



भारतीय प्रौद्योगिकी संस्थान गुवाहाटी  
INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI

# MA 374: Financial Engineering Lab

## Lab 07

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AB Satyaprakash (180123062)

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Note:  

1. Please run python programs using python3, i.e. `python3 <filename>.py`

## Question 1.

For this question, we write the function `calEurCallPutPrices(T, K, S, r, sigma, t)` in python, which uses the following formulae:

- To calculate Call Option Price -

$$C(t, x) = xN(d_+(T-t, x)) - Ke^{-r(T-t)}N(d_-(T-t, x))$$

- To calculate Put Option Price -

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

- To calculate  $d(T-t, x)$  -

$$d_{\pm}(T-t, x) = \frac{1}{\sigma\sqrt{T-t}}[\log(x/K) + (r \pm \frac{\sigma^2}{2})(T-t)]$$

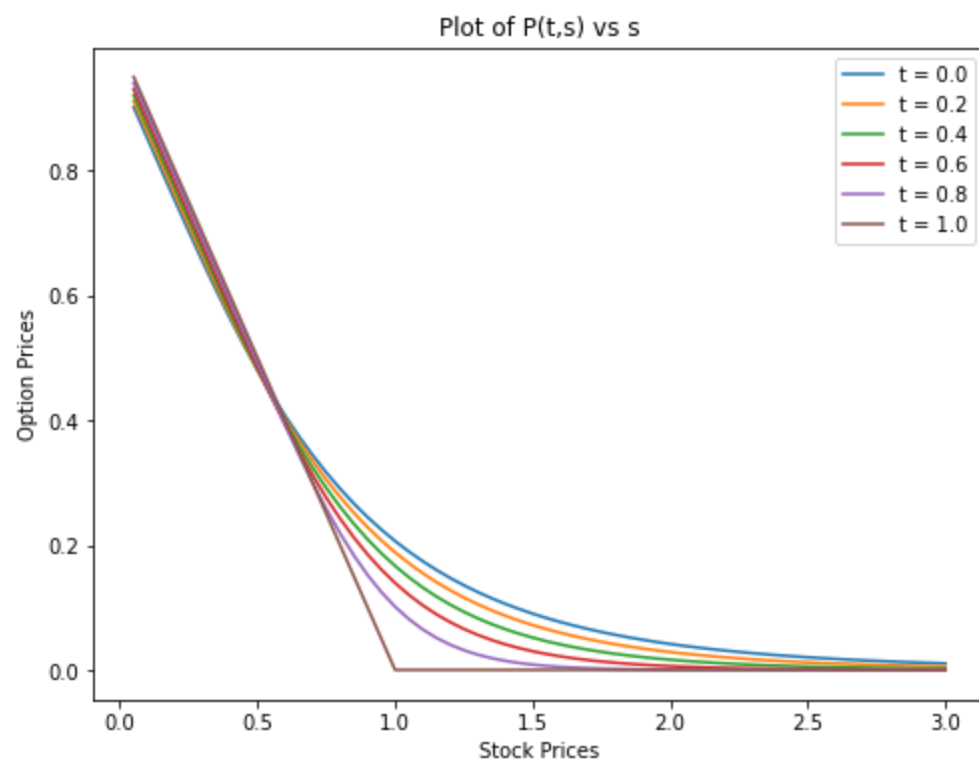
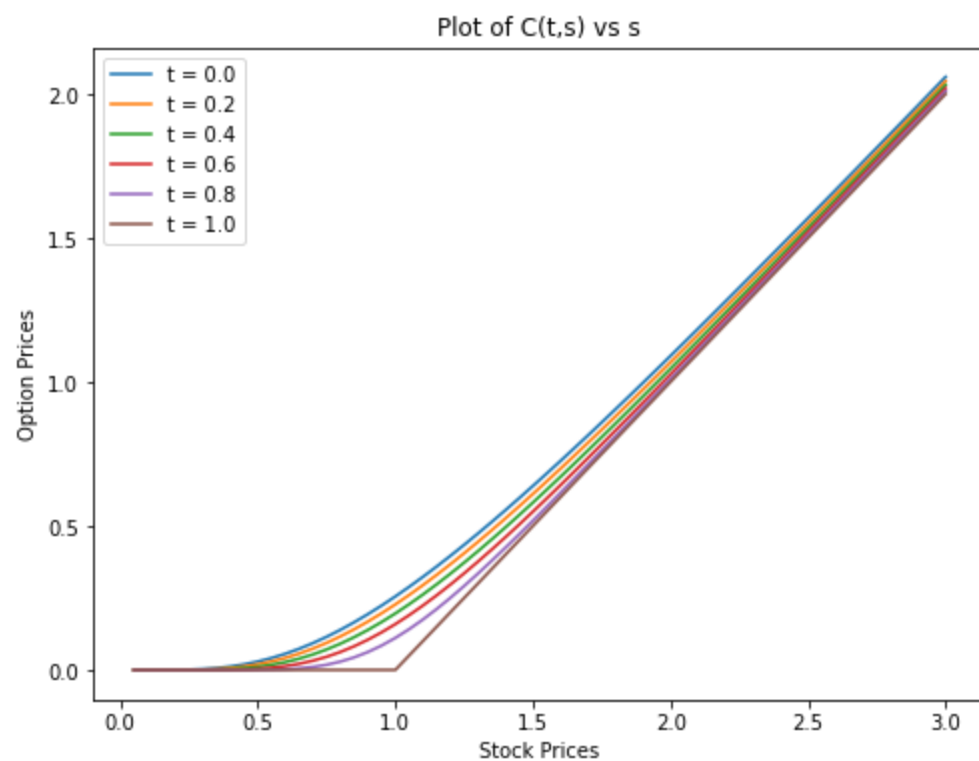
## Question 2.

The plots for Call and Put options for different values of  $t$  (given 0,0.2,0.4,0.6,0.8,1), on varying stock prices, are as shown below.

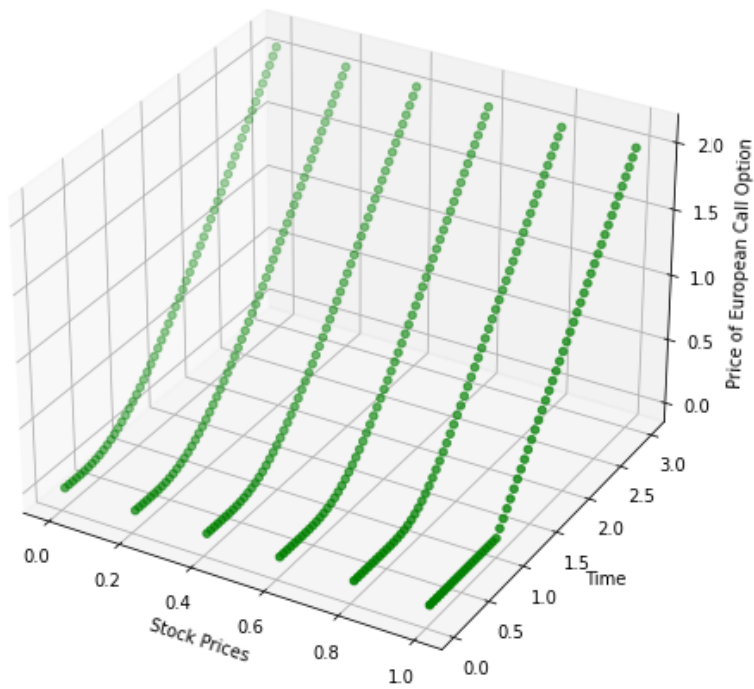
Observations -

- As expected, with an increase in Stock Prices ( $S$  or  $x$ )-
  1. Call Option Prices increase
  2. Put Option Prices decrease
- For both call and put options, the value is higher for the same asset price when the time left to maturity is higher.

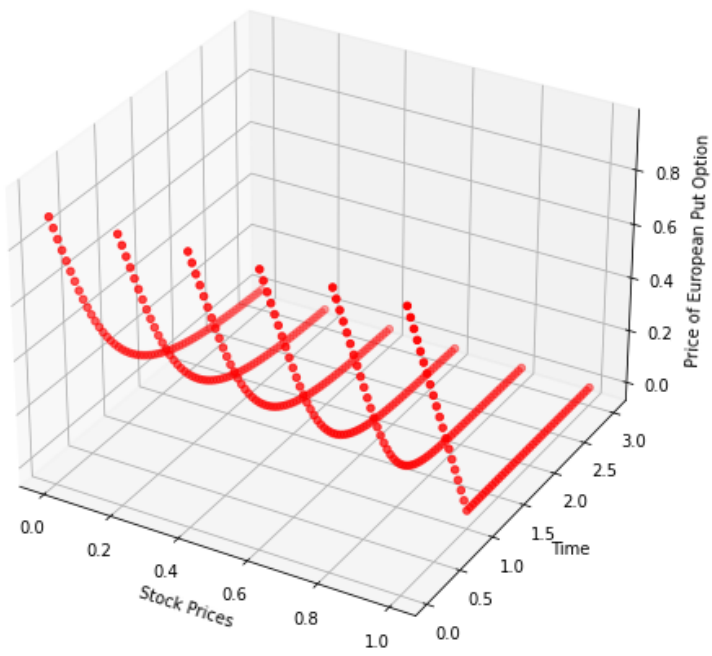
The 3D Scatter Plots of Option prices versus both  $t$  and  $x$  are drawn after that.



