sigma
8
7
6
5
4
3
2
1
0
0.00
0.05
0.10
0.15
0.20
0.25
0.30

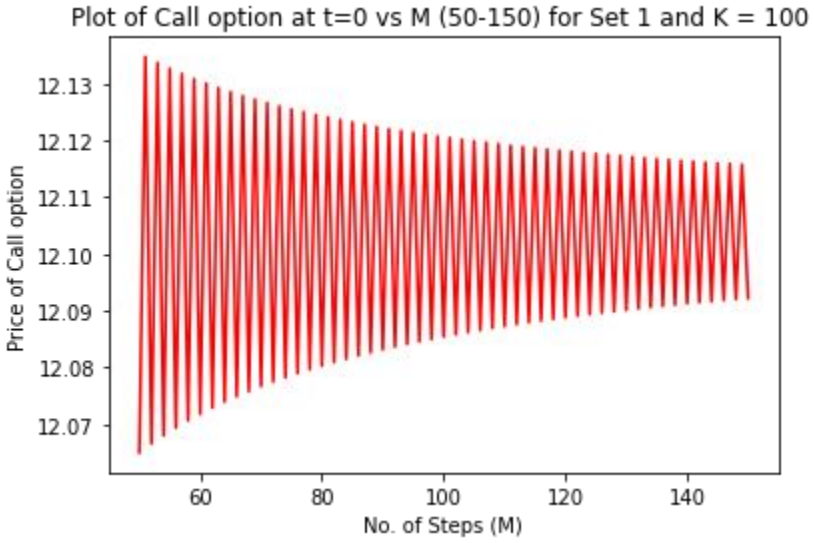
- Call Option price and Put Option price fluctuates as M ranges

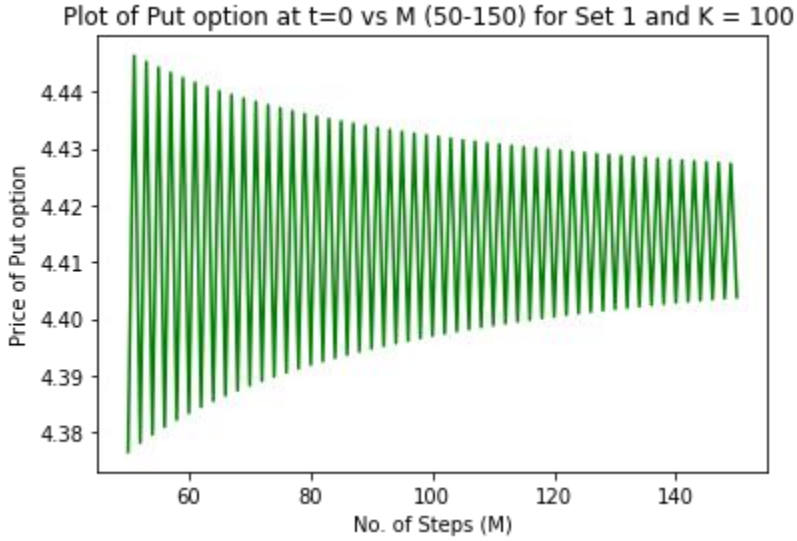


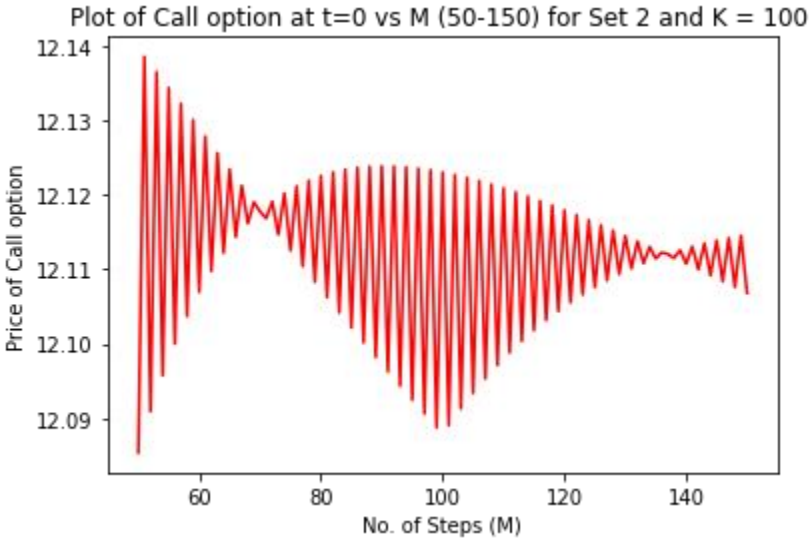


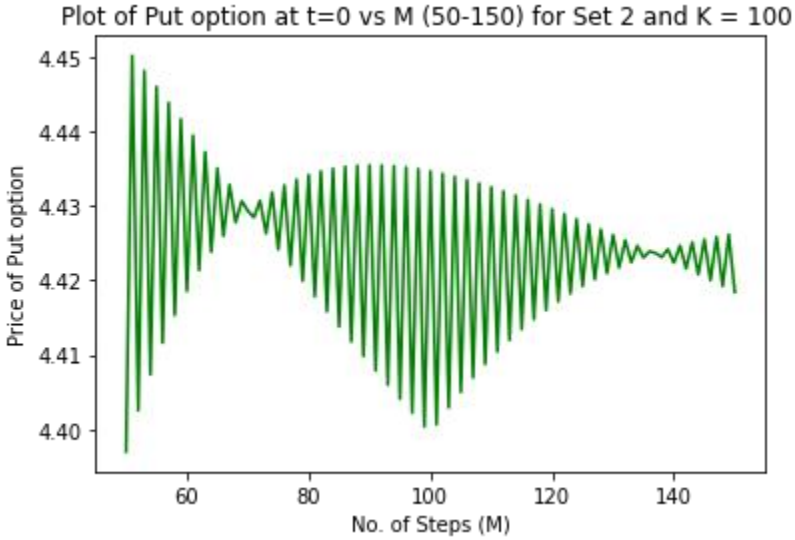

Plot of Call option at t=0 vs M (50-150) for Set 2 and K = 95
Price of Call option
15.20
15.19
15.18
15.17
15.16
15.15
60
80
100
120
140
No. of Steps (M)

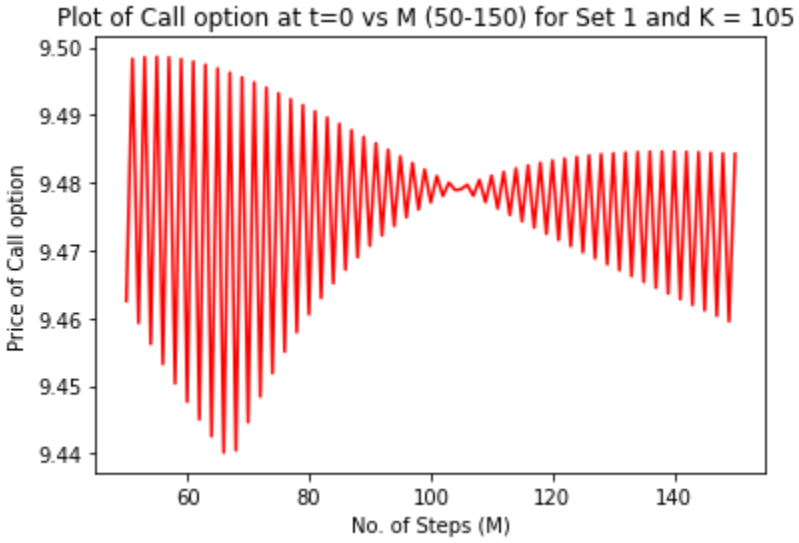

Plot of Put option at t=0 vs M (50-150) for Set 2 and K = 95
Price of Put option
2.90
2.89
2.88
2.87
2.86
2.85
2.84
60
80
100
120
140
No. of Steps (M)

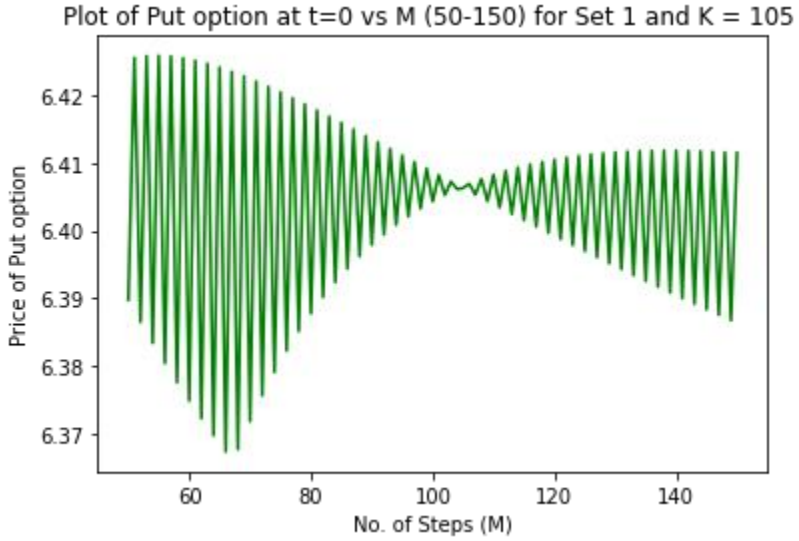

Plot of Call option at t=0 vs M (50-150) for Set 1 and K = 100
Price of Call option
12.13
12.12
12.11
12.10
12.09
12.08
12.07
60
80
100
120
140
No. of Steps (M)

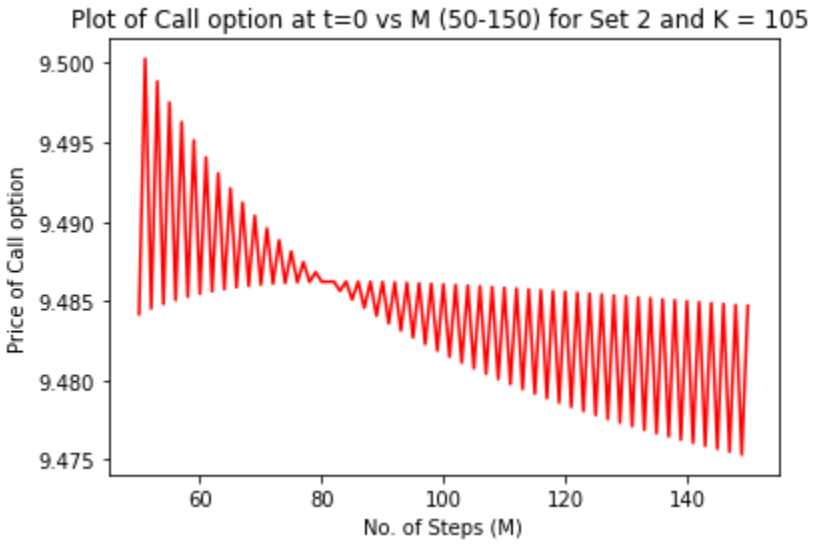

Plot of Put option at t=0 vs M (50-150) for Set 1 and K = 100
Price of Put option
4.44
4.43
4.42
4.41
4.40
4.39
4.38
60
80
100
120
140
No. of Steps (M)

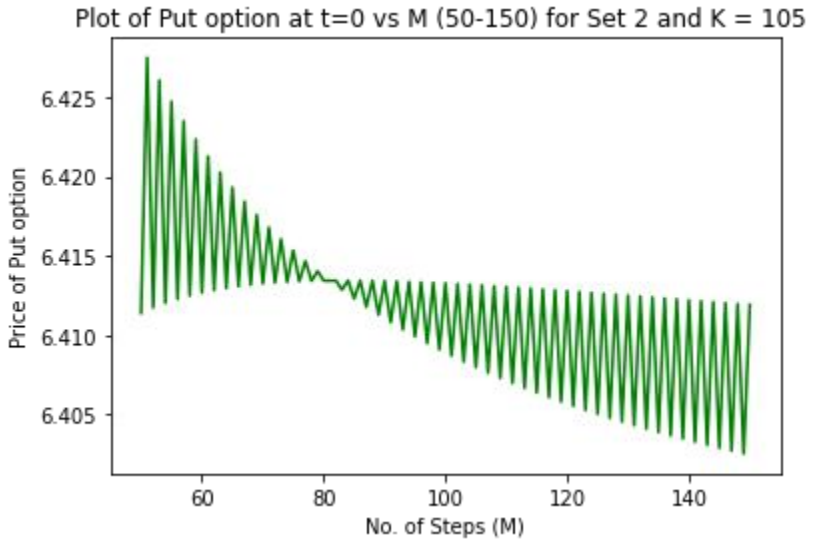

Plot of Call option at t=0 vs M (50-150) for Set 2 and K = 100
Price of Call option
12.14
12.13
12.12
12.11
12.10
12.09
60
80
100
120
140
No. of Steps (M)


Plot of Put option at t=0 vs M (50-150) for Set 2 and K = 100
Price of Put option
4.45
4.44
4.43
4.42
4.41
4.40
60
80
100
120
140
No. of Steps (M)

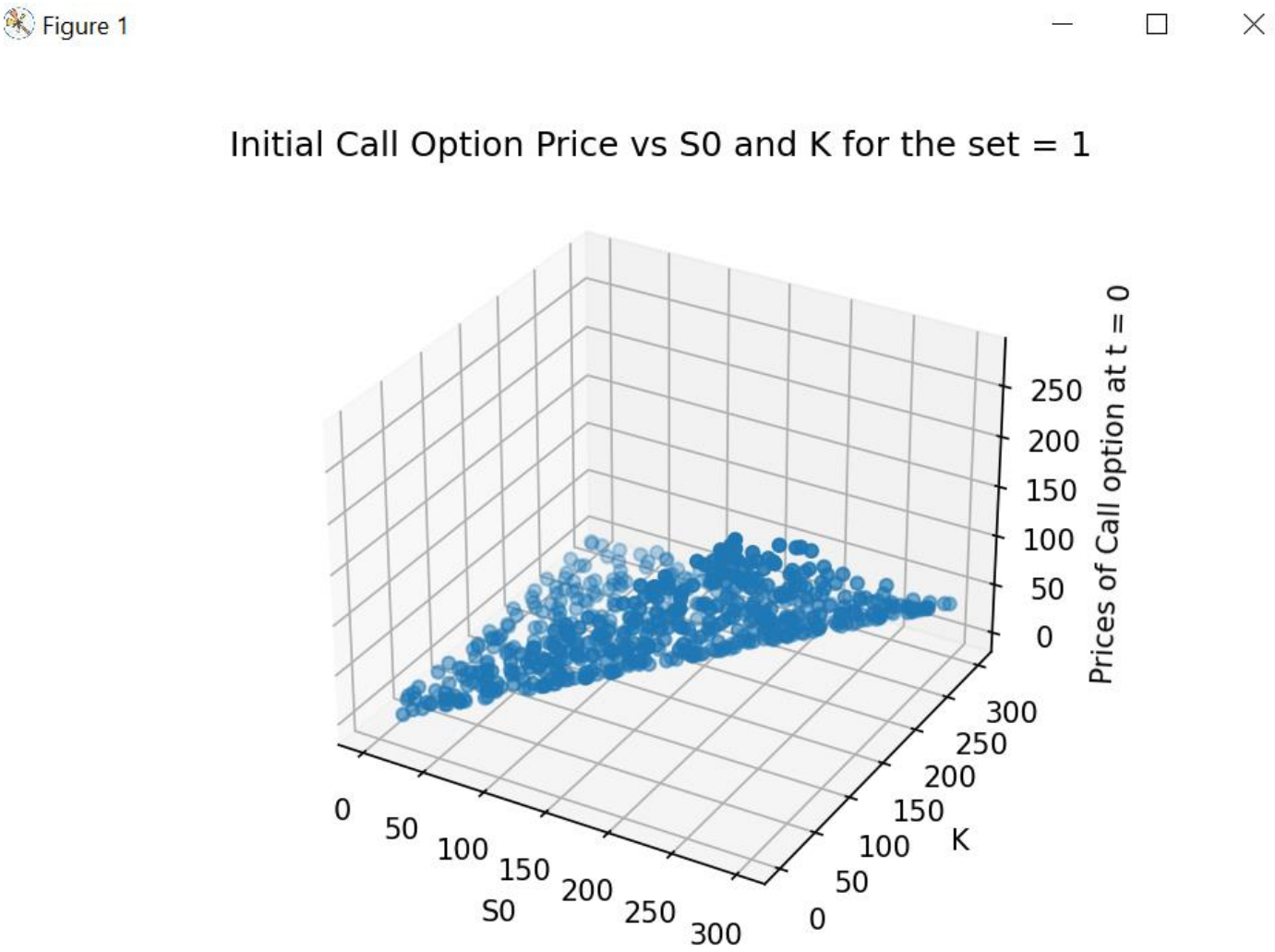

Plot of Call option at t=0 vs M (50-150) for Set 1 and K = 105
Price of Call option
9.50
9.49
9.48
9.47
9.46
9.45
9.44
60
80
100
120
140
No. of Steps (M)

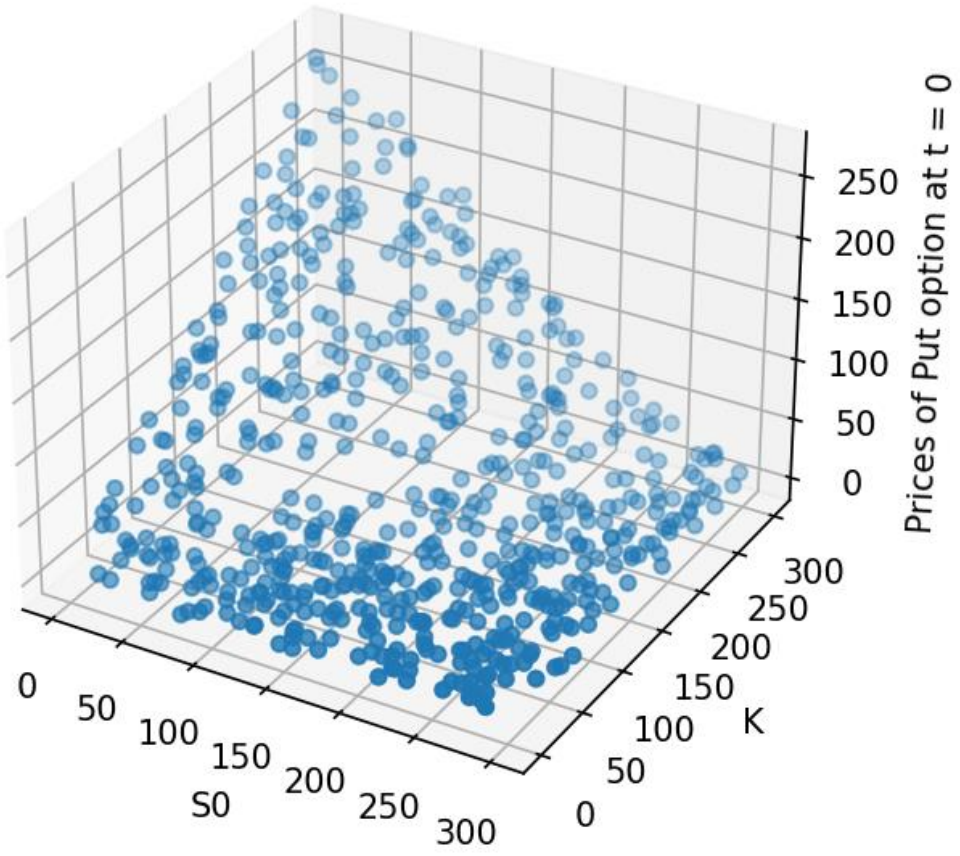

Plot of Put option at t=0 vs M (50-150) for Set 1 and K = 105
Price of Put option
6.42
6.41
6.40
6.39
6.38
6.37
60
80
100
120
140
No. of Steps (M)

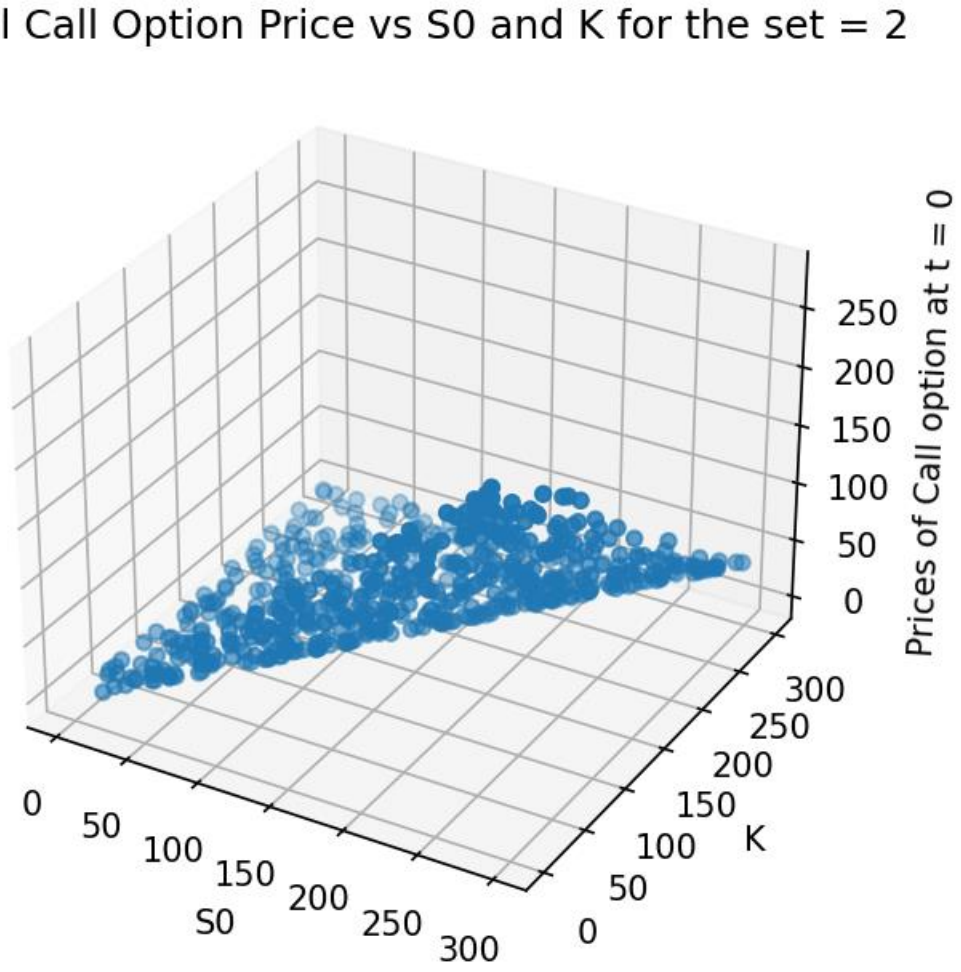

Plot of Call option at t=0 vs M (50-150) for Set 2 and K = 105
Price of Call option
9.500
9.495
9.490
9.485
9.480
9.475
60
80
100
120
140
No. of Steps (M)

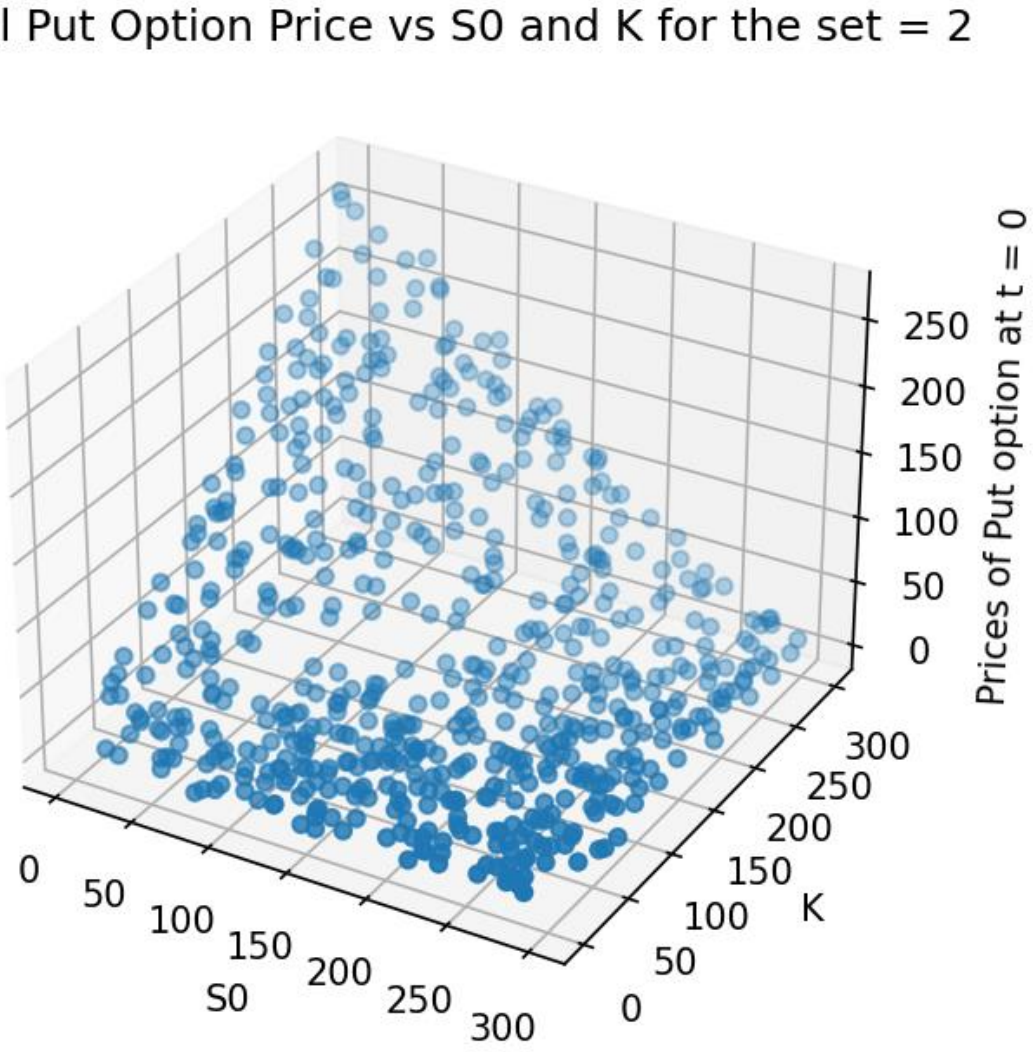

Plot of Put option at t=0 vs M (50-150) for Set 2 and K = 105
Price of Put option
6.425
6.420
6.415
6.410
6.405
60
80
100
120
140
No. of Steps (M)

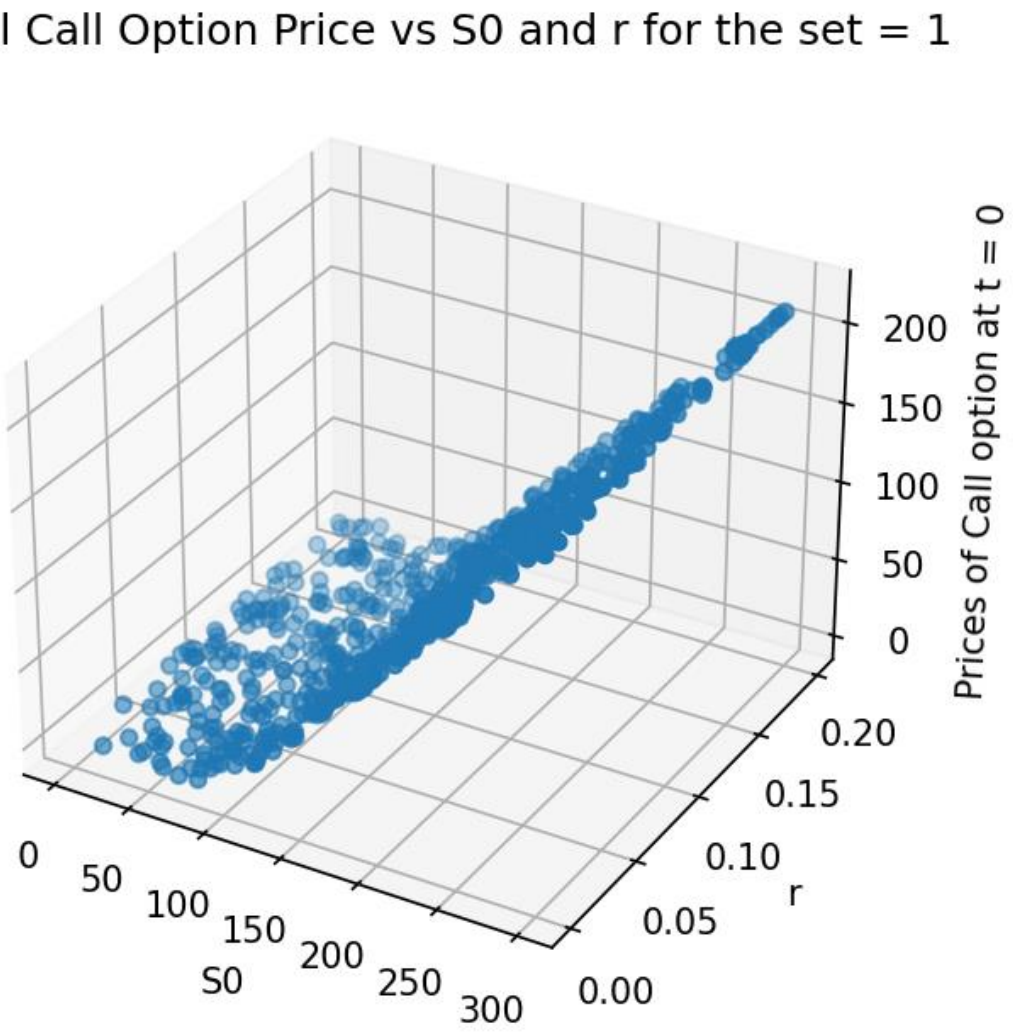
3D Plots (2 params at a time)

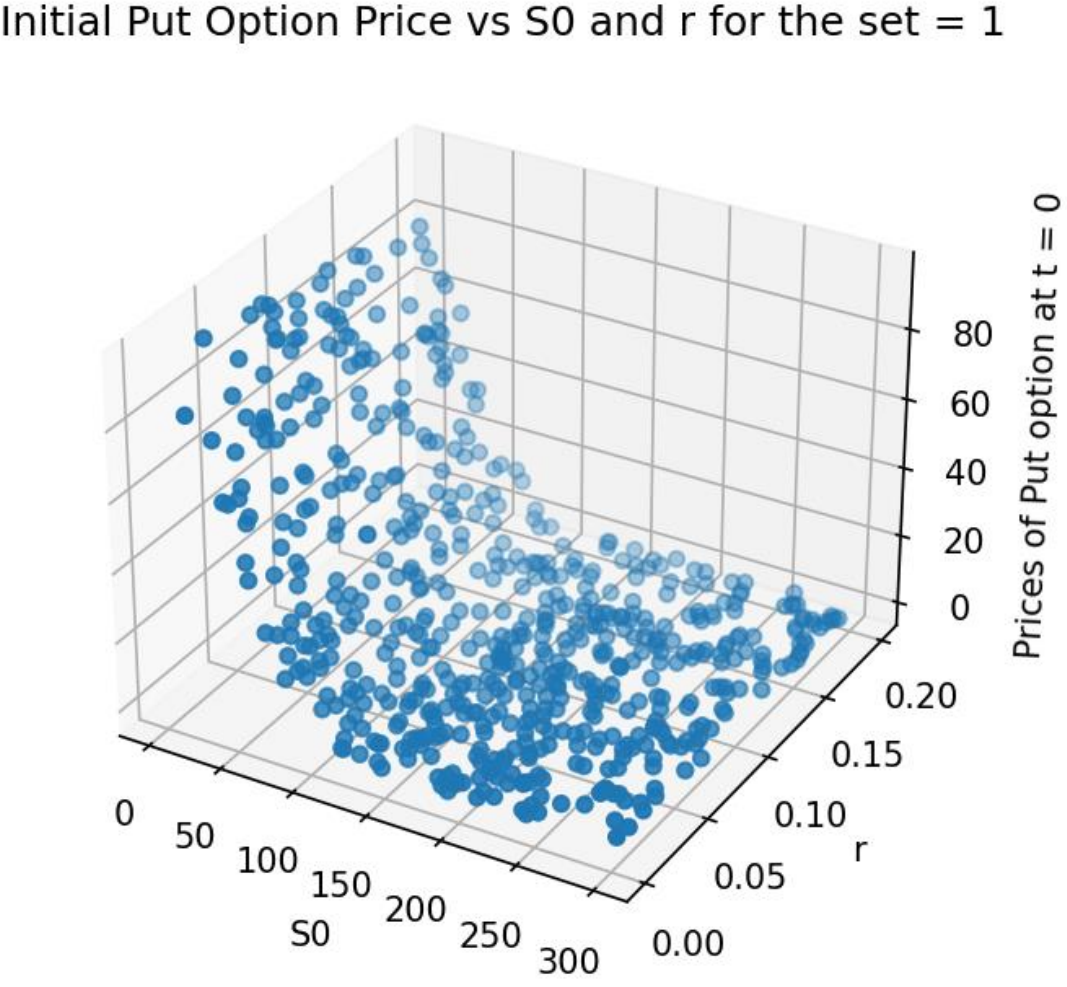


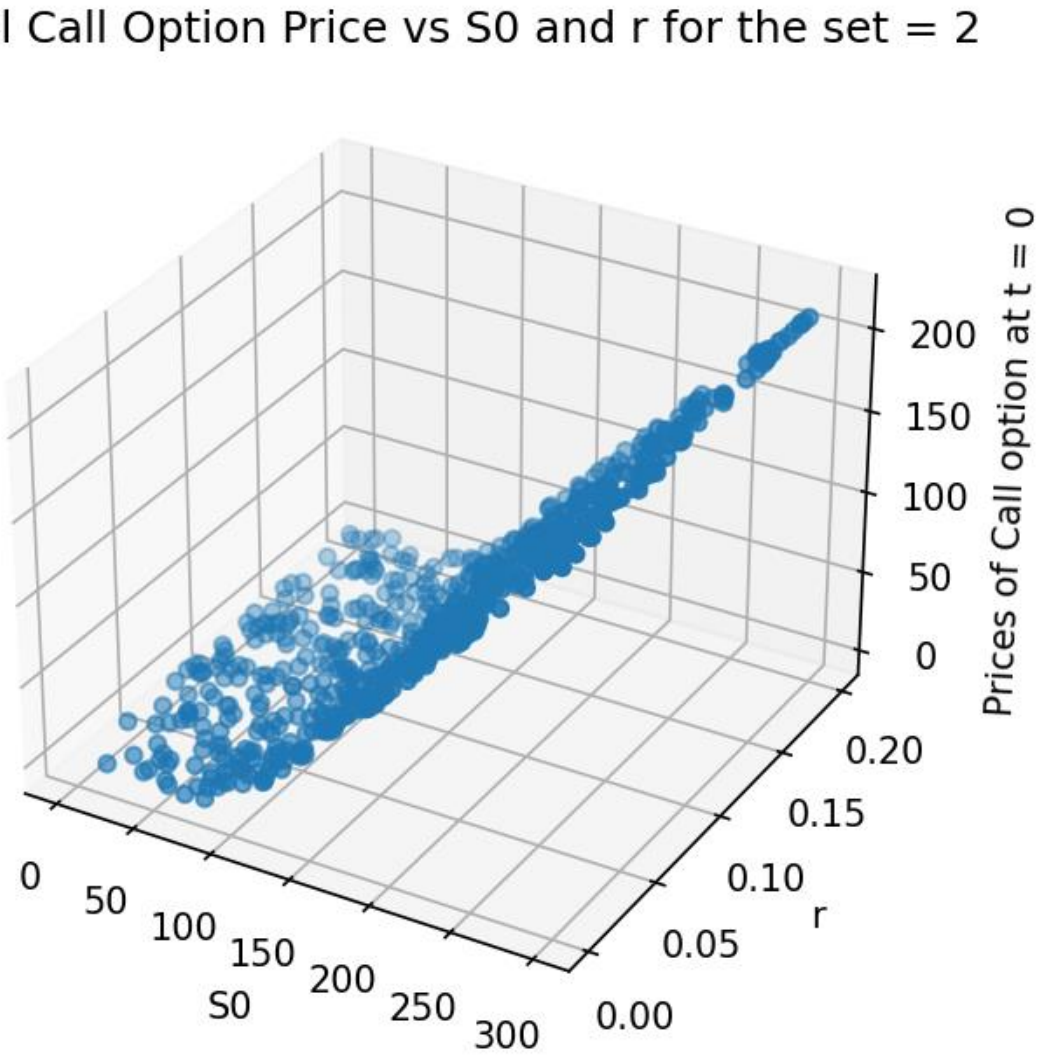

Initial Put Option Price vs S0 and K for the set = 1
Prices of Put option at t = 0
0
50
100
150
200
250
S0
0
50
100
150
200
250
300
K
0
50
100
150
200
250
300

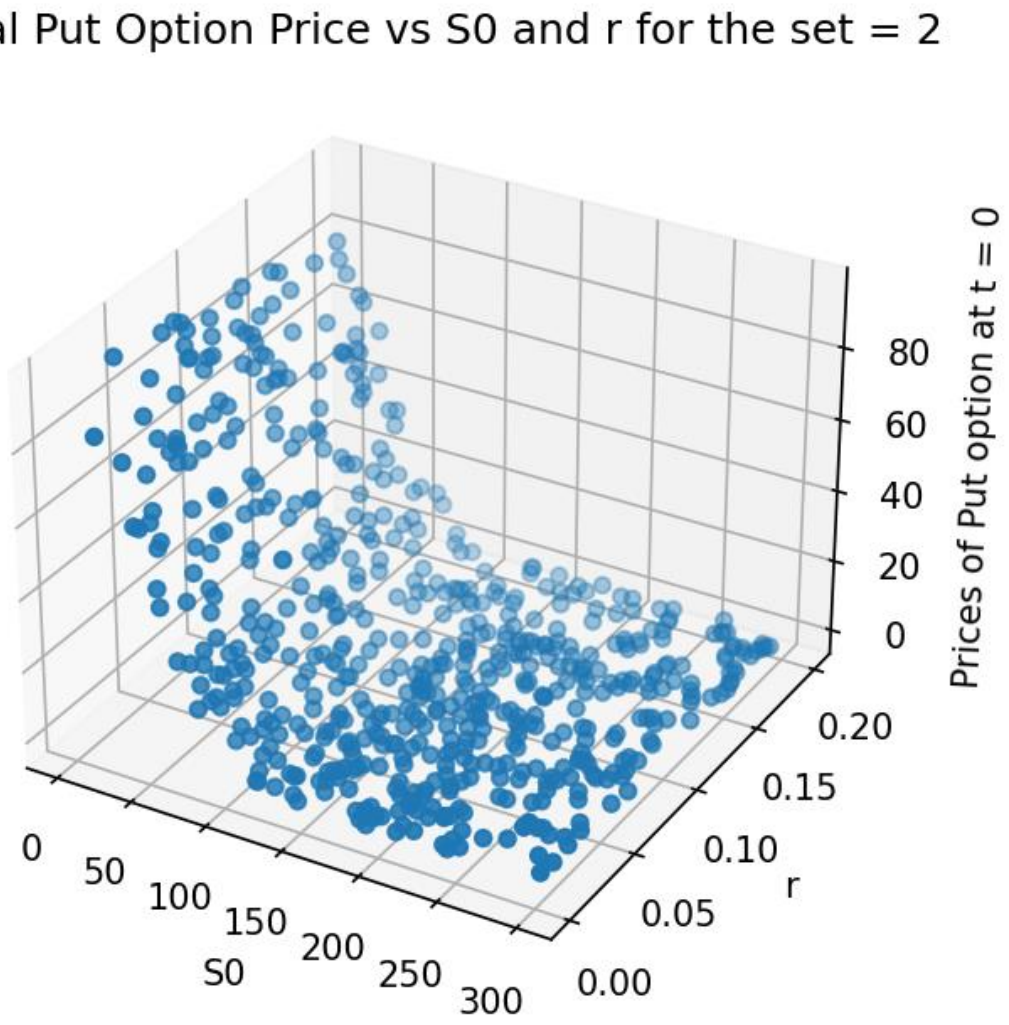

Initial Call Option Price vs S0 and K for the set = 2
Prices of Call option at t = 0
0
50
100
150
200
250
S0
0
50
100
150
200
250
300
K


Initial Put Option Price vs S0 and K for the set = 2
Prices of Put option at t = 0
0
50
100
150
200
250
S0
K
300

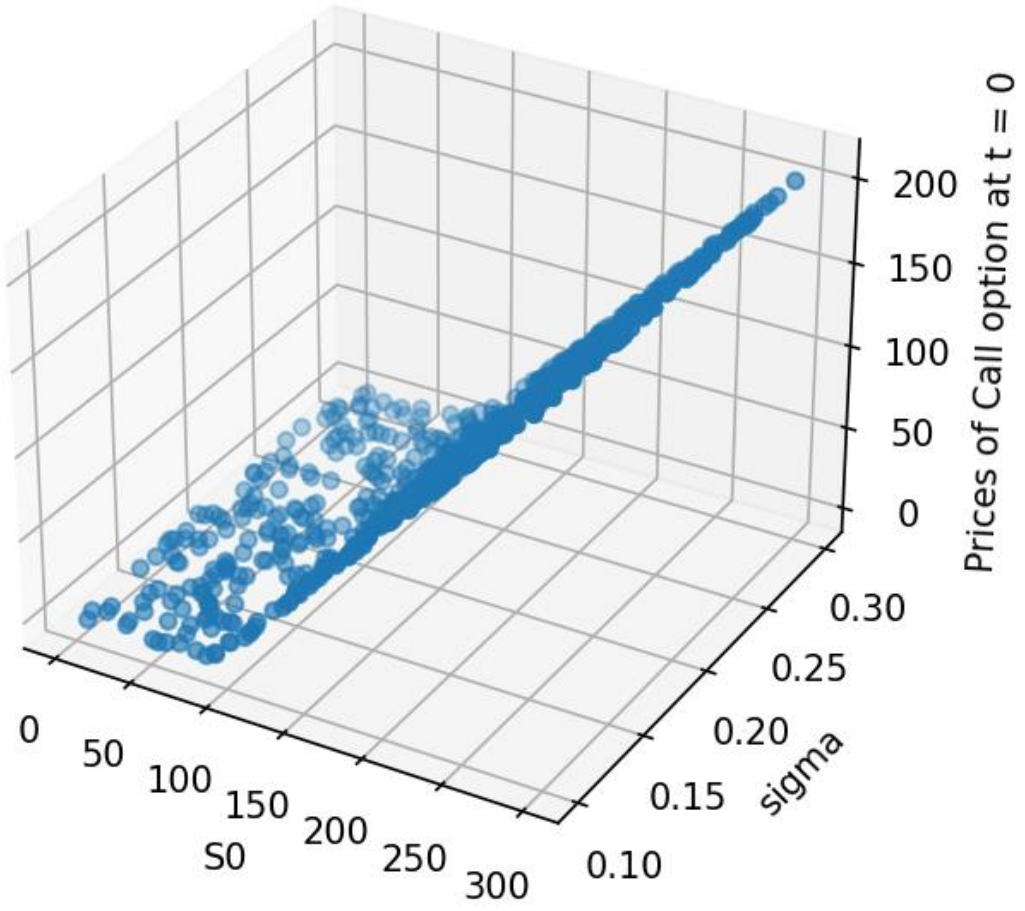

Initial Call Option Price vs S0 and r for the set = 1
Prices of Call option at t = 0
200
150
100
50
0
0.20
0.15
0.10
0.05
0.00
r
0
50
100
150
200
250
300
S0


