

In [4]:

#Question No: 1

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import numpy as np
import matplotlib.pyplot as plt
plt.rcParams["figure.figsize"] = (20,12)

def GBM(init, mu, sigma, T, dt, str):
    if str == 'Normal':
        no_values = round(T/dt)
        values = np.zeros([1,no_values])
        values[0][0] = init
        for i in range(1,no_values):
            c = (mu-0.5*sigma**2)
            values[0][i] = values[0][i-1]*np.exp(c*dt + sigma*np.sqrt(dt)*np.random.no
rml())
    elif str == 'var_reduce':
        no_values = round(T/dt)
        values1 = np.zeros([1,no_values])
        values2 = np.zeros([1,no_values])
        values1[0][0] = init
        values2[0][0] = init
        for i in range(1,no_values):
            c = (mu-0.5*sigma**2)
            values1[0][i] = values1[0][i-1]*np.exp(c*dt + sigma*np.sqrt(dt)*np.random.
normal())
            values2[0][i] = values2[0][i-1]*np.exp(c*dt + sigma*np.sqrt(dt)*np.random.
normal())
        values = (values1 + values2)/2
    return values

init = 100
r = 0.05
mu = 0.1
sigma = 0.2
T = 0.5
dt = 0.001
path = 10
K = 105
values = np.zeros([round(T/dt),path])
str = 'Normal'
for i in range(0,path):
    values[:,i] = GBM(init, mu, sigma, T, dt, str)

print('Check for correctness:')
print('Mean :',np.mean(values[-1,:]))
print('Variance :',np.var(values[-1,:]))

x = np.linspace(0,T-dt,500)
plt.plot(x,values)
plt.xlabel('t')
plt.ylabel('Price')
plt.title('Real world')
plt.show()

for i in range(0,path):
    values[:,i] = GBM(init, r, sigma, T, dt, str)

print('Check for correctness:')
print('Mean :',np.mean(values[-1,:]))
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print('Variance :',np.var(values[-1,:]))

x = np.linspace(0,T-dt,500)
plt.plot(x,values)
plt.xlabel('t')
plt.ylabel('Price')
plt.title('Risk-free world')
plt.show()

K = []
K.append(90)
K.append(105)
K.append(110)
path = 100

for i in range(0,3):
    call_price = 0
    put_price = 0
    for k in range(0,path):
        S = GBM(init, r, sigma, T, dt, str)
        X = (sum(S[0])/(T/dt))-K[i]
        X_1 = K[i]-(sum(S[0])/(T/dt))
        call_price = call_price + max(X,0)
        put_price = put_price + max(X_1,0)
    call = (call_price/path)*np.exp(-r*T)
    put = (put_price/path)*np.exp(-r*T)
    print("Price of call option with strike price: %d is %f"%(K[i],call))
    print("Price of put option with strike price : %d is %f"%(K[i],put))

init = 100
r = 0.05
mu = 0.1
sigma = 0.2
T = 0.5
dt = 0.001
path = 10
K = 105

var = np.linspace(80,120,81)
path = 100
call = np.zeros([1,81])
put = np.zeros([1,81])

for i in range(0,81):
    call_price = 0
    put_price = 0
    for k in range(0,path):
        S = GBM(var[i], r, sigma, T, dt, str)
        f = (sum(S[0])/(T/dt))-K
        q = K-(sum(S[0])/(T/dt))
        call_price = call_price + max(f,0)
        put_price = put_price + max(q,0)
    call[0][i] = (call_price/path)*np.exp(-r*T)
    put[0][i] = (put_price/path)*np.exp(-r*T)

plt.subplot(2,1,1)
plt.plot(var,call[0])
plt.xlabel('Initial Stock price')
plt.ylabel('Call Price')

plt.subplot(2,1,2)

