In [1]:

```python
from IPython.core.display import display, HTML
```

In [2]:

```python
display(HTML('<h1 style="text-align:center;">MA 374 | Assignment 9</h1>'))
display(HTML('<h2 style="text-align:center;">Deepak Kumar Gouda</h2>'))
```

MA 374 | Assignment 9

Deepak Kumar Gouda

In [3]:

```python
from pandas import read_csv, to_datetime
import numpy as np
from scipy.stats import norm
```

In [4]:

```python
from mpl_toolkits.mplot3d import Axes3D
import matplotlib.pyplot as plt
```

In [5]:

```python
%matplotlib tk
```

In [6]:

```python
fields=['Expiry', 'Strike Price', 'Put Price', 'Call Price']
orig_data = read_csv('NIFTYoptiondata.csv', usecols=fields, index_col=False)
```

In [7]:

```python
optionData = read_csv("NIFTYoptiondata.csv")
stockData = read_csv("./Data/nsedata1.csv")
optionData['Date2'] = to_datetime(optionData['Date'])
stockData['Date2'] = to_datetime(stockData['Date'])
stockData = stockData[['Date2','Close']]
data = optionData.merge(stockData,on='Date2')
```

In [8]:

```python
data.head()
```

Out[8]:

	Symbol	Date	Expiry	Strike Price	Put Price	Call Price	Date2	Close
0	NIFTY	01-Jan-2014	30-Jan-2014	7800	1341.90	1.00	2014-01-01	6301.65
1	NIFTY	01-Jan-2014	30-Jan-2014	7550	1111.85	0.25	2014-01-01	6301.65
2	NIFTY	01-Jan-2014	30-Jan-2014	7850	1387.35	3.60	2014-01-01	6301.65
3	NIFTY	01-Jan-2014	30-Jan-2014	7700	1248.90	2.75	2014-01-01	6301.65
4	NIFTY	01-Jan-2014	30-Jan-2014	7250	849.65	1.55	2014-01-01	6301.65

In [9]:

```python
numSample = 1000
mask = np.random.randint(0, len(data), numSample)
data = data.loc[mask]
```

In [10]:

```python
data.head()
```

Out[10]:

	Symbol	Date	Expiry	Strike Price	Put Price	Call Price	Date2	Close
13555	NIFTY	22-Jan-2014	29-Jun-2017	7700	425.05	2558.60	2014-01-22	6338.95
8256	NIFTY	14-Jan-2014	30-Jun-2016	4000	99.00	2612.45	2014-01-14	6241.85
42898	NIFTY	12-Mar-2014	28-Dec-2017	4200	0.85	3122.55	2014-03-12	6516.90
22185	NIFTY	05-Feb-2014	28-Dec-2017	6300	55.10	2868.90	2014-02-05	6022.40
18064	NIFTY	30-Jan-2014	30-Jan-2014	5500	0.05	1583.25	2014-01-30	6073.70

In [11]:

```python
len(data)
```

Out[11]:

```
1000
```

In [12]:

```python
import matplotlib.dates as mdates
```

In [13]:

```python
plot_data = orig_data[:numSample]
```

In [14]:

```
def plotPrices(plot_data):
    dates = to_datetime(plot_data['Expiry'])
    x = to_datetime(dates)
    x = mdates.date2num(x)

    y = plot_data['Strike Price']
    z_call = plot_data['Call Price']
    z_put = plot_data['Put Price']

    fig = plt.figure()
    ax = fig.add_subplot(111, projection='3d')

    ax.scatter(x, y, z_call, c='b', marker='.', label='Call Option')

    plt.xticks(x, data['Expiry'], rotation=90)
    ax.set_xlabel('Maturity Date')
    ax.set_ylabel('Strike Price')
    ax.set_zlabel('Option Prices')
    ax.legend()

    plt.show()

    fig = plt.figure()
    ax = fig.add_subplot(111, projection='3d')

    ax.scatter(x, y, z_put, c='r', marker='.', label='Put Option')

    plt.xticks(x, data['Expiry'], rotation=90)
    ax.set_xlabel('Maturity Date')
    ax.set_ylabel('Strike Price')
    ax.set_zlabel('Option Prices')
    ax.legend()

    plt.show()
```

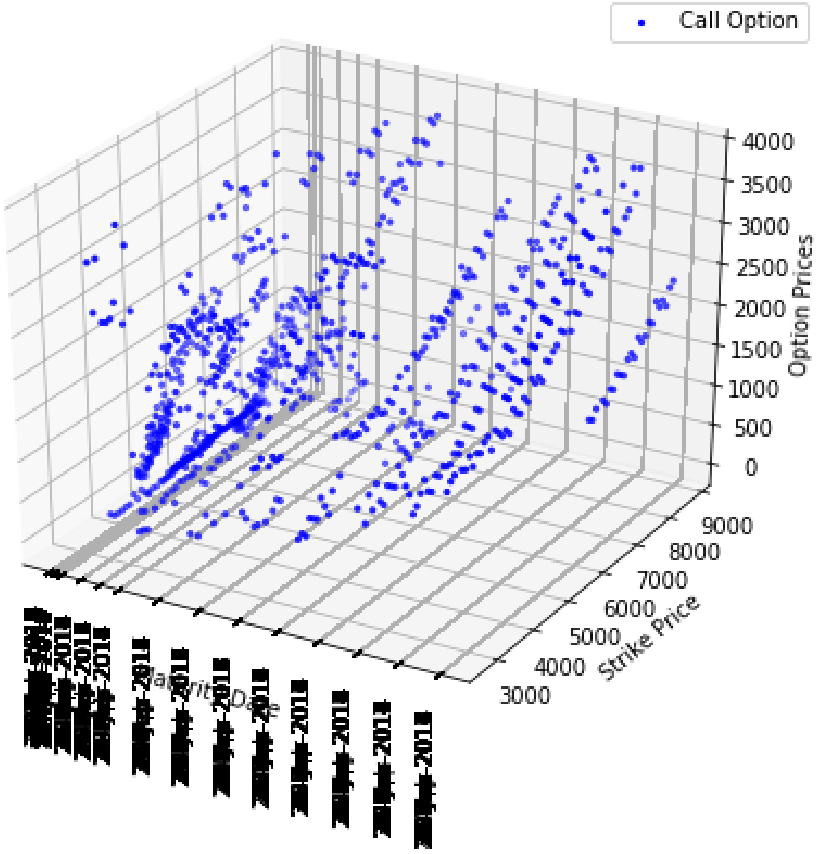
In [15]:

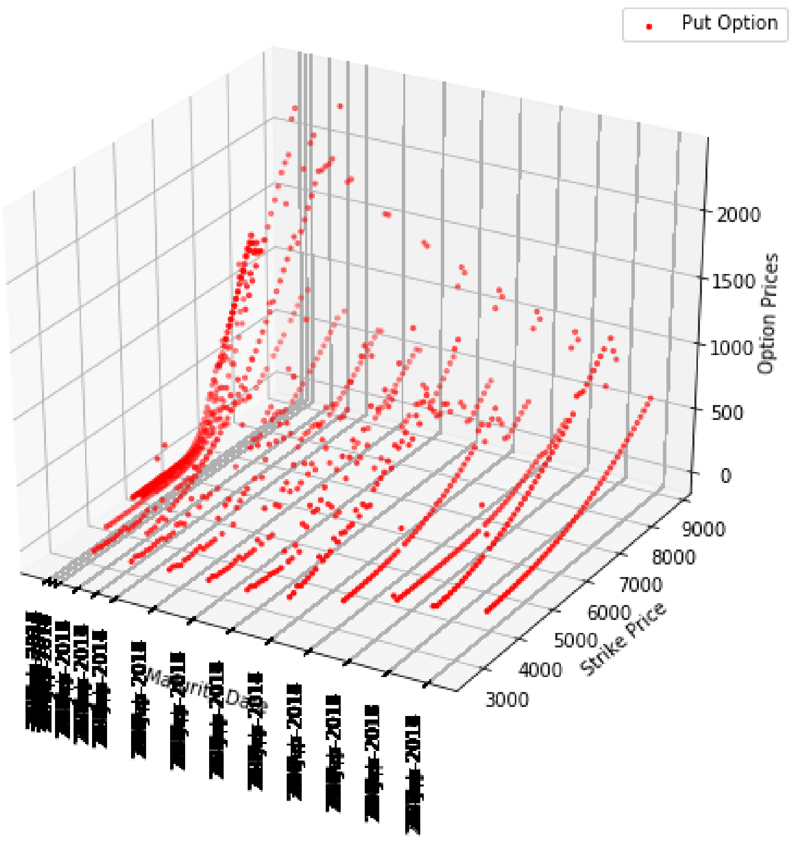
```
plotPrices(plot_data)
```

In [16]:

```
display(HTML('<h3 style="text-align:center;">Maturity vs Strike Price vs Option
display(HTML('<img src="Figure_3.png" alt="Drawing" style="width: 600px;"/>'))
display(HTML('<img src="Figure_4.png" alt="Drawing" style="width: 600px;"/>'))
```

Maturity vs Strike Price vs Option Prices





In [17]:

```python
def getCall(S, K, r, t, sig):
    d1 = (np.log(S/K)+t*(r+(sig**2)/2))/(sig*(t**0.5))
    d2 = d1-sig*(t**0.5)
    Nd1 = norm.cdf(d1)
    Nd2 = norm.cdf(d2)
    C = S*Nd1 - K*np.exp(-r*t)*Nd2
    return C
```

In [18]:

```python
def getPut(S, K, r, t, sig):
    d1 = (np.log(S/K)+t*(r+(sig**2)/2))/(sig*(t**0.5))
    d2 = d1-sig*(t**0.5)
    Nd1 = norm.cdf(-d1)
    Nd2 = norm.cdf(-d2)
    P = K*np.exp(-r*t)*Nd2 - S*Nd1
    return P
```

In [19]:

```python
def f(Price, St, K, r, t, sig, option='Call'):
    if option is 'Call':
        return getCall(St, K, r, t, sig)-Price
    else:
        return getPut(St, K, r, t, sig)-Price
```

In [20]:

```
def Secant(Price, St, K, r, t, option='Call'):
    x0 = 0.1
    x1 = 0.2

    tol = 0.00001
    num = 100
    alpha = 0.1
    for i in range(num):
        x2 = x1 - f(Price, St, K, r, t, x1, option)*(x1-x0)/(f(Price, St, K, r,
        x0 = x1
        x1 = x2
#         print(x1, f(Price, St, K, r, t, x1, option))
        if abs(f(Price, St, K, r, t, x1, option)) < tol:
            break
    return x1
```

In [21]:

```
from datetime import datetime
```

In [22]:

```
num = len(data)
sig_c = np.zeros(num)
for i in range(num):
    St = data.iloc[-i]['Close']
    r = 0.05
    init_date=data.iloc[-i]['Date']
    exp_date=data.iloc[-i]['Expiry']

    date_format = "%d-%b-%Y"
    d0 = datetime.strptime(init_date, date_format)
    d1 = datetime.strptime(exp_date, date_format)
    t = (d1-d0).days/252
    K = data.iloc[-i]['Strike Price']
    P = data.iloc[-i]['Put Price']
    C = data.iloc[-i]['Call Price']

    sig_c[i] = Secant(C, St, K, r, t, 'Call')
    if abs(sig_c[i]) > 10:
        sig_c[i] = np.nan
#     if i%50 is 0:
#         print(str(i+1)+"/"+str(num))
```

```
/home/epsilon/.virtualenvs/finance/lib/python3.6/site-packages/ipykern
el_launcher.py:2: RuntimeWarning: overflow encountered in double_scala
rs

/home/epsilon/.virtualenvs/finance/lib/python3.6/site-packages/ipykern
el_launcher.py:9: RuntimeWarning: overflow encountered in double_scala
rs
  if __name__ == '__main__':
/home/epsilon/.virtualenvs/finance/lib/python3.6/site-packages/ipykern
el_launcher.py:2: RuntimeWarning: invalid value encountered in double_
scalars

/home/epsilon/.virtualenvs/finance/lib/python3.6/site-packages/ipykern
el_launcher.py:2: RuntimeWarning: divide by zero encountered in double
_scalars
```

In [23]:

```
data.head()
```

Out[23]:

	Symbol	Date	Expiry	Strike Price	Put Price	Call Price	Date2	Close
13555	NIFTY	22-Jan-2014	29-Jun-2017	7700	425.05	2558.60	2014-01-22	6338.95
8256	NIFTY	14-Jan-2014	30-Jun-2016	4000	99.00	2612.45	2014-01-14	6241.85
42898	NIFTY	12-Mar-2014	28-Dec-2017	4200	0.85	3122.55	2014-03-12	6516.90
22185	NIFTY	05-Feb-2014	28-Dec-2017	6300	55.10	2868.90	2014-02-05	6022.40
18064	NIFTY	30-Jan-2014	30-Jan-2014	5500	0.05	1583.25	2014-01-30	6073.70

In [24]:

```
data['Volatility']=sig_c
data.drop(['Date2'], axis=1)
data.to_csv('result.csv', index=False)
```

In [25]:

```
def plotVolatility(data):
    dates = to_datetime(data['Expiry'])
    x = to_datetime(dates)
    x = mdates.date2num(x)

    y = data['Strike Price']
    z = data['Volatility']

    fig = plt.figure()
    ax = fig.add_subplot(111, projection='3d')

    ax.scatter(x, y, z, c='b', marker='.', label='Call Option')

    plt.xticks(x, data['Expiry'], rotation=90)
    ax.set_xlabel('Maturity Date')
    ax.set_ylabel('Strike Price')
    ax.set_zlabel('Volatility')
    ax.legend()
    plt.title('Maturity vs Strike Price vs Volatility')
    plt.show()
```

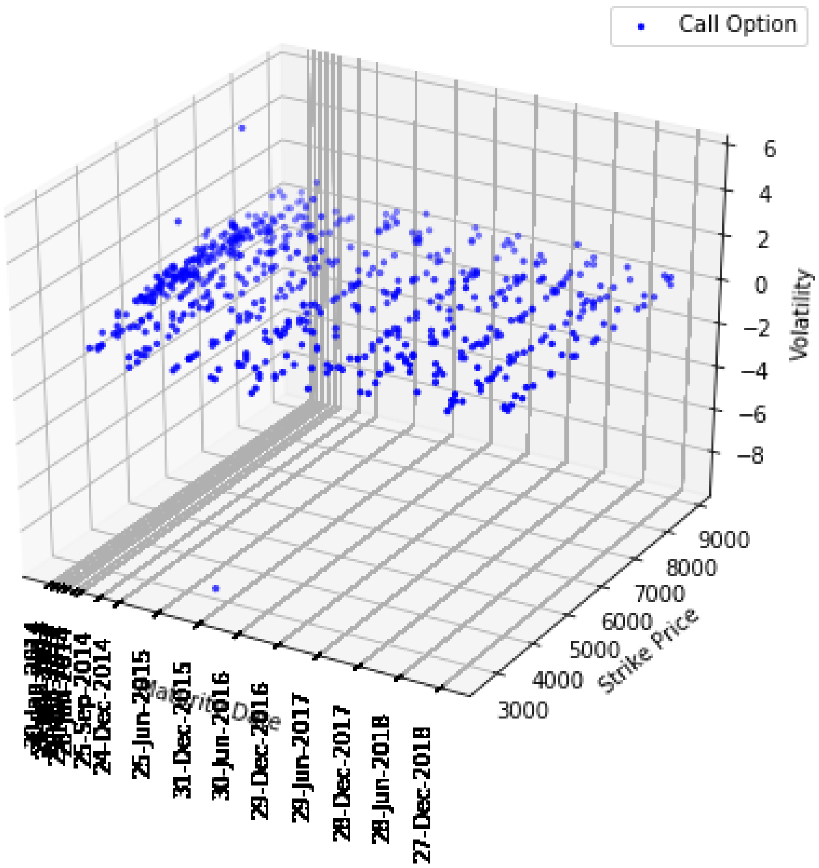
In [26]:

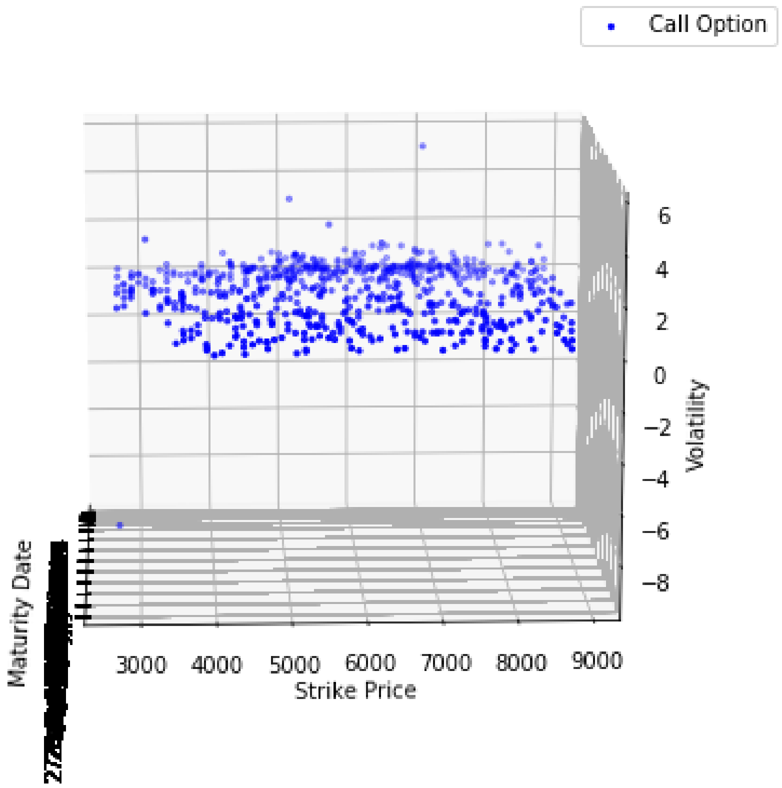
```
plotVolatility(data)
```

In [27]:

```
display(HTML('<h3 style="text-align:center;">Maturity vs Strike Price vs Volati
display(HTML('<img src="Figure_1.png" alt="Drawing" style="width: 600px;"/>'))
display(HTML('<img src="Figure_2.png" alt="Drawing" style="width: 600px;"/>'))
```

Maturity vs Strike Price vs Volatility




Call Option
Volatility
6
4
2
0
−2
−4
−6
−8
Maturity Date
3000
4000
5000
6000
7000
8000
9000
Strike Price

In [ ]:

```

```