Initial Put Option Price vs S0 and r for the set = 1
Prices of Put option at t = 0
80
60
40
20
0
0.20
0.15
0.10
0.05
0.00
r
0
50
100
150
200
250
300
S0

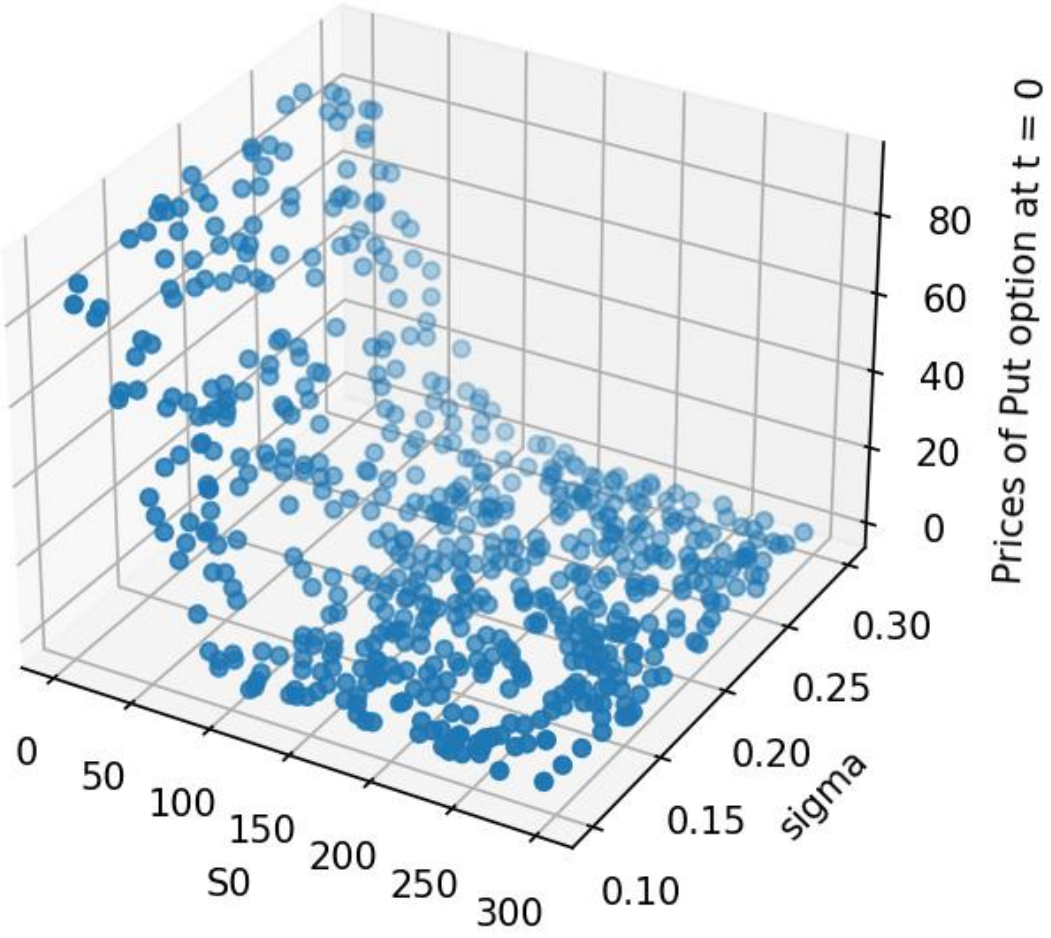

Initial Call Option Price vs S0 and r for the set = 2
Prices of Call option at t = 0
200
150
100
50
0
0.20
0.15
0.10
0.05
0.00
r
0
50
100
150
200
250
300
S0


Initial Put Option Price vs S0 and r for the set = 2
Prices of Put option at t = 0
80
60
40
20
0
0.20
0.15
0.10
0.05
0.00
r
0
50
100
150
200
250
300
S0

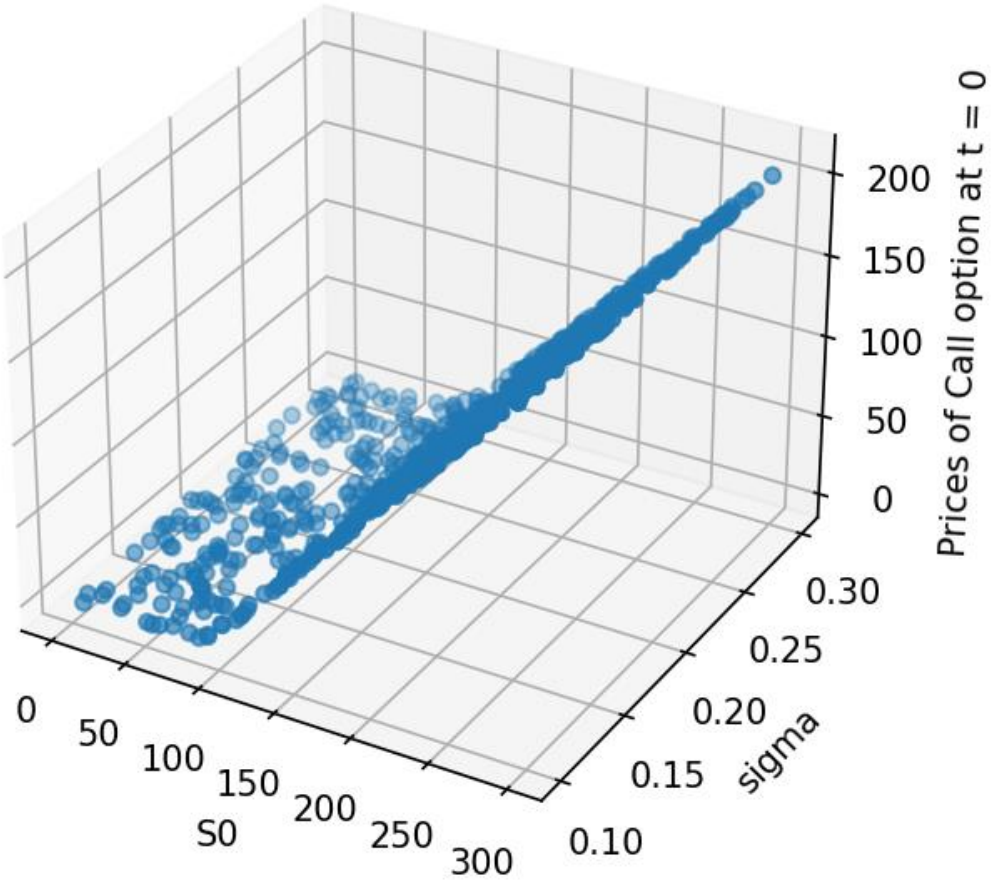
Initial Call Option Price vs S0 and sigma for the set = 1



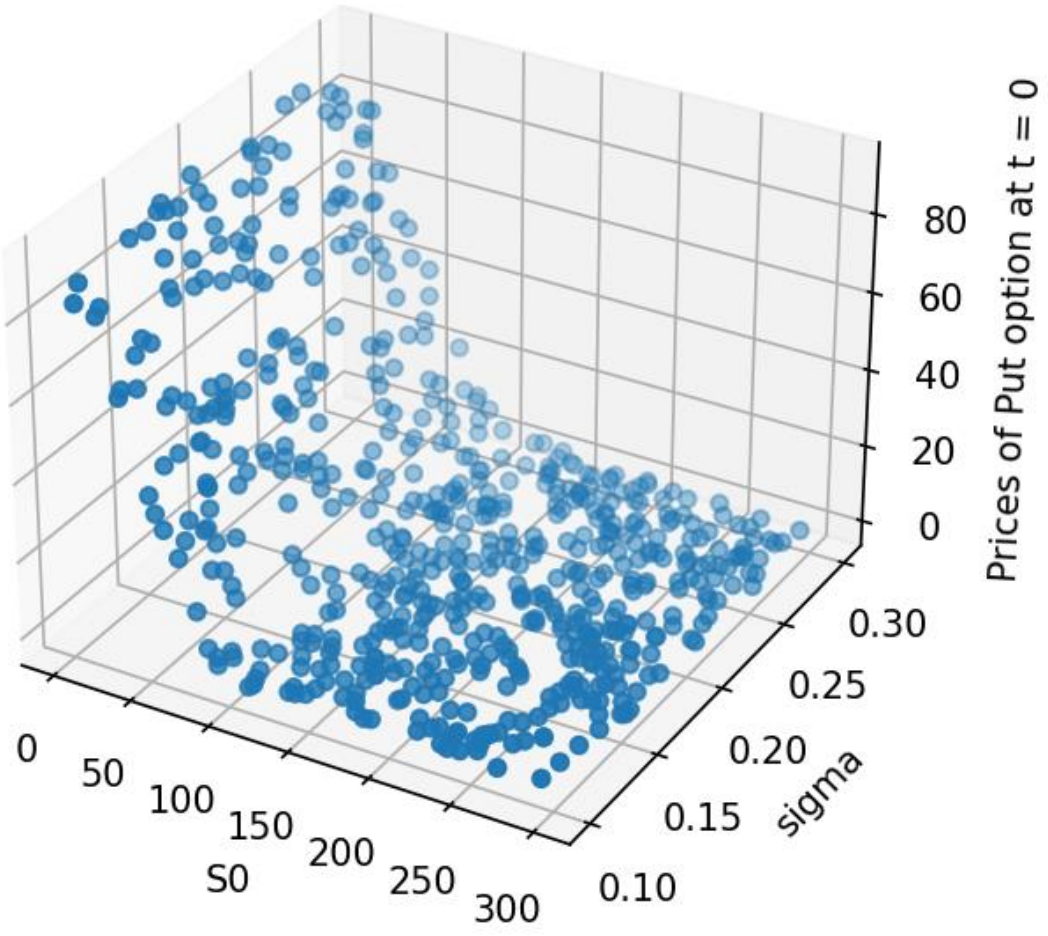
Initial Put Option Price vs S0 and sigma for the set = 1

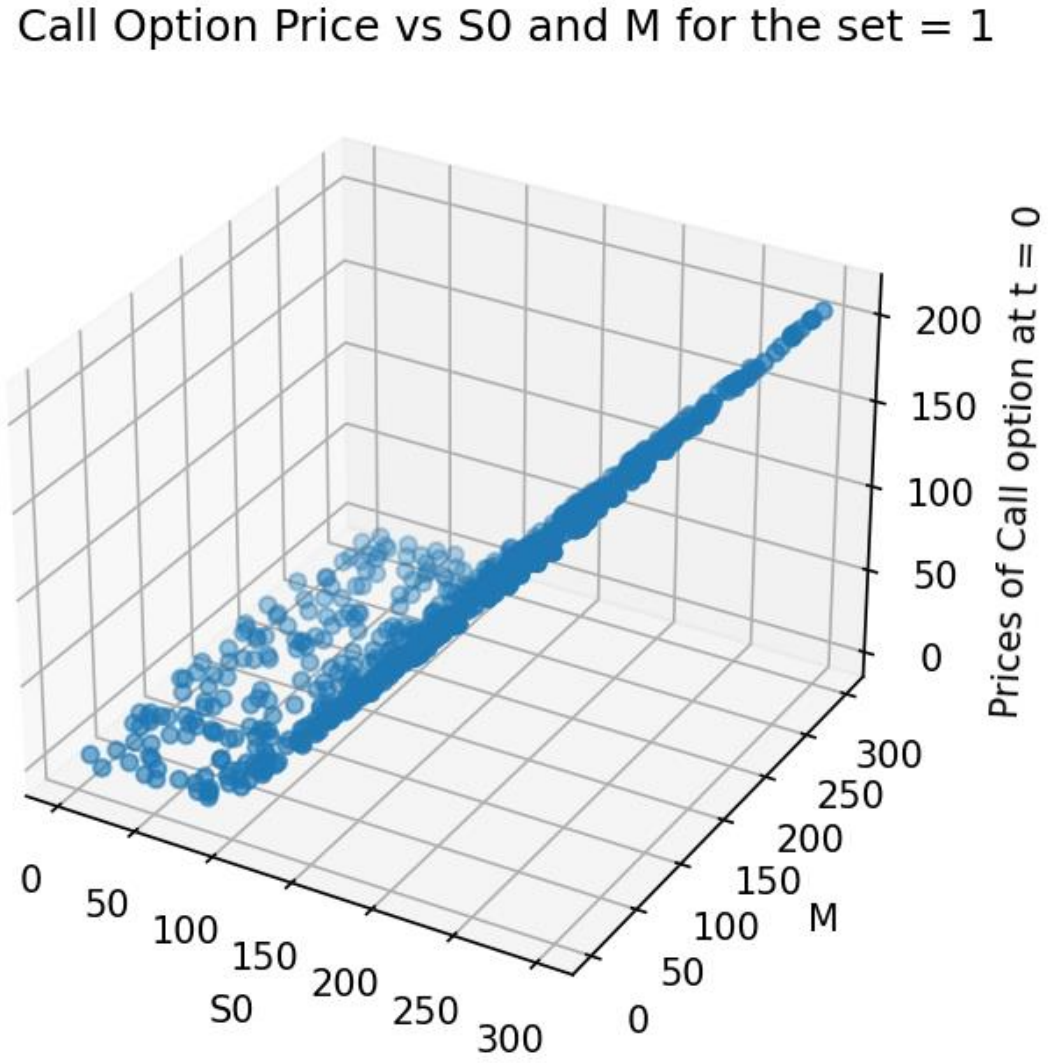


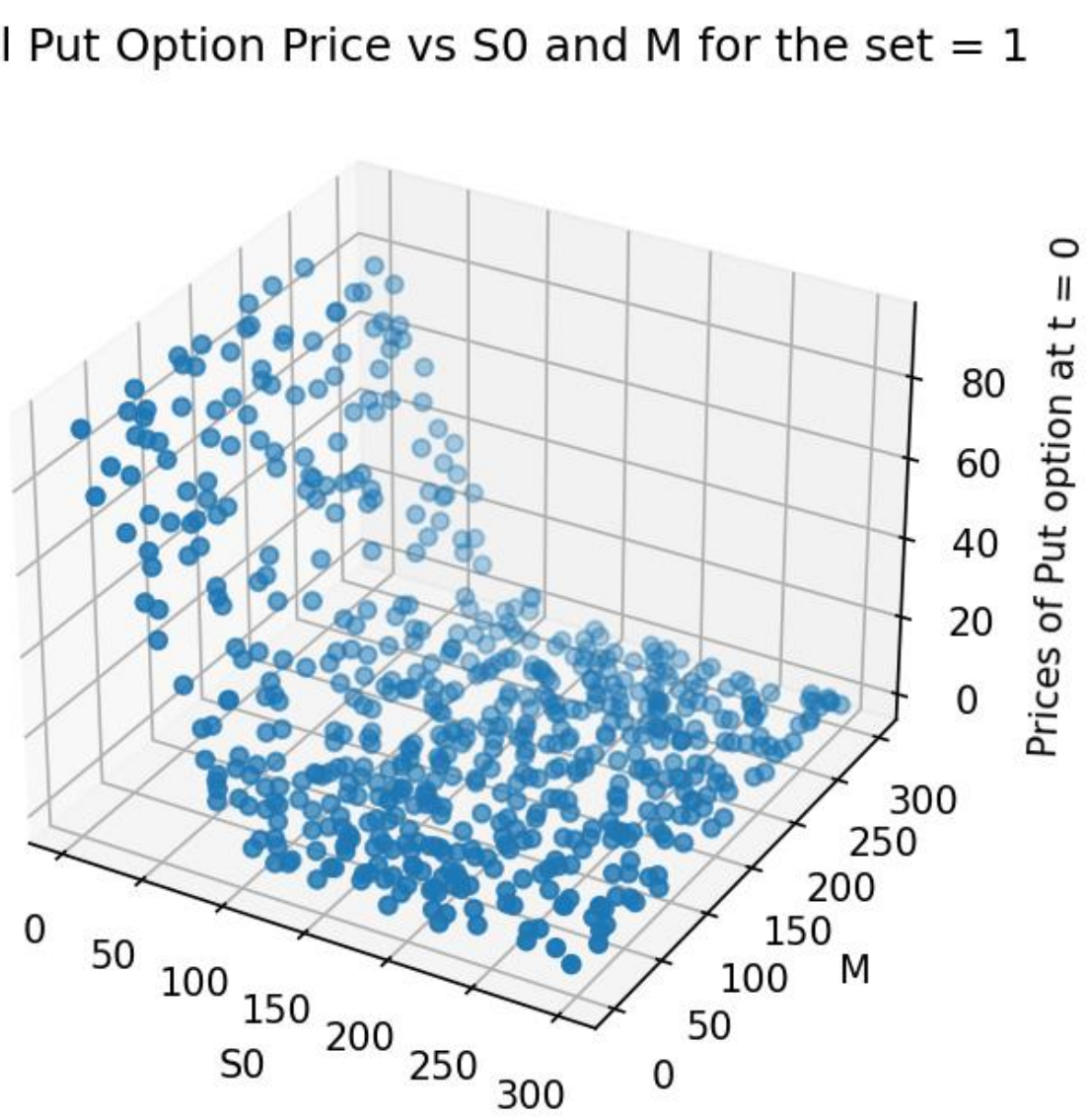
Initial Call Option Price vs S0 and sigma for the set = 2

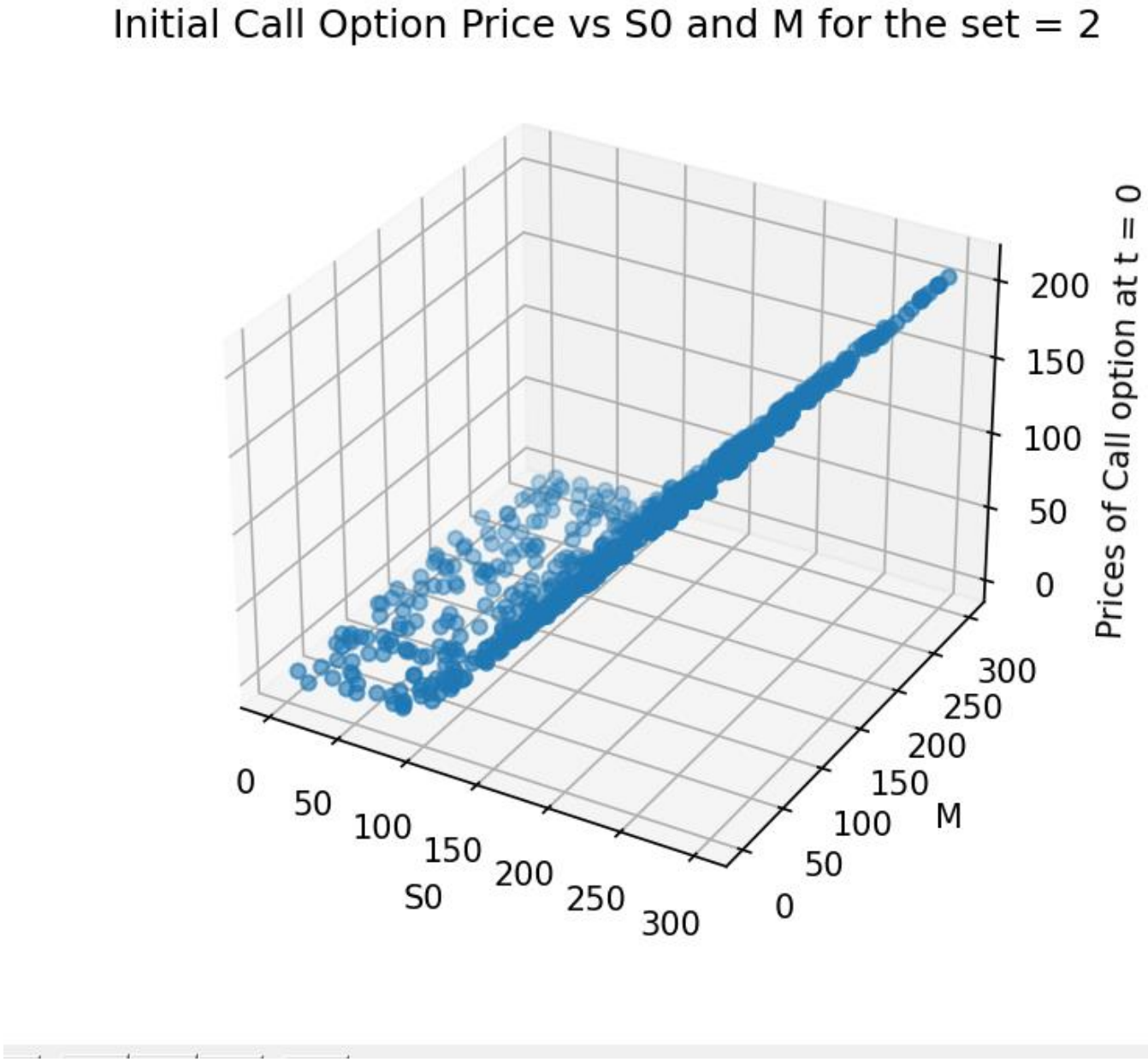


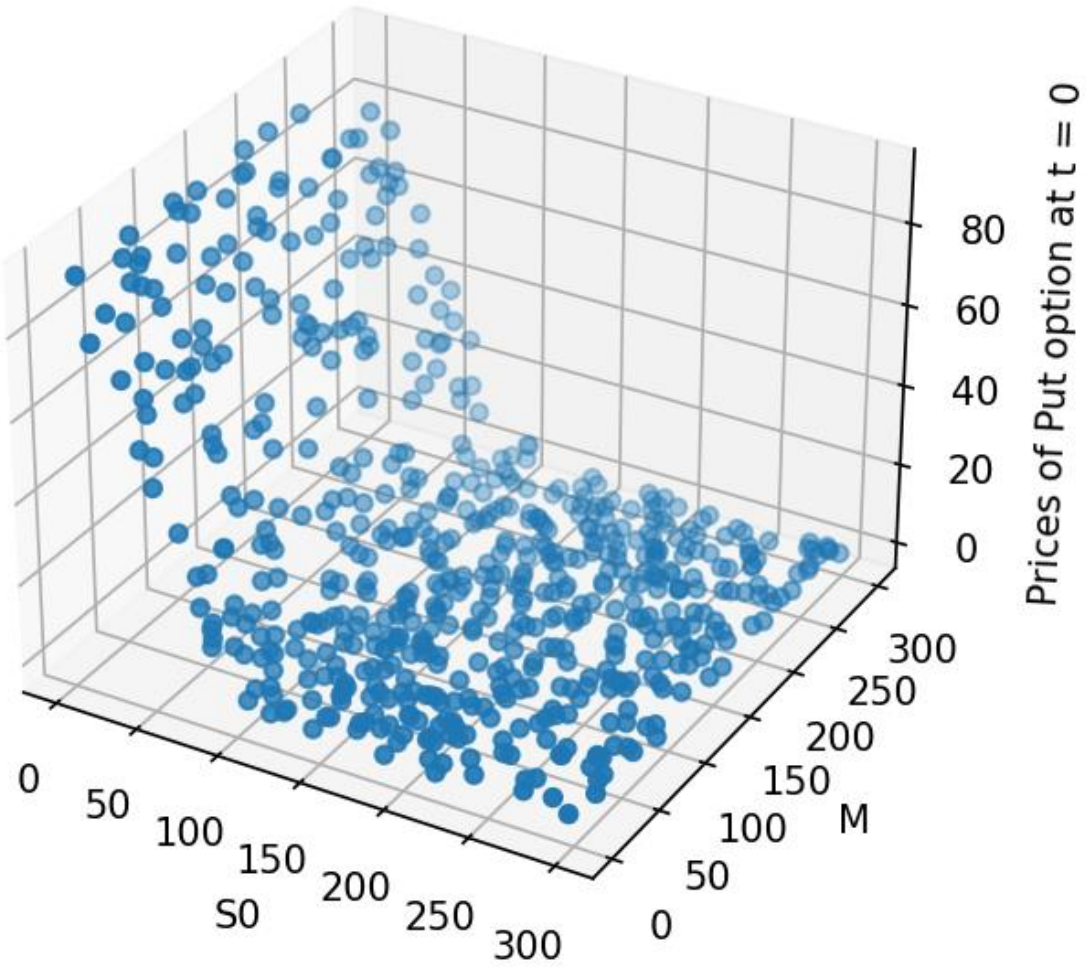
Initial Put Option Price vs S0 and sigma for the set = 2

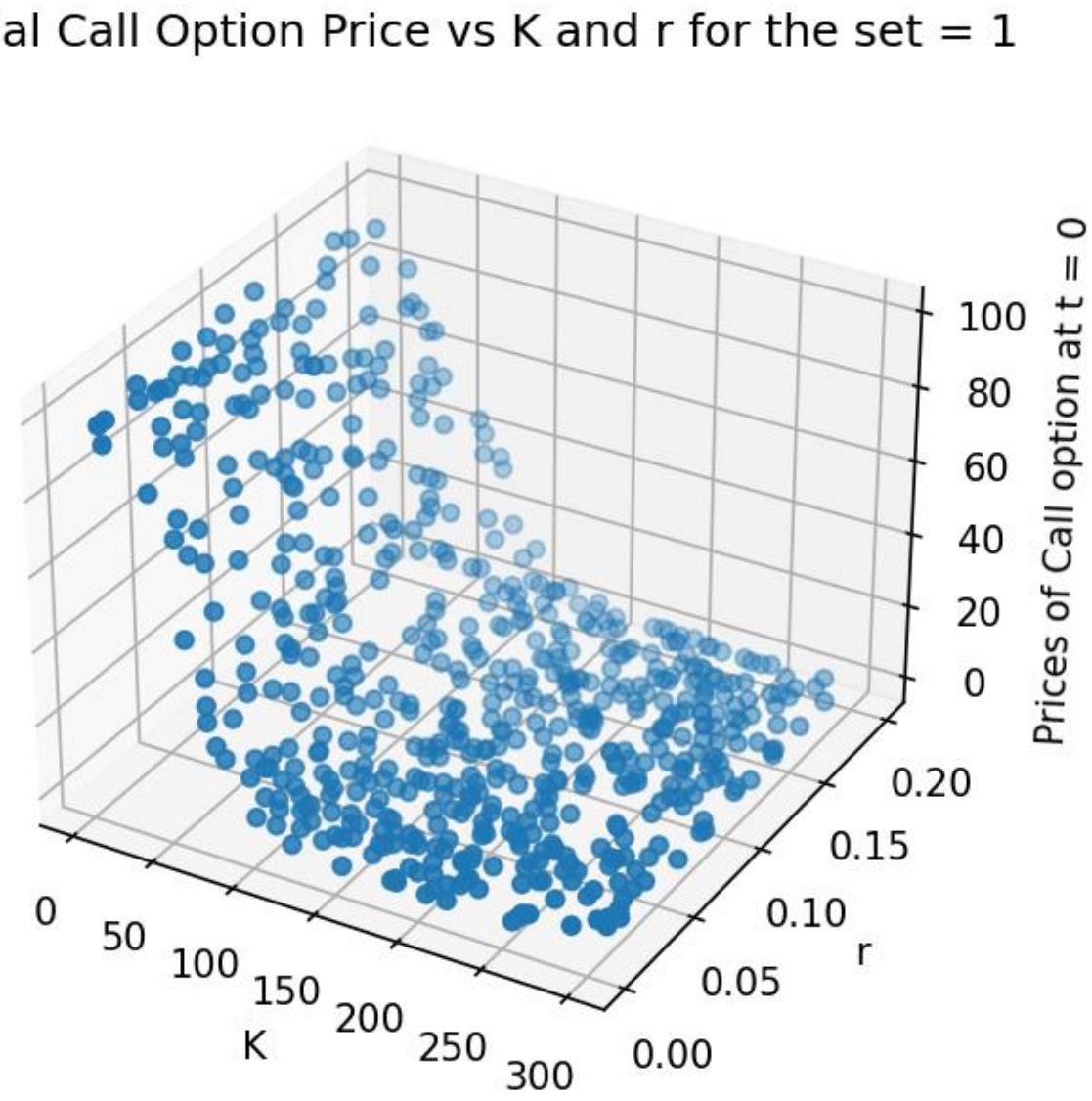


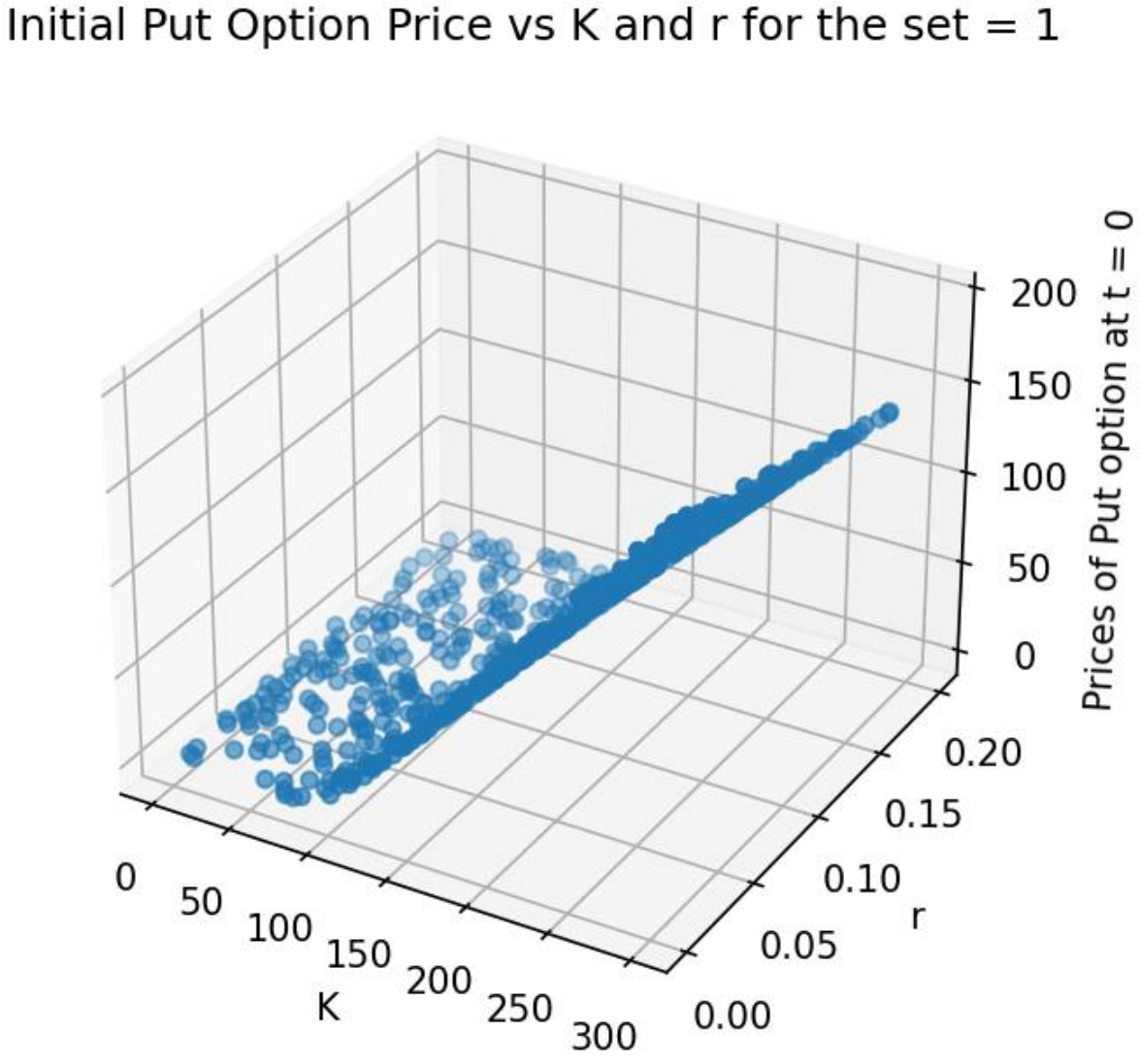

Initial Call Option Price vs S0 and M for the set = 1
Prices of Call option at t = 0
0
50
100
150
200
S0
0
50
100
150
200
250
300
M
0
50
100
150
200
Prices of Call option at t = 0
300
250
200
150
100
M
50
0
S0
0
50
100
150
200
250
300


Initial Put Option Price vs S0 and M for the set = 1
Prices of Put option at t = 0
0
20
40
60
80
S0
0
50
100
150
200
250
300
M
0
50
100
150
200
250
300

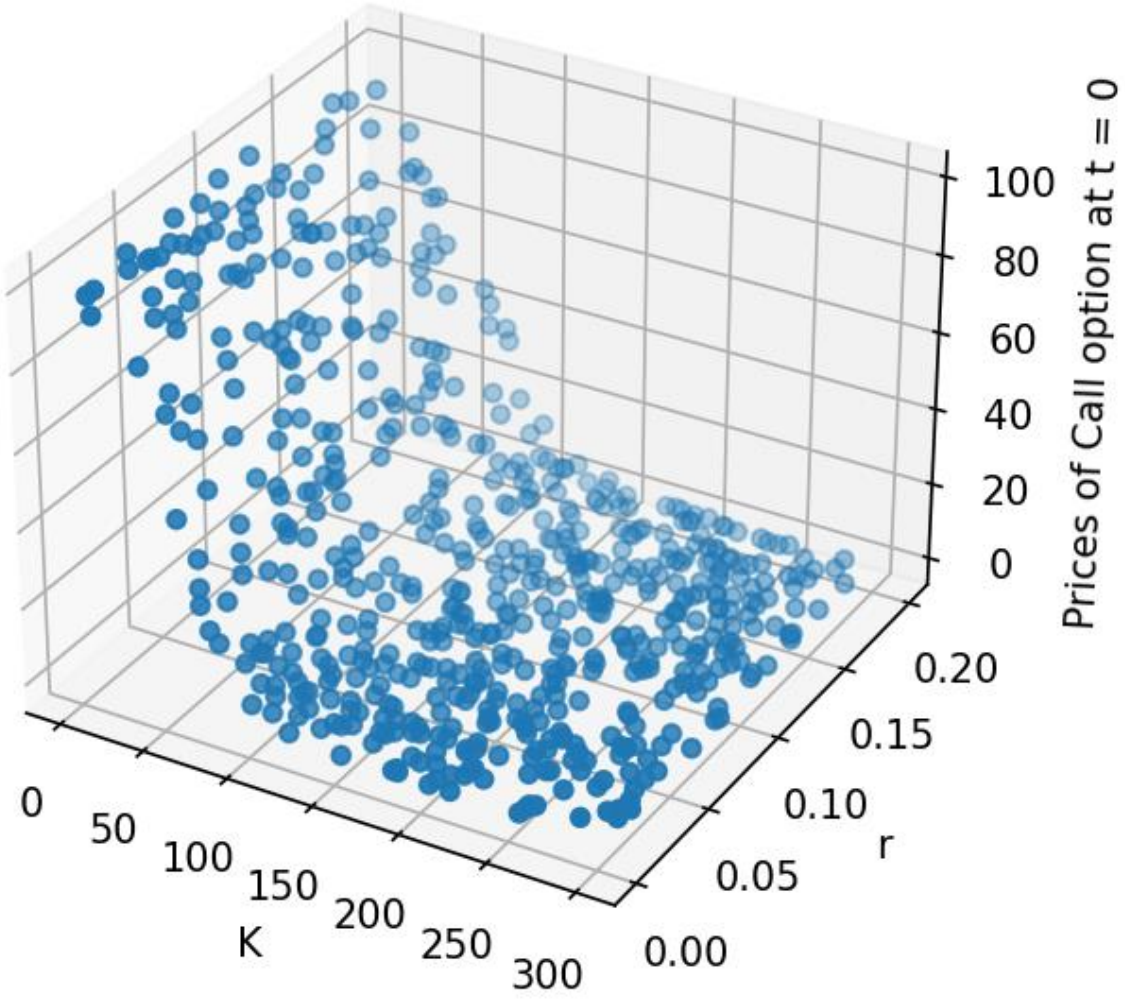

Initial Call Option Price vs S0 and M for the set = 2
Prices of Call option at t = 0
0
50
100
150
200
S0
0
50
100
150
200
250
300
M
0
50
100
150
200
250
300

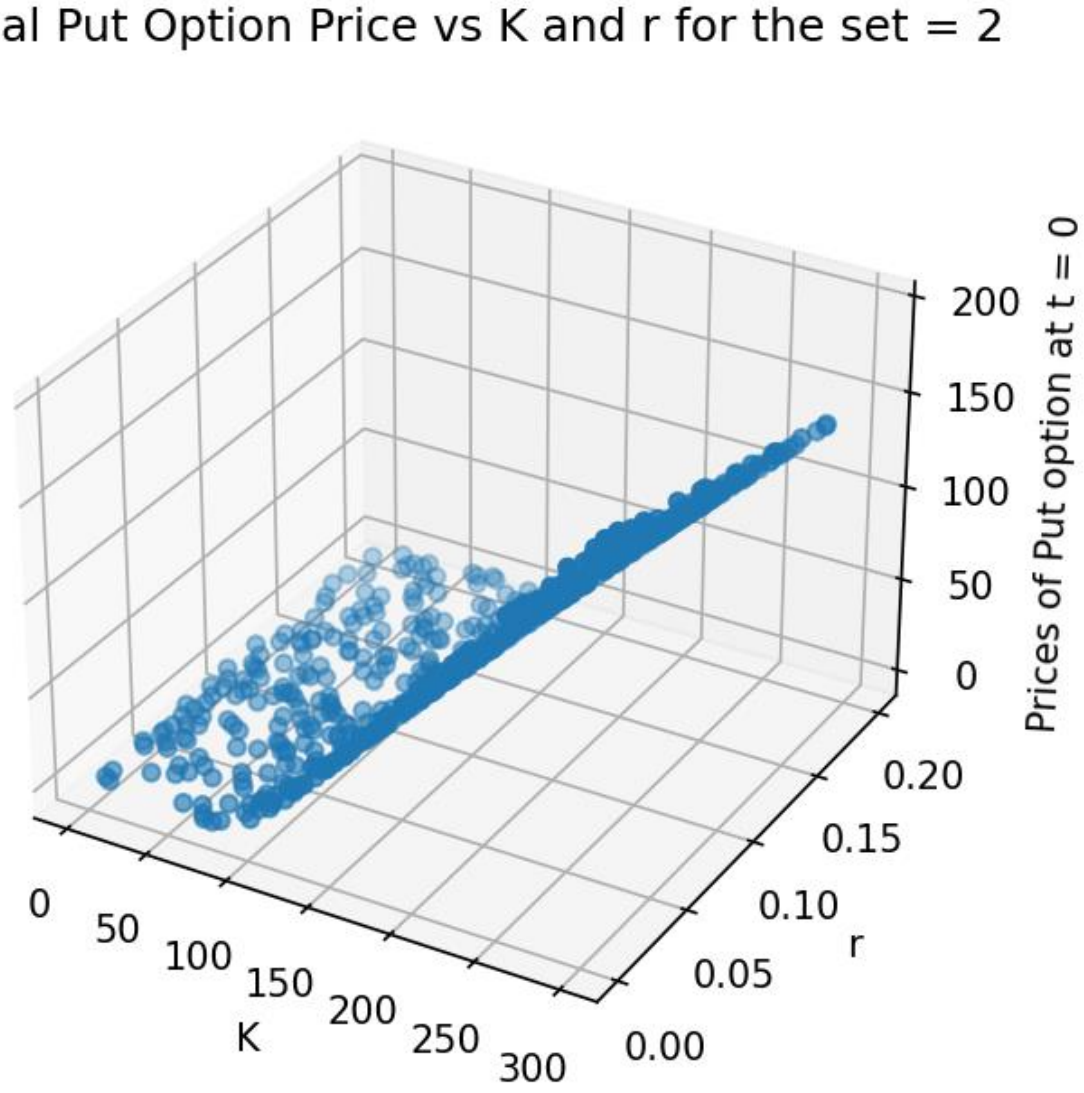

Initial Put Option Price vs S0 and M for the set = 2
Prices of Put option at t = 0
0
20
40
60
80
S0
0
50
100
150
200
250
300
M
0
50
100
150
200
250
300


Initial Call Option Price vs K and r for the set = 1
Prices of Call option at t = 0
100
80
60
40
20
0
0
50
100
150
200
250
300
K
0.00
0.05
0.10
0.15
0.20
r

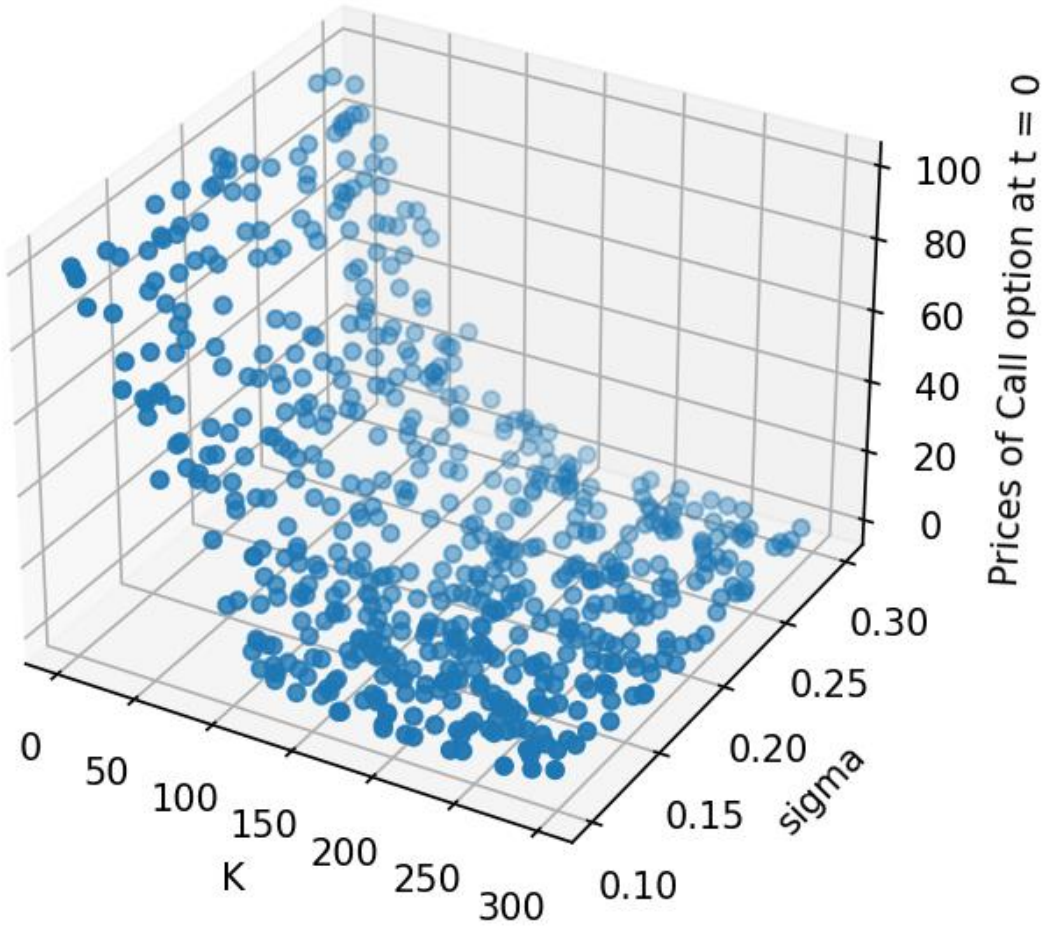

Initial Put Option Price vs K and r for the set = 1
Prices of Put option at t = 0
200
150
100
50
0
0.20
0.15
0.10
0.05
0.00
r
0
50
100
150
200
250
300
K