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plt.plot(var,put[0])
plt.xlabel('Initial Stock price')
plt.ylabel('Put Price')
plt.show()

path = 100
call = np.zeros([1,81])
put = np.zeros([1,81])

for i in range(0,81):
    call_price = 0
    put_price = 0
    for k in range(0,path):
        S = GBM(init, r, sigma, T, dt, str)
        f = (sum(S[0])/(T/dt))-var[i]
        q = var[i]-(sum(S[0])/(T/dt))
        call_price = call_price + max(f,0)
        put_price = put_price + max(q,0)
    call[0][i] = (call_price/path)*np.exp(-r*T)
    put[0][i] = (put_price/path)*np.exp(-r*T)

plt.subplot(2,1,1)
plt.plot(var,call[0])
plt.xlabel('Strike price')
plt.ylabel('Call Price')

plt.subplot(2,1,2)
plt.plot(var,put[0])
plt.xlabel('Strike price')
plt.ylabel('Put Price')
plt.show()

var = np.linspace(0.01,0.9,90)
path = 500
call = np.zeros([1,90])
put = np.zeros([1,90])

for i in range(0,90):
    call_price = 0
    put_price = 0
    for k in range(0,path):
        S = GBM(init, var[i], sigma, T, dt, str)
        f = (sum(S[0])/(T/dt))-K
        q = K-(sum(S[0])/(T/dt))
        call_price = call_price + max(f,0)
        put_price = put_price + max(q,0)
    call[0][i] = (call_price/path)*np.exp(-r*T)
    put[0][i] = (put_price/path)*np.exp(-r*T)

plt.subplot(2,1,1)
plt.plot(var,call[0])
plt.xlabel('Risk-free price')
plt.ylabel('Call Price')

plt.subplot(2,1,2)
plt.plot(var,put[0])
plt.xlabel('Risk-free price')
plt.ylabel('Put Price')
plt.show()

var = np.linspace(0.01,0.9,90)

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path = 500
call = np.zeros([1,90])
put = np.zeros([1,90])

for i in range(0,90):
    call_price = 0
    put_price = 0
    for k in range(0,path):
        S = GBM(init, r, var[i], T, dt, str)
        f = (sum(S[0])/(T/dt))-K
        q = K-(sum(S[0])/(T/dt))
        call_price = call_price + max(f,0)
        put_price = put_price + max(q,0)
    call[0][i] = (call_price/path)*np.exp(-r*T)
    put[0][i] = (put_price/path)*np.exp(-r*T)

plt.subplot(2,1,1)
plt.plot(var,call[0])
plt.xlabel('Volatility')
plt.ylabel('Call Price')

plt.subplot(2,1,2)
plt.plot(var,put[0])
plt.xlabel('Volatility')
plt.ylabel('Put Price')
plt.show()

var = np.linspace(0.01,0.9,18)
path = 500
call = np.zeros([1,18])
put = np.zeros([1,18])

for i in range(0,18):
    call_price = 0
    put_price = 0
    for k in range(0,path):
        S = GBM(init, r, sigma, var[i], dt, str)
        f = (sum(S[0])/(T/dt))-K
        q = K-(sum(S[0])/(T/dt))
        call_price = call_price + max(f,0)
        put_price = put_price + max(q,0)
    call[0][i] = (call_price/path)*np.exp(-r*T)
    put[0][i] = (put_price/path)*np.exp(-r*T)

plt.subplot(2,1,1)
plt.plot(var,call[0])
plt.xlabel('Maturity')
plt.ylabel('Call Price')

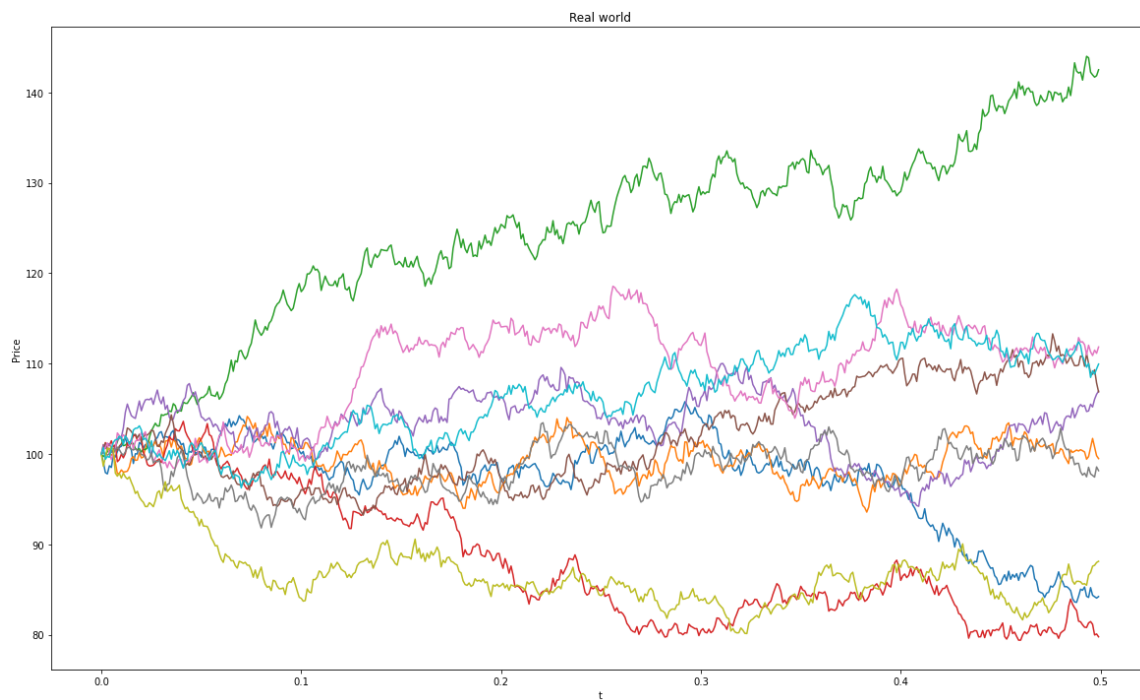
plt.subplot(2,1,2)
plt.plot(var,put[0])
plt.xlabel('Maturity')
plt.ylabel('Put Price')
plt.show()

