

Assignment 9

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Explanations

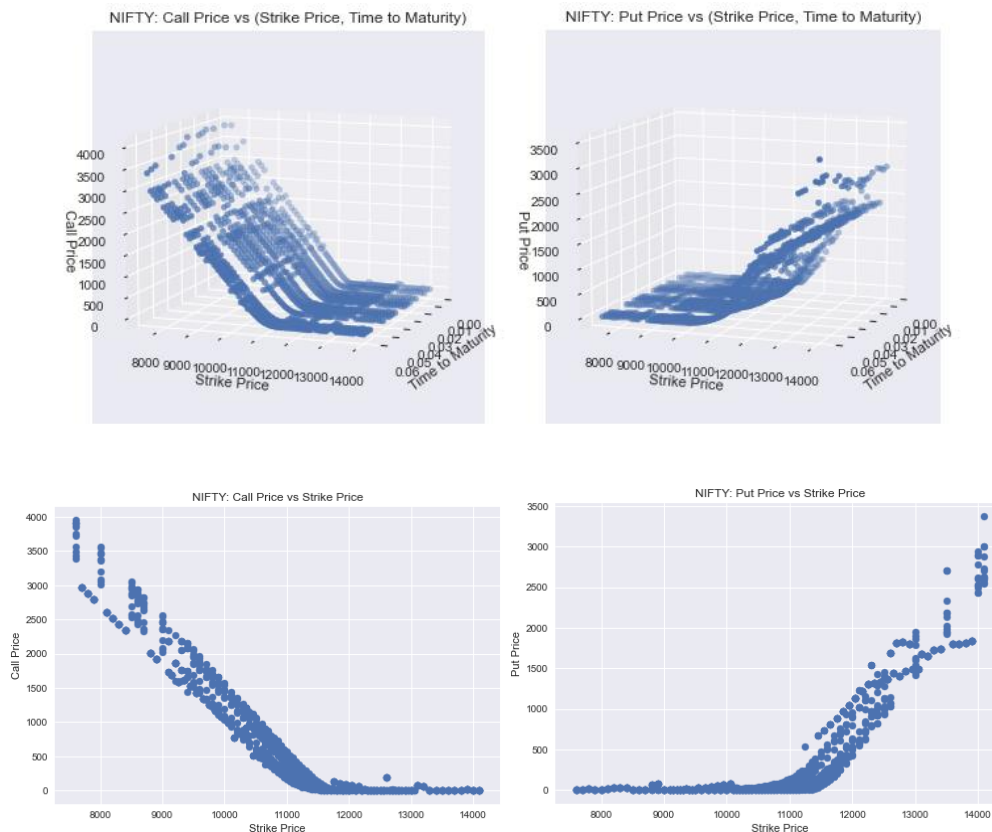
Question 1

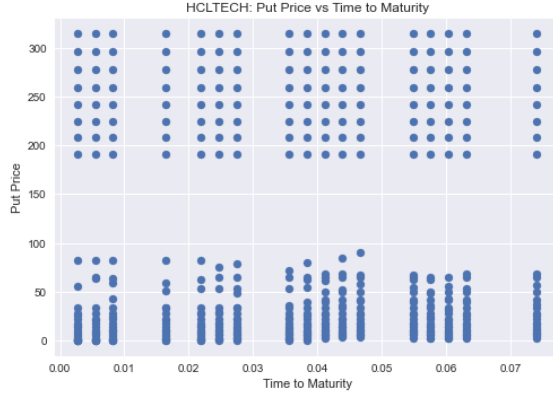
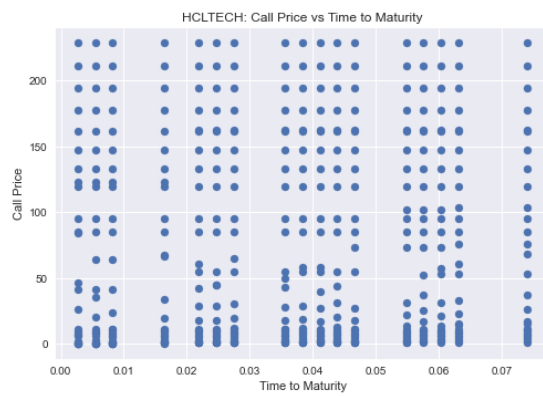
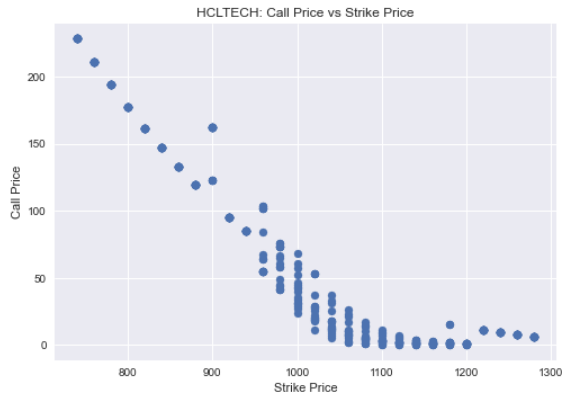
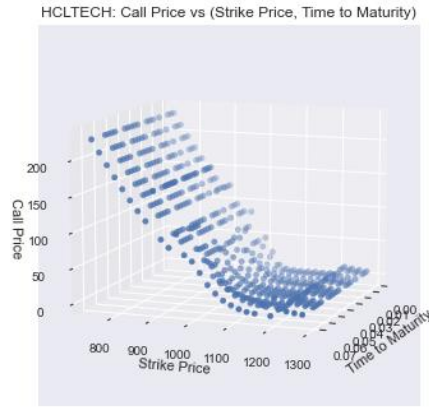
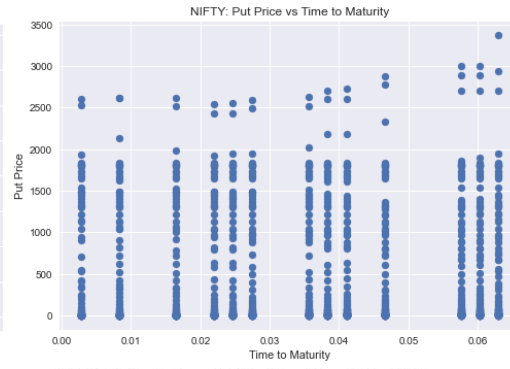
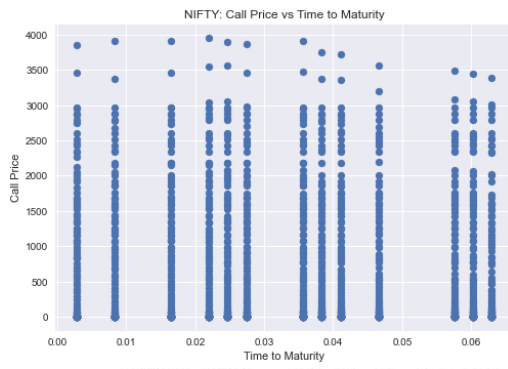
- Historical data was collected, from "[nseindia](https://nseindia.com/)" website, for 3 different companies in NIFTY, i.e. NTPC, HCLTECH and ADANI PORTS. Data contains option prices from 1st March to 27th March with expiry at 28th March for various strike prices. All this data is stored in [stockoptiondata.csv](#).

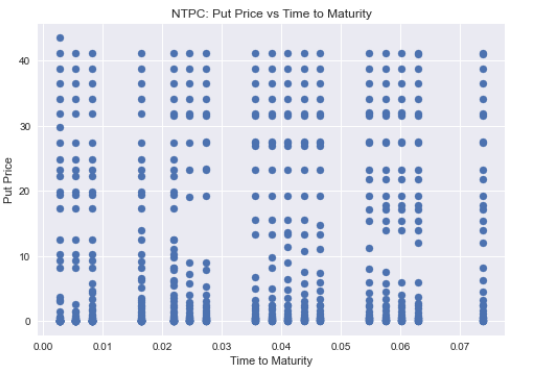
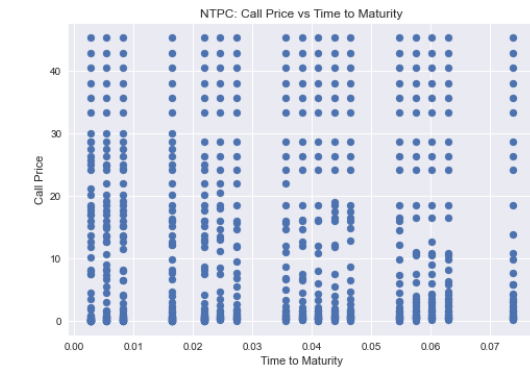
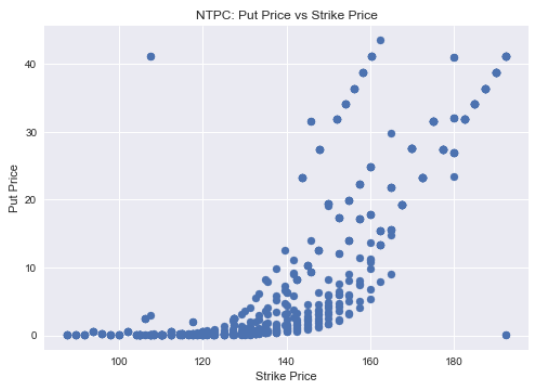
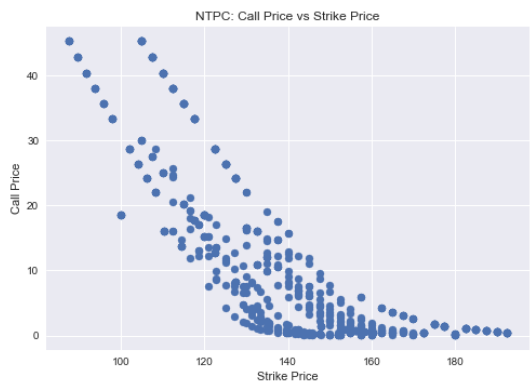
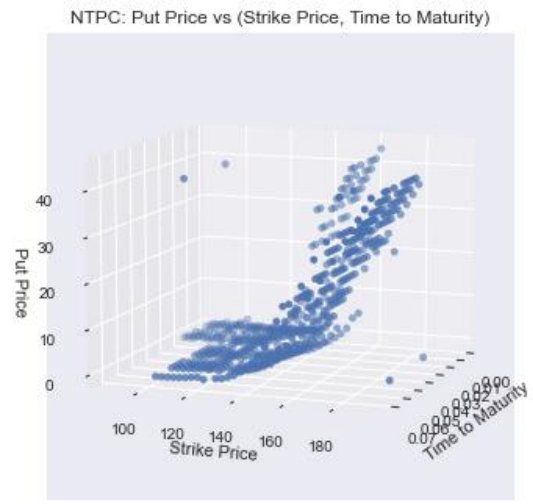
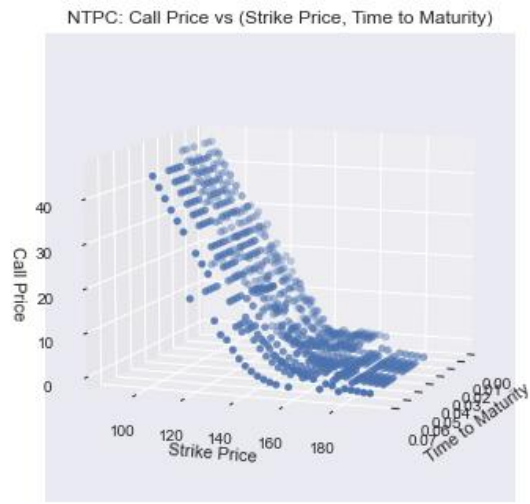
Question 2

- A new column Time to Maturity is added by subtracting starting date of the option price with the exercising date. It is then divided by 365 to get it in years.
- Option prices were plotted against time to maturity and strike price in three dimensions and also against each of these 2 parameters in two dimensions. These plots are shown below.

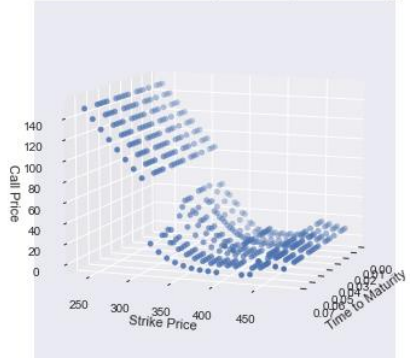
Output



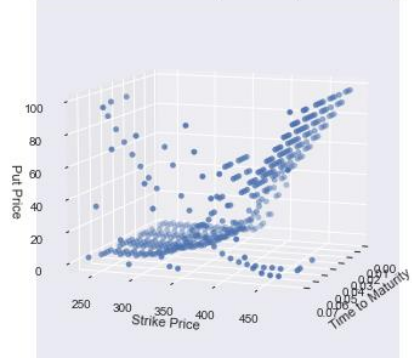


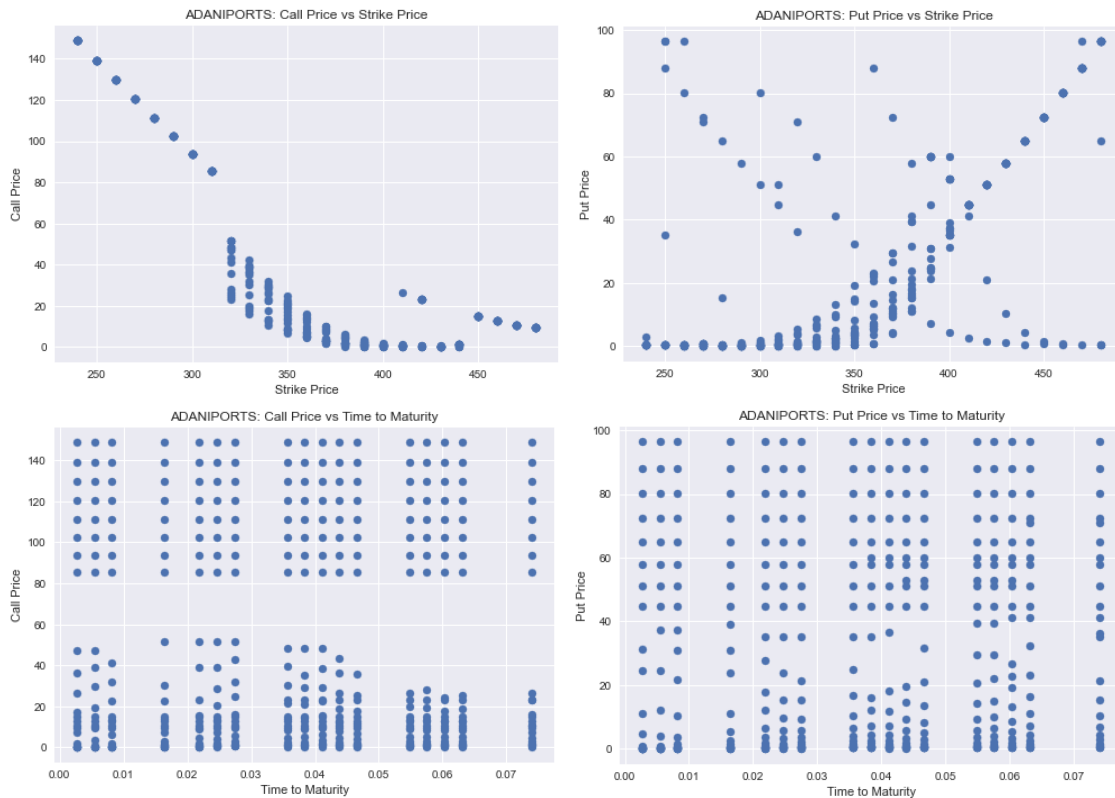


ADANI PORTS: Call Price vs (Strike Price, Time to Maturity)



ADANI PORTS: Put Price vs (Strike Price, Time to Maturity)





Observations

- The call options prices decreases with strike price and put option prices increases with strike price, which is the expected behaviour.
- Options prices are evenly distributed when plotted against time to maturity in two dimensions.

Question 3

- Implied volatility is calculated by finding the roots of the following equation-

$$f(\sigma) = C(\sigma) - C_m$$

where

- $C(\sigma)$ = BSM price for given S_0 , K , r , T which would be a function of implied volatility.
 - C_m = Market price of the Call option.
- Root is founded by newton raphson method using the following iteration:

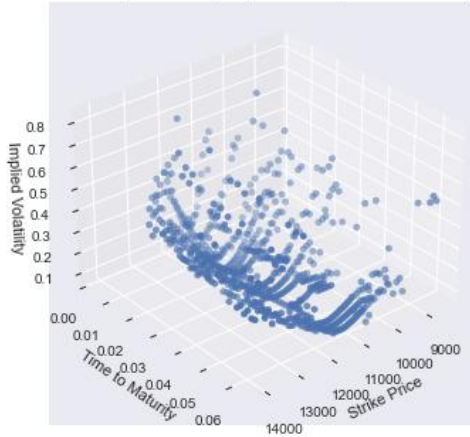
$$\sigma_{n+1} = \sigma_n - f(\sigma_n)/f'(\sigma_n)$$

where $f'(\sigma_n) = \text{Vega}(\sigma_n) = \sqrt{T} \cdot S_0 \cdot \frac{1}{\sqrt{2\pi}} e^{-\frac{d_1^2}{2}}$

$$d_1 = \frac{1}{\sigma\sqrt{T}} \left[\log(S_0/K) + \left(r + \frac{\sigma^2}{2} \right) T \right]$$

Output

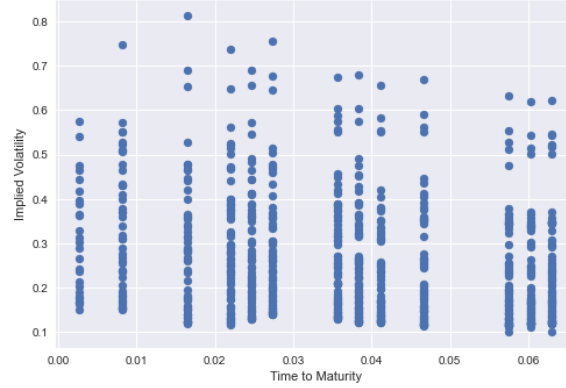
NIFTY: Implied Volatility vs (Strike Price, Time to Maturity)



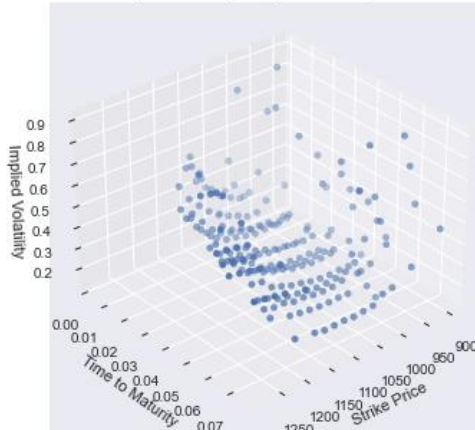
NIFTY: Imp Vol vs Strike Price



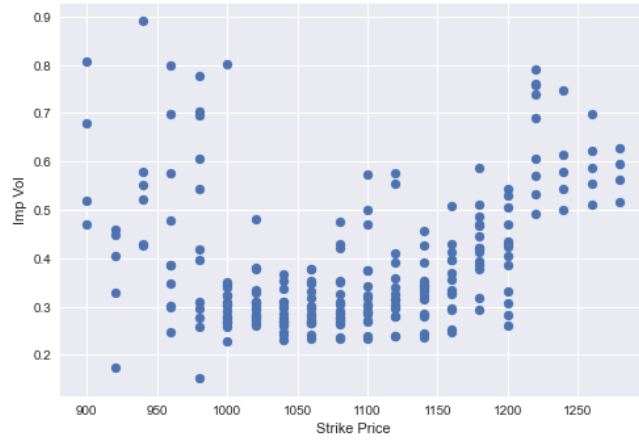
NIFTY: Implied Volatility vs Time to Maturity



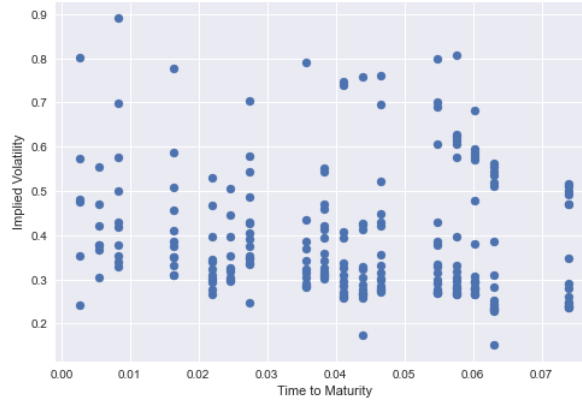
HCLTECH: Implied Volatility vs (Strike Price, Time to Maturity)

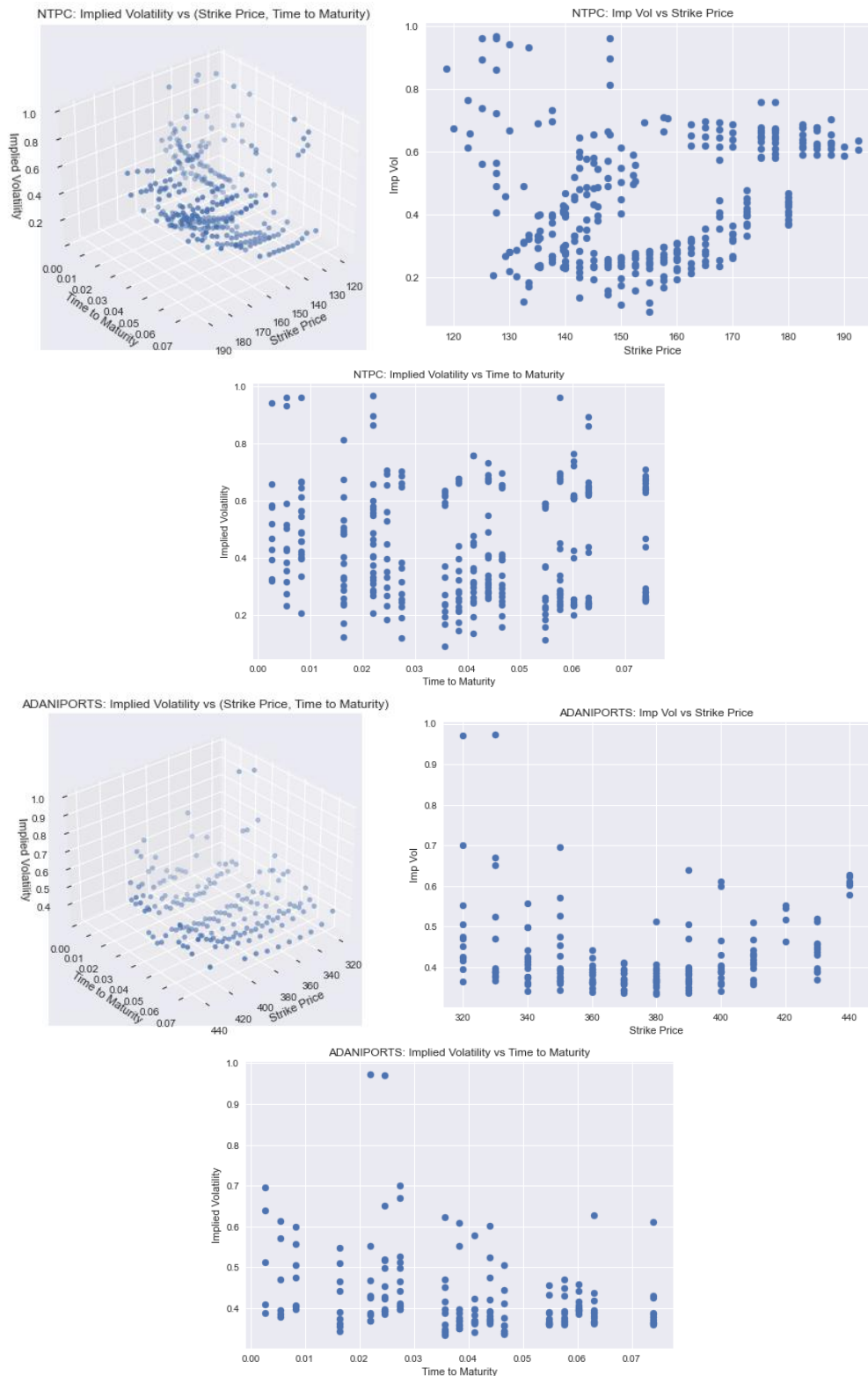


HCLTECH: Imp Vol vs Strike Price



HCLTECH: Implied Volatility vs Time to Maturity





Obeservations

- In the 3D plots for any given time to maturity, a convex curve can be observed for implied volatility and strike price. This is often referred to as "Volatility Smile".
- In 2D plot of implied volatility vs Strike price, many smiles (of different time to maturity) can be observed overlapping with each other.

Question 4

- Historical data of prices of underlying asset is collected from 1st March to 27th March 2019. It is the same period for which data of option prices is collected. This data is stored in [underlyingAssetData.csv](#).

- Historical volatility is computed using the following methodology –

- Returns were calculated using the following formula:

$$Returns(i) = \frac{S(i+1) - S(i)}{S(i)}$$

where $S(i)$ denote the stock price at time point i .

- Annual Volatility is calculated using the following formula:

$$Volatility = Standard_Deviation(Returns) * \sqrt{252}$$

- Mean implied volatility is computed by taking the mean of the implied volatilities obtained in question 3

Output

Underlying Asset	Implied Volatility	Historical Volatility
NIFTY	0.270884	0.101249
NTPC	0.472006	0.407745
HCLTECH	0.408545	0.228939
ADANI PORTS	0.550594	0.197391

Observations

- Historical volatilities are far away from the implied volatilities, so we can conclude that there is no direct correlation between them.
- Implied volatility are higher than historical volatility for all the underlying assets.