Initial Call Option Price vs K and r for the set = 2

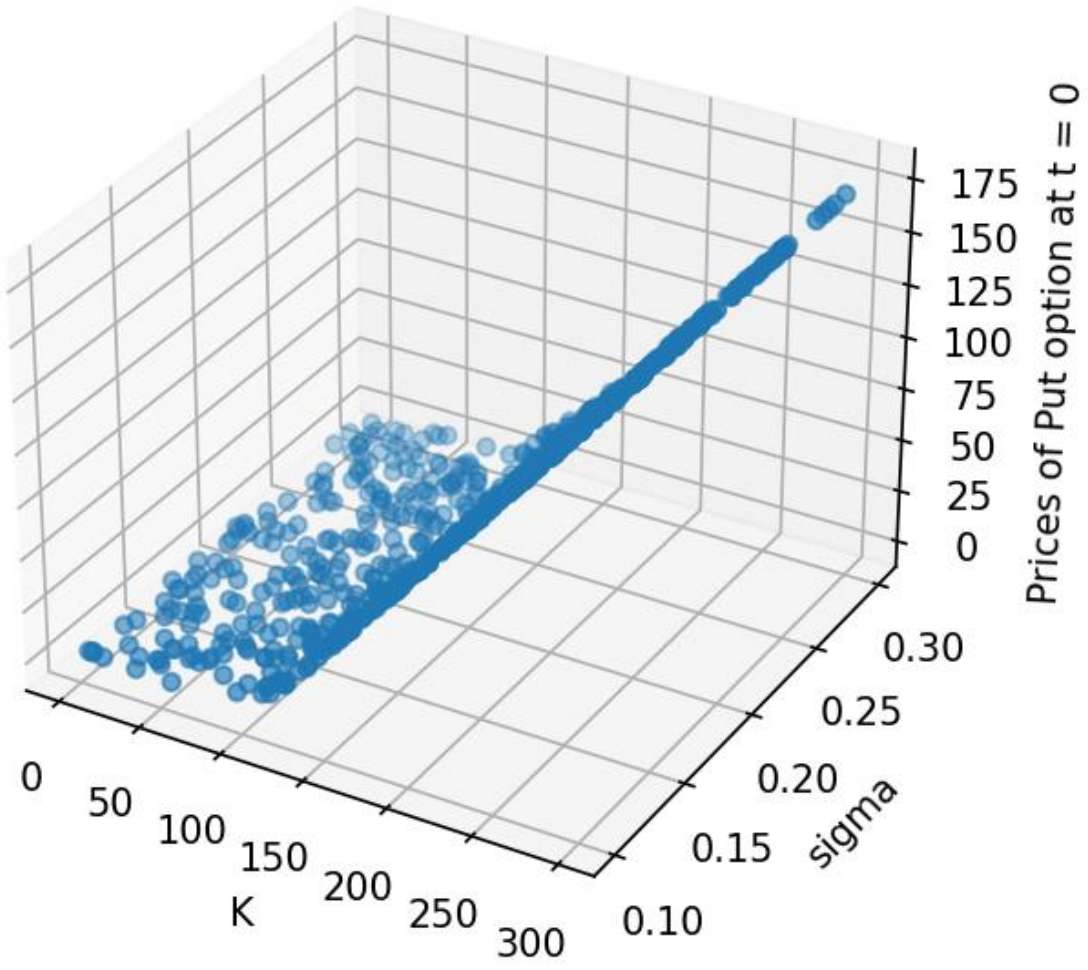



Initial Put Option Price vs K and r for the set = 2
Prices of Put option at t = 0
200
150
100
50
0
0
50
100
150
200
250
300
K
0.00
0.05
0.10
0.15
0.20
r

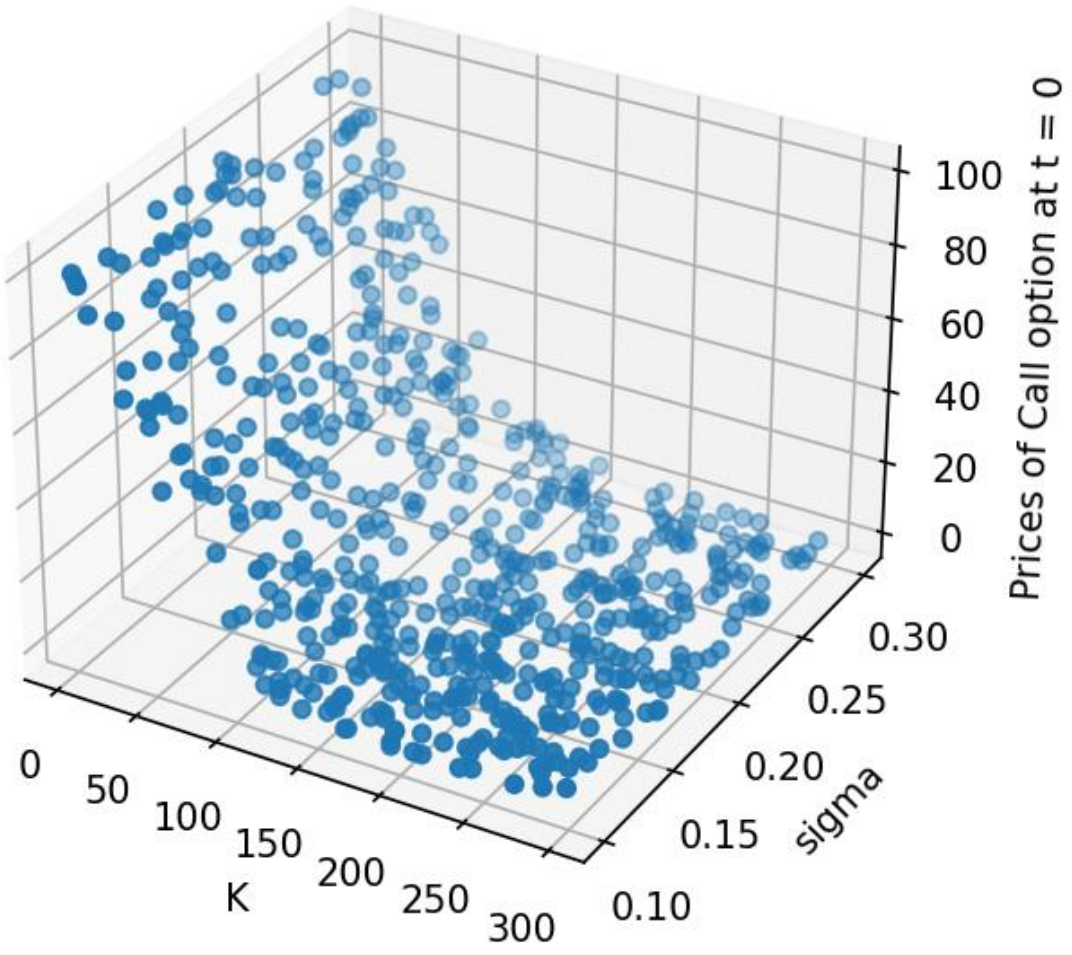
Initial Call Option Price vs K and sigma for the set = 1



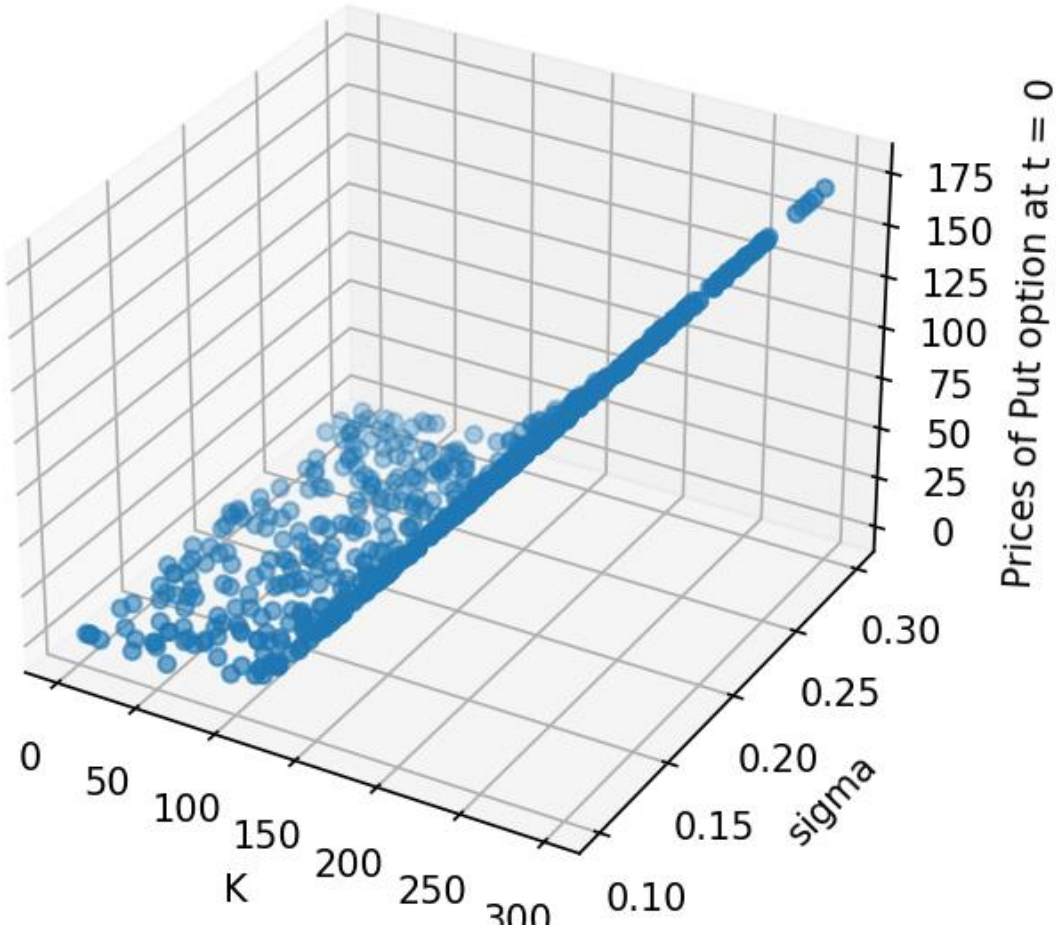
Initial Put Option Price vs K and sigma for the set = 1

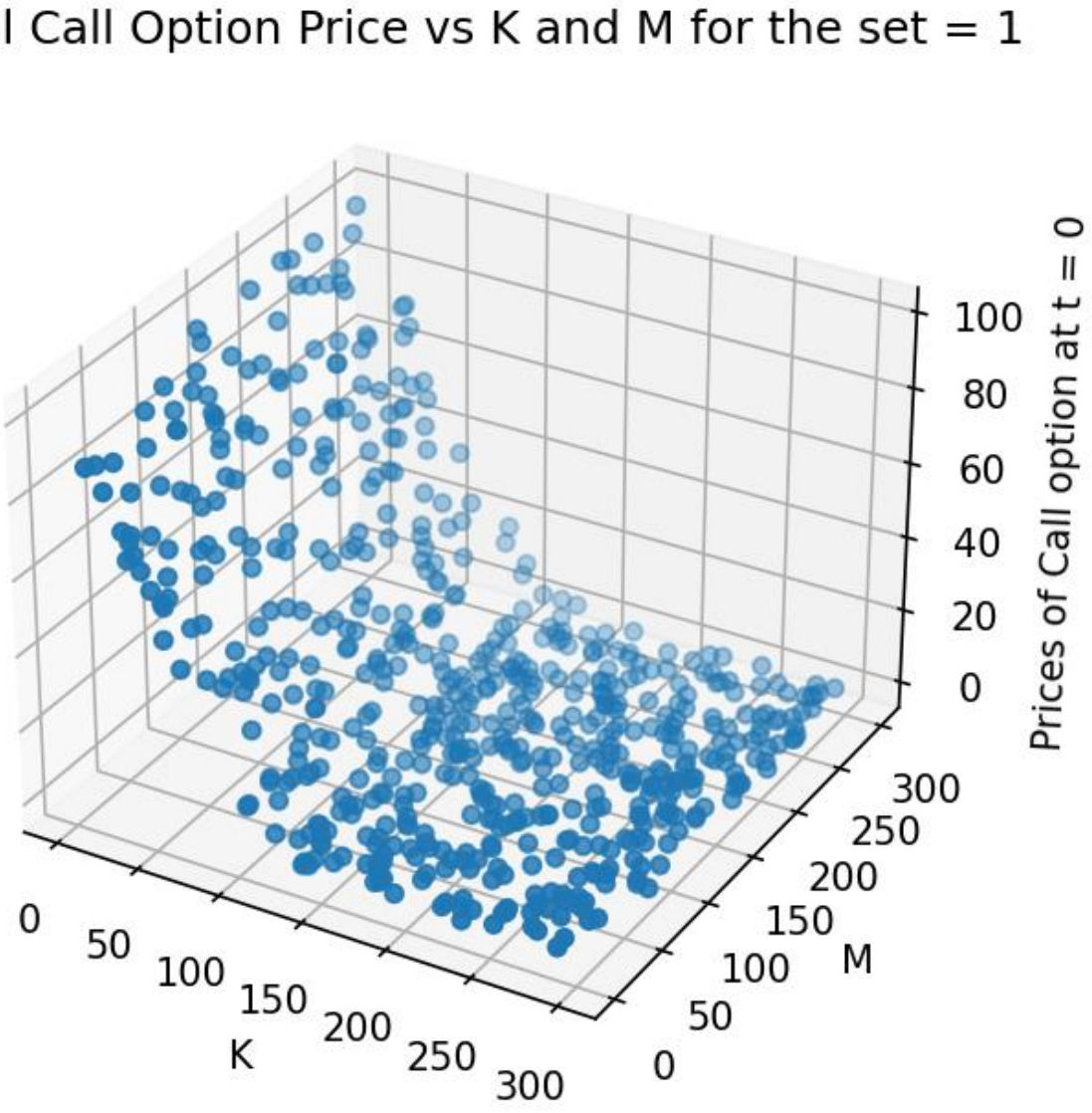


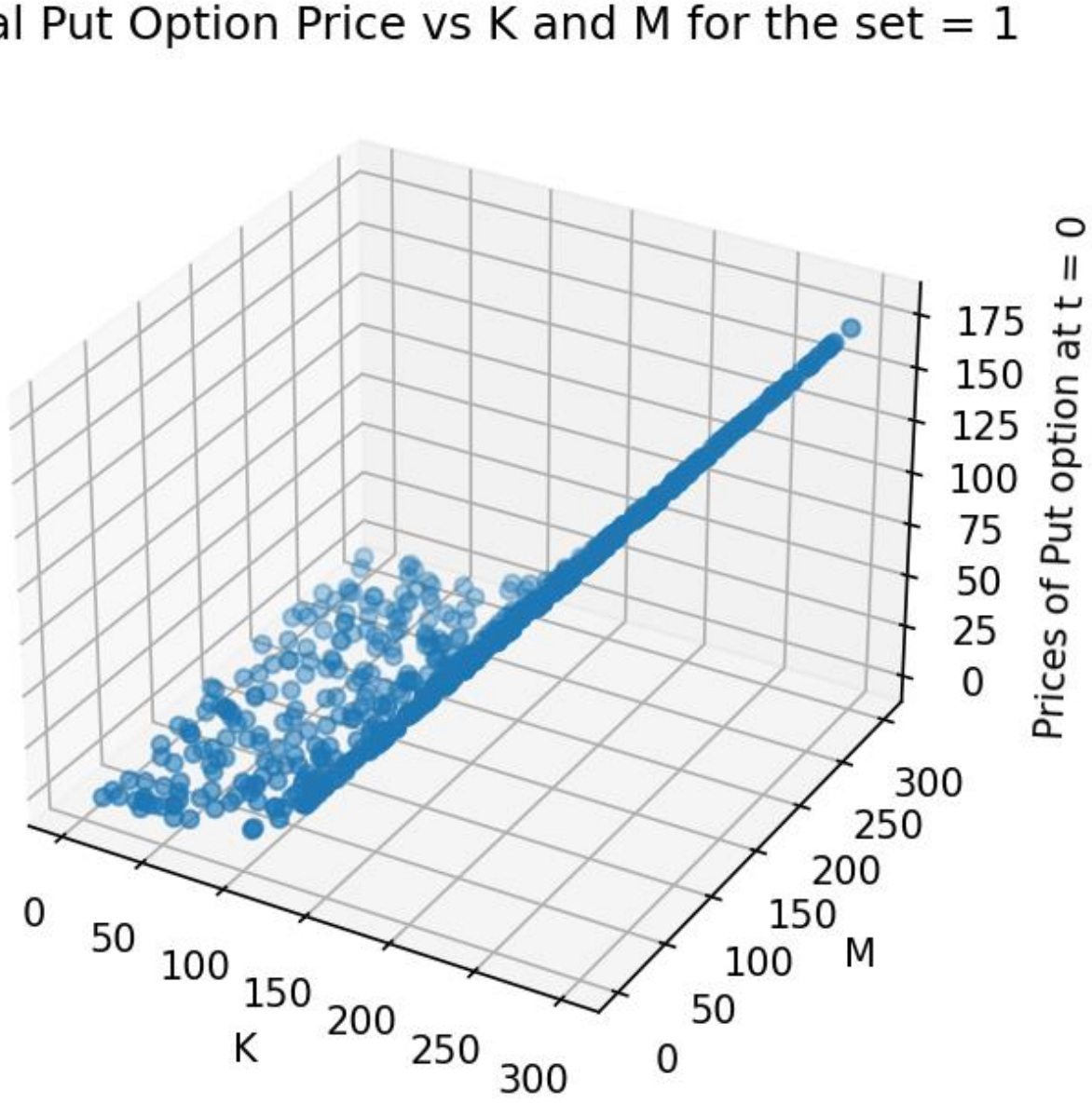
Initial Call Option Price vs K and sigma for the set = 2

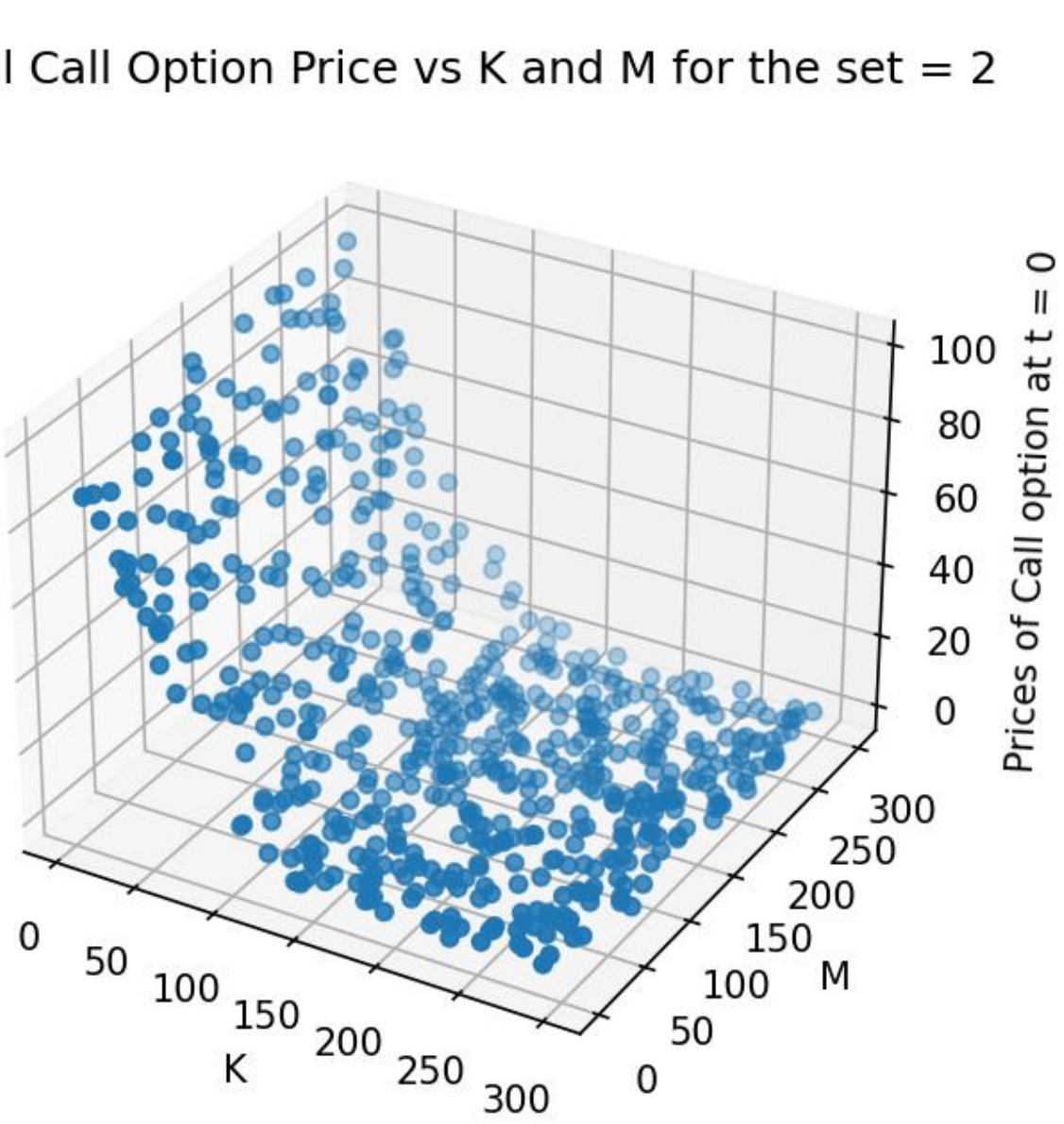


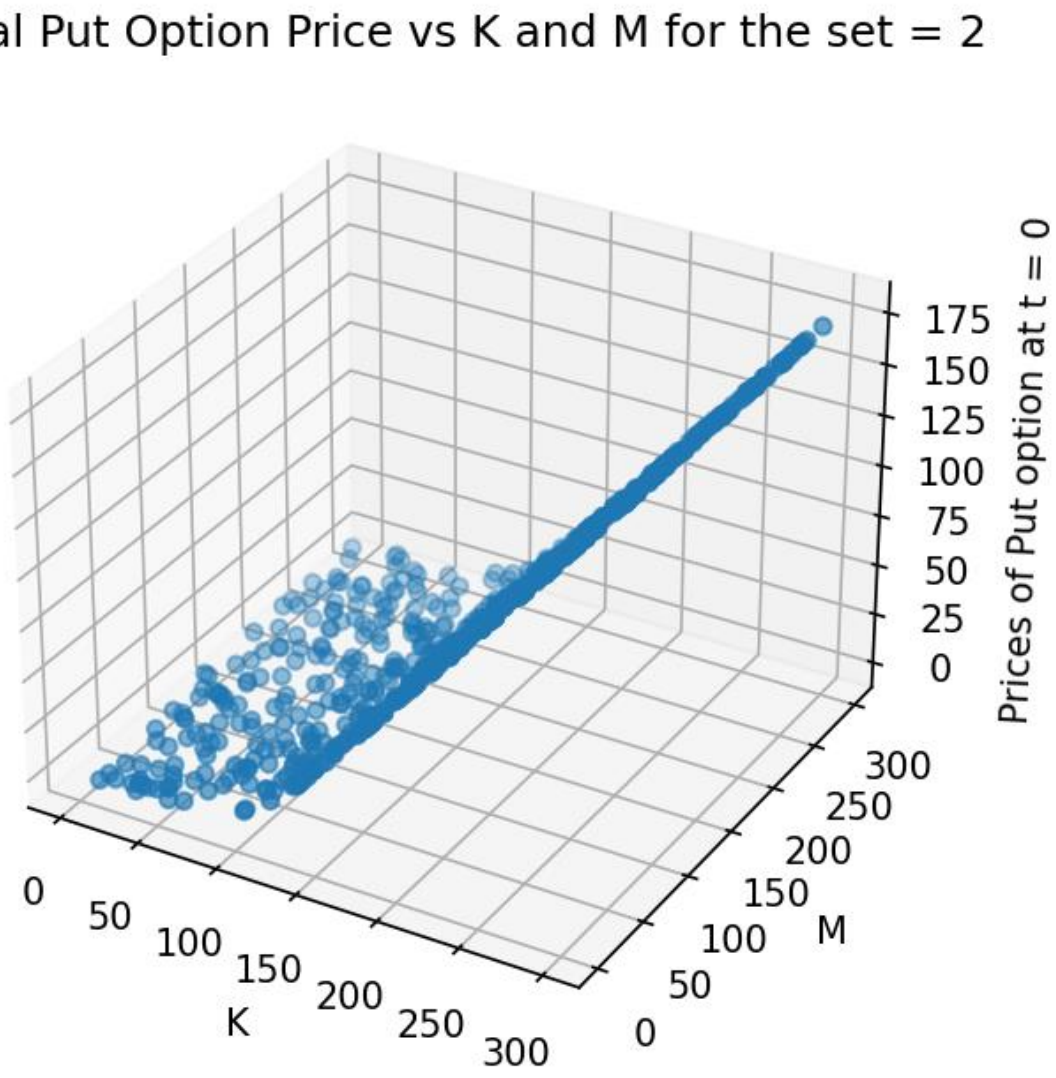
Initial Put Option Price vs K and sigma for the set = 2

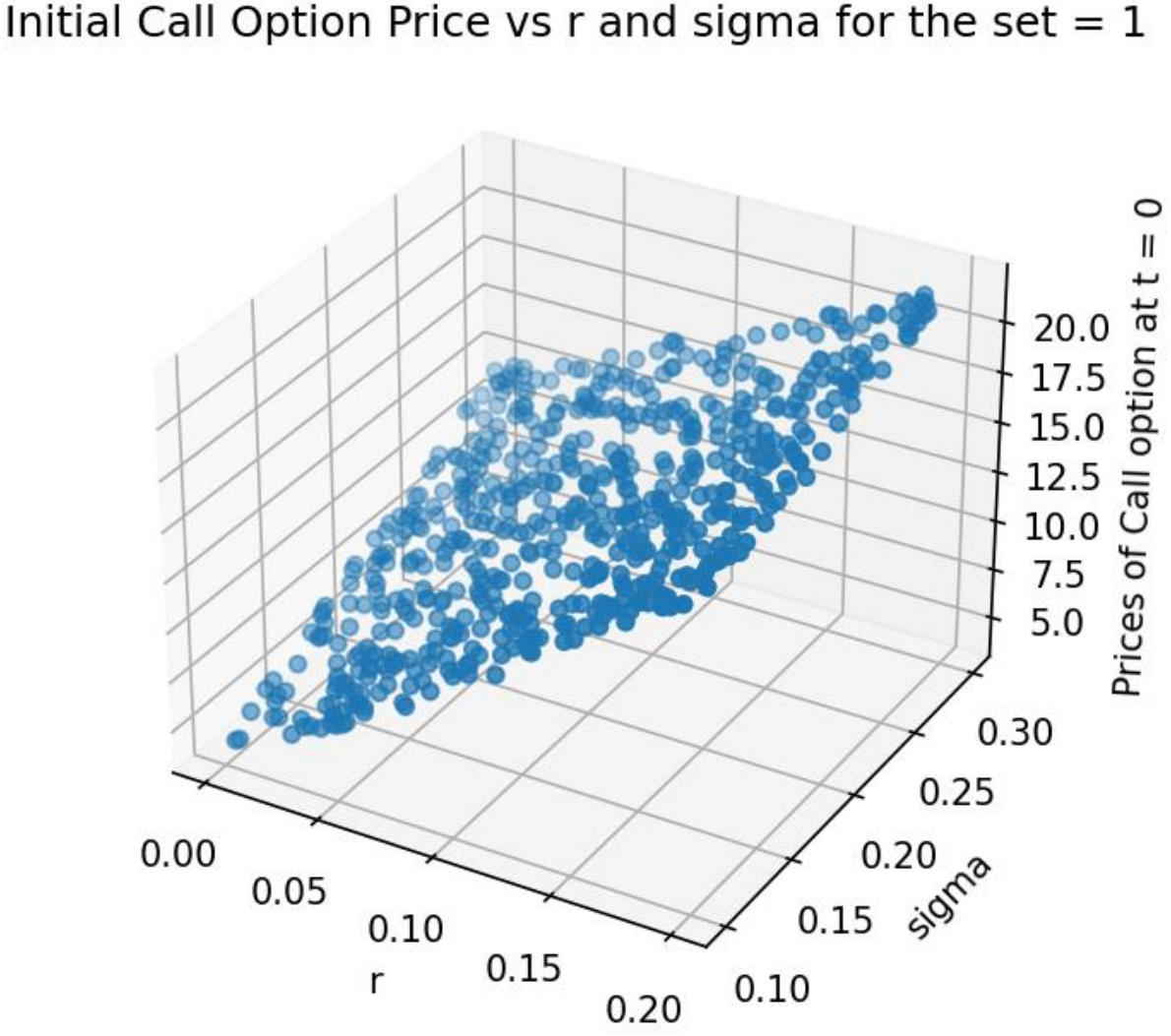


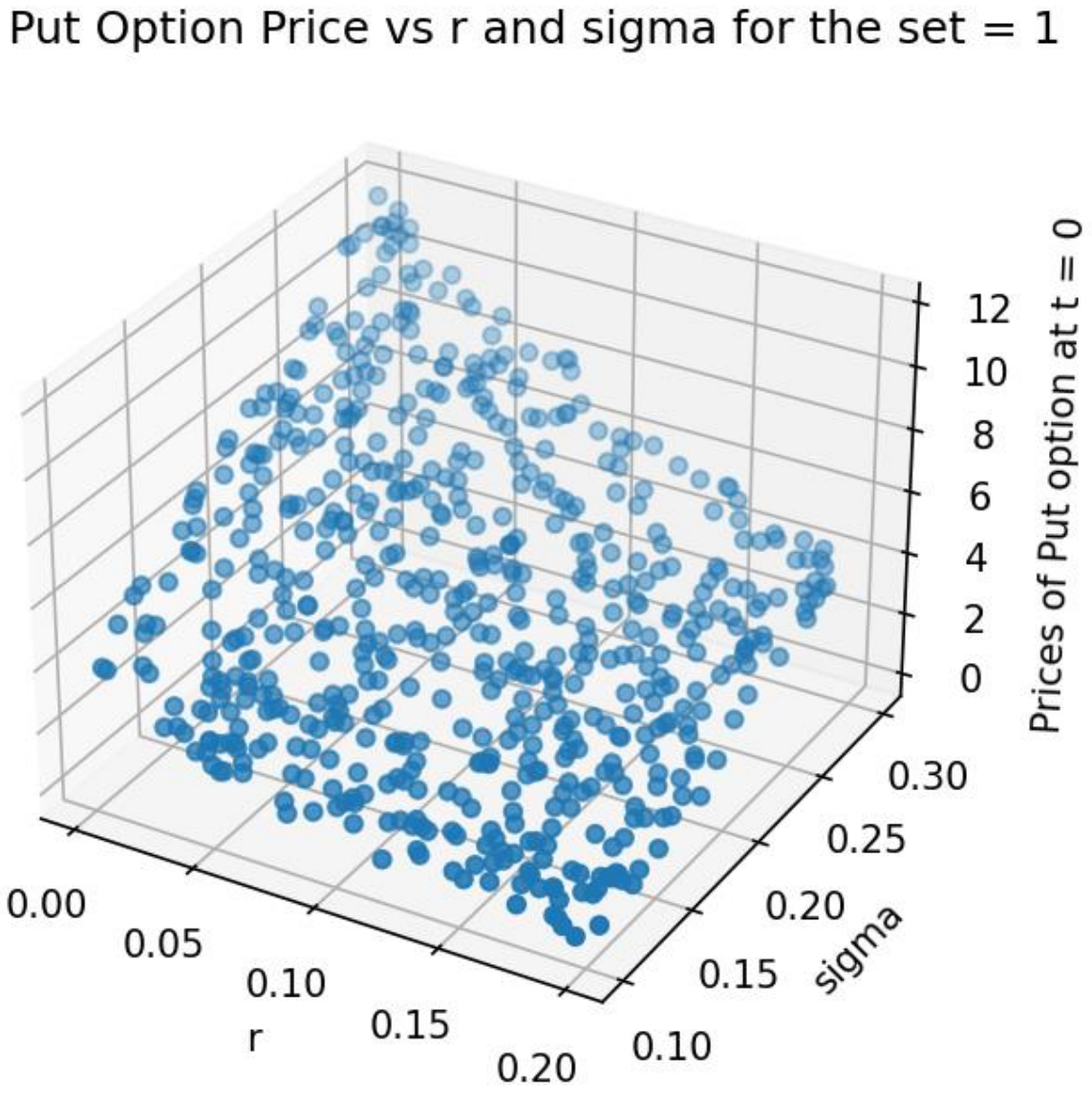

Initial Call Option Price vs K and M for the set = 1
Prices of Call option at t = 0
0
20
40
60
80
100
K
0
50
100
150
200
250
300
M
0
50
100
150
200
250
300

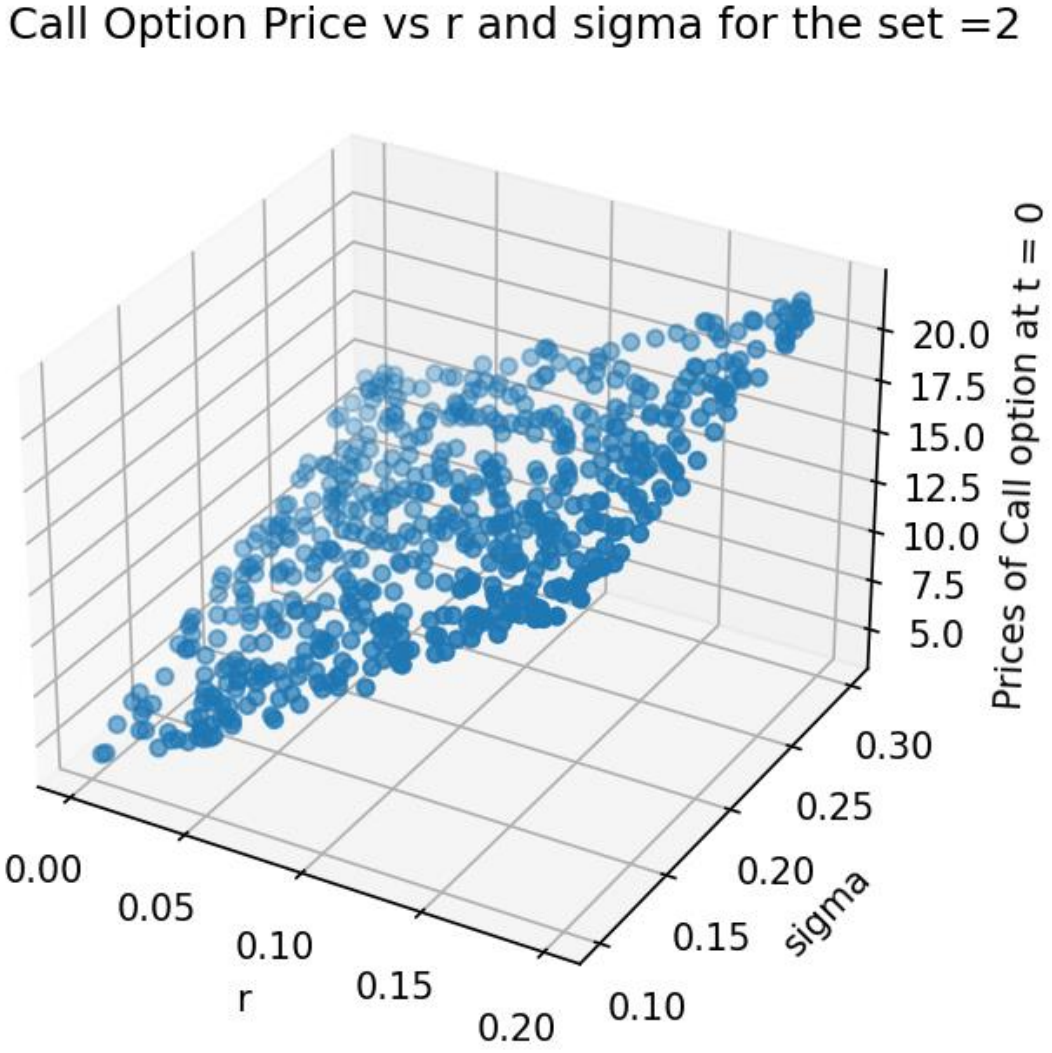

Initial Put Option Price vs K and M for the set = 1
Prices of Put option at t = 0
175
150
125
100
75
50
25
0
0
50
100
150
200
250
300
K
0
50
100
150
200
250
300
M

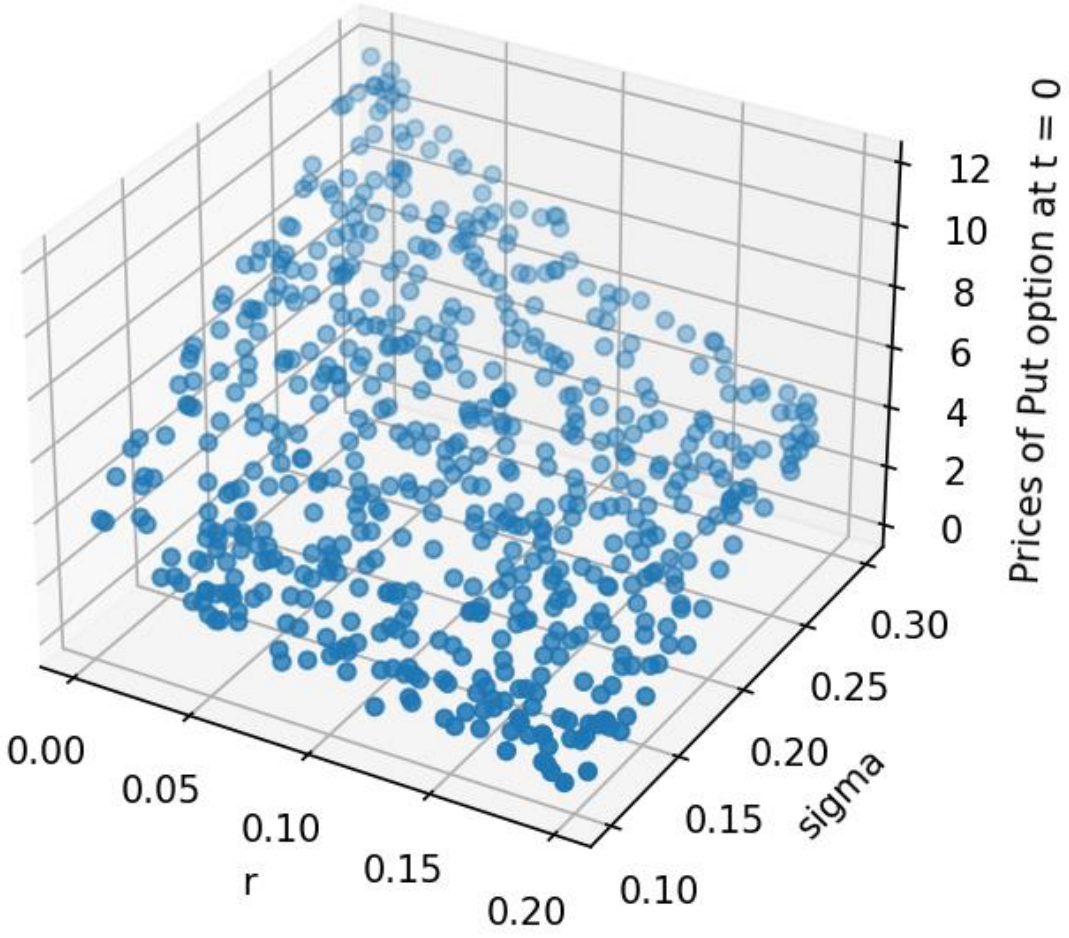

Initial Call Option Price vs K and M for the set = 2
Prices of Call option at t = 0
0
20
40
60
80
100
K
0
50
100
150
200
250
300
M
0
50
100
150
200
250
300

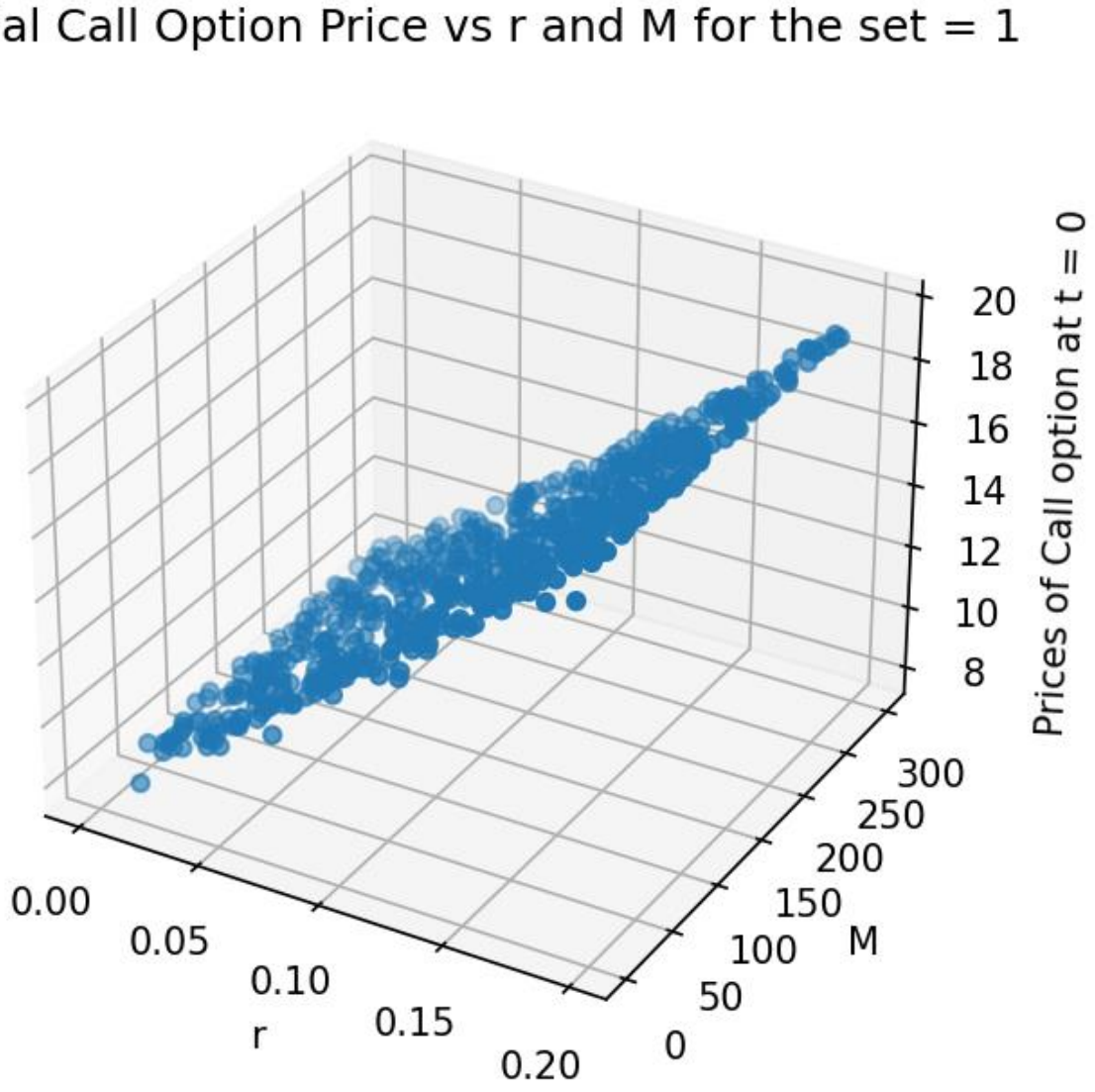

Initial Put Option Price vs K and M for the set = 2
Prices of Put option at t = 0
175
150
125
100
75
50
25
0
0
50
100
150
200
250
300
K
0
50
100
150
200
250
300
M