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Check for correctness:

Mean : 102.79766834386074

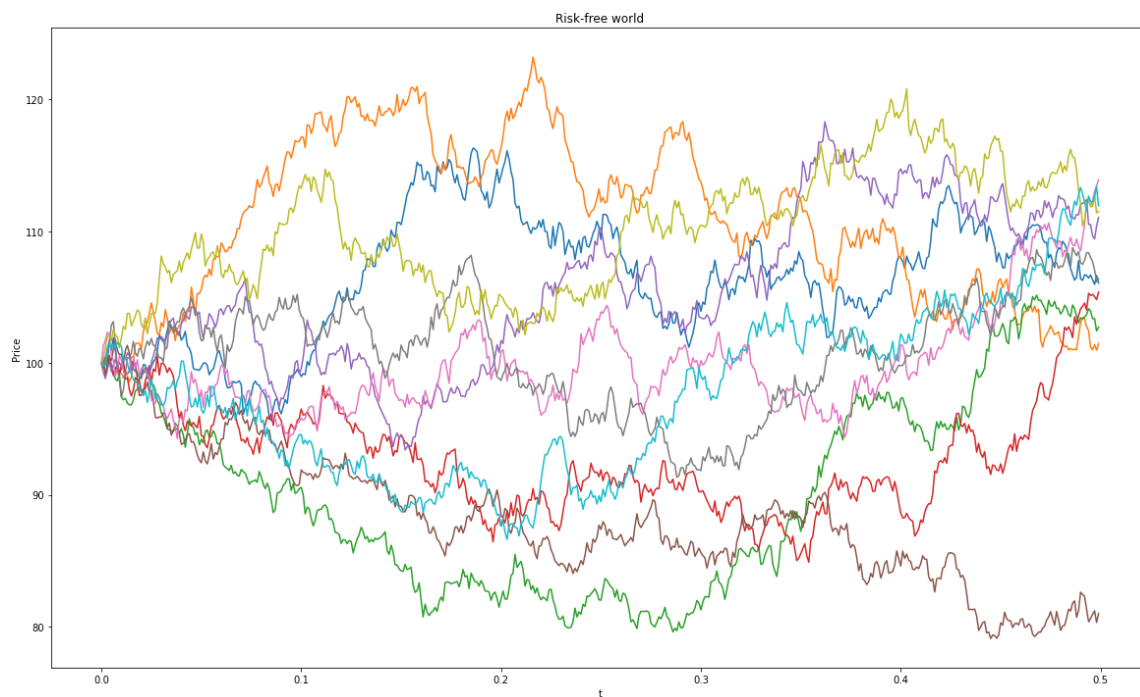
Variance : 286.6844702680746



Check for correctness:

Mean : 105.14070596697198

Variance : 80.36098301936885



Price of call option with strike price: 90 is 12.067154

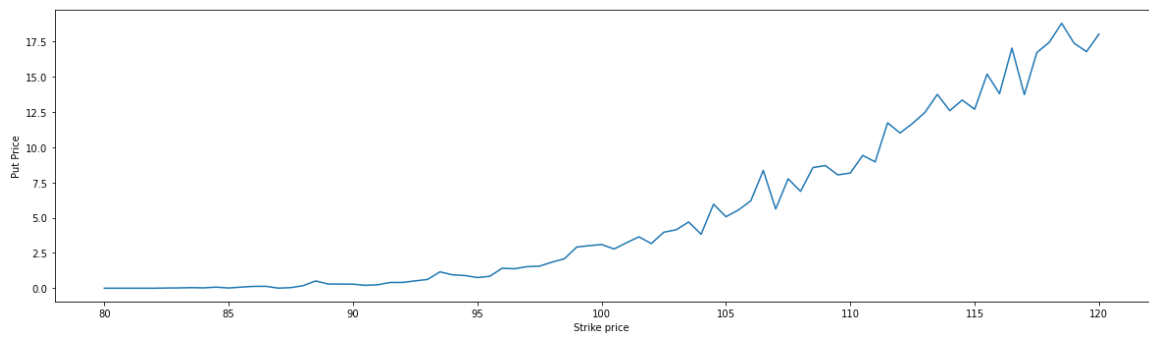
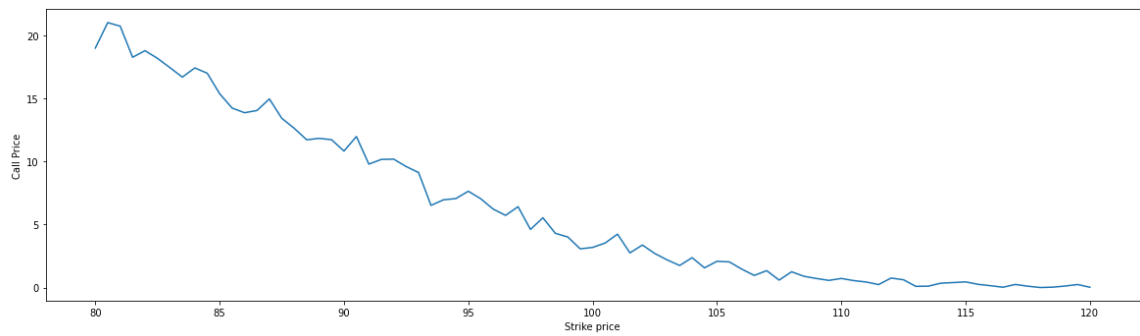
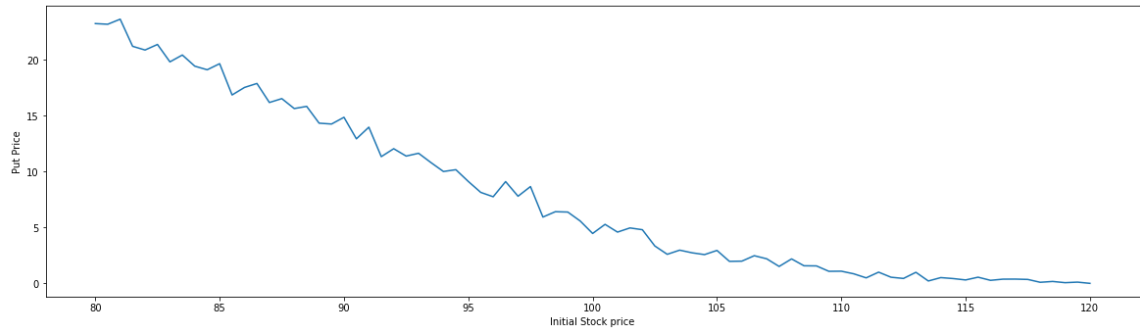
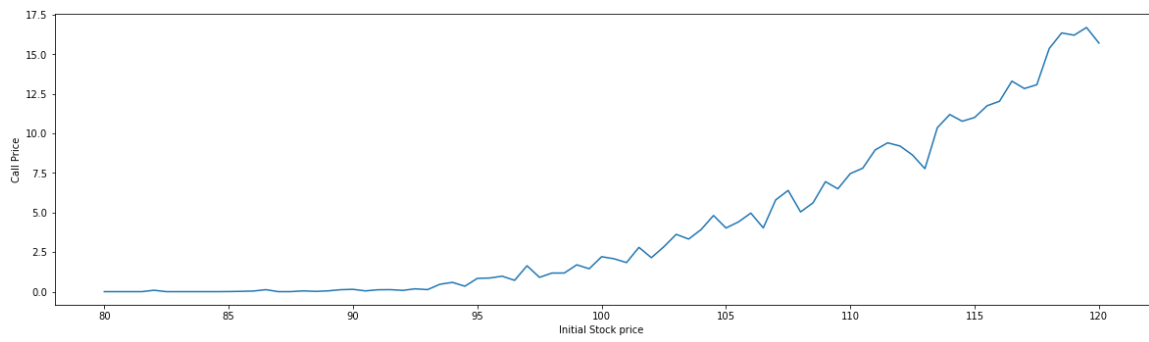
Price of put option with strike price : 90 is 0.166322

