Using sentiment analysis to study relationship between Tweets and Stock Price Movement

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Proposed Business Problem

- This project presents the analysis of stock price movements and sentiment analysis of tweets for a selected group of companies. The aim is to explore the relationship between sentiment in tweets and stock price movements for the companies in the dataset.

Data Exporation and Data Preprocessing

Import necessary libraries

In [2]:
```
import yfinance as yf
from datetime import datetime, timedelta
import pandas as pd
import nltk
from nltk.corpus import stopwords
from nltk.tokenize import word_tokenize
from nltk.probability import FreqDist
from nltk.sentiment.vader import SentimentIntensityAnalyzer
import matplotlib.pyplot as plt
from wordcloud import WordCloud
#nltk.download('punkt')
from sklearn.model_selection import train_test_split
from sklearn import preprocessing
from sklearn.linear_model import LogisticRegression
from sklearn.naive_bayes import GaussianNB
from sklearn.preprocessing import OneHotEncoder
from sklearn.feature_extraction.text import CountVectorizer
import seaborn as sns
from sklearn.metrics import (
    accuracy_score,
    confusion_matrix,
    ConfusionMatrixDisplay,
    f1_score,
    classification_report,
)
```

Importing Tweet Dataset

The Tweet dataset consists of following columns:

- Timestamp : Conatining date, time of tweet and timezone
- Tweet : Contains tweet
- Stock Name : Ticker symbol ofthe stock
- Company Name : Name of the company to which the tweet is related
- Date_Format : Contains date and time without time zone (Performed in excel)
- Actual Date : Contains date and time but the time decreased by 4 hrs as the time zone of the stock price dataset (loaded subsquently) has time zone of (-04:00)

In [66]:
```
path = r"C:\Users\DELL1\Desktop\MMSc\MSCI 623\Project\stock_tweets.csv"#[1]
data  = pd.read_csv(path, encoding='latin-1')
df = pd.DataFrame(data)
df
```

Out[66]:

	Timestamp	Tweet	Stock Name	Company Name	Date_Format	Actual Date
0	2022-09-29 23:41:16+00:00	Mainstream media has done an amazing job at br...	TSLA	Tesla, Inc.	2022/09/29 23:41:16	2022/09/29 19:41:16
1	2022-09-29 23:24:43+00:00	Tesla delivery estimates are at around 364k fr...	TSLA	Tesla, Inc.	2022/09/29 23:24:43	2022/09/29 19:24:43
2	2022-09-29 23:18:08+00:00	3/ Even if I include 63.0M unvested RSUs as of...	TSLA	Tesla, Inc.	2022/09/29 23:18:08	2022/09/29 19:18:08
3	2022-09-29 22:40:07+00:00	@RealDanODowd @WholeMarsBlog @Tesla Hahaha why...	TSLA	Tesla, Inc.	2022/09/29 22:40:07	2022/09/29 18:40:07
4	2022-09-29 22:27:05+00:00	@RealDanODowd @Tesla Stop trying to kill kids,...	TSLA	Tesla, Inc.	2022/09/29 22:27:05	2022/09/29 18:27:05
...	...	...	...	...	...	...
80788	2021-10-07 17:11:57+00:00	Some of the fastest growing tech stocks on the...	XPEV	XPeng Inc.	2021/10/07 17:11:57	2021/10/07 13:11:57
80789	2021-10-04 17:05:59+00:00	With earnings on the horizon, here is a quick ...	XPEV	XPeng Inc.	2021/10/04 17:05:59	2021/10/04 13:05:59
80790	2021-10-01 04:43:41+00:00	Our record delivery results are a testimony of...	XPEV	XPeng Inc.	2021/10/01 04:43:41	2021/10/01 00:43:41
80791	2021-10-01 00:03:32+00:00	We delivered 10,412 Smart EVs in Sep 2021, rea...	XPEV	XPeng Inc.	2021/10/01 00:03:32	2021/09/30 20:03:32
80792	2021-09-30 10:22:52+00:00	Why can XPeng P5 deliver outstanding performan...	XPEV	XPeng Inc.	2021/09/30 10:22:52	2021/09/30 06:22:52

80793 rows × 6 columns

Converting the datatype of 'Actual Date' column in %Y-%m-%d %H:%M:%S format

In [4]:
```
df['Actual Date'] = pd.to_datetime(df['Actual Date'], format='%Y-%m-%d %H:%M:%S')
```

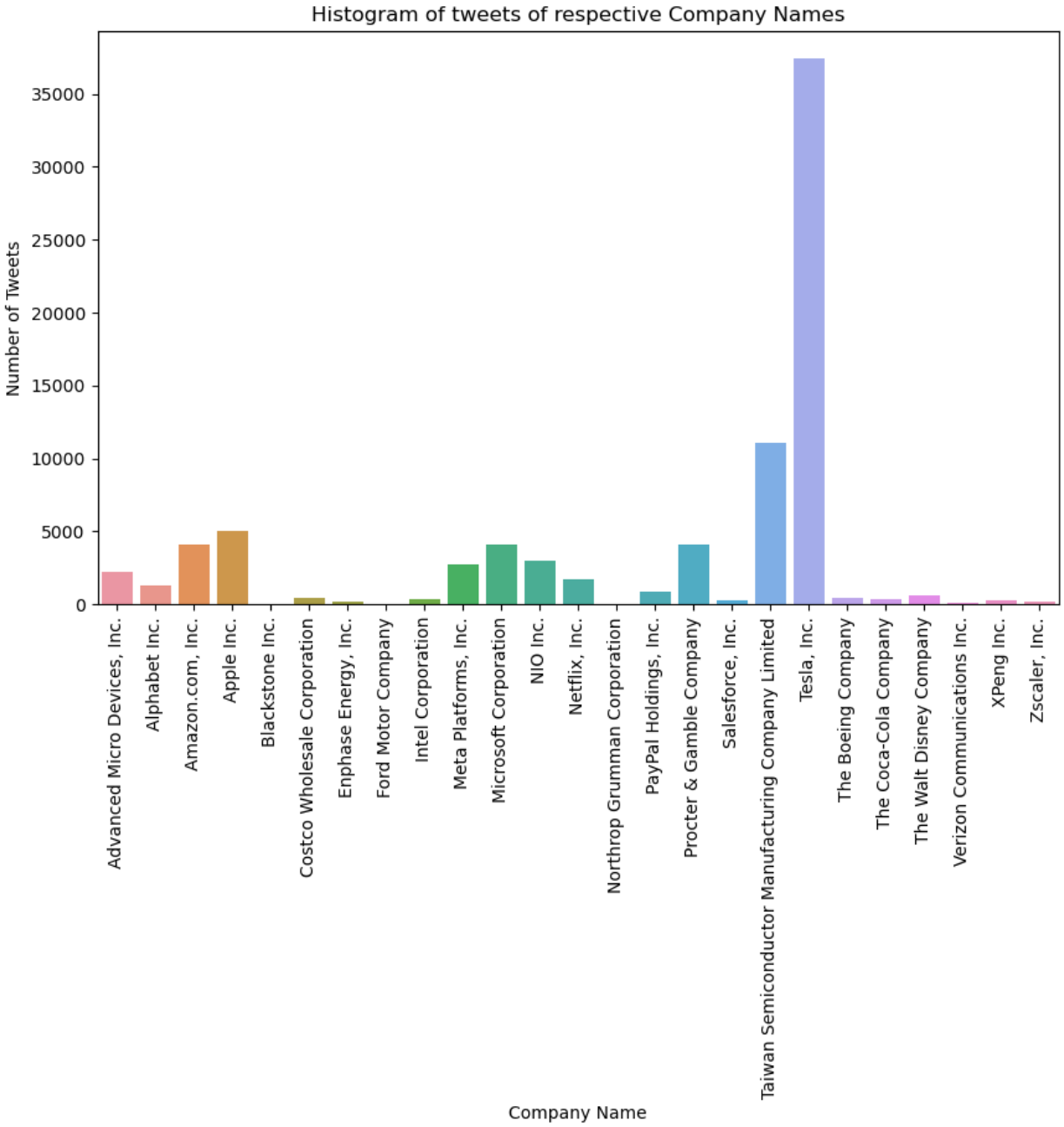
Out[4]:

	Timestamp	Tweet	Stock Name	Company Name	Date_Format	Actual Date
0	2022-09-29 23:41:16+00:00	Mainstream media has done an amazing job at br...	TSLA	Tesla, Inc.	2022/09/29 23:41:16	2022-09-29 19:41:16
1	2022-09-29 23:24:43+00:00	Tesla delivery estimates are at around 364k fr...	TSLA	Tesla, Inc.	2022/09/29 23:24:43	2022-09-29 19:24:43
2	2022-09-29 23:18:08+00:00	3/ Even if I include 63.0M unvested RSUs as of...	TSLA	Tesla, Inc.	2022/09/29 23:18:08	2022-09-29 19:18:08
3	2022-09-29 22:40:07+00:00	@RealDanODowd @WholeMarsBlog @Tesla Hahaha why...	TSLA	Tesla, Inc.	2022/09/29 22:40:07	2022-09-29 18:40:07
4	2022-09-29 22:27:05+00:00	@RealDanODowd @Tesla Stop trying to kill kids,...	TSLA	Tesla, Inc.	2022/09/29 22:27:05	2022-09-29 18:27:05
...	...	...	...	...	...	...
80788	2021-10-07 17:11:57+00:00	Some of the fastest growing tech stocks on the...	XPEV	XPeng Inc.	2021/10/07 17:11:57	2021-10-07 13:11:57
80789	2021-10-04 17:05:59+00:00	With earnings on the horizon, here is a quick ...	XPEV	XPeng Inc.	2021/10/04 17:05:59	2021-10-04 13:05:59
80790	2021-10-01 04:43:41+00:00	Our record delivery results are a testimony of...	XPEV	XPeng Inc.	2021/10/01 04:43:41	2021-10-01 00:43:41
80791	2021-10-01 00:03:32+00:00	We delivered 10,412 Smart EVs in Sep 2021, rea...	XPEV	XPeng Inc.	2021/10/01 00:03:32	2021-09-30 20:03:32
80792	2021-09-30 10:22:52+00:00	Why can XPeng P5 deliver outstanding performan...	XPEV	XPeng Inc.	2021/09/30 10:22:52	2021-09-30 06:22:52

80793 rows × 6 columns

In [5]:

```
temp_df = df.groupby('Company Name').size().reset_index(name='Count')
plt.figure(figsize=(10, 6))  # Set the size of the figure (width, height)
sns.barplot(x='Company Name', y='Count', data=temp_df)
plt.xlabel('Company Name')
plt.ylabel('Number of Tweets')
plt.title('Histogram of tweets of respective Company Names')
plt.xticks(rotation=90)  # Rotate the x-axis labels for better visibility
plt.show()
```



Removing rows having null values

In [6]:
```
df = df.dropna()
```

Out[6]:

	Timestamp	Tweet	Stock Name	Company Name	Date_Format	Actual Date
0	2022-09-29 23:41:16+00:00	Mainstream media has done an amazing job at br...	TSLA	Tesla, Inc.	2022/09/29 23:41:16	2022-09-29 19:41:16
1	2022-09-29 23:24:43+00:00	Tesla delivery estimates are at around 364k fr...	TSLA	Tesla, Inc.	2022/09/29 23:24:43	2022-09-29 19:24:43
2	2022-09-29 23:18:08+00:00	3/ Even if I include 63.0M unvested RSUs as of...	TSLA	Tesla, Inc.	2022/09/29 23:18:08	2022-09-29 19:18:08
3	2022-09-29 22:40:07+00:00	@RealDanODowd @WholeMarsBlog @Tesla Hahaha why...	TSLA	Tesla, Inc.	2022/09/29 22:40:07	2022-09-29 18:40:07
4	2022-09-29 22:27:05+00:00	@RealDanODowd @Tesla Stop trying to kill kids,...	TSLA	Tesla, Inc.	2022/09/29 22:27:05	2022-09-29 18:27:05
...	...	...	...	...	...	...
80788	2021-10-07 17:11:57+00:00	Some of the fastest growing tech stocks on the...	XPEV	XPeng Inc.	2021/10/07 17:11:57	2021-10-07 13:11:57
80789	2021-10-04 17:05:59+00:00	With earnings on the horizon, here is a quick ...	XPEV	XPeng Inc.	2021/10/04 17:05:59	2021-10-04 13:05:59
80790	2021-10-01 04:43:41+00:00	Our record delivery results are a testimony of...	XPEV	XPeng Inc.	2021/10/01 04:43:41	2021-10-01 00:43:41
80791	2021-10-01 00:03:32+00:00	We delivered 10,412 Smart EVs in Sep 2021, rea...	XPEV	XPeng Inc.	2021/10/01 00:03:32	2021-09-30 20:03:32
80792	2021-09-30 10:22:52+00:00	Why can XPeng P5 deliver outstanding performan...	XPEV	XPeng Inc.	2021/09/30 10:22:52	2021-09-30 06:22:52

80793 rows × 6 columns

We don't check for normality distribution (needed for Naïve Bayes) as there are no numeric variables in tweet dataset

Filtering data by stocks which are included for analysis

In [8]:
```
# Defining the stock for which analysis is conducted
stock_considered = ['TSLA','MSFT','GOOG', 'AAPL', 'PG','BA']

# Filter data for selected stock symbols

df = df[(df['Stock Name'].isin(stock_considered))]
```

```
# Get unique stock symbols and sort in reverse order

ticker_symbol = df['Stock Name'].unique().tolist()
ticker_symbol.sort(reverse = True)

# Get unique company names

company_symbol = df['Company Name'].unique().tolist()
company_symbol
```

Out[8]:
```
['Tesla, Inc.',
 'Microsoft Corporation',
 'Procter & Gamble Company',
 'Alphabet Inc.',
 'Apple Inc.',
 'The Boeing Company']
```

Getting hourly stock prices of all the stocks from 1st Oct 2021 to 30th September 2022 using Yahoo Finance Library in 'history

In [9]:
```
# Create an empty list to store data for all stock symbols
data_list = []

# Specify the start and end dates for which the prices are to fetched and convert them

start_date = '2021-10-01 09:30:00'
start_date = datetime.strptime(start_date, '%Y-%m-%d %H:%M:%S')
end_date = '2022-09-30 04:00:00'
end_date = datetime.strptime(end_date, '%Y-%m-%d %H:%M:%S')

# Fetch historical stock price data for each stock symbol

for symbol in ticker_symbol:
    ticker = yf.Ticker(symbol)
    history = ticker.history(start=start_date, end=end_date, interval='1h')
    closing_history = ticker.history(start=start_date, end=end_date, interval='1d')

    # Add the 'Symbol' column to both DataFrames
    history['Symbol'] = symbol
    closing_history['Symbol'] = symbol
    # Append the DataFrames to the data_list
    data_list.append(history)
    data_list.append(closing_history)

# Concatenate all DataFrames in the data_list into the final DataFrame
history = pd.concat(data_list)
```