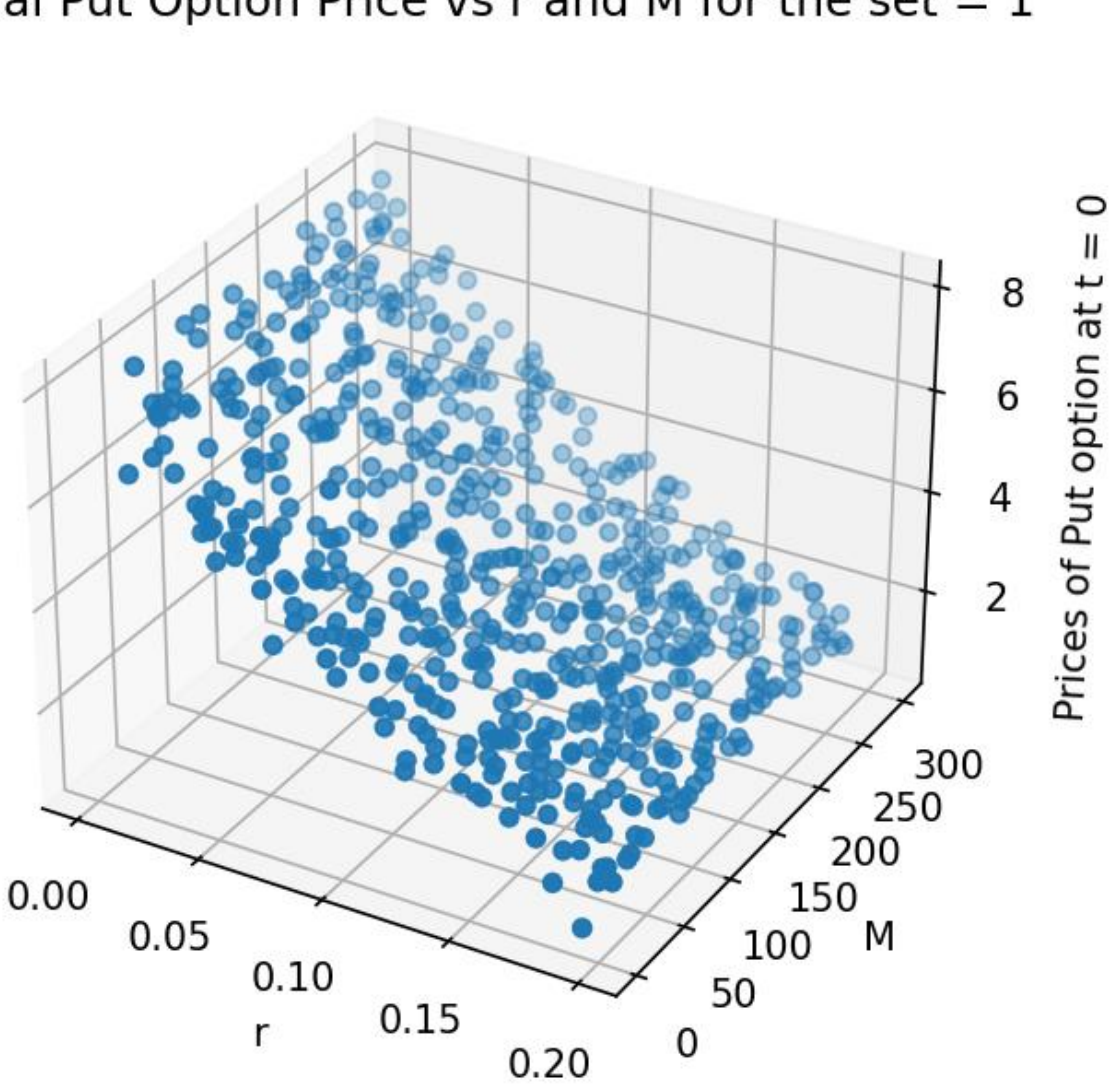

Initial Call Option Price vs r and sigma for the set = 1
Prices of Call option at t = 0
20.0
17.5
15.0
12.5
10.0
7.5
5.0
0.00
0.05
0.10
0.15
0.20
r
0.10
0.15
0.20
0.25
0.30
sigma

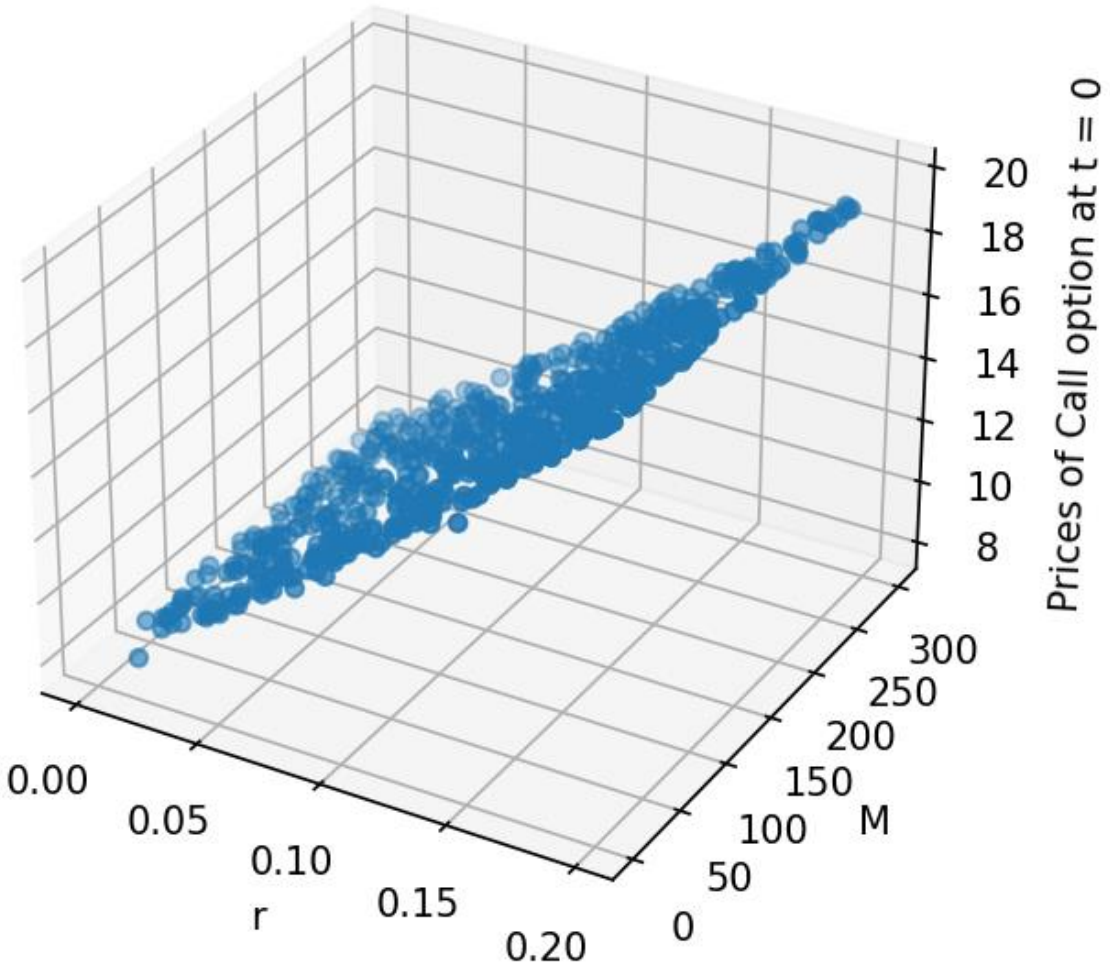

Initial Put Option Price vs r and sigma for the set = 1
Prices of Put option at t = 0
0
2
4
6
8
10
12
0.00
0.05
0.10
0.15
0.20
r
0.10
0.15
0.20
0.25
0.30
sigma


Initial Call Option Price vs r and sigma for the set =2
Prices of Call option at t = 0
20.0
17.5
15.0
12.5
10.0
7.5
5.0
0.00
0.05
0.10
0.15
0.20
r
0.10
0.15
0.20
0.25
0.30
sigma

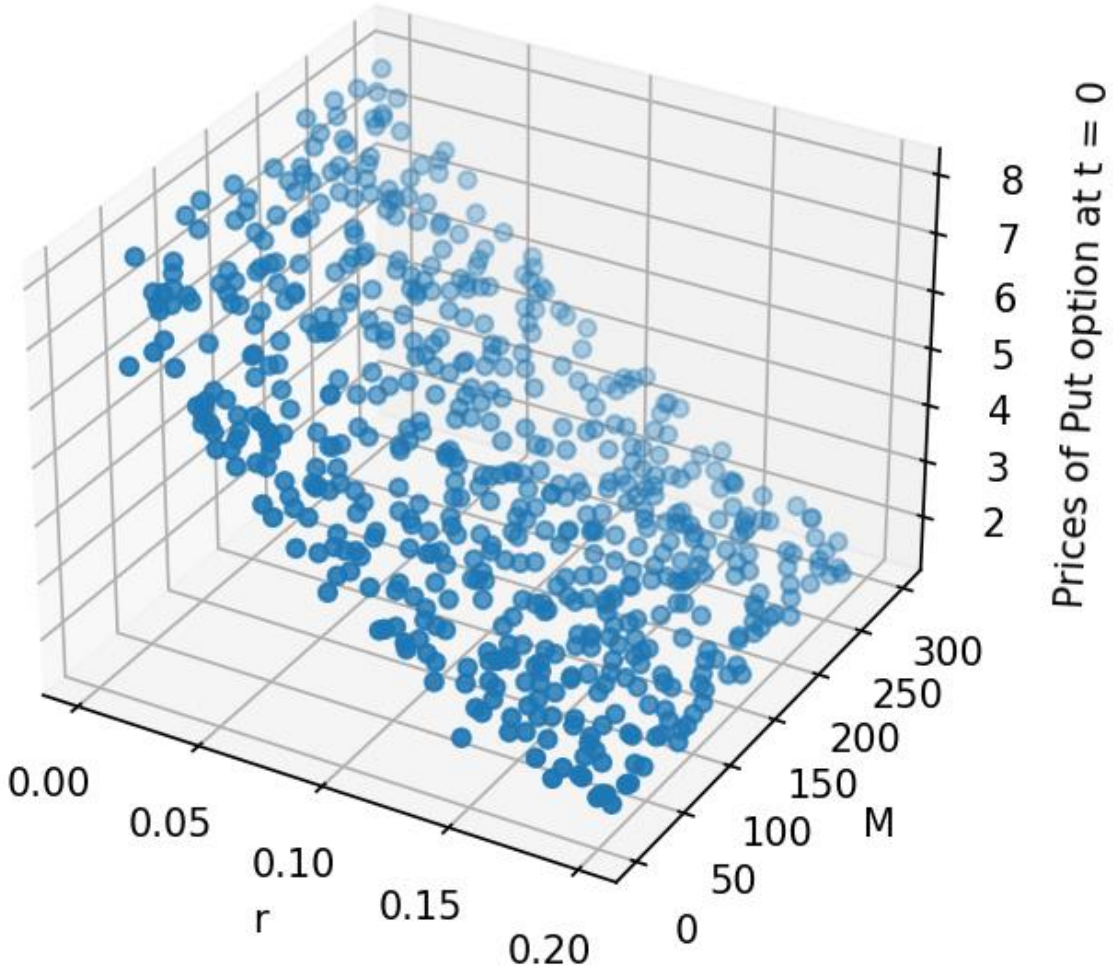

Initial Put Option Price vs r and sigma for the set = 2
Prices of Put option at t = 0
0
2
4
6
8
10
12
0.00
0.05
0.10
0.15
0.20
r
0.10
0.15
0.20
0.25
0.30
sigma

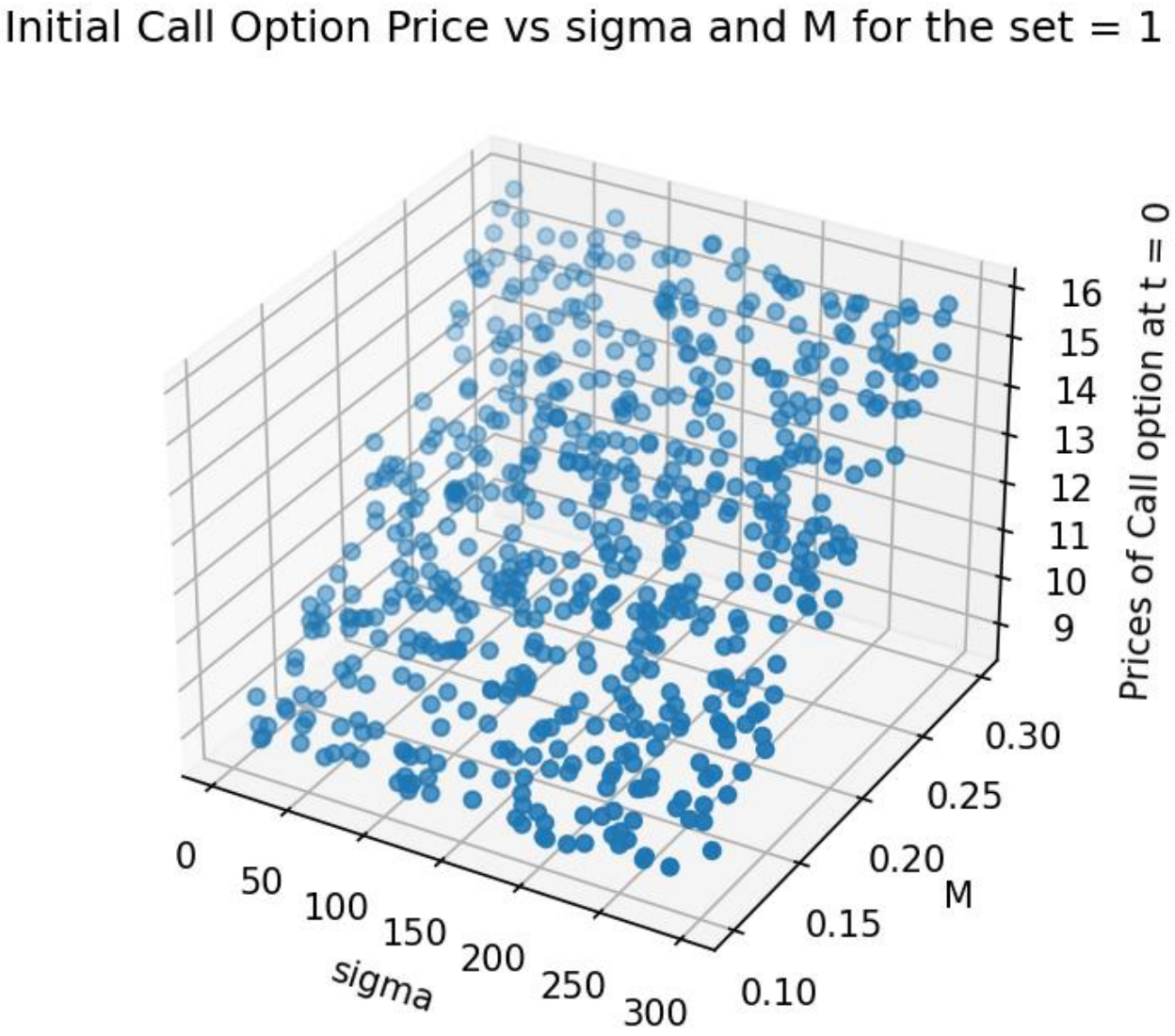

Initial Call Option Price vs r and M for the set = 1
Prices of Call option at t = 0
20
18
16
14
12
10
8
0.00
0.05
0.10
0.15
0.20
r
0
50
100
150
200
250
300
M

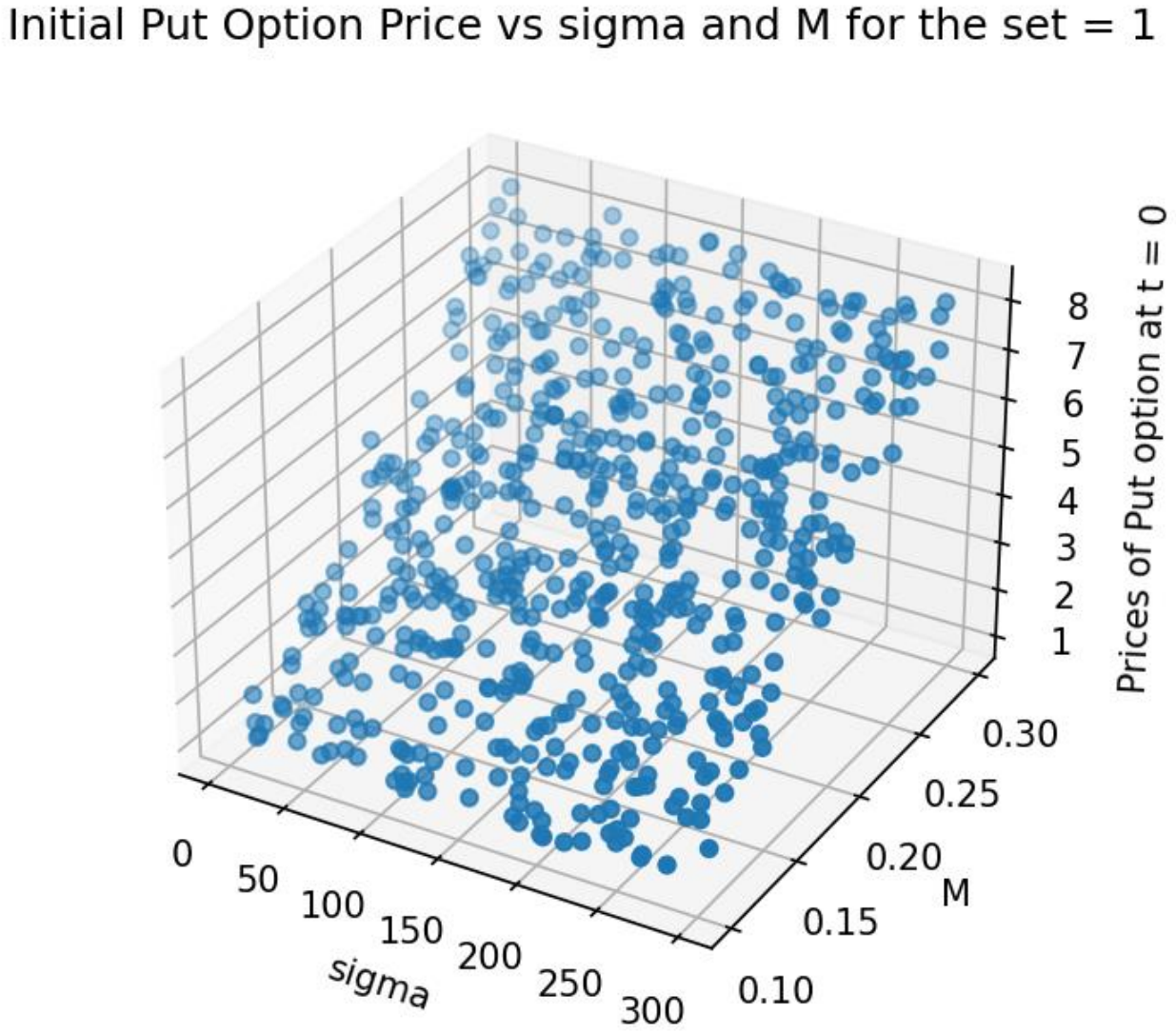

Initial Put Option Price vs r and M for the set = 1
Prices of Put option at t = 0
8
6
4
2
0.00
0.05
0.10
0.15
0.20
r
0
50
100
150
200
250
300
M

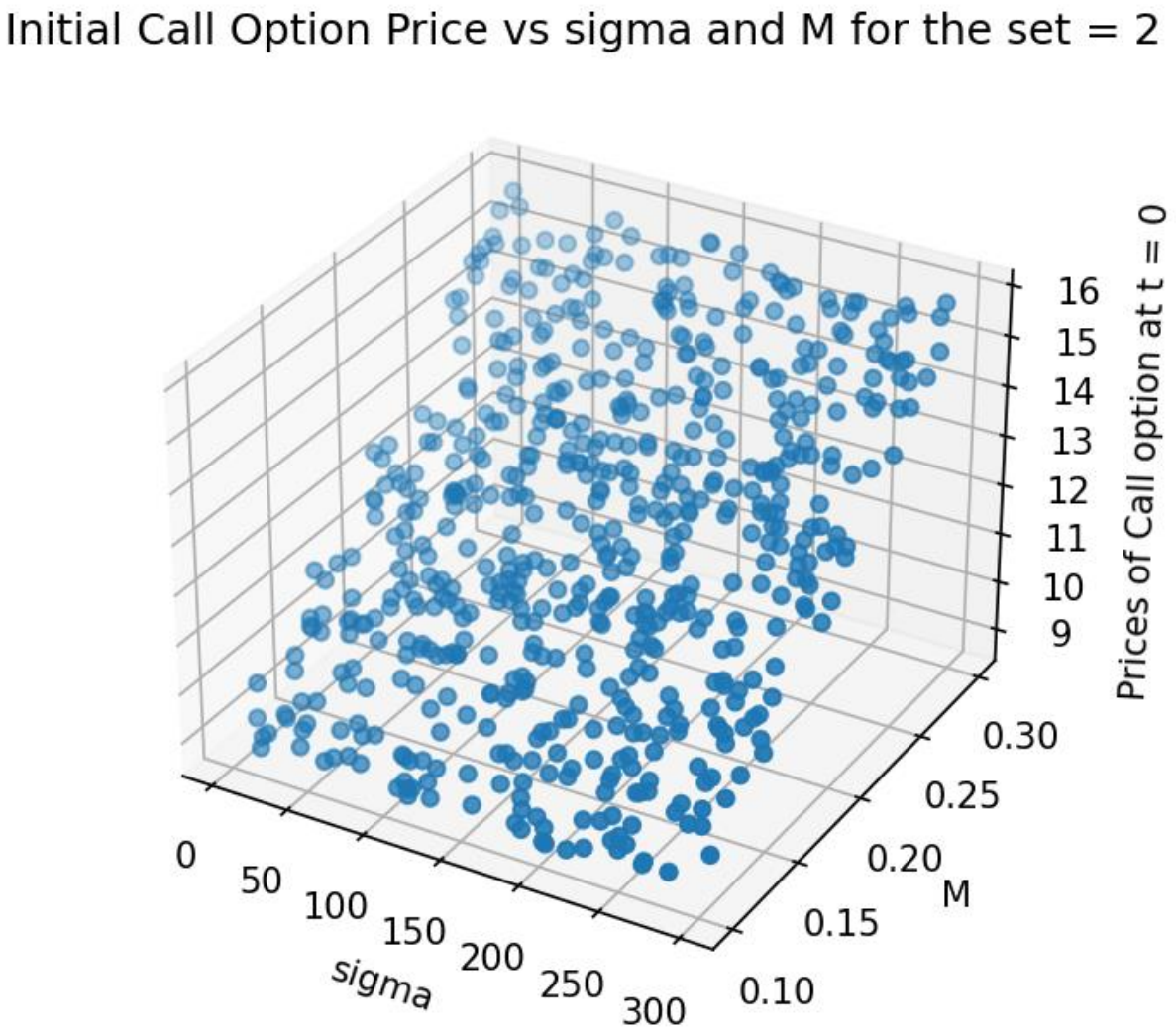

Initial Call Option Price vs r and M for the set = 2
Prices of Call option at t = 0
20
18
16
14
12
10
8
0.00
0.05
0.10
0.15
0.20
r
0
50
100
150
200
250
300
M

Initial Put Option Price vs r and M for the set = 2

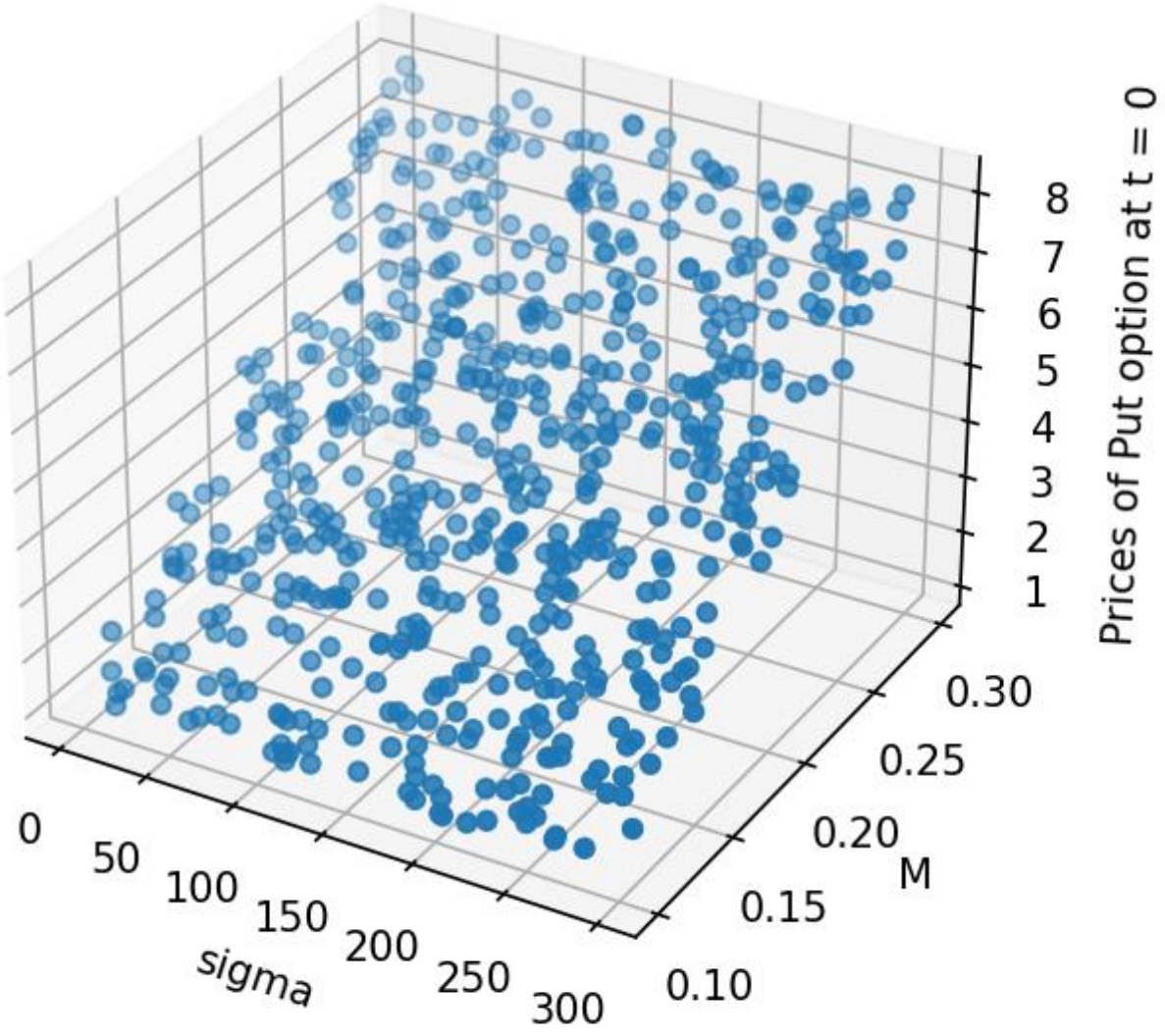



Initial Call Option Price vs sigma and M for the set = 1
Prices of Call option at t = 0
16
15
14
13
12
11
10
9
0.30
0.25
0.20
M
0.15
0.10
0
50
100
150
200
250
300
sigma


Initial Put Option Price vs sigma and M for the set = 1
Prices of Put option at t = 0
1
2
3
4
5
6
7
8
0
50
100
150
200
250
300
sigma
0.10
0.15
0.20
0.25
0.30
M

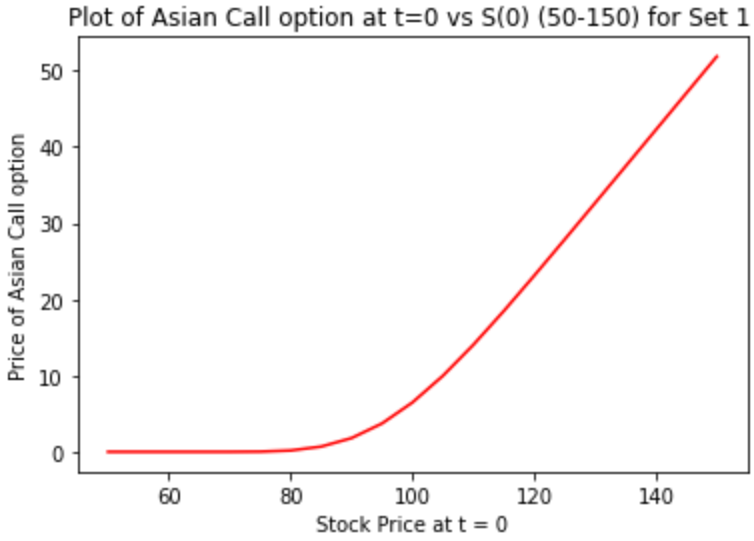

Initial Call Option Price vs sigma and M for the set = 2
Prices of Call option at t = 0
16
15
14
13
12
11
10
9
0.30
0.25
0.20
M
0.15
0.10
0
50
100
150
200
250
300
sigma

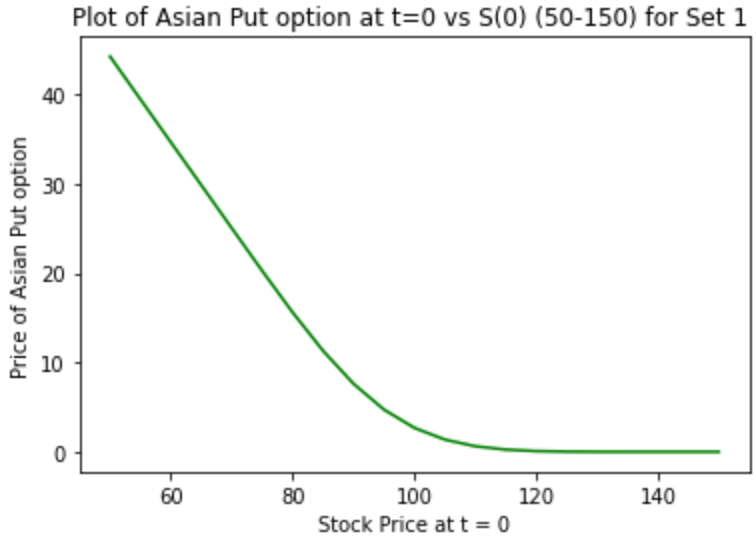
Initial Put Option Price vs sigma and M for the set = 2

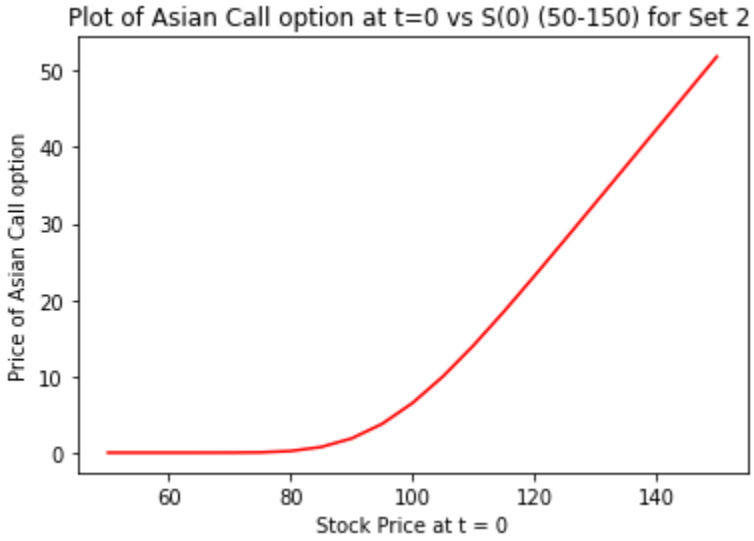


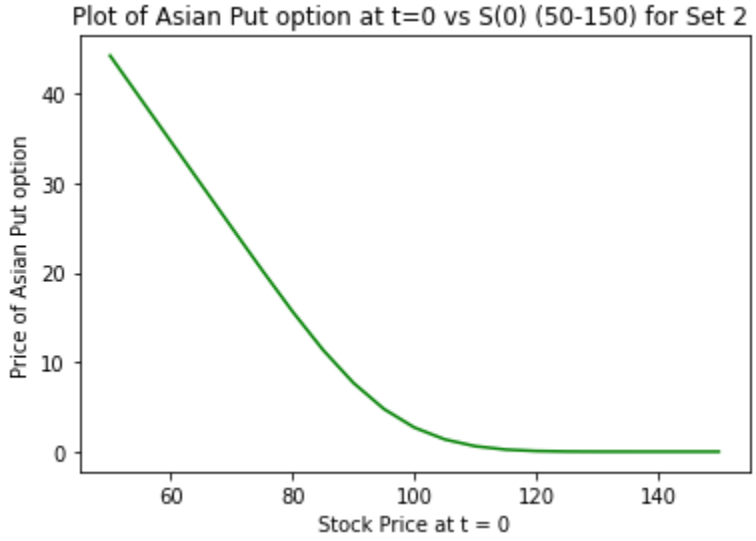
Question 2 Plots -

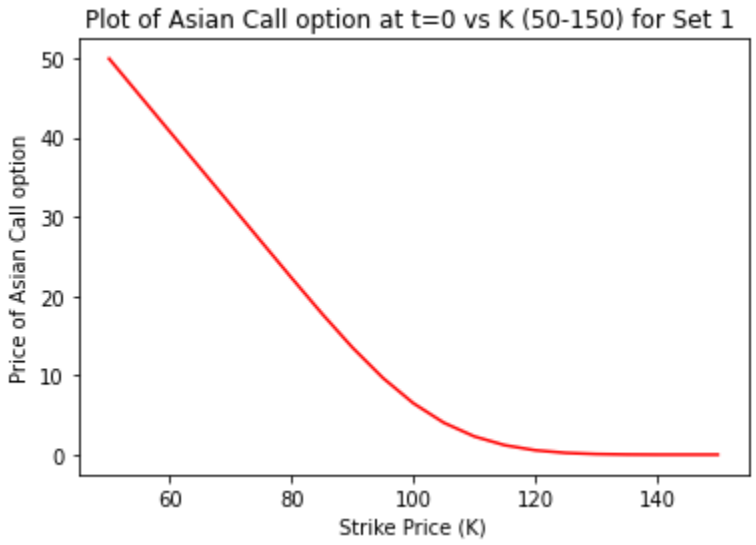
2D Plots (1 param at a time)

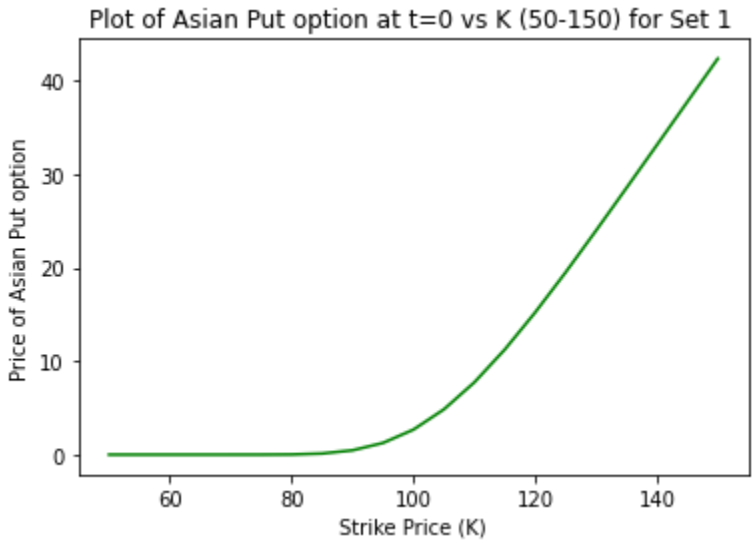


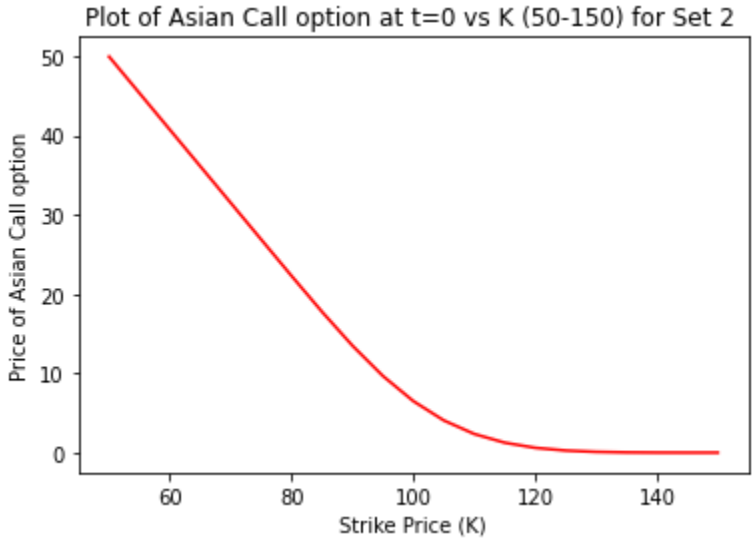


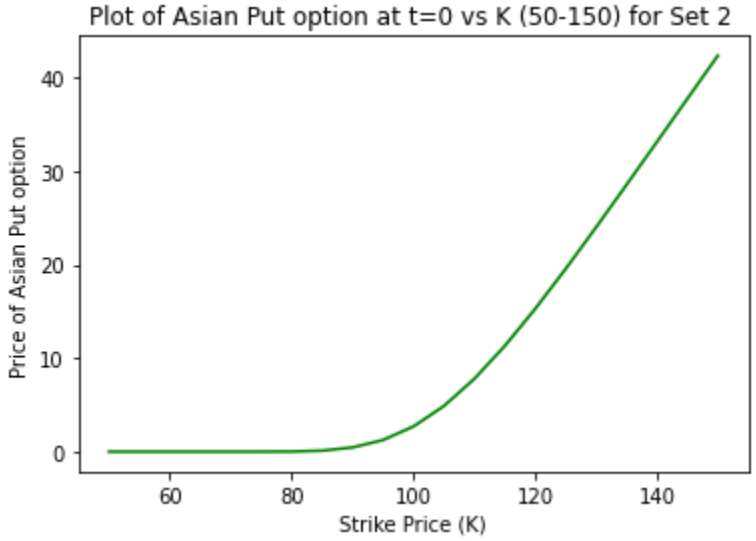

Plot of Asian Call option at t=0 vs S(0) (50-150) for Set 2
Price of Asian Call option
0
10
20
30
40
50
60
80
100
120
140
Stock Price at t = 0

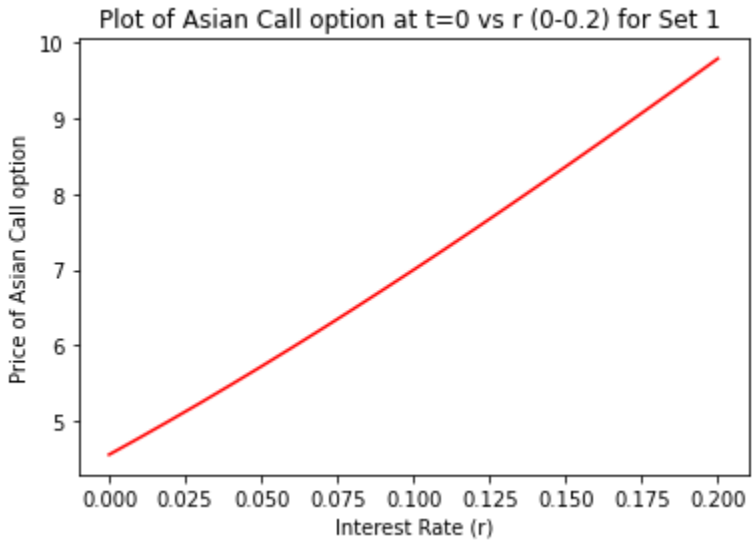

Plot of Asian Put option at t=0 vs S(0) (50-150) for Set 2
Price of Asian Put option
0
10
20
30
40
60
80
100
120
140
Stock Price at t = 0

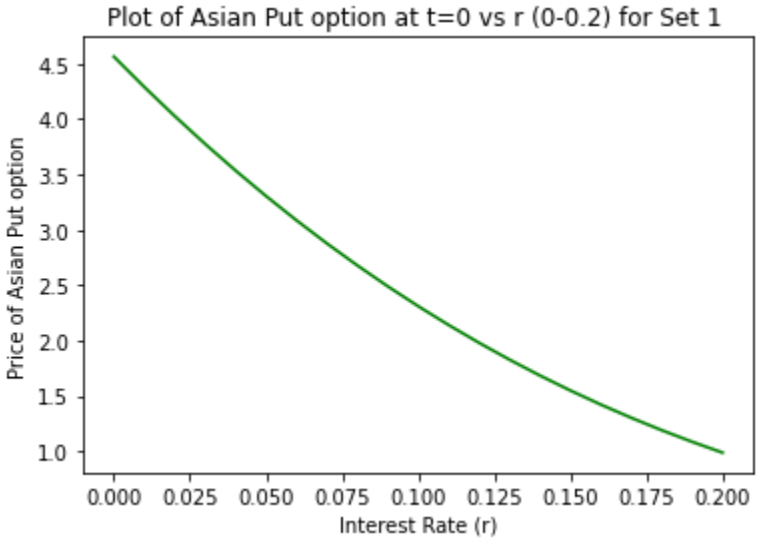

Plot of Asian Call option at t=0 vs K (50-150) for Set 1
Price of Asian Call option
Strike Price (K)
0
10
20
30
40
50
60
80
100
120
140