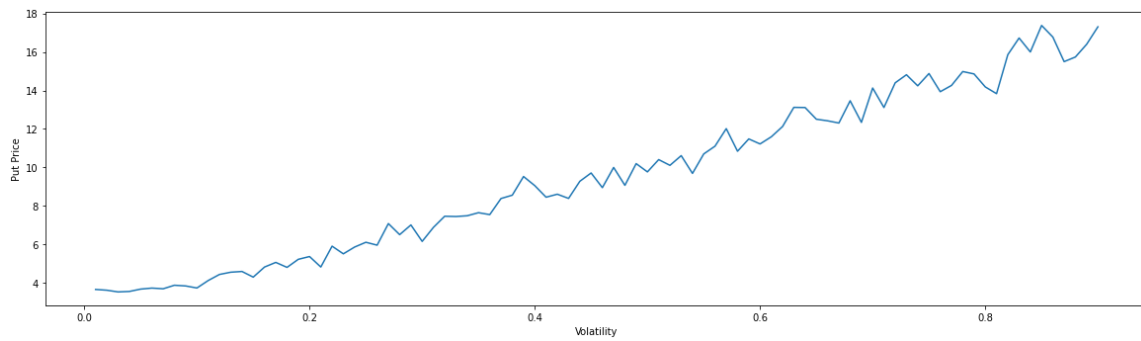
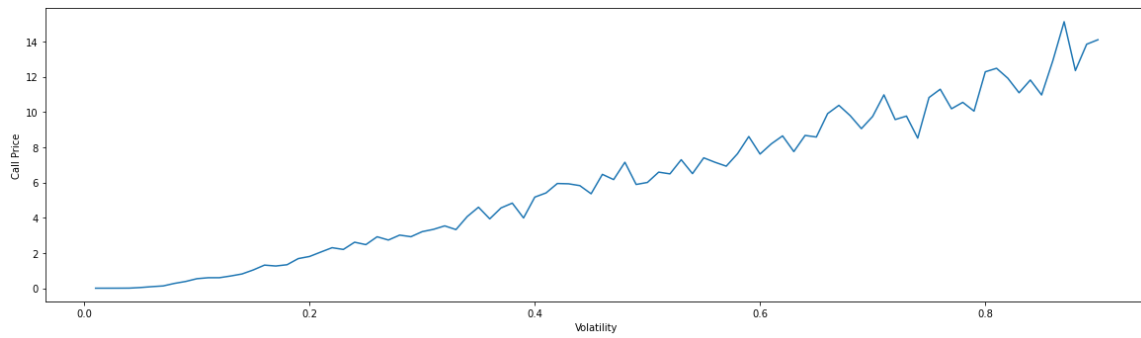
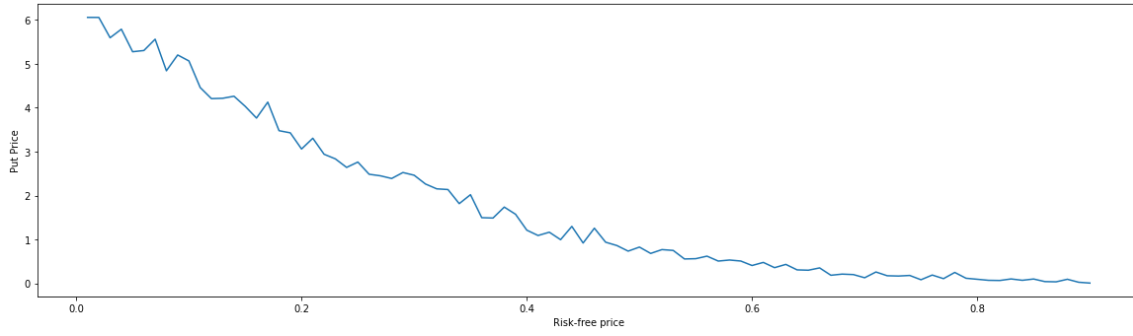
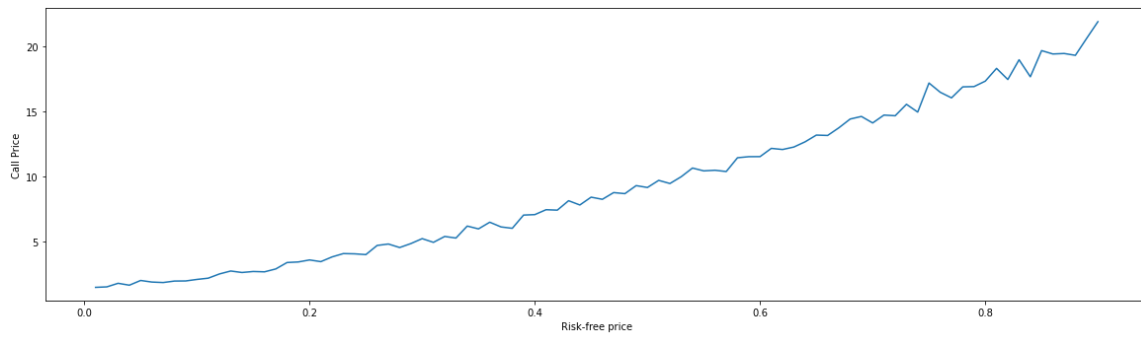
Price of call option with strike price: 105 is 2.342011