Converting history table to dataframe and dropping unnecesary columns

In [10]:
```
history = history.reset_index().rename(columns={'index': 'Datetime'})
history = pd.DataFrame(history)
history['Datetime'] = pd.to_datetime(history['Datetime']).dt.tz_localize(None)

# Drop unnecessary columns from historical stock price data
```

```
history = history.drop(['Volume', 'Dividends', 'Stock Splits', 'High', 'Low'], axis=1)
history
```

Out[10]:

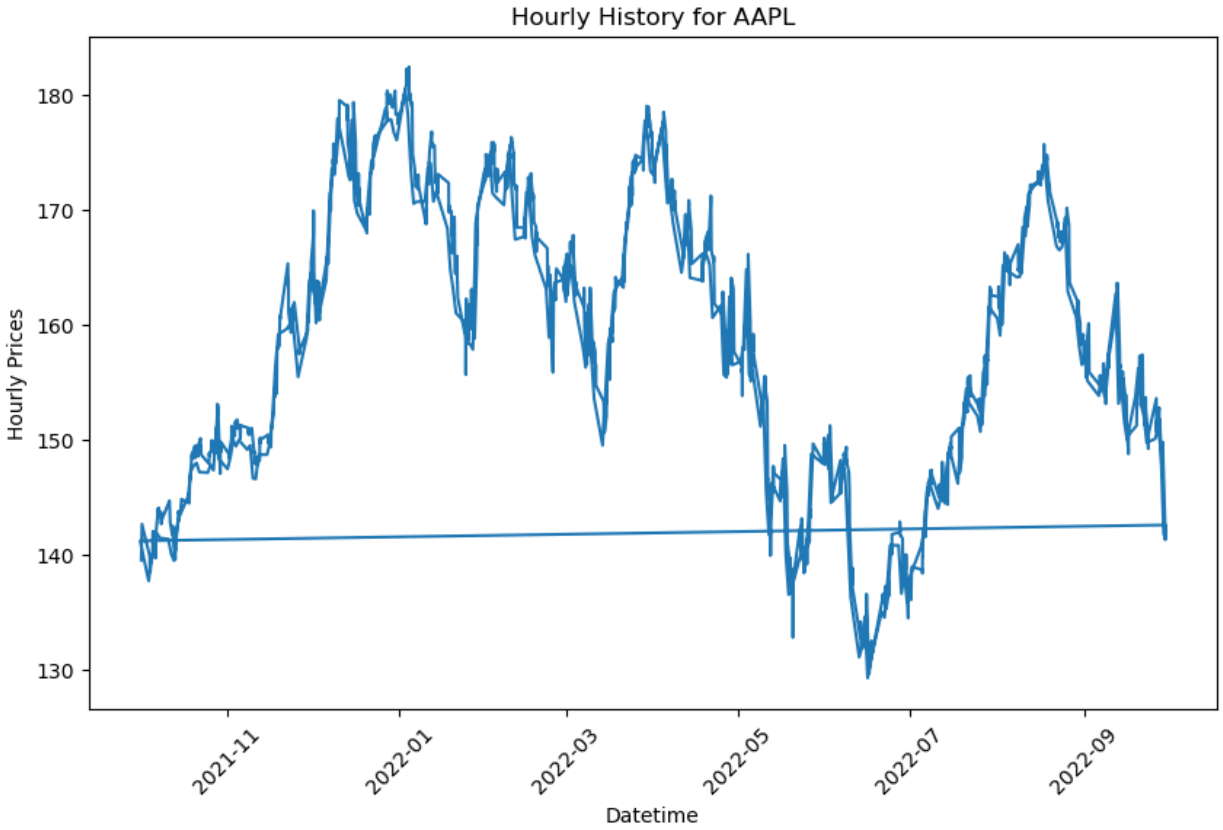
	Datetime	Open	Close	Symbol
0	2021-10-01 09:30:00	259.466675	254.966675	TSLA
1	2021-10-01 10:30:00	255.046677	258.903351	TSLA
2	2021-10-01 11:30:00	259.363342	257.333344	TSLA
3	2021-10-01 12:30:00	257.363342	256.933319	TSLA
4	2021-10-01 13:30:00	256.949982	257.203339	TSLA
...	...	...	...	...
12019	2022-09-23 00:00:00	150.501345	149.744797	AAPL
12020	2022-09-26 00:00:00	148.978307	150.083252	AAPL
12021	2022-09-27 00:00:00	152.044288	151.068741	AAPL
12022	2022-09-28 00:00:00	146.967495	149.157471	AAPL
12023	2022-09-29 00:00:00	145.434515	141.830994	AAPL

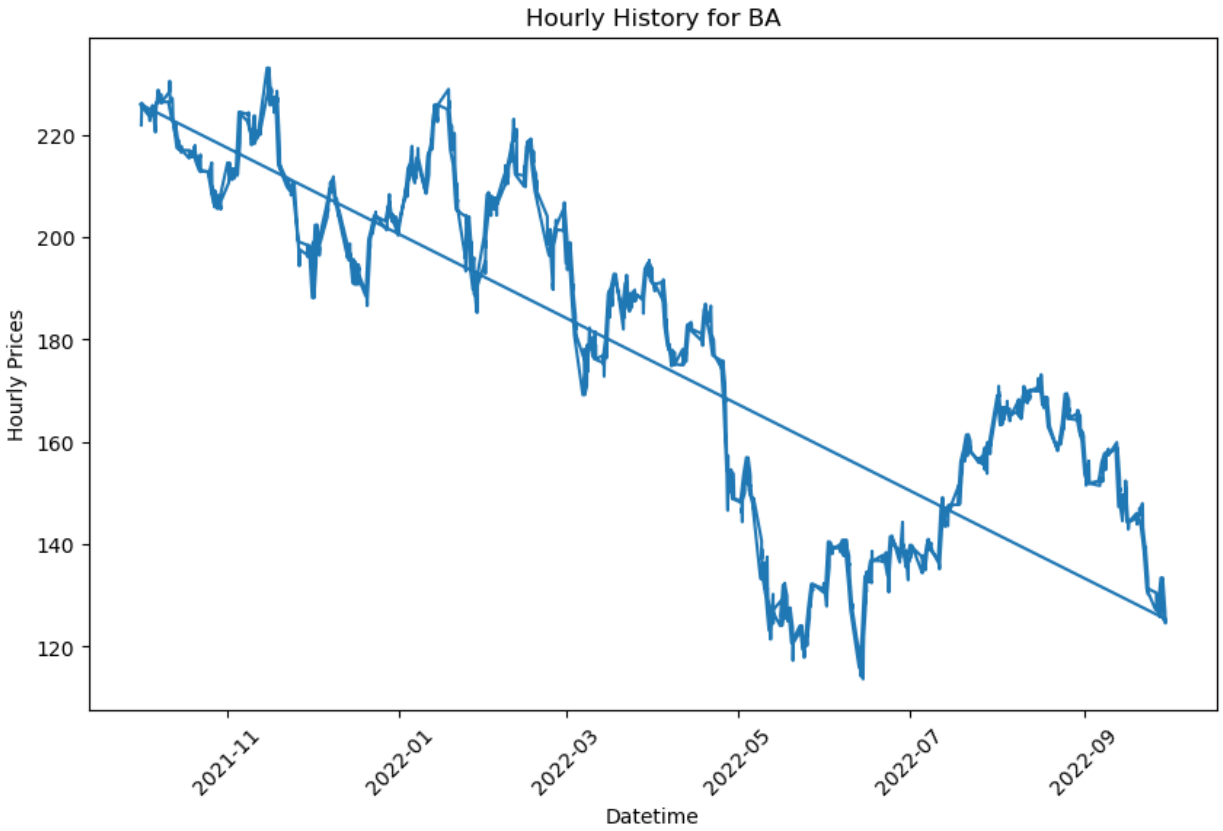
12024 rows × 4 columns

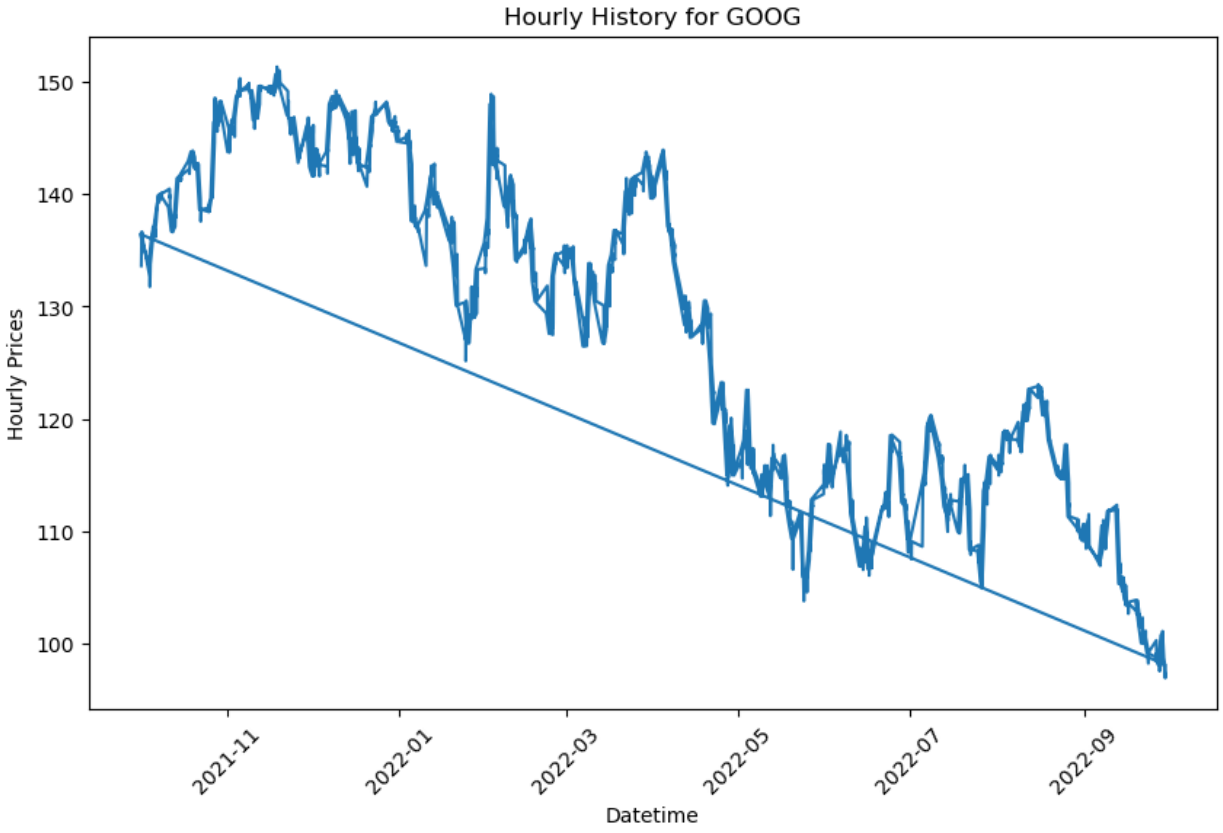
Ploting the hourly price movement for different stocks

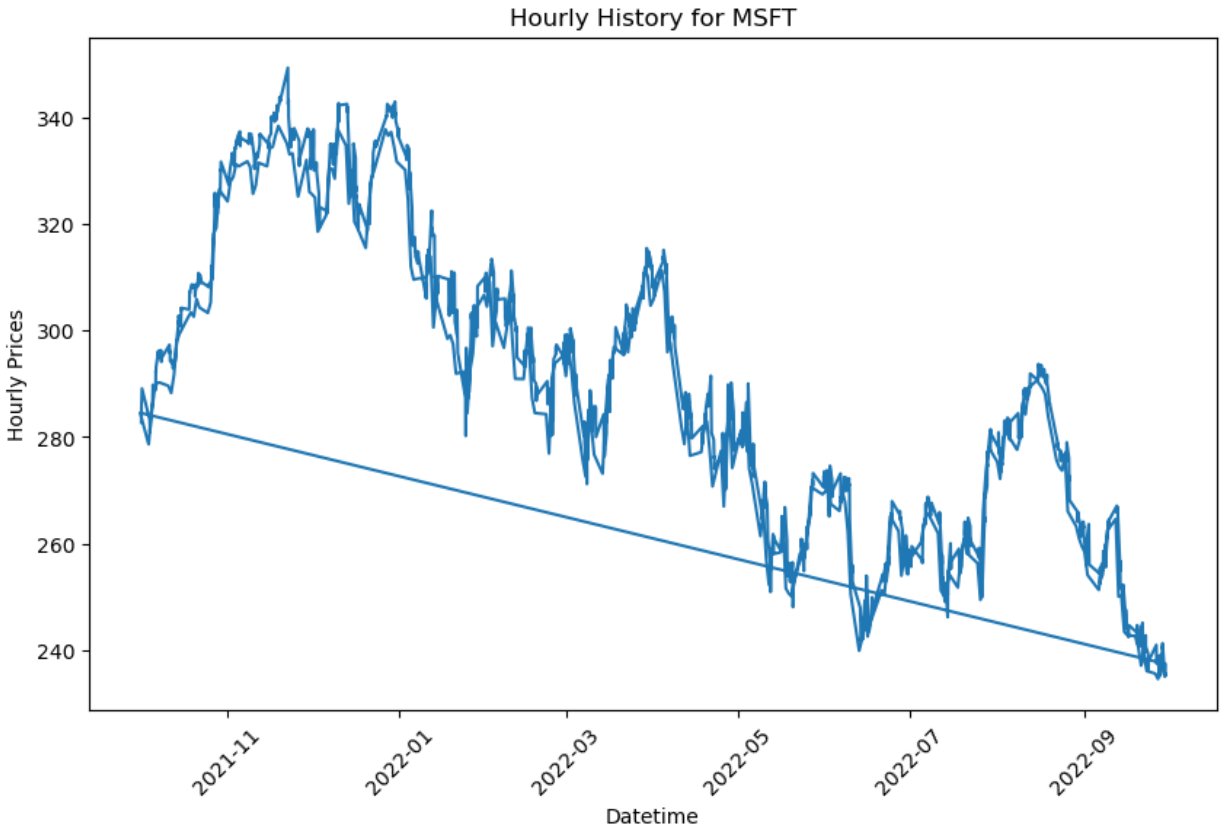
In [11]:

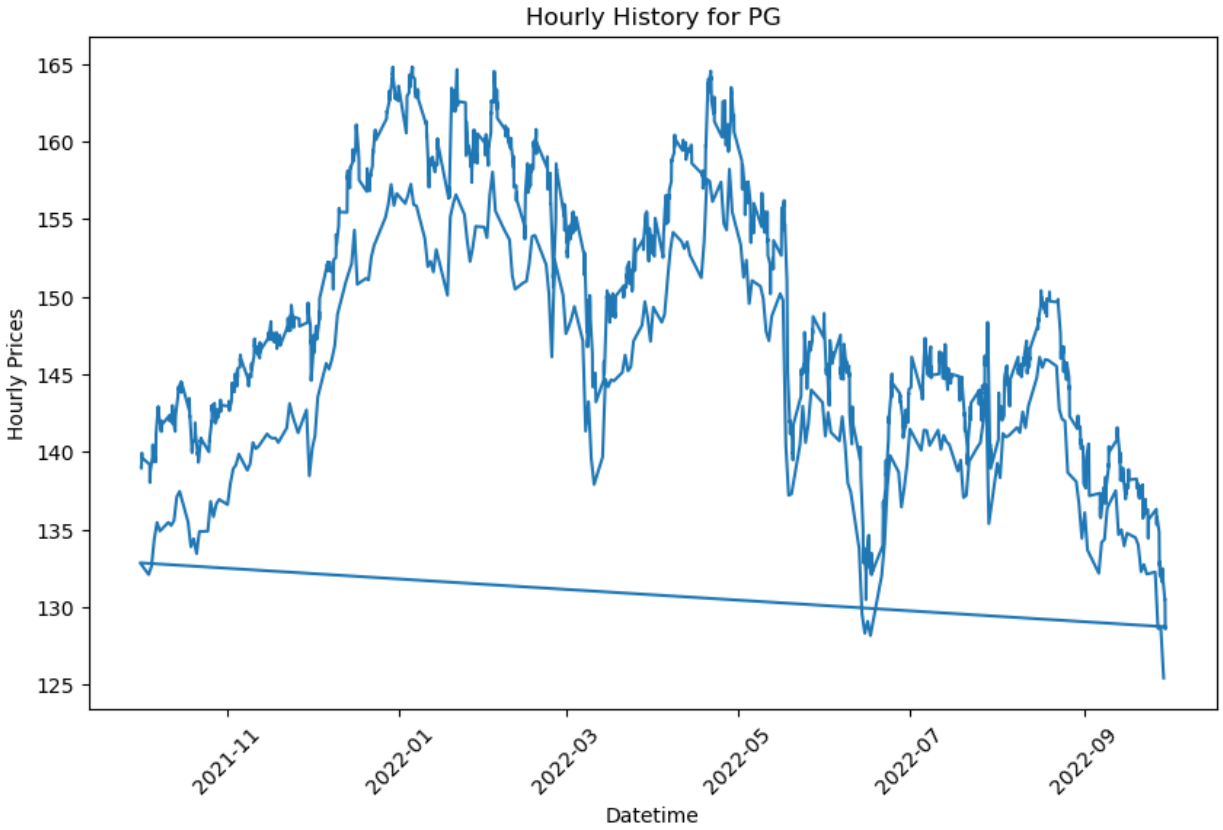
```
# Group the data by 'Symbol'
temp_data = history.groupby('Symbol')

# Create a separate plot for each symbol
for symbol, symbol_data in temp_data:
    plt.figure(figsize=(10, 6))  # Set the size of the figure (width, height)
    plt.plot('Datetime', 'Close', data=symbol_data)
    plt.xlabel('Datetime')
    plt.ylabel('Hourly Prices')
    plt.title(f'Hourly History for {symbol}')
    plt.xticks(rotation=45)  # Rotate the x-axis labels for better visibility
    plt.show()
```

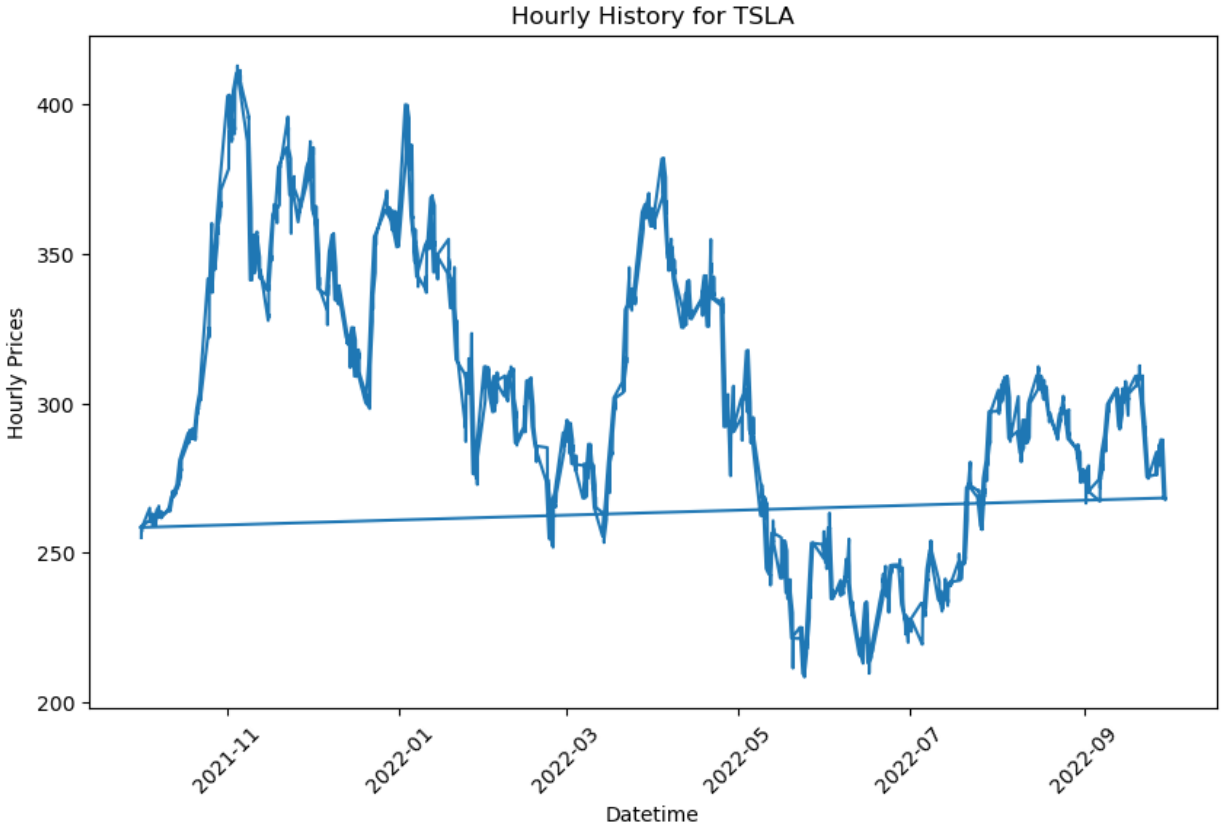

Hourly History for AAPL
Hourly Prices
180
170
160
150
140
130
2021-11
2022-01
2022-03
2022-05
2022-07
2022-09
Datetime


Hourly History for BA
Hourly Prices
220
200
180
160
140
120
2021-11
2022-01
2022-03
2022-05
2022-07
2022-09
Datetime


Hourly History for GOOG
Hourly Prices
150
140
130
120
110
100
2021-11
2022-01
2022-03
2022-05
2022-07
2022-09
Datetime


Hourly History for MSFT
Hourly Prices
340
320
300
280
260
240
2021-11
2022-01
2022-03
2022-05
2022-07
2022-09
Datetime





Retrieving index value of Dow Jones Industrial Average (^DJI) and NASDAQ (NQ=F)

- The Dow Jones IA and the Nasdaq represent a stock market index, or an average of a great many numbers derived from the price movements of certain stocks.

In [12]:
```
datalist = []
index = ['^DJI','NQ=F']
start_date = '2021-10-01'
start_date = datetime.strptime(start_date, '%Y-%m-%d')
end_date = '2022-09-30'
end_date = datetime.strptime(end_date, '%Y-%m-%d')

# Fetch historical stock price data for each stock symbol

for symbol in index:
    ticker = yf.Ticker(symbol)
    index_history = ticker.history(start=start_date, end = end_date)

    # Add the 'Symbol' column to both DataFrames
    index_history['Symbol'] = symbol
    if symbol == 'NQ=F':
        index_history['Index Name'] = 'NASDAQ'
    else:
        index_history['Index Name'] = 'Dow Jones Industrial Average'
    datalist.append(index_history)

index_history = pd.concat(datalist)
index_history
```

Out[12]:

Date	Open	High	Low	Close	Volume	Dividends	Stock Splits	Sym
2021-10-01 00:00:00-04:00	33930.699219	34490.558594	33785.539062	34326.460938	427580000	0.0	0.0	^
2021-10-04 00:00:00-04:00	34312.960938	34410.281250	33821.578125	34002.921875	396860000	0.0	0.0	^
2021-10-05 00:00:00-04:00	34035.250000	34490.949219	34035.250000	34314.671875	311520000	0.0	0.0	^
2021-10-06 00:00:00-04:00	34198.960938	34432.679688	33854.691406	34416.988281	322170000	0.0	0.0	^
2021-10-07 00:00:00-04:00	34509.718750	34975.191406	34509.718750	34754.941406	273290000	0.0	0.0	^
...	...	...	...	...	...	...	...	
2022-09-23 00:00:00-04:00	11583.750000	11600.250000	11229.000000	11376.750000	799378	0.0	0.0	NC
2022-09-26 00:00:00-04:00	11362.500000	11537.750000	11256.500000	11316.250000	809853	0.0	0.0	NC
2022-09-27 00:00:00-04:00	11315.500000	11568.250000	11233.500000	11333.750000	841073	0.0	0.0	NC
2022-09-28 00:00:00-04:00	11361.000000	11613.500000	11141.500000	11555.750000	897742	0.0	0.0	NC
2022-09-29 00:00:00-04:00	11544.000000	11567.250000	11091.500000	11228.250000	891823	0.0	0.0	NC

502 rows × 9 columns

Calculating difference between closing index value and opening

index value

- The difference between closing and opening value is calculated and percentage change is calculated, which show positive or negative bias of the market.

In [13]:
```
index_history = index_history.reset_index().rename(columns={'Date': 'Datetime'})
index_history = pd.DataFrame(index_history)
index_history['Datetime'] = pd.to_datetime(index_history['Datetime']).dt.tz_localize(N

# Drop unnecessary columns from historical stock price data

index_history = index_history.drop(['Volume', 'Dividends', 'Stock Splits', 'High', 'Lo
index_history['% change'] = (index_history['Close'] - index_history['Open'])/index_his
index_history.head()
```

Out[13]:

	Datetime	Open	Close	Symbol	Index Name	% change
0	2021-10-01	33930.699219	34326.460938	^DJI	Dow Jones Industrial Average	1.166382
1	2021-10-04	34312.960938	34002.921875	^DJI	Dow Jones Industrial Average	-0.903563
2	2021-10-05	34035.250000	34314.671875	^DJI	Dow Jones Industrial Average	0.820978
3	2021-10-06	34198.960938	34416.988281	^DJI	Dow Jones Industrial Average	0.637526
4	2021-10-07	34509.718750	34754.941406	^DJI	Dow Jones Industrial Average	0.710590

Filter tweets that are lying between trading days and trading hours (9:30 AM to 4:00 PM)

In [14]:
```
# Making list of all the trading days between 1st Oct 2021 and 30th Sept 2022
trading_days = history['Datetime'].dt.date.unique().tolist()

# Filtering tweet data based on trading days
df = df[df['Actual Date'].dt.date.isin(trading_days)]

# Filtering data which lies between the trading hours
df = df[(df['Actual Date'].dt.time >= pd.to_datetime('09:30:00').time()) & (df['Actual
df
```

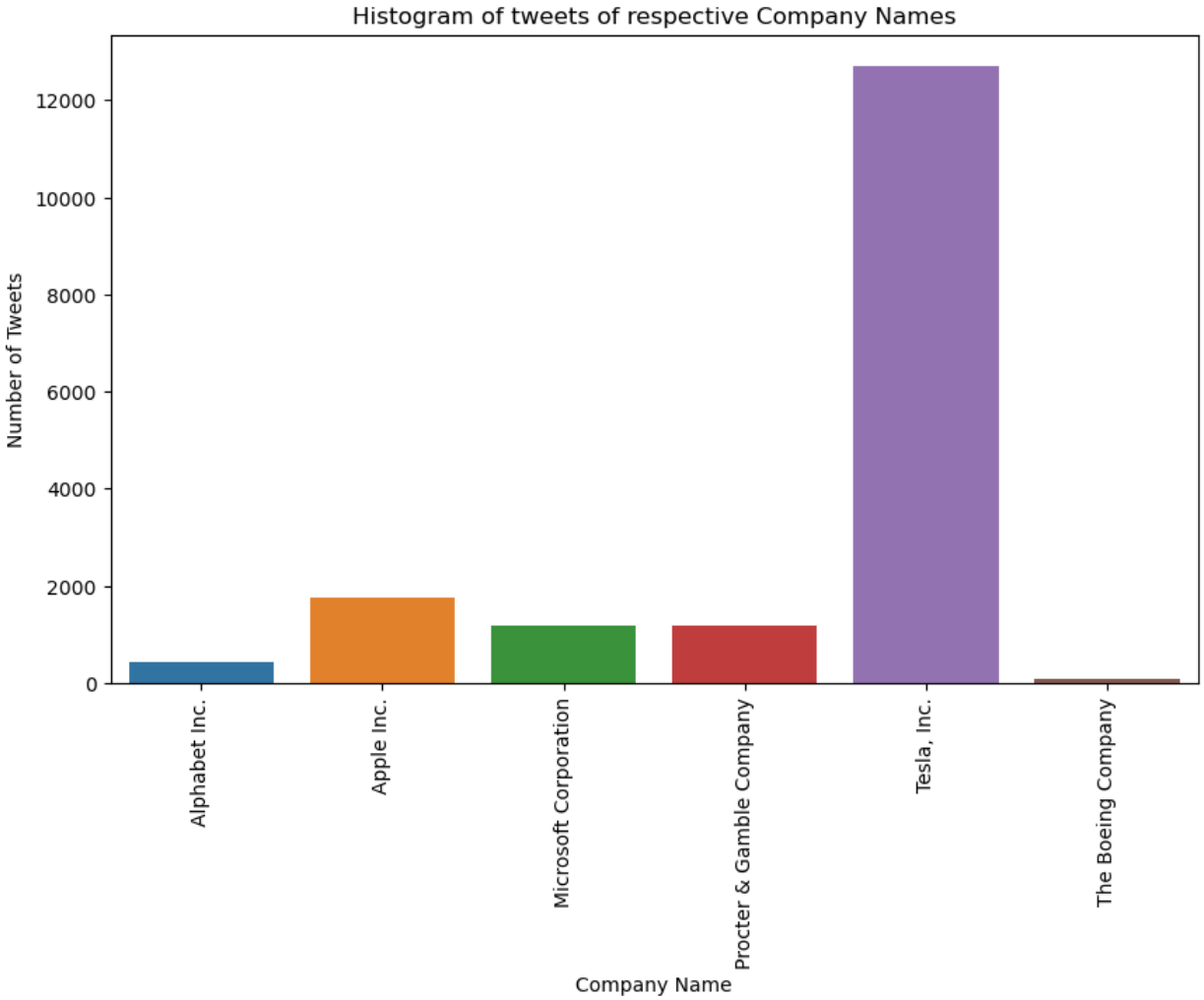
Out[14]:

	Timestamp	Tweet	Stock Name	Company Name	Date_Format	Actual Date
15	2022-09-29 19:38:29+00:00	Picked up some $TSLA shares at 269 https://t....	TSLA	Tesla, Inc.	2022/09/29 19:38:29	2022-09-29 15:38:29
16	2022-09-29 19:36:59+00:00	2/ Even if @elonmusk loses the $TWTR trial (wo...	TSLA	Tesla, Inc.	2022/09/29 19:36:59	2022-09-29 15:36:59
17	2022-09-29 19:27:54+00:00	Everyone should keep a long term perspective. ...	TSLA	Tesla, Inc.	2022/09/29 19:27:54	2022-09-29 15:27:54
18	2022-09-29 19:24:50+00:00	$TSLA Cybertruck can act as a boat according t...	TSLA	Tesla, Inc.	2022/09/29 19:24:50	2022-09-29 15:24:50
19	2022-09-29 19:17:48+00:00	#GigaBerlinBrandenburg\n@tesla destination cha...	TSLA	Tesla, Inc.	2022/09/29 19:17:48	2022-09-29 15:17:48
...	...	...	...	...	...	...
76196	2021-10-13 14:37:50+00:00	ðŸ¦ˆs if you didnâ™t catch $BA itâ™s okay th...	BA	The Boeing Company	2021/10/13 14:37:50	2021-10-13 10:37:50
76203	2021-10-08 17:14:29+00:00	How SpaceX compares to the market value of top...	BA	The Boeing Company	2021/10/08 17:14:29	2021-10-08 13:14:29
76207	2021-10-06 18:08:02+00:00	Blessed with another amazing day. \n\n+$5,125....	BA	The Boeing Company	2021/10/06 18:08:02	2021-10-06 14:08:02
76208	2021-10-06 16:18:10+00:00	Boeing statement to CNBC: "We understand the a...	BA	The Boeing Company	2021/10/06 16:18:10	2021-10-06 12:18:10
76209	2021-10-06 15:20:50+00:00	NASA confirms the reassignment of astronauts N...	BA	The Boeing Company	2021/10/06 15:20:50	2021-10-06 11:20:50

17297 rows × 6 columns

Plotting Histogram for number of tweets for respective stocks after filtering

In [15]:
```
temp_df = df.groupby('Company Name').size().reset_index(name='Count')
plt.figure(figsize=(10, 6))  # Set the size of the figure (width, height)
sns.barplot(x='Company Name', y='Count', data=temp_df)
plt.xlabel('Company Name')
plt.ylabel('Number of Tweets')
plt.title('Histogram of tweets of respective Company Names')
plt.xticks(rotation=90)  # Rotate the x-axis labels for better visibility
plt.show()
```



Converting closing price time to 16:00:00

- Closing price retrieved through yahoo finance library have 00:00:00 as the time of closing price which needs to be changed to 16:00:00

In [16]:
```
condition = history['Datetime'].dt.time.apply(lambda x: x == pd.to_datetime('00:00:00'
history.loc[condition, 'Datetime'] = history.loc[condition, 'Datetime'].dt.strftime('%
history.to_csv('history.csv')
```

Calculating 20 Day Moving average

In [17]:
```
# Define the desired start time
start_time = pd.to_datetime('2021-09-01 09:30:00')

history['Datetime'] = pd.to_datetime(history['Datetime'])

# Filter the DataFrame to keep only rows where the time is 00:00:00
history_filtered = history[history['Datetime'].dt.time == pd.to_datetime('16:00:00').t

# Group the DataFrame by 'Symbol'
grouped_history = history_filtered.groupby('Symbol')

# Calculate the rolling average of the previous 20 close prices for each group
```

```
history_filtered['20_Day_MA'] = grouped_history['Close'].transform(lambda x: x.rolling
history_filtered['20_Day_MA'] = history_filtered['20_Day_MA'].mask(history_filtered['D


# Display the DataFrame with the new '20_Day_MA' column
history_filtered
```

```
C:\Users\DELL1\AppData\Local\Temp\ipykernel_1208\4198518307.py:13: SettingWithCopyWar
ning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/us
er_guide/indexing.html#returning-a-view-versus-a-copy
  history_filtered['20_Day_MA'] = grouped_history['Close'].transform(lambda x: x.roll
ing(window=20, min_periods=1).mean())
C:\Users\DELL1\AppData\Local\Temp\ipykernel_1208\4198518307.py:14: SettingWithCopyWar
ning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/us
er_guide/indexing.html#returning-a-view-versus-a-copy
  history_filtered['20_Day_MA'] = history_filtered['20_Day_MA'].mask(history_filtered
['Datetime'] < start_time, None)
```

Out[17]:

	Datetime	Open	Close	Symbol	20_Day_MA
1753	2021-10-01 16:00:00	259.466675	258.406677	TSLA	258.406677
1754	2021-10-04 16:00:00	265.500000	260.510010	TSLA	259.458344
1755	2021-10-05 16:00:00	261.600006	260.196655	TSLA	259.704447
1756	2021-10-06 16:00:00	258.733337	260.916656	TSLA	260.007500
1757	2021-10-07 16:00:00	261.820007	264.536682	TSLA	260.913336
...	...	...	...	...	...
12019	2022-09-23 16:00:00	150.501345	149.744797	AAPL	155.346163
12020	2022-09-26 16:00:00	148.978307	150.083252	AAPL	154.706590
12021	2022-09-27 16:00:00	152.044288	151.068741	AAPL	154.227781
12022	2022-09-28 16:00:00	146.967495	149.157471	AAPL	153.776346
12023	2022-09-29 16:00:00	145.434515	141.830994	AAPL	153.042702

1506 rows × 5 columns

In [18]:
```
history_filtered.to_csv('history_filtered.csv')
```

Creating 'main_data' dataframe creating hourly interval for grouping of tweets

In [19]:
```
# Create main_data DataFrame with start_interval and end_interval
main_data = pd.DataFrame()
main_data['start_interval'] = history['Datetime'].unique()
main_data['end_interval'] = main_data['start_interval'].shift(-1)
```

```
main_data = main_data.drop(main_data.index[-1])
main_data = main_data[main_data['start_interval'].dt.time != pd.to_datetime('15:30:00'
main_data.head(15)
```

Out[19]:

	start_interval	end_interval
0	2021-10-01 09:30:00	2021-10-01 10:30:00
1	2021-10-01 10:30:00	2021-10-01 11:30:00
2	2021-10-01 11:30:00	2021-10-01 12:30:00
3	2021-10-01 12:30:00	2021-10-01 13:30:00
4	2021-10-01 13:30:00	2021-10-01 14:30:00
5	2021-10-01 14:30:00	2021-10-01 15:30:00
7	2021-10-04 09:30:00	2021-10-04 10:30:00
8	2021-10-04 10:30:00	2021-10-04 11:30:00
9	2021-10-04 11:30:00	2021-10-04 12:30:00
10	2021-10-04 12:30:00	2021-10-04 13:30:00
11	2021-10-04 13:30:00	2021-10-04 14:30:00
12	2021-10-04 14:30:00	2021-10-04 15:30:00
14	2021-10-05 09:30:00	2021-10-05 10:30:00
15	2021-10-05 10:30:00	2021-10-05 11:30:00
16	2021-10-05 11:30:00	2021-10-05 12:30:00

Creating 'main_data2' for merging tweets based on the hourly interval specified in 'main_data'

In [20]:

```
stocks = df['Company Name'].unique().tolist()
main_data2 = pd.DataFrame(columns=['start_interval', 'end_interval', 'merged_tweet', '
```

Grouping the tweets that lies in the specified interval

- Here, the execution took 3 hrs. So, I have attached the main_data2 csv file which was my output.
- Printing after every loop to check the output.

In [21]:

```
# Create a new column to store merged tweets
main_data2['merged_tweet'] = ''
j = 0
# Iterate through each stock symbol
for ticker in stocks:
    # Create a temporary dataframe containing tweets for the current stock symbol
    temp_df = df[df['Company Name'] == ticker].copy()

    # Iterate through each row in main_data and filter tweets based on time intervals
    for i, interval in main_data.iterrows():
```

```
        start_time = pd.to_datetime(interval['start_interval'])
        end_time = pd.to_datetime(interval['end_interval'])

        # Iterate through each tweet row in the temporary dataframe
        for _, tweet_row in temp_df.iterrows():
            tweet_time = tweet_row['Actual Date']

            # Check if the tweet time is within the current time interval
            if start_time <= tweet_time <= end_time:
                # Concatenate tweets for the corresponding time interval and stock sym
                main_data2.loc[len(main_data2)] = [start_time, end_time,tweet_row['Twe
                print(main_data2)
                # Increment j to keep track of the row index in main_data2
                j += 1
main_data2
```

```
       start_interval        end_interval  \
0 2021-10-01 09:30:00 2021-10-01 10:30:00

                                      merged_tweet Company Name
0  Markets are now oversold. NASDAQ is off 6.5% n...  Tesla, Inc.
       start_interval        end_interval  \
0 2021-10-01 09:30:00 2021-10-01 10:30:00
1 2021-10-01 09:30:00 2021-10-01 10:30:00

                                      merged_tweet Company Name
0  Markets are now oversold. NASDAQ is off 6.5% n...  Tesla, Inc.
1  I broke my rule holding $TSLA into a Friday. N...  Tesla, Inc.
       start_interval        end_interval  \
0 2021-10-01 09:30:00 2021-10-01 10:30:00
1 2021-10-01 09:30:00 2021-10-01 10:30:00
2 2021-10-01 09:30:00 2021-10-01 10:30:00

                                      merged_tweet Company Name
0  Markets are now oversold. NASDAQ is off 6.5% n...  Tesla, Inc.
1  I broke my rule holding $TSLA into a Friday. N...  Tesla, Inc.
2  Jesus Christ. My portfolio looks like a murder...  Tesla, Inc.
       start_interval        end_interval  \
0 2021-10-01 09:30:00 2021-10-01 10:30:00
1 2021-10-01 09:30:00 2021-10-01 10:30:00
2 2021-10-01 09:30:00 2021-10-01 10:30:00
3 2021-10-01 09:30:00 2021-10-01 10:30:00

                                      merged_tweet Company Name
0  Markets are now oversold. NASDAQ is off 6.5% n...  Tesla, Inc.
1  I broke my rule holding $TSLA into a Friday. N...  Tesla, Inc.
2  Jesus Christ. My portfolio looks like a murder...  Tesla, Inc.
3              $TSLA was almost at $800 Monday. ðŸ˜¯  Tesla, Inc.
       start_interval        end_interval  \
0 2021-10-01 09:30:00 2021-10-01 10:30:00
1 2021-10-01 09:30:00 2021-10-01 10:30:00
2 2021-10-01 09:30:00 2021-10-01 10:30:00
3 2021-10-01 09:30:00 2021-10-01 10:30:00
4 2021-10-01 09:30:00 2021-10-01 10:30:00

                                      merged_tweet Company Name
0  Markets are now oversold. NASDAQ is off 6.5% n...  Tesla, Inc.
1  I broke my rule holding $TSLA into a Friday. N...  Tesla, Inc.
2  Jesus Christ. My portfolio looks like a murder...  Tesla, Inc.
3              $TSLA was almost at $800 Monday. ðŸ˜¯  Tesla, Inc.
4                                  Q4 started $TSLA  Tesla, Inc.
       start_interval        end_interval  \
0 2021-10-01 09:30:00 2021-10-01 10:30:00
1 2021-10-01 09:30:00 2021-10-01 10:30:00
2 2021-10-01 09:30:00 2021-10-01 10:30:00
3 2021-10-01 09:30:00 2021-10-01 10:30:00
4 2021-10-01 09:30:00 2021-10-01 10:30:00
5 2021-10-01 09:30:00 2021-10-01 10:30:00

                                      merged_tweet Company Name
0  Markets are now oversold. NASDAQ is off 6.5% n...  Tesla, Inc.
1  I broke my rule holding $TSLA into a Friday. N...  Tesla, Inc.
2  Jesus Christ. My portfolio looks like a murder...  Tesla, Inc.
3              $TSLA was almost at $800 Monday. ðŸ˜¯  Tesla, Inc.
4                                  Q4 started $TSLA  Tesla, Inc.
5  Well, look at the positive. We don't have to w...  Tesla, Inc.
```

```
      start_interval        end_interval  \
0 2021-10-01 09:30:00 2021-10-01 10:30:00
1 2021-10-01 09:30:00 2021-10-01 10:30:00
2 2021-10-01 09:30:00 2021-10-01 10:30:00
3 2021-10-01 09:30:00 2021-10-01 10:30:00
4 2021-10-01 09:30:00 2021-10-01 10:30:00
5 2021-10-01 09:30:00 2021-10-01 10:30:00
6 2021-10-01 09:30:00 2021-10-01 10:30:00

                                      merged_tweet Company Name
0  Markets are now oversold. NASDAQ is off 6.5% n...  Tesla, Inc.
1  I broke my rule holding $TSLA into a Friday. N...  Tesla, Inc.
2  Jesus Christ. My portfolio looks like a murder...  Tesla, Inc.
3              $TSLA was almost at $800 Monday. ðŸ˜¨  Tesla, Inc.
4                                  Q4 started $TSLA  Tesla, Inc.
5  Well, look at the positive. We don't have to w...  Tesla, Inc.
6  Bought 1,000 at $768.18. Should see a tiny bou...  Tesla, Inc.
      start_interval        end_interval  \
0 2021-10-01 09:30:00 2021-10-01 10:30:00
1 2021-10-01 09:30:00 2021-10-01 10:30:00
2 2021-10-01 09:30:00 2021-10-01 10:30:00
3 2021-10-01 09:30:00 2021-10-01 10:30:00
4 2021-10-01 09:30:00 2021-10-01 10:30:00
5 2021-10-01 09:30:00 2021-10-01 10:30:00
6 2021-10-01 09:30:00 2021-10-01 10:30:00
7 2021-10-01 09:30:00 2021-10-01 10:30:00

                                      merged_tweet Company Name
0  Markets are now oversold. NASDAQ is off 6.5% n...  Tesla, Inc.
1  I broke my rule holding $TSLA into a Friday. N...  Tesla, Inc.
2  Jesus Christ. My portfolio looks like a murder...  Tesla, Inc.
3              $TSLA was almost at $800 Monday. ðŸ˜¨  Tesla, Inc.
4                                  Q4 started $TSLA  Tesla, Inc.
5  Well, look at the positive. We don't have to w...  Tesla, Inc.
6  Bought 1,000 at $768.18. Should see a tiny bou...  Tesla, Inc.
7  $TSLA selling off in front of production &amp;...  Tesla, Inc.
      start_interval        end_interval  \
0 2021-10-01 09:30:00 2021-10-01 10:30:00
1 2021-10-01 09:30:00 2021-10-01 10:30:00
2 2021-10-01 09:30:00 2021-10-01 10:30:00
3 2021-10-01 09:30:00 2021-10-01 10:30:00
4 2021-10-01 09:30:00 2021-10-01 10:30:00
5 2021-10-01 09:30:00 2021-10-01 10:30:00
6 2021-10-01 09:30:00 2021-10-01 10:30:00
7 2021-10-01 09:30:00 2021-10-01 10:30:00
8 2021-10-01 10:30:00 2021-10-01 11:30:00

                                      merged_tweet Company Name
0  Markets are now oversold. NASDAQ is off 6.5% n...  Tesla, Inc.
1  I broke my rule holding $TSLA into a Friday. N...  Tesla, Inc.
2  Jesus Christ. My portfolio looks like a murder...  Tesla, Inc.
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4                                  Q4 started $TSLA  Tesla, Inc.
5  Well, look at the positive. We don't have to w...  Tesla, Inc.
6  Bought 1,000 at $768.18. Should see a tiny bou...  Tesla, Inc.
7  $TSLA selling off in front of production &amp;...  Tesla, Inc.
8  Youâ™re eyes arenâ™t deceiving you. Thatâ™s...  Tesla, Inc.
      start_interval        end_interval  \
0 2021-10-01 09:30:00 2021-10-01 10:30:00
1 2021-10-01 09:30:00 2021-10-01 10:30:00
```

```
2 2021-10-01 09:30:00 2021-10-01 10:30:00
3 2021-10-01 09:30:00 2021-10-01 10:30:00
4 2021-10-01 09:30:00 2021-10-01 10:30:00
5 2021-10-01 09:30:00 2021-10-01 10:30:00
6 2021-10-01 09:30:00 2021-10-01 10:30:00
7 2021-10-01 09:30:00 2021-10-01 10:30:00
8 2021-10-01 10:30:00 2021-10-01 11:30:00
9 2021-10-01 10:30:00 2021-10-01 11:30:00
```