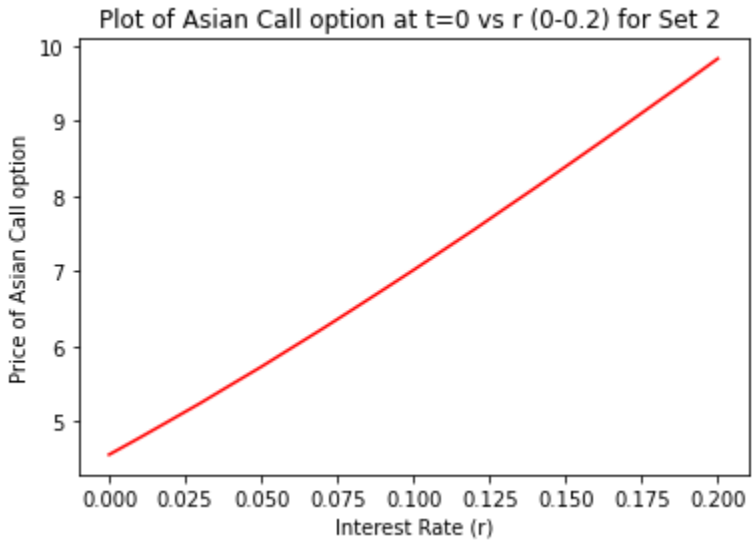

Plot of Asian Put option at t=0 vs K (50-150) for Set 1
Price of Asian Put option
Strike Price (K)
0
10
20
30
40
60
80
100
120
140

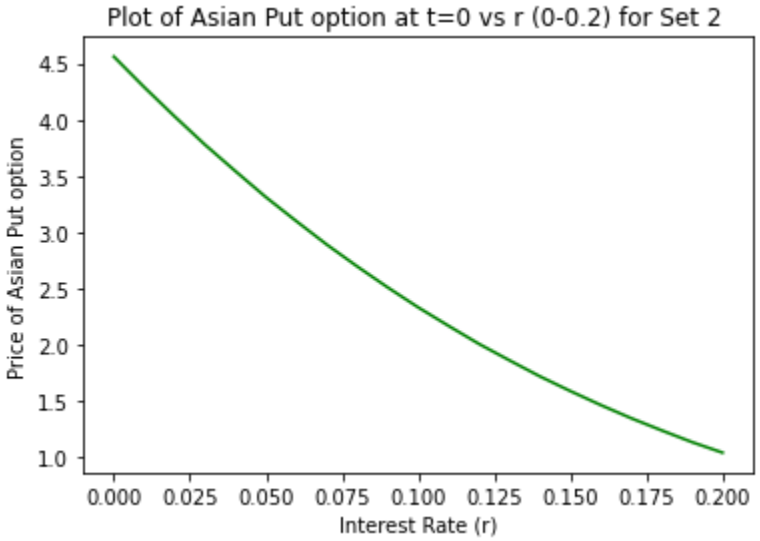

Plot of Asian Call option at t=0 vs K (50-150) for Set 2
Price of Asian Call option
Strike Price (K)
0
10
20
30
40
50
60
80
100
120
140

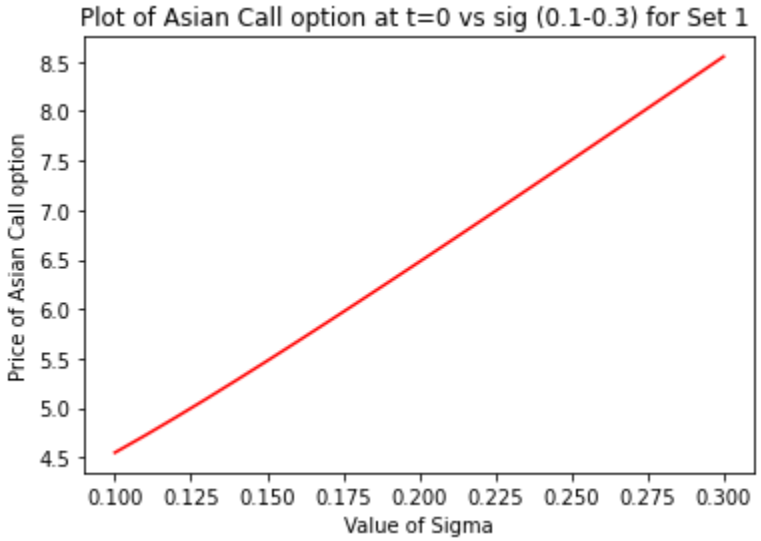

Plot of Asian Put option at t=0 vs K (50-150) for Set 2
Price of Asian Put option
Strike Price (K)
0
10
20
30
40
60
80
100
120
140

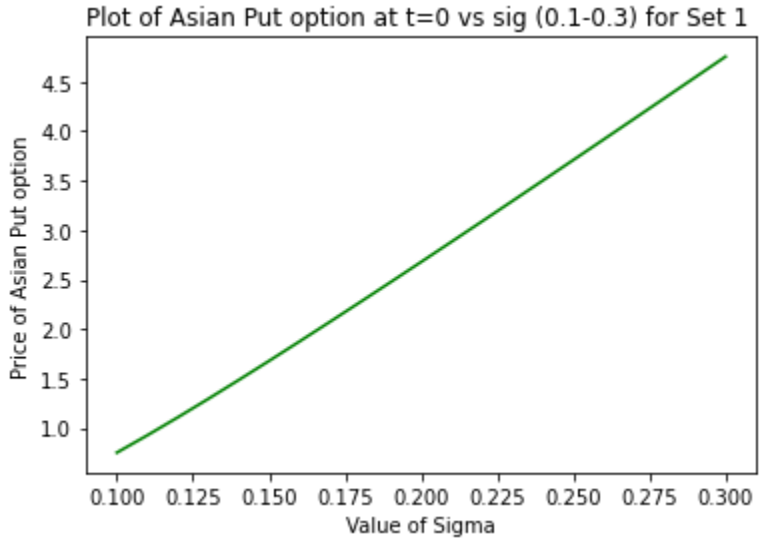

Plot of Asian Call option at t=0 vs r (0-0.2) for Set 1
Price of Asian Call option
10
9
8
7
6
5
0.000
0.025
0.050
0.075
0.100
0.125
0.150
0.175
0.200
Interest Rate (r)

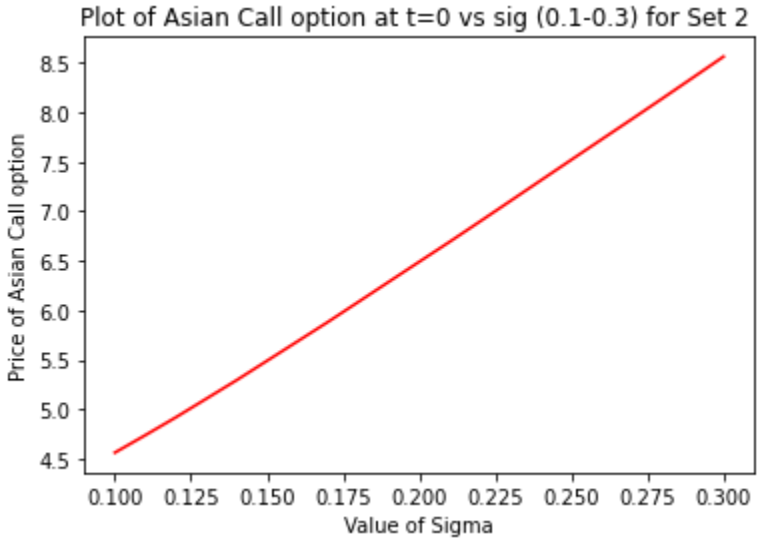

Plot of Asian Put option at t=0 vs r (0-0.2) for Set 1
Price of Asian Put option
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.000
0.025
0.050
0.075
0.100
0.125
0.150
0.175
0.200
Interest Rate (r)

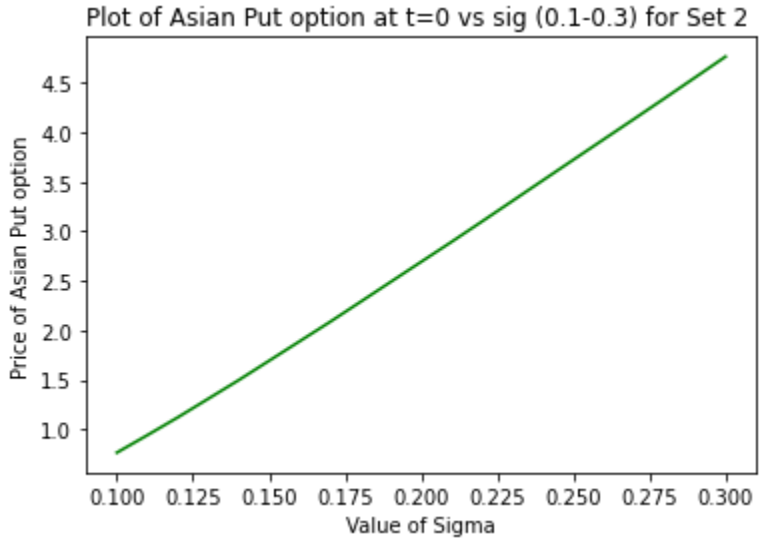

Plot of Asian Call option at t=0 vs r (0-0.2) for Set 2
Price of Asian Call option
10
9
8
7
6
5
0.000
0.025
0.050
0.075
0.100
0.125
0.150
0.175
0.200
Interest Rate (r)

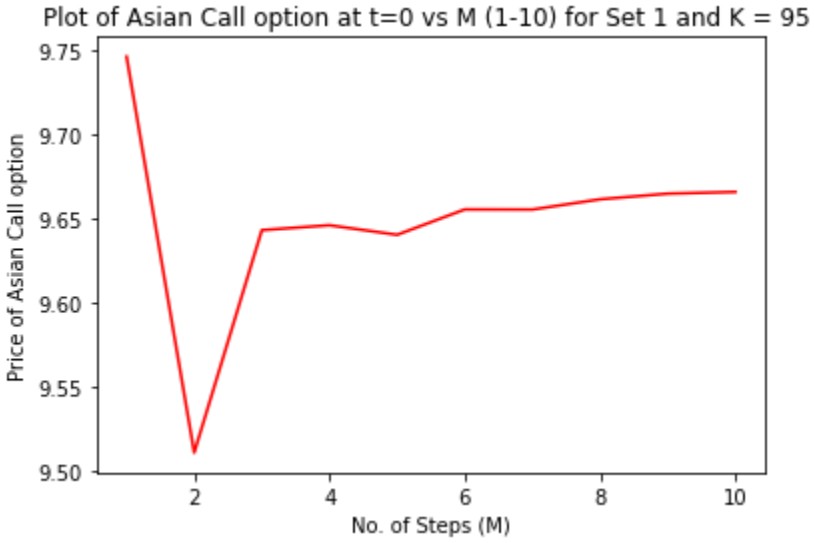

Plot of Asian Put option at t=0 vs r (0-0.2) for Set 2
Price of Asian Put option
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.000
0.025
0.050
0.075
0.100
0.125
0.150
0.175
0.200
Interest Rate (r)

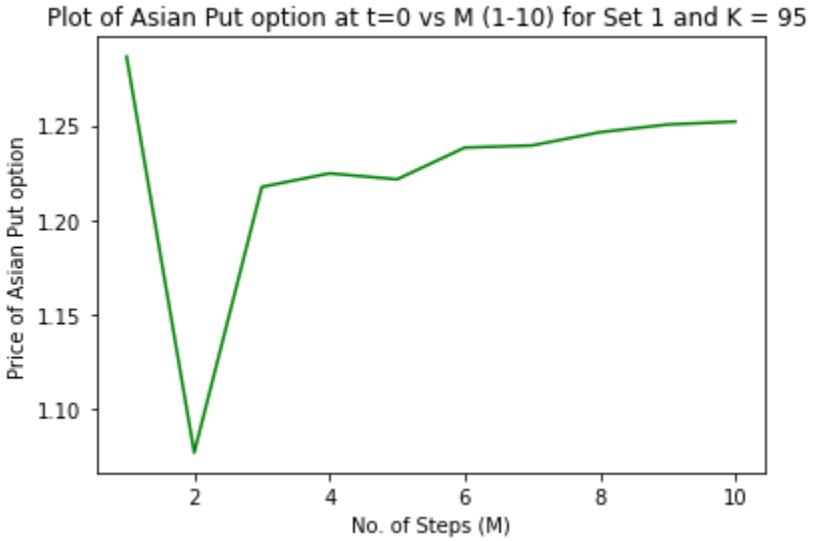

Plot of Asian Call option at t=0 vs sig (0.1-0.3) for Set 1
Price of Asian Call option
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
0.100
0.125
0.150
0.175
0.200
0.225
0.250
0.275
0.300
Value of Sigma

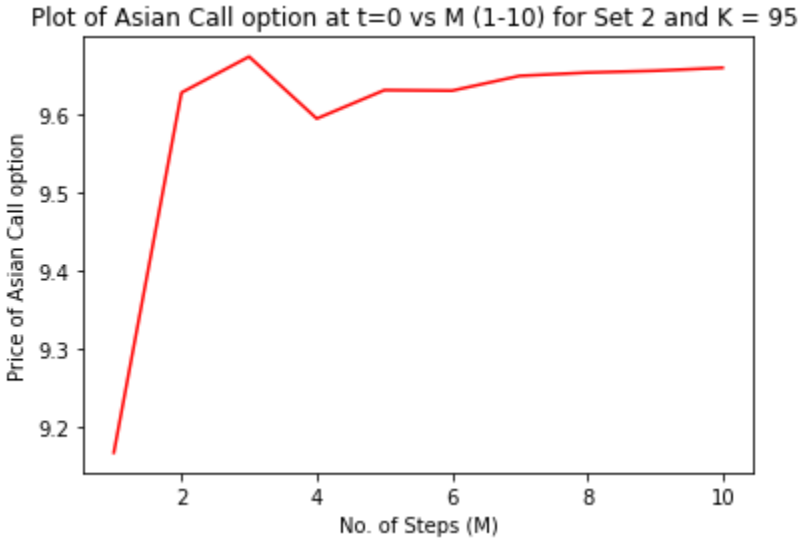

Plot of Asian Put option at t=0 vs sig (0.1-0.3) for Set 1
Price of Asian Put option
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.100
0.125
0.150
0.175
0.200
0.225
0.250
0.275
0.300
Value of Sigma

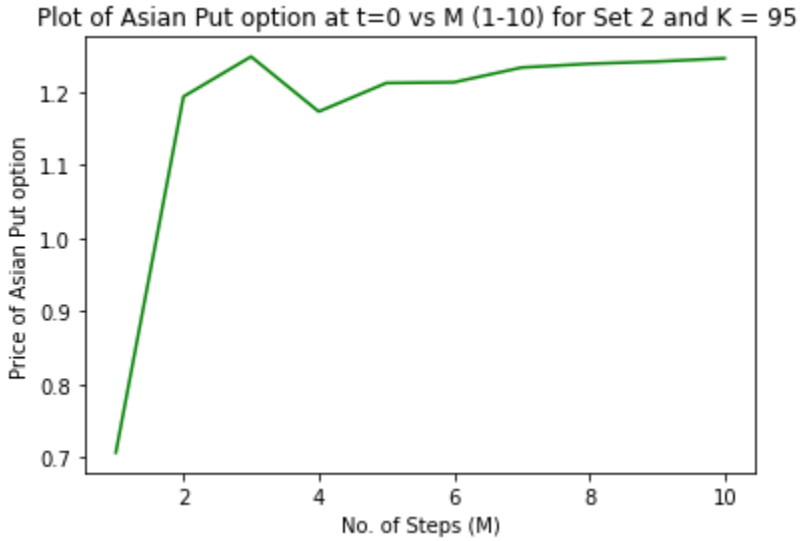

Plot of Asian Call option at t=0 vs sig (0.1-0.3) for Set 2
Price of Asian Call option
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
0.100
0.125
0.150
0.175
0.200
0.225
0.250
0.275
0.300
Value of Sigma

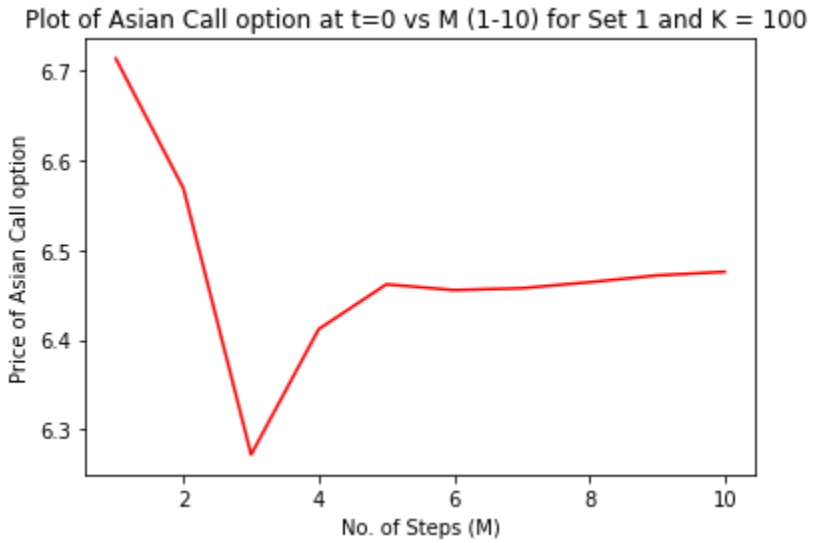

Plot of Asian Put option at t=0 vs sig (0.1-0.3) for Set 2
Price of Asian Put option
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.100
0.125
0.150
0.175
0.200
0.225
0.250
0.275
0.300
Value of Sigma

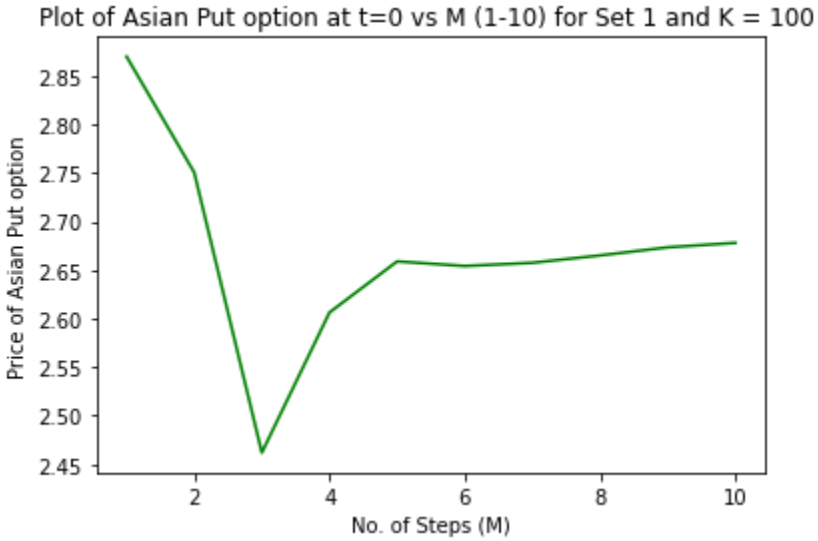

Plot of Asian Call option at t=0 vs M (1-10) for Set 1 and K = 95
Price of Asian Call option
9.75
9.70
9.65
9.60
9.55
9.50
2
4
6
8
10
No. of Steps (M)

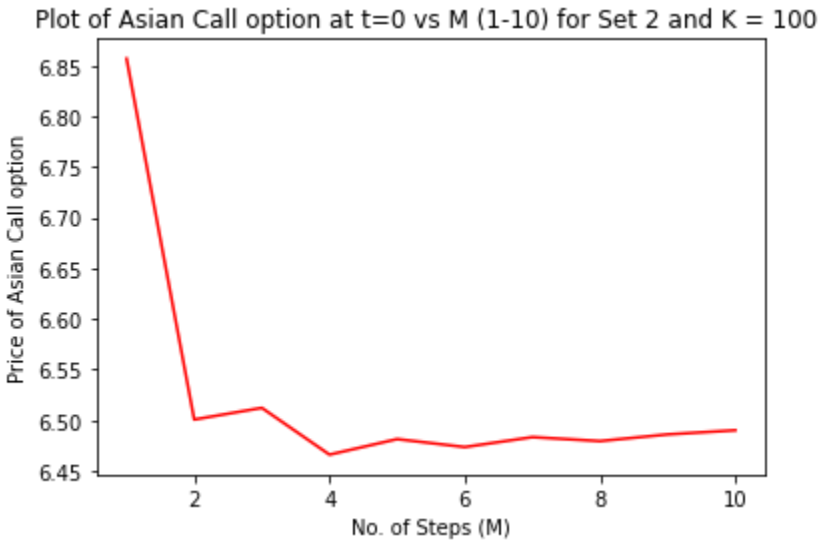

Plot of Asian Put option at t=0 vs M (1-10) for Set 1 and K = 95
Price of Asian Put option
1.25
1.20
1.15
1.10
2
4
6
8
10
No. of Steps (M)

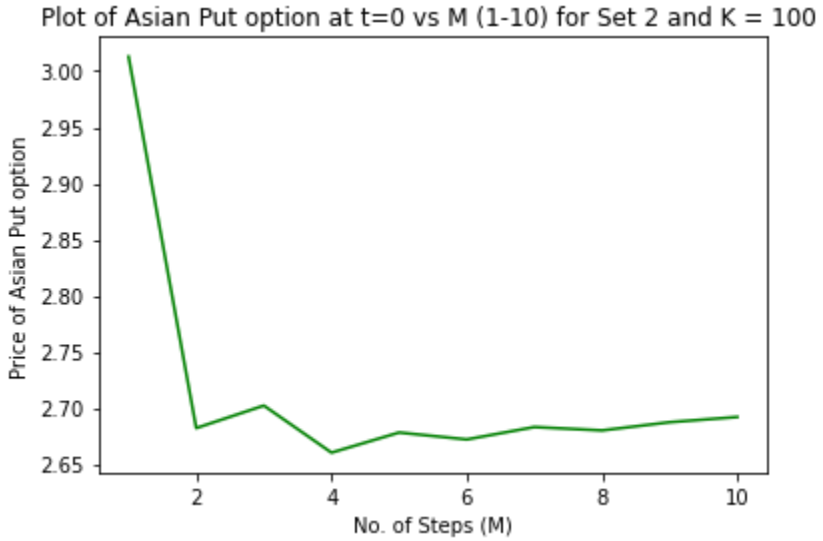

Plot of Asian Call option at t=0 vs M (1-10) for Set 2 and K = 95
Price of Asian Call option
9.2
9.3
9.4
9.5
9.6
2
4
6
8
10
No. of Steps (M)

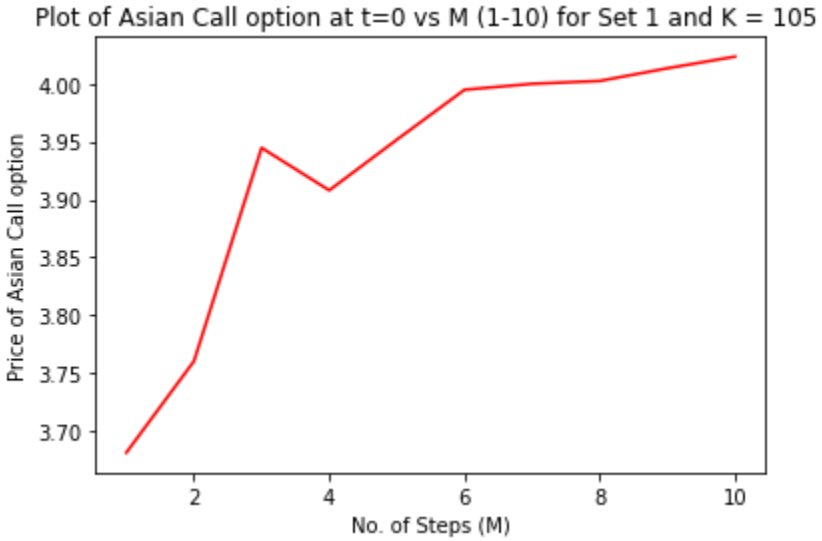

Plot of Asian Put option at t=0 vs M (1-10) for Set 2 and K = 95
Price of Asian Put option
0.7
0.8
0.9
1.0
1.1
1.2
2
4
6
8
10
No. of Steps (M)

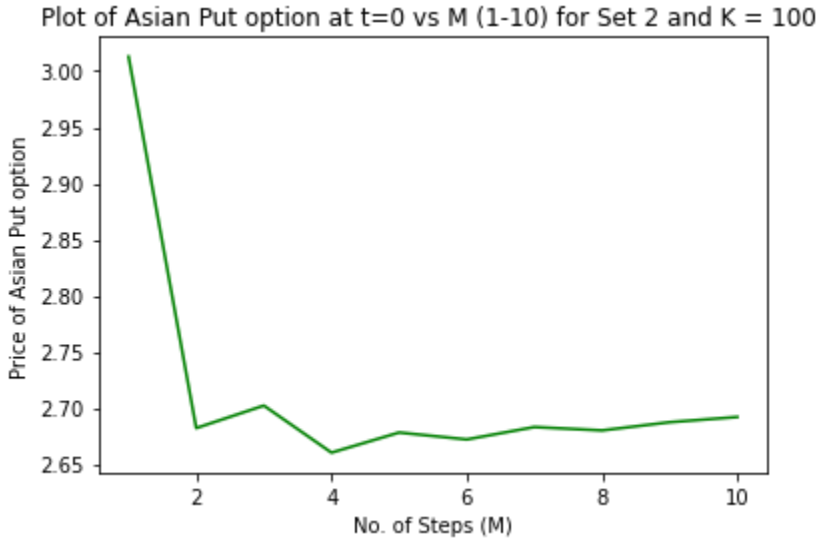

Plot of Asian Call option at t=0 vs M (1-10) for Set 1 and K = 100
Price of Asian Call option
6.7
6.6
6.5
6.4
6.3
2
4
6
8
10
No. of Steps (M)

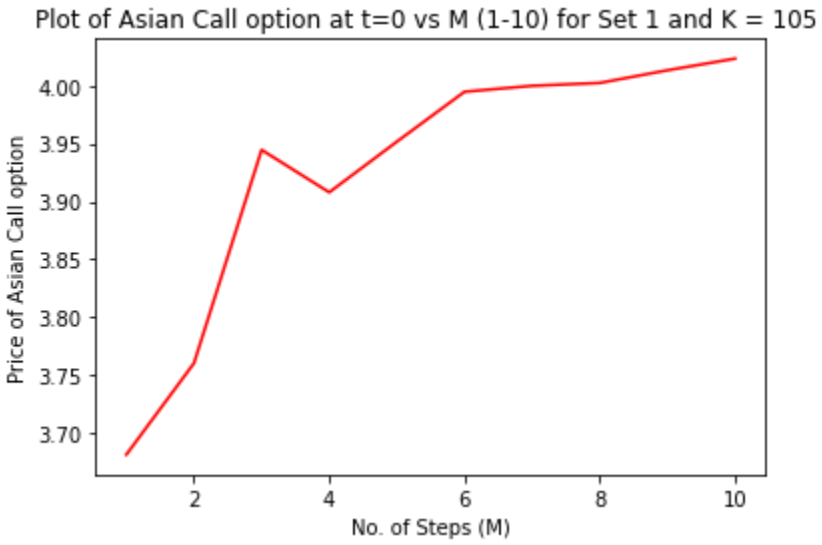

Plot of Asian Put option at t=0 vs M (1-10) for Set 1 and K = 100
Price of Asian Put option
2.85
2.80
2.75
2.70
2.65
2.60
2.55
2.50
2.45
2
4
6
8
10
No. of Steps (M)

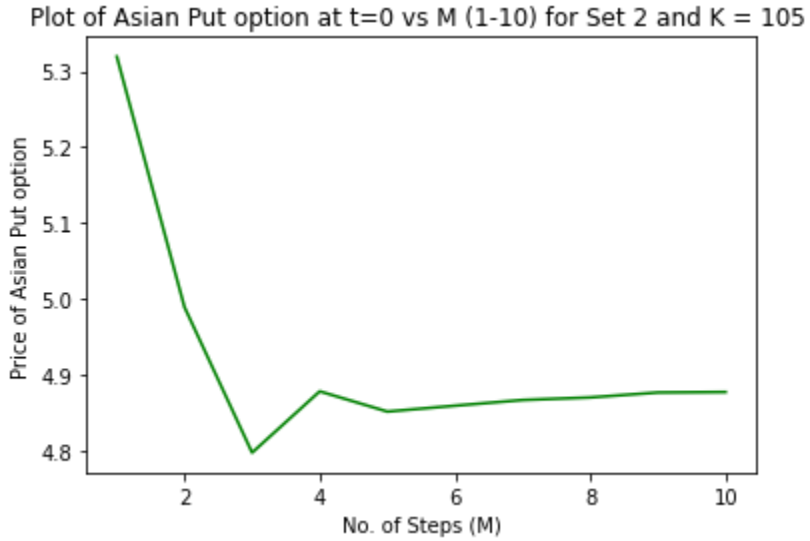

Plot of Asian Call option at t=0 vs M (1-10) for Set 2 and K = 100
Price of Asian Call option
6.85
6.80
6.75
6.70
6.65
6.60
6.55
6.50
6.45
2
4
6
8
10
No. of Steps (M)


Plot of Asian Put option at t=0 vs M (1-10) for Set 2 and K = 100
Price of Asian Put option
3.00
2.95
2.90
2.85
2.80
2.75
2.70
2.65
2
4
6
8
10
No. of Steps (M)

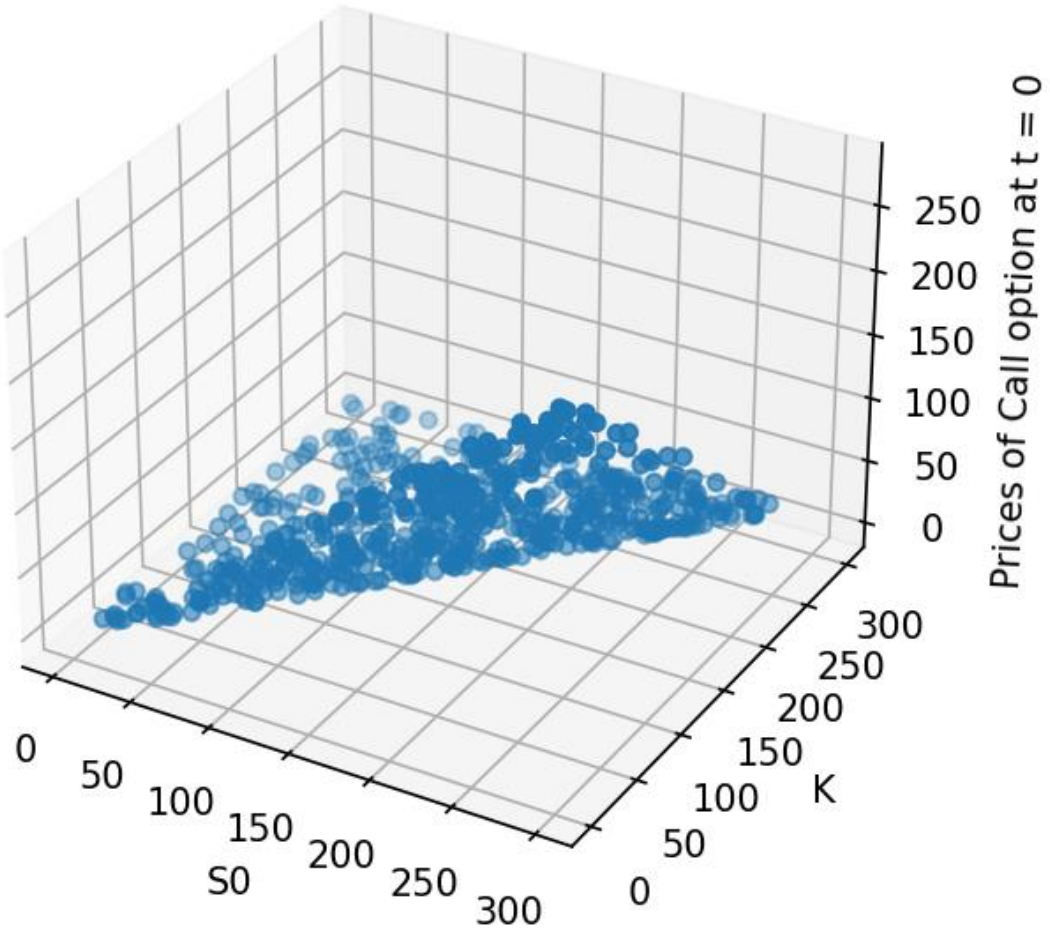

Plot of Asian Call option at t=0 vs M (1-10) for Set 1 and K = 105
Price of Asian Call option
4.00
3.95
3.90
3.85
3.80
3.75
3.70
2
4
6
8
10
No. of Steps (M)

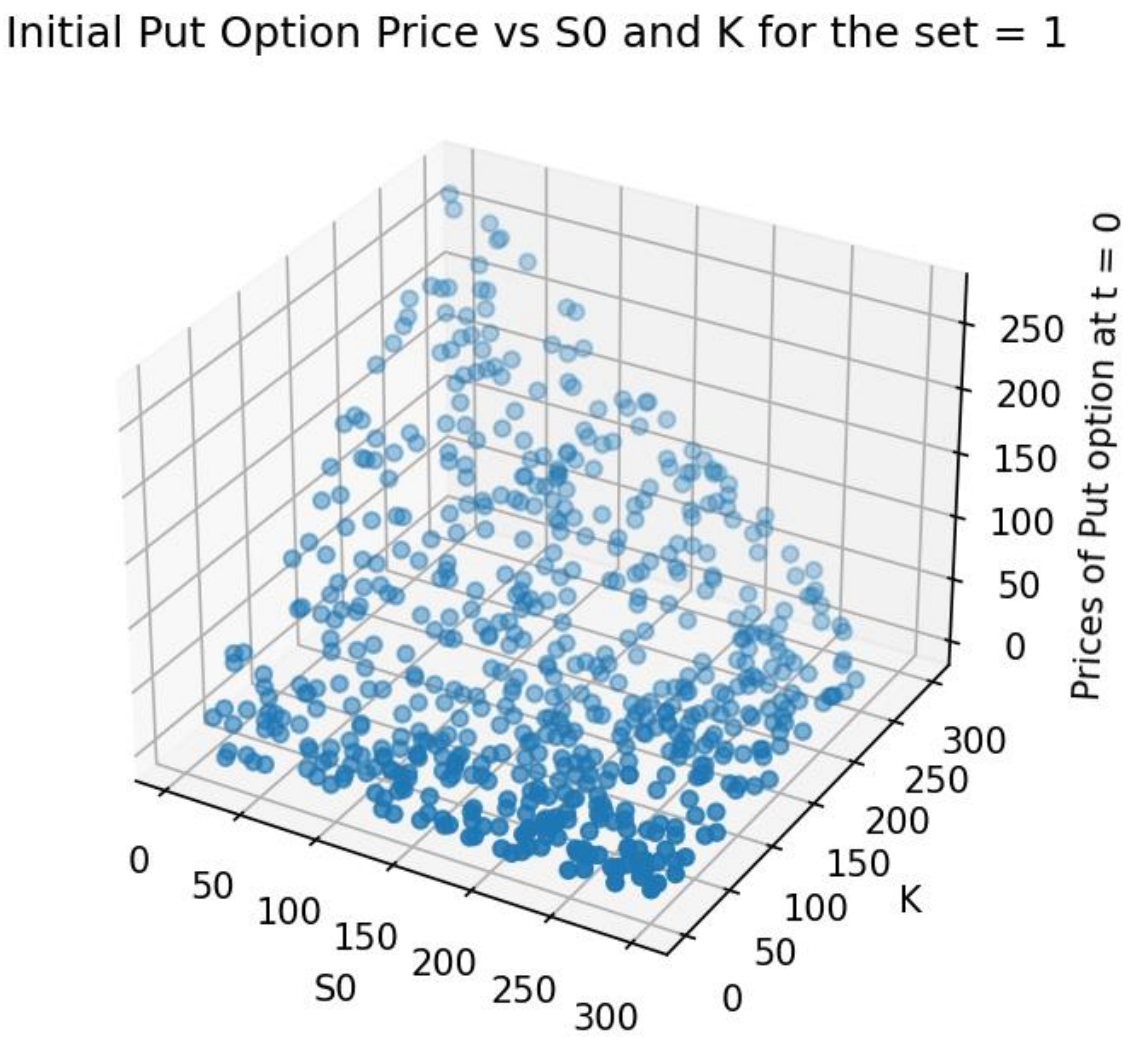

Plot of Asian Put option at t=0 vs M (1-10) for Set 2 and K = 100
Price of Asian Put option
3.00
2.95
2.90
2.85
2.80
2.75
2.70
2.65
2
4
6
8
10
No. of Steps (M)

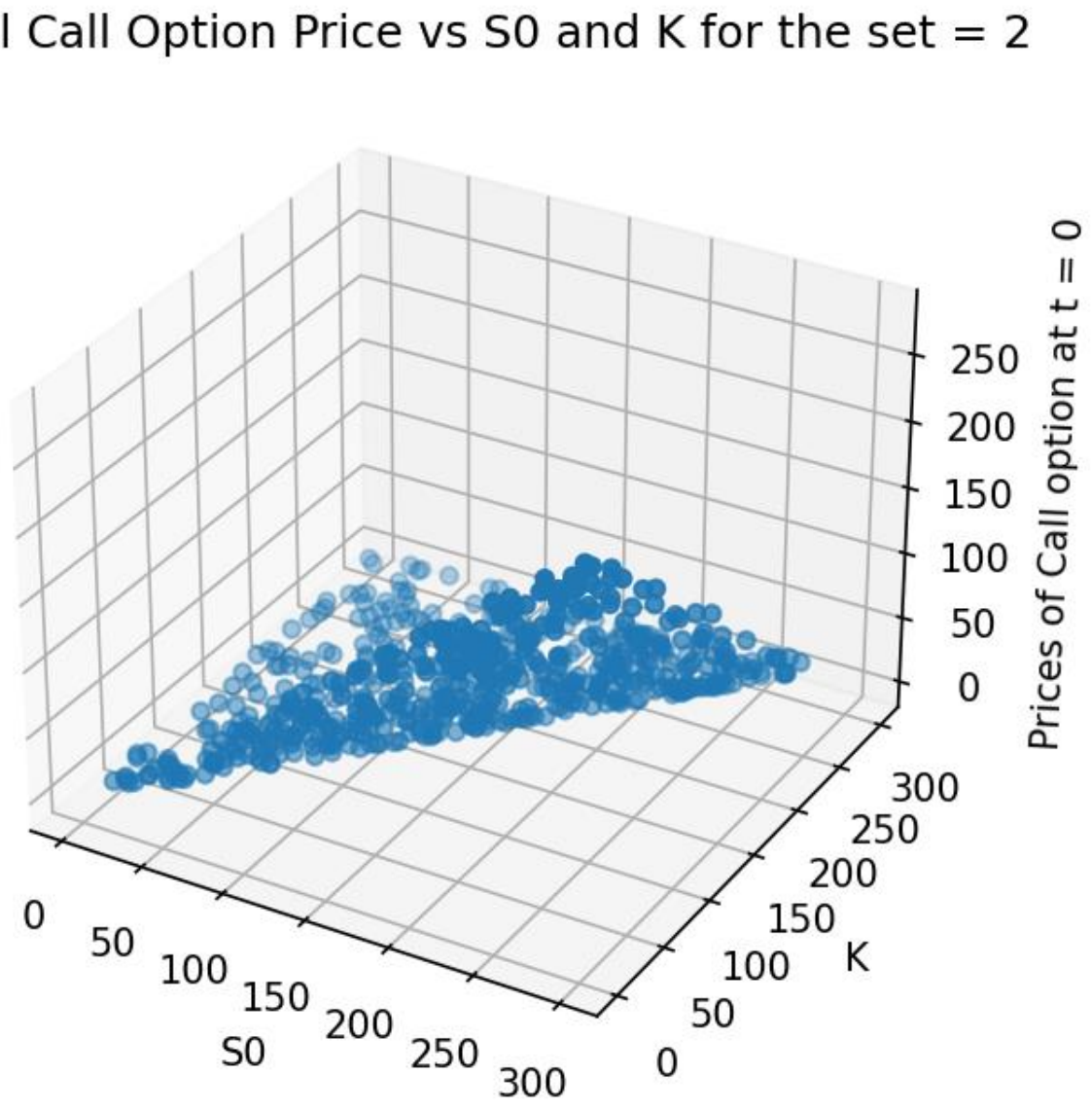

Plot of Asian Call option at t=0 vs M (1-10) for Set 1 and K = 105
Price of Asian Call option
4.00
3.95
3.90
3.85
3.80
3.75
3.70
2
4
6
8
10
No. of Steps (M)

