MA 374 Lab 07

Name- Dev Sandip Shah
Roll No- 200123074

The price of European call and put option with continuously paying dividend at rate a is given by -

$$C(t,x) = xN(d_1) - Ke^{-r(T-t)}N(d_2)$$
$$P(t,x) = Ke^{-r(T-t)}N(-d_2) - xN(-d_1)$$

where

$$d_1 = \frac{log(\frac{x}{K}) + (r+\frac{1}{2}\sigma^2)(T-t)}{\sigma\sqrt{(T-t)}}$$

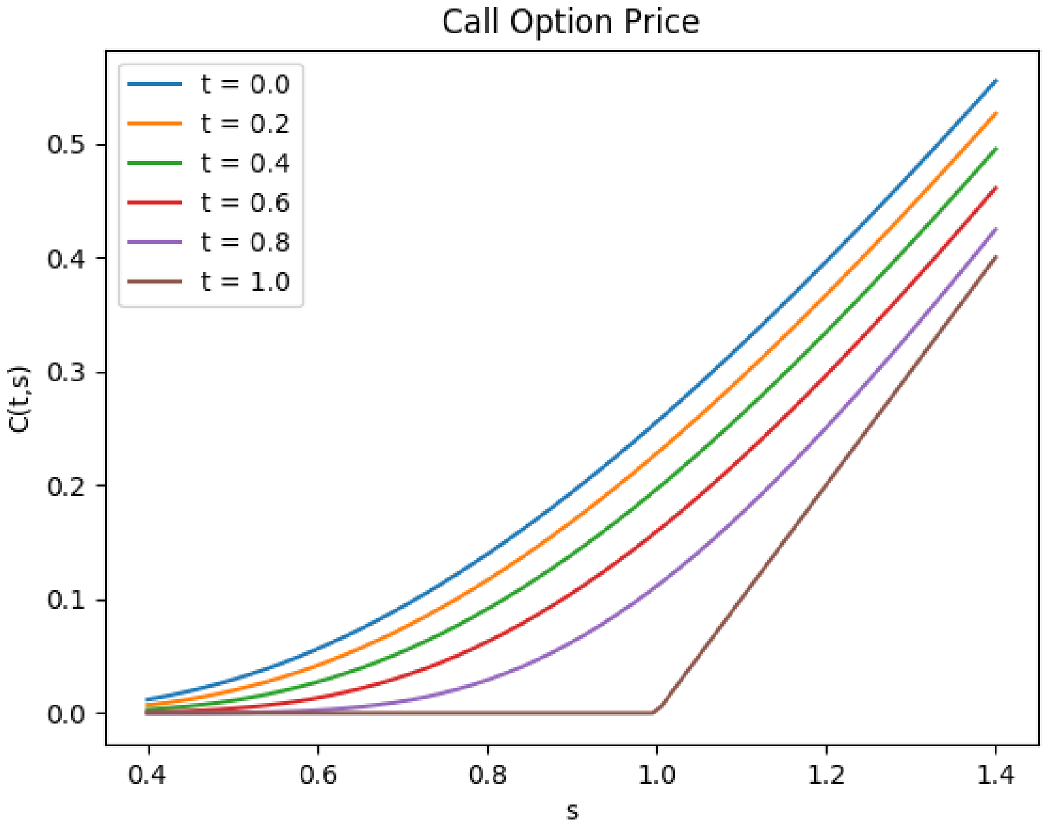
$$d_2 = \frac{log(\frac{x}{K}) + (r-\frac{1}{2}\sigma^2)(T-t)}{\sigma\sqrt{(T-t)}}$$

$$N(x) = \int_{-\infty}^{x} \frac{1}{\sigma\sqrt{2\pi}} e^{\frac{-x^2}{2}} dx$$

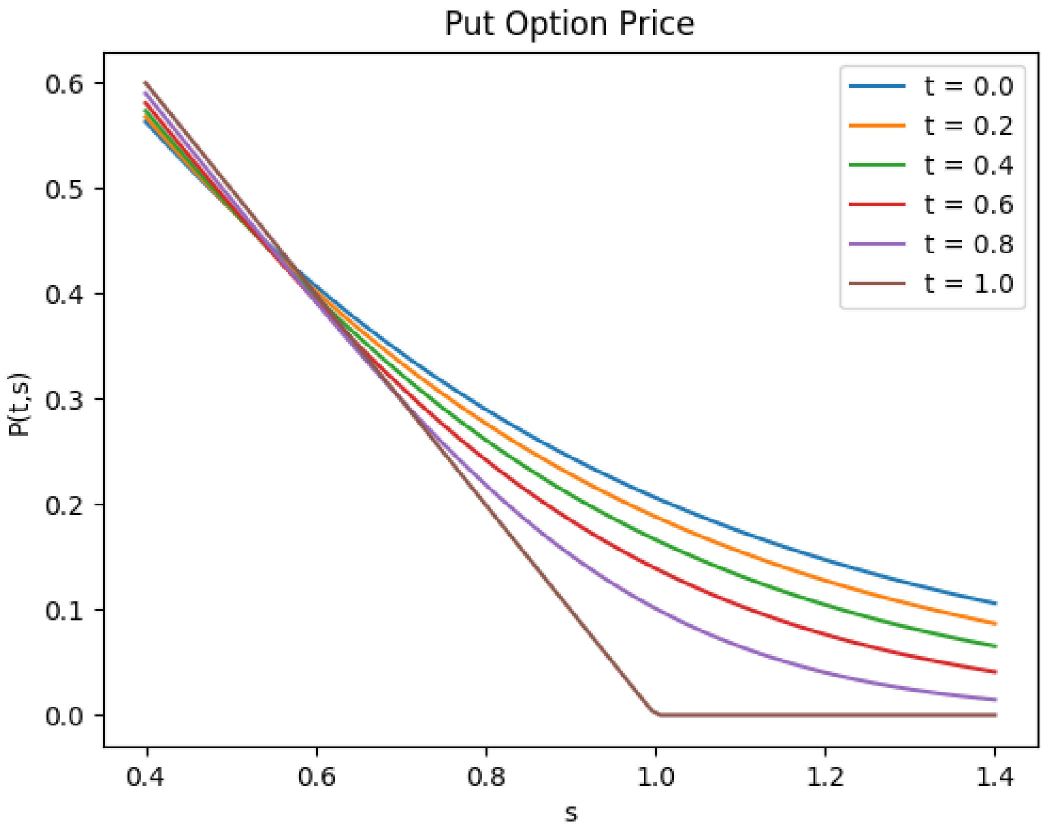
Question 1:

```
PS C:\Users\Dev Sandip Shah\IITG\Sem6\FE Lab\Lab-7> python q1.py
Call price for t =  0  and S =  1  is  0.255232056656095
Put price for t =  0  and S =  1  is  0.20646148115680907
```

Question 2:

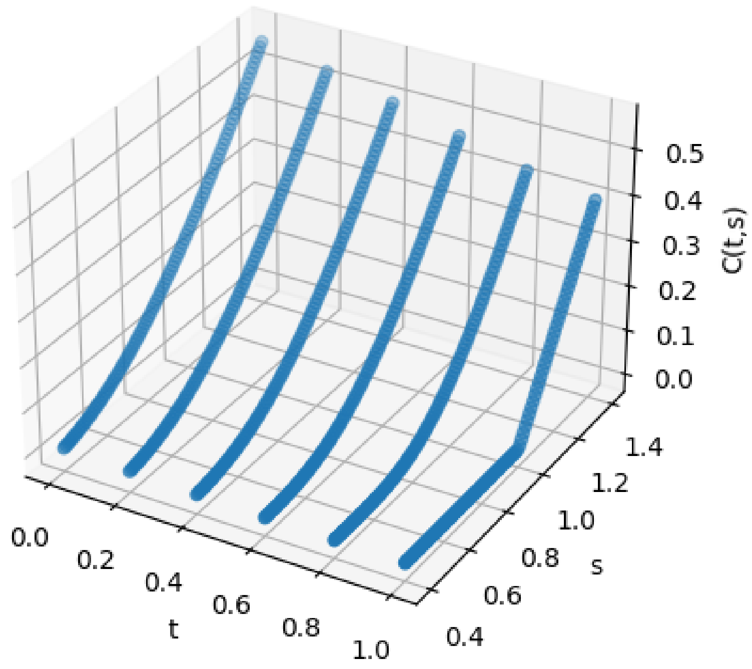


Call Option Price
t = 0.0
t = 0.2
t = 0.4
t = 0.6
t = 0.8
t = 1.0
C(t,s)
0.0
0.1
0.2
0.3
0.4
0.5
0.4
0.6
0.8
1.0
1.2
1.4
s

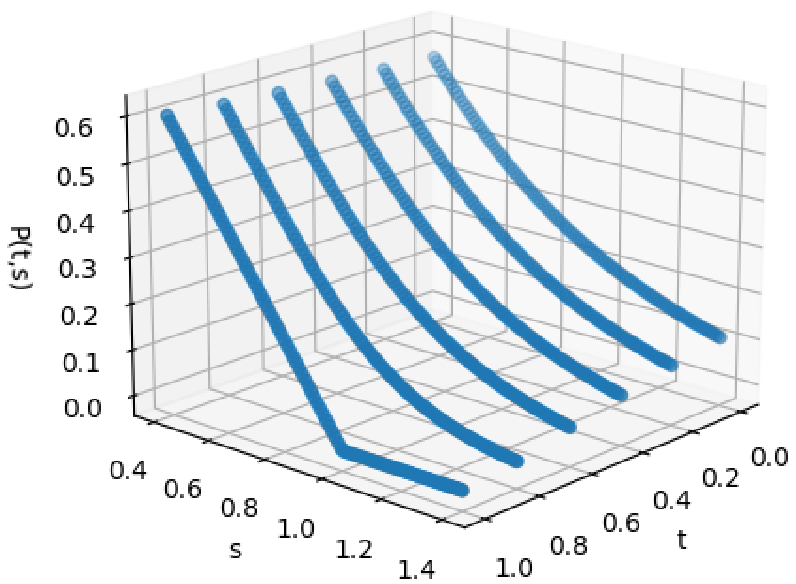


Put Option Price
t = 0.0
t = 0.2
t = 0.4
t = 0.6
t = 0.8
t = 1.0
P(t,s)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.4
0.6
0.8
1.0
1.2
1.4
s

Call Option Price

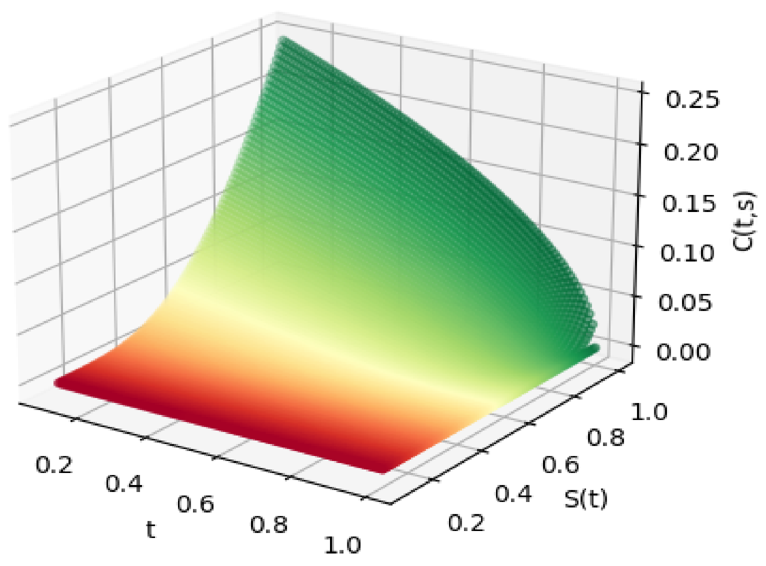


Put Option Price

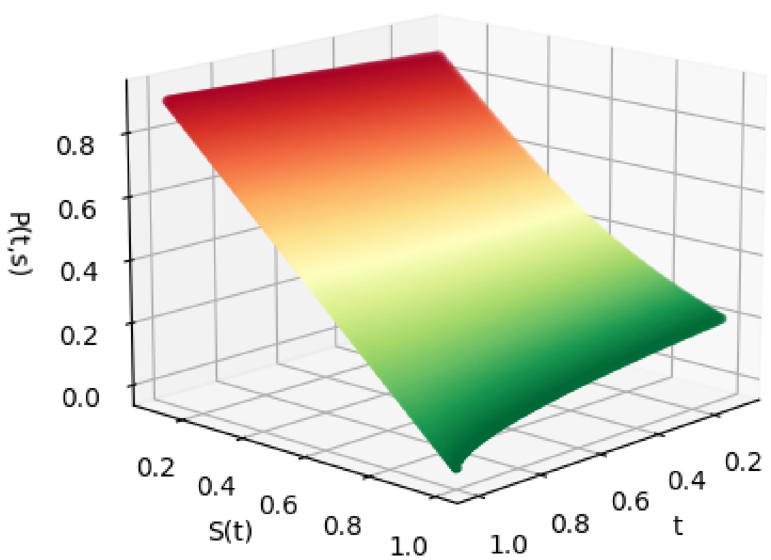


Question 3:

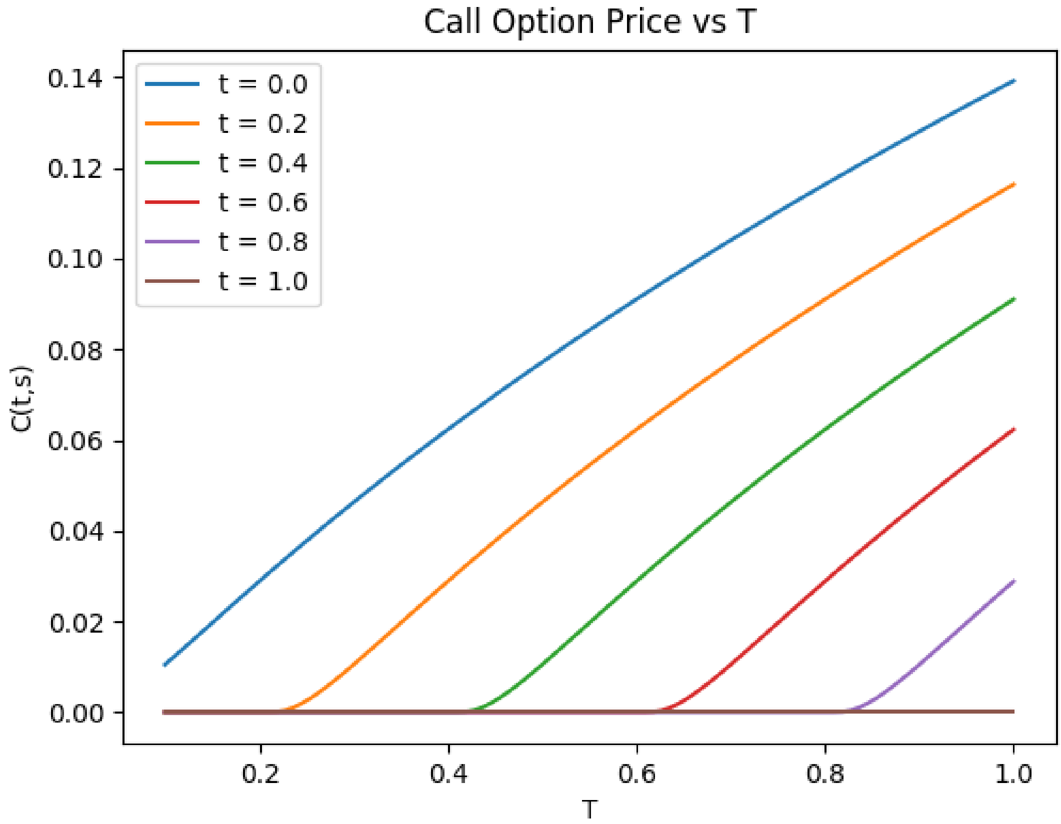
Call Option Price vs t vs S(t)

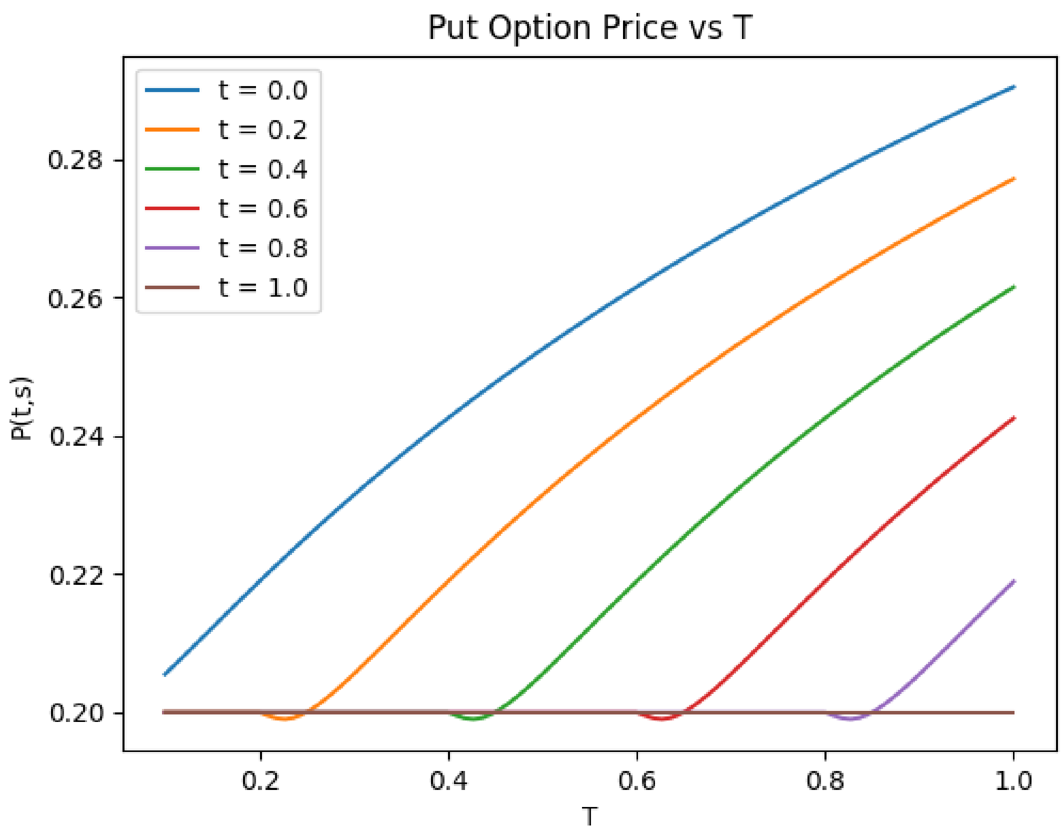


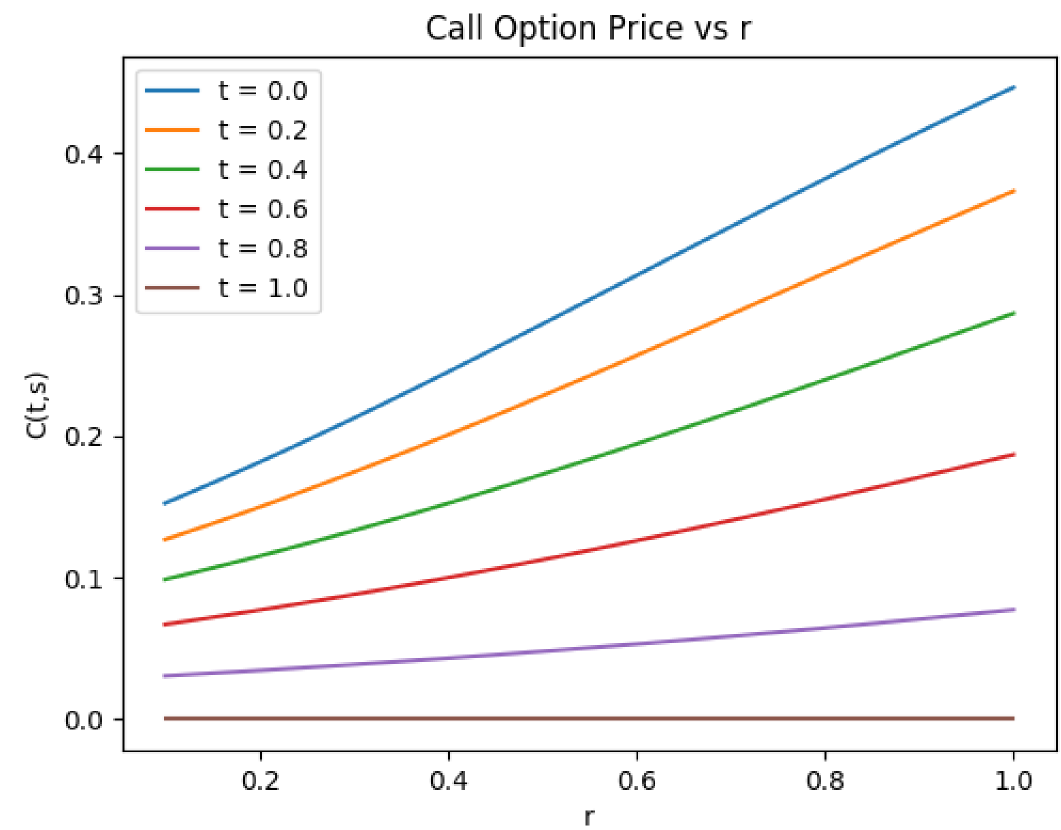
Put Option Price vs t vs S(t)

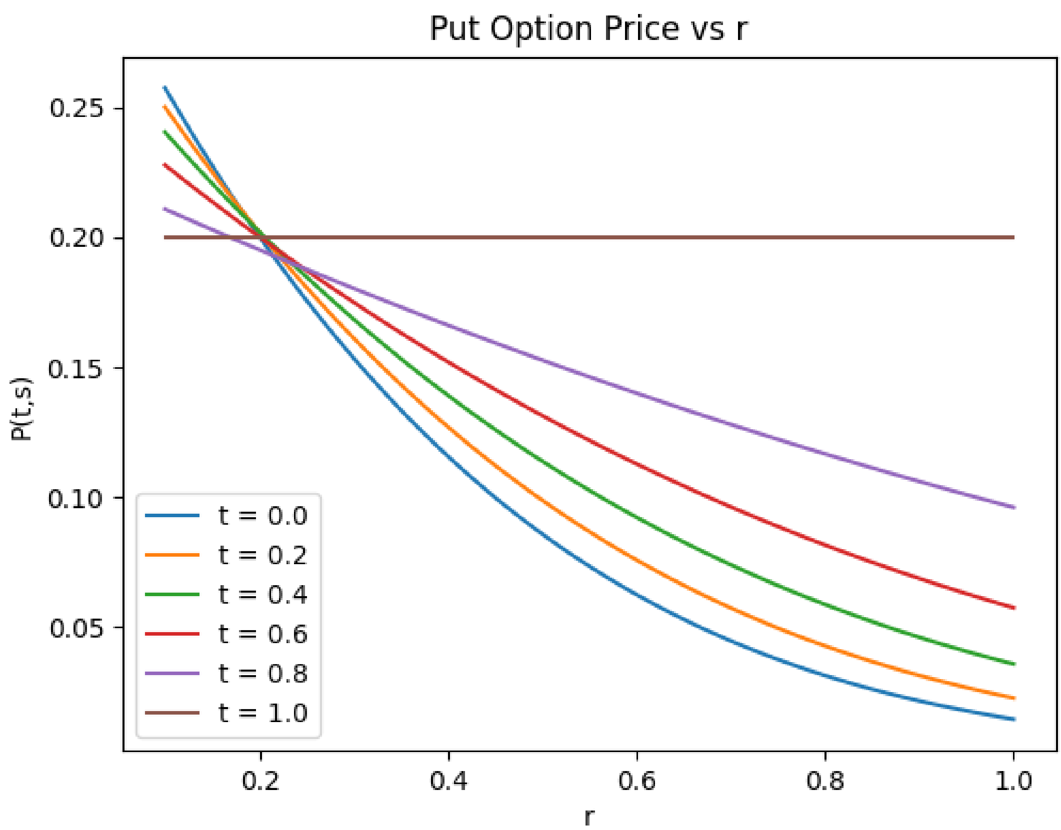


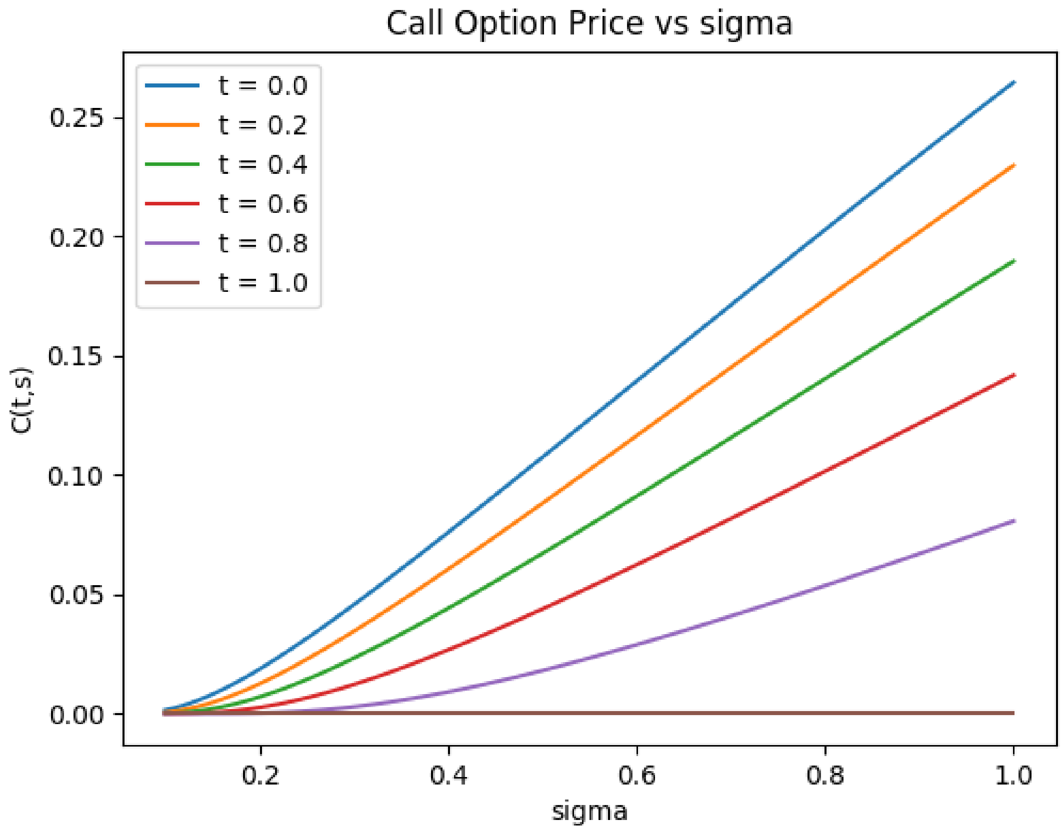
Question 4:

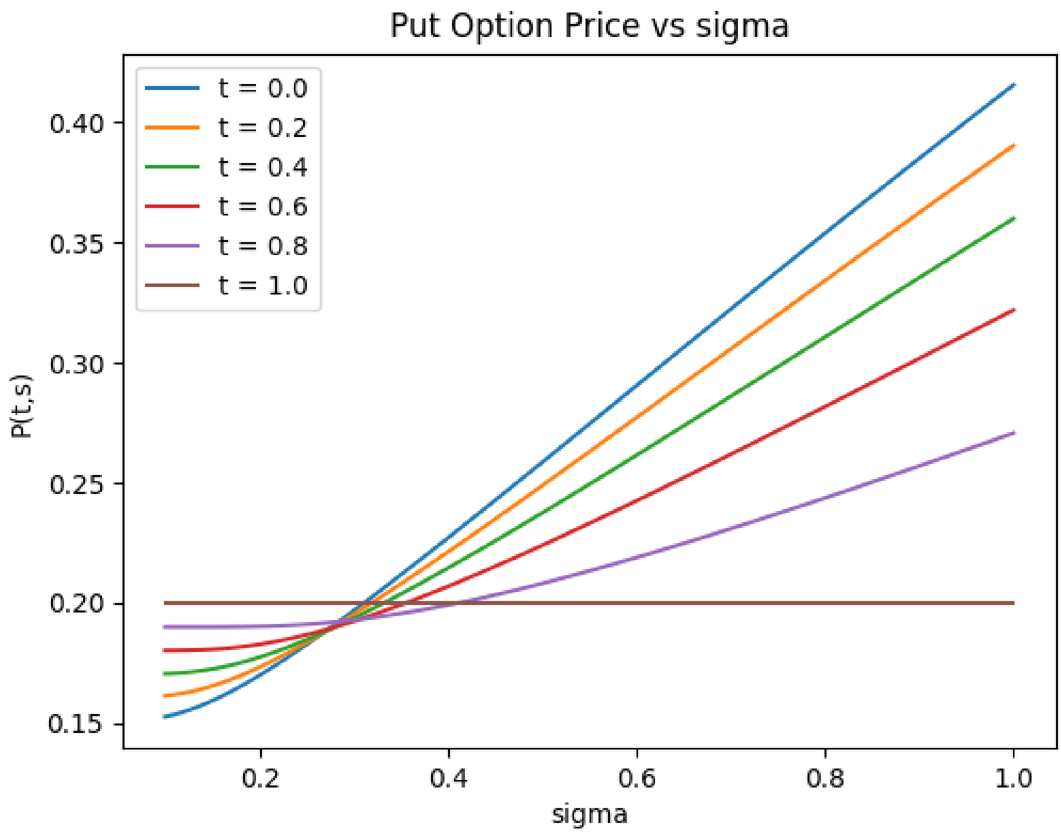

Call Option Price vs T
t = 0.0
t = 0.2
t = 0.4
t = 0.6
t = 0.8
t = 1.0
C(t,s)
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
0.2
0.4
0.6
0.8
1.0
T

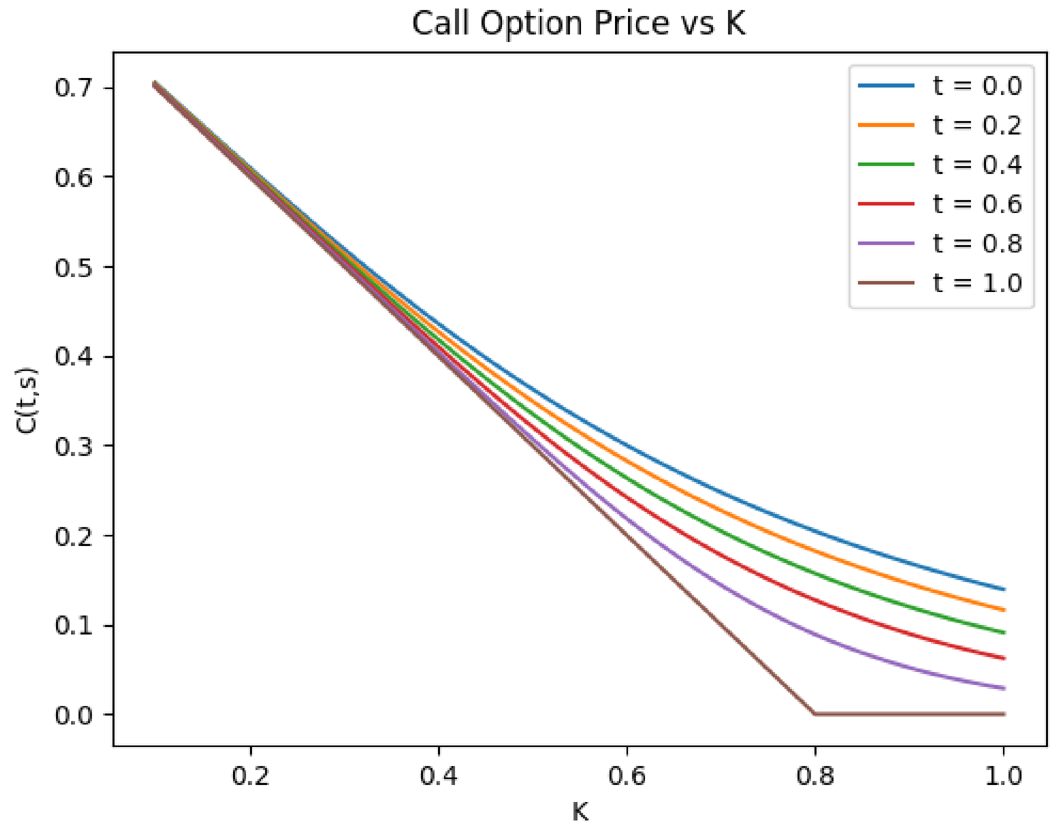

Put Option Price vs T
t = 0.0
t = 0.2
t = 0.4
t = 0.6
t = 0.8
t = 1.0
P(t,s)
0.28
0.26
0.24
0.22
0.20
0.2
0.4
0.6
0.8
1.0
T

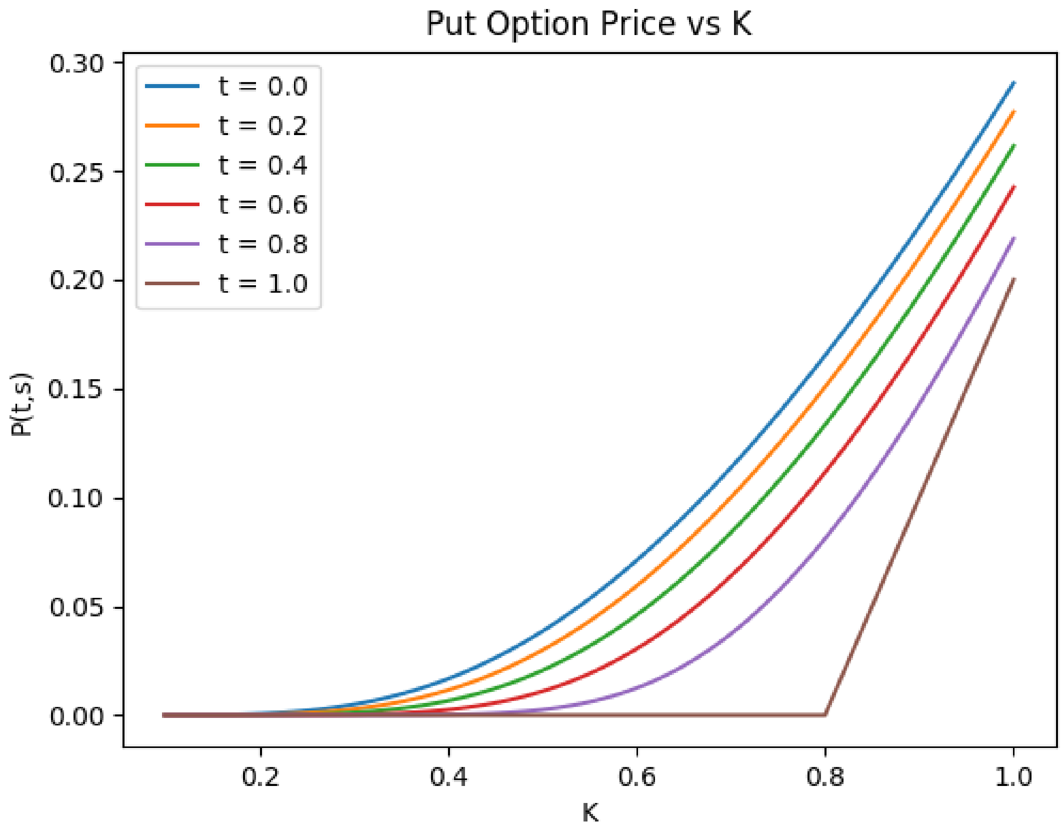

Call Option Price vs r
t = 0.0
t = 0.2
t = 0.4
t = 0.6
t = 0.8
t = 1.0
C(t,s)
0.0
0.1
0.2
0.3
0.4
0.2
0.4
0.6
0.8
1.0
r


Put Option Price vs r
t = 0.0
t = 0.2
t = 0.4
t = 0.6
t = 0.8
t = 1.0
P(t,s)
0.05
0.10
0.15
0.20
0.25
0.2
0.4
0.6
0.8
1.0
r

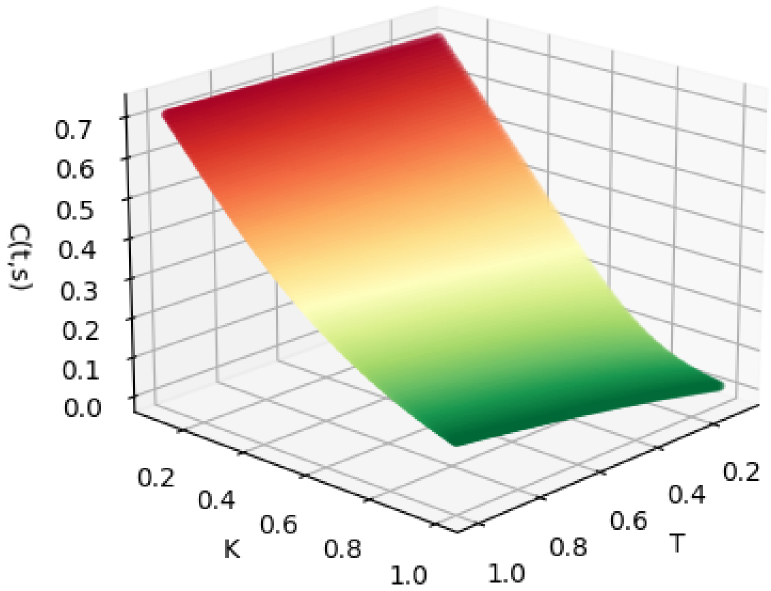

Call Option Price vs sigma
t = 0.0
t = 0.2
t = 0.4
t = 0.6
t = 0.8
t = 1.0
C(t,s)
0.25
0.20
0.15
0.10
0.05
0.00
0.2
0.4
0.6
0.8
1.0
sigma


Put Option Price vs sigma
t = 0.0
t = 0.2
t = 0.4
t = 0.6
t = 0.8
t = 1.0
P(t,s)
0.40
0.35
0.30
0.25
0.20
0.15
0.2
0.4
0.6
0.8
1.0
sigma

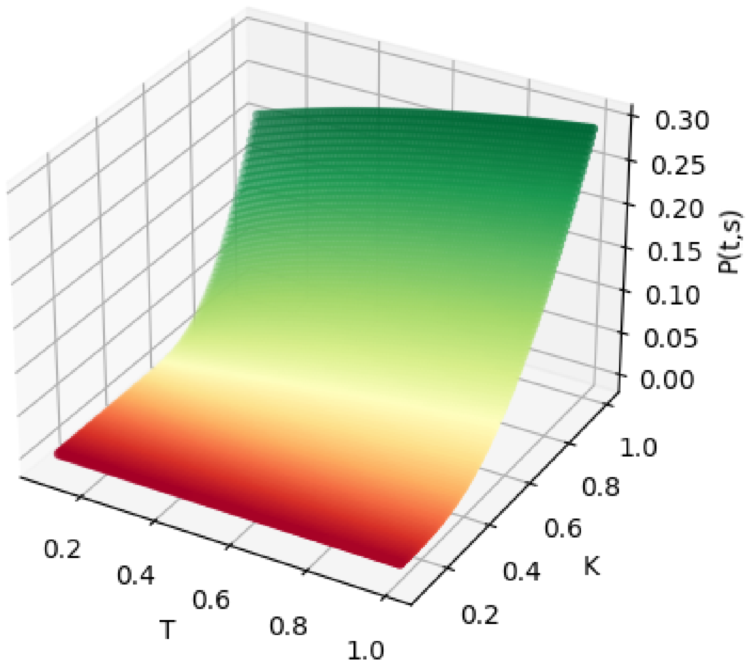

Call Option Price vs K
C(t,s)
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0.2
0.4
0.6
0.8
1.0
K
t = 0.0
t = 0.2
t = 0.4
t = 0.6
t = 0.8
t = 1.0

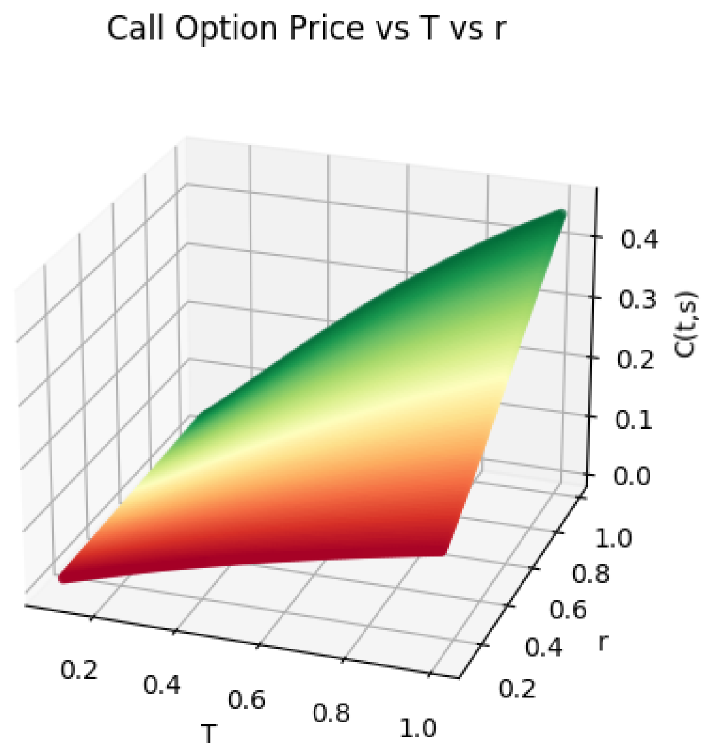

Put Option Price vs K
P(t,s)
0.30
0.25
0.20
0.15
0.10
0.05
0.00
0.2
0.4
0.6
0.8
1.0
K
t = 0.0
t = 0.2
t = 0.4
t = 0.6
t = 0.8
t = 1.0

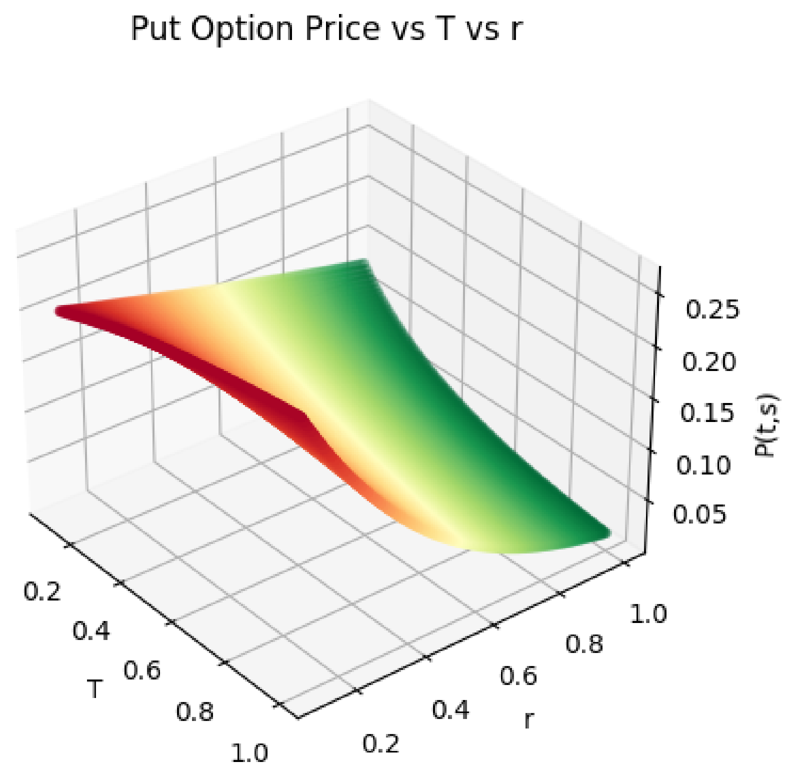
Call Option Price vs T vs K



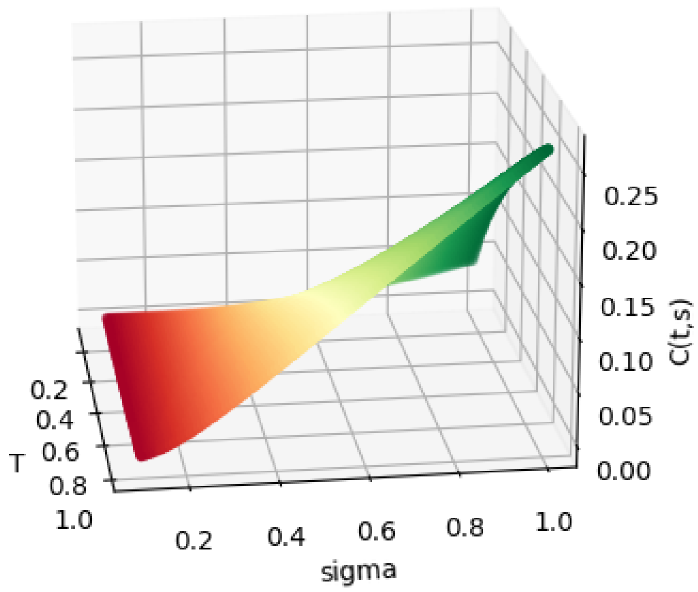
Put Option Price vs T vs K



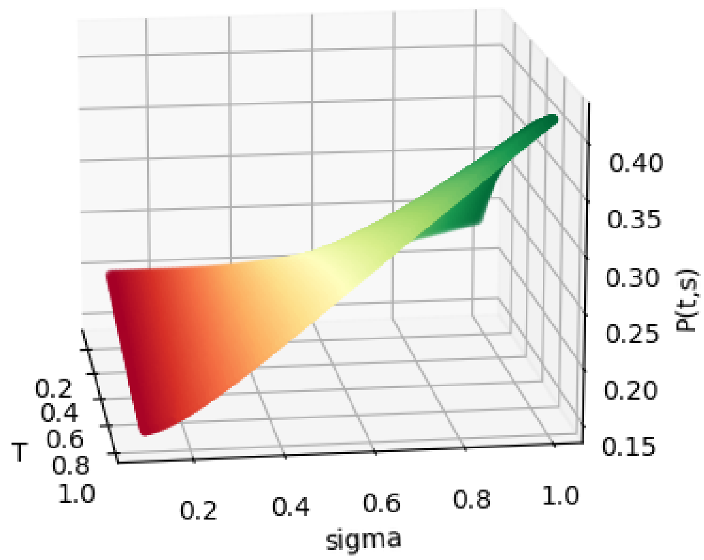

Call Option Price vs T vs r
C(t,s)
0.0
0.1
0.2
0.3
0.4
T
0.2
0.4
0.6
0.8
1.0
r
0.2
0.4
0.6
0.8
1.0


Put Option Price vs T vs r
P(t,s)
0.05
0.10
0.15
0.20
0.25
T
0.2
0.4
0.6
0.8
1.0
r
0.2
0.4
0.6
0.8
1.0

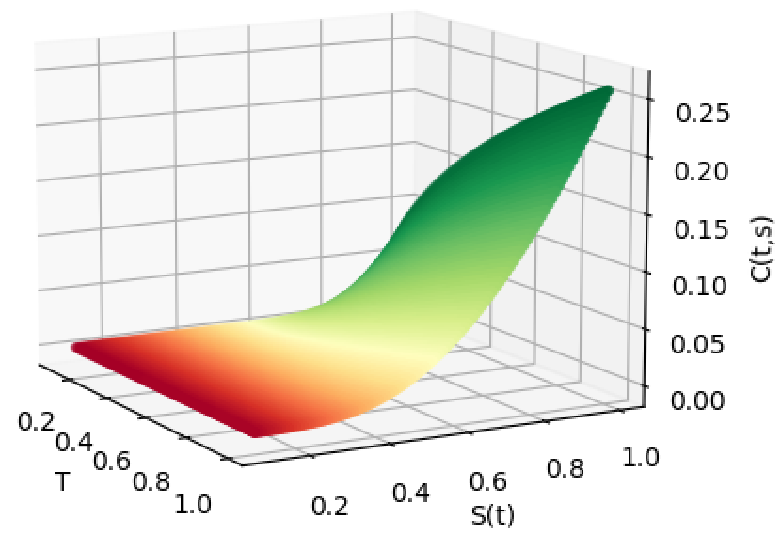
Call Option Price vs T vs sigma



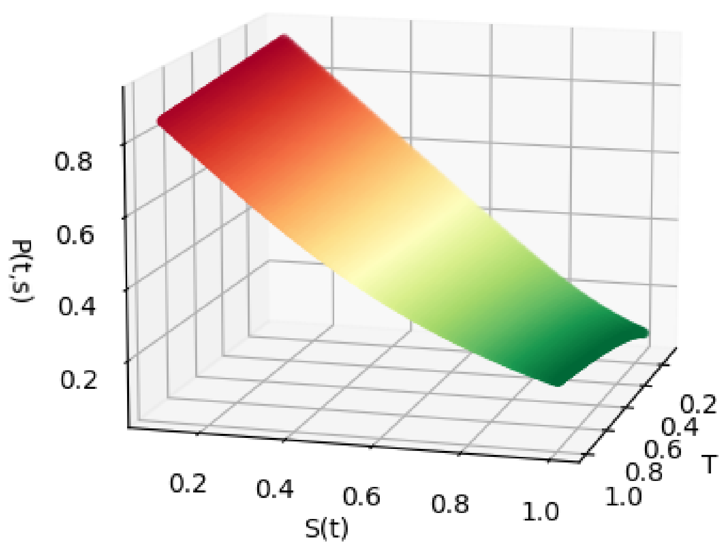
Put Option Price vs T vs sigma



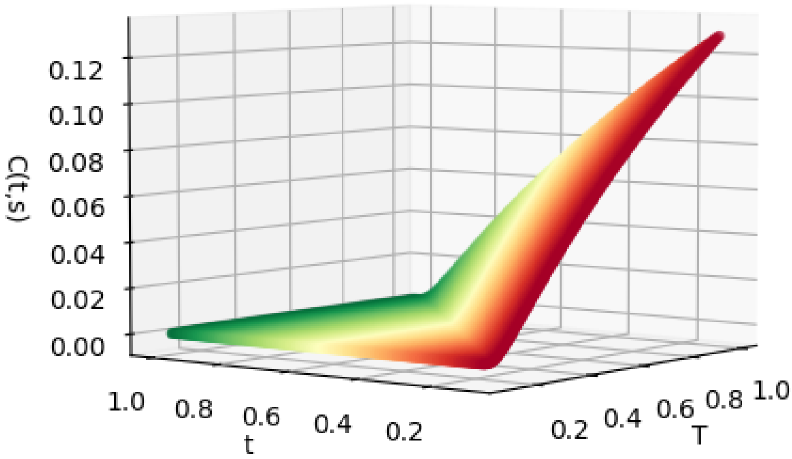
Call Option Price vs T vs S(t)



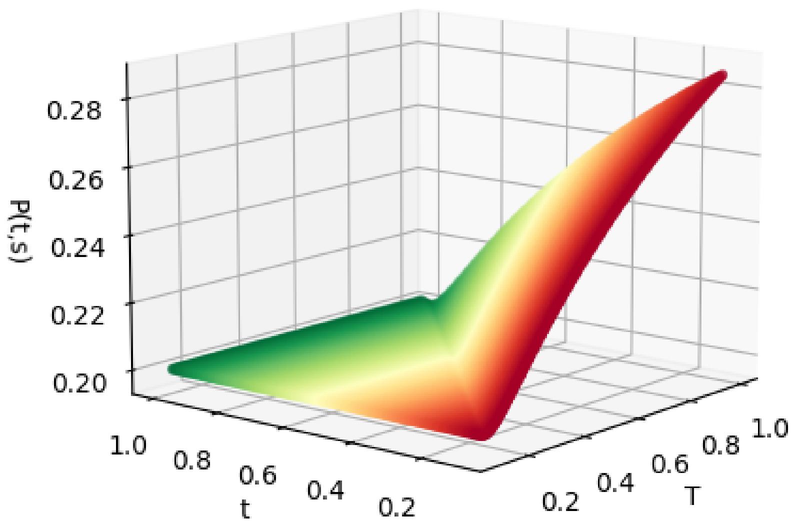
Put Option Price vs T vs S(t)



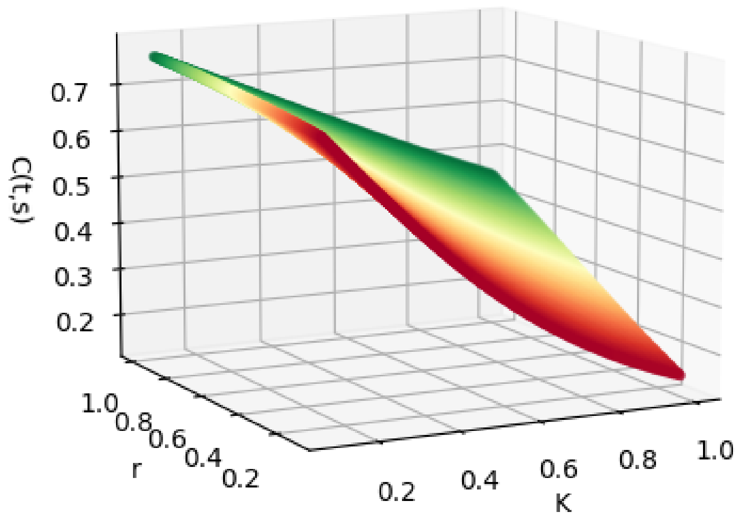
Call Option Price vs T vs t



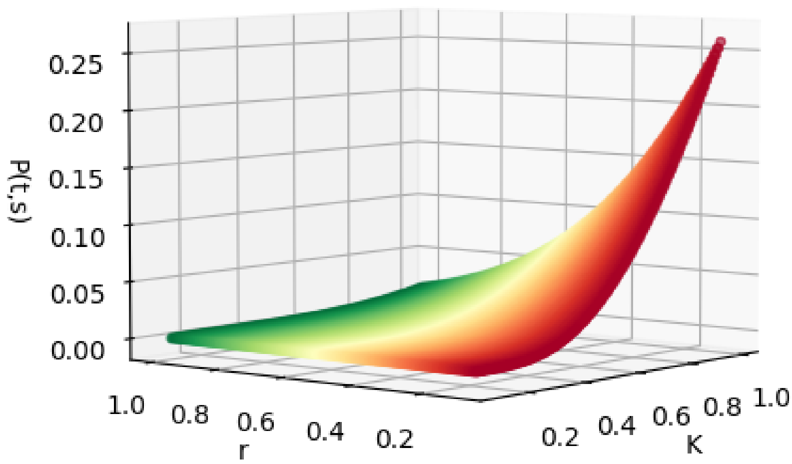
Put Option Price vs T vs t



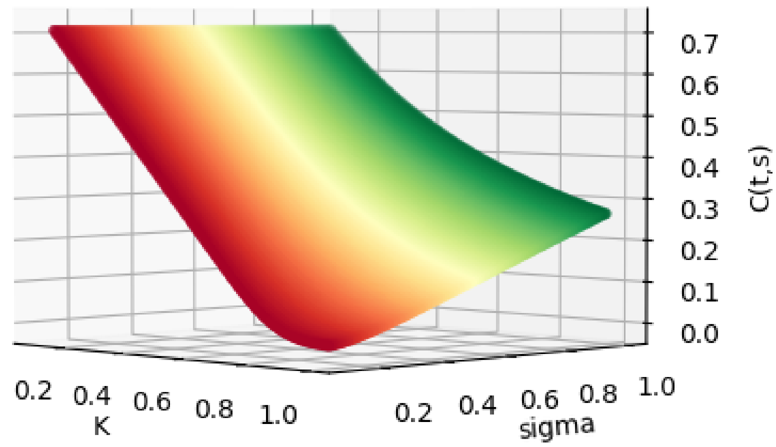
Call Option Price vs K vs r



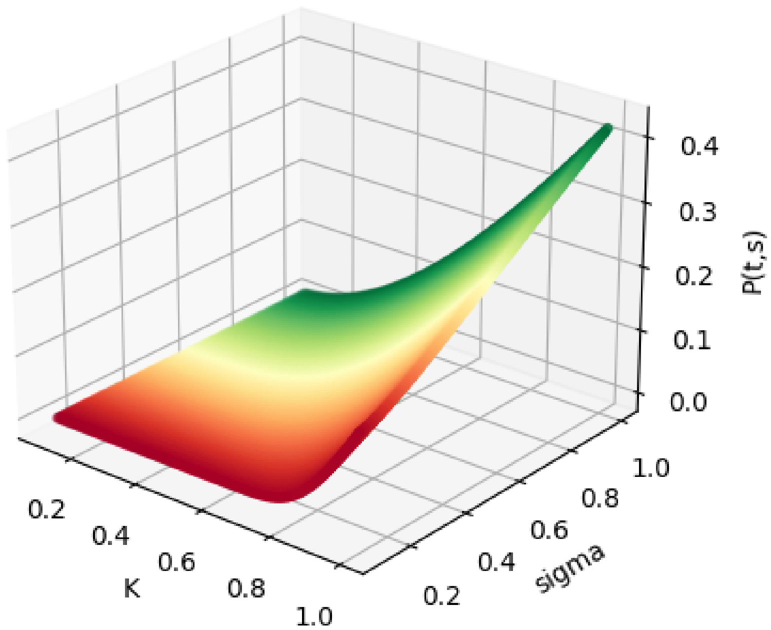
Put Option Price vs K vs r



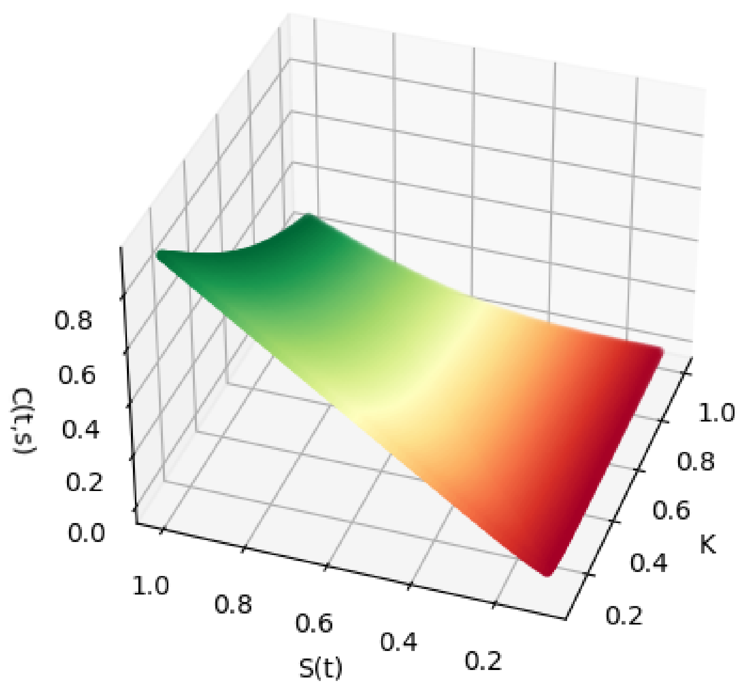
Call Option Price vs K vs sigma



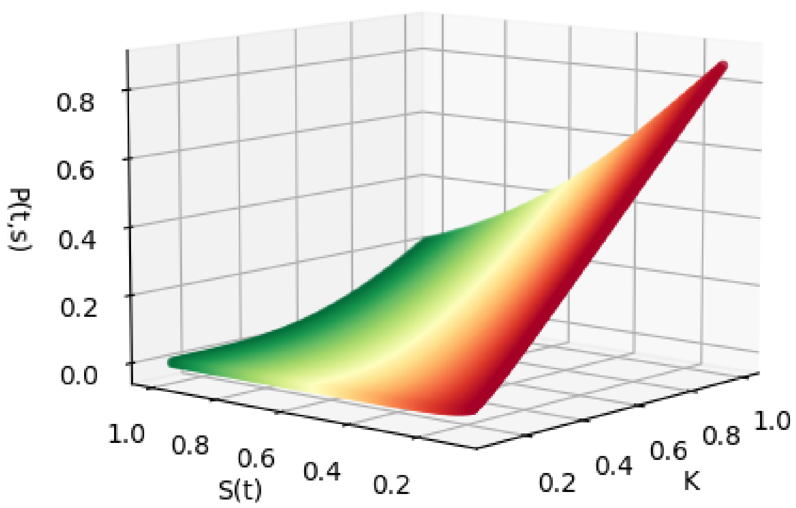
Put Option Price vs K vs sigma

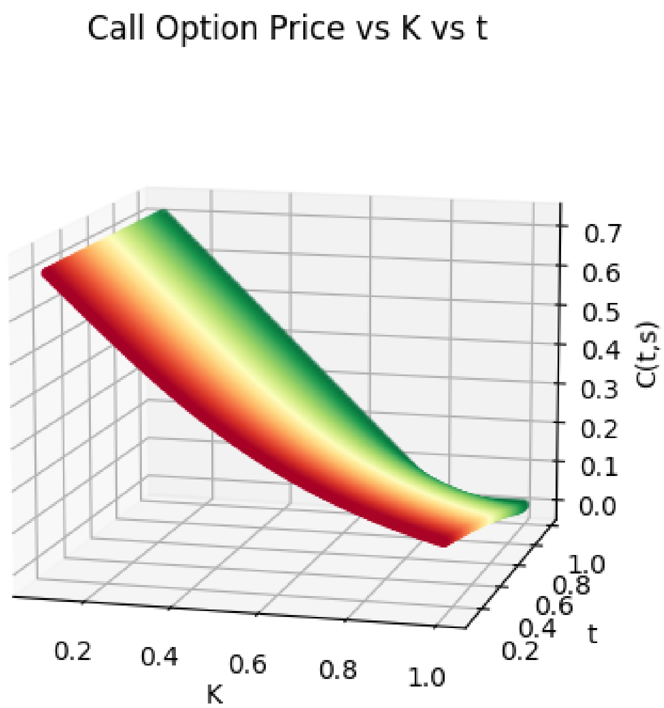


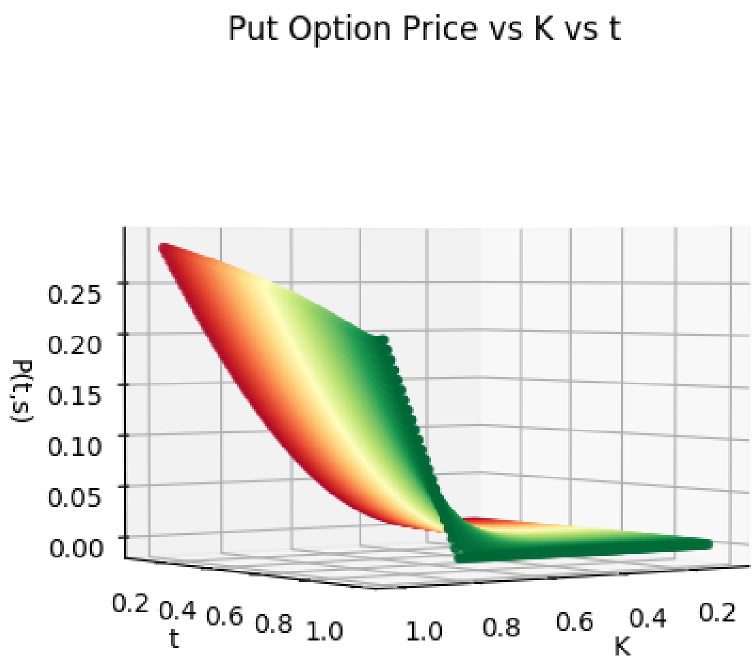
Call Option Price vs K vs S(t)



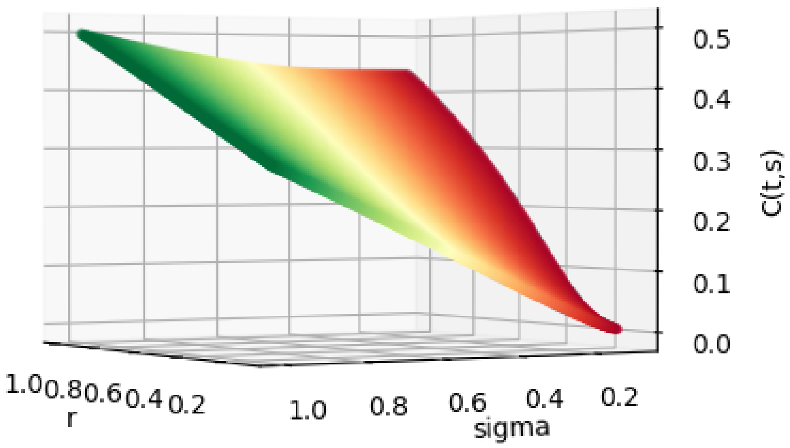
Put Option Price vs K vs S(t)



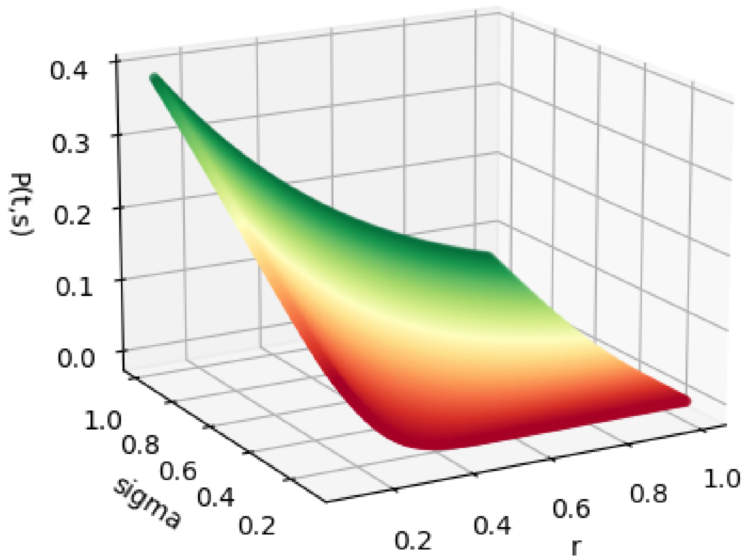

Call Option Price vs K vs t
C(t,s)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
K
0.2
0.4
0.6
0.8
1.0
t
0.2
0.4
0.6
0.8
1.0


Put Option Price vs K vs t
P(t,s)
0.00
0.05
0.10
0.15
0.20
0.25
t
0.2
0.4
0.6
0.8
1.0
K
1.0
0.8
0.6
0.4
0.2

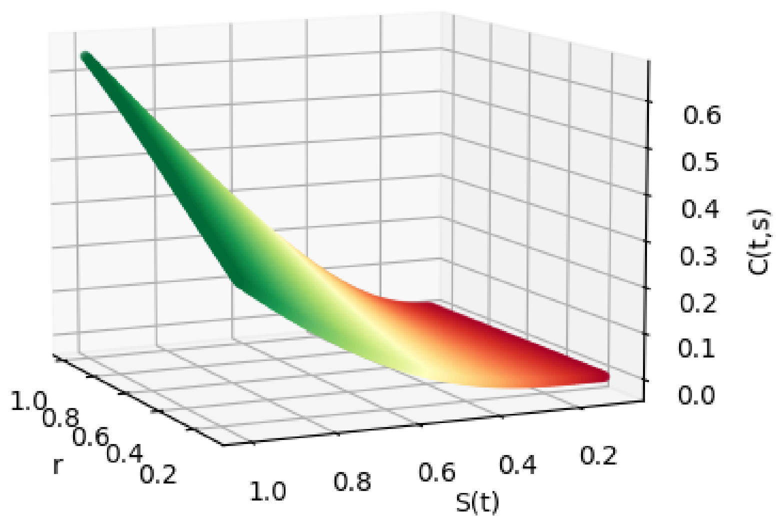
Call Option Price vs r vs sigma



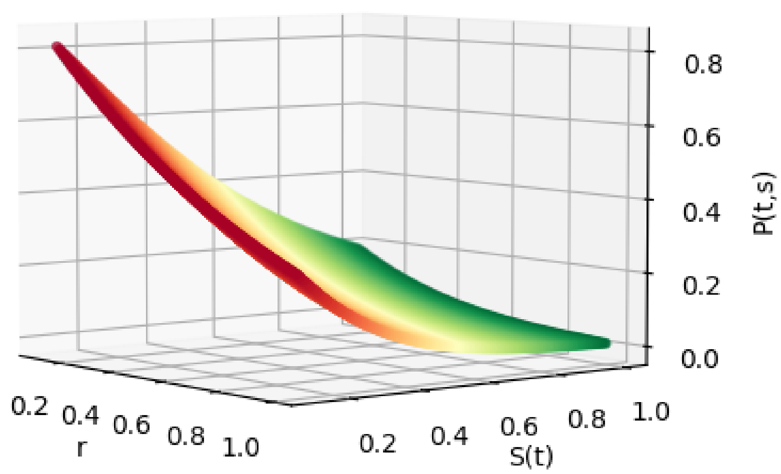
Put Option Price vs r vs sigma



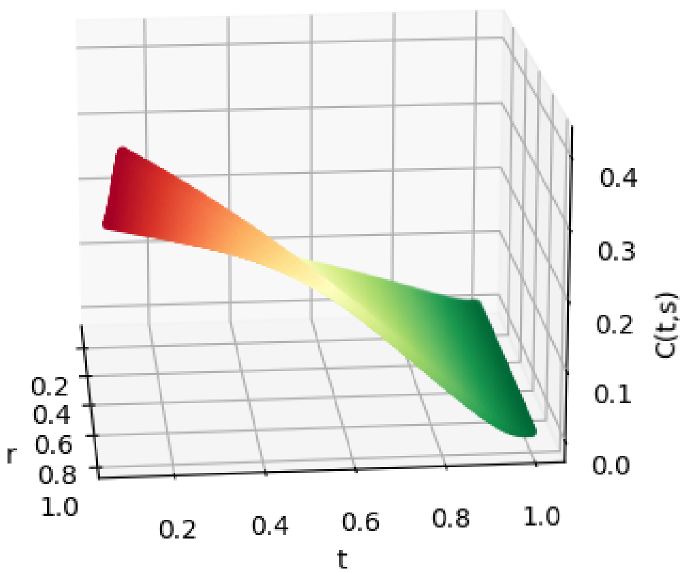
Call Option Price vs r vs S(t)



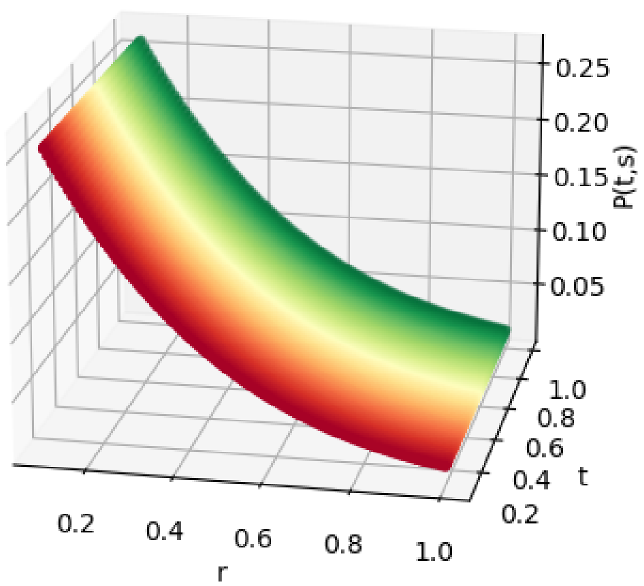
Put Option Price vs r vs S(t)



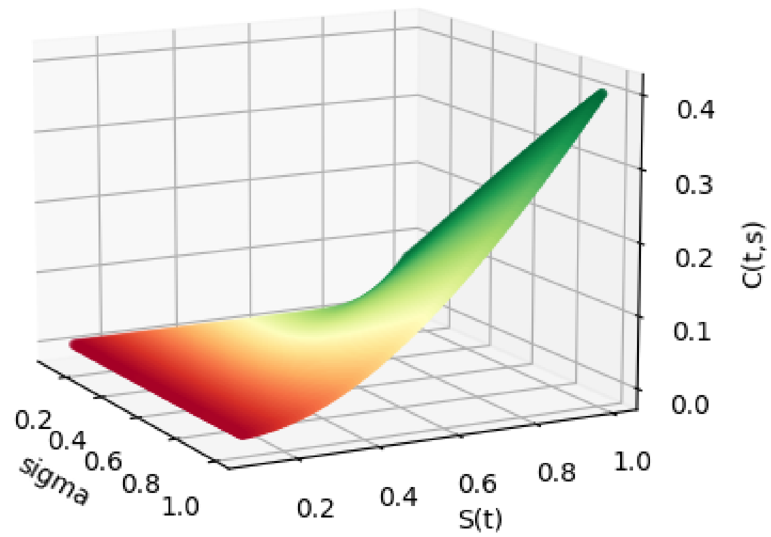
Call Option Price vs r vs t



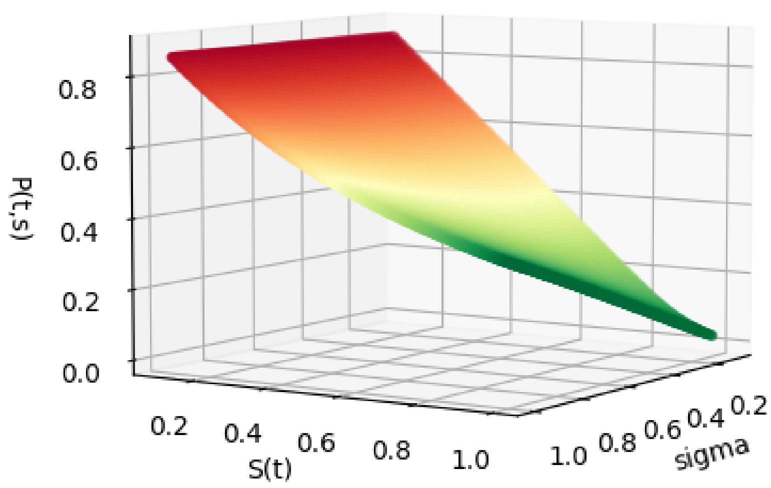
Put Option Price vs r vs t



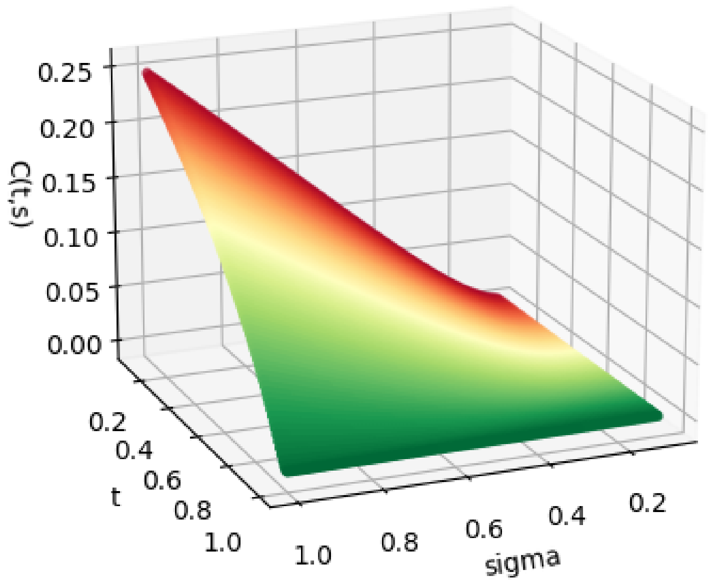
Call Option Price vs sigma vs S(t)



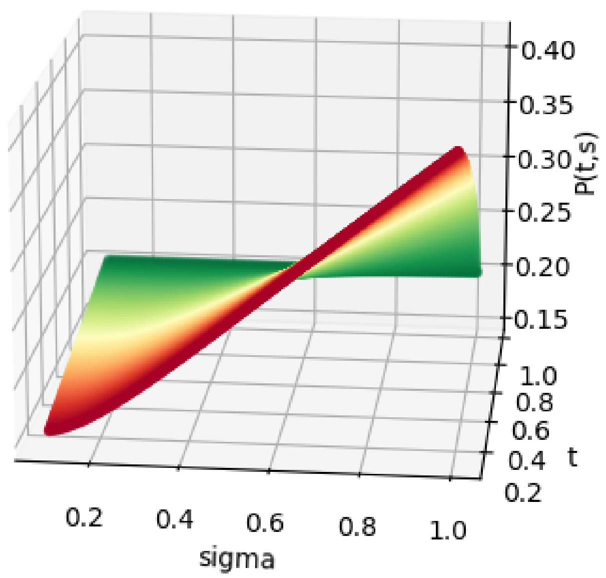
Put Option Price vs sigma vs S(t)



Call Option Price vs sigma vs t



Put Option Price vs sigma vs t



Question 5:

The price of European call and put option with continuously paying dividend at rate a is given by -

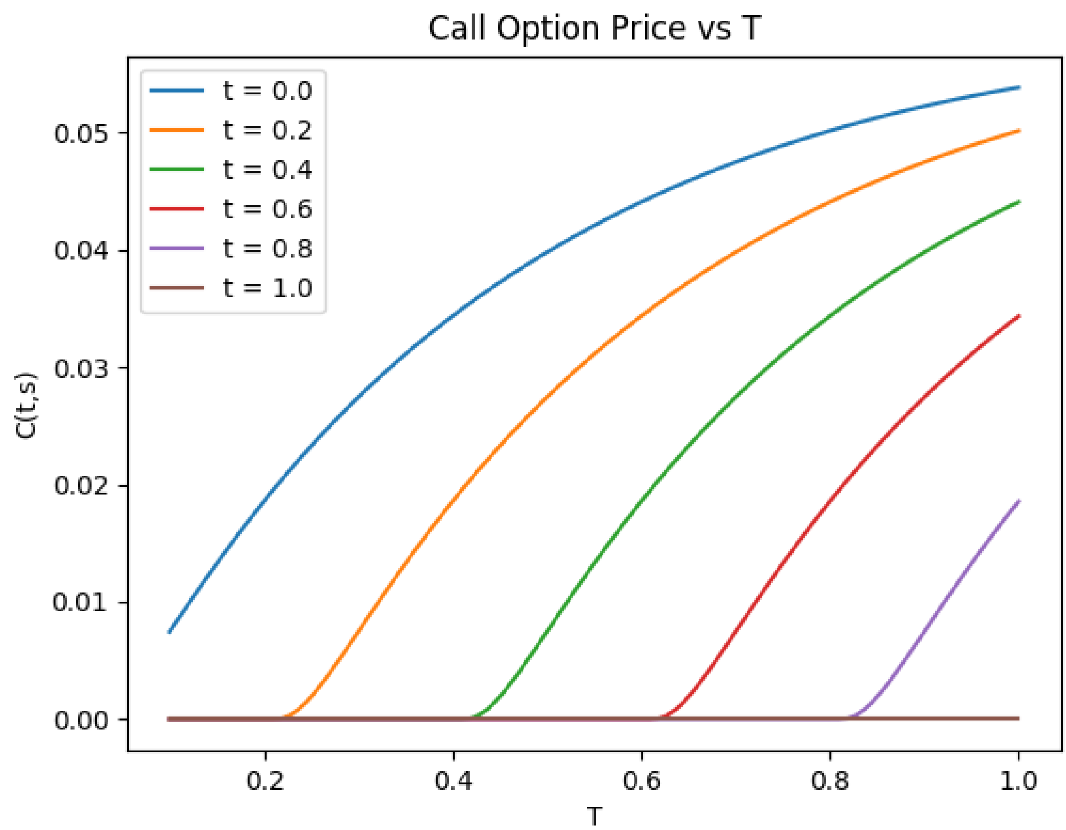
$$C(t, x) = xe^{-a(T-t)}N(d_1) - Ke^{-r(T-t)}N(d_2)$$
$$P(t, x) = Ke^{-r(T-t)}N(-d_2) - xe^{-a(T-t)}N(-d_1)$$

where

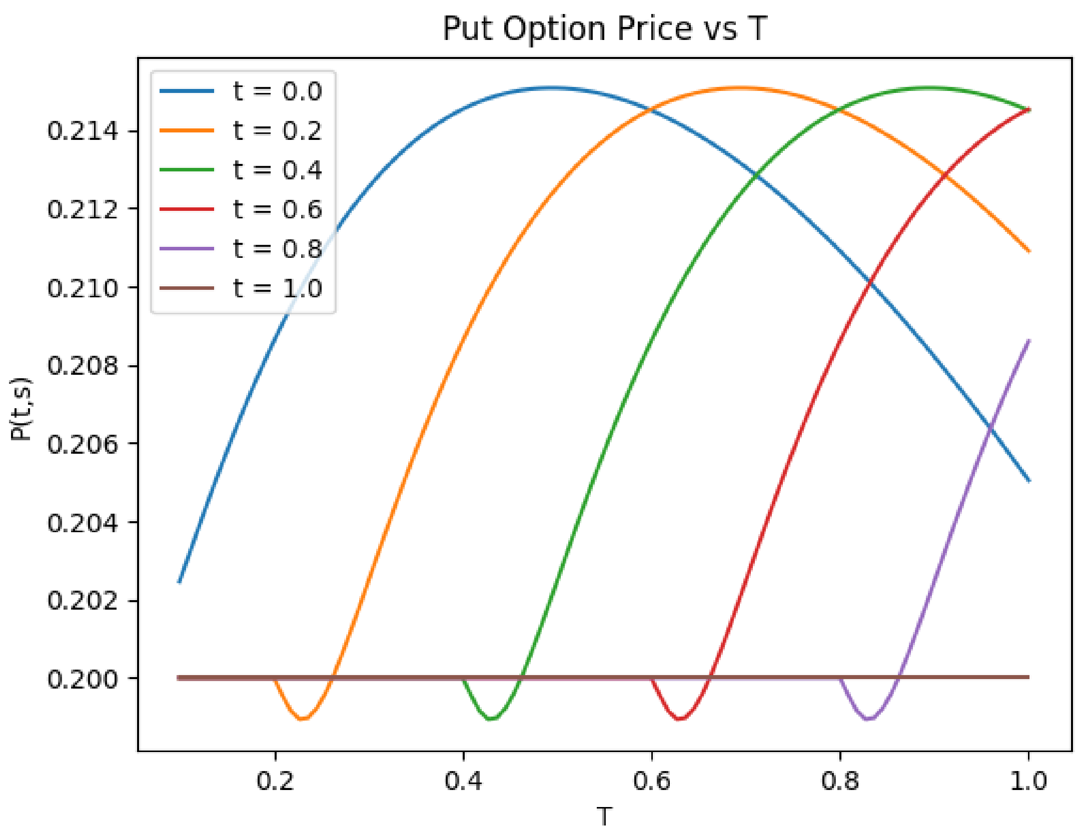
$$d_1 = \frac{log(\frac{x}{K}) + (r-a+\frac{1}{2}\sigma^2)(T-t)}{\sigma\sqrt{(T-t)}}$$

$$d_2 = \frac{log(\frac{x}{K}) + (r-a-\frac{1}{2}\sigma^2)(T-t)}{\sigma\sqrt{(T-t)}}$$

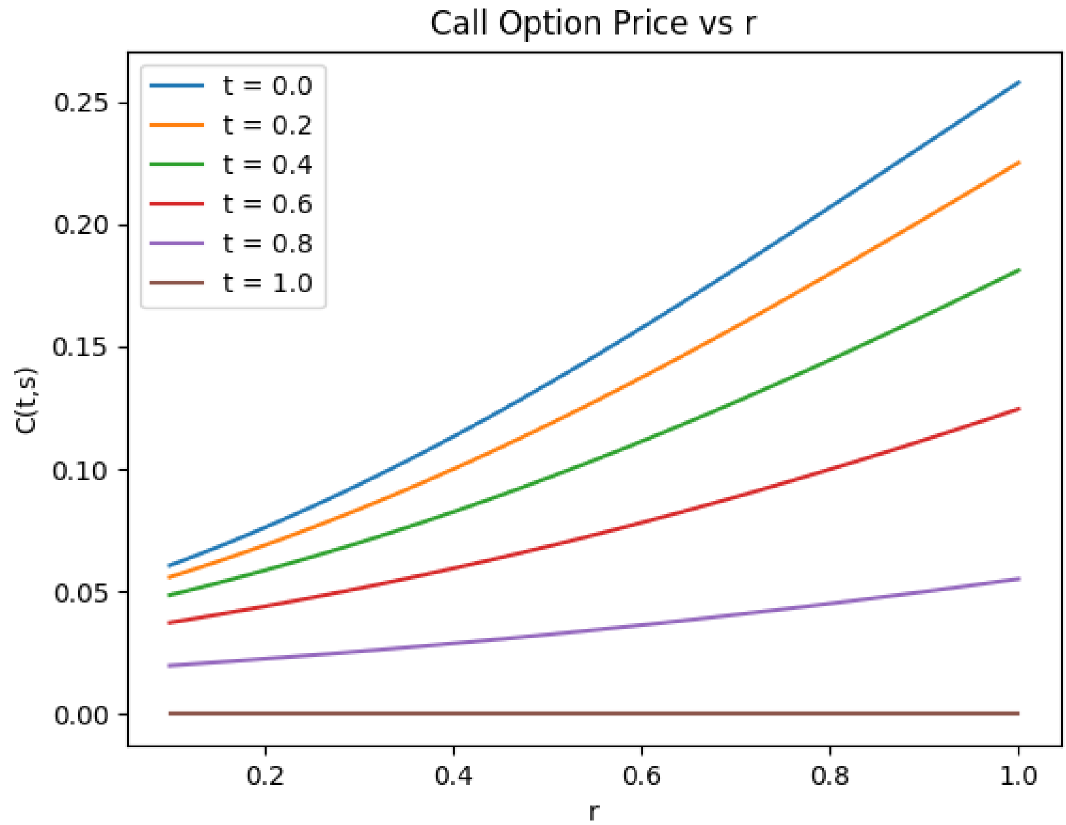
$$N(x) = \int_{-\infty}^{x} \frac{1}{\sigma\sqrt{2\pi}} e^{\frac{-x^2}{2}} dx$$

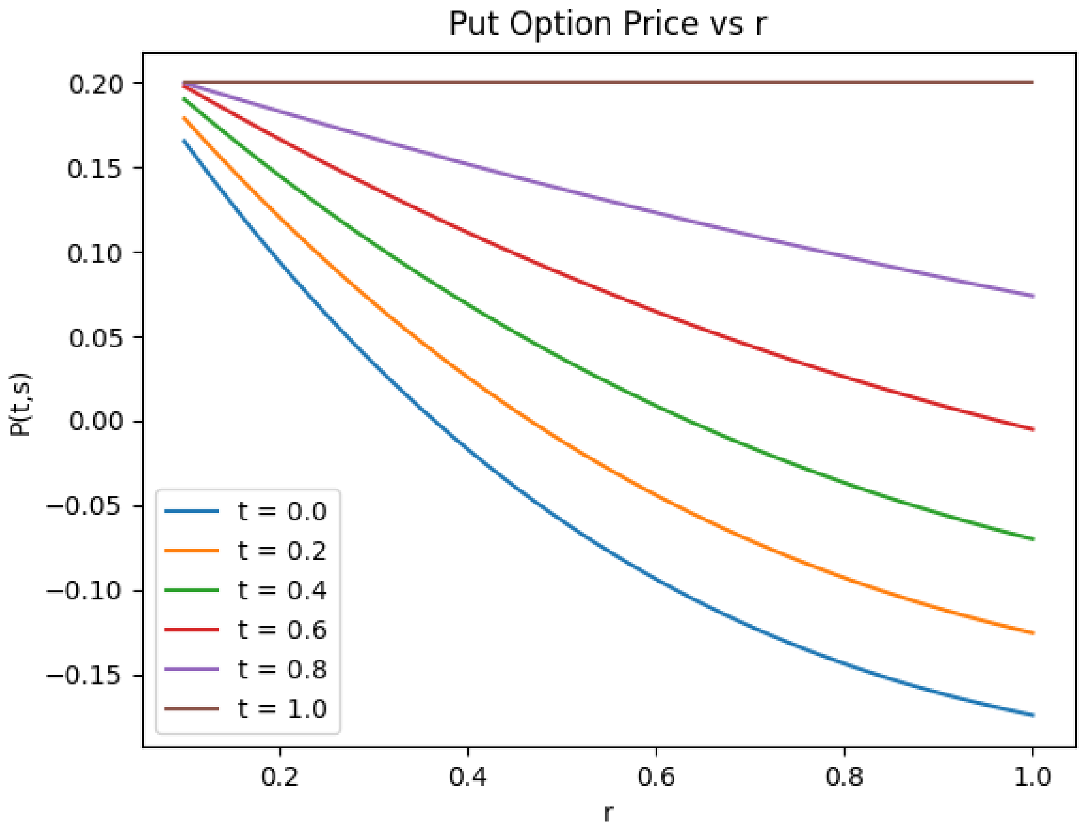


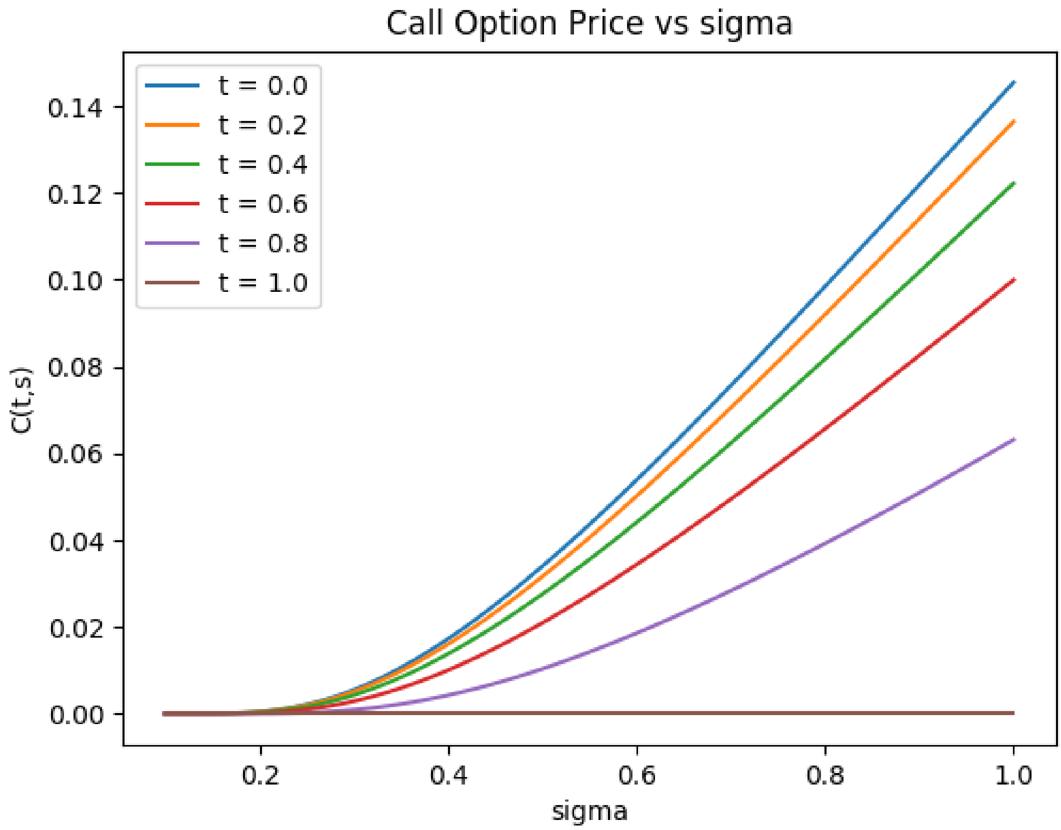
Call Option Price vs T
t = 0.0
t = 0.2
t = 0.4
t = 0.6
t = 0.8
t = 1.0
C(t,s)
0.05
0.04
0.03
0.02
0.01
0.00
0.2
0.4
0.6
0.8
1.0
T



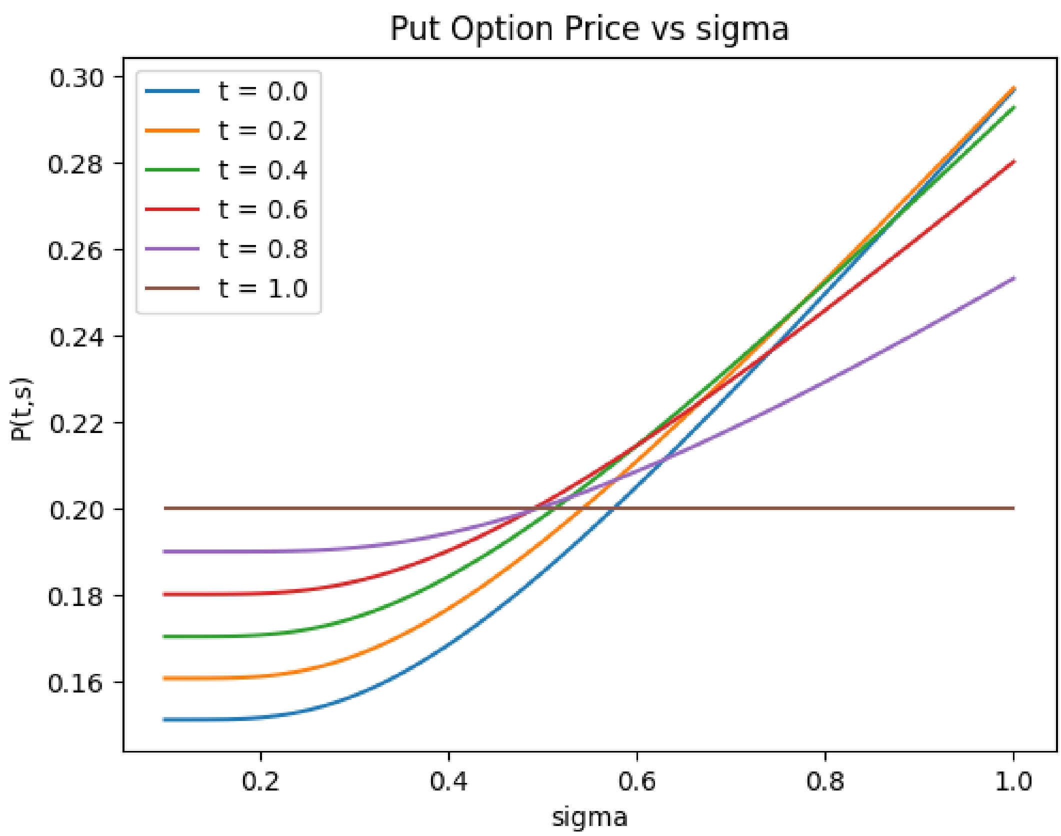
Put Option Price vs T
t = 0.0
t = 0.2
t = 0.4
t = 0.6
t = 0.8
t = 1.0
P(t,s)
0.214
0.212
0.210
0.208
0.206
0.204
0.202
0.200
0.2
0.4
0.6
0.8
1.0
T


Call Option Price vs r
t = 0.0
t = 0.2
t = 0.4
t = 0.6
t = 0.8
t = 1.0
C(t,s)
r
0.00
0.05
0.10
0.15
0.20
0.25
0.2
0.4
0.6
0.8
1.0

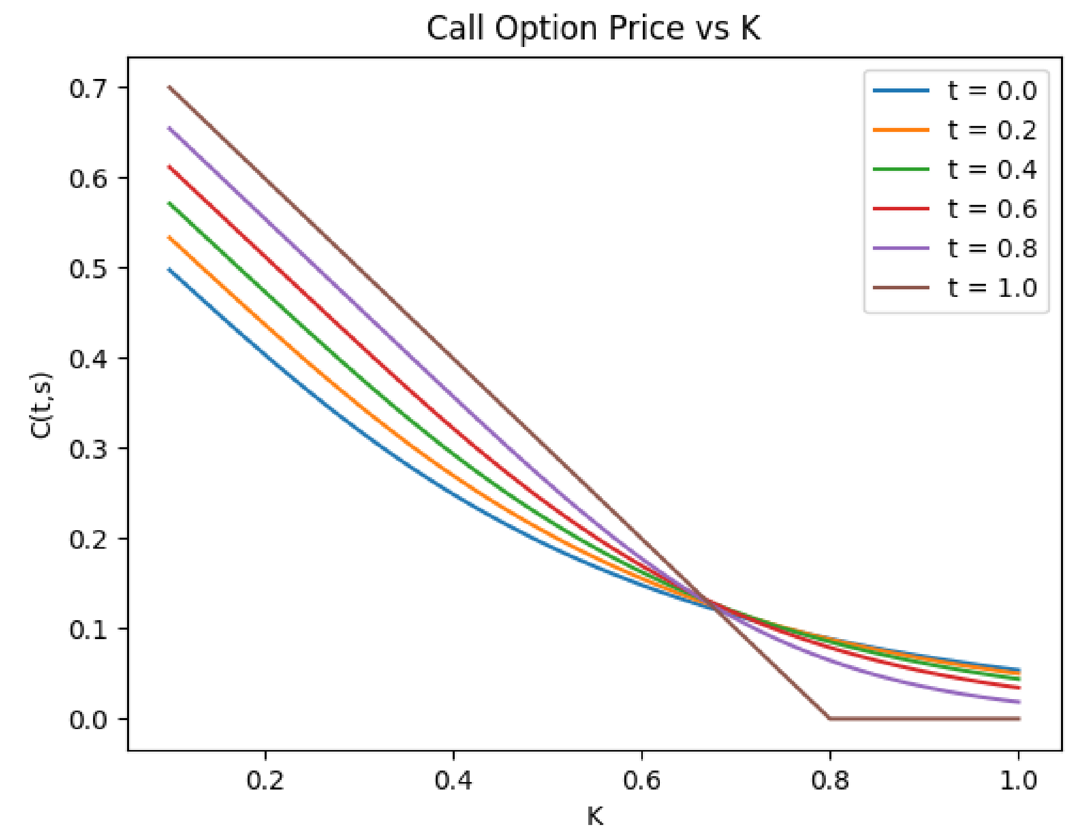

Put Option Price vs r
t = 0.0
t = 0.2
t = 0.4
t = 0.6
t = 0.8
t = 1.0
P(t,s)
r
−0.15
−0.10
−0.05
0.00
0.05
0.10
0.15
0.20
0.2
0.4
0.6
0.8
1.0

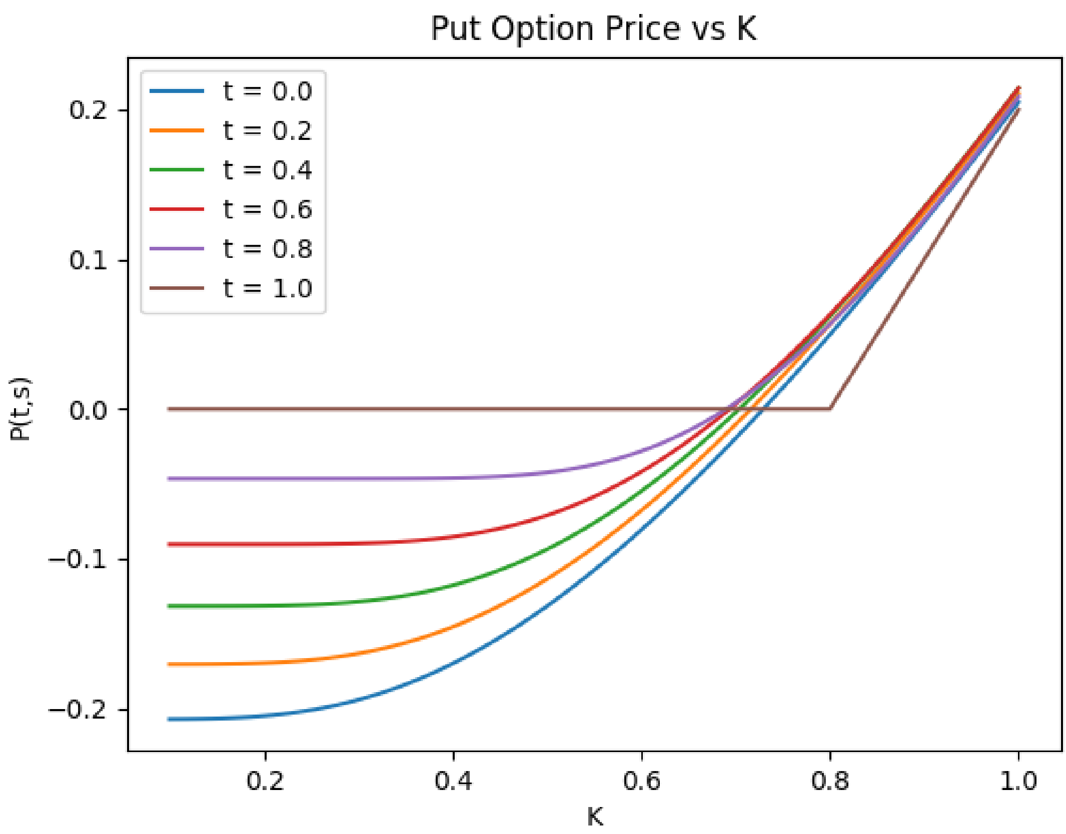


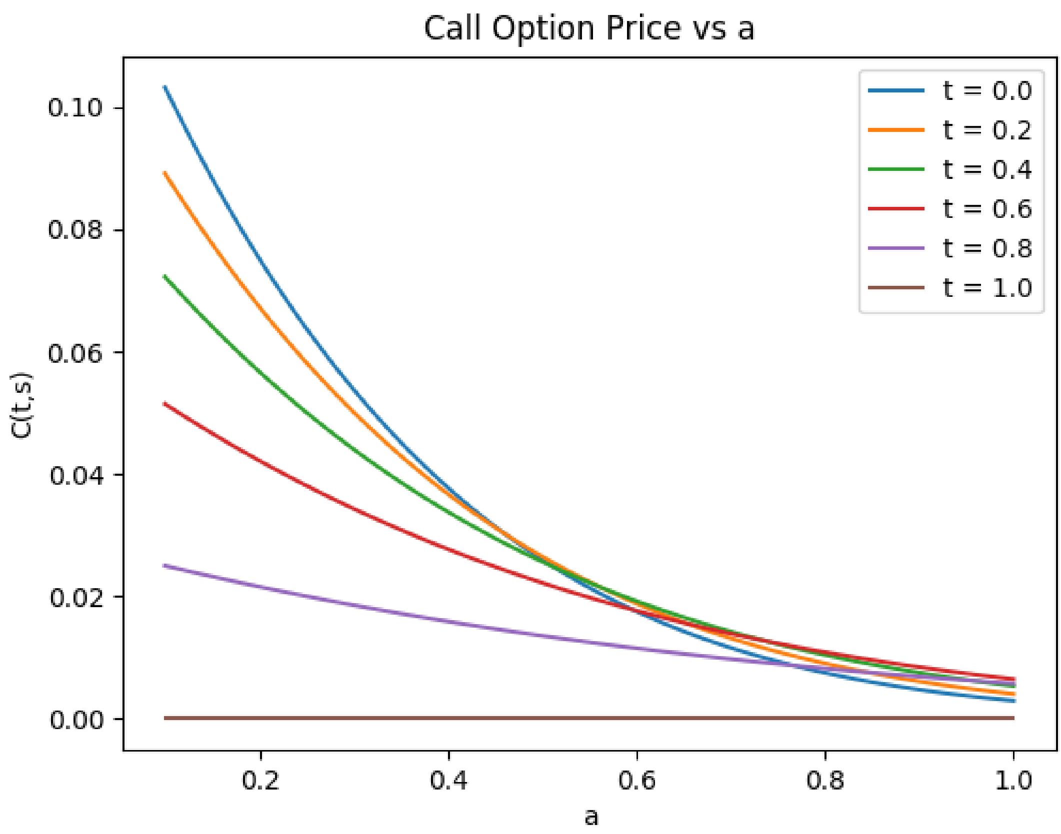
Call Option Price vs sigma
t = 0.0
t = 0.2
t = 0.4
t = 0.6
t = 0.8
t = 1.0
C(t,s)
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
0.2
0.4
0.6
0.8
1.0
sigma

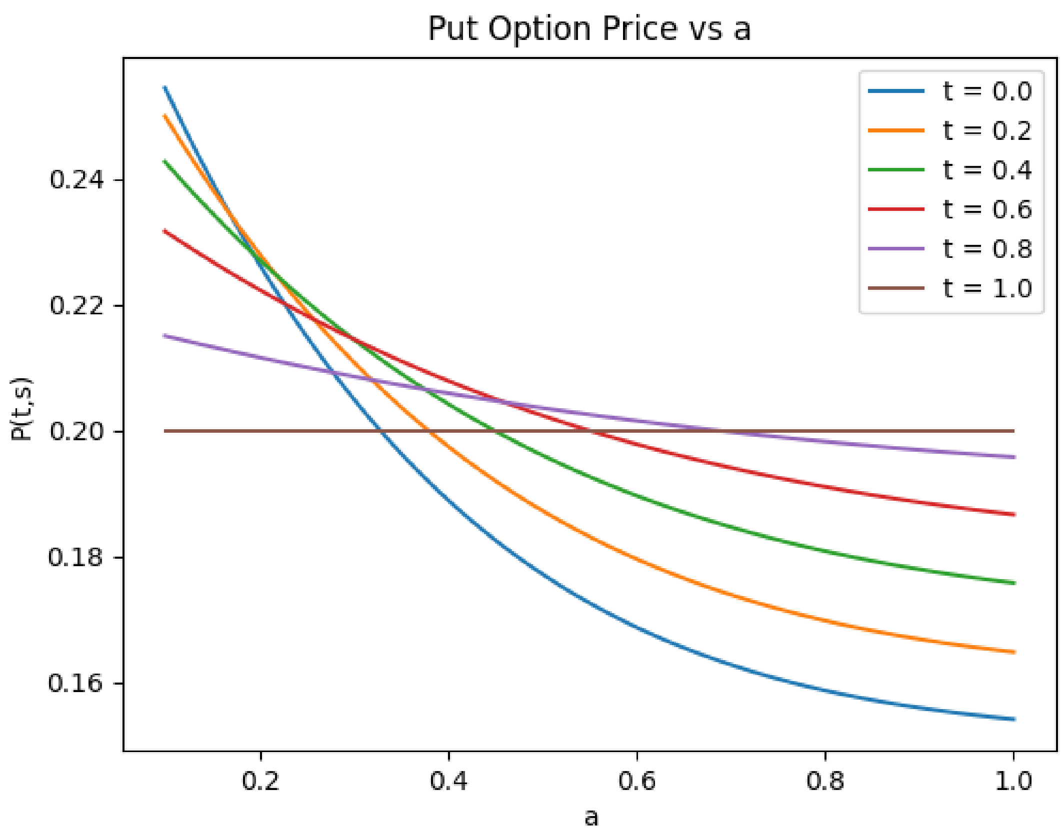


Put Option Price vs sigma
t = 0.0
t = 0.2
t = 0.4
t = 0.6
t = 0.8
t = 1.0
P(t,s)
0.30
0.28
0.26
0.24
0.22
0.20
0.18
0.16
0.2
0.4
0.6
0.8
1.0
sigma

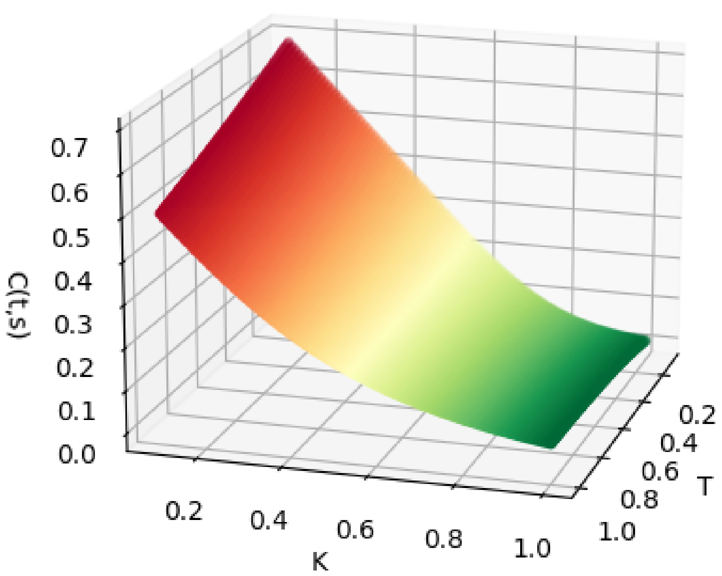

Call Option Price vs K
C(t,s)
K
t = 0.0
t = 0.2
t = 0.4
t = 0.6
t = 0.8
t = 1.0


Put Option Price vs K
P(t,s)
K
t = 0.0
t = 0.2
t = 0.4
t = 0.6
t = 0.8
t = 1.0

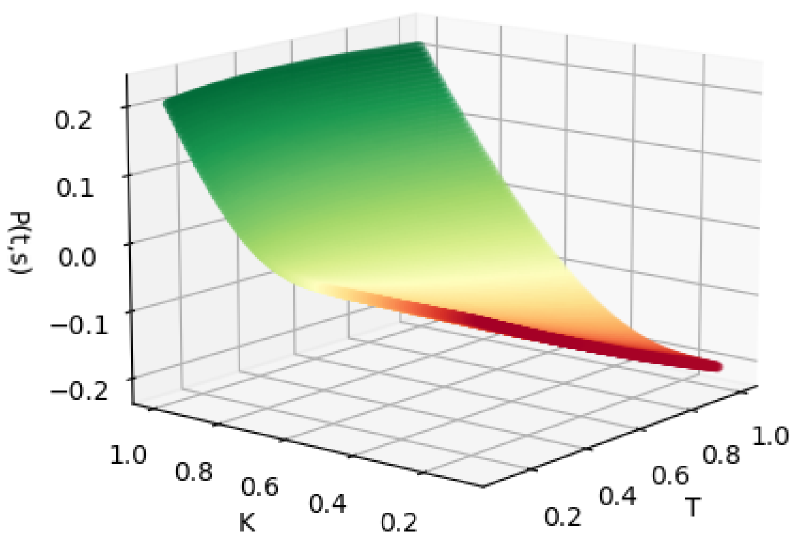

Call Option Price vs a
C(t,s)
a
0.10
0.08
0.06
0.04
0.02
0.00
0.2
0.4
0.6
0.8
1.0
t = 0.0
t = 0.2
t = 0.4
t = 0.6
t = 0.8
t = 1.0


Put Option Price vs a
P(t,s)
a
0.24
0.22
0.20
0.18
0.16
0.2
0.4
0.6
0.8
1.0
t = 0.0
t = 0.2
t = 0.4
t = 0.6
t = 0.8
t = 1.0

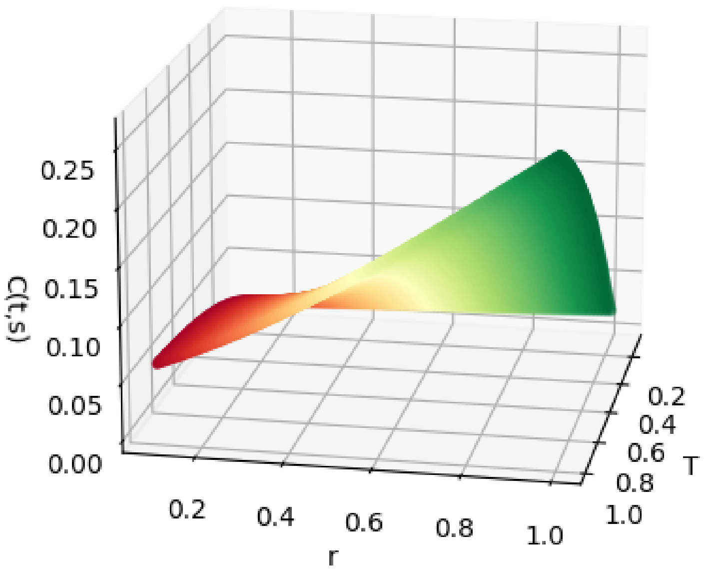
Call Option Price vs T vs K



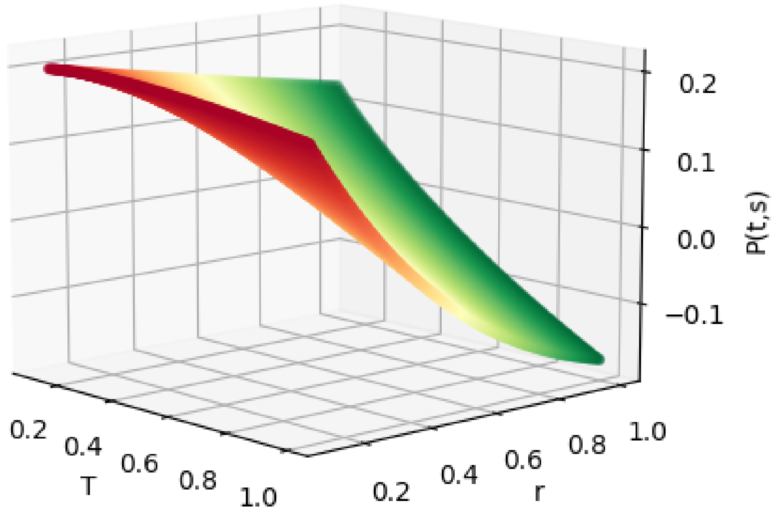
Put Option Price vs T vs K



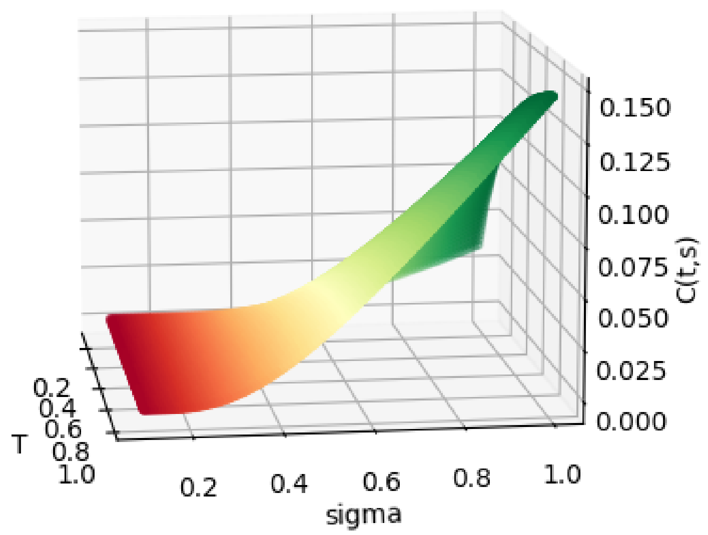
Call Option Price vs T vs r



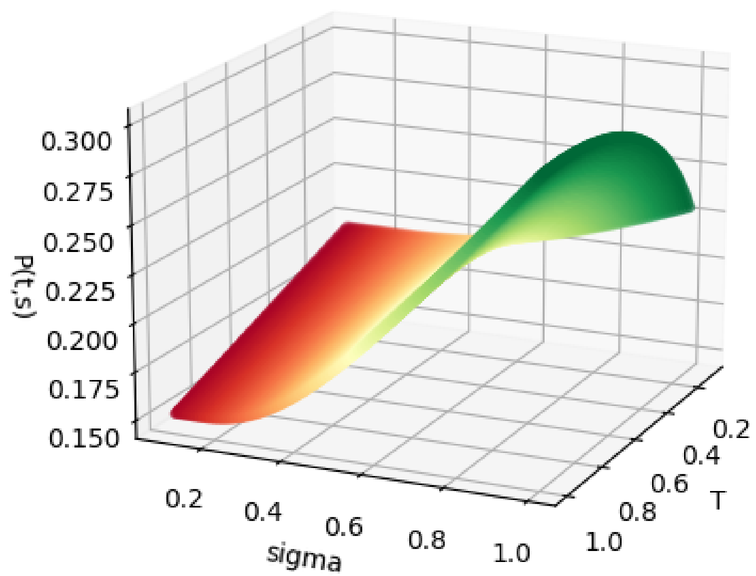
Put Option Price vs T vs r



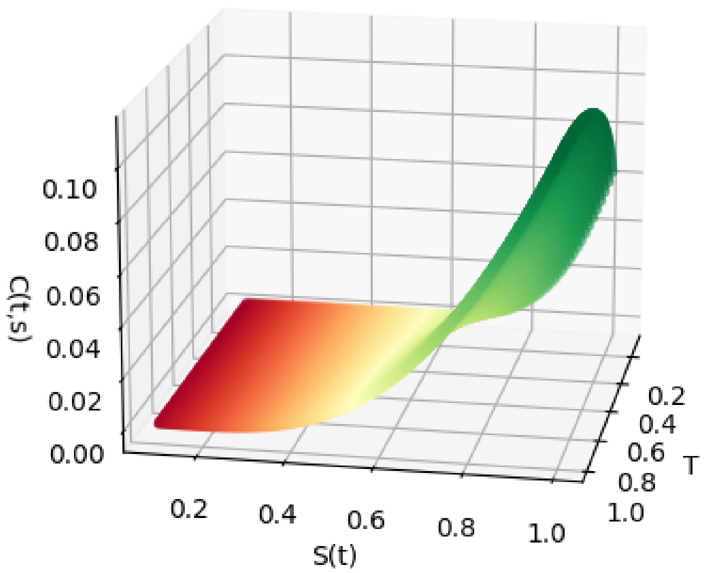
Call Option Price vs T vs sigma



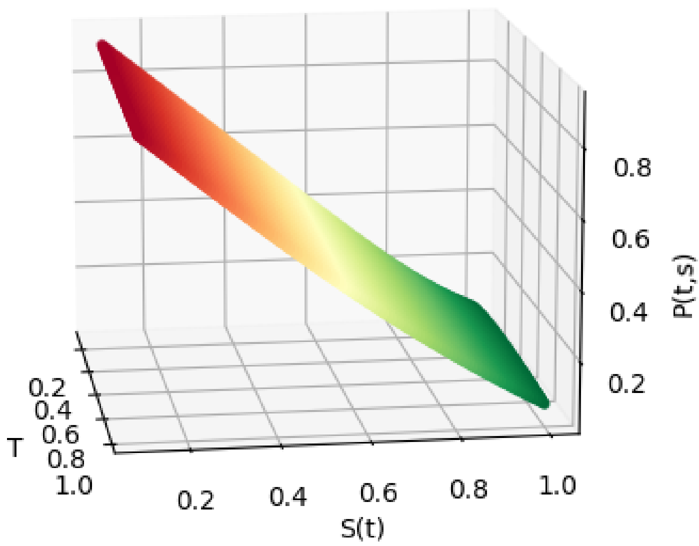
Put Option Price vs T vs sigma



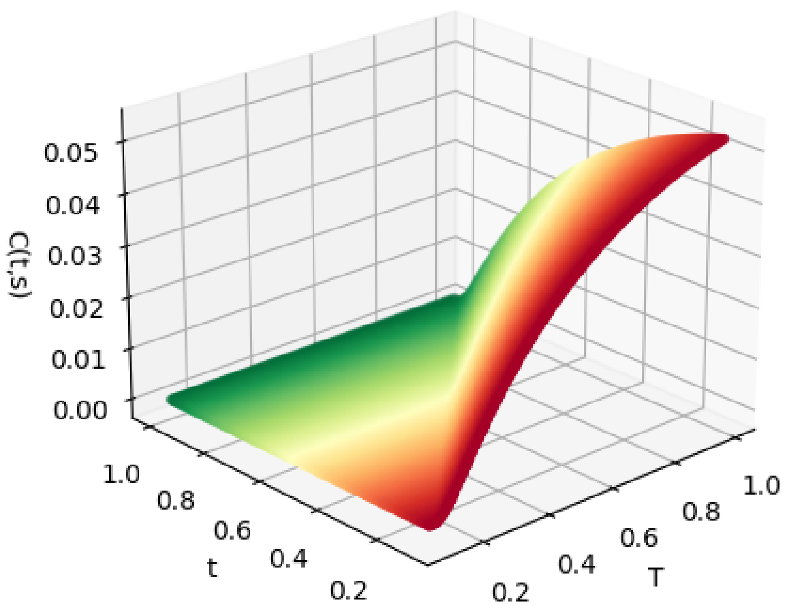
Call Option Price vs T vs S(t)



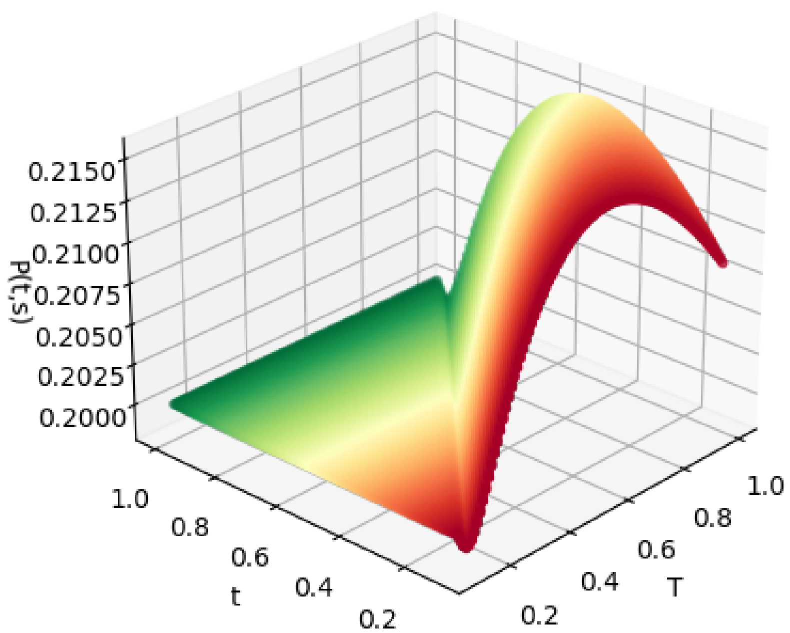
Put Option Price vs T vs S(t)



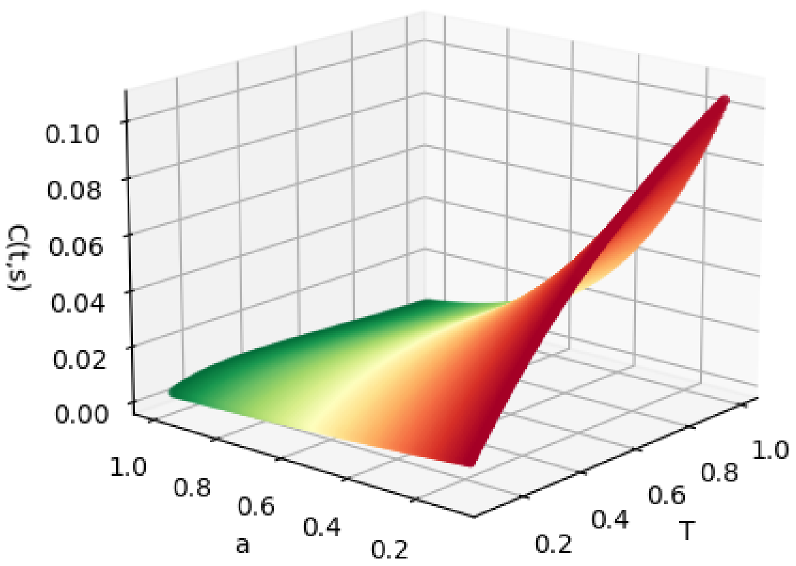
Call Option Price vs T vs t



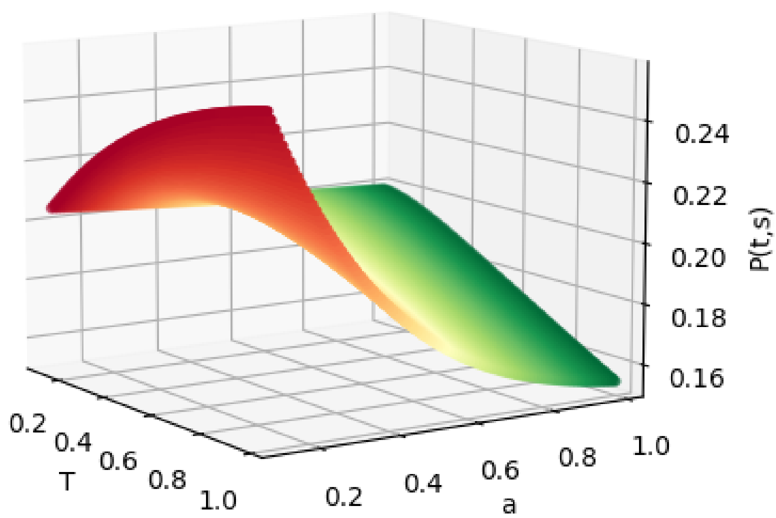
Put Option Price vs T vs t



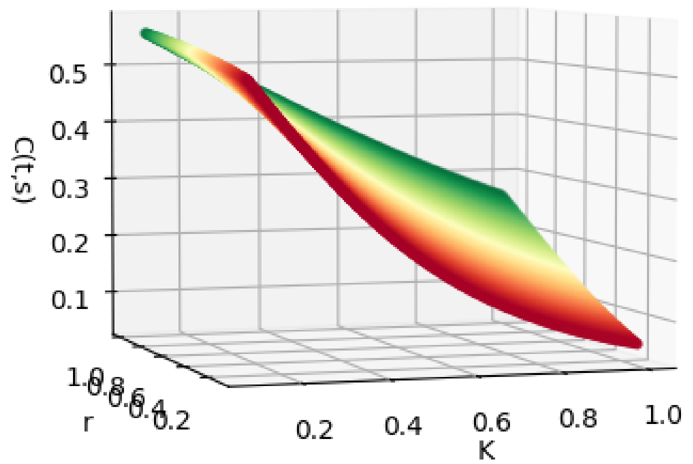
Call Option Price vs T vs a



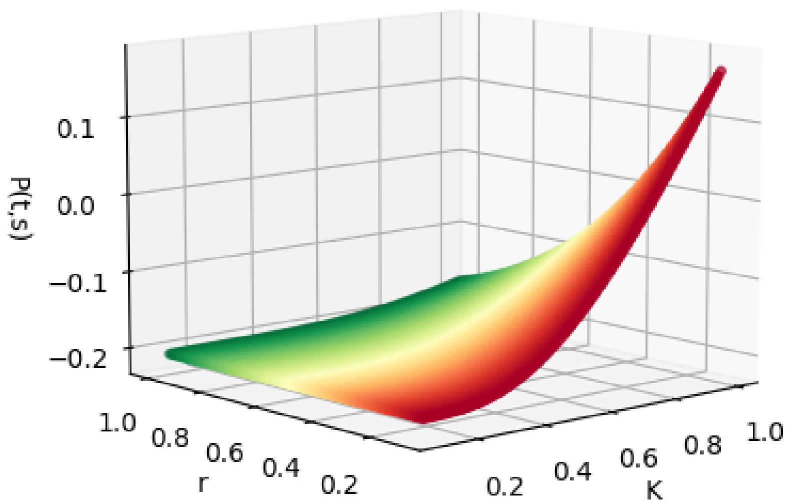
Put Option Price vs T vs a



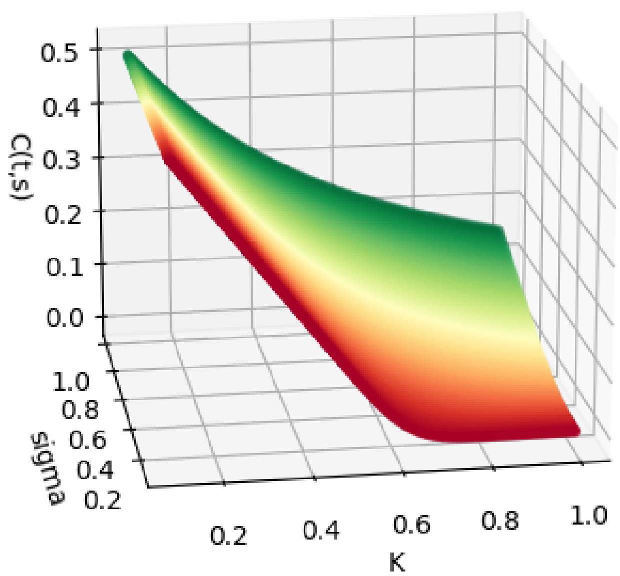
Call Option Price vs K vs r



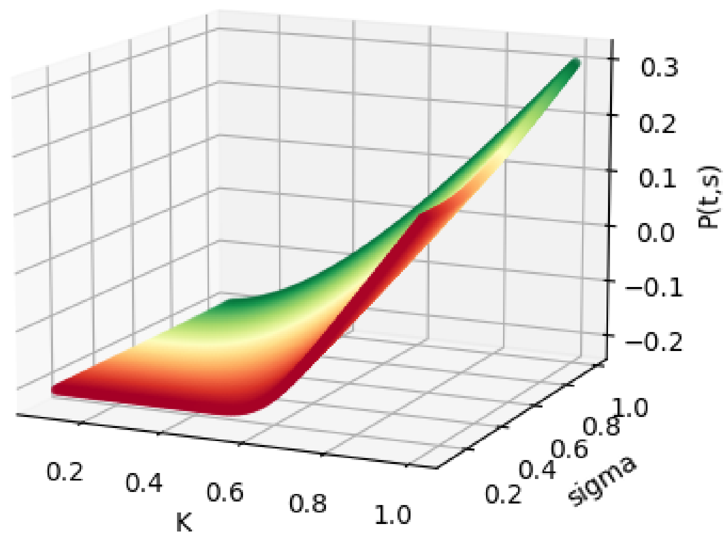
Put Option Price vs K vs r

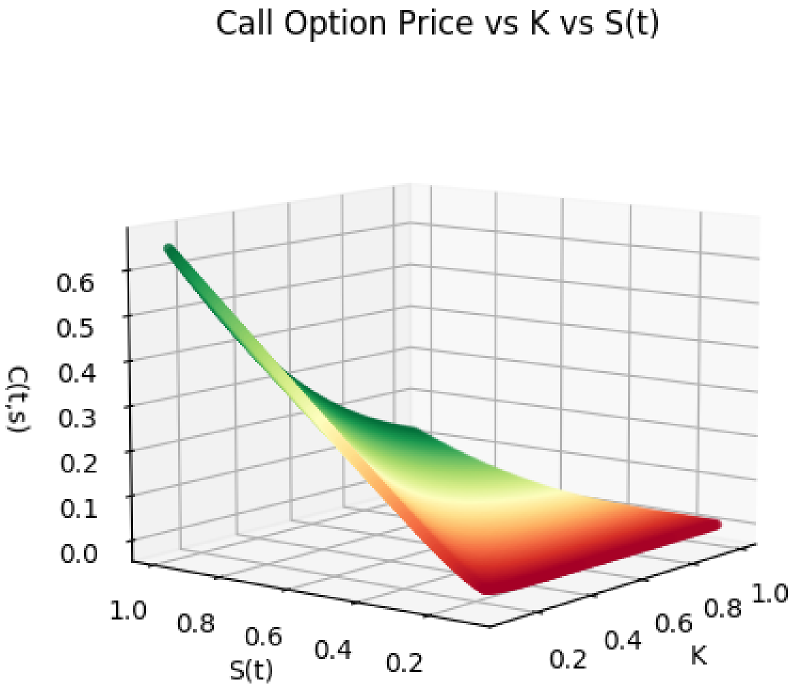


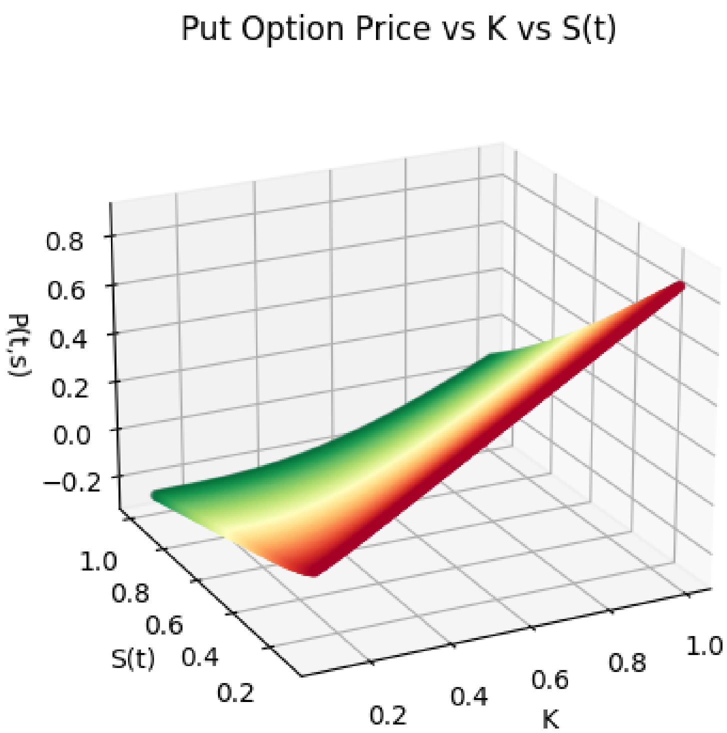
Call Option Price vs K vs sigma



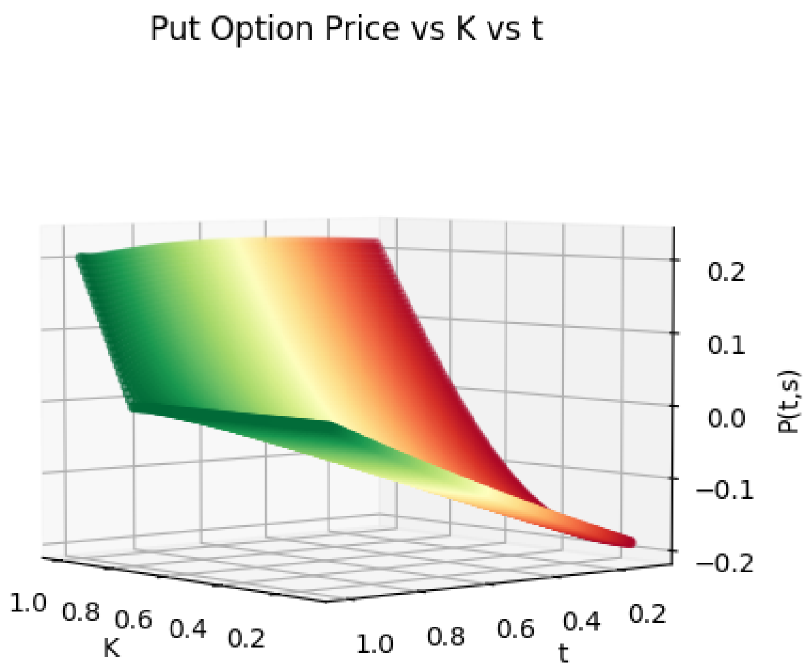
Put Option Price vs K vs sigma



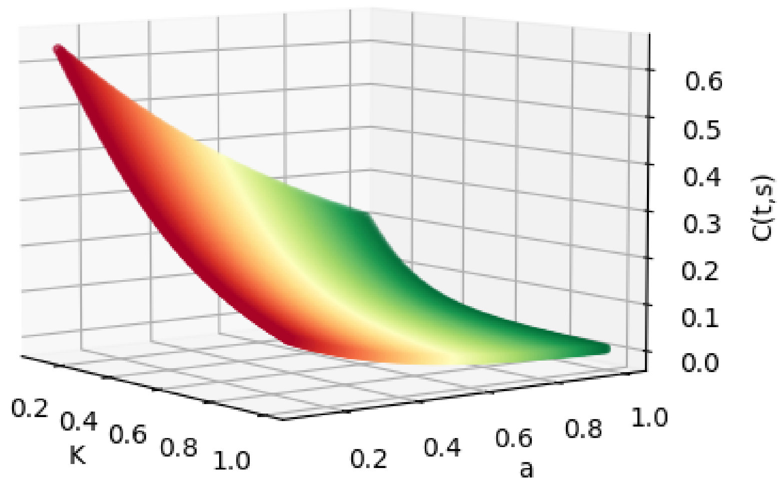

Call Option Price vs K vs S(t)
C(t,s)
0.6
0.5
0.4
0.3
0.2
0.1
0.0
1.0
0.8
0.6
0.4
0.2
S(t)
0.2
0.4
0.6
0.8
1.0
K


Put Option Price vs K vs S(t)
P(t,s)
0.8
0.6
0.4
0.2
0.0
−0.2
1.0
0.8
0.6
0.4
0.2
S(t)
0.2
0.4
0.6
0.8
1.0
K

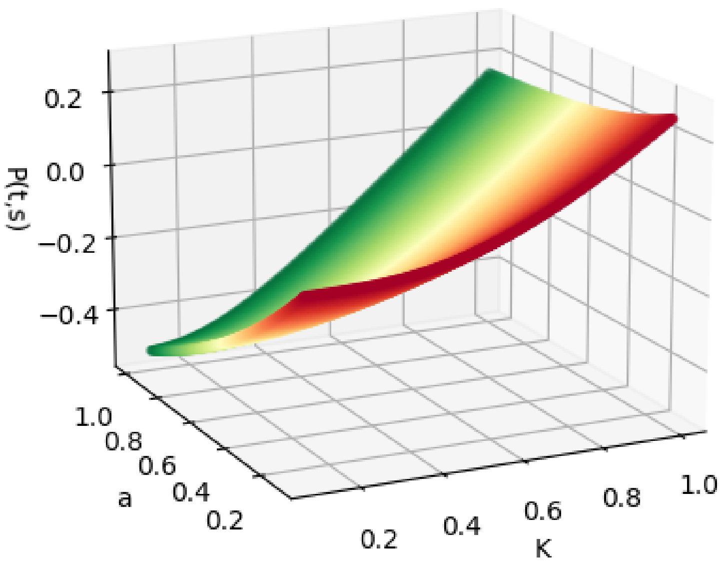

Call Option Price vs K vs t
C(t,s)
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0.2 0.4 0.6 0.8 1.0
K
0.2 0.4 0.6 0.8 1.0
t


Put Option Price vs K vs t
P(t,s)
0.2
0.1
0.0
−0.1
−0.2
1.0 0.8 0.6 0.4 0.2
K
1.0 0.8 0.6 0.4 0.2
t

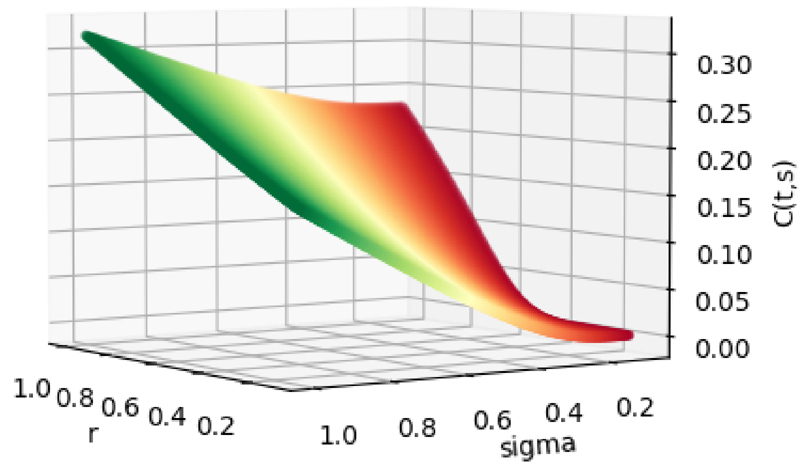
Call Option Price vs K vs a



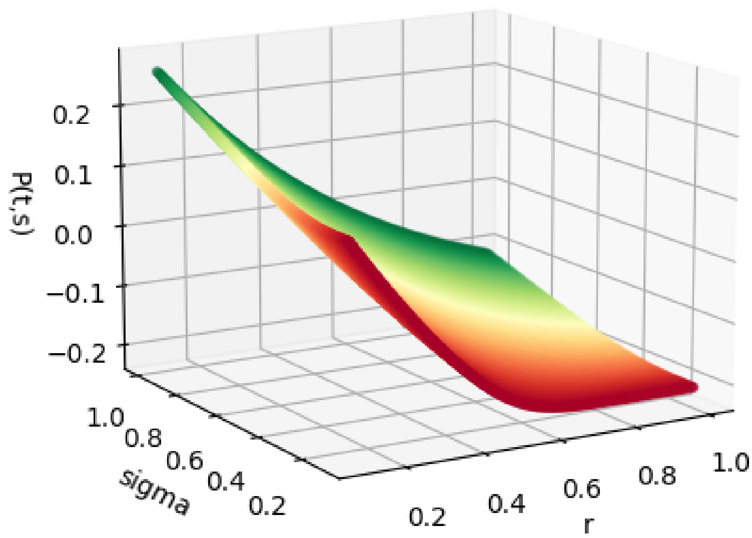
Put Option Price vs K vs a



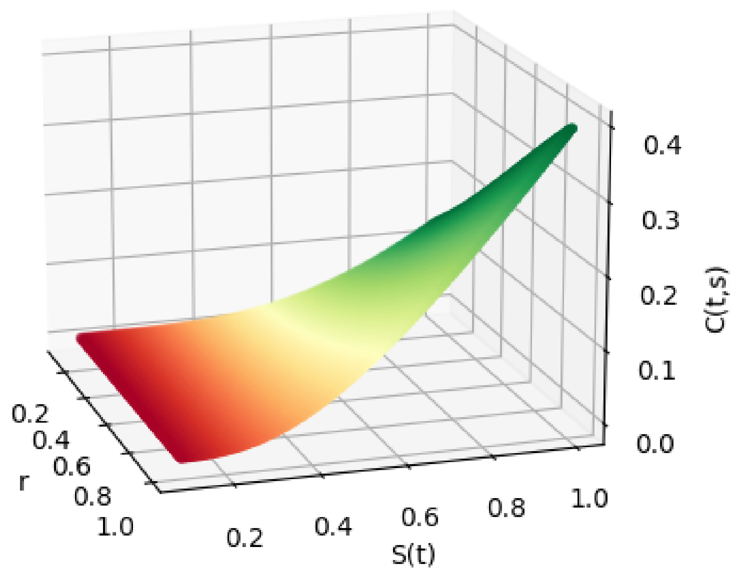
Call Option Price vs r vs sigma



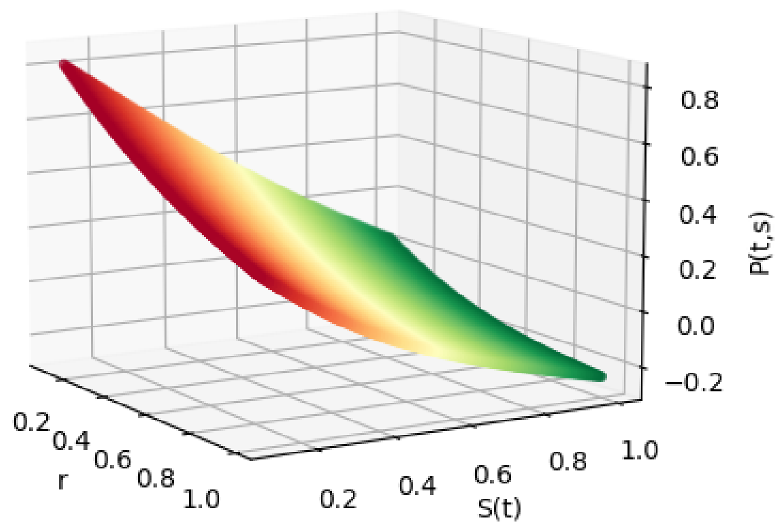
Put Option Price vs r vs sigma



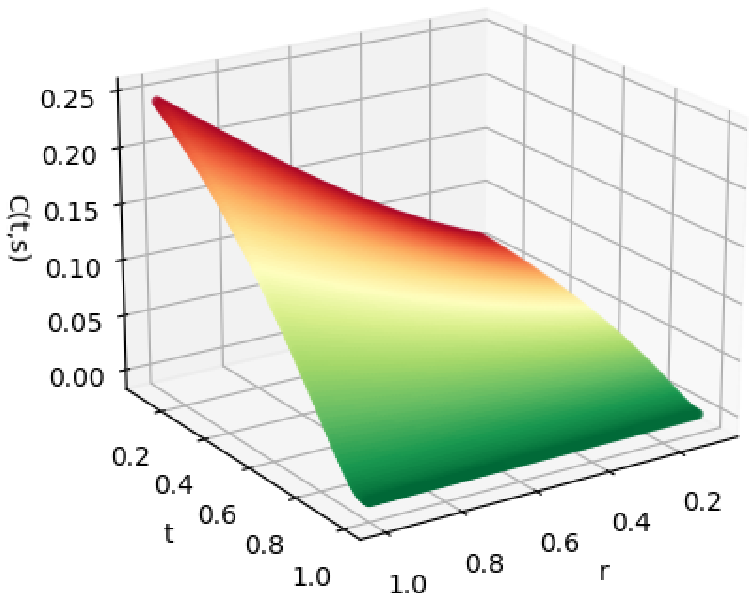
Call Option Price vs r vs S(t)



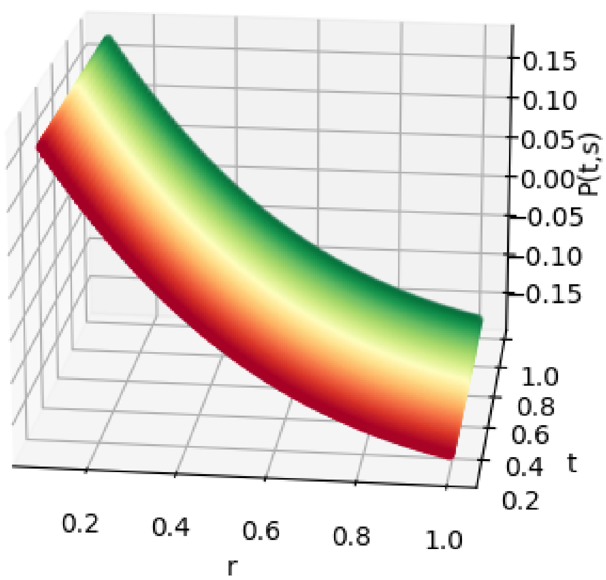
Put Option Price vs r vs S(t)

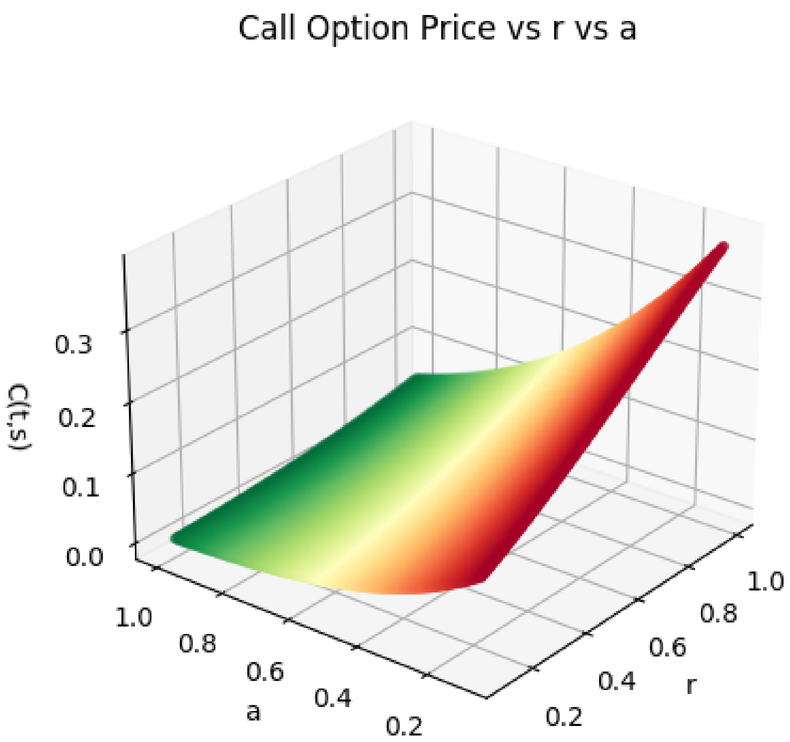


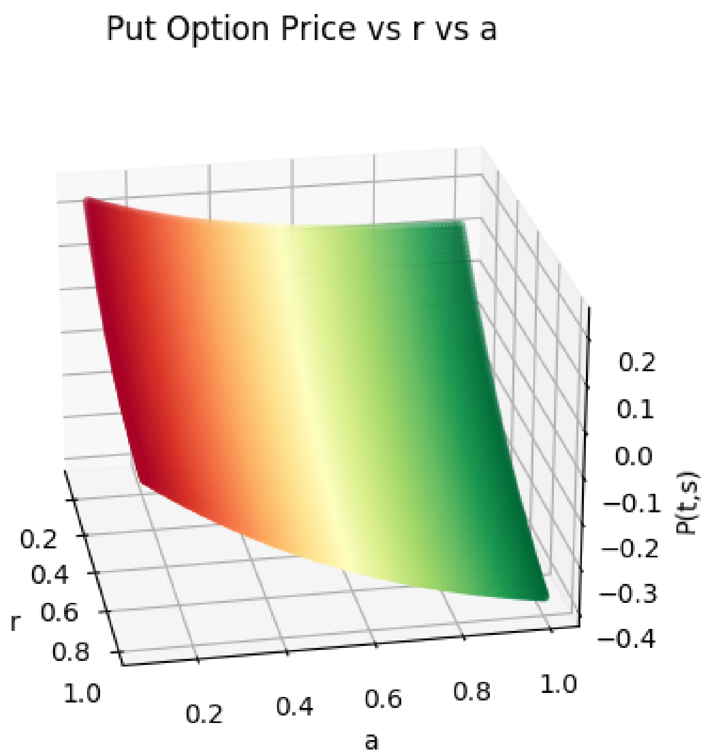
Call Option Price vs r vs t



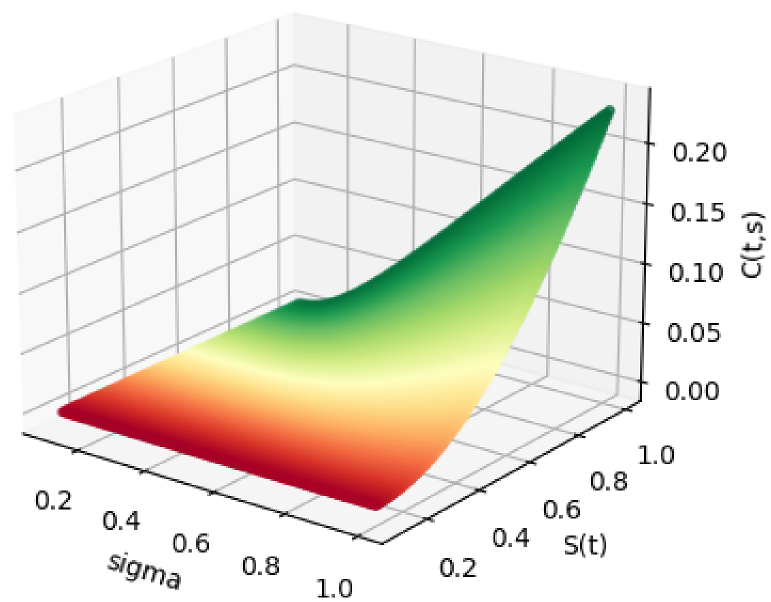
Put Option Price vs r vs t



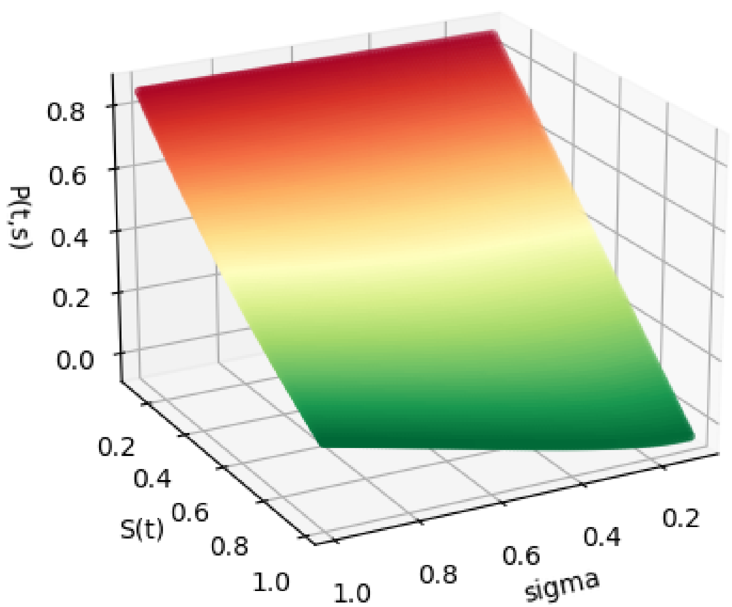

Call Option Price vs r vs a
C(t,s)
0.3
0.2
0.1
0.0
1.0
0.8
0.6
0.4
0.2
a
1.0
0.8
0.6
0.4
0.2
r


Put Option Price vs r vs a
0.2
0.1
0.0
−0.1
−0.2
−0.3
−0.4
P(t,s)
0.2
0.4
r
0.6
0.8
1.0
0.2
0.4
0.6
0.8
1.0
a

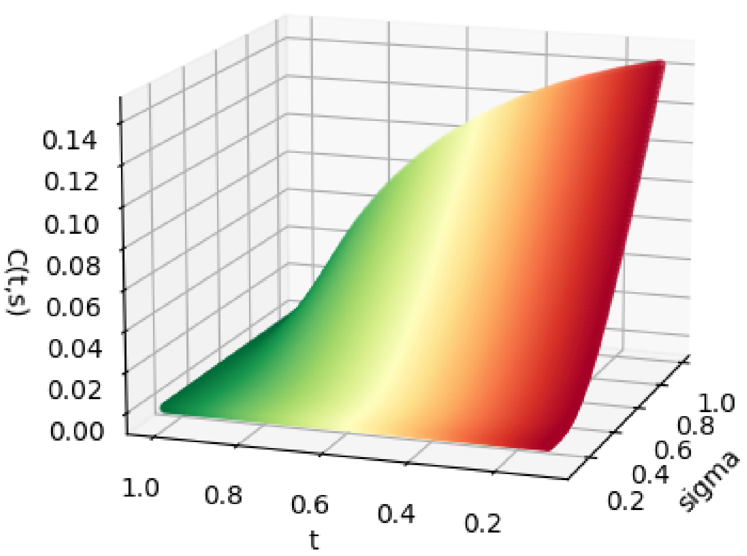
Call Option Price vs sigma vs S(t)



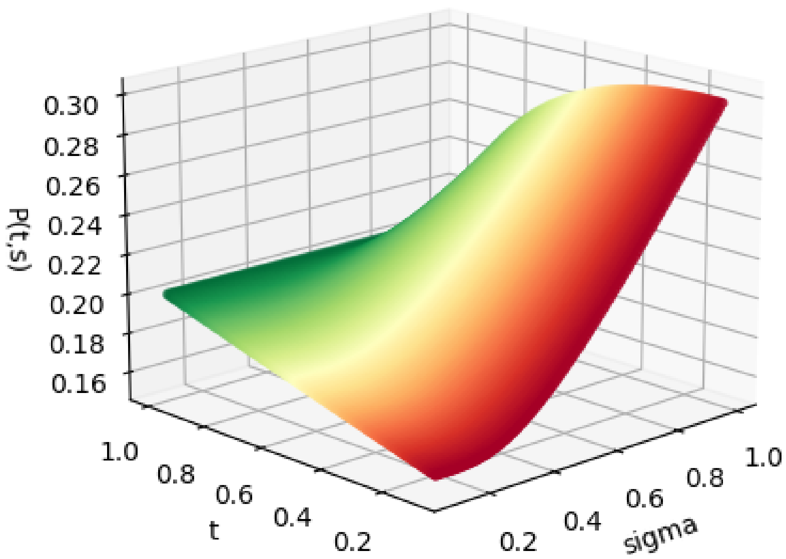
Put Option Price vs sigma vs S(t)



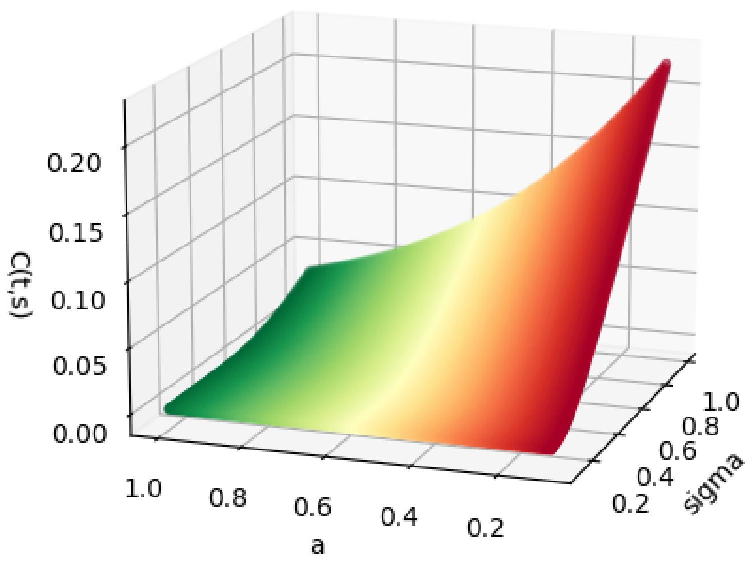
Call Option Price vs sigma vs t



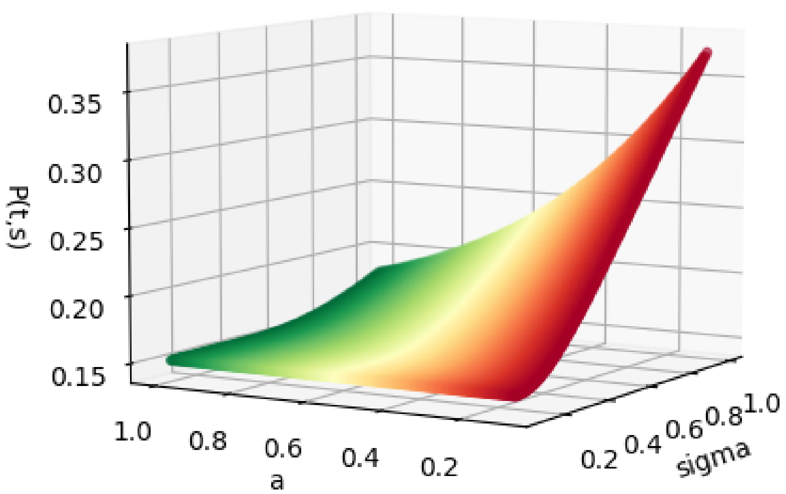
Put Option Price vs sigma vs t



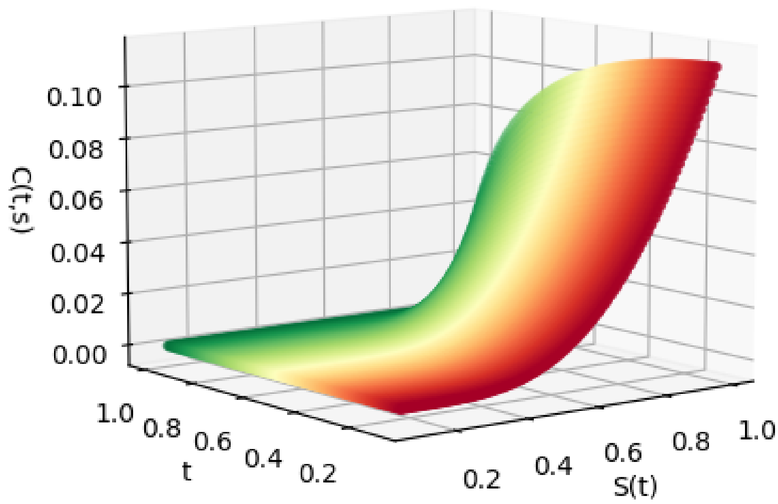
Call Option Price vs sigma vs a



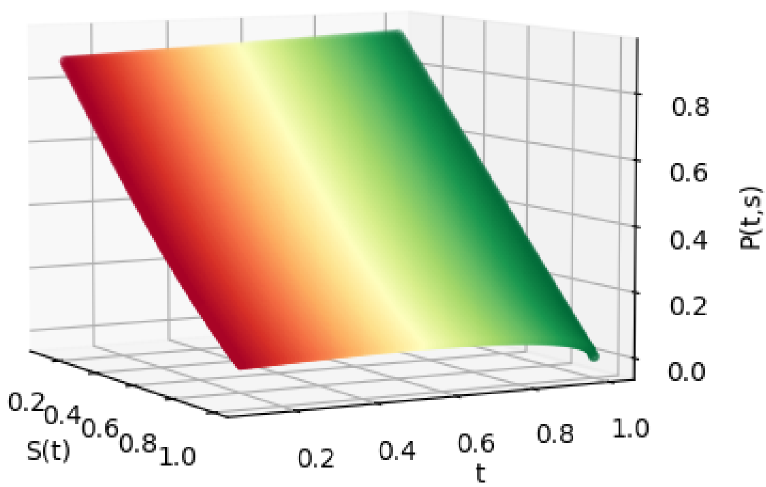
Put Option Price vs sigma vs a

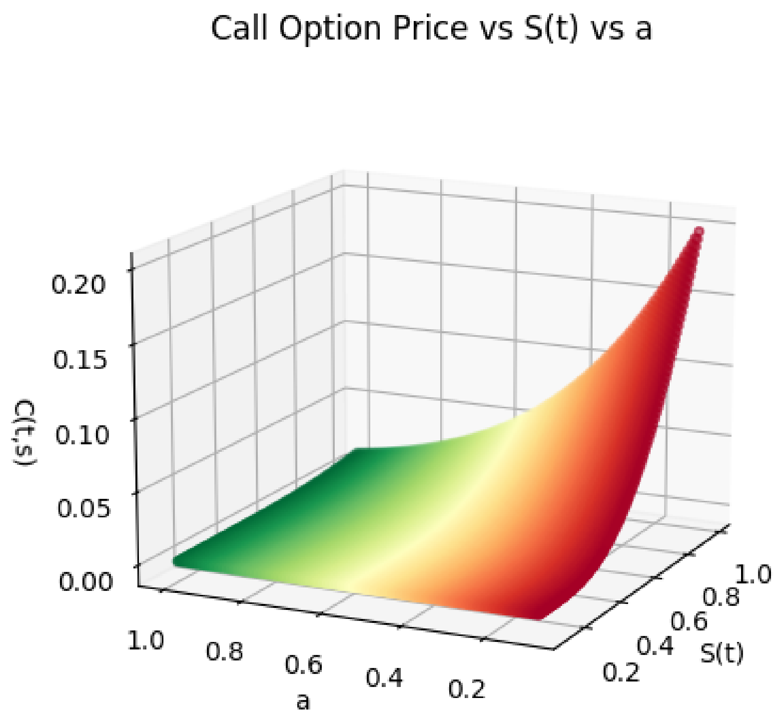


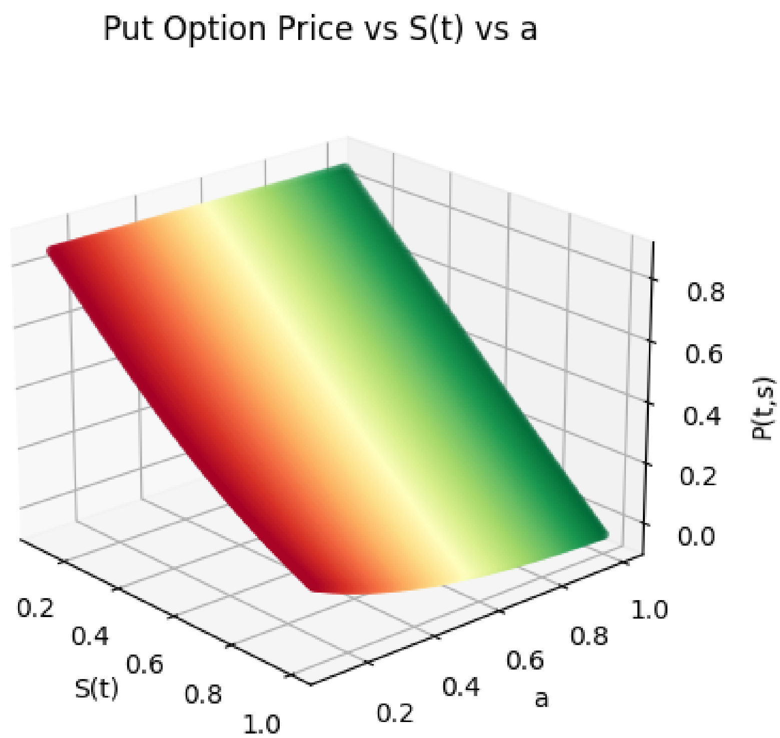
Call Option Price vs S(t) vs t



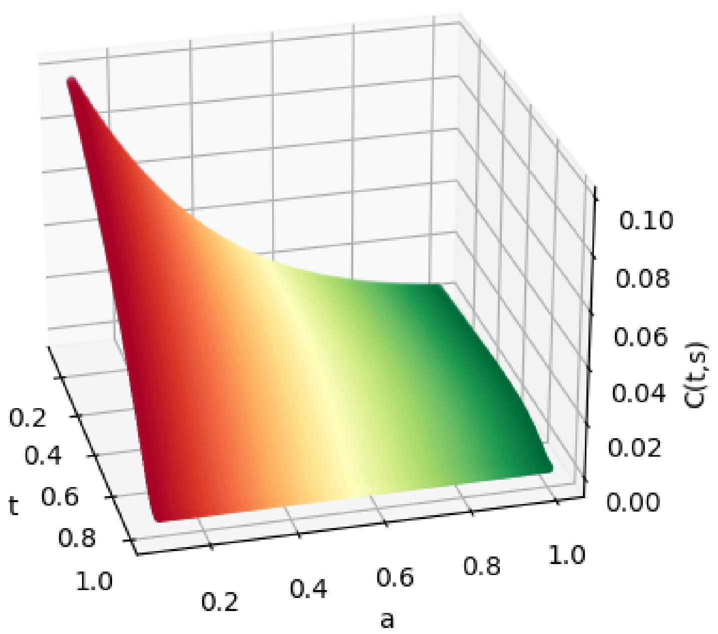
Put Option Price vs S(t) vs t




Call Option Price vs S(t) vs a
C(t,s)
0.00
0.05
0.10
0.15
0.20
1.0
0.8
0.6
0.4
0.2
a
0.2
0.4
0.6
0.8
1.0
S(t)


Put Option Price vs S(t) vs a
P(t,s)
0.0
0.2
0.4
0.6
0.8
0.2
0.4
0.6
0.8
1.0
S(t)
0.2
0.4
0.6
0.8
1.0
a

Call Option Price vs t vs a



Put Option Price vs t vs a