	merged_tweet	Company Name	start_interval	end_interval
0	Markets are now oversold. NASDAQ is off 6.5% n...	Tesla, Inc.	2021-10-01 09:30:00	2021-10-01 10:30:00
1	I broke my rule holding $TSLA into a Friday. N...	Tesla, Inc.	2021-10-01 09:30:00	2021-10-01 10:30:00
2	Jesus Christ. My portfolio looks like a murder...	Tesla, Inc.	2021-10-01 09:30:00	2021-10-01 10:30:00
3	$TSLA was almost at $800 Monday. ðŸ˜¨	Tesla, Inc.	2021-10-01 09:30:00	2021-10-01 10:30:00
4	Q4 started $TSLA	Tesla, Inc.	2021-10-01 09:30:00	2021-10-01 10:30:00
5	Well, look at the positive. We don't have to w...	Tesla, Inc.	2021-10-01 09:30:00	2021-10-01 10:30:00
6	Bought 1,000 at $768.18. Should see a tiny bou...	Tesla, Inc.	2021-10-01 09:30:00	2021-10-01 10:30:00
7	$TSLA selling off in front of production &...	Tesla, Inc.	2021-10-01 09:30:00	2021-10-01 10:30:00
8	YouâTMre eyes arenâTMt deceiving you. ThatâTMs...	Tesla, Inc.	2021-10-01 10:30:00	2021-10-01 11:30:00
9	IMHO, @Tesla & @elonmusk lead the revoluti...	Tesla, Inc.	2021-10-01 10:30:00	2021-10-01 11:30:00

	merged_tweet	Company Name	start_interval	end_interval
0	Markets are now oversold. NASDAQ is off 6.5% n...	Tesla, Inc.	2021-10-01 09:30:00	2021-10-01 10:30:00
1	I broke my rule holding $TSLA into a Friday. N...	Tesla, Inc.	2021-10-01 09:30:00	2021-10-01 10:30:00
2	Jesus Christ. My portfolio looks like a murder...	Tesla, Inc.	2021-10-01 09:30:00	2021-10-01 10:30:00
3	$TSLA was almost at $800 Monday. ðŸ˜¨	Tesla, Inc.	2021-10-01 09:30:00	2021-10-01 10:30:00
4	Q4 started $TSLA	Tesla, Inc.	2021-10-01 09:30:00	2021-10-01 10:30:00
5	Well, look at the positive. We don't have to w...	Tesla, Inc.	2021-10-01 09:30:00	2021-10-01 10:30:00
6	Bought 1,000 at $768.18. Should see a tiny bou...	Tesla, Inc.	2021-10-01 09:30:00	2021-10-01 10:30:00
7	$TSLA selling off in front of production &...	Tesla, Inc.	2021-10-01 09:30:00	2021-10-01 10:30:00
8	YouâTMre eyes arenâTMt deceiving you. ThatâTMs...	Tesla, Inc.	2021-10-01 10:30:00	2021-10-01 11:30:00
9	IMHO, @Tesla & @elonmusk lead the revoluti...	Tesla, Inc.	2021-10-01 10:30:00	2021-10-01 11:30:00
10	Important read, indeed. In days of yore, stock...	Tesla, Inc.	2021-10-01 10:30:00	2021-10-01 11:30:00

	merged_tweet	Company Name

```
0   Markets are now oversold. NASDAQ is off 6.5% n...  Tesla, Inc.
1   I broke my rule holding $TSLA into a Friday. N...  Tesla, Inc.
2   Jesus Christ. My portfolio looks like a murder...  Tesla, Inc.
3               $TSLA was almost at $800 Monday. ðŸ˜¨  Tesla, Inc.
4                                   Q4 started $TSLA  Tesla, Inc.
5   Well, look at the positive. We don't have to w...  Tesla, Inc.
6   Bought 1,000 at $768.18. Should see a tiny bou...  Tesla, Inc.
7   $TSLA selling off in front of production &amp;...  Tesla, Inc.
8   Youâ™re eyes arenâ™t deceiving you. Thatâ™s...  Tesla, Inc.
9   IMHO, @Tesla &amp; @elonmusk lead the revoluti...  Tesla, Inc.
10  Important read, indeed. In days of yore, stock...  Tesla, Inc.
11  sold my 1000 $768's at $775 for a quick $7K. $...  Tesla, Inc.
        start_interval        end_interval  \
0  2021-10-01 09:30:00 2021-10-01 10:30:00
1  2021-10-01 09:30:00 2021-10-01 10:30:00
2  2021-10-01 09:30:00 2021-10-01 10:30:00
3  2021-10-01 09:30:00 2021-10-01 10:30:00
4  2021-10-01 09:30:00 2021-10-01 10:30:00
5  2021-10-01 09:30:00 2021-10-01 10:30:00
6  2021-10-01 09:30:00 2021-10-01 10:30:00
7  2021-10-01 09:30:00 2021-10-01 10:30:00
8  2021-10-01 10:30:00 2021-10-01 11:30:00
9  2021-10-01 10:30:00 2021-10-01 11:30:00
10 2021-10-01 10:30:00 2021-10-01 11:30:00
11 2021-10-01 10:30:00 2021-10-01 11:30:00
12 2021-10-01 10:30:00 2021-10-01 11:30:00

                                        merged_tweet Company Name
0   Markets are now oversold. NASDAQ is off 6.5% n...  Tesla, Inc.
1   I broke my rule holding $TSLA into a Friday. N...  Tesla, Inc.
2   Jesus Christ. My portfolio looks like a murder...  Tesla, Inc.
3               $TSLA was almost at $800 Monday. ðŸ˜¨  Tesla, Inc.
4                                   Q4 started $TSLA  Tesla, Inc.
5   Well, look at the positive. We don't have to w...  Tesla, Inc.
6   Bought 1,000 at $768.18. Should see a tiny bou...  Tesla, Inc.
7   $TSLA selling off in front of production &amp;...  Tesla, Inc.
8   Youâ™re eyes arenâ™t deceiving you. Thatâ™s...  Tesla, Inc.
9   IMHO, @Tesla &amp; @elonmusk lead the revoluti...  Tesla, Inc.
10  Important read, indeed. In days of yore, stock...  Tesla, Inc.
11  sold my 1000 $768's at $775 for a quick $7K. $...  Tesla, Inc.
12  BREAKING: $TSLA down on the news that record d...  Tesla, Inc.
        start_interval        end_interval  \
0  2021-10-01 09:30:00 2021-10-01 10:30:00
1  2021-10-01 09:30:00 2021-10-01 10:30:00
2  2021-10-01 09:30:00 2021-10-01 10:30:00
3  2021-10-01 09:30:00 2021-10-01 10:30:00
4  2021-10-01 09:30:00 2021-10-01 10:30:00
5  2021-10-01 09:30:00 2021-10-01 10:30:00
6  2021-10-01 09:30:00 2021-10-01 10:30:00
7  2021-10-01 09:30:00 2021-10-01 10:30:00
8  2021-10-01 10:30:00 2021-10-01 11:30:00
9  2021-10-01 10:30:00 2021-10-01 11:30:00
10 2021-10-01 10:30:00 2021-10-01 11:30:00
11 2021-10-01 10:30:00 2021-10-01 11:30:00
12 2021-10-01 10:30:00 2021-10-01 11:30:00
13 2021-10-01 10:30:00 2021-10-01 11:30:00

                                        merged_tweet Company Name
0   Markets are now oversold. NASDAQ is off 6.5% n...  Tesla, Inc.
1   I broke my rule holding $TSLA into a Friday. N...  Tesla, Inc.
```

```
2   Jesus Christ. My portfolio looks like a murder...  Tesla, Inc.
3               $TSLA was almost at $800 Monday. ðŸ˜¨  Tesla, Inc.
4                                    Q4 started $TSLA  Tesla, Inc.
5   Well, look at the positive. We don't have to w...  Tesla, Inc.
6   Bought 1,000 at $768.18. Should see a tiny bou...  Tesla, Inc.
7   $TSLA selling off in front of production &amp;...  Tesla, Inc.
8   Youâ™re eyes arenâ™t deceiving you. Thatâ™s...  Tesla, Inc.
9   IMHO, @Tesla &amp; @elonmusk lead the revoluti...  Tesla, Inc.
10  Important read, indeed. In days of yore, stock...  Tesla, Inc.
11  sold my 1000 $768's at $775 for a quick $7K. $...  Tesla, Inc.
12  BREAKING: $TSLA down on the news that record d...  Tesla, Inc.
13  $AMC Finds its way back to become the top most...  Tesla, Inc.
        start_interval        end_interval  \
0  2021-10-01 09:30:00 2021-10-01 10:30:00
1  2021-10-01 09:30:00 2021-10-01 10:30:00
2  2021-10-01 09:30:00 2021-10-01 10:30:00
3  2021-10-01 09:30:00 2021-10-01 10:30:00
4  2021-10-01 09:30:00 2021-10-01 10:30:00
5  2021-10-01 09:30:00 2021-10-01 10:30:00
6  2021-10-01 09:30:00 2021-10-01 10:30:00
7  2021-10-01 09:30:00 2021-10-01 10:30:00
8  2021-10-01 10:30:00 2021-10-01 11:30:00
9  2021-10-01 10:30:00 2021-10-01 11:30:00
10 2021-10-01 10:30:00 2021-10-01 11:30:00
11 2021-10-01 10:30:00 2021-10-01 11:30:00
12 2021-10-01 10:30:00 2021-10-01 11:30:00
13 2021-10-01 10:30:00 2021-10-01 11:30:00
14 2021-10-01 10:30:00 2021-10-01 11:30:00

                                        merged_tweet Company Name
0   Markets are now oversold. NASDAQ is off 6.5% n...  Tesla, Inc.
1   I broke my rule holding $TSLA into a Friday. N...  Tesla, Inc.
2   Jesus Christ. My portfolio looks like a murder...  Tesla, Inc.
3               $TSLA was almost at $800 Monday. ðŸ˜¨  Tesla, Inc.
4                                    Q4 started $TSLA  Tesla, Inc.
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19	2021-10-01 11:30:00	2021-10-01 12:30:00	
20	2021-10-01 11:30:00	2021-10-01 12:30:00	
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2  2021-10-01 09:30:00 2021-10-01 10:30:00
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6  2021-10-01 09:30:00 2021-10-01 10:30:00
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9  2021-10-01 10:30:00 2021-10-01 11:30:00
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9	2021-10-01 10:30:00	2021-10-01 11:30:00
10	2021-10-01 10:30:00	2021-10-01 11:30:00
11	2021-10-01 10:30:00	2021-10-01 11:30:00
12	2021-10-01 10:30:00	2021-10-01 11:30:00
13	2021-10-01 10:30:00	2021-10-01 11:30:00
14	2021-10-01 10:30:00	2021-10-01 11:30:00
15	2021-10-01 11:30:00	2021-10-01 12:30:00
16	2021-10-01 11:30:00	2021-10-01 12:30:00
17	2021-10-01 11:30:00	2021-10-01 12:30:00
18	2021-10-01 11:30:00	2021-10-01 12:30:00
19	2021-10-01 11:30:00	2021-10-01 12:30:00
20	2021-10-01 11:30:00	2021-10-01 12:30:00
21	2021-10-01 11:30:00	2021-10-01 12:30:00
22	2021-10-01 12:30:00	2021-10-01 13:30:00
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7	2021-10-01 09:30:00	2021-10-01 10:30:00	$TSLA selling off in front of production &...	Tesla, Inc.
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11	2021-10-01 09:30:00	2021-10-01 10:30:00	sold my 1000 $768's at $775 for a quick $7K. $...	Tesla, Inc.
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21	2021-10-01 09:30:00	2021-10-01 10:30:00	Day 1 of Q4. ðŸ”¥ \n\nFor anyone that thinks E...	Tesla, Inc.
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24	2021-10-01 09:30:00	2021-10-01 10:30:00	#tradingtips \nGolden Rule to remember is "Sup...	Tesla, Inc.
25	2021-10-01 09:30:00	2021-10-01 10:30:00	Tesla Gigafactory Texas progress today, check ...	Tesla, Inc.
26	2021-10-01 09:30:00	2021-10-01 10:30:00	While traders may still sell the news on a $TS...	Tesla, Inc.

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27  The joys of owning a car with games on it. My ...  Tesla, Inc.
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20  Got real-time confirmation just now by few fri...  Tesla, Inc.
21  Day 1 of Q4. ðŸ”¥ \n\nFor anyone that thinks E...  Tesla, Inc.
22  Yes, $TSLA is (still) the most shorted stock b...  Tesla, Inc.
23  Bought 1,000 $TSLA at $768.68 for another day ...  Tesla, Inc.
24  #tradingtips \nGolden Rule to remember is "Sup...  Tesla, Inc.
25  Tesla Gigafactory Texas progress today, check ...  Tesla, Inc.
26  While traders may still sell the news on a $TS...  Tesla, Inc.
27  The joys of owning a car with games on it. My ...  Tesla, Inc.
28  $TSLA performed better when the NASDAQ was dow...  Tesla, Inc.
       start_interval        end_interval  \
0  2021-10-01 09:30:00 2021-10-01 10:30:00
1  2021-10-01 09:30:00 2021-10-01 10:30:00
```

2	2021-10-01 09:30:00	2021-10-01 10:30:00
3	2021-10-01 09:30:00	2021-10-01 10:30:00
4	2021-10-01 09:30:00	2021-10-01 10:30:00
5	2021-10-01 09:30:00	2021-10-01 10:30:00
6	2021-10-01 09:30:00	2021-10-01 10:30:00
7	2021-10-01 09:30:00	2021-10-01 10:30:00
8	2021-10-01 10:30:00	2021-10-01 11:30:00
9	2021-10-01 10:30:00	2021-10-01 11:30:00
10	2021-10-01 10:30:00	2021-10-01 11:30:00
11	2021-10-01 10:30:00	2021-10-01 11:30:00
12	2021-10-01 10:30:00	2021-10-01 11:30:00
13	2021-10-01 10:30:00	2021-10-01 11:30:00
14	2021-10-01 10:30:00	2021-10-01 11:30:00
15	2021-10-01 11:30:00	2021-10-01 12:30:00
16	2021-10-01 11:30:00	2021-10-01 12:30:00
17	2021-10-01 11:30:00	2021-10-01 12:30:00
18	2021-10-01 11:30:00	2021-10-01 12:30:00
19	2021-10-01 11:30:00	2021-10-01 12:30:00
20	2021-10-01 11:30:00	2021-10-01 12:30:00
21	2021-10-01 11:30:00	2021-10-01 12:30:00
22	2021-10-01 12:30:00	2021-10-01 13:30:00
23	2021-10-01 12:30:00	2021-10-01 13:30:00
24	2021-10-01 12:30:00	2021-10-01 13:30:00
25	2021-10-01 12:30:00	2021-10-01 13:30:00
26	2021-10-01 13:30:00	2021-10-01 14:30:00
27	2021-10-01 13:30:00	2021-10-01 14:30:00
28	2021-10-01 13:30:00	2021-10-01 14:30:00
29	2021-10-01 13:30:00	2021-10-01 14:30:00

	merged_tweet	Company Name
0	Markets are now oversold. NASDAQ is off 6.5% n...	Tesla, Inc.
1	I broke my rule holding $TSLA into a Friday. N...	Tesla, Inc.
2	Jesus Christ. My portfolio looks like a murder...	Tesla, Inc.
3	$TSLA was almost at $800 Monday. ðŸ˜¨	Tesla, Inc.
4	Q4 started $TSLA	Tesla, Inc.
5	Well, look at the positive. We don't have to w...	Tesla, Inc.
6	Bought 1,000 at $768.18. Should see a tiny bou...	Tesla, Inc.
7	$TSLA selling off in front of production &...	Tesla, Inc.
8	Youâ™re eyes arenâ™t deceiving you. Thatâ™s...	Tesla, Inc.
9	IMHO, @Tesla & @elonmusk lead the revoluti...	Tesla, Inc.
10	Important read, indeed. In days of yore, stock...	Tesla, Inc.
11	sold my 1000 $768's at $775 for a quick $7K. $...	Tesla, Inc.
12	BREAKING: $TSLA down on the news that record d...	Tesla, Inc.
13	$AMC Finds its way back to become the top most...	Tesla, Inc.
14	When I bought my 1st batch of $TSLA back in 20...	Tesla, Inc.
15	WOW ðŸ¤¯\nRecord high markedshare of BEVs in n...	Tesla, Inc.
16	Tech focused firms dominate the top 10 by mark...	Tesla, Inc.
17	When is the last time Max Pain on a Friday was...	Tesla, Inc.
18	Next week is huge for tesla. Itâ™s all coming...	Tesla, Inc.
19	@Tesla Hello Elon. I'm having a major issue wi...	Tesla, Inc.
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28	$TSLA performed better when the NASDAQ was dow...	Tesla, Inc.
29	3x faster to build a Model 3 vs a VW ID3.\n\nP...	Tesla, Inc.

	start_interval	end_interval	merged_tweet	Company Name
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6	2021-10-01 09:30:00	2021-10-01 10:30:00	Bought 1,000 at $768.18. Should see a tiny bou...	Tesla, Inc.
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28	2021-10-01 10:30:00	2021-10-01 11:30:00		
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31	2021-10-01 11:30:00	2021-10-01 12:30:00		
32	2021-10-01 11:30:00	2021-10-01 12:30:00		
33	2021-10-01 11:30:00	2021-10-01 12:30:00		
34	2021-10-01 11:30:00	2021-10-01 12:30:00		
35	2021-10-01 11:30:00	2021-10-01 12:30:00		
36	2021-10-01 11:30:00	2021-10-01 12:30:00		
37	2021-10-01 11:30:00	2021-10-01 12:30:00		
38	2021-10-01 12:30:00	2021-10-01 13:30:00		
39	2021-10-01 12:30:00	2021-10-01 13:30:00		
40	2021-10-01 12:30:00	2021-10-01 13:30:00		
41	2021-10-01 12:30:00	2021-10-01 13:30:00		
42	2021-10-01 13:30:00	2021-10-01 14:30:00		
43	2021-10-01 13:30:00	2021-10-01 14:30:00		
44	2021-10-01 13:30:00	2021-10-01 14:30:00		
45	2021-10-01 13:30:00	2021-10-01 14:30:00		
46	2021-10-01 13:30:00	2021-10-01 14:30:00		

26	While traders may still sell the news on a $TS...	Tesla, Inc.
27	The joys of owning a car with games on it. My ...	Tesla, Inc.
28	$TSLA performed better when the NASDAQ was dow...	Tesla, Inc.
29	3x faster to build a Model 3 vs a VW ID3.\n\nP...	Tesla, Inc.
30	VW's stategy to dominate EVs is to call panic ...	Tesla, Inc.

```
---------------------------------------------------------------------------
KeyboardInterrupt                         Traceback (most recent call last)
~\AppData\Local\Temp\ipykernel_1208\1930479990.py in <module>
     13
     14         # Iterate through each tweet row in the temporary dataframe
---> 15         for _, tweet_row in temp_df.iterrows():
     16             tweet_time = tweet_row['Actual Date']
     17

C:\Program Files\Anaconda\lib\site-packages\pandas\core\frame.py in iterrows(self)
   1322         klass = self._constructor_sliced
   1323         for k, v in zip(self.index, self.values):
-> 1324             s = klass(v, index=columns, name=k)
   1325             yield k, s
   1326

C:\Program Files\Anaconda\lib\site-packages\pandas\core\series.py in __init__(self, d
ata, index, dtype, name, copy, fastpath)
    453                 manager = get_option("mode.data_manager")
    454                 if manager == "block":
--> 455                     data = SingleBlockManager.from_array(data, index)
    456                 elif manager == "array":
    457                     data = SingleArrayManager.from_array(data, index)

C:\Program Files\Anaconda\lib\site-packages\pandas\core\internals\managers.py in from
_array(cls, array, index)
   1748         Constructor for if we have an array that is not yet a Block.
   1749         """
-> 1750         block = new_block(array, placement=slice(0, len(index)), ndim=1)
   1751         return cls(block, index)
   1752

C:\Program Files\Anaconda\lib\site-packages\pandas\core\internals\blocks.py in new_bl
ock(values, placement, ndim)
   2047         placement = BlockPlacement(placement)
   2048
-> 2049     check_ndim(values, placement, ndim)
   2050
   2051     klass = get_block_type(values.dtype)

C:\Program Files\Anaconda\lib\site-packages\pandas\core\internals\blocks.py in check_
ndim(values, placement, ndim)
   2080         )
   2081
-> 2082     elif not is_1d_only_ea_dtype(values.dtype):
   2083         # TODO(EA2D): special case not needed with 2D EAs
   2084         if values.ndim != ndim:

C:\Program Files\Anaconda\lib\site-packages\pandas\core\dtypes\common.py in is_1d_onl
y_ea_dtype(dtype)
   1422     # NB: need to check DatetimeTZDtype and not is_datetime64tz_dtype
   1423     #  to exclude ArrowTimestampUSDtype
-> 1424     return isinstance(dtype, ExtensionDtype) and not isinstance(
   1425         dtype, (DatetimeTZDtype, PeriodDtype)
   1426     )

KeyboardInterrupt:
```

Importing 'main_data2' csv file which is the output of previous cell

In [22]:
```
file_path2 = r"C:\Users\DELL1\Desktop\MMSc\MSCI 623\Project\main_data2.csv"
main_data2 = pd.read_csv(file_path2, encoding='latin1')
main_data2 = pd.DataFrame(main_data2)
main_data2
```

Out[22]:

	Unnamed: 0	start_interval	end_interval	merged_tweet	Company Name
0	0	2021-10-01 09:30:00	2021-10-01 10:30:00	Markets are now oversold. NASDAQ is off 6.5% n...	Tesla, Inc.
1	1	2021-10-01 09:30:00	2021-10-01 10:30:00	I broke my rule holding $TSLA into a Friday. N...	Tesla, Inc.
2	2	2021-10-01 09:30:00	2021-10-01 10:30:00	Jesus Christ. My portfolio looks like a murder...	Tesla, Inc.
3	3	2021-10-01 09:30:00	2021-10-01 10:30:00	$TSLA was almost at 800 Monday. Ã°ÂŸÂ˜Â,	Tesla, Inc.
4	4	2021-10-01 09:30:00	2021-10-01 10:30:00	Q4 started $TSLA	Tesla, Inc.
...	...	...	...	...	...
33283	33283	2022-08-05 16:00:00	2022-08-08 16:00:00	Called $Pypl news before news hit stock gapped...	The Boeing Company
33284	33284	2022-08-10 16:00:00	2022-08-11 16:00:00	$BA delivers first 787 to AAL after 14 month ...	The Boeing Company
33285	33285	2022-08-18 16:00:00	2022-08-19 16:00:00	Two pilots in a $BA 737 fell asleep and overfl...	The Boeing Company
33286	33286	2022-09-14 16:00:00	2022-09-15 16:00:00	Alan Lowenthal (D) CA sits on the Transportati...	The Boeing Company
33287	33287	2022-09-14 16:00:00	2022-09-15 16:00:00	Boeing Company $BA Wins 506 Million Contract ...	The Boeing Company

33288 rows × 5 columns

Allocating stocks to their respective indices

In [23]:
```
stock_index = {'Company Name' :['Tesla, Inc.', 'Microsoft Corporation', 'Procter & Gam
                'Index Name' : ['NASDAQ','NASDAQ', 'Dow Jones Industrial Average', '
stock_index = pd.DataFrame(stock_index)
stock_index
```

Out[23]:

	Company Name	Index Name
0	Tesla, Inc.	NASDAQ
1	Microsoft Corporation	NASDAQ
2	Procter & Gamble Company	Dow Jones Industrial Average
3	Alphabet Inc.	NASDAQ
4	Apple Inc.	NASDAQ
5	The Boeing Company	Dow Jones Industrial Average

Merging main_data2 and stock_index dataframes to specify the index in Tweet dataset

In [24]:
```
main_data2 = pd.merge(main_data2, stock_index, on='Company Name', how='inner')
main_data2
```

Out[24]:

	Unnamed: 0	start_interval	end_interval	merged_tweet	Company Name	Index Name
0	0	2021-10-01 09:30:00	2021-10-01 10:30:00	Markets are now oversold. NASDAQ is off 6.5% n...	Tesla, Inc.	NASDAQ
1	1	2021-10-01 09:30:00	2021-10-01 10:30:00	I broke my rule holding $TSLA into a Friday. N...	Tesla, Inc.	NASDAQ
2	2	2021-10-01 09:30:00	2021-10-01 10:30:00	Jesus Christ. My portfolio looks like a murder...	Tesla, Inc.	NASDAQ
3	3	2021-10-01 09:30:00	2021-10-01 10:30:00	$TSLA was almost at $800 Monday. Ã°ÂŸÂ˜Â,	Tesla, Inc.	NASDAQ
4	4	2021-10-01 09:30:00	2021-10-01 10:30:00	Q4 started $TSLA	Tesla, Inc.	NASDAQ
...	...	...	...	...	...	...
33283	33283	2022-08-05 16:00:00	2022-08-08 16:00:00	Called $Pypl news before news hit stock gapped...	The Boeing Company	Dow Jones Industrial Average
33284	33284	2022-08-10 16:00:00	2022-08-11 16:00:00	$BA delivers first 787 to AAL after 14 month ...	The Boeing Company	Dow Jones Industrial Average
33285	33285	2022-08-18 16:00:00	2022-08-19 16:00:00	Two pilots in a $BA 737 fell asleep and overfl...	The Boeing Company	Dow Jones Industrial Average
33286	33286	2022-09-14 16:00:00	2022-09-15 16:00:00	Alan Lowenthal (D) CA sits on the Transportati...	The Boeing Company	Dow Jones Industrial Average
33287	33287	2022-09-14 16:00:00	2022-09-15 16:00:00	Boeing Company $BA Wins 506 Million Contract ...	The Boeing Company	Dow Jones Industrial Average

33288 rows × 6 columns

Merging the tweets according to hourly interval using ';' as separator

In [25]:
```
# Group the data by 'Company Name' and 'start_interval', and aggregate 'Tweet' using d
grouped_df = main_data2.groupby(['Company Name', 'start_interval', 'Index Name'])['mer

# Convert the list of tweets into a single merged tweet string using ';'.join
grouped_df['Merged Tweet'] = grouped_df['merged_tweet'].apply(';'.join)

# Drop the original 'Tweet' column as it is no longer needed
grouped_df.drop(columns=['merged_tweet'], inplace=True)

grouped_df
```

Out[25]:

	Company Name	start_interval	Index Name	Merged Tweet
0	Alphabet Inc.	2021-10-01 11:30:00	NASDAQ	Google Abandons Plans to Offer Bank Accounts, ...
1	Alphabet Inc.	2021-10-01 16:00:00	NASDAQ	Innovation & Growth:\nSell $AAPL, BuyTSL...
2	Alphabet Inc.	2021-10-04 11:30:00	NASDAQ	BUY THE DIP. Buy fear. Sell Greed.\n\nFear ove...
3	Alphabet Inc.	2021-10-04 12:30:00	NASDAQ	Innovation & Growth:\nSell $AAPL, BuyTSL...
4	Alphabet Inc.	2021-10-05 16:00:00	NASDAQ	Largest market cap $(trillion)$: \n\n1 AAPL $...
...	...	...	...	...
5287	The Boeing Company	2022-08-18 16:00:00	Dow Jones Industrial Average	Two pilots in a $BA 737 fell asleep and overfl...
5288	The Boeing Company	2022-08-19 10:30:00	Dow Jones Industrial Average	Two pilots in a $BA 737 fell asleep and overfl...
5289	The Boeing Company	2022-09-14 16:00:00	Dow Jones Industrial Average	Alan Lowenthal (D) CA sits on the Transportati...
5290	The Boeing Company	2022-09-15 09:30:00	Dow Jones Industrial Average	Boeing Company $BAWins$506 Million Contract ...
5291	The Boeing Company	2022-09-15 14:30:00	Dow Jones Industrial Average	Alan Lowenthal (D) CA sits on the Transportati...

5292 rows × 4 columns

Dropping rows which doesn't have any merged tweets

In [26]:
```
grouped_df['start_interval'] = pd.to_datetime(grouped_df['start_interval'], format='%\
grouped_df.dropna(subset=['Merged Tweet'], inplace=True)
#Dropping tweets with intevals starting at 16:00:00 as we are not concerned with tweet
grouped_df = grouped_df[grouped_df['start_interval'].dt.time != pd.to_datetime('16:00:
```

Sentiment Analysis of Merged Tweets

- To perform sentiment analysis, we preprocess the merged tweet text by converting it to lowercase, removing punctuation and numbers, and tokenizing the text into individual words. We also remove stop words to focus on meaningful words in the sentiment analysis.
- Next, we apply SentimentIntensityAnalyzer from the nltk.sentiment.vader library to calculate sentiment scores for each tweet. The sentiment scores indicate the overall sentiment of each tweet, with positive values representing positive sentiment, negative values representing negative sentiment, and zero representing neutral sentiment.

- Based on the sentiment scores, we categorize the sentiment into three classes: positive (1), neutral (0), and negative (-1). This categorization allows us to analyze the relationship between tweet sentiment and stock price movements.

Calculating sentiment score

In [27]:
```
# Convert the text to lowercase
grouped_df['Merged Tweet'] = grouped_df['Merged Tweet'].str.lower()

# Remove punctuation
grouped_df['Merged Tweet'] = grouped_df['Merged Tweet'].str.replace('[^\w\s]', '')

# Remove numbers
grouped_df['Merged Tweet'] = grouped_df['Merged Tweet'].str.replace('\d+', '')

# Tokenization
grouped_df['Tokens'] = grouped_df['Merged Tweet'].apply(word_tokenize)

# Remove stop words
stop_words = set(stopwords.words('english'))
grouped_df['Tokens'] = grouped_df['Tokens'].apply(lambda x: [word for word in x if wor
# Initialize SentimentIntensityAnalyzer
sia = SentimentIntensityAnalyzer()

# Perform sentiment analysis on each tweet
grouped_df['Sentiment Score'] = grouped_df['Merged Tweet'].apply(lambda x: sia.polarit

# Map sentiment scores to positive (1), neutral (0), or negative (-1)
grouped_df['Sentiment'] = grouped_df['Sentiment Score'].apply(lambda score: 1 if score

# Print the DataFrame with sentiment scores
grouped_df.head()
```

```
C:\Users\DELL1\AppData\Local\Temp\ipykernel_1208\3682075653.py:2: SettingWithCopyWarn
ing:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/us
er_guide/indexing.html#returning-a-view-versus-a-copy
  grouped_df['Merged Tweet'] = grouped_df['Merged Tweet'].str.lower()
C:\Users\DELL1\AppData\Local\Temp\ipykernel_1208\3682075653.py:5: FutureWarning: The
default value of regex will change from True to False in a future version.
  grouped_df['Merged Tweet'] = grouped_df['Merged Tweet'].str.replace('[^\w\s]', '')
C:\Users\DELL1\AppData\Local\Temp\ipykernel_1208\3682075653.py:5: SettingWithCopyWarn
ing:
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See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/us
er_guide/indexing.html#returning-a-view-versus-a-copy
  grouped_df['Merged Tweet'] = grouped_df['Merged Tweet'].str.replace('[^\w\s]', '')
C:\Users\DELL1\AppData\Local\Temp\ipykernel_1208\3682075653.py:8: FutureWarning: The
default value of regex will change from True to False in a future version.
  grouped_df['Merged Tweet'] = grouped_df['Merged Tweet'].str.replace('\d+', '')
C:\Users\DELL1\AppData\Local\Temp\ipykernel_1208\3682075653.py:8: SettingWithCopyWarn
ing:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/us
er_guide/indexing.html#returning-a-view-versus-a-copy
  grouped_df['Merged Tweet'] = grouped_df['Merged Tweet'].str.replace('\d+', '')
C:\Users\DELL1\AppData\Local\Temp\ipykernel_1208\3682075653.py:11: SettingWithCopyWar
ning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/us
er_guide/indexing.html#returning-a-view-versus-a-copy
  grouped_df['Tokens'] = grouped_df['Merged Tweet'].apply(word_tokenize)
C:\Users\DELL1\AppData\Local\Temp\ipykernel_1208\3682075653.py:15: SettingWithCopyWar
ning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/us
er_guide/indexing.html#returning-a-view-versus-a-copy
  grouped_df['Tokens'] = grouped_df['Tokens'].apply(lambda x: [word for word in x if
word not in stop_words])
C:\Users\DELL1\AppData\Local\Temp\ipykernel_1208\3682075653.py:20: SettingWithCopyWar
ning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/us
er_guide/indexing.html#returning-a-view-versus-a-copy
  grouped_df['Sentiment Score'] = grouped_df['Merged Tweet'].apply(lambda x: sia.pola
rity_scores(x)['compound'])
C:\Users\DELL1\AppData\Local\Temp\ipykernel_1208\3682075653.py:23: SettingWithCopyWar
ning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead
```

```
See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  grouped_df['Sentiment'] = grouped_df['Sentiment Score'].apply(lambda score: 1 if score > 0 else (-1 if score < 0 else 0))
```

Out[27]:

	Company Name	start_interval	Index Name	Merged Tweet	Tokens	Sentiment Score	Sentiment
0	Alphabet Inc.	2021-10-01 11:30:00	NASDAQ	google abandons plans to offer bank accounts s...	[google, abandons, plans, offer, bank, account...	-0.3182	-1
2	Alphabet Inc.	2021-10-04 11:30:00	NASDAQ	buy the dip buy fear sell greed\n\nfear over j...	[buy, dip, buy, fear, sell, greed, fear, jobs,...	-0.9788	-1
3	Alphabet Inc.	2021-10-04 12:30:00	NASDAQ	innovation amp growth\nsell aapl buy tsla\n\np...	[innovation, amp, growth, sell, aapl, buy, tsl...	0.8519	1
5	Alphabet Inc.	2021-10-06 11:30:00	NASDAQ	largest market cap trillion \n\n aapl t\n msf...	[largest, market, cap, trillion, aapl, msft, g...	0.0000	0
7	Alphabet Inc.	2021-10-13 11:30:00	NASDAQ	the meeting with google was fantastic\nthere w...	[meeting, google, fantastic, big, chainlink, a...	0.7096	1

Data Preprocessing for Model Building

- First, we load the required Python libraries and import the data from the CSV file containing stock tweets. We filter the data to consider only the stocks of interest, and we retrieve historical stock price data using Yahoo Finance (yfinance library) for the selected stock symbols.
- The historical stock price data is merged with the tweet data based on time intervals. We create one-hour time intervals and aggregate the tweets falling within each interval. This process results in a DataFrame containing the merged tweets, company names, sentiment scores, and stock price data for each time interval.

Retriving ticker symbol for each stock

- We need ticker symbol as the 'history' (containing hourly prices for each stock) dataframe has ticker symbol and does not have stock name.

In [28]:
```
Company_name = df[['Stock Name', 'Company Name']].drop_duplicates()
# Merge the grouped_df with the company_name dataframe on 'Company Name'
```

```
grouped_df = grouped_df.merge(Company_name, on='Company Name', how='left')

#Creating end_interval column which specifies the end of the interval for merged tweet

grouped_df['end_interval'] = grouped_df['start_interval'] + pd.Timedelta(hours=1)
grouped_df.head()
```

Out[28]:

	Company Name	start_interval	Index Name	Merged Tweet	Tokens	Sentiment Score	Sentiment	Stock Name	end_
0	Alphabet Inc.	2021-10-01 11:30:00	NASDAQ	google abandons plans to offer bank accounts s...	[google, abandons, plans, offer, bank, account...	-0.3182	-1	GOOG	202
1	Alphabet Inc.	2021-10-04 11:30:00	NASDAQ	buy the dip buy fear sell greed\n\nfear over j...	[buy, dip, buy, fear, sell, greed, fear, jobs,...	-0.9788	-1	GOOG	202
2	Alphabet Inc.	2021-10-04 12:30:00	NASDAQ	innovation amp growth\nsell aapl buy tsla\n\np...	[innovation, amp, growth, sell, aapl, buy, tsl...	0.8519	1	GOOG	202
3	Alphabet Inc.	2021-10-06 11:30:00	NASDAQ	largest market cap trillion \n\n aapl t\n msf...	[largest, market, cap, trillion, aapl, msft, g...	0.0000	0	GOOG	202
4	Alphabet Inc.	2021-10-13 11:30:00	NASDAQ	the meeting with google was fantastic\nthere w...	[meeting, google, fantastic, big, chainlink, a...	0.7096	1	GOOG	202

In [29]:
```
#Converting start_interval column in datetime format
grouped_df['start_interval'] = pd.to_datetime(grouped_df['start_interval'], format='%\
```

Matching change in index with tweet dataset

- We retrieve the change in the index depending on the date corresonding the grouped tweets.

In [30]:
```
for index, price in grouped_df.iterrows():
    # Convert the 'end_interval' to a datetime object
    end_interval_date = price['end_interval'].date()

    # Create the condition to match 'Index Name' and 'end_interval' in index_history
    condition = (index_history['Index Name'] == price['Index Name']) & (index_history[

    # Get the matching rows from index_history DataFrame
    matching_rows = index_history.loc[condition, '% change']
```

```
    if not matching_rows.empty:
        # If there are matching rows, calculate the 'change in index' by taking the fi
        grouped_df.at[index, '% change in index'] = matching_rows.iloc[0]
    else:
        # If there are no matching rows, assign None to 'change in index'
        grouped_df.at[index, '% change in index'] = None
grouped_df
```

Out[30]:

	Company Name	start_interval	Index Name	Merged Tweet	Tokens	Sentiment Score	Sentiment	Stock Name
0	Alphabet Inc.	2021-10-01 11:30:00	NASDAQ	google abandons plans to offer bank accounts s...	[google, abandons, plans, offer, bank, account...	-0.3182	-1	GOOG
1	Alphabet Inc.	2021-10-04 11:30:00	NASDAQ	buy the dip buy fear sell greed\n\nfear over j...	[buy, dip, buy, fear, sell, greed, fear, jobs,...	-0.9788	-1	GOOG
2	Alphabet Inc.	2021-10-04 12:30:00	NASDAQ	innovation amp growth\nsell aapl buy tsla\n\np...	[innovation, amp, growth, sell, aapl, buy, tsl...	0.8519	1	GOOG
3	Alphabet Inc.	2021-10-06 11:30:00	NASDAQ	largest market cap trillion \n\n aapl t\n msf...	[largest, market, cap, trillion, aapl, msft, g...	0.0000	0	GOOG
4	Alphabet Inc.	2021-10-13 11:30:00	NASDAQ	the meeting with google was fantastic\nthere w...	[meeting, google, fantastic, big, chainlink, a...	0.7096	1	GOOG
...	...	...	...	...	...	...	...	...
4077	The Boeing Company	2022-08-08 13:30:00	Dow Jones Industrial Average	called pypl news before news hit stock gapped ...	[called, pypl, news, news, hit, stock, gapped,...	0.6344	1	BA
4078	The Boeing Company	2022-08-11 09:30:00	Dow Jones Industrial Average	ba delivers first to aal after month delay ...	[ba, delivers, first, aal, month, delay, produ...	0.5504	1	BA
4079	The Boeing Company	2022-08-19 10:30:00	Dow Jones Industrial Average	two pilots in a ba fell asleep and overflew a...	[two, pilots, ba, fell, asleep, overflew, runw...	0.0000	0	BA
4080	The Boeing Company	2022-09-15 09:30:00	Dow Jones Industrial Average	boeing company ba wins million contract to ma...	[boeing, company, ba, wins, million, contract,...	0.5719	1	BA
4081	The Boeing Company	2022-09-15 14:30:00	Dow Jones Industrial Average	alan lowenthal d ca sits on the transportation...	[alan, lowenthal, ca, sits, transportation, co...	0.0000	0	BA

4082 rows × 10 columns

Retrieving 20 Day Moving Average to twitter dataset

In [31]:
```
for index, price in grouped_df.iterrows():
    # Convert the 'start_interval' to datetime type (if not already done)
    grouped_df.at[index, 'start_interval'] = pd.to_datetime(price['start_interval'])

    # Create the condition to match 'Symbol' and 'Datetime' in history_filtered
    condition = (history_filtered['Symbol'] == price['Stock Name']) & (history_filtere

    # Get the matching rows from index_history DataFrame
    matching_rows = history_filtered.loc[condition, '20_Day_MA']

    if not matching_rows.empty:
        # If there are matching rows, calculate the '20_Day_MA' by taking the first va
        grouped_df.at[index, '20_Day_MA'] = matching_rows.iloc[0]
    else:
        # If there are no matching rows, assign None to '20_Day_MA'
        grouped_df.at[index, '20_Day_MA'] = None

grouped_df
```

Out[31]:

	Company Name	start_interval	Index Name	Merged Tweet	Tokens	Sentiment Score	Sentiment	Stock Name
0	Alphabet Inc.	2021-10-01 11:30:00	NASDAQ	google abandons plans to offer bank accounts s...	[google, abandons, plans, offer, bank, account...	-0.3182	-1	GOOG
1	Alphabet Inc.	2021-10-04 11:30:00	NASDAQ	buy the dip buy fear sell greed\n\nfear over j...	[buy, dip, buy, fear, sell, greed, fear, jobs,...	-0.9788	-1	GOOG
2	Alphabet Inc.	2021-10-04 12:30:00	NASDAQ	innovation amp growth\nsell aapl buy tsla\n\np...	[innovation, amp, growth, sell, aapl, buy, tsl...	0.8519	1	GOOG
3	Alphabet Inc.	2021-10-06 11:30:00	NASDAQ	largest market cap trillion \n\n aapl t\n msf...	[largest, market, cap, trillion, aapl, msft, g...	0.0000	0	GOOG
4	Alphabet Inc.	2021-10-13 11:30:00	NASDAQ	the meeting with google was fantastic\nthere w...	[meeting, google, fantastic, big, chainlink, a...	0.7096	1	GOOG
...	...	...	...	...	...	...	...	...
4077	The Boeing Company	2022-08-08 13:30:00	Dow Jones Industrial Average	called pypl news before news hit stock gapped ...	[called, pypl, news, news, hit, stock, gapped,...	0.6344	1	BA
4078	The Boeing Company	2022-08-11 09:30:00	Dow Jones Industrial Average	ba delivers first to aal after month delay ...	[ba, delivers, first, aal, month, delay, produ...	0.5504	1	BA
4079	The Boeing Company	2022-08-19 10:30:00	Dow Jones Industrial Average	two pilots in a ba fell asleep and overflew a...	[two, pilots, ba, fell, asleep, overflew, runw...	0.0000	0	BA
4080	The Boeing Company	2022-09-15 09:30:00	Dow Jones Industrial Average	boeing company ba wins million contract to ma...	[boeing, company, ba, wins, million, contract,...	0.5719	1	BA
4081	The Boeing Company	2022-09-15 14:30:00	Dow Jones Industrial Average	alan lowenthal d ca sits on the transportation...	[alan, lowenthal, ca, sits, transportation, co...	0.0000	0	BA

4082 rows × 11 columns

Retrieving price of the stock at the end of interval from'history' dataframe

In [32]:
```
for index, price in grouped_df.iterrows():
    condition = (history['Symbol'] == price['Stock Name']) & (history['Datetime'] == p
    matching_rows = history.loc[condition, 'Close']
    if not matching_rows.empty:
        grouped_df.at[index, 'Price at end_interval'] = matching_rows.iloc[0]
    else:
        grouped_df.at[index, 'Price at end_interval'] = None
```

Creating column with time 1 hr after end of the interval

- We need time after 1 hr end of the interval becasue we will use the price at the end of interval as initial price and compare price after exactly 1 hr

In [33]:
```
grouped_df['1 hr lag'] = grouped_df['end_interval'] + pd.Timedelta(hours=1)
condition = grouped_df['1 hr lag'].dt.time.apply(lambda x: x == pd.to_datetime('16:30:
grouped_df.loc[condition, '1 hr lag'] = grouped_df.loc[condition, '1 hr lag'].dt.strft
```

Retrieving price after 1 hr from end interval for the resprctive stock

In [34]:
```
for index, price in grouped_df.iterrows():
    condition = (history['Symbol'] == price['Stock Name']) & (history['Datetime'] == p
    matching_rows =history.loc[condition, 'Close']
    if not matching_rows.empty:
        grouped_df.at[index, 'Price after 1 hr'] = matching_rows.iloc[0]
    else:
        # Handle the case when there is no matching row in history DataFrame
        grouped_df.at[index, 'Price after 1 hr'] = None
```

In [35]:
```
grouped_df.to_csv('grouped_df.csv')
grouped_df
```

Out[35]:

	Company Name	start_interval	Index Name	Merged Tweet	Tokens	Sentiment Score	Sentiment	Stock Name
0	Alphabet Inc.	2021-10-01 11:30:00	NASDAQ	google abandons plans to offer bank accounts s...	[google, abandons, plans, offer, bank, account...	-0.3182	-1	GOOG
1	Alphabet Inc.	2021-10-04 11:30:00	NASDAQ	buy the dip buy fear sell greed\n\nfear over j...	[buy, dip, buy, fear, sell, greed, fear, jobs,...	-0.9788	-1	GOOG
2	Alphabet Inc.	2021-10-04 12:30:00	NASDAQ	innovation amp growth\nsell aapl buy tsla\n\np...	[innovation, amp, growth, sell, aapl, buy, tsl...	0.8519	1	GOOG
3	Alphabet Inc.	2021-10-06 11:30:00	NASDAQ	largest market cap trillion \n\n aapl t\n msf...	[largest, market, cap, trillion, aapl, msft, g...	0.0000	0	GOOG
4	Alphabet Inc.	2021-10-13 11:30:00	NASDAQ	the meeting with google was fantastic\nthere w...	[meeting, google, fantastic, big, chainlink, a...	0.7096	1	GOOG
...	...	...	...	...	...	...	...	...
4077	The Boeing Company	2022-08-08 13:30:00	Dow Jones Industrial Average	called pypl news before news hit stock gapped ...	[called, pypl, news, news, hit, stock, gapped,...	0.6344	1	BA
4078	The Boeing Company	2022-08-11 09:30:00	Dow Jones Industrial Average	ba delivers first to aal after month delay ...	[ba, delivers, first, aal, month, delay, produ...	0.5504	1	BA
4079	The Boeing Company	2022-08-19 10:30:00	Dow Jones Industrial Average	two pilots in a ba fell asleep and overflew a...	[two, pilots, ba, fell, asleep, overflew, runw...	0.0000	0	BA
4080	The Boeing Company	2022-09-15 09:30:00	Dow Jones Industrial Average	boeing company ba wins million contract to ma...	[boeing, company, ba, wins, million, contract,...	0.5719	1	BA
4081	The Boeing Company	2022-09-15 14:30:00	Dow Jones Industrial Average	alan lowenthal d ca sits on the transportation...	[alan, lowenthal, ca, sits, transportation, co...	0.0000	0	BA

4082 rows × 14 columns

Dropping the rows that has null value

- Trading hours for 26th November is from 09:30:00 to 13:00:00. So, we need to remove the intervals that requires price after 13:00:00

In [36]:
```
#We drop the rows having date 26th November as trading stops at 1 pm because of black
grouped_df.dropna(subset=['Price at end_interval'], inplace=True)
```

Creating Class label of 'Did Price Rise'

- First, we take the difference of price after 1 hr and price at end_interval.
- If the price is >0 then, we label it 1 indicating rise in price and 0 if the price <=0.

In [37]:
```
#Calculating change in price
grouped_df['change in price'] = grouped_df['Price after 1 hr'] - grouped_df['Price at

#Creating labels
grouped_df['Did Price Rise'] = grouped_df['change in price'].apply(lambda x: 1 if x>0
grouped_df
```

Out[37]:

	Company Name	start_interval	Index Name	Merged Tweet	Tokens	Sentiment Score	Sentiment	Stock Name
0	Alphabet Inc.	2021-10-01 11:30:00	NASDAQ	google abandons plans to offer bank accounts s...	[google, abandons, plans, offer, bank, account...	-0.3182	-1	GOOG
1	Alphabet Inc.	2021-10-04 11:30:00	NASDAQ	buy the dip buy fear sell greed\n\nfear over j...	[buy, dip, buy, fear, sell, greed, fear, jobs,...	-0.9788	-1	GOOG
2	Alphabet Inc.	2021-10-04 12:30:00	NASDAQ	innovation amp growth\nsell aapl buy tsla\n\np...	[innovation, amp, growth, sell, aapl, buy, tsl...	0.8519	1	GOOG
3	Alphabet Inc.	2021-10-06 11:30:00	NASDAQ	largest market cap trillion \n\n aapl t\n msf...	[largest, market, cap, trillion, aapl, msft, g...	0.0000	0	GOOG
4	Alphabet Inc.	2021-10-13 11:30:00	NASDAQ	the meeting with google was fantastic\nthere w...	[meeting, google, fantastic, big, chainlink, a...	0.7096	1	GOOG
...	...	...	...	...	...	...	...	...
4077	The Boeing Company	2022-08-08 13:30:00	Dow Jones Industrial Average	called pypl news before news hit stock gapped ...	[called, pypl, news, news, hit, stock, gapped,...	0.6344	1	BA
4078	The Boeing Company	2022-08-11 09:30:00	Dow Jones Industrial Average	ba delivers first to aal after month delay ...	[ba, delivers, first, aal, month, delay, produ...	0.5504	1	BA
4079	The Boeing Company	2022-08-19 10:30:00	Dow Jones Industrial Average	two pilots in a ba fell asleep and overflew a...	[two, pilots, ba, fell, asleep, overflew, runw...	0.0000	0	BA
4080	The Boeing Company	2022-09-15 09:30:00	Dow Jones Industrial Average	boeing company ba wins million contract to ma...	[boeing, company, ba, wins, million, contract,...	0.5719	1	BA
4081	The Boeing Company	2022-09-15 14:30:00	Dow Jones Industrial Average	alan lowenthal d ca sits on the transportation...	[alan, lowenthal, ca, sits, transportation, co...	0.0000	0	BA

4078 rows × 16 columns

Initially, as directed by professor, I was going to add type of indutry to which the stock belongs as a categorical but as the stocks are from different industry, it would have made no difference.

In [38]:
```
#industry_types = {'company_name' :['Tesla, Inc.', 'Microsoft Corporation', 'Procter &
                  #'industry' : ['Auto Manufacturers','Software—Infrastructure', 'Hous
#industry = pd.DataFrame(industry_types)
#industry
```

```
  File "C:\Users\DELL1\AppData\Local\Temp\ipykernel_1208\4141650483.py", line 2
    'industry' : ['Auto Manufacturers','Software—Infrastructure', 'Household & Person
al Products', 'Internet Content & Information', 'Consumer Electronics', 'Aerospace &
Defense']}
    ^
IndentationError: unexpected indent
```

In [39]:
```
#grouped_df = pd.merge(grouped_df, industry, left_on='Company Name', right_on='company
#grouped_df
```

Feature Engineering

1) Sentiment :

- Twitter is a widely used platform with millions of active users, making it a significant source of information and sentiment about various stocks and the overall market. Sentiment analysis can help capture the collective emotions and opinions of Twitter users, reflecting the crowd psychology that can influence stock prices.

2) % Change in Index :

- The DJI and NASDAQ represent a broad selection of stocks from various industries. The percentage change in these major indices reflects the overall sentiment of the market on a given day. Positive changes suggest optimism and confidence, while negative changes indicate uncertainty or pessimism. This sentiment can influence individual stock movements since many stocks are correlated with market indices.[2]

3) 20-day Moving Average :

- By calculating the moving average over a fixed period, such as 20 days, it becomes easier to identify the direction of the stock's trend. If the stock price is consistently trading above the 20-day moving average, it indicates an uptrend, while trading below the moving average suggests a downtrend.[3]

Price Movement Prediction Model

- To predict stock price movements, we build a logistic regression model and Naïve Bayes. The model takes the sentiment polarity or sentiment scores and additional features as input

and predicts whether the stock price will rise or not after one hour.

- We split the dataset into training and testing sets using the train_test_split function from sklearn.model_selection. The logistic regression model and Naïve Bayes are then trained on the training set using the fit method.

Logistic Regression Model

Filtering columns for model training

- 'data_for_analysis_1' includes Sentiment (labels with 1 as positive, -1 as negative and 0 as neutral), % change in Index and 20 Day Moving Average as predictor variable and Did Price Rise as class label.

In [40]:
```
data_for_analysis_1 = grouped_df[['Sentiment', '% change in index', '20_Day_MA','Did P
data_for_analysis_1
```

Out[40]:

	Sentiment	% change in index	20_Day_MA	Did Price Rise
0	-1	0.404700	136.462494	1
1	-1	-2.182956	135.113747	1
2	1	-2.182956	135.113747	1
3	0	0.661574	135.939625	1
4	1	1.166575	137.384499	0
...	...	...	...	...
4077	1	-0.136326	157.563000	0
4078	1	-0.343302	160.738001	0
4079	0	-0.583852	164.828500	1
4080	1	-0.523248	158.512501	0
4081	0	-0.523248	158.512501	0

4078 rows × 4 columns

Taking 'data_for_analysis_1' and splitting as training and testing data

In [41]:
```
y1 = data_for_analysis_1['Did Price Rise']
predictors = data_for_analysis_1.drop(['Did Price Rise'], axis=1)
predictors_train, predictors_test, y_train, y_test = train_test_split(predictors, y1,
predictors_train
```

Out[41]:

	Sentiment	% change in index	20_Day_MA
2936	1	0.115459	344.295497
3462	-1	2.654162	288.395168
1715	-1	-2.185230	254.798068
2414	1	0.661116	139.522114
3844	1	0.149967	291.599667
...	...	...	...
1924	1	-0.085629	138.571568
449	0	0.804899	155.757296
2074	1	-0.017096	154.172224
2880	1	-0.469342	339.117166
3728	1	1.607717	239.340501

3262 rows × 3 columns

Fitting Logistic Regression Model on the training data and predicting the values of testing dataset