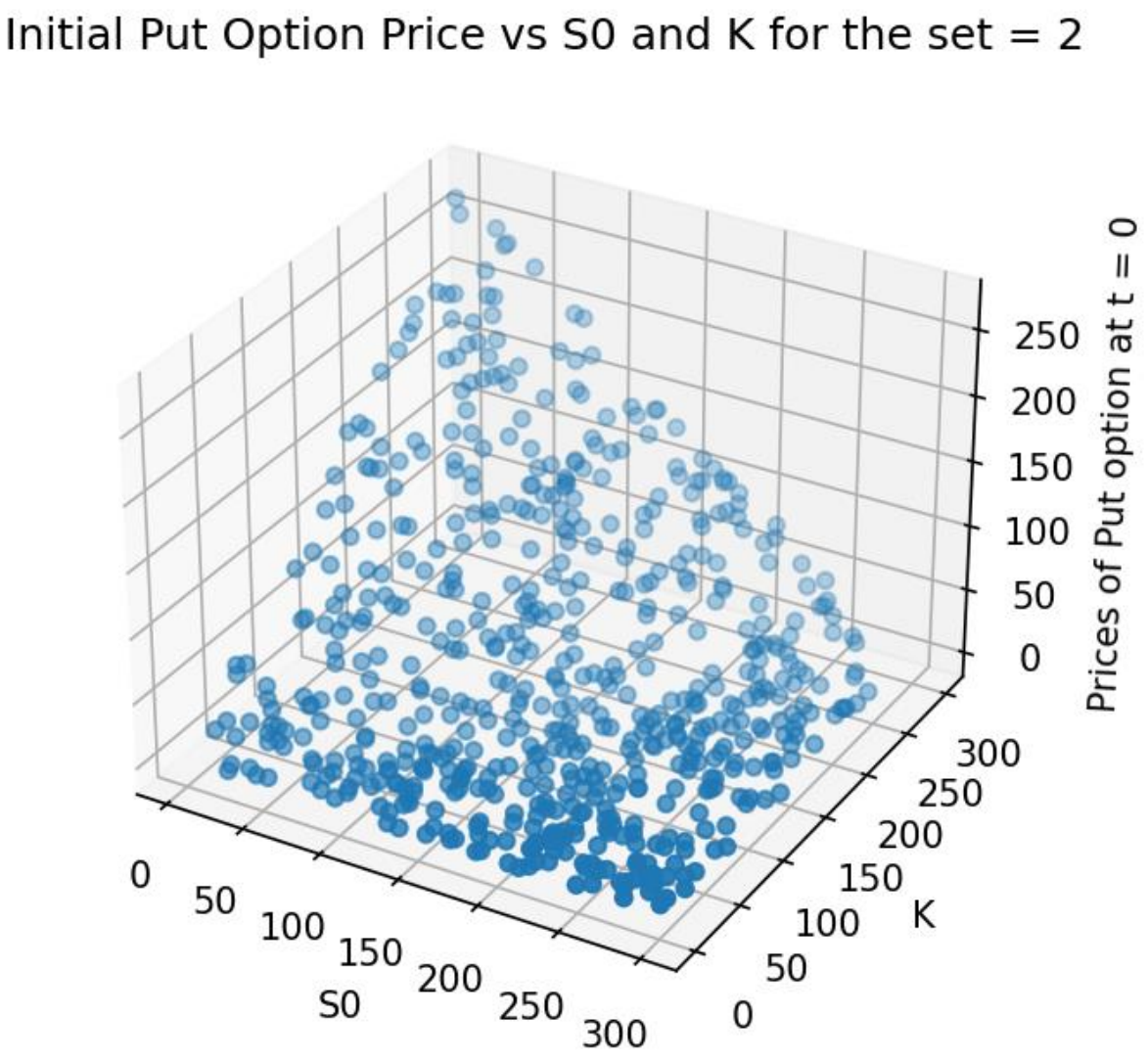

Plot of Asian Put option at t=0 vs M (1-10) for Set 2 and K = 105
Price of Asian Put option
5.3
5.2
5.1
5.0
4.9
4.8
2
4
6
8
10
No. of Steps (M)

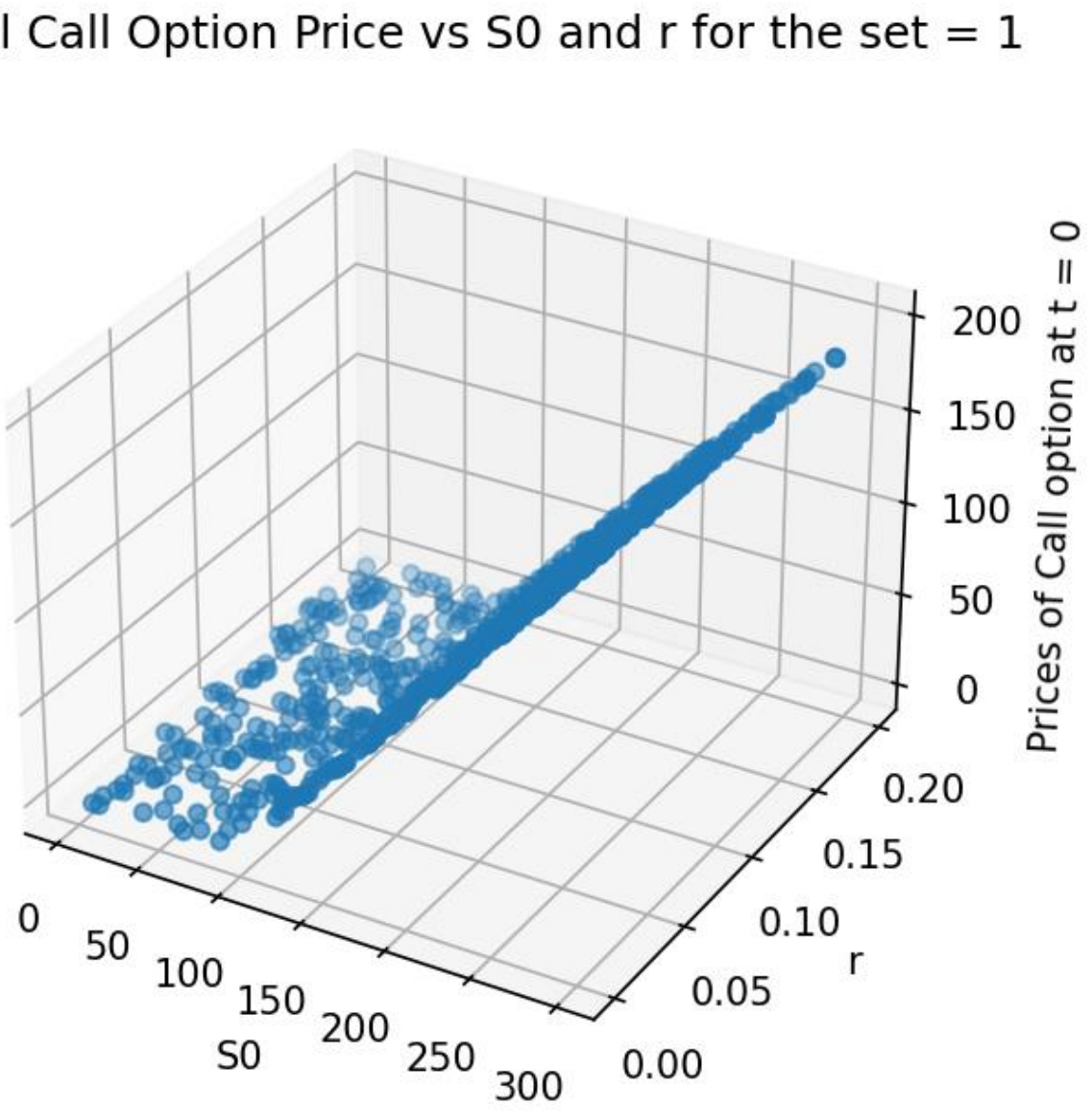
3D Plots (2 params at a time)

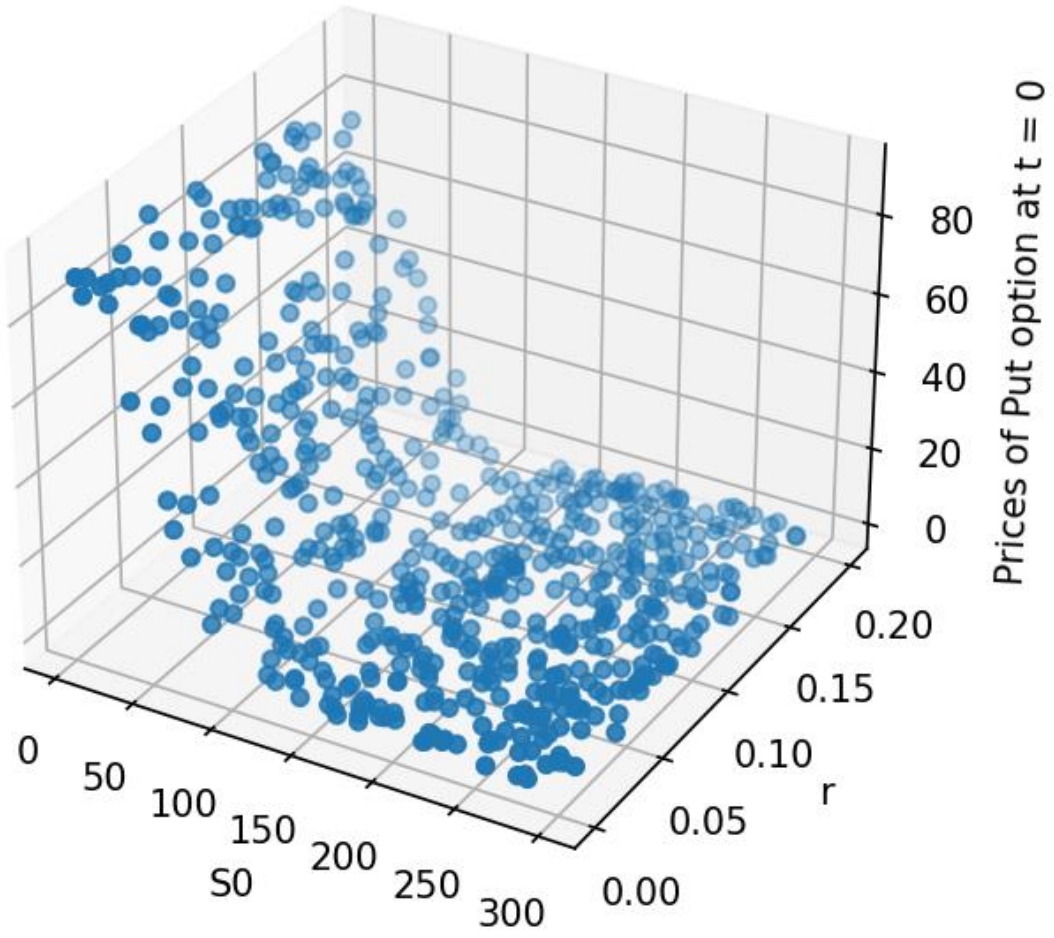


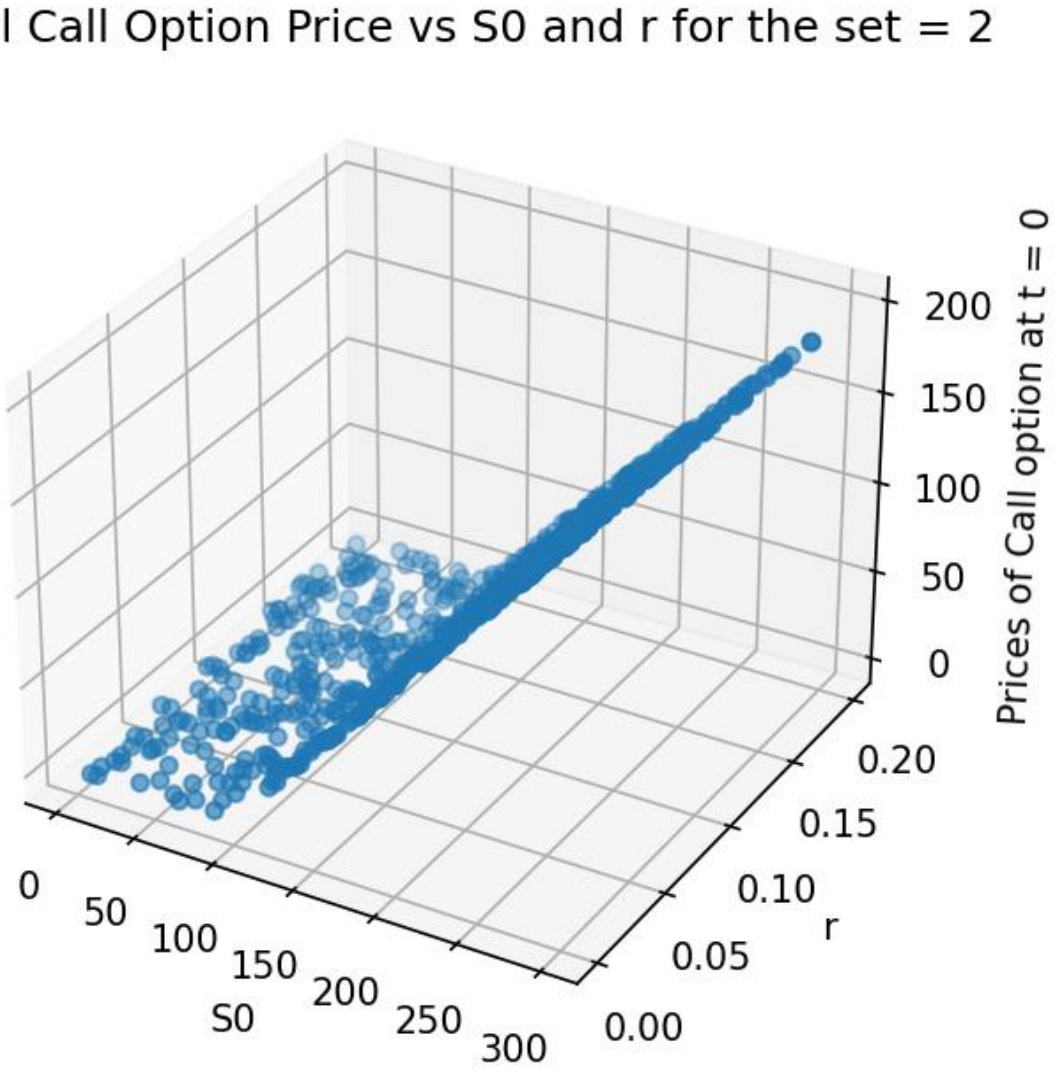

Initial Put Option Price vs S0 and K for the set = 1
Prices of Put option at t = 0
0
50
100
150
200
250
S0
0
50
100
150
200
250
300
K

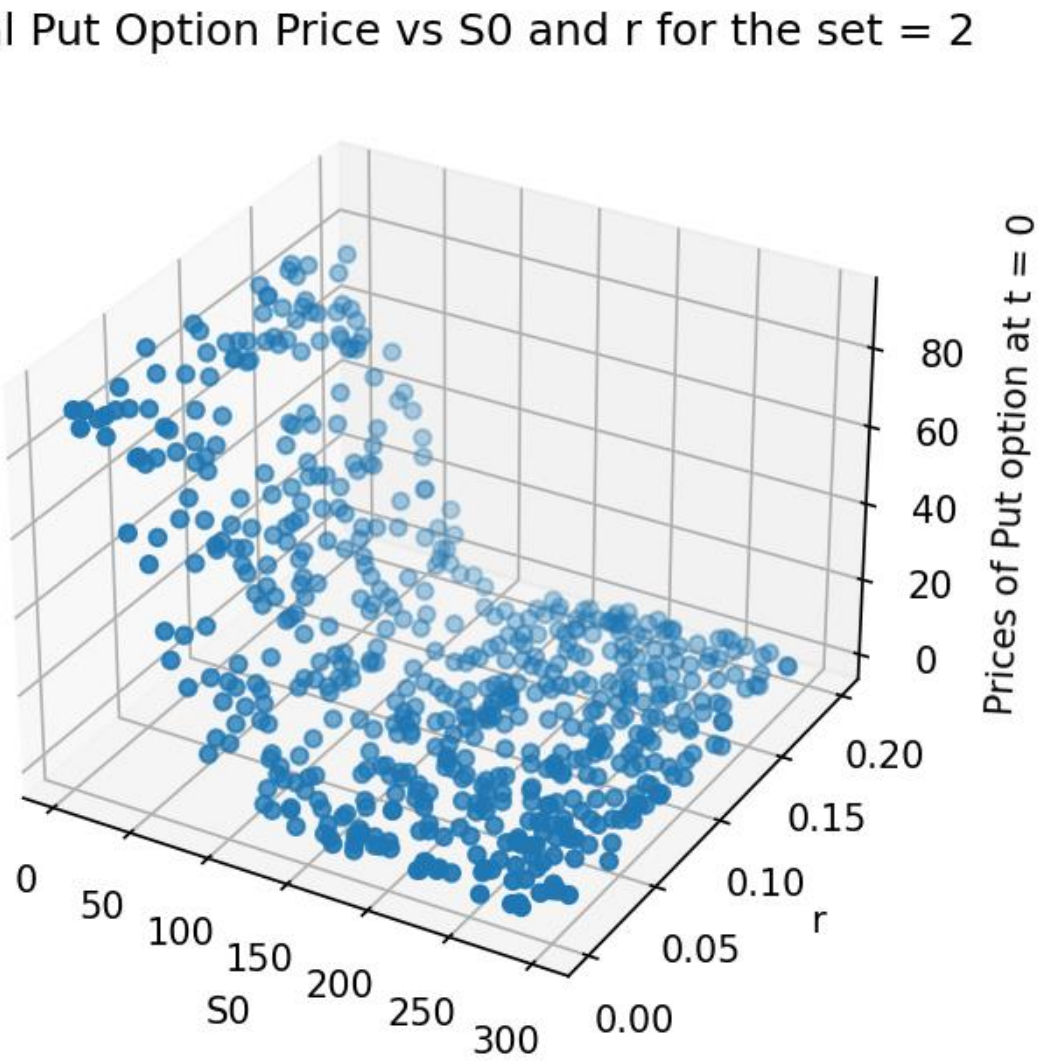

Initial Call Option Price vs S0 and K for the set = 2
Prices of Call option at t = 0
0
50
100
150
200
250
S0
0
50
100
150
200
250
300
K
0
50
100
150
200
250
300

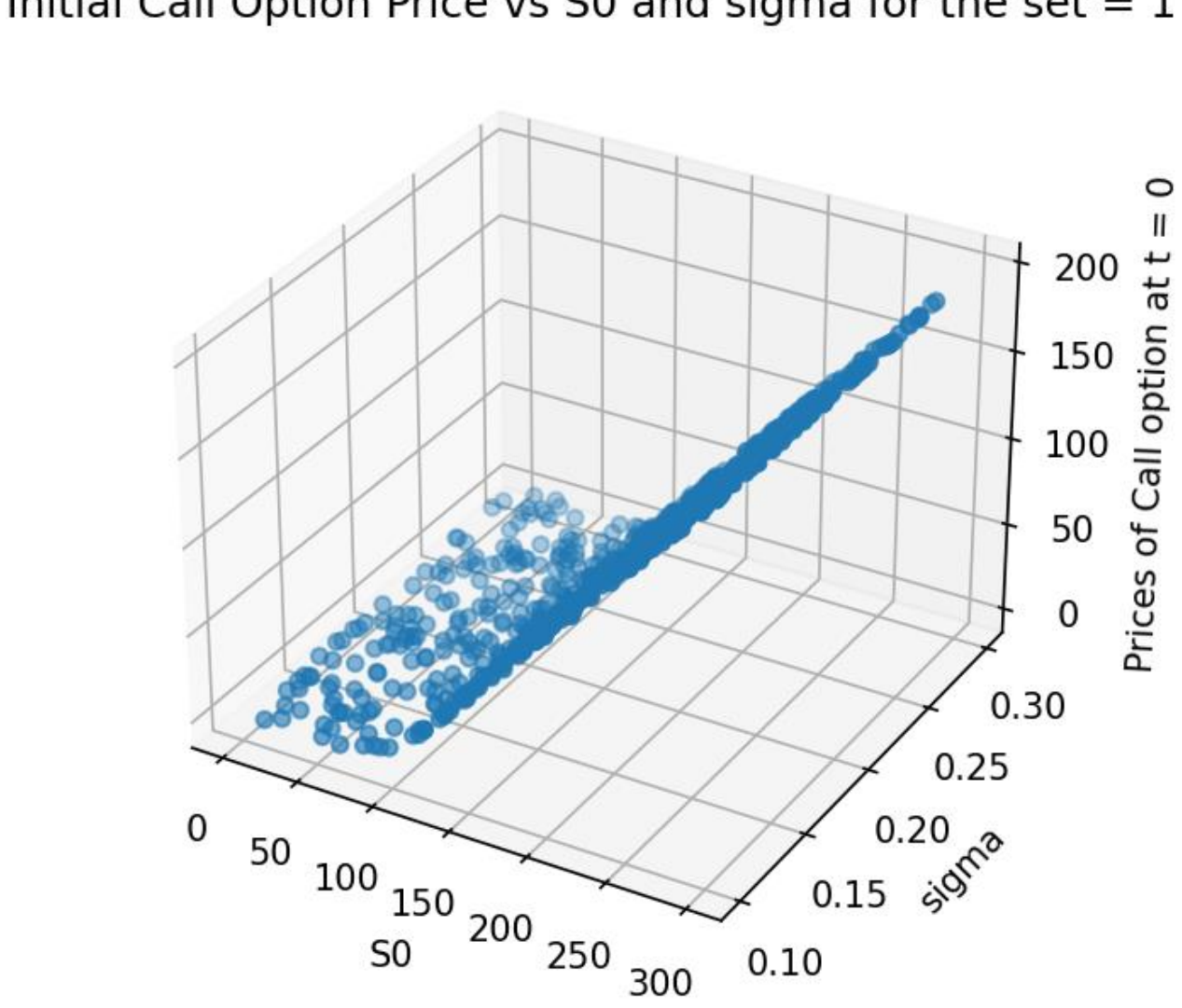

Initial Put Option Price vs S0 and K for the set = 2
Prices of Put option at t = 0
0
50
100
150
200
250
S0
0
50
100
150
200
250
300
K


Initial Call Option Price vs S0 and r for the set = 1
Prices of Call option at t = 0
200
150
100
50
0
0.20
0.15
0.10
0.05
0.00
r
0
50
100
150
200
250
300
S0

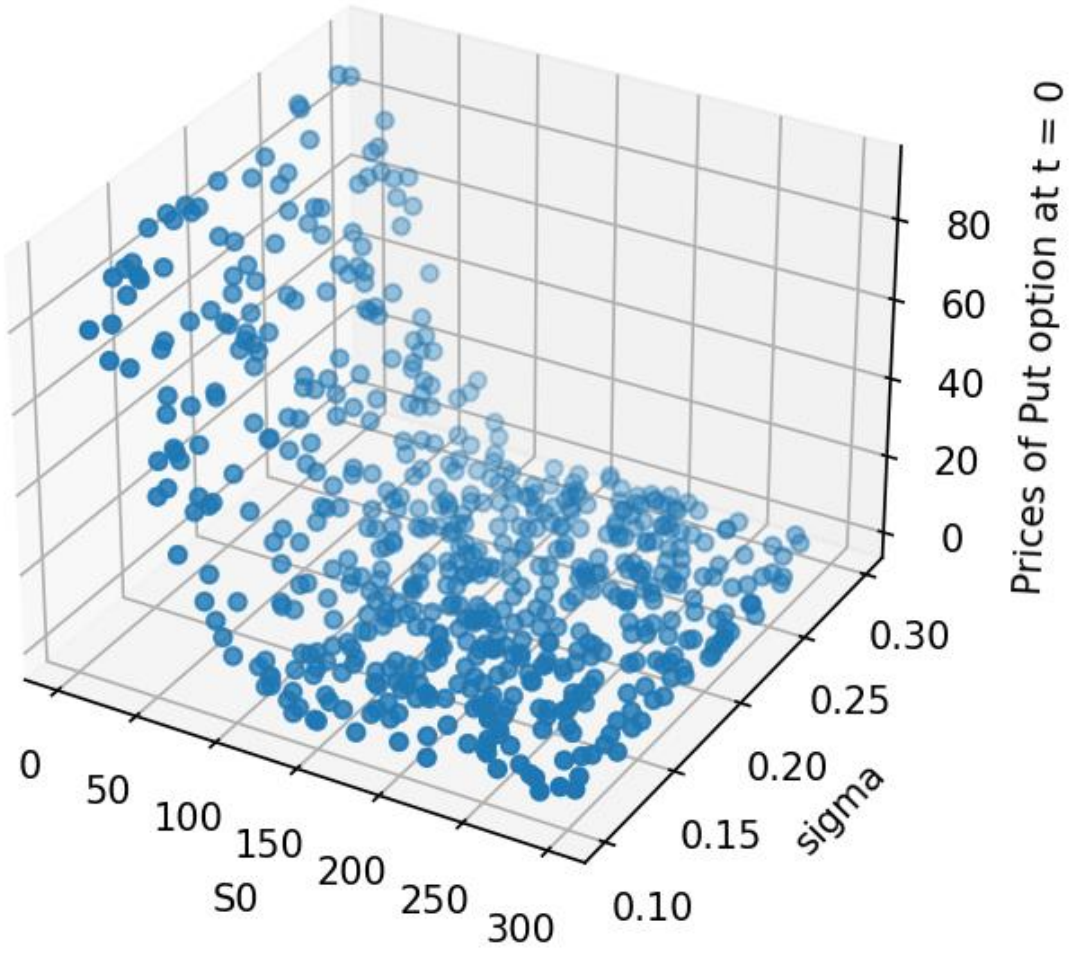

Initial Put Option Price vs S0 and r for the set = 1
Prices of Put option at t = 0
0
20
40
60
80
S0
0
50
100
150
200
250
300
r
0.00
0.05
0.10
0.15
0.20


Initial Call Option Price vs S0 and r for the set = 2
Prices of Call option at t = 0
200
150
100
50
0
0.20
0.15
0.10
0.05
0.00
r
0
50
100
150
200
250
300
S0

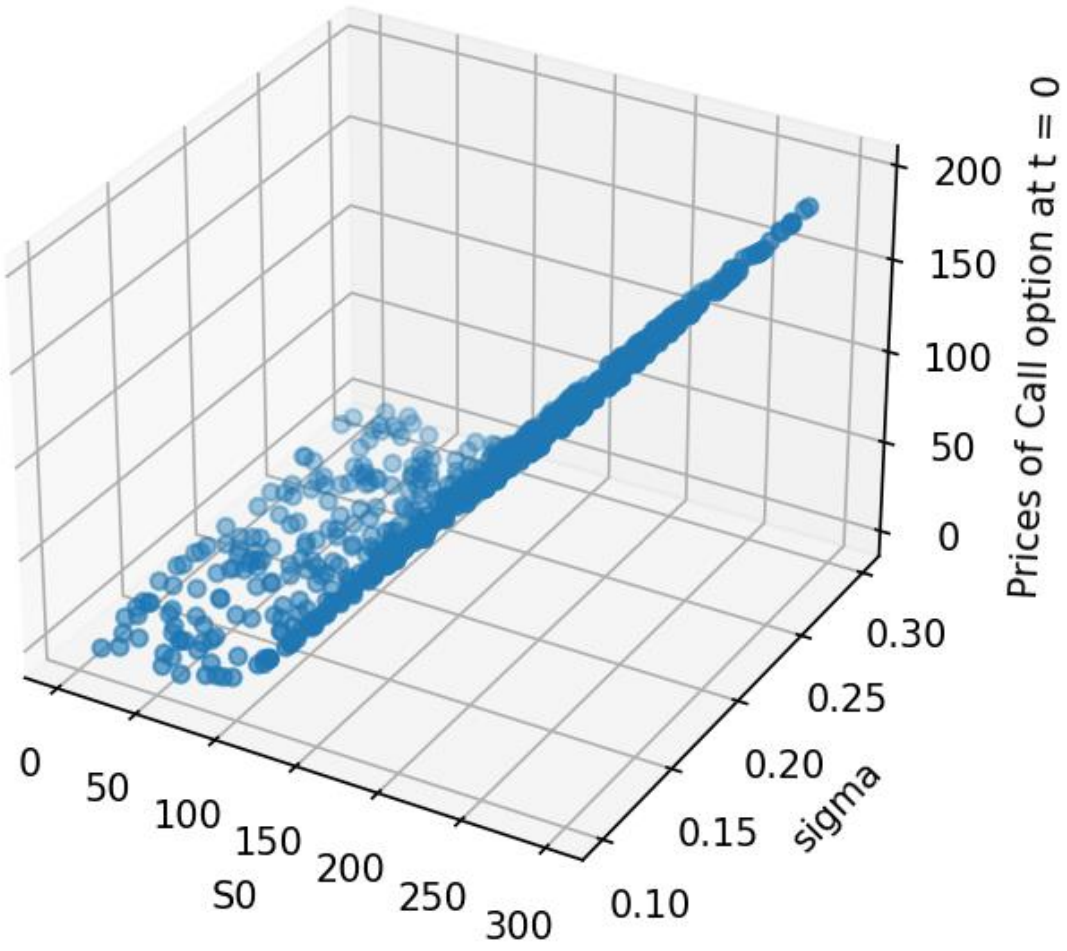

Initial Put Option Price vs S0 and r for the set = 2
Prices of Put option at t = 0
0
20
40
60
80
S0
0
50
100
150
200
250
300
r
0.00
0.05
0.10
0.15
0.20


Initial Call Option Price vs S0 and sigma for the set = 1
Prices of Call option at t = 0
200
150
100
50
0
0.30
0.25
0.20
0.15
0.10
sigma
0
50
100
150
200
250
300
S0

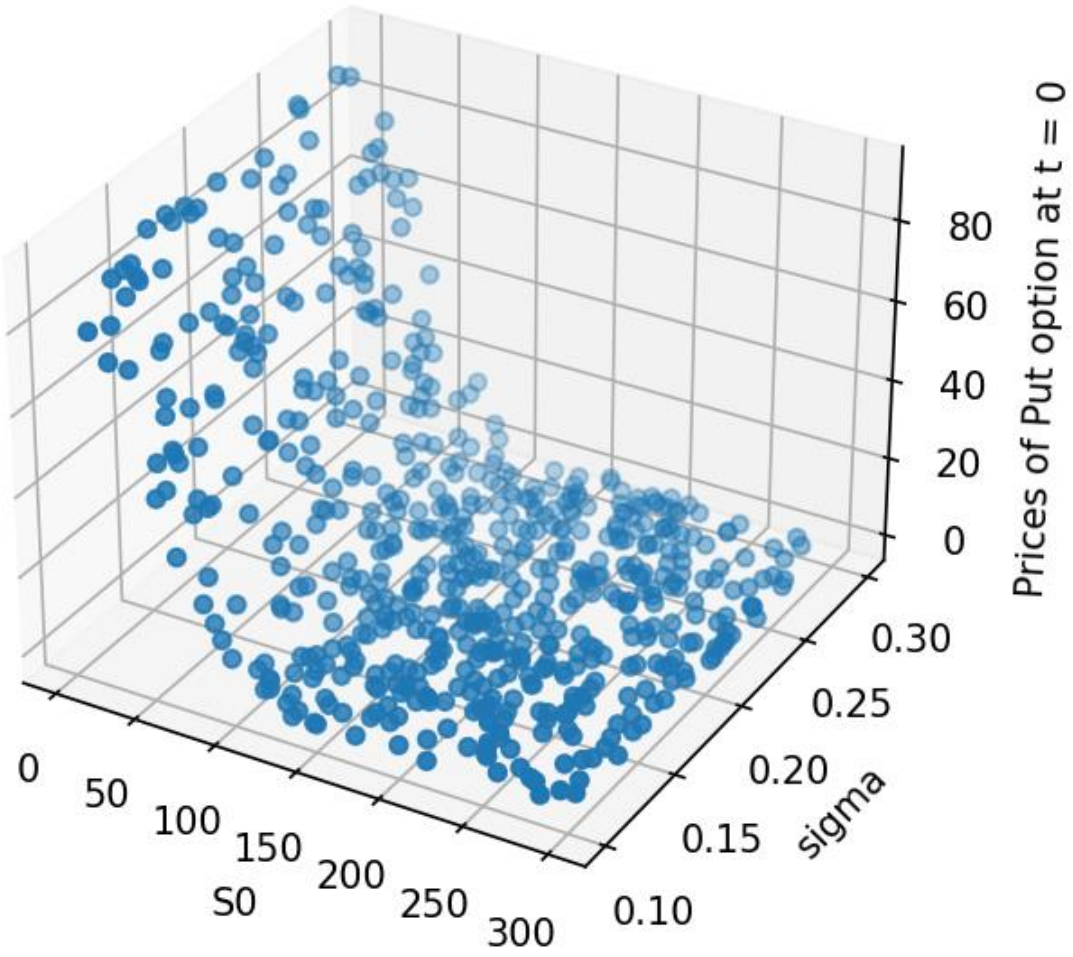
Initial Put Option Price vs S0 and sigma for the set = 1

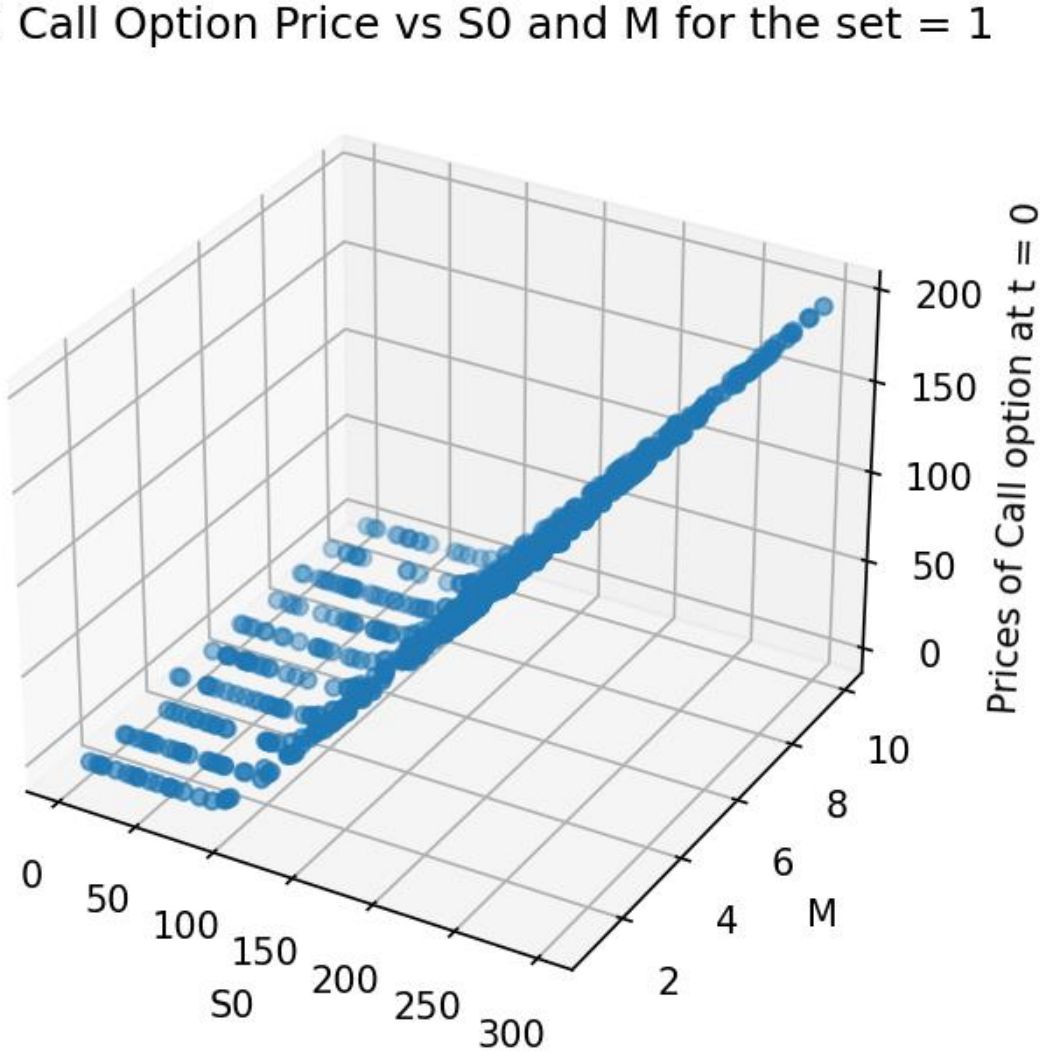


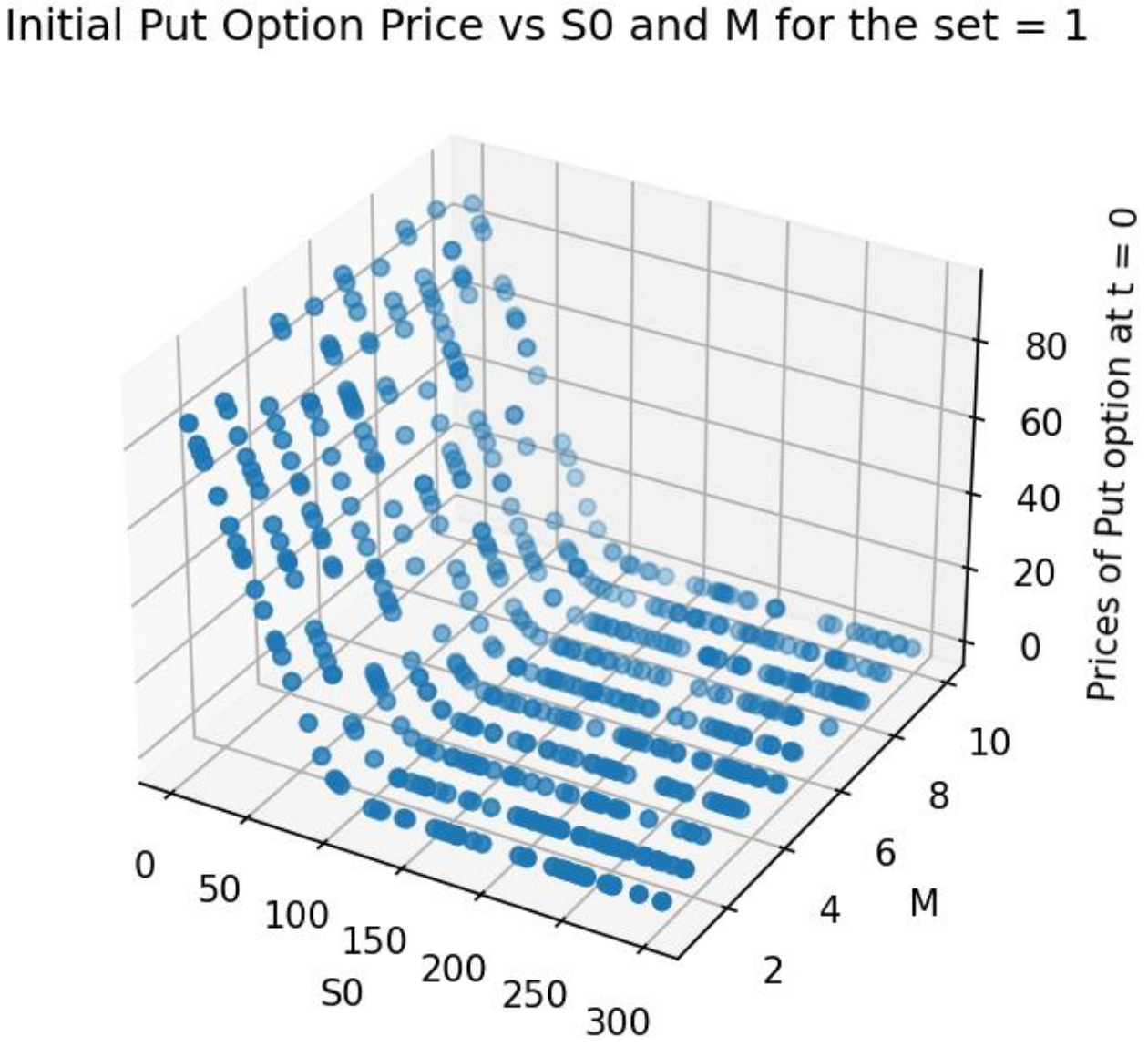
Initial Call Option Price vs S0 and sigma for the set = 2

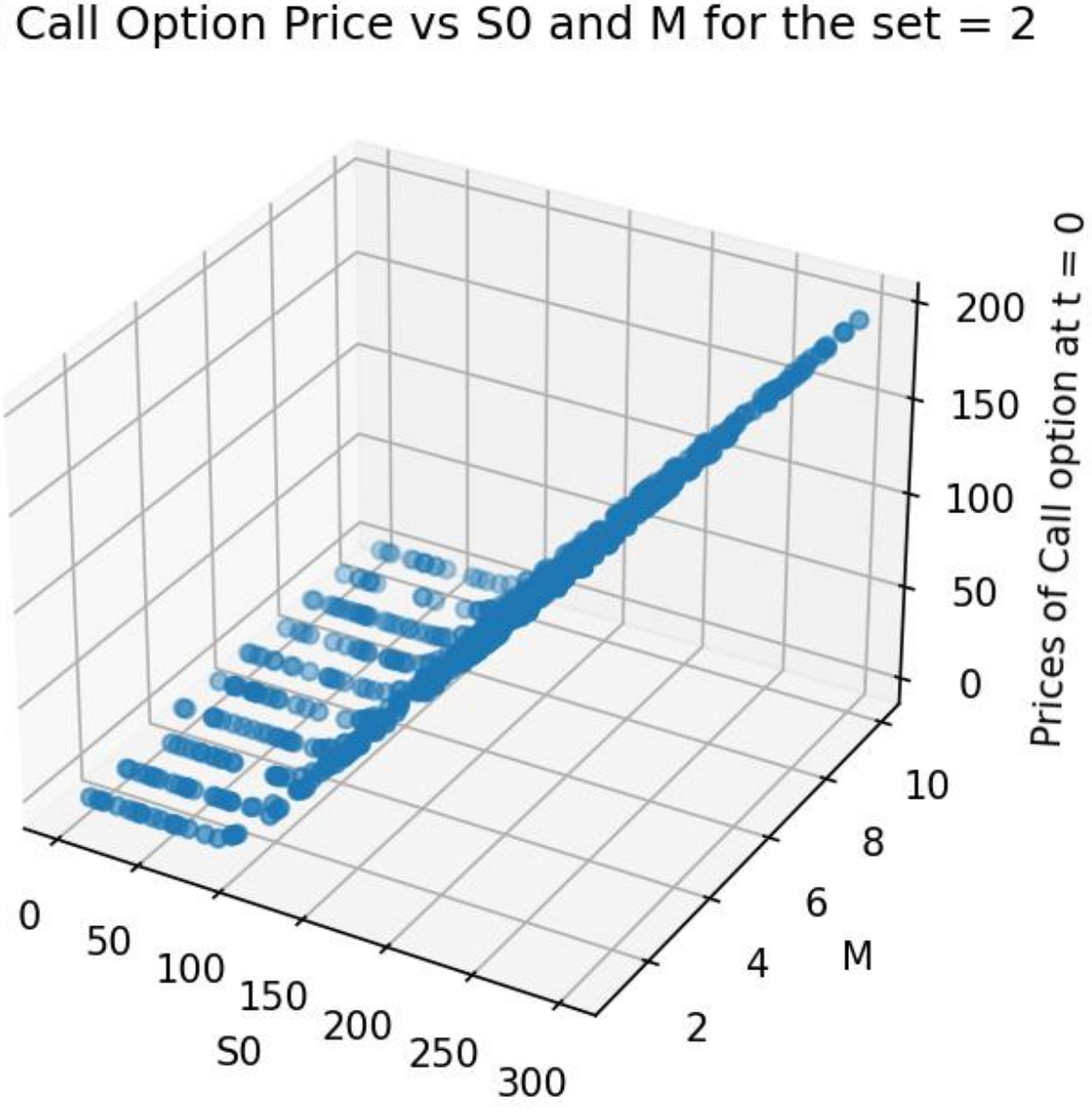


Initial Put Option Price vs S0 and sigma for the set = 2

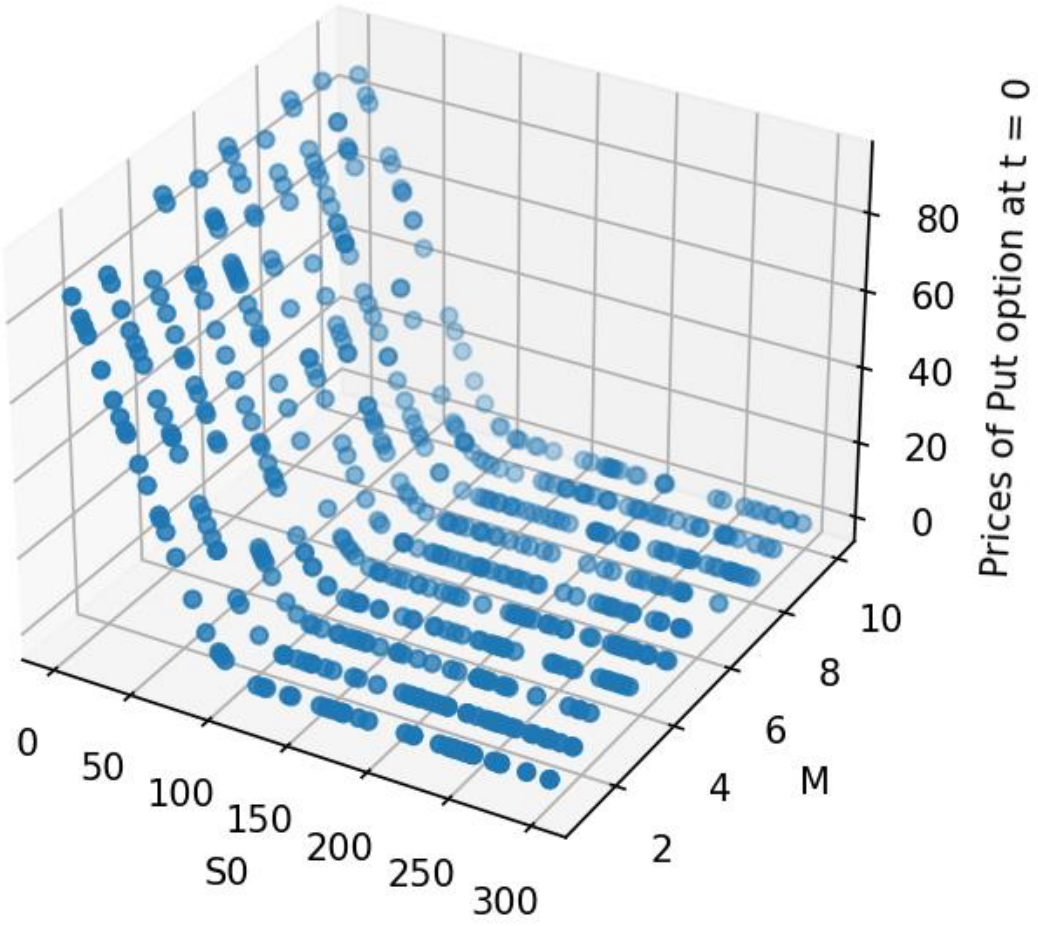


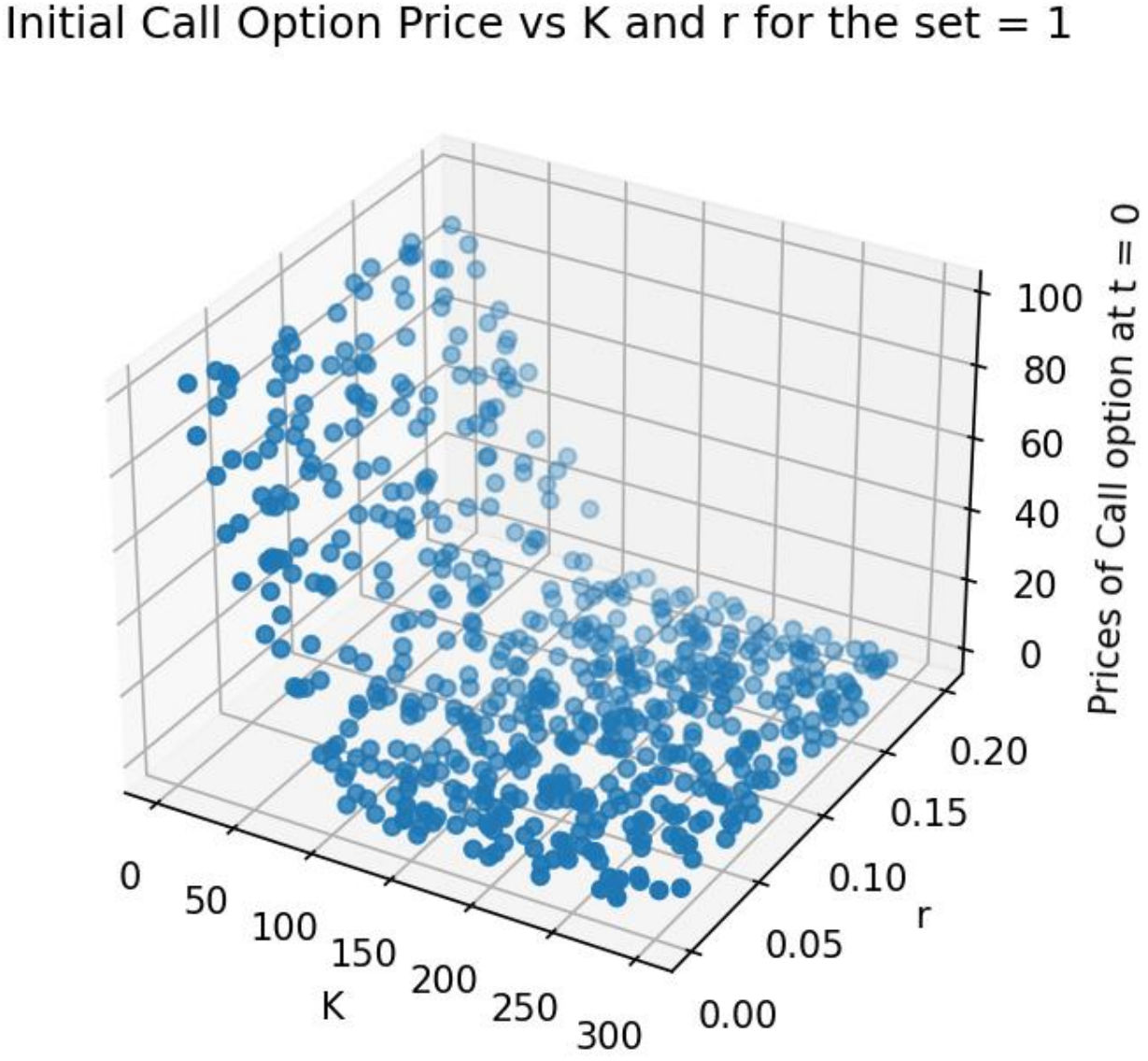

Initial Call Option Price vs S0 and M for the set = 1
Prices of Call option at t = 0
200
150
100
50
0
10
8
6
4
2
M
0
50
100
150
200
250
300
S0

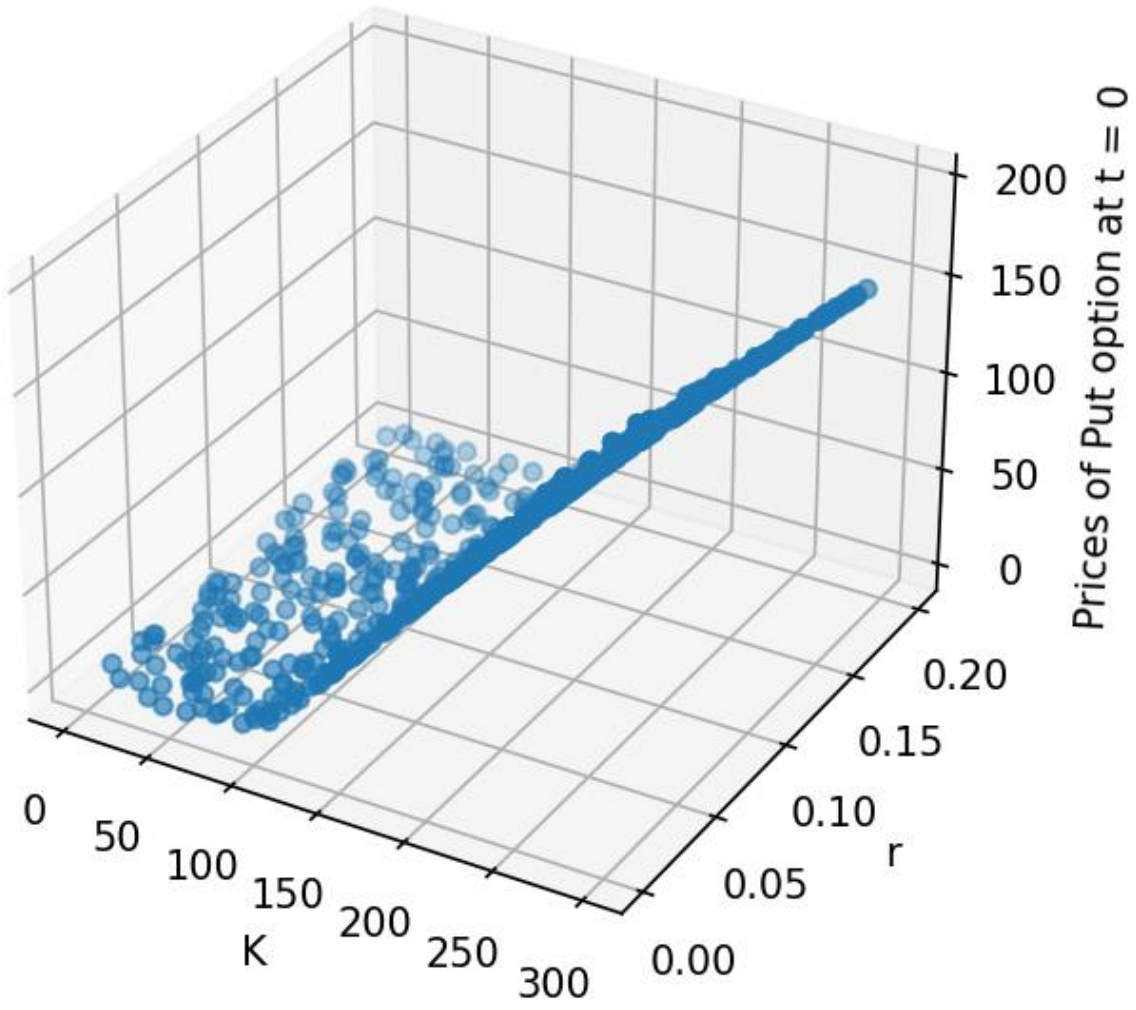

Initial Put Option Price vs S0 and M for the set = 1
Prices of Put option at t = 0
0
20
40
60
80
0
50
100
150
200
250
300
S0
2
4
6
8
10
M


Initial Call Option Price vs S0 and M for the set = 2
Prices of Call option at t = 0
200
150
100
50
0
10
8
6
4
2
M
0
50
100
150
200
250
300
S0

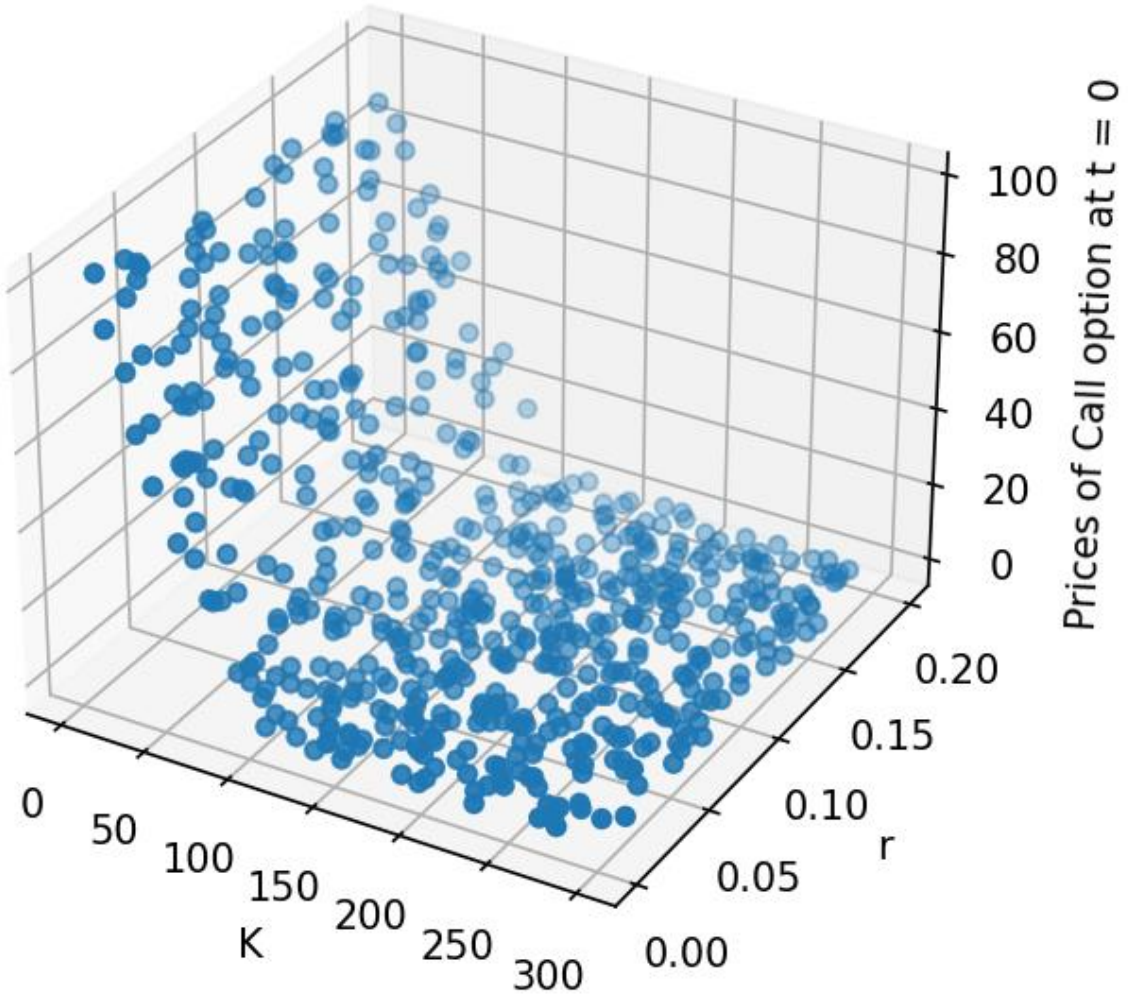
Initial Put Option Price vs S0 and M for the set = 2



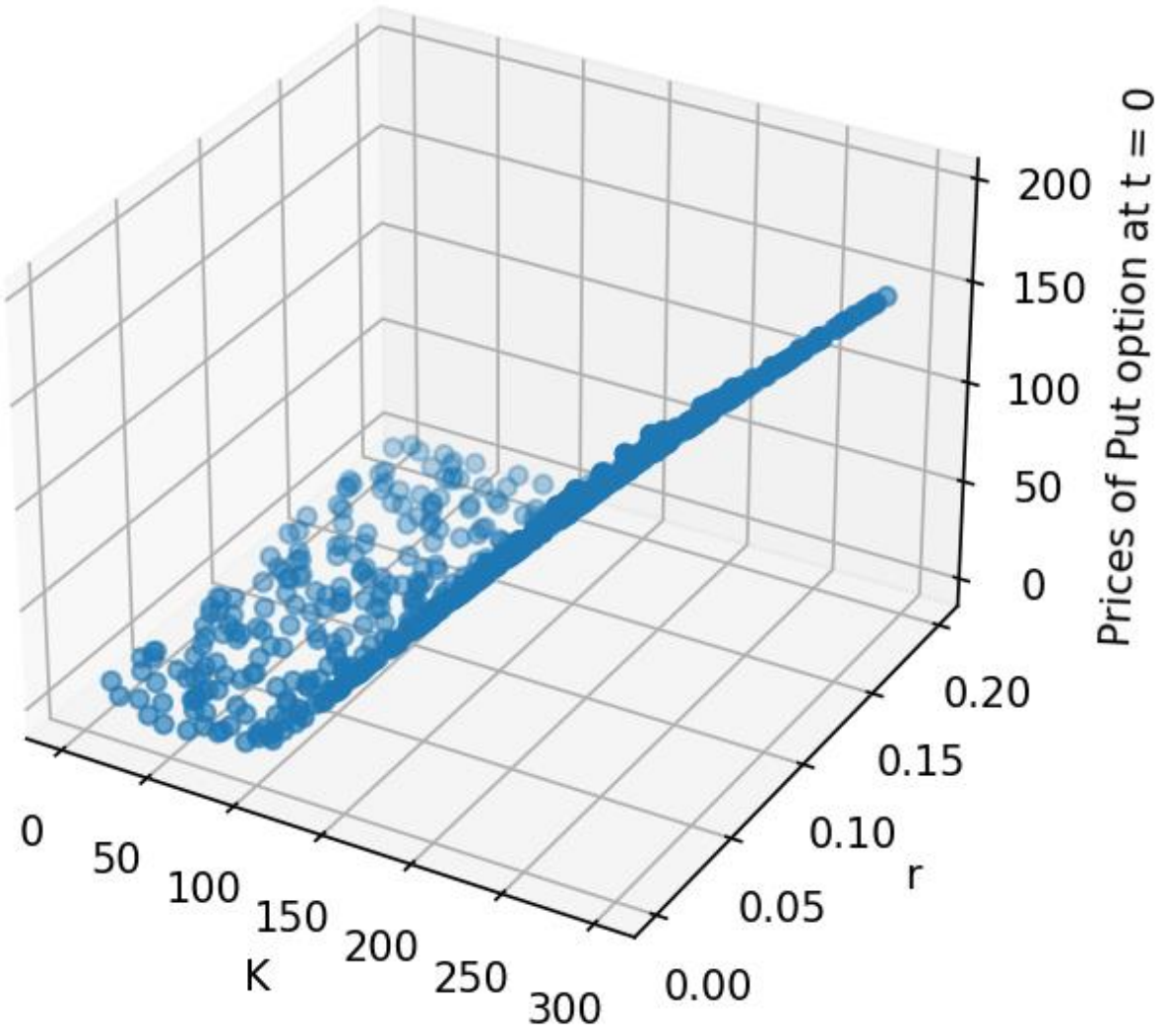

Initial Call Option Price vs K and r for the set = 1
Prices of Call option at t = 0
100
80
60
40
20
0
0
50
100
150
200
250
300
K
0.00
0.05
0.10
0.15
0.20
r


Initial Put Option Price vs K and r for the set = 1
Prices of Put option at t = 0
200
150
100
50
0
0
50
100
150
200
250
300
K
0.00
0.05
0.10
0.15
0.20
r

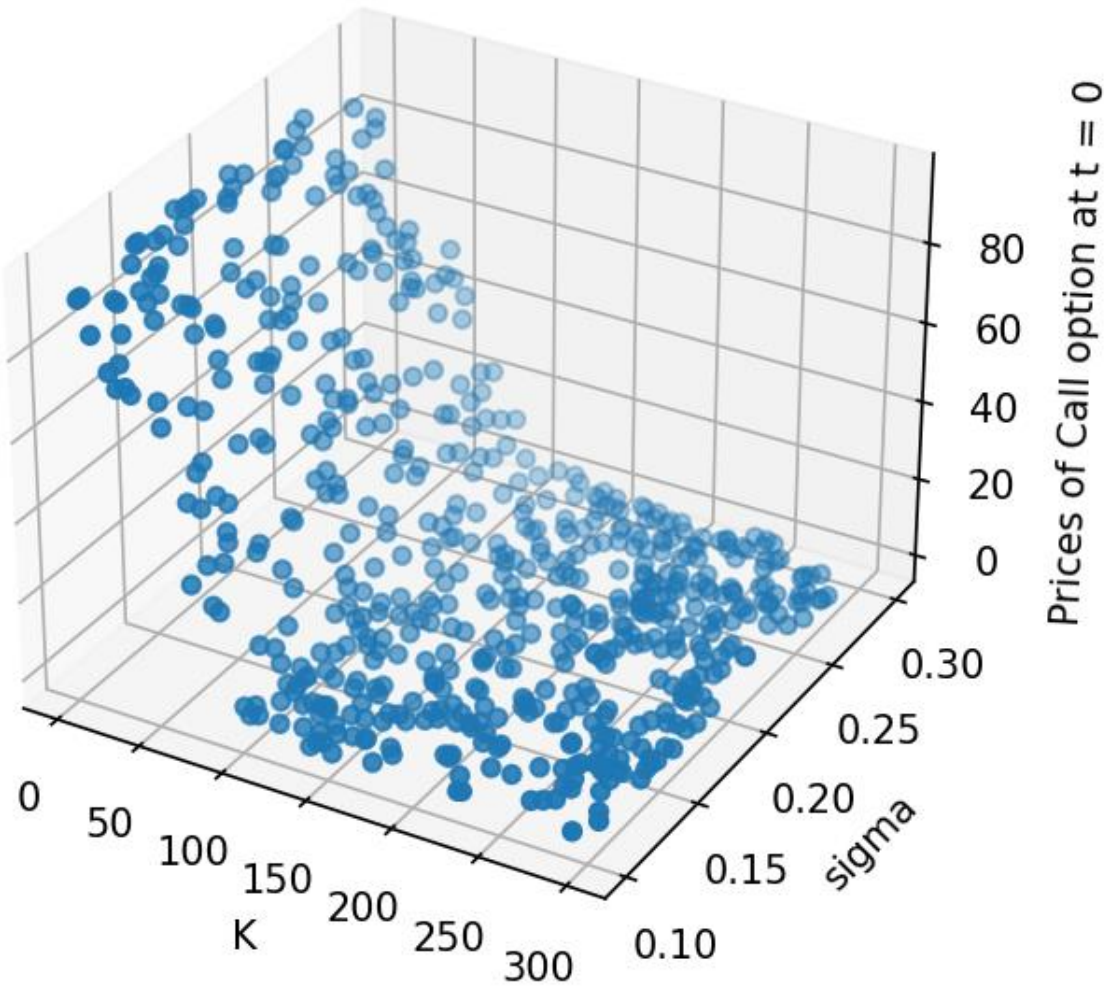
Initial Call Option Price vs K and r for the set = 2

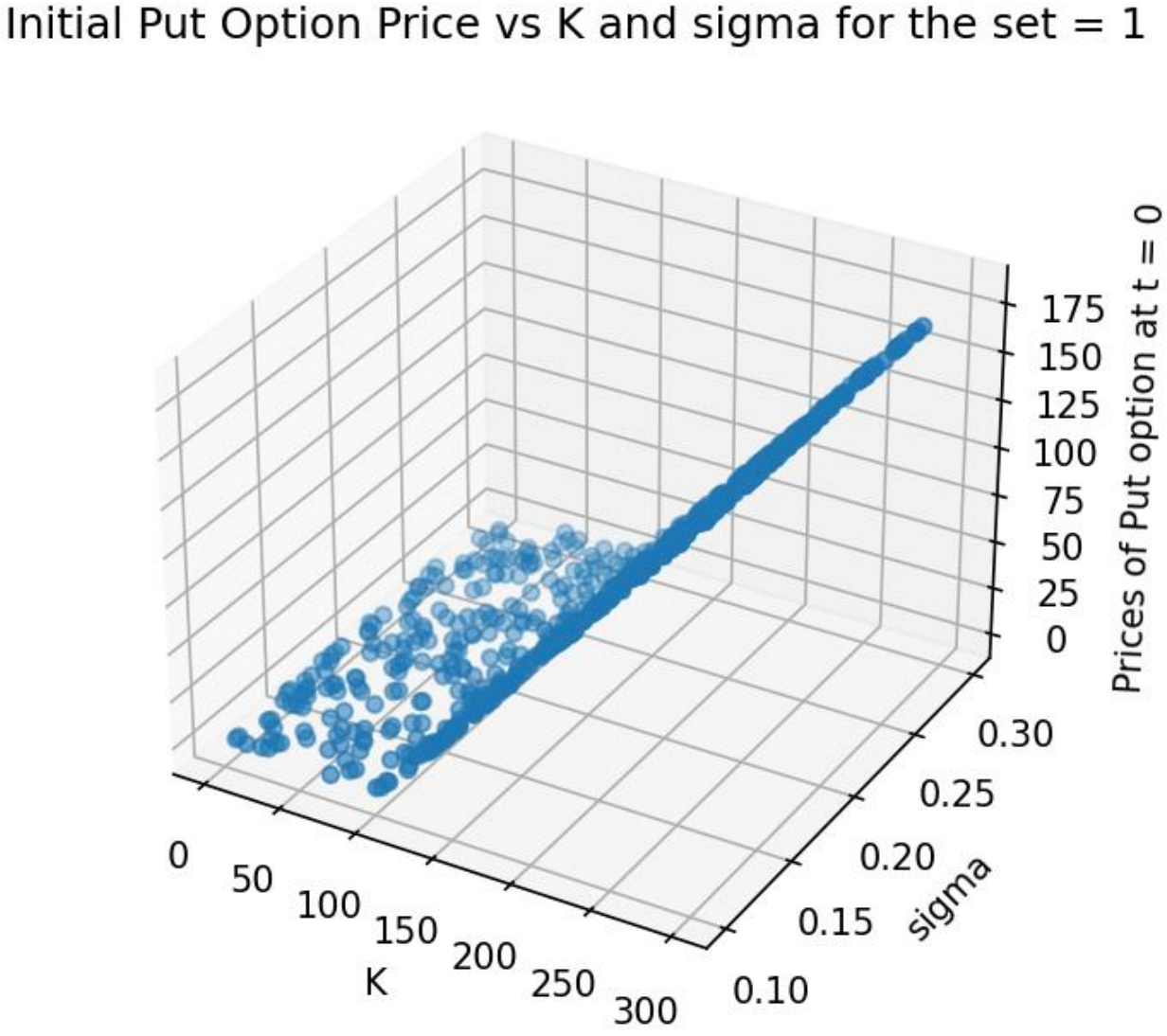


Initial Put Option Price vs K and r for the set = 2

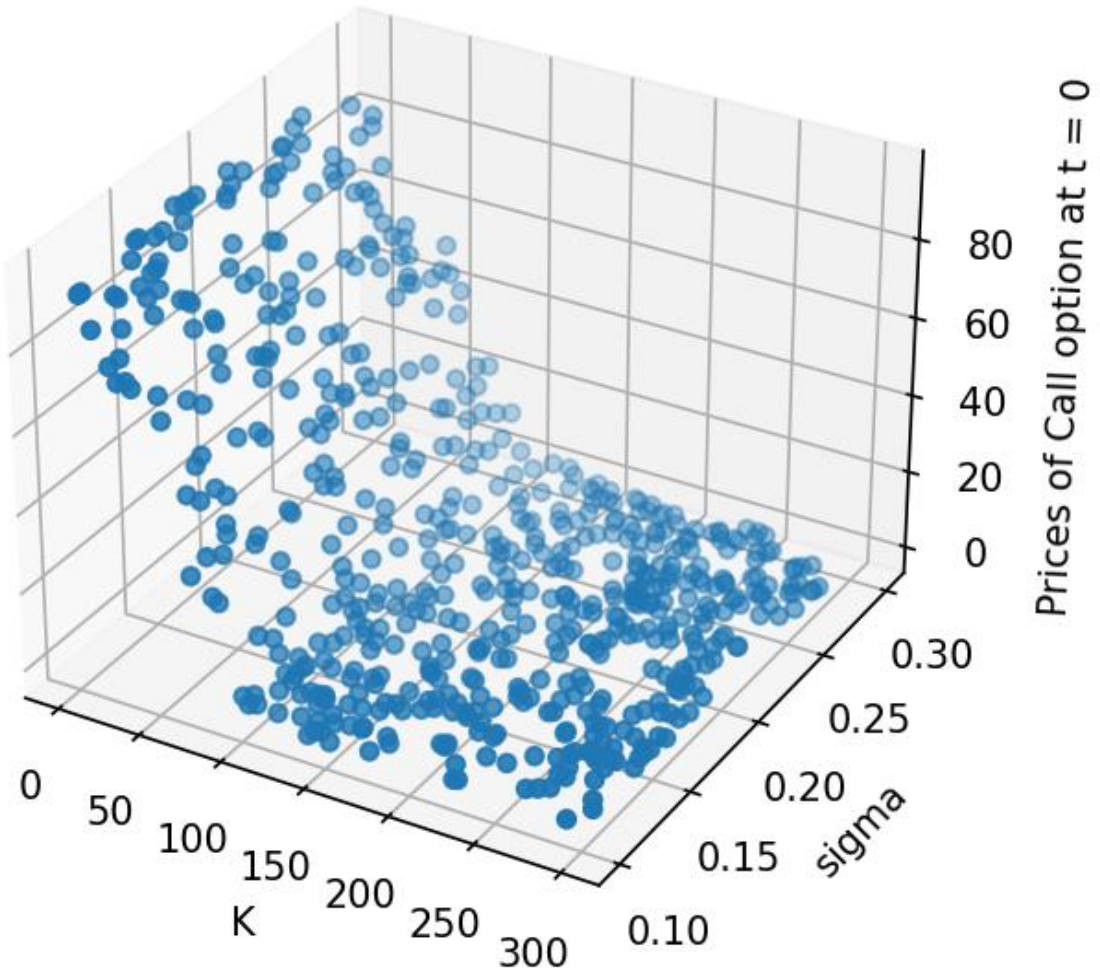


Initial Call Option Price vs K and sigma for the set = 1

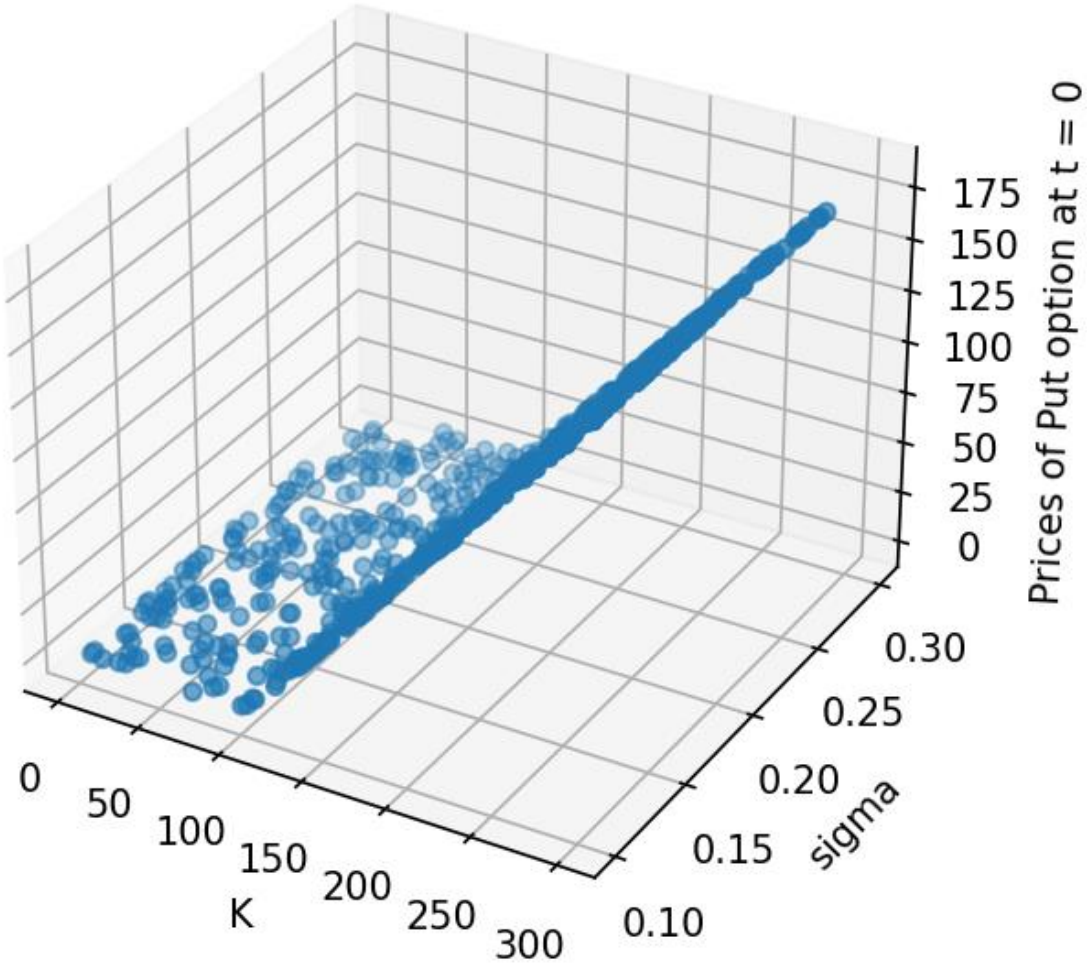


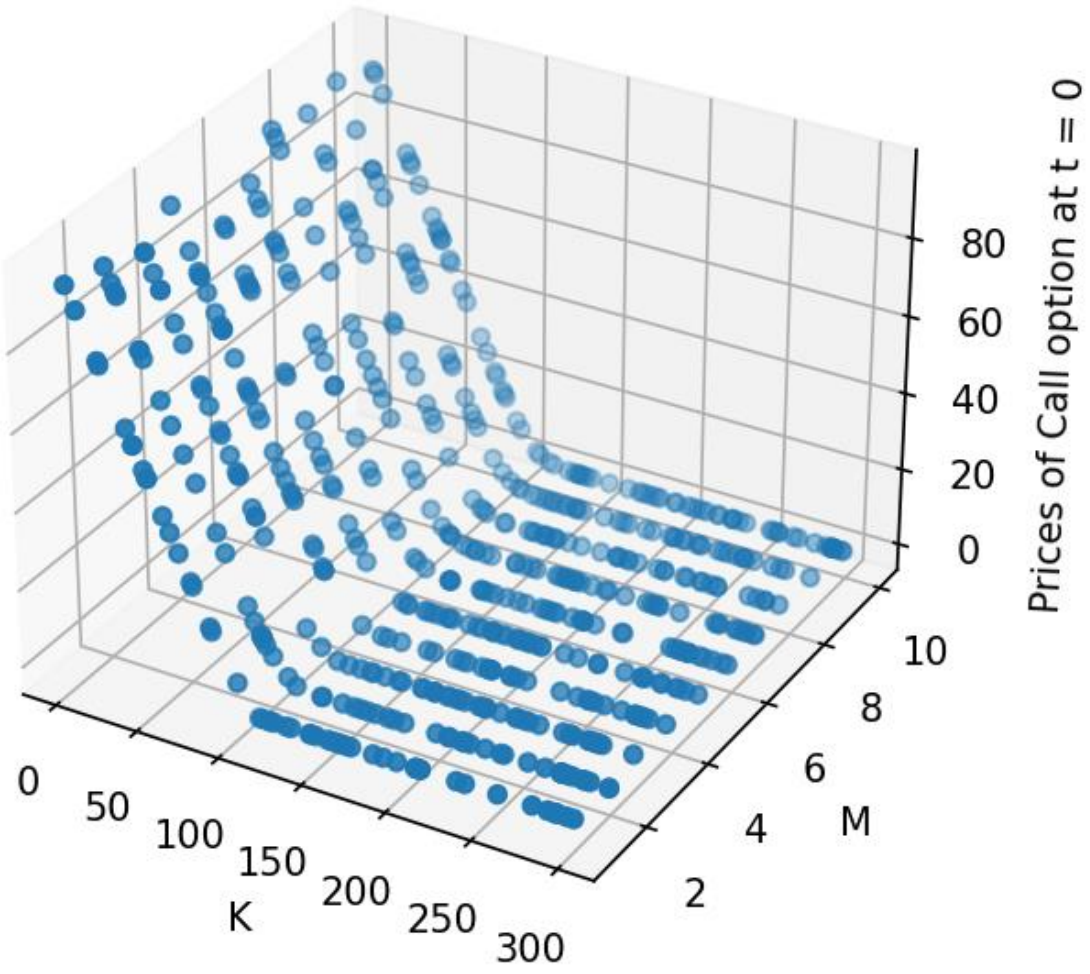

Initial Put Option Price vs K and sigma for the set = 1
Prices of Put option at t = 0
175
150
125
100
75
50
25
0
0
50
100
150
200
250
300
K
0.10
0.15
0.20
0.25
0.30
sigma

Initial Call Option Price vs K and sigma for the set = 2

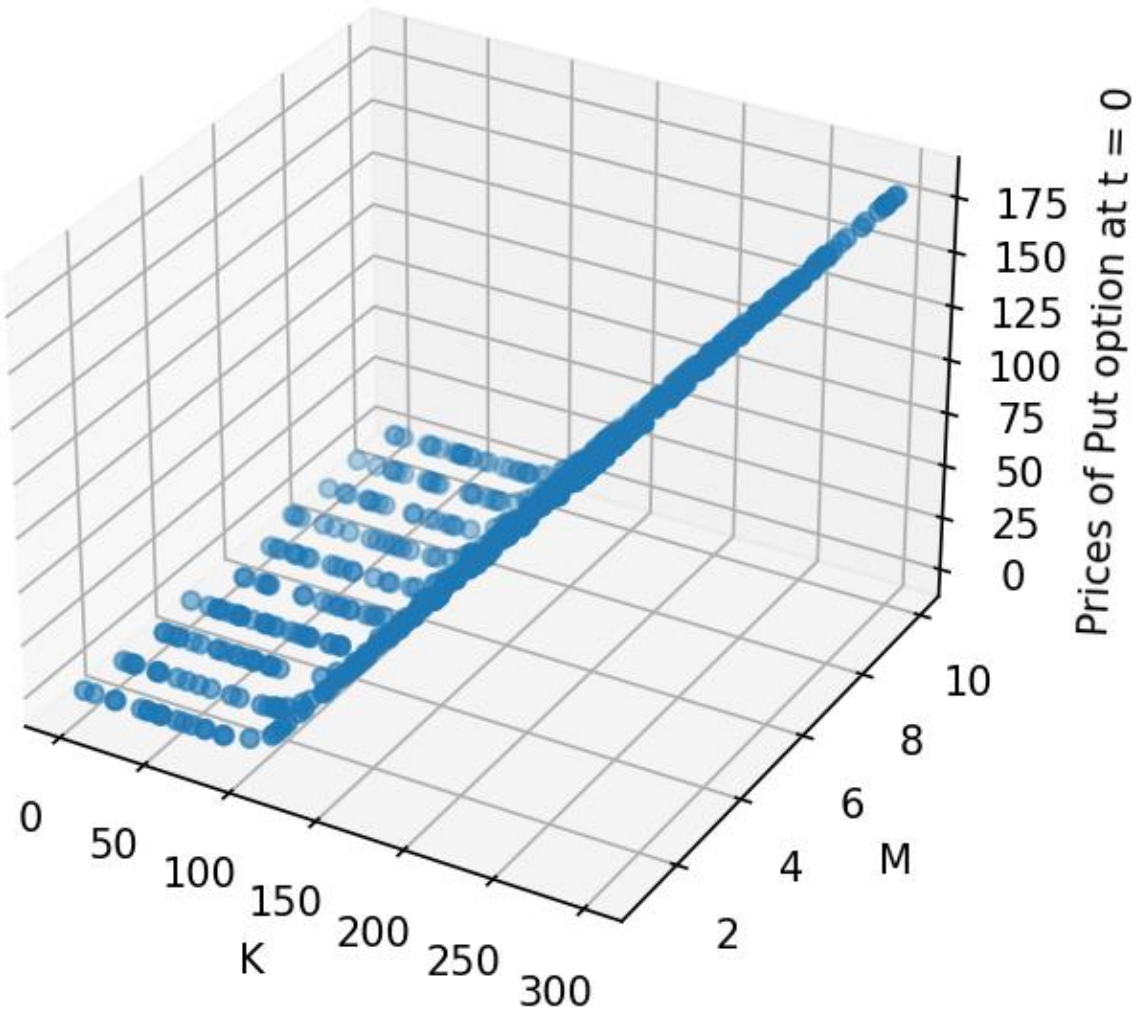


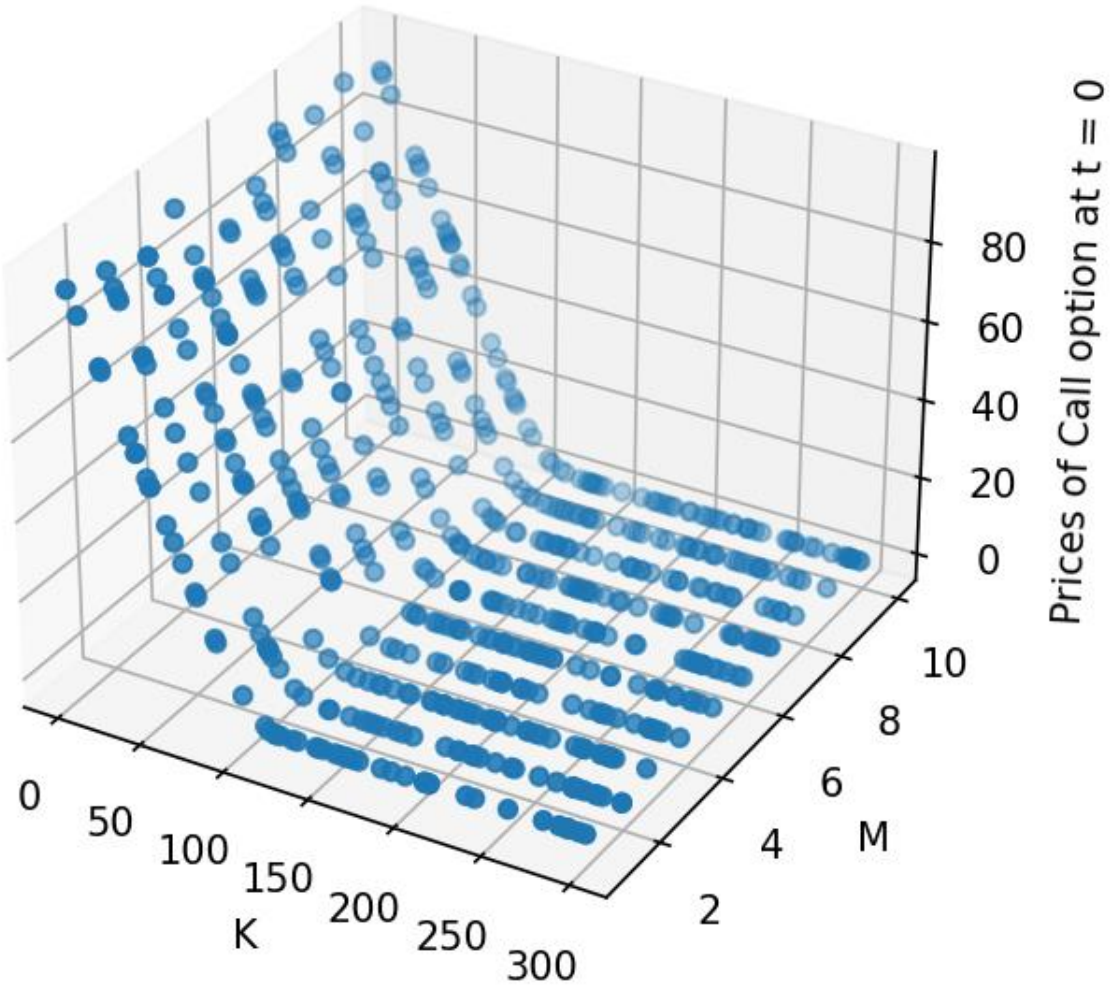
Initial Put Option Price vs K and sigma for the set = 2



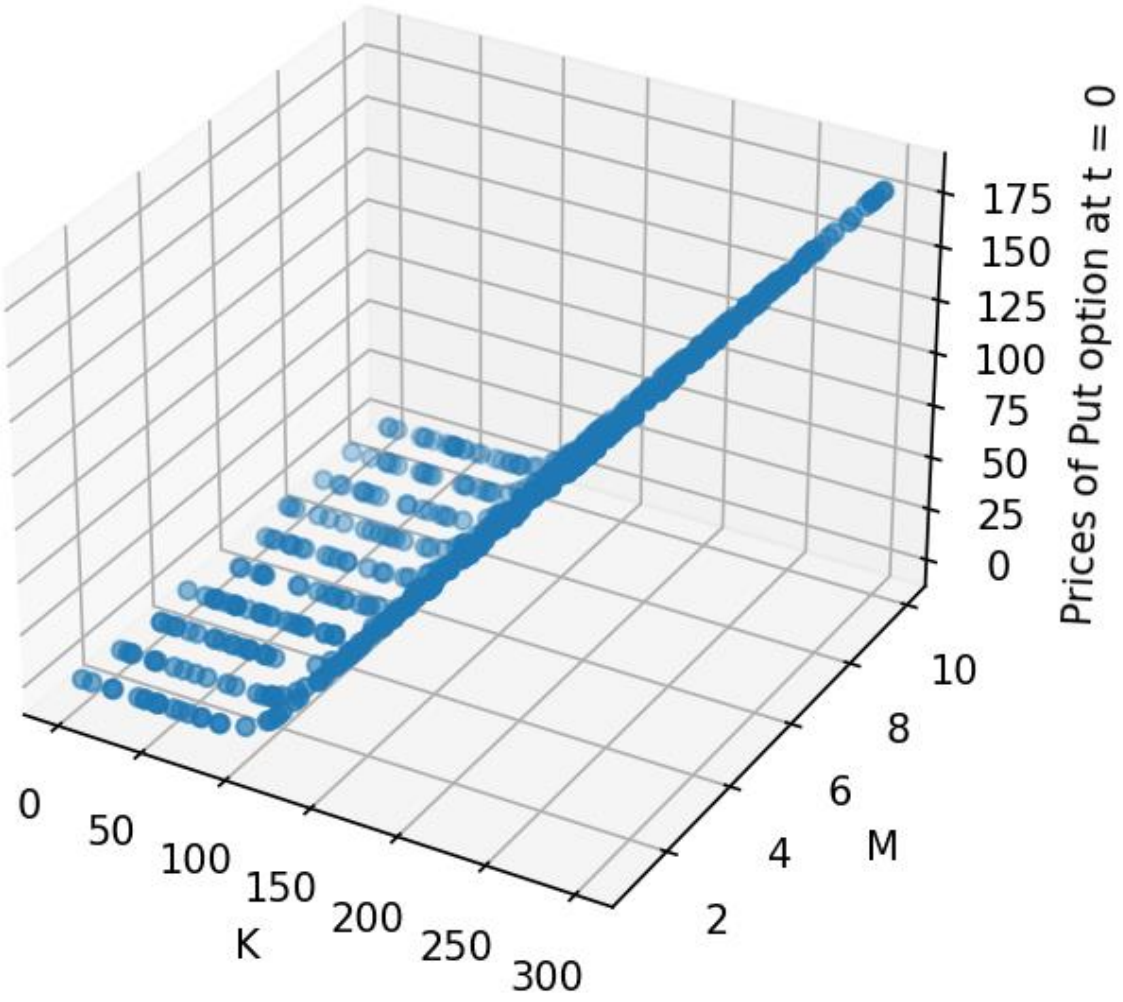

Initial Call Option Price vs K and M for the set = 1
Prices of Call option at t = 0
0
20
40
60
80
0
50
100
150
200
250
300
K
2
4
6
8
10
M

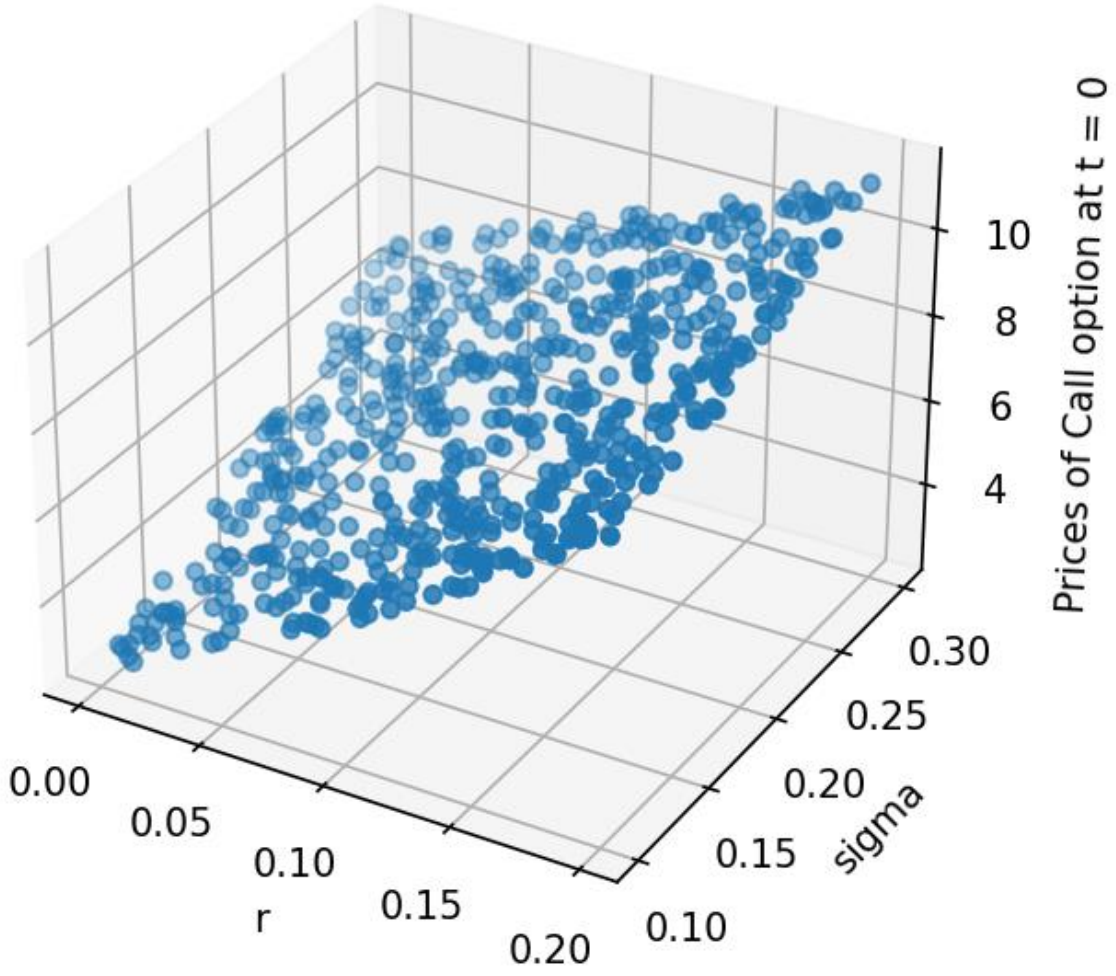
Initial Put Option Price vs K and M for the set = 1

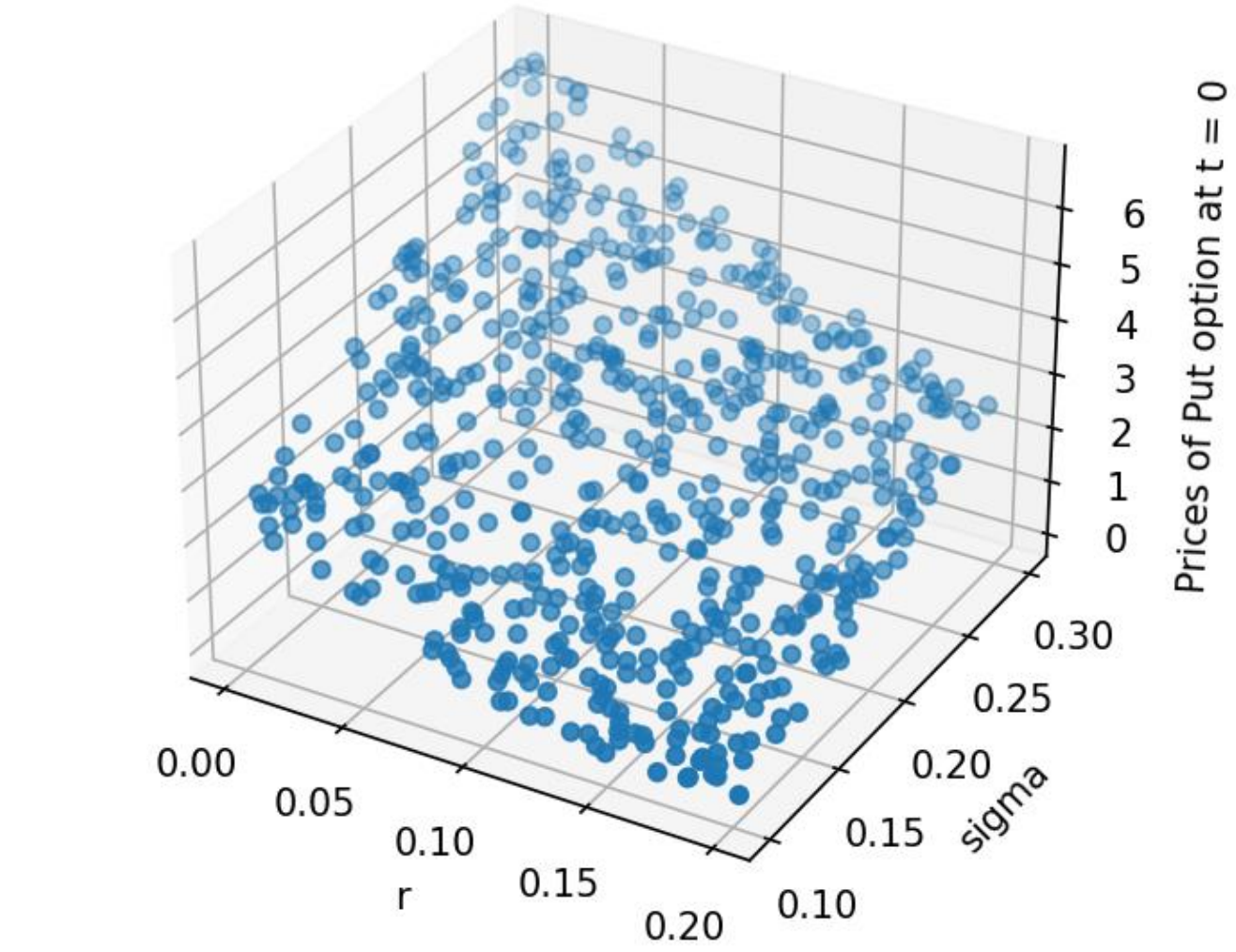



Initial Call Option Price vs K and M for the set = 2
Prices of Call option at t = 0
0
20
40
60
80
K
0
50
100
150
200
250
300
M
2
4
6
8
10

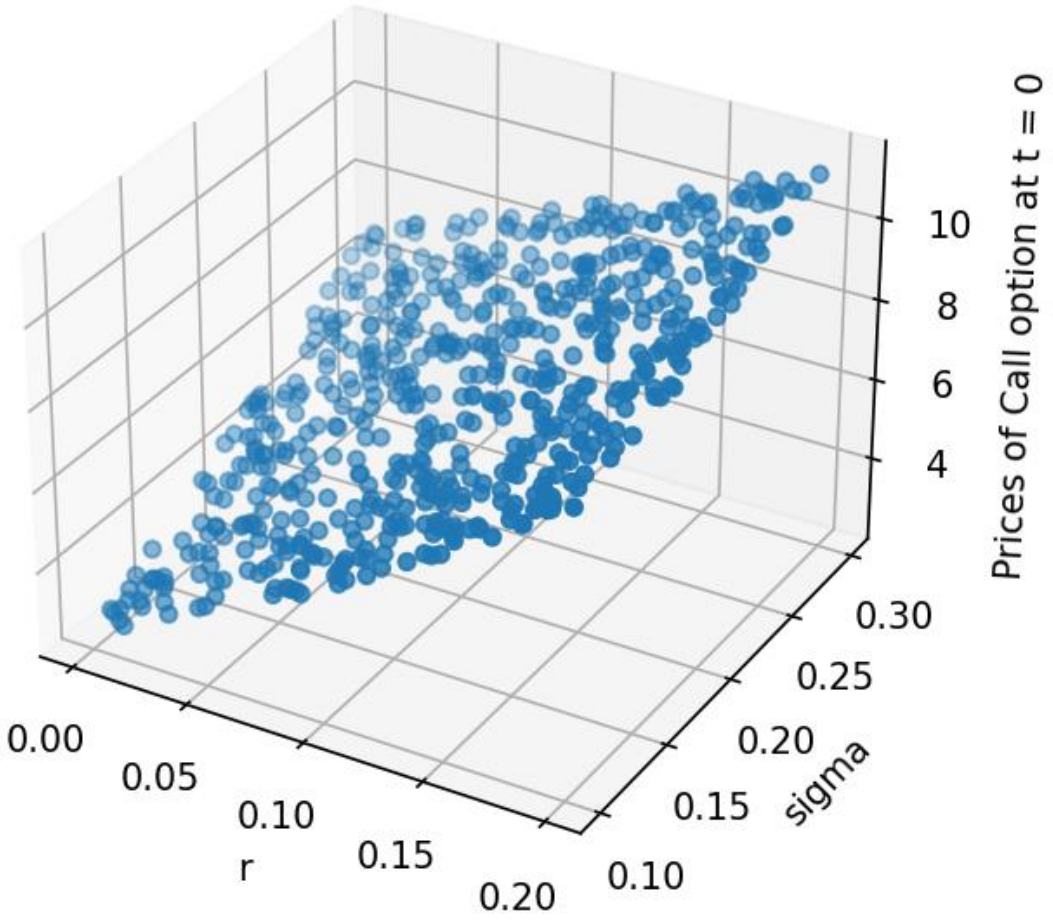
Initial Put Option Price vs K and M for the set = 2

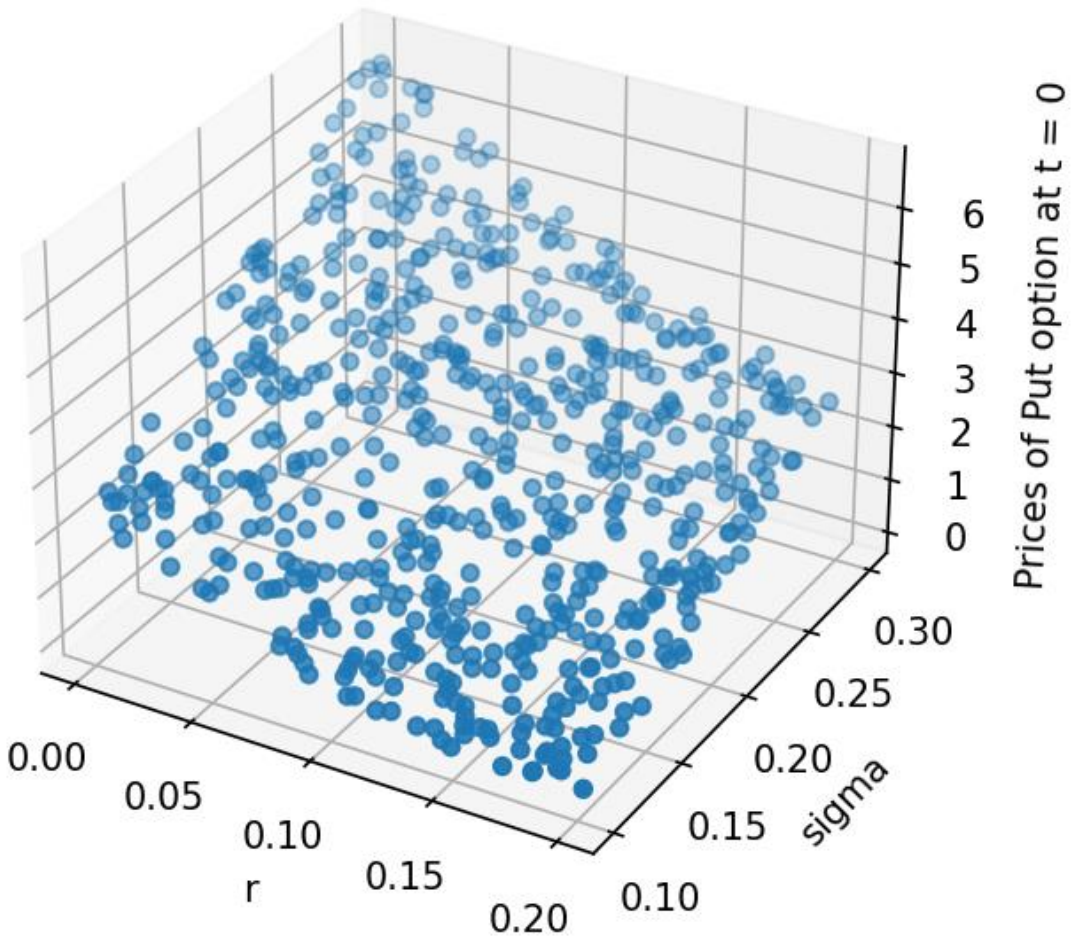


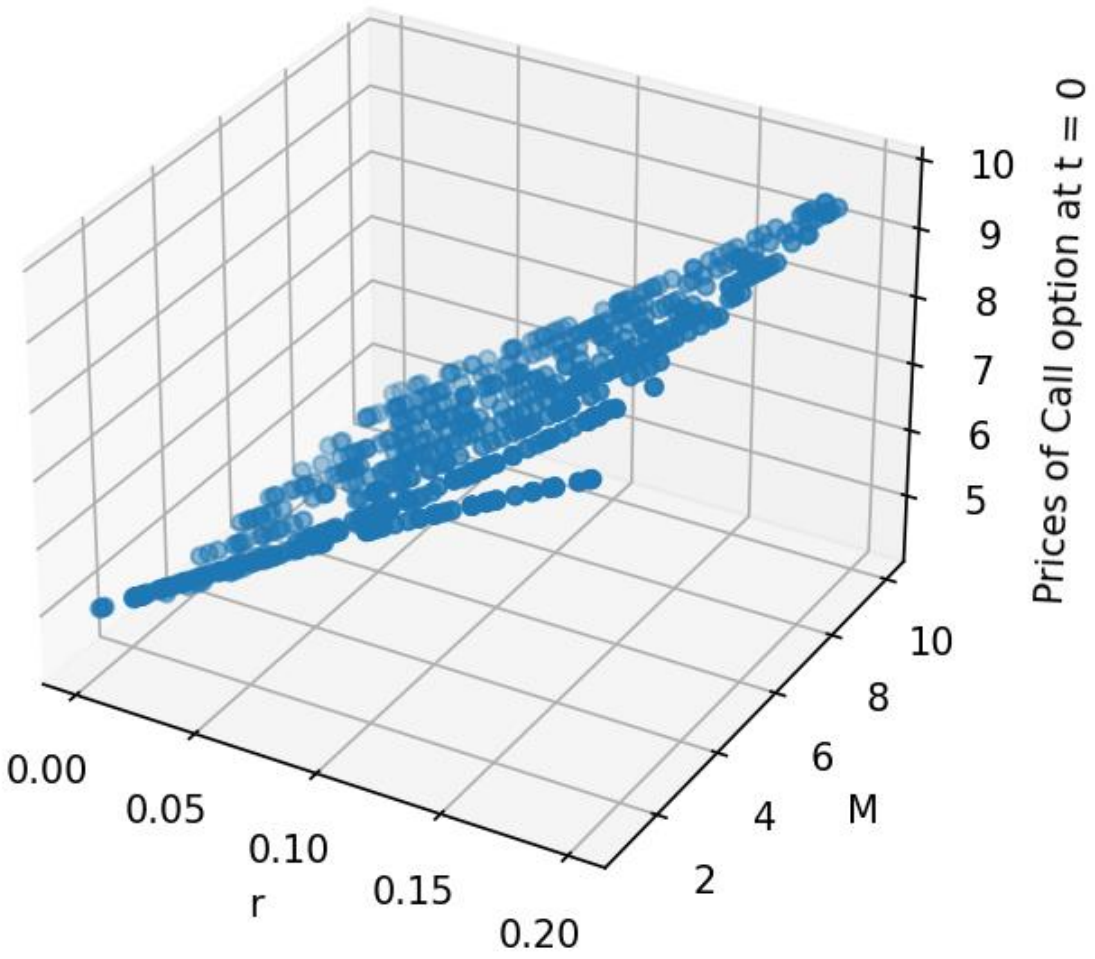

Initial Call Option Price vs r and sigma for the set = 1
Prices of Call option at t = 0
10
8
6
4
0.00
0.05
0.10
0.15
0.20
r
0.10
0.15
0.20
0.25
0.30
sigma

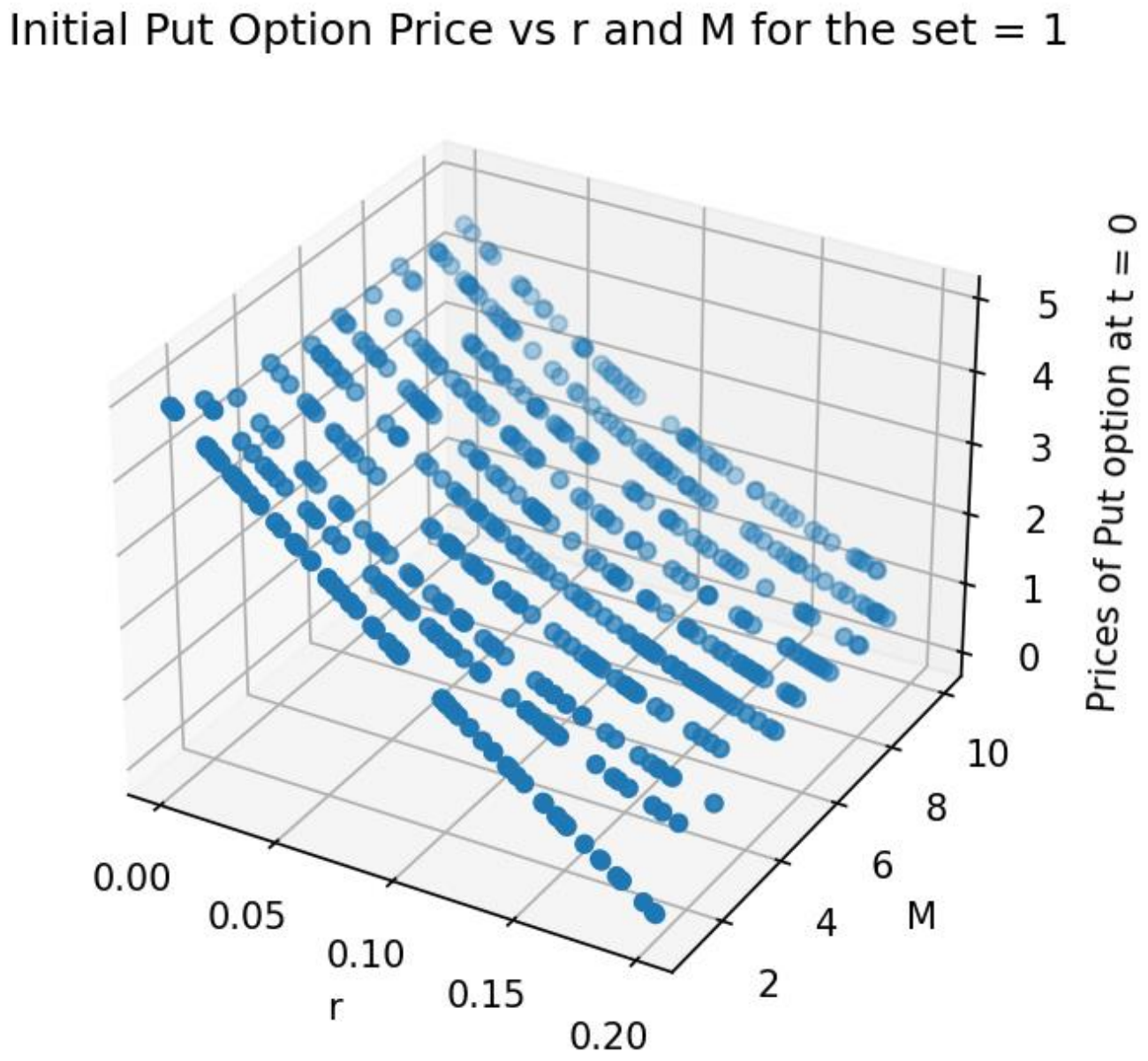

Initial Put Option Price vs r and sigma for the set = 1
Prices of Put option at t = 0
0
1
2
3
4
5
6
0.00
0.05
0.10
0.15
0.20
r
0.10
0.15
0.20
0.25
0.30
sigma

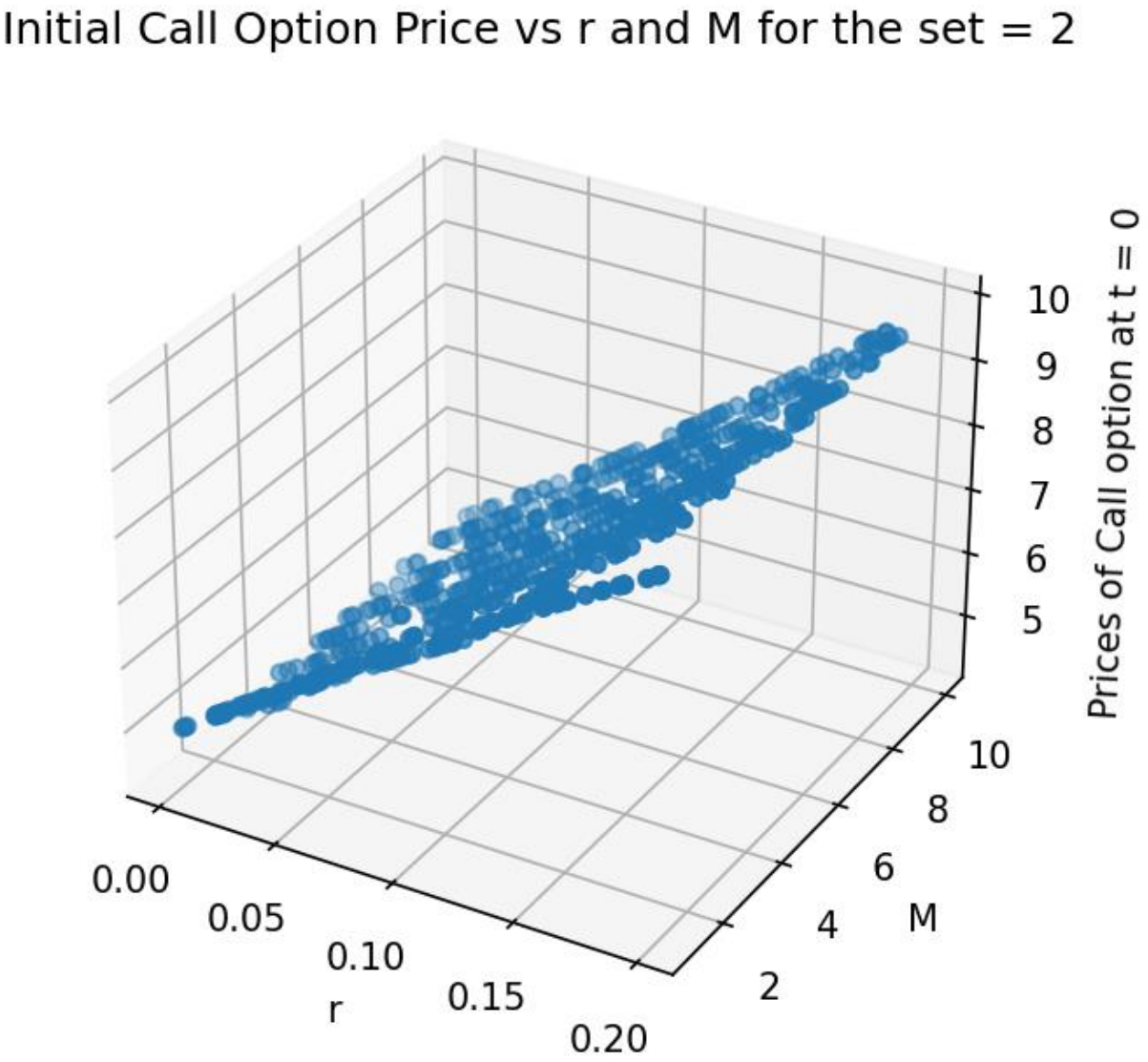
Initial Call Option Price vs r and sigma for the set =2



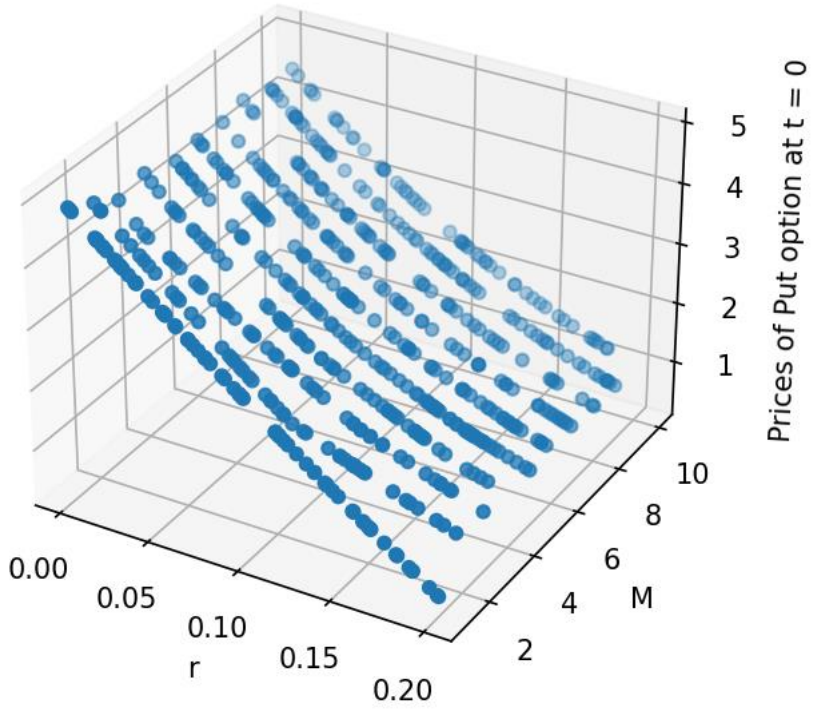

Initial Put Option Price vs r and sigma for the set = 2
Prices of Put option at t = 0
0
1
2
3
4
5
6
0.00
0.05
0.10
0.15
0.20
r
0.10
0.15
0.20
0.25
0.30
sigma

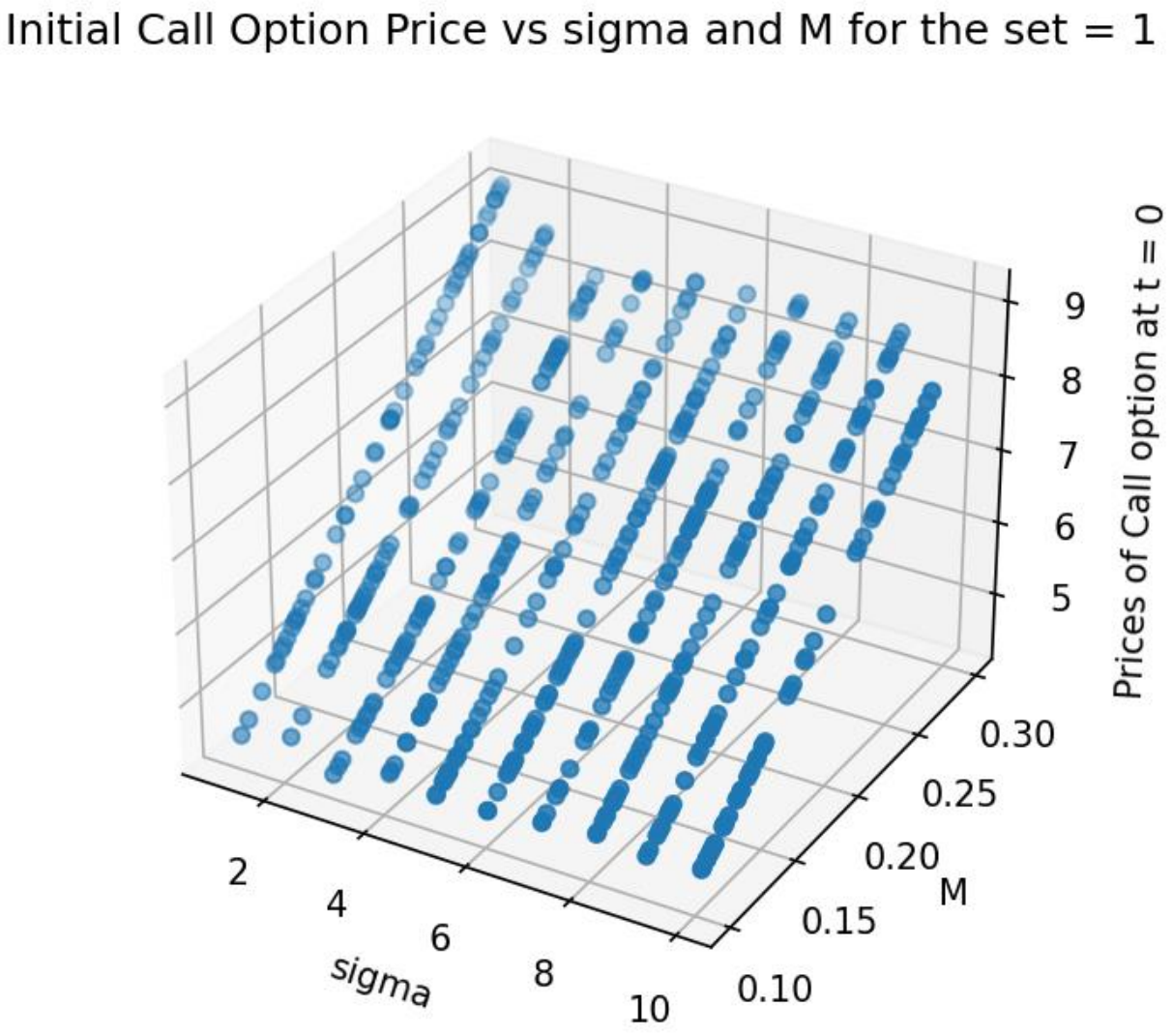

Initial Call Option Price vs r and M for the set = 1
Prices of Call option at t = 0
10
9
8
7
6
5
0.00
0.05
0.10
0.15
0.20
r
2
4
6
8
10
M

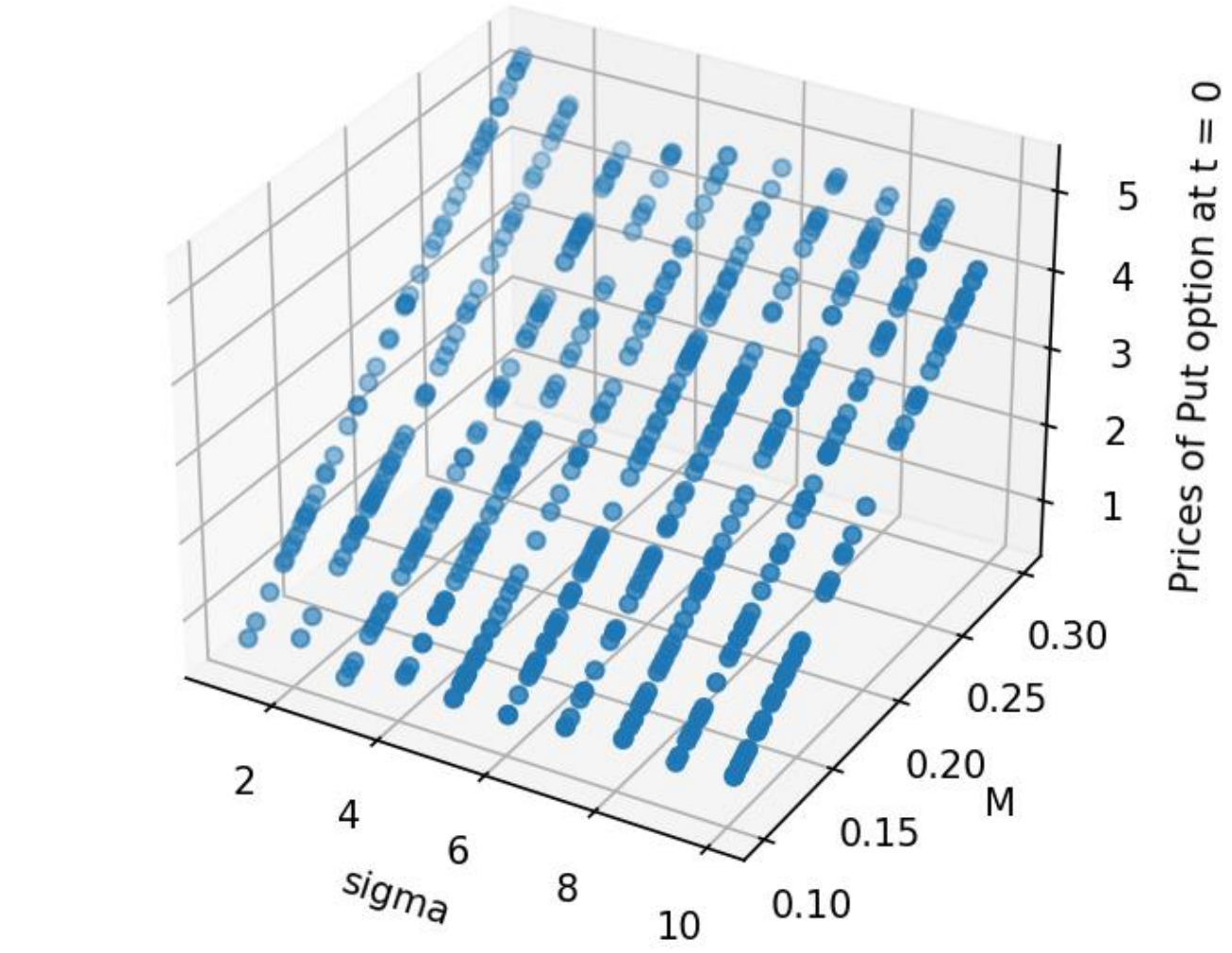

Initial Put Option Price vs r and M for the set = 1
Prices of Put option at t = 0
0
1
2
3
4
5
0.00
0.05
0.10
0.15
0.20
r
2
4
6
8
10
M


Initial Call Option Price vs r and M for the set = 2
Prices of Call option at t = 0
10
9
8
7
6
5
0.00
0.05
0.10
0.15
0.20
r
2
4
6
8
10
M

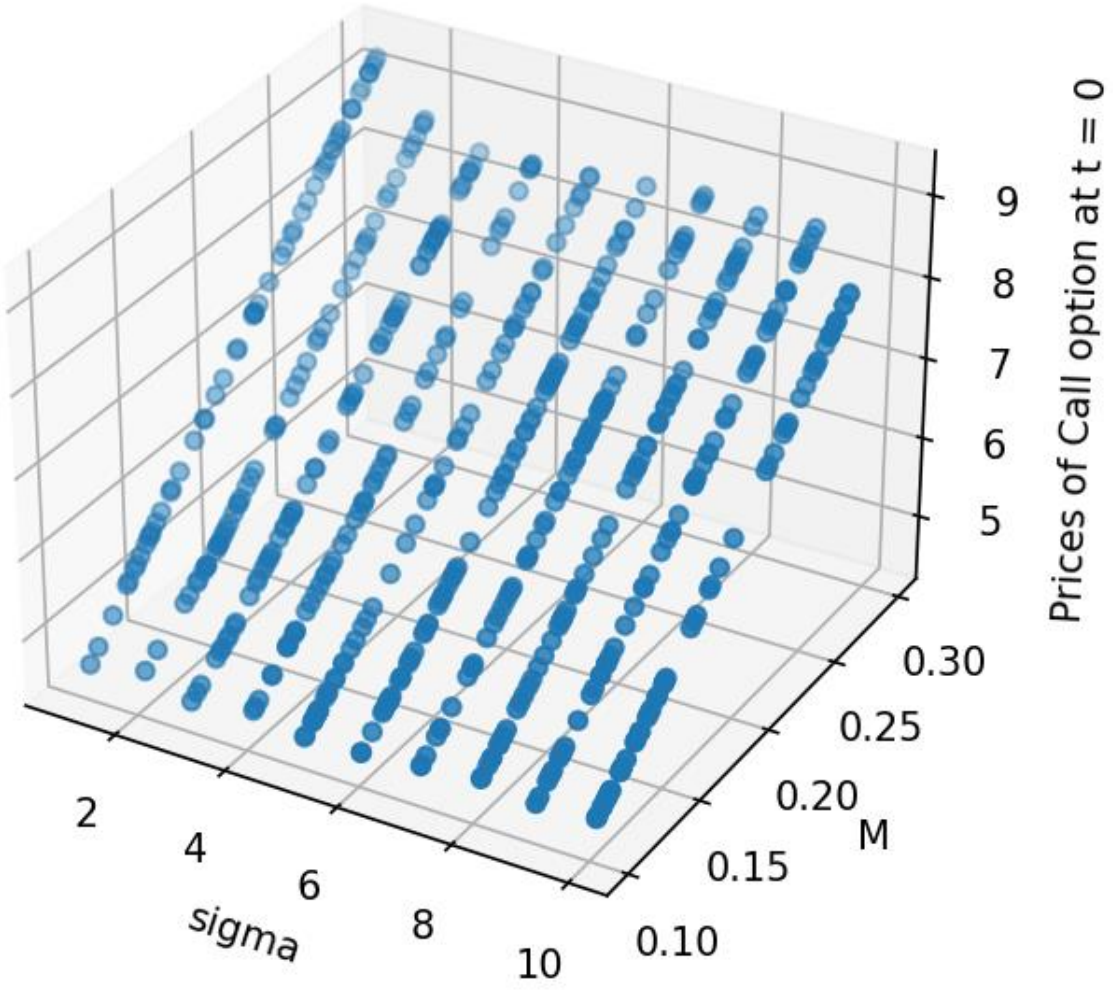
Initial Put Option Price vs r and M for the set = 2




Initial Call Option Price vs sigma and M for the set = 1
Prices of Call option at t = 0
9
8
7
6
5
0.30
0.25
0.20
0.15
0.10
M
2
4
6
8
10
sigma


Initial Put Option Price vs sigma and M for the set = 1
Prices of Put option at t = 0
1
2
3
4
5
sigma
2
4
6
8
10
M
0.10
0.15
0.20
0.25
0.30

Initial Call Option Price vs sigma and M for the set = 2



Initial Put Option Price vs sigma and M for the set = 2