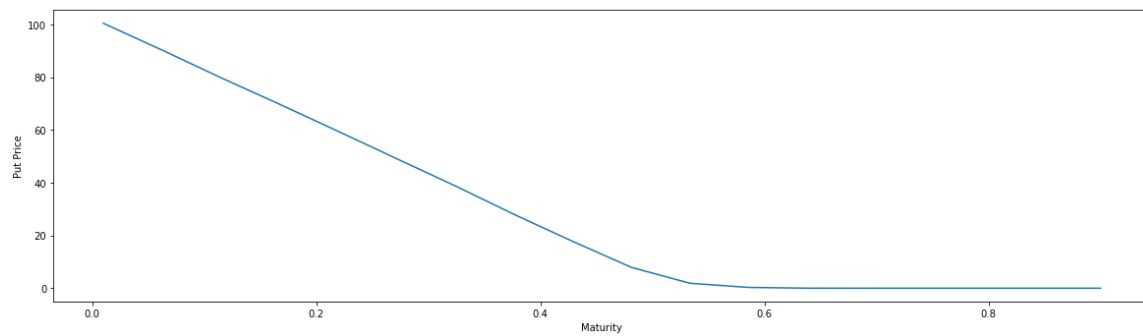
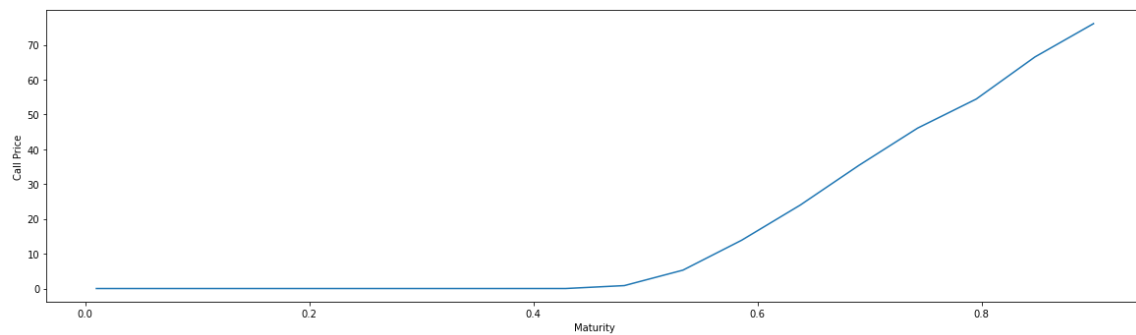
Price of put option with strike price : 105 is 4.477174

Price of call option with strike price: 110 is 0.323496

Price of put option with strike price : 110 is 8.844254







In []: