

# Task 7 - Stock Market Prediction using Numerical and Textual Analysis

## TSF-GRIP Internship

## Data Science & Business Analytics Tasks

Level : Advanced

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Date : 07/08/2021

Objective: Create a hybrid model for stock price/performance prediction using numerical analysis of historical stock prices, and sentimental analysis of news headlines

Stock to analyze and predict - SENSEX (S&P BSE SENSEX)

Data used: for historical stock prices from finance.yahoo.com

Data used: for textual (news) data from <https://bit.ly/36FFPI6>

```
In [1]: # Import Libraries

# To ignore warnings during the session
import warnings
warnings.filterwarnings('ignore')

# Importing essential libraries
import pandas as pd
import numpy as np

# Importing Data Visualization Libraries
import matplotlib.pyplot as plt
import seaborn as sns

%matplotlib inline
```

## Downloading Historical Stock Prices of Reliance Industries from Yahoo Finance

```
In [2]: # Importing required libraries
import time
import datetime

In [3]: # Creating Variables, we can create data file for many companies but here i will take Microsoft only for assets
tickers = ['MSFT', 'GOOG', 'AAPL', 'RELIANCE.NS'] # For downloading Multiple companies data from Yahoo Finance
tickers = ['RELIANCE.NS']
period1 = '1414'
period2 = int(time.mktime(datetime.datetime(2016,8,10,23,59).timetuple()))
period3 = int(time.mktime(datetime.datetime(2020,12,31,23,59).timetuple()))
print(period1)
print(period2)
print(period3)

1470862740
1609448340

In [4]: xlwriter = pd.ExcelWriter('Historical_Stock_Prices.xlsx', engine='openpyxl')

for ticker in tickers:
    query_string = f'https://query1.finance.yahoo.com/v7/finance/download/{ticker}?period1={period1}&period2={period3}&events=history&filter=history'
    df = pd.read_csv(query_string)
    df.to_excel(xlwriter, sheet_name=ticker, index=False)

# xlwriter.save() # For saving an excel file
df.to_csv('Historical_Stock_Prices_csv.csv', index=False) # For saving a csv file

In [5]: # Reading the datasets into pandas

stock_price = pd.read_csv('C:/Users/rv/TSF-GRIP-TSF-GRIP-DBSA-Internship/Historical_Stock_Prices_csv.csv')

In [6]: stock_price.head()
```

	Date	Open	High	Low	Close	Adj Close	Volume
0	2016-08-11	496.27084	506.62271	495.10687	502.28881	489.48925	65392010
1	2016-08-12	503.725189	516.553589	503.725189	510.036926	499.901855	75526410
2	2016-08-16	513.036926	517.494690	502.982239	507.338092	494.641266	61691340
3	2016-08-17	507.241852	509.569794	498.871185	501.892548	489.042816	71470500
4	2016-08-18	503.229889	507.018982	503.229889	504.245270	491.335297	35764810

## Loading already downloaded Times of India News Headlines from Harvard Dataserve

```
In [7]: news_headlines = pd.read_csv('India-news-headlines.csv')

In [8]: news_headlines.head()
```

	publish_date	headline_category	headline_text
0	20010102	unknown	Status quo will not be disturbed at Ayodhya s...
1	20010102	unknown	Fissures in Huriyat over Pak visit
2	20010102	unknown	America's unwanted heading for India
3	20010102	unknown	For bilgwig; it is destination Goa
4	20010102	unknown	Extra buses to clear tourist traffic

```
In [9]: news_headlines.tail()
```

	publish_date	headline_category	headline_text
3424062	20201231	city/jodhpur	Covid-19 Despite dip in cases; Rajasthan amon...
3424063	20201231	city/udaipur	Covid-19 Despite dip in cases; Rajasthan amon...
3424064	20201231	city/ajmer	Covid-19 Despite dip in cases; Rajasthan amon...
3424065	20201231	city/rajmow	Govt extends deadline for use of FASTag till F...
3424066	20201231	entertainment/bengali/movies/news	Celebs plan to party safely and responsibly on...

## Data Visualization & Cleaning

### Stock Price Data

```
In [10]: # checking for null values in both the datasets

stock_price.isna().any()
```

Date	Open	High	Low	Close	Adj Close	Volume
2016-08-11	496.27084	506.62271	495.10687	502.28881	489.48925	65392010
2016-08-12	503.725189	516.553589	503.725189	510.036926	499.901855	75526410
2016-08-16	513.036926	517.494690	502.982239	507.338092	494.641266	61691340
2016-08-17	507.241852	509.569794	498.871185	501.892548	489.042816	71470500
2016-08-18	503.229889	507.018982	503.229889	504.245270	491.335297	35764810

```
In [11]: news_headlines.isna().any()
```

	publish_date	headline_category	headline_text
0	20010102	unknown	Status quo will not be disturbed at Ayodhya s...
1	20010102	unknown	Fissures in Huriyat over Pak visit
2	20010102	unknown	America's unwanted heading for India
3	20010102	unknown	For bilgwig; it is destination Goa
4	20010102	unknown	Extra buses to clear tourist traffic

```
In [12]: stock_price.info()
```

	publish_date	headline_category	headline_text
0	20010102	unknown	Status quo will not be disturbed at Ayodhya s...
1	20010102	unknown	Fissures in Huriyat over Pak visit
2	20010102	unknown	America's unwanted heading for India
3	20010102	unknown	For bilgwig; it is destination Goa
4	20010102	unknown	Extra buses to clear tourist traffic

```
In [13]: news_headlines.info()
```

	publish_date	headline_category	headline_text
0	20010102	unknown	Status quo will not be disturbed at Ayodhya s...
1	20010102	unknown	Fissures in Huriyat over Pak visit
2	20010102	unknown	America's unwanted heading for India
3	20010102	unknown	For bilgwig; it is destination Goa
4	20010102	unknown	Extra buses to clear tourist traffic

```
In [14]: # converting the "Date" column datatype from 'object' to 'datetime'
stock_price['Date'] = pd.to_datetime(stock_price['Date']).dt.normalize()

# Filtering the important columns required
stock_price = stock_price.filter(['Date', 'Close', 'Open', 'High', 'Low', 'Volume'])

# setting column 'Date' as the index column
stock_price.set_index('Date', inplace=True)

# sorting the data according to the index i.e 'Date'
stock_price = stock_price.sort_index(ascending=True, axis=0)

stock_price
```

	Close	Open	High	Low	Volume
2016-08-11	502.288818	496.270844	506.622711	495.106873	65392010
2016-08-12	513.036926	503.725189	516.553589	503.725189	75526410
2016-08-16	507.338092	513.259827	517.494690	502.982239	61691340
2016-08-17	501.892548	507.241852	509.569794	498.871185	71470500
2016-08-18	504.245270	503.229889	507.018982	503.229889	35764810

```
Out[14]:
```

	Close	Open	High	Low	Volume
2016-08-11	502.288818	496.270844	506.622711	495.106873	65392010
2016-08-12	513.036926	503.725189	516.553589	503.725189	75526410
2016-08-16	507.338092	513.259827	517.494690	502.982239	61691340
2016-08-17	501.892548	507.241852	509.569794	498.871185	71470500
2016-08-18	504.245270	503.229889	507.018982	503.229889	35764810

```
In [15]: df=stock_price[['Close']]

In [16]: df.head()
```

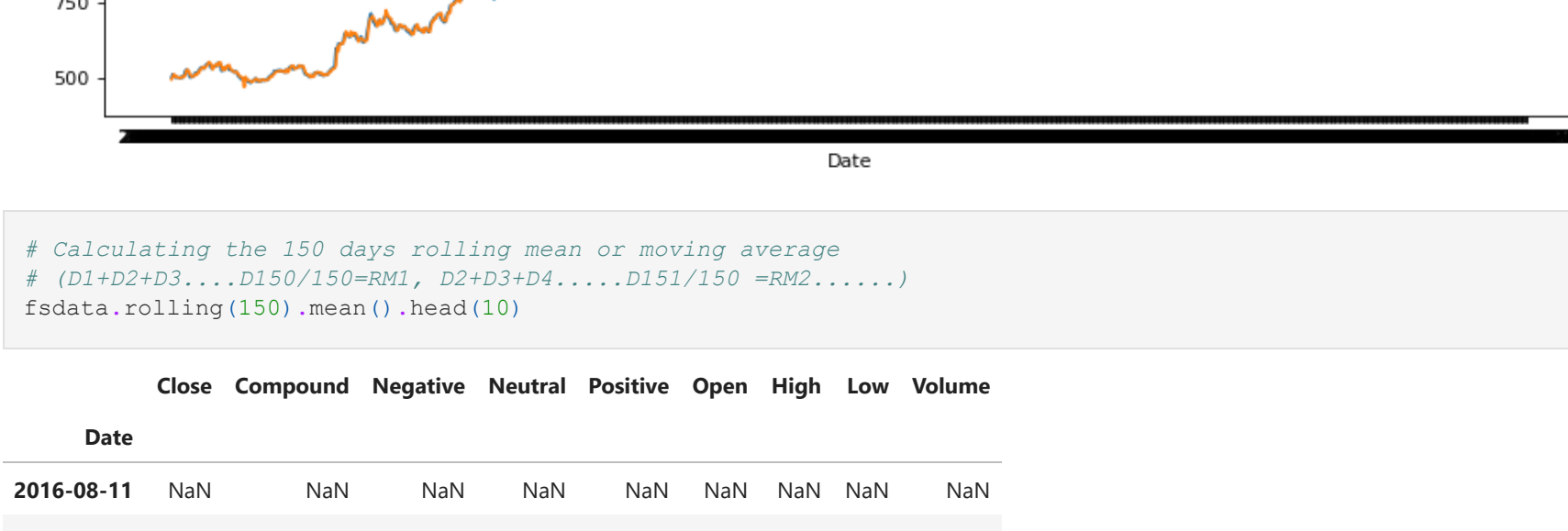
	Close
2016-08-11	502.288818
2016-08-12	513.036926
2016-08-16	507.338092
2016-08-17	501.892548
2016-08-18	504.245270

```
In [17]: from matplotlib.pyplot import figure

figure(figsize=(14, 6), dpi=80)
plt.plot(stock_price['Close'], label='Close')
plt.plot(stock_price['Open'], label='Open')
plt.plot(stock_price['High'], label='High')
plt.plot(stock_price['Low'], label='Low')

plt.legend()
plt.title("Stock Prices of Reliance Industries Limited")
plt.xlabel("Date")
plt.ylabel("Price")

Text(0, 0.5, 'Price')
```



```
In [18]: figure(figsize=(14, 5), dpi=80)
plt.plot(stock_price['Volume'], label='Volume')

plt.legend()
plt.title("Stock Prices of Reliance Industries Limited")
plt.xlabel("Date")
plt.ylabel("Price")

Text(0, 0.5, 'Price')
```



## News Data

```
In [19]: # converting the "Date" column datatype from 'object' to 'datetime'
news_headlines['publish_date'] = news_headlines['publish_date'].astype(str)
news_headlines['publish_date'] = news_headlines['publish_date'].apply(lambda x: x[0:4]+'-'+x[4:6]+'-'+x[6:8])
news_headlines['publish_date'] = pd.to_datetime(news_headlines['publish_date']).dt.normalize()

# Filtering the important columns required
news_headlines = news_headlines.filter(['publish_date', 'headline_text'])

# grouping the news_headlines according to 'Date'
news_headlines = news_headlines.groupby(['publish_date'])['headline_text'].apply(lambda x: ','.join(x).reset_index(drop=True))

# setting column 'Date' as the index column
news_headlines.set_index('publish_date', inplace=True)

# sorting the data according to the index i.e 'Date'
news_headlines = news_headlines.sort_index(ascending=True, axis=0)

news_headlines
```

	publish_date	headline_text
2001-01-02	2001-01-02	Status quo will not be disturbed at Ayodhya s...
2001-01-03	2001-01-03	Status quo will not be disturbed at Ayodhya s...
2001-01-04	2001-01-04	The string that pulled Stephen Hawking to Indi...
2001-01-05	2001-01-05	Light combat craft takes India into club class...
2001-01-06	2001-01-06	Light combat craft takes India into club class...

```
Out[19]:
```

	publish_date	headline_text
2001-01-02	2001-01-02	Status quo will not be disturbed at Ayodhya s...
2001-01-03	2001-01-03	Status quo will not be disturbed at Ayodhya s...
2001-01-04	2001-01-04	The string that pulled Stephen Hawking to Indi...
2001-01-05	2001-01-05	Light combat craft takes India into club class...
2001-01-06	2001-01-06	Light combat craft takes India into club class...

```
7262 rows x 3 columns
```

## Concatenating(combining) both Stock Price and News data

```
In [20]: # concatenating the datasets stock_price and news_headlines
concat_data = pd.concat([stock_price, news_headlines], axis=1)

# dropping the null values if any
concat_data.dropna(inplace=True)

# displaying the combined stock_data
concat_data
```

	Close	Open	High	Low	Volume	headline_text
2016-08-11	502.288818	496.270844	506.622711	495.106873	65392010	Watch: Poja Hegde recreates Hrithik Roshan's ...
2016-08-12	513.036926	503.725189	516.553589	503.725189	75526410	Bomb scare at west Delhi Metro station,Mobile ...
2016-08-16	507.338092	513.259827	517.494690	502.982239	61691340	Gnocchi: The delightful dumplings,5 delicious ...
2016-08-17	501.892548	507.241852	509.569794	498.871185	71470500	Vicky Kaushal: Lesser known facts,Withold 20%...
2016-08-18	504.245270	503.229889	507.018982	503.229889	35764810	Rakshabandhan Special: Bollywood brother-siste...

```
Out[20]:
```

	Close	Open	High	Low	Volume	headline_text	Compound	Negative	Neutral	Positive
2016-08-11	502.288818	496.270844	506.622711	495.106873	65392010	Watch: Poja Hegde recreates Hrithik Roshan's ...	-0.9999	0.159	0.750	0.091
2016-08-12	513.036926	503.725189	516.553589	503.725189	75526410	Bomb scare at west Delhi Metro station,Mobile ...	-0.9999	0.138	0.779	0.083
2016-08-16	507.338092	513.259827	517.494690	502.982239	61691340	Gnocchi: The delightful dumplings,5 delicious ...	-0.9511	0.117	0.764	0.119
2016-08-17	501.892548	507.241852	509.569794	498.871185	71470500	Vicky Kaushal: Lesser known facts,Withold 20%...	-0.9999	0.147	0.759	0.094
2016-08-18	504.245270	503.229889	507.018982	503.229889	35764810	Rakshabandhan Special: Bollywood brother-siste...	-0.9990	0.142	0.734	0.125

```
In [21]: # adding columns to concat_data
concat_data['Compound'] = ''
concat_data['Negative'] = ''
concat_data['Neutral'] = ''
concat_data['Positive'] = ''
concat_data.head()
```

	Close	Open	High	Low	Volume	headline_text	Compound	Negative	Neutral	Positive
2016-08-11	502.288818	496.270844	506.622711	495.106873	65392010	Watch: Poja Hegde recreates Hrithik Roshan's ...	-0.9999	0.159	0.750	0.091
2016-08-12	513.036926	503.725189	516.553589	503.725189	75526410	Bomb scare at west Delhi Metro station,Mobile ...	-0.9999	0.138	0.779	0.083
2016-08-16	507.338092	513.259827	517.494690	502.982239	61691340	Gnocchi: The delightful dumplings,5 delicious ...	-0.9511	0.117	0.764	0.119
2016-08-17	501.892548	507.241852	509.569794	498.871185	71470500	Vicky Kaushal: Lesser known facts,Withold 20%...	-0.9999	0.147	0.759	0.094
2016-08-18	504.245270	503.229889	507.018982	503.229889	35764810	Rakshabandhan Special: Bollywood brother-siste...	-0.9990	0.142	0.734	0.125

```
Out[21]:
```

	Close	Open	High	Low	Volume	headline_text	Compound	Negative	Neutral	Positive
2016-08-11	502.288818	496.270844	506.622711	495.106873	65392010	Watch: Poja Hegde recreates Hrithik Roshan's ...	-0.9999	0.159	0.750	0.091
2016-08-12	513.036926	503.725189	516.553589	503.725189	75526410	Bomb scare at west Delhi Metro station,Mobile ...	-0.9999	0.138	0.779	0.083
2016-08-16	507.338092	513.259827	517.494690	502.982239	61691340	Gnocchi: The delightful dumplings,5 delicious ...	-0.9511	0.117	0.764	0.119
2016-08-17	501.892548	507.241852	509.569794	498.871185	71470500	Vicky Kaushal: Lesser known facts,Withold 20%...	-0.9999	0.147	0.759	0.094
2016-08-18	504.245270	503.229889	507.018982	503.229889	35764810	Rakshabandhan Special: Bollywood brother-siste...	-0.9990	0.142	0.734	0.125

```
In [22]: # Importing Libraries for developing Sentiment Analysis
import nltk
from nltk.classify import NaiveBayesClassifier
from nltk.corpus import subjectivity
from nltk.sentiment import SentimentIntensityAnalyzer
from nltk.sentiment.vader import SentimentIntensityAnalyzer
import unioledata
import nltk.download('vader_lexicon')
```

```
In [23]: # instantiating the Sentiment Analyzer
s_analyzer = SentimentIntensityAnalyzer()

# calculating sentiment scores
concat_data['Compound'] = concat_data['headline_text'].apply(lambda x: s_analyzer.compound_scores(x))
concat_data['Negative'] = concat_data['headline_text'].apply(lambda x: s_analyzer.negative_scores(x))
concat_data['Neutral'] = concat_data['headline_text'].apply(lambda x: s_analyzer.neutral_scores(x))
concat_data['Positive'] = concat_data['headline_text'].apply(lambda x: s_analyzer.positive_scores(x))

# displaying the stock data
concat_data.head()
```

	Close	Open	High	Low	Volume	headline_text	Compound	Negative	Neutral	Positive
2016-08-11	502.288818	496.270844	506.622711	495.106873	65392010	Watch: Poja Hegde recreates Hrithik Roshan's ...	-0.9999	0.159	0.750	0.091
2016-08-12	513.036926	503.725189	516.553589	503.725189	75526410	Bomb scare at west Delhi Metro station,Mobile ...	-0.9999	0.138	0.779	0.083
2016-08-16	507.338092	513.259827	517.494690	502.982239	61691340	Gnocchi: The delightful dumplings,5 delicious ...	-0.9511	0.117	0.764	0.119
2016-08-17	501.892548	507.241852	509.569794	498.871185	71470500	Vicky Kaushal: Lesser known facts,Withold 20%...	-0.9999	0.147	0.759	0.094
2016-08-18	504.245270	503.229889	507.018982	503.229889	35764810	Rakshabandhan Special: Bollywood brother-siste...	-0.9990	0.142	0.734	0.125

```
Out[23]:
```

	Close	Open	High	Low	Volume	headline_text	Compound	Negative	Neutral	Positive
2016-08-11	502.288818	496.270844	506.622711	495.106873	65392010	Watch: Poja Hegde recreates Hrithik Roshan's ...	-0.9999	0.159	0.750	0.091
2016-08-12	513.036926	503.725189	516.553589	503.725189	75526410	Bomb scare at west Delhi Metro station,Mobile ...	-0.9999	0.138	0.779	0.083
2016-08-16	507.338092	513.259827	517.494690	502.982239	61691340	Gnocchi: The delightful dumplings,5 delicious ...	-0.9511	0.117	0.764	0.119
2016-08-17	501.8925									



```
[46]: X_train.shape, y_train.shape, X_test.shape, y_test.shape

Out[46]: ((756, 8), (756, 1), (325, 8), (325, 1))

In [47]: X_train

Out[47]: array([[ -0.39898986,  0.37007874, -0.68345324, ..., -0.88409357,
          -0.96272598,  0.83755675],
        [-0.39989898,  0.03937008,  0.26618705, ..., -0.97351564,
          -0.35124247, -0.80615766],
        [-0.95109022,  0.28133858,  0.48201433, ..., -0.97251323,
          -0.95421569,  0.84902242],
        ...,
        [-0.39979896, -0.00787402, -0.3381295 , ..., -0.25200179,
          -0.22777126,  0.5690317 ],
        [-0.39969994, -0.00787402, -0.38129496, ..., -0.2436133 ,
          -0.22006586,  0.71133577 ],
        [-0.39970994,  0.52755906,  0.15107914, ..., -0.22694191,
          -0.21791822, -0.70862193]])

In [48]: y_train

Out[48]: array([[ -0.98043286,
          -0.98781823,
          -0.97461927,
          -0.98063533,
          -0.96261812,
          -0.98000223,
          -0.98164043,
          -0.97698776,
          -0.98186513,
          -0.95205482,
          -0.95709771,
          -0.95227995,
          -0.97230458,
          -0.9803666 ,
          -0.95785219,
          -0.97004376,
          -0.94366711,
          -0.96299206,
          -0.94735358,
          -0.94366714,
          -0.94813086,
          -0.94014334,
          -0.93931743,
          -0.92854103,
          -0.94902332,
          -0.94329674,
          -0.95033562,
          -0.98740383,
          -0.98424585,
          -0.98708086,
          -0.95952966,
          -0.9925984 ,
          -0.98742343,
          -0.99483233,
          -0.99141416,
          -0.99020381,
          -0.98926095,
          -0.99337894,
          -0.99243461,
          -0.99084893,
          -0.9913334 ,
          -0.98848041,
          -0.97732001,
          -0.96243972,
          -0.97338117,
          -0.96659866,
          -0.9593942 ,
          -0.95952 ,
          -0.95729917,
          -0.95435233,
          -0.95397555,
          -0.95717844,
          -0.96248064,
          -0.95313908,
          -0.96126946,
          -0.95279131,
          -0.94366711,
          -0.94221379,
          -0.9398991 ,
          -0.94635867,
          -0.9476775 ,
          -0.93865685,
          -0.94170236,
          -0.98730771,
          -0.93930811,
          -0.94697769,
          -0.95851614,
          -0.97050129,
          -0.96988224,
          -0.97946394,
          -0.97332734,
          -0.97451162,
          -0.96309713,
          -0.96126939,
          -0.96460694,
          -0.9629628 ,
          -0.9656028 ,
          -0.97138949,
          -0.97448465,
          -0.97039363,
          -0.97179323,
          -0.96321567,
          -0.9604082 ,
          -0.95453972,
          -0.94738146,
          -0.94743525,
          -0.94503562,
          -0.87632616,
          -0.88964901,
          -0.94236461,
          -0.85988122,
          -0.86192144,
          -0.86884613,
          -0.82365379,
          -0.83127067,
          -0.83366609,
          -0.84641411,
          -0.8321858 ,
          -0.82615686,
          -0.84822704,
          -0.8409062 ,
          -0.85285642,
          -0.84232269,
          -0.8152833 ,
          -0.7646295 ,
          -0.75297947,
          -0.78274318,
          -0.78759788,
          -0.79165204,
          -0.77709108,
          -0.7894988 ,
          -0.7890951 ,
          -0.7633376 ,
          -0.75504777,
          -0.76759014,
          -0.77528775,
          -0.78879905,
          -0.79533935,
          -0.81501412,
          -0.81019635,
          -0.79447809,
          -0.79937658,
          -0.80684781,
          -0.79622755,
          -0.79759009,
          -0.81363674,
          -0.81353383,
          -0.82777174,
          -0.82521487,
          -0.79590458,
          -0.79485975,
          -0.813268 ,
          -0.81396435 ,
          -0.80554011,
          -0.80731644,
          -0.7955816 ,
          -0.76772467,
          -0.76605599,
          -0.75512856,
          -0.75340566,
          -0.77351142,
          -0.77663352,
          -0.78436461,
          -0.78280471,
          -0.76088832,
          -0.79799937,
          -0.72363817,
          -0.72102041,
          -0.72191557,
          -0.70070666,
          -0.69101733,
          -0.70113729,
          -0.70331746,
          -0.65683548,
          -0.66784364,
          -0.66832023,
          -0.6631066 ,
          -0.64932619,
          -0.65321233,
          -0.65624333,
          -0.66593047,
          -0.67951516,
          -0.67892799,
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        -1.09360160e+00,
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        5.78484650e+00,
        5.86255295e+00,
        6.40921369e+00,
        6.50865613e+00,
        6.36465318e+00,
        6.42388523e+00,
        6.31303220e+01]])
```

In [51]:

```
# printing the shape of the training and the test datasets
print('Number of rows and columns in the Training set X:', X_train.shape, 'and y:', y_train.shape)
print('Number of rows and columns in the Test set X:', X_test.shape, 'and y:', y_test.shape)
```

Number of rows and columns in the Training set X: (756, 8) and y: (756, 1)  
Number of rows and columns in the Test set X: (325, 8) and y: (325, 1)

## Reshape input to be [samples, time steps, features] which is required for LSTM

In [52]:

```
X_train = X_train.reshape(X_train.shape[0],1,)
X_test = X_test.reshape(X_test.shape[0],1,)

# printing the re-shaped feature dataset
print('Shape of Training set X:', X_train.shape)
print('Shape of Training set y:', y_train.shape)
print('Shape of Test set y:', y_test.shape)
```

Shape of Training set X: (756, 1)  
Shape of Test set X: (325, 8, 1)  
Shape of Training set y: (756, 1)  
Shape of Test set y: (325, 1)

In [53]:

```
# Importing Libraries for Model Building
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Dense, LSTM, Dropout, Activation
```

In [54]:

```
# setting the seed to achieve consistent and less random predictions at each execution
np.random.seed(2000)
```

In [55]:

```
# Setting model architecture and compiling it
model=Sequential()
model.add(LSTM(150,return_sequences=True,input_shape=(len(cols),1)))
model.add(Dropout(0.2))
model.add(LSTM(150,return_sequences=True))
model.add(Dropout(0.2))
model.add(LSTM(150))
model.add(Dropout(0.2))
model.add(Dense(1))
model.compile(loss='mean_squared_error',optimizer='adam')
model.summary()
```

Model: "sequential"		
Layer (type)	Output Shape	Param #
-----		
lstm_1 (LSTM)	(None, 8, 150)	91200
-----		
dropout_1 (Dropout)	(None, 8, 150)	0
-----		
lstm_2 (LSTM)	(None, 150)	180600
-----		
dropout_2 (Dropout)	(None, 150)	0
-----		
dense_1 (Dense)	(None, 1)	151
-----		
Total params: 452,551		
Trainable params: 452,551		
Non-trainable params: 0		
-----		

In [56]:

```
# fitting the model using the training dataset
model.fit(X_train, y_train, validation_data=(X_test,y_test), epochs=100, batch_size=64, verbose=1)

Epoch 1/100
12/12 =====> 2s 201ms/step - loss: 0.1408 - val_loss: 0.3922
Epoch 2/100
12/12 =====> 1s 63ms/step - loss: 0.0644 - val_loss: 0.4223
Epoch 3/100
12/12 =====> 1s 65ms/step - loss: 0.0456 - val_loss: 0.3638
Epoch 4/100
12/12 =====> 1s 60ms/step - loss: 0.0280 - val_loss: 0.1994
Epoch 5/100
12/12 =====> 1s 65ms/step - loss: 0.0124 - val_loss: 0.0833
Epoch 6/100
12/12 =====> 1s 66ms/step - loss: 0.0094 - val_loss: 0.0738
Epoch 7/100
12/12 =====> 1s 62ms/step - loss: 0.0079 - val_loss: 0.0941
Epoch 8/100
12/12 =====> 1s 63ms/step - loss: 0.0070 - val_loss: 0.0831
Epoch 9/100
12/12 =====> 1s 64ms/step - loss: 0.0069 - val_loss: 0.0732
Epoch 10/100
12/12 =====> 1s 61ms/step - loss: 0.0062 - val_loss: 0.0614
Epoch 11/100
12/12 =====> 1s 61ms/step - loss: 0.0063 - val_loss: 0.0663
Epoch 12/100
12/12 =====> 1s 60ms/step - loss: 0.0056 - val_loss: 0.0614
Epoch 13/100
12/12 =====> 1s 60ms/step - loss: 0.0055 - val_loss: 0.0496
Epoch 14/100
12/12 =====> 1s 60ms/step - loss: 0.0050 - val_loss: 0.0360
Epoch 15/100
12/12 =====> 1s 61ms/step - loss: 0.0045 - val_loss: 0.0318
Epoch 16/100
12/12 =====> 1s 61ms/step - loss: 0.0044 - val_loss: 0.0289
Epoch 17/100
12/12 =====> 1s 63ms/step - loss: 0.0046 - val_loss: 0.0264
Epoch 18/100
12/12 =====> 1s 61ms/step - loss: 0.0039 - val_loss: 0.0202
Epoch 19/100
12/12 =====> 1s 62ms/step - loss: 0.0038 - val_loss: 0.0219
Epoch 20/100
12/12 =====> 1s 64ms/step - loss: 0.0036 - val_loss: 0.0163
Epoch 21/100
12/12 =====> 1s 66ms/step - loss: 0.0035 - val_loss: 0.0145
Epoch 22/100
12/12 =====> 1s 62ms/step - loss: 0.0037 - val_loss: 0.0149
Epoch 23/100
12/12 =====> 1s 64ms/step - loss: 0.0033 - val_loss: 0.0132
Epoch 24/100
12/12 =====> 1s 64ms/step - loss: 0.0030 - val_loss: 0.0112
Epoch 25/100
12/12 =====> 1s 62ms/step - loss: 0.0030 - val_loss: 0.0088
Epoch 26/100
12/12 =====> 1s 64ms/step - loss: 0.0025 - val_loss: 0.0087
Epoch 27/100
12/12 =====> 1s 62ms/step - loss: 0.0026 - val_loss: 0.0066
Epoch 28/100
12/12 =====> 1s 62ms/step - loss: 0.0022 - val_loss: 0.0076
Epoch 29/100
12/12 =====> 1s 62ms/step - loss: 0.0024 - val_loss: 0.0067
Epoch 30/100
12/12 =====> 1s 61ms/step - loss: 0.0026 - val_loss: 0.0061
Epoch 31/100
12/12 =====> 1s 62ms/step - loss: 0.0022 - val_loss: 0.0060
Epoch 32/100
12/12 =====> 1s 62ms/step - loss: 0.0024 - val_loss: 0.0060
Epoch 33/100
12/12 =====> 1s 61ms/step - loss: 0.0022 - val_loss: 0.0061
Epoch 34/100
12/12 =====> 1s 62ms/step - loss: 0.0022 - val_loss: 0.0060
Epoch 35/100
12/12 =====> 1s 63ms/step - loss: 0.0022 - val_loss: 0.0055
Epoch 36/100
12/12 =====> 1s 62ms/step - loss: 0.0024 - val_loss: 0.0060
Epoch 37/100
12/12 =====> 1s 62ms/step - loss: 0.0021 - val_loss: 0.0053
Epoch 38/100
12/12 =====> 1s 62ms/step - loss: 0.0022 - val_loss: 0.0054
Epoch 39/100
12/12 =====> 1s 61ms/step - loss: 0.0020 - val_loss: 0.0054
Epoch 40/100
12/12 =====> 1s 62ms/step - loss: 0.0020 - val_loss: 0.0053
Epoch 41/100
12/12 =====> 1s 63ms/step - loss: 0.0020 - val_loss: 0.0050
Epoch 42/100
12/12 =====> 1s 62ms/step - loss: 0.0020 - val_loss: 0.0050
Epoch 43/100
12/12 =====> 1s 66ms/step - loss: 0.0018 - val_loss: 0.0051
Epoch 44/100
12/12 =====> 1s 65ms/step - loss: 0.0018 - val_loss: 0.0053
Epoch 45/100
12/12 =====> 1s 62ms/step - loss: 0.0018 - val_loss: 0.0052
Epoch 46/100
12/12 =====> 1s 65ms/step - loss: 0.0020 - val_loss: 0.0055
Epoch 47/100
12/12 =====> 1s 66ms/step - loss: 0.0020 - val_loss: 0.0054
Epoch 48/100
12/12 =====> 1s 62ms/step - loss: 0.0019 - val_loss: 0.0053
Epoch 49/100
12/12 =====> 1s 64ms/step - loss: 0.0018 - val_loss: 0.0055
Epoch 50/100
12/12 =====> 1s 64ms/step - loss: 0.0019 - val_loss: 0.0053
Epoch 51/100
12/12 =====> 1s 63ms/step - loss: 0.0017 - val_loss: 0.0053
Epoch 52/100
12/12 =====> 1s 62ms/step - loss: 0.0017 - val_loss: 0.0051
Epoch 53/100
12/12 =====> 1s 63ms/step - loss: 0.0020 - val_loss: 0.0060
Epoch 54/100
12/12 =====> 1s 63ms/step - loss: 0.0019 - val_loss: 0.0051
Epoch 55/100
12/12 =====> 1s 63ms/step - loss: 0.0017 - val_loss: 0.0053
Epoch 56/100
12/12 =====> 1s 62ms/step - loss: 0.0017 - val_loss: 0.0053
Epoch 57/100
12/12 =====> 1s 64ms/step - loss: 0.0017 - val_loss: 0.0055
Epoch 58/100
12/12 =====> 1s 62ms/step - loss: 0.0018 - val_loss: 0.0058
Epoch 59/100
12/12 =====> 1s 63ms/step - loss: 0.0014 - val_loss: 0.0056
Epoch 60/100
12/12 =====> 1s 62ms/step - loss: 0.0016 - val_loss: 0.0058
Epoch 61/100
12/12 =====> 1s 62ms/step - loss: 0.0016 - val_loss: 0.0063
Epoch 62/100
12/12 =====> 1s 66ms/step - loss: 0.0016 - val_loss: 0.0054
Epoch 63/100
12/12 =====> 1s 65ms/step - loss: 0.0017 - val_loss: 0.0061
Epoch 64/100
12/12 =====> 1s 62ms/step - loss: 0.0017 - val_loss: 0.0067
Epoch 65/100
12/12 =====> 1s 66ms/step - loss: 0.0018 - val_loss: 0.0060
Epoch 66/100
12/12 =====> 1s 65ms/step - loss: 0.0016 - val_loss: 0.0055
Epoch 67/100
12/12 =====> 1s 62ms/step - loss: 0.0015 - val_loss: 0.0112
Epoch 68/100
12/12 =====> 1s 63ms/step - loss: 0.0017 - val_loss: 0.0062
Epoch 69/100
12/12 =====> 1s 63ms/step - loss: 0.0015 - val_loss: 0.0061
Epoch 70/100
12/12 =====> 1s 63ms/step - loss: 0.0015 - val_loss: 0.0068
Epoch 71/100
12/12 =====> 1s 62ms/step - loss: 0.0014 - val_loss: 0.0061
Epoch 72/100
12/12 =====> 1s 63ms/step - loss: 0.0015 - val_loss: 0.0070
Epoch 73/100
12/12 =====> 1s 62ms/step - loss: 0.0015 - val_loss: 0.0090
Epoch 74/100
12/12 =====> 1s 63ms/step - loss: 0.0014 - val_loss: 0.0077
Epoch 75/100
12/12 =====> 1s 62ms/step - loss: 0.0014 - val_loss: 0.0082
Epoch 76/100
12/12 =====> 1s 62ms/step - loss: 0.0014 - val_loss: 0.0135
Epoch 77/100
12/12 =====> 1s 64ms/step - loss: 0.0013 - val_loss: 0.0087
Epoch 78/100
12/12 =====> 1s 64ms/step - loss: 0.0013 - val_loss: 0.0078
Epoch 79/100
12/12 =====> 1s 62ms/step - loss: 0.0014 - val_loss: 0.0114
Epoch 80/100
12/12 =====> 1s 68ms/step - loss: 0.0015 - val_loss: 0.0079
Epoch 81/100
12/12 =====> 1s 66ms/step - loss: 0.0013 - val_loss: 0.0076
Epoch 82/100
12/12 =====> 1s 62ms/step - loss: 0.0013 - val_loss: 0.0082
Epoch 83/100
12/12 =====> 1s 66ms/step - loss: 0.0015 - val_loss: 0.0110
Epoch 84/100
12/12 =====> 1s 65ms/step - loss: 0.0016 - val_loss: 0.0091
Epoch 85/100
12/12 =====> 1s 62ms/step - loss: 0.0014 - val_loss: 0.0077
Epoch 86/100
12/12 =====> 1s 64ms/step - loss: 0.0012 - val_loss: 0.0080
Epoch 87/100
12/12 =====> 1s 61ms/step - loss: 0.0012 - val_loss: 0.0121
Epoch 88/100
12/12 =====> 1s 62ms/step - loss: 0.0012 - val_loss: 0.0106
Epoch 89/100
12/12 =====> 1s 62ms/step - loss: 0.0012 - val_loss: 0.0102
Epoch 90/100
12/12 =====> 1s 63ms/step - loss: 0.0013 - val_loss: 0.0131
Epoch 91/100
12/12 =====> 1s 73ms/step - loss: 0.0013 - val_loss: 0.0110
Epoch 92/100
12/12 =====> 1s 68ms/step - loss: 0.0013 - val_loss: 0.0087
Epoch 93/100
12/12 =====> 1s 62ms/step - loss: 0.0013 - val_loss: 0.0135
Epoch 94/100
12/12 =====> 1s 69ms/step - loss: 0.0012 - val_loss: 0.0103
Epoch 95/100
12/12 =====> 1s 68ms/step - loss: 0.0012 - val_loss: 0.0131
Epoch 96/100
12/12 =====> 1s 62ms/step - loss: 0.0014 - val_loss: 0.0145
Epoch 97/100
12/12 =====> 1s 71ms/step - loss: 0.0012 - val_loss: 0.0137
Epoch 98/100
12/12 =====> 1s 70ms/step - loss: 0.0013 - val_loss: 0.0128
Epoch 99/100
12/12 =====> 1s 70ms/step - loss: 0.0011 - val_loss: 0.0096
```

Out[56]:



```
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In [68]: test_predict
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