Scatter Plot of  $C(t,x)$  vs  $t$  and  $x$



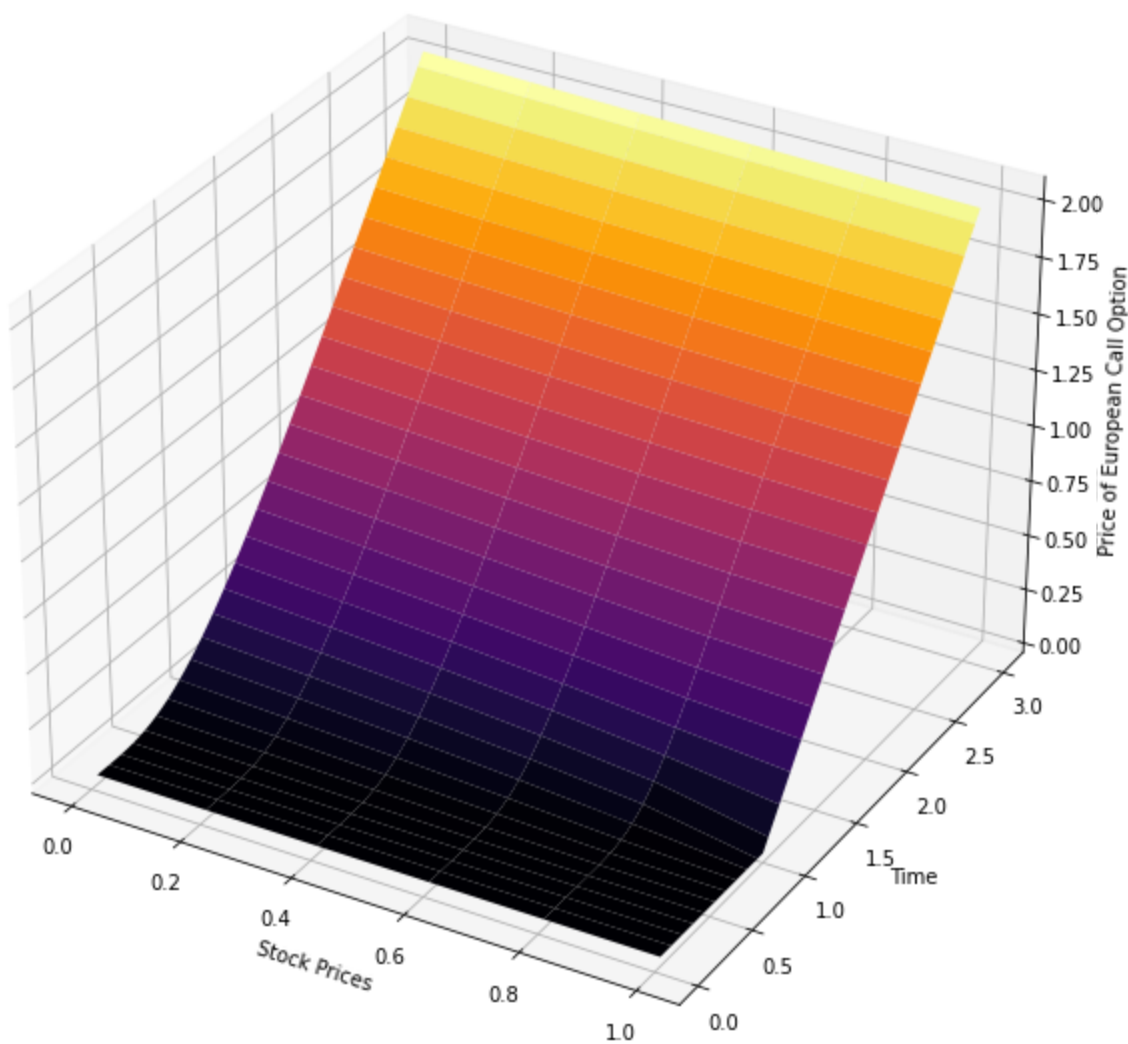
Scatter Plot of  $P(t,x)$  vs  $t$  and  $x$



### Question 3.

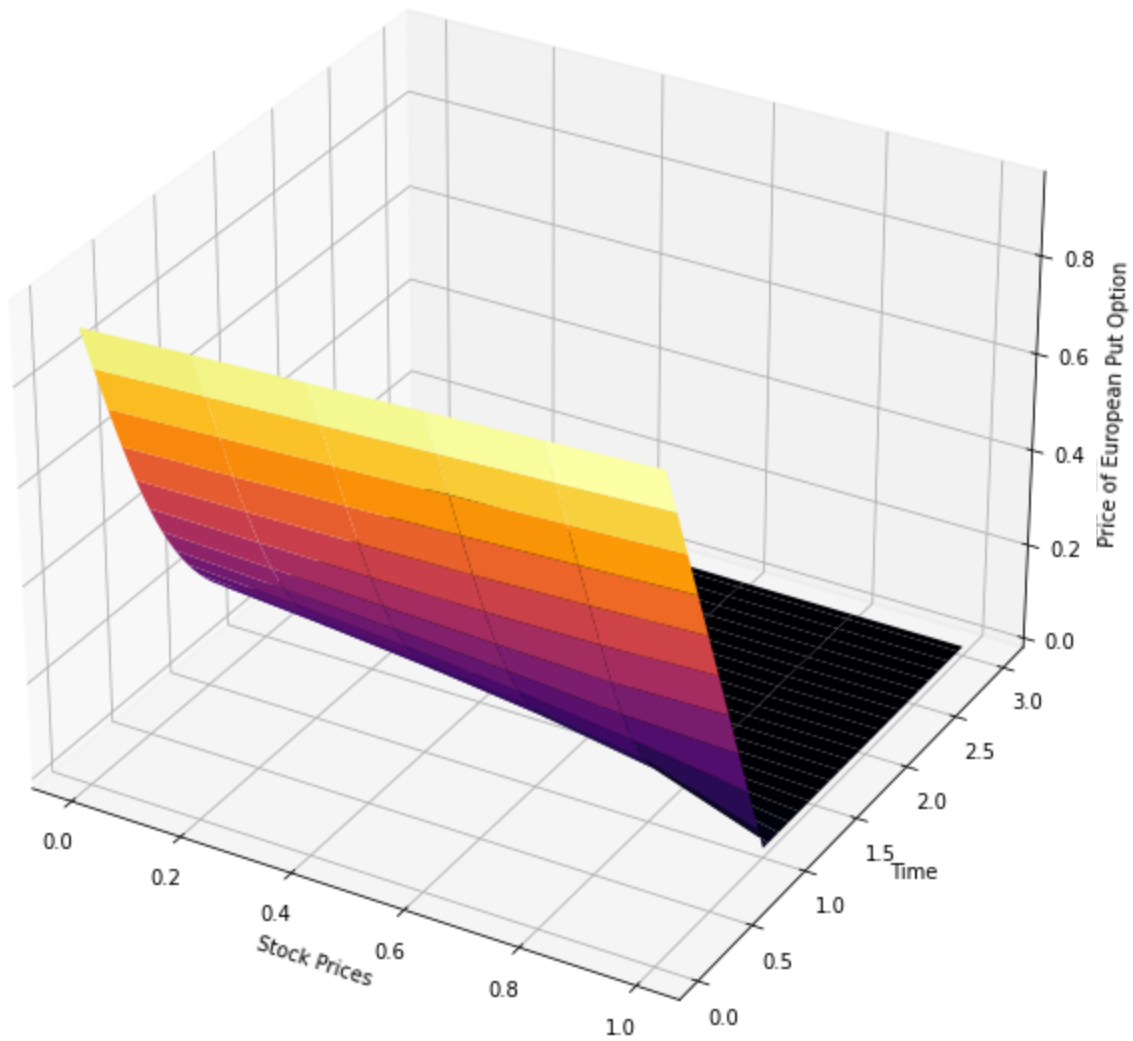
Smooth 3D Surface Plots for  $C(t,x)$  and  $P(t,x)$  are drawn below:

Surface Plot of  $C(t,x)$  vs  $t$  and  $x$





Surface Plot of  $P(t,x)$  vs  $t$  and  $x$



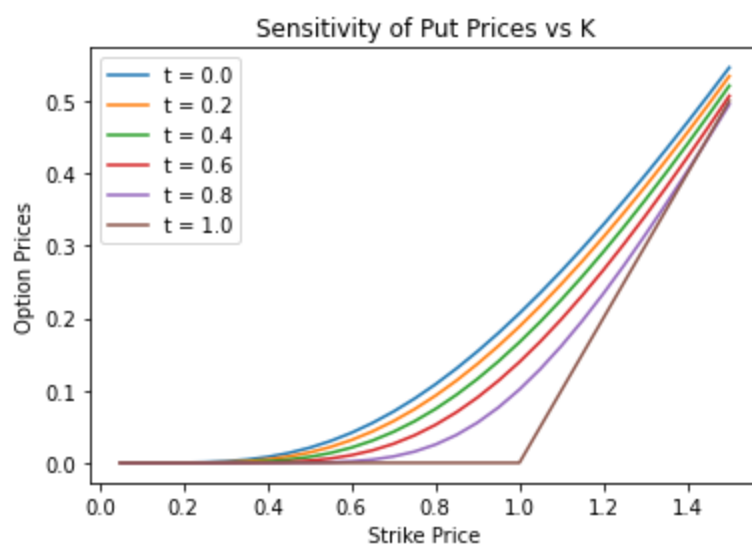
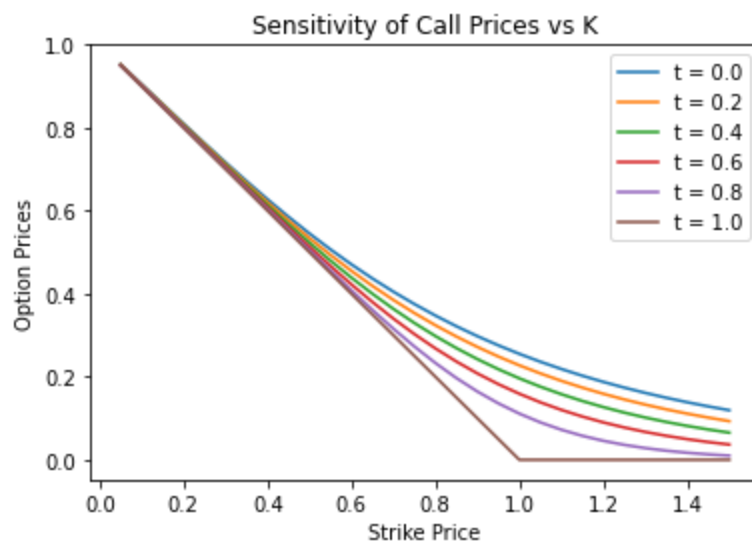
The surface plots here are (as expected) similar to the scatter plots drawn in question 2.

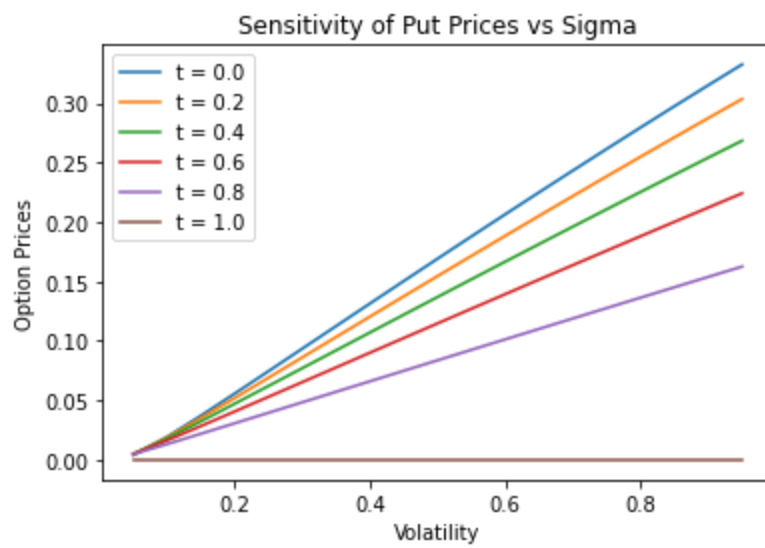
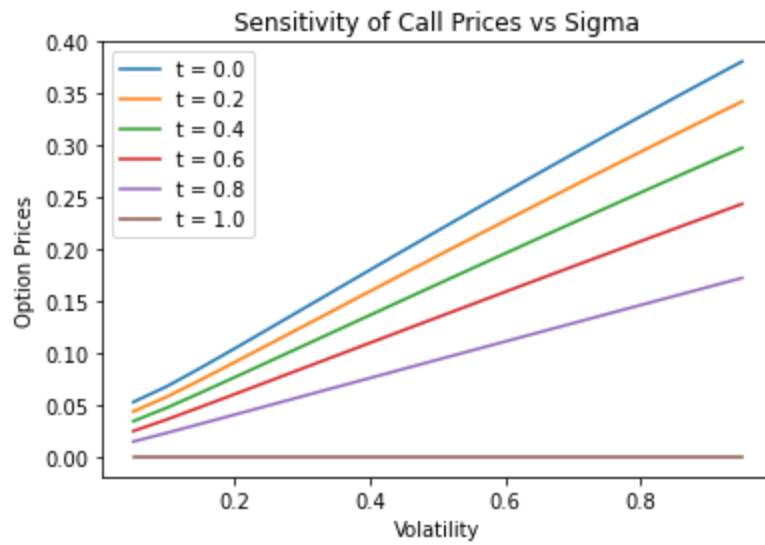
## Question 4.

The model parameters taken here are:

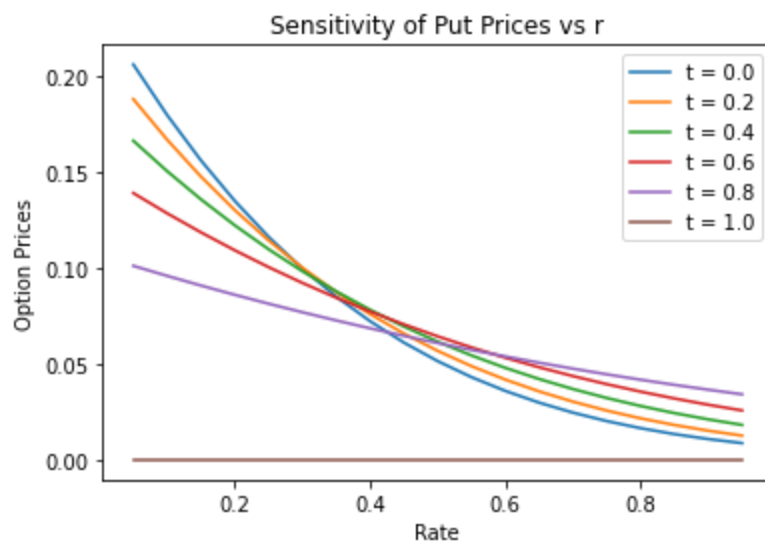
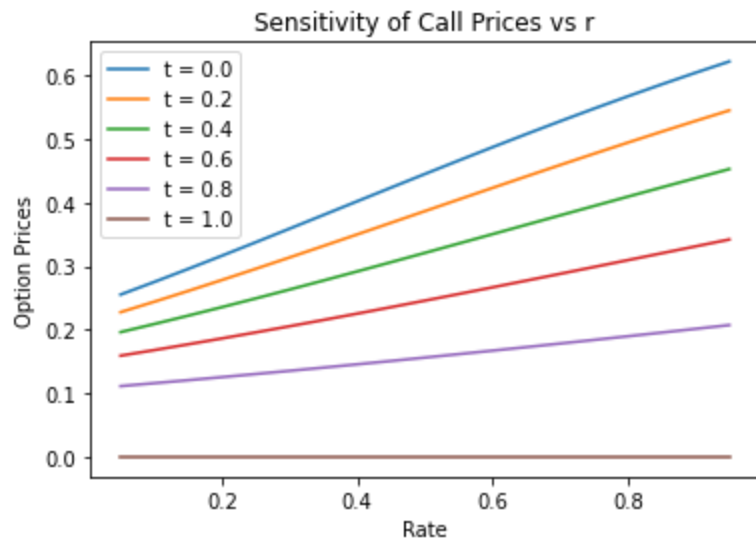
- Strike Price (K)
- Expiry Time (T) or Time to Maturity
- Rate (r)
- Volatility (sigma)

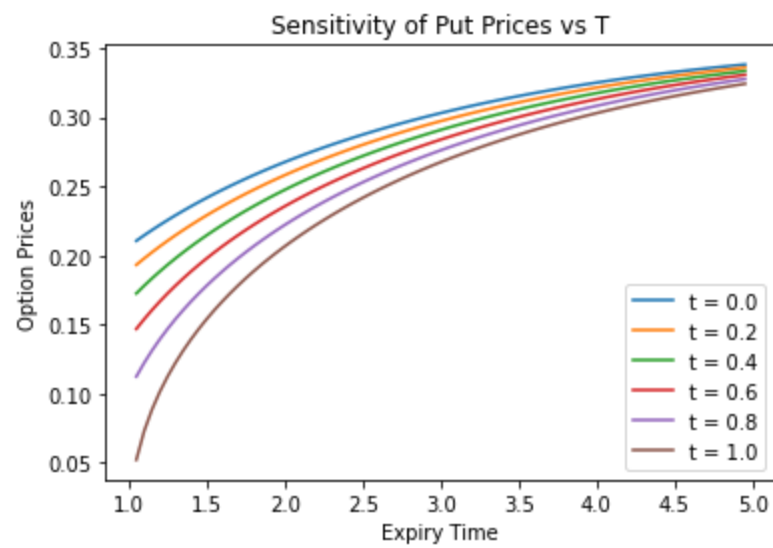
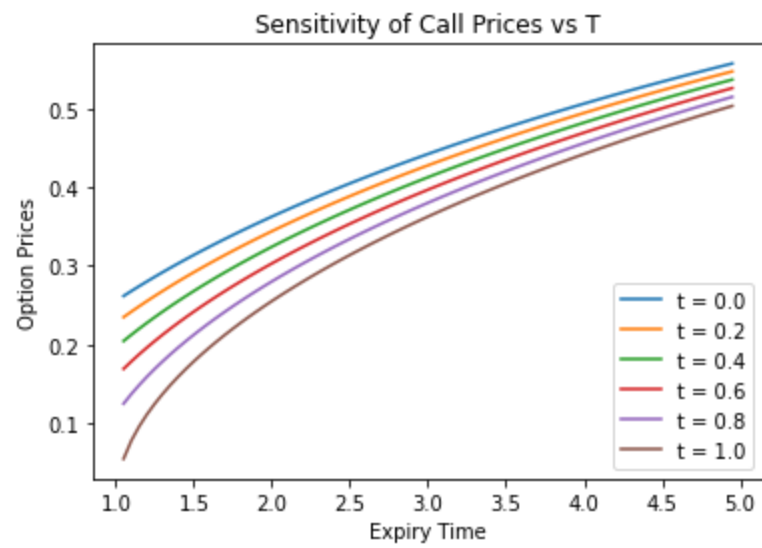
We have first made 2D plots for sensitivity analysis taking  $S$  or  $x = 1$  for different values of  $t$ .











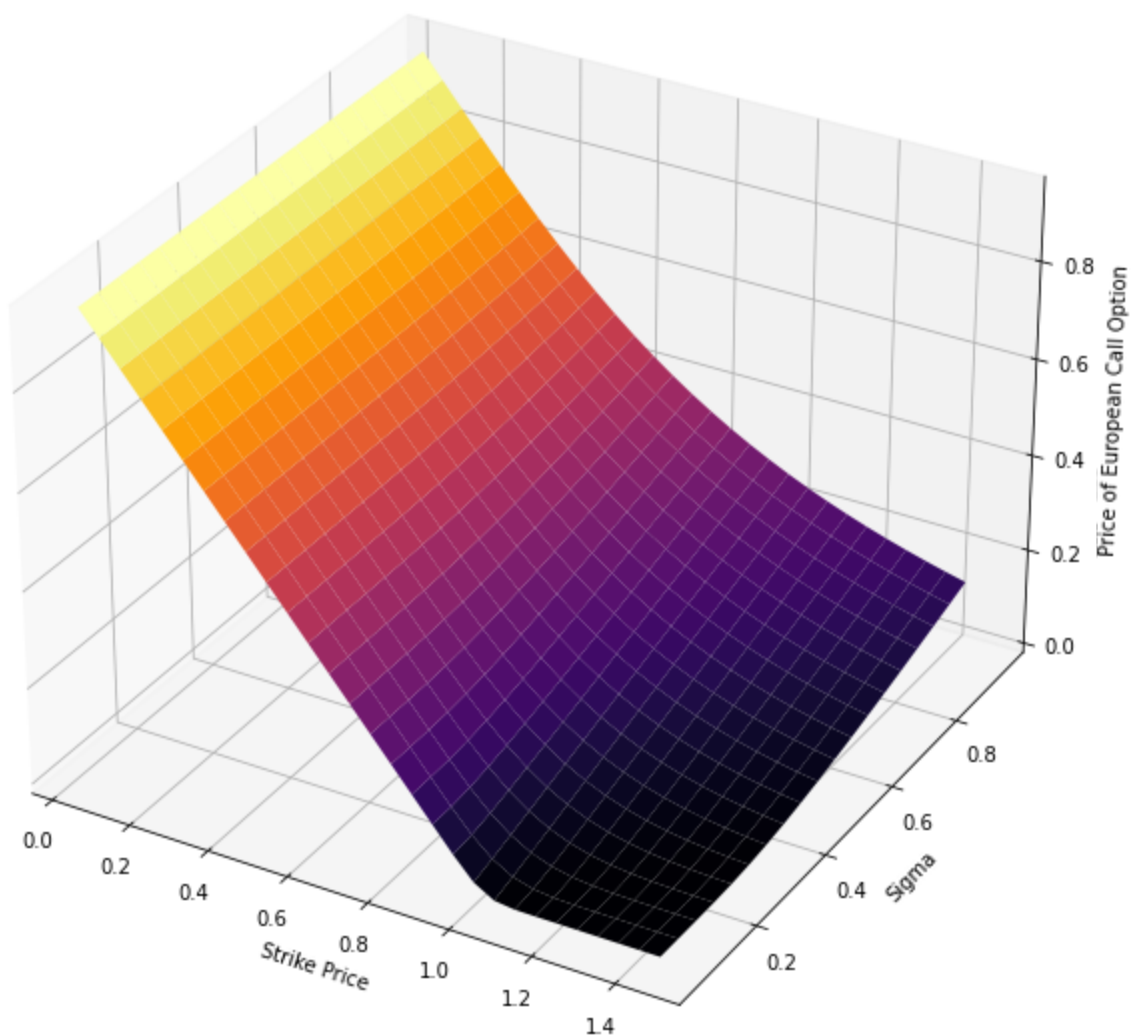
## 3D Graphs

We have made these by taking 2 parameters at a time.

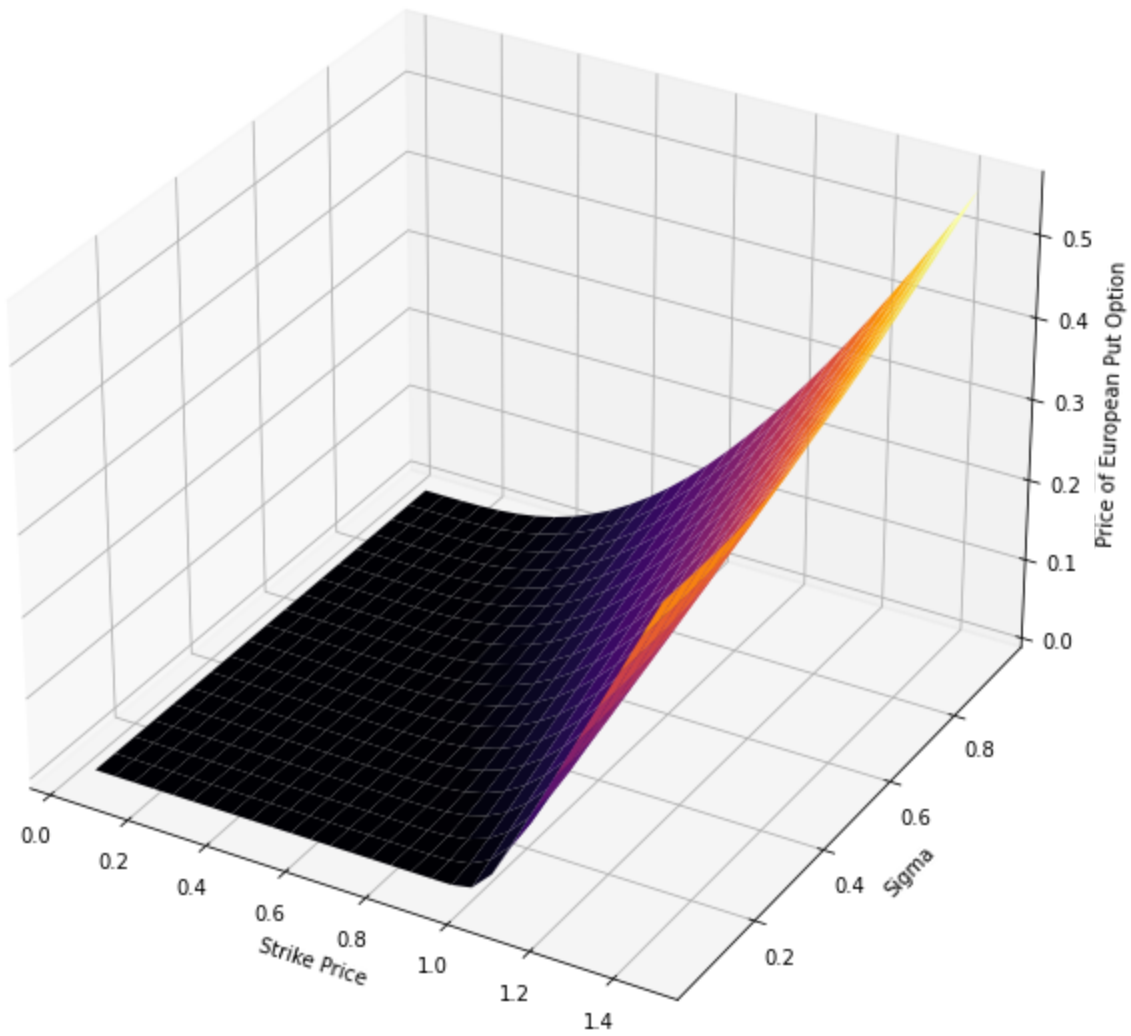
Fix  $x = 1$  and  $t = 0.5$ .

### (a) K and Sigma

Surface Plot of Call Option Prices vs K and sigma

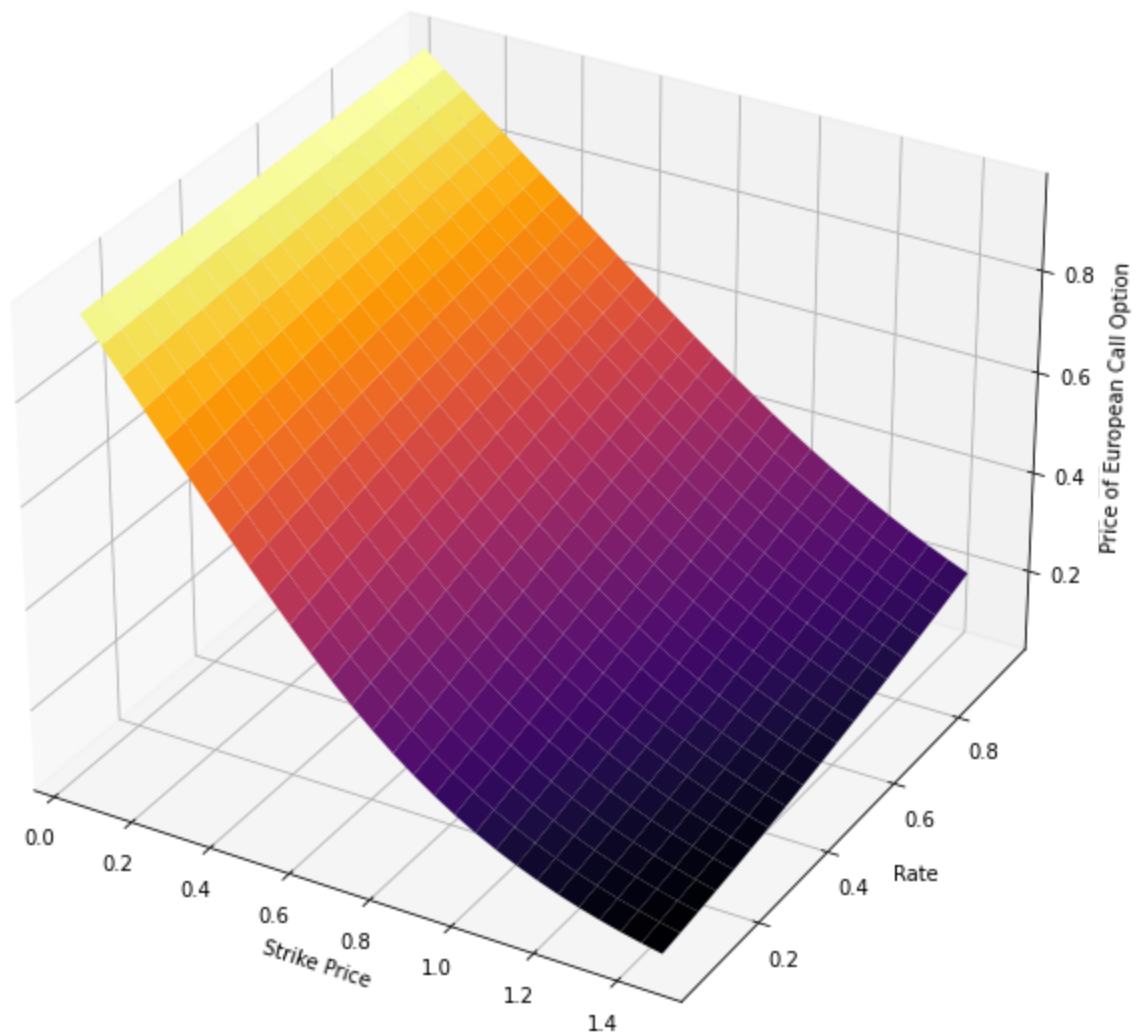


Surface Plot of Put Option Prices vs K and sigma

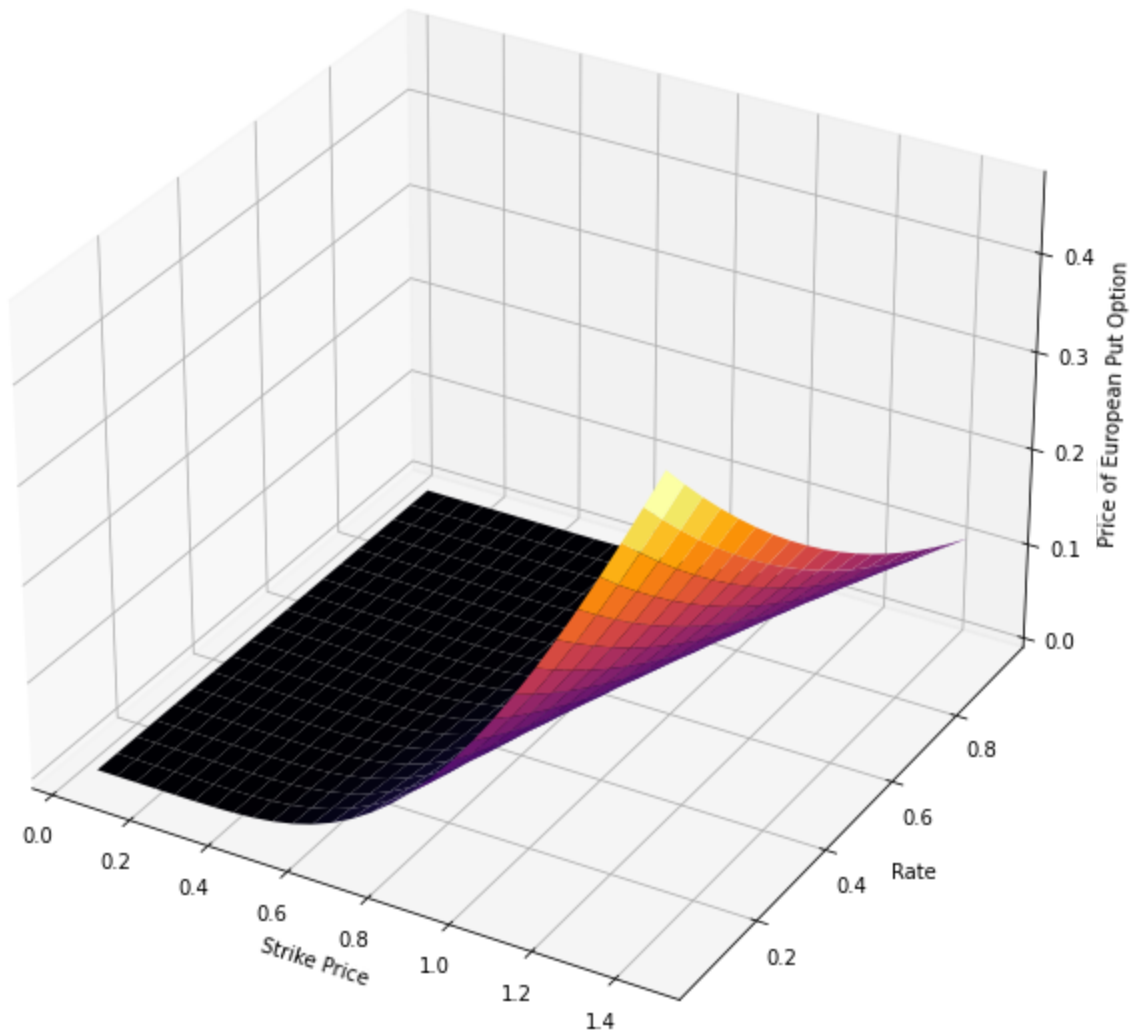


## (b) K and r

Surface Plot of Call Option Prices vs K and r

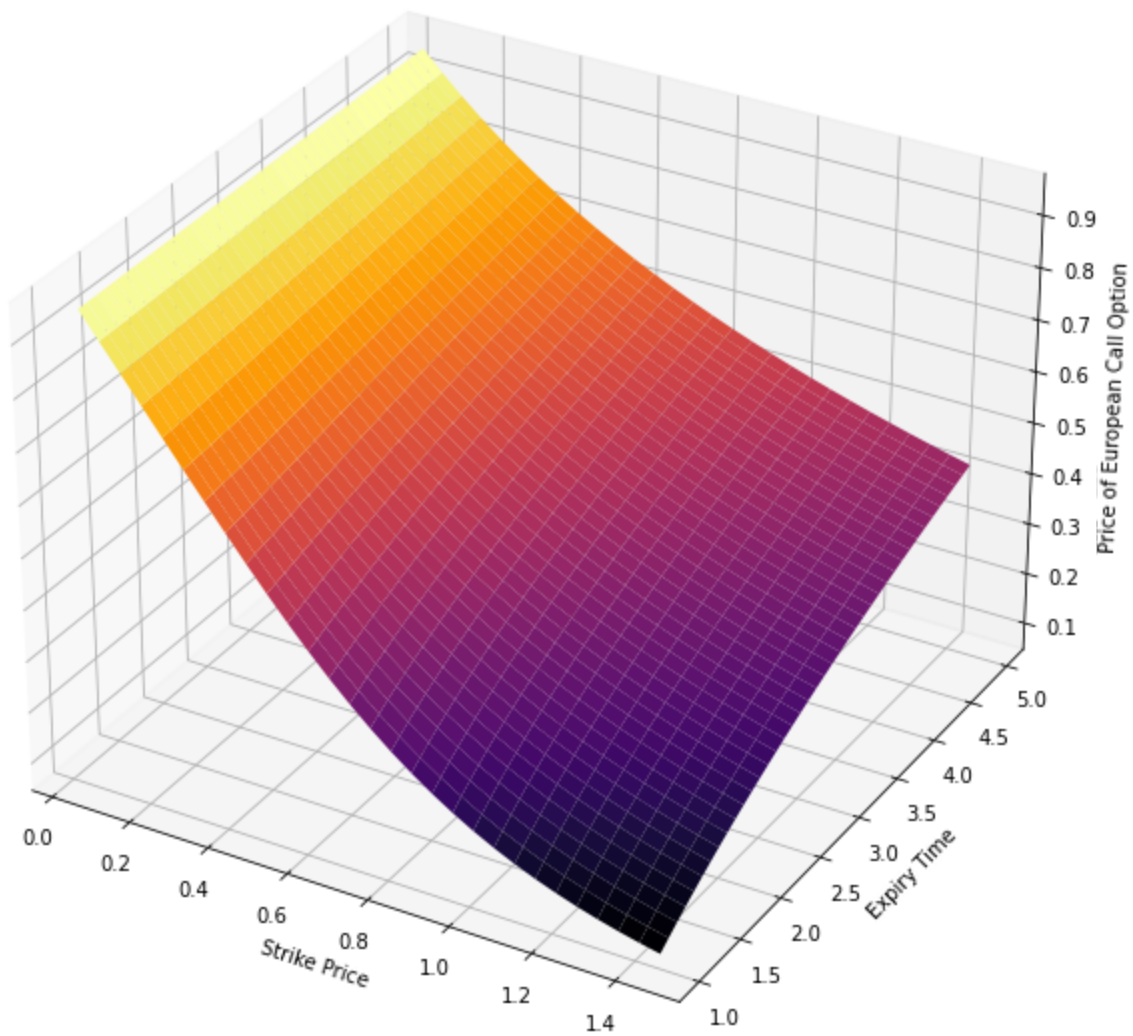


Surface Plot of Put Option Prices vs K and r

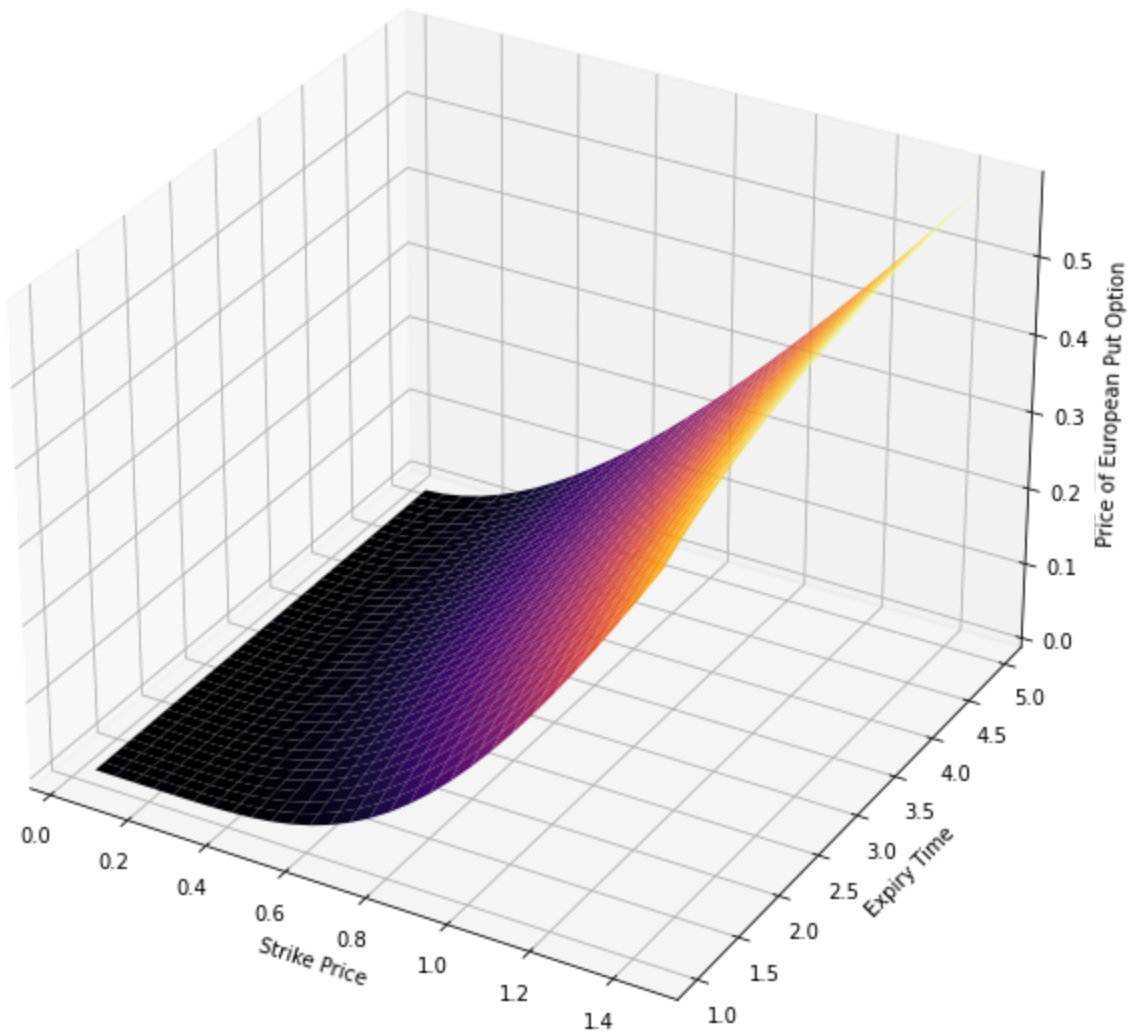


## (c) K and T

Surface Plot of Call Option Prices vs K and T



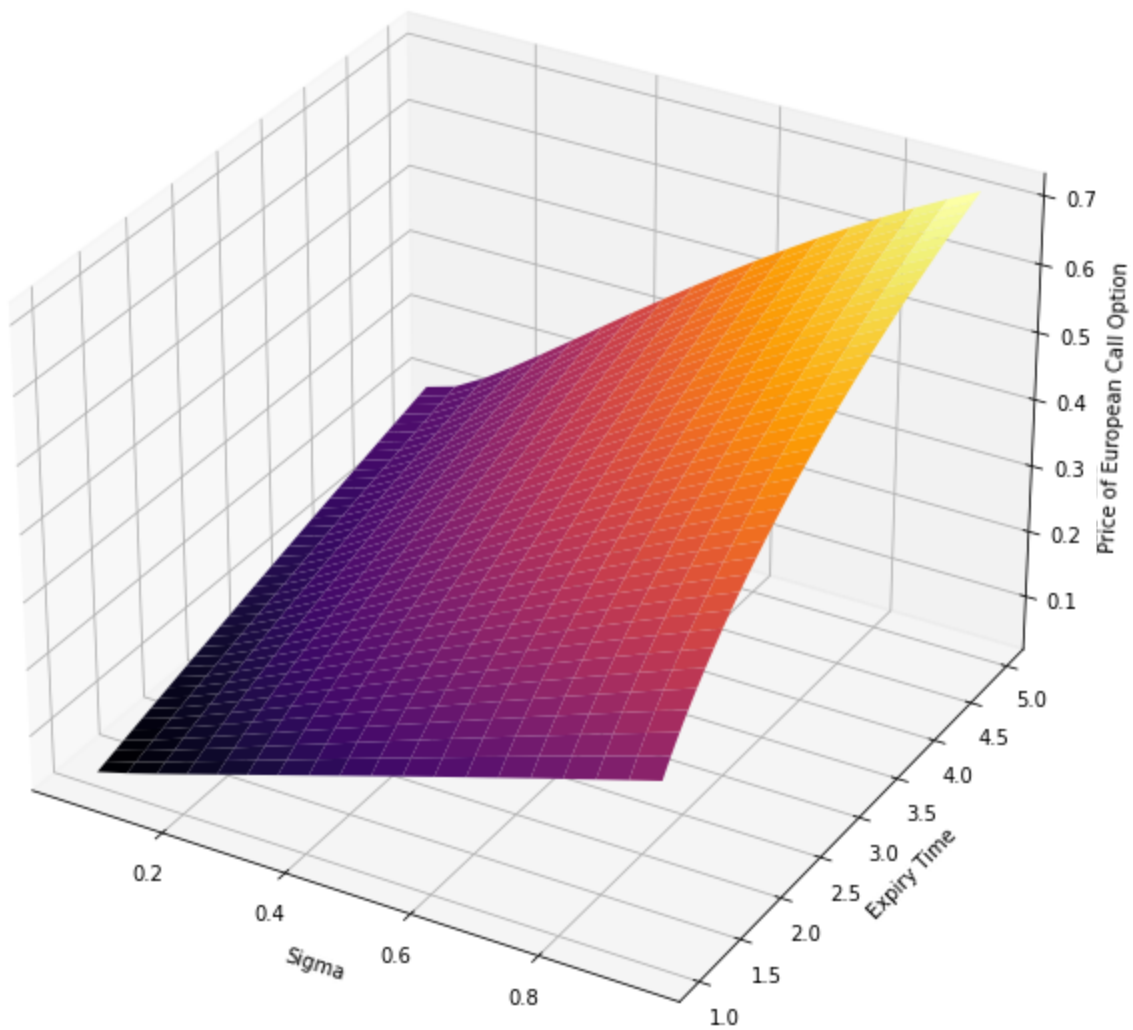
Surface Plot of Put Option Prices vs K and T



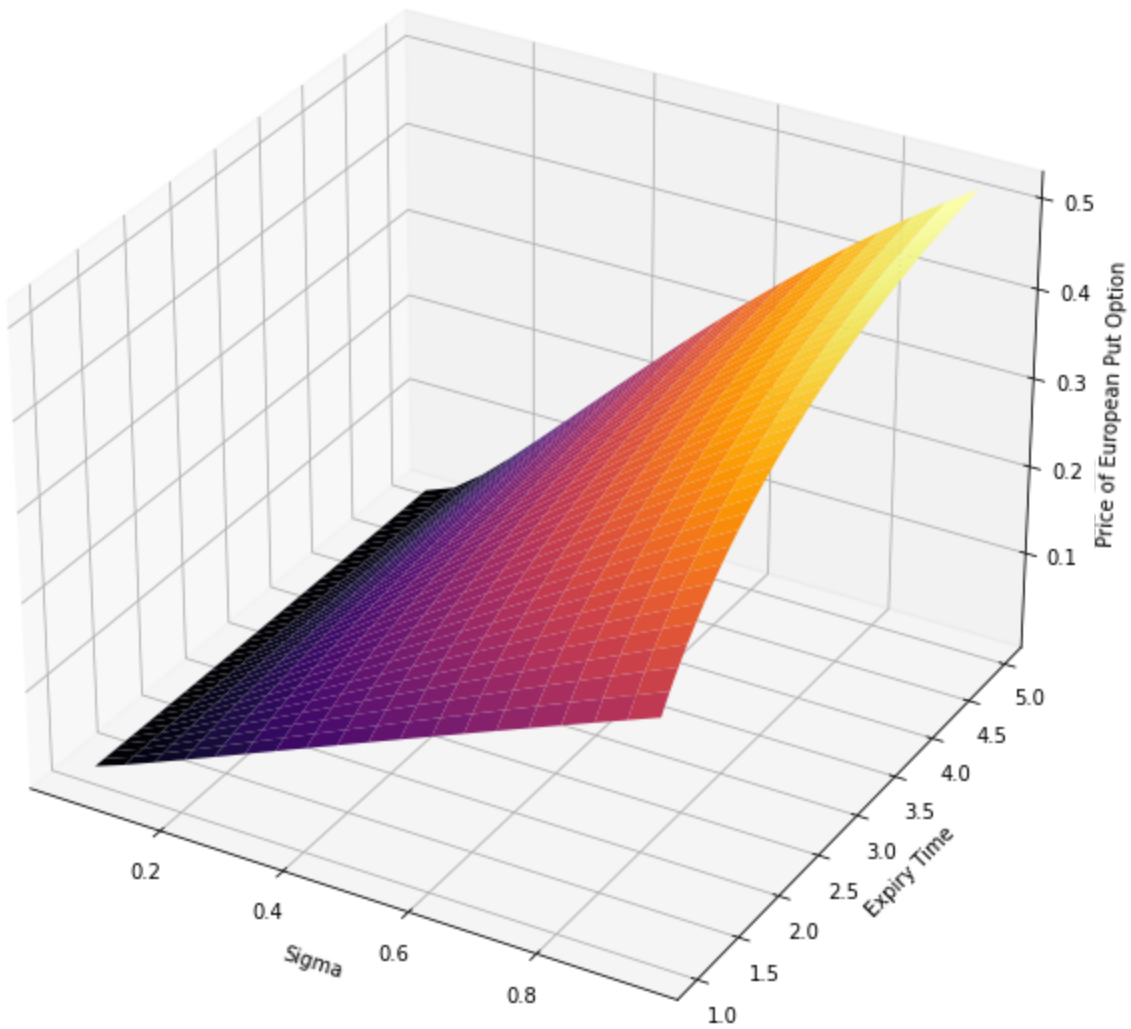


## (d) Sigma and T

Surface Plot of Call Option Prices vs sig and T

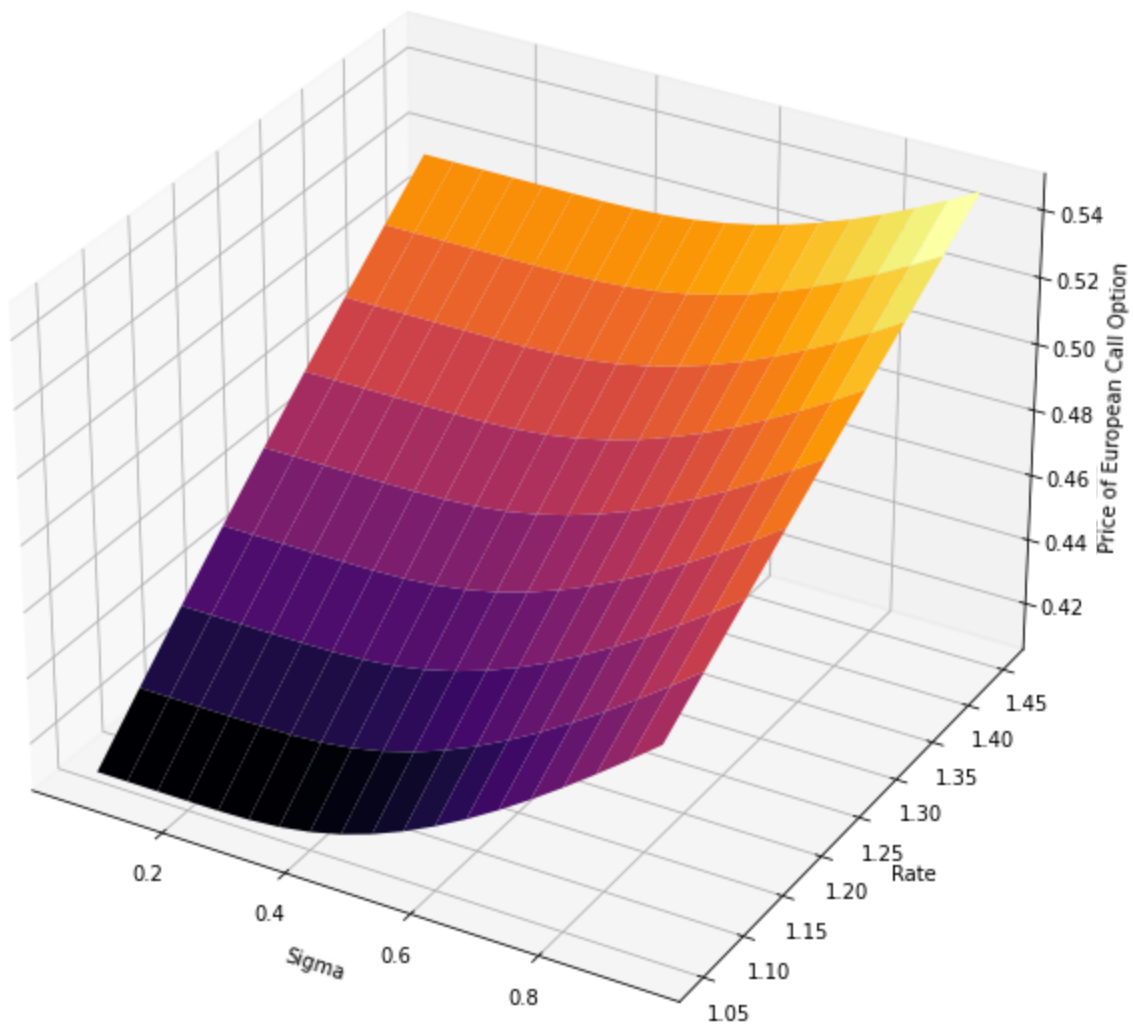


Surface Plot of Put Option Prices vs sig and T

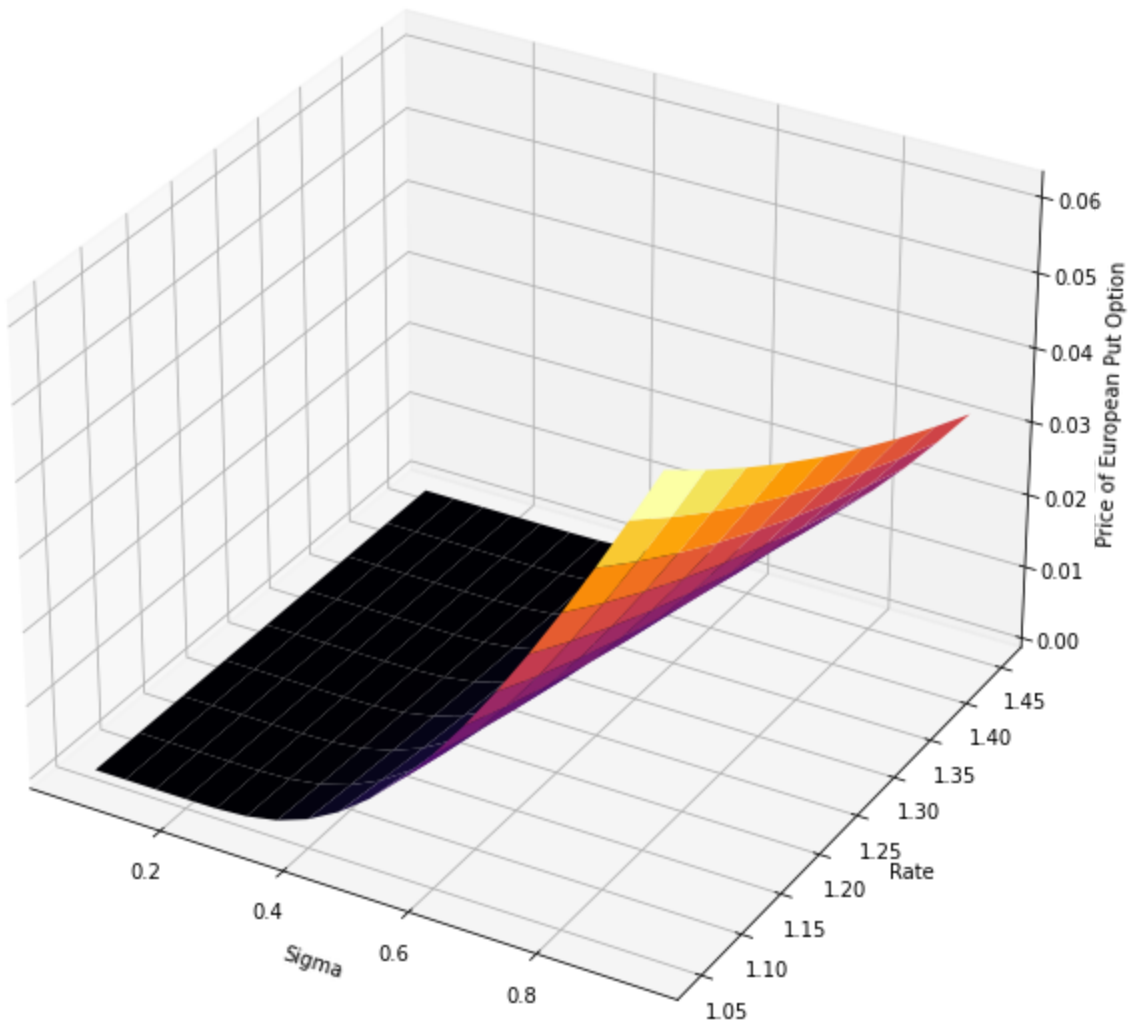


## (e) Sigma and r

Surface Plot of Call Option Prices vs sig and r

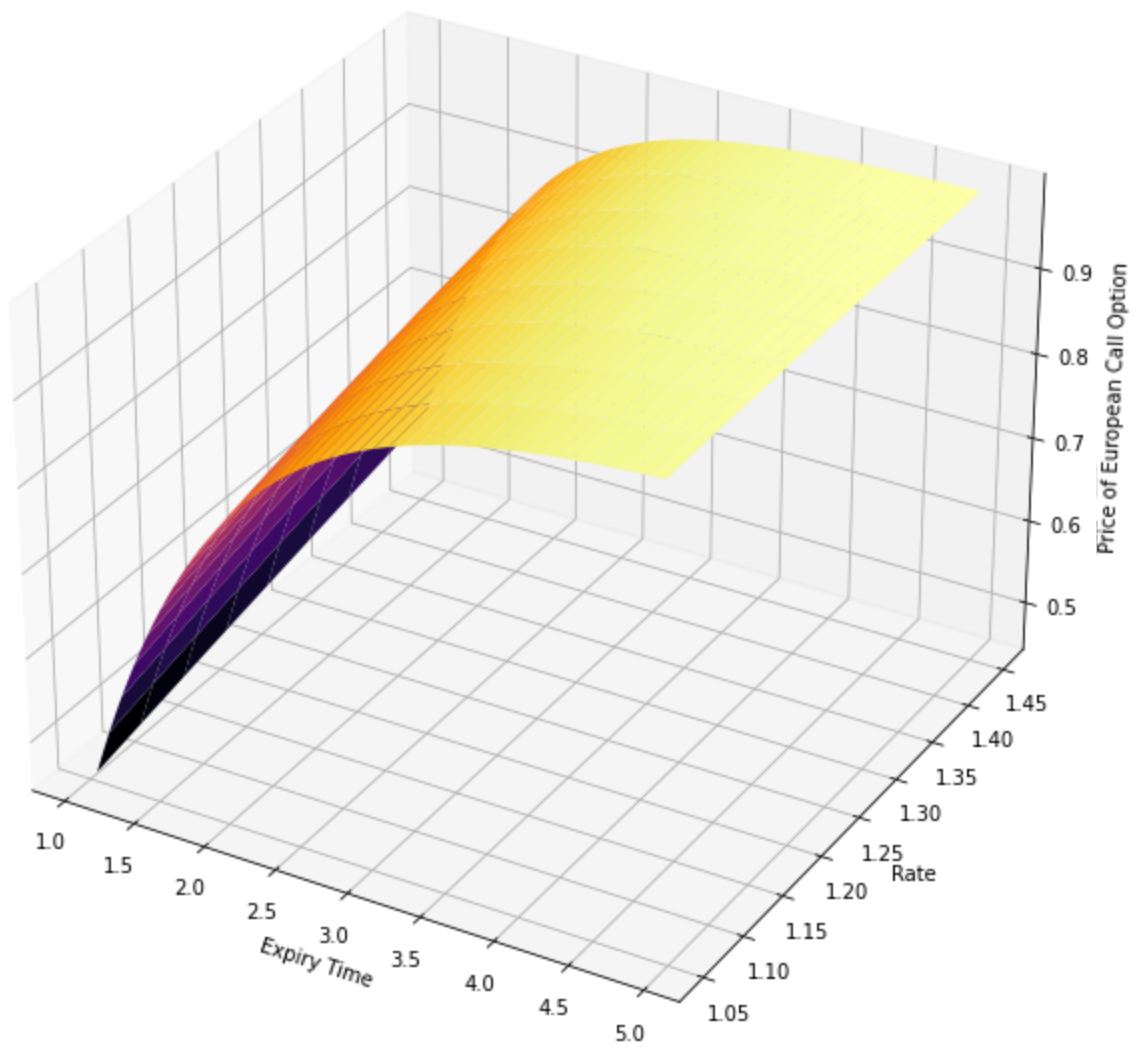


Surface Plot of Put Option Prices vs sig and r

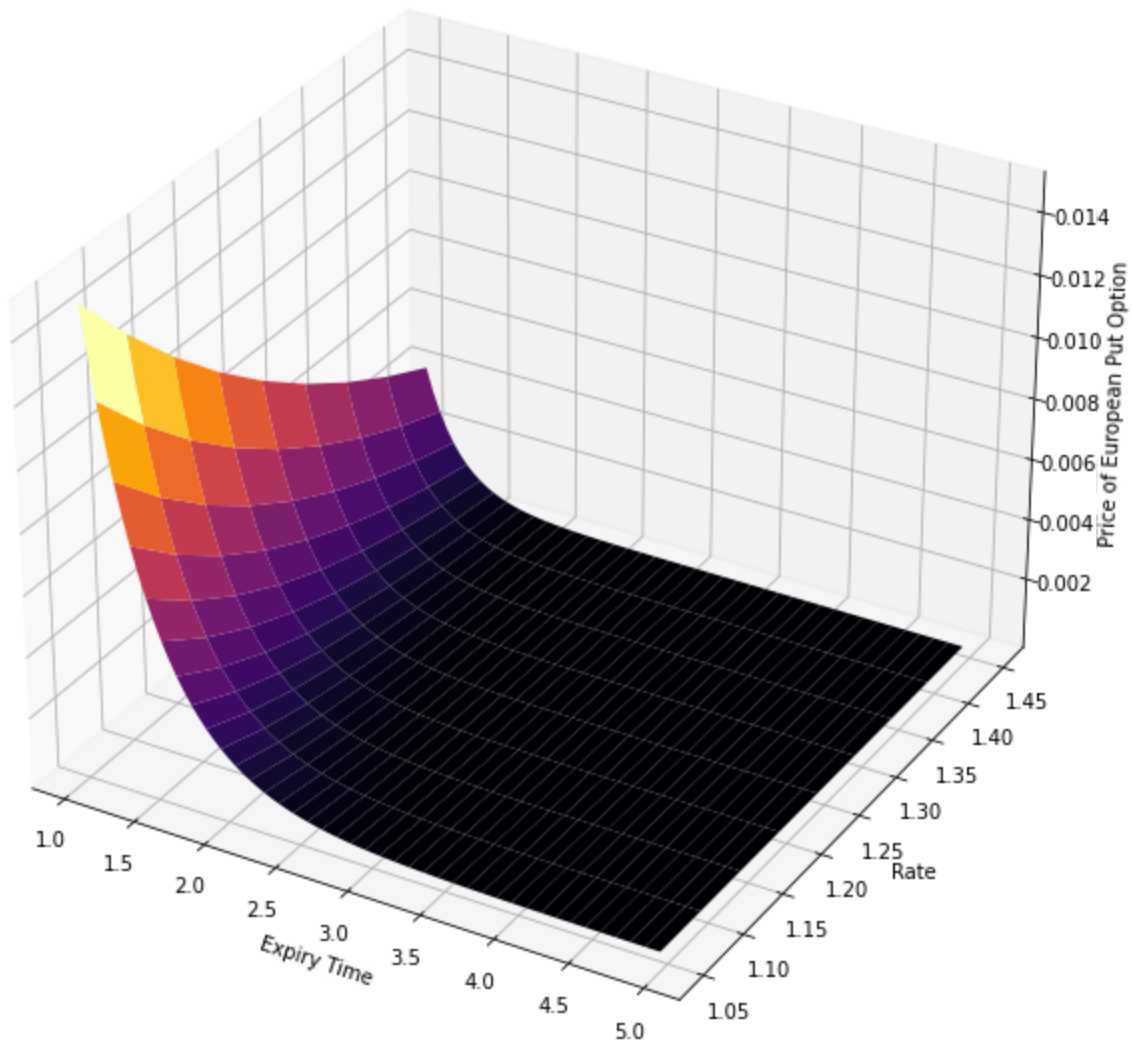


## (f) T and r

Surface Plot of Call Option Prices vs T and r



Surface Plot of Put Option Prices vs T and r



## 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  
Scipy - pip3 install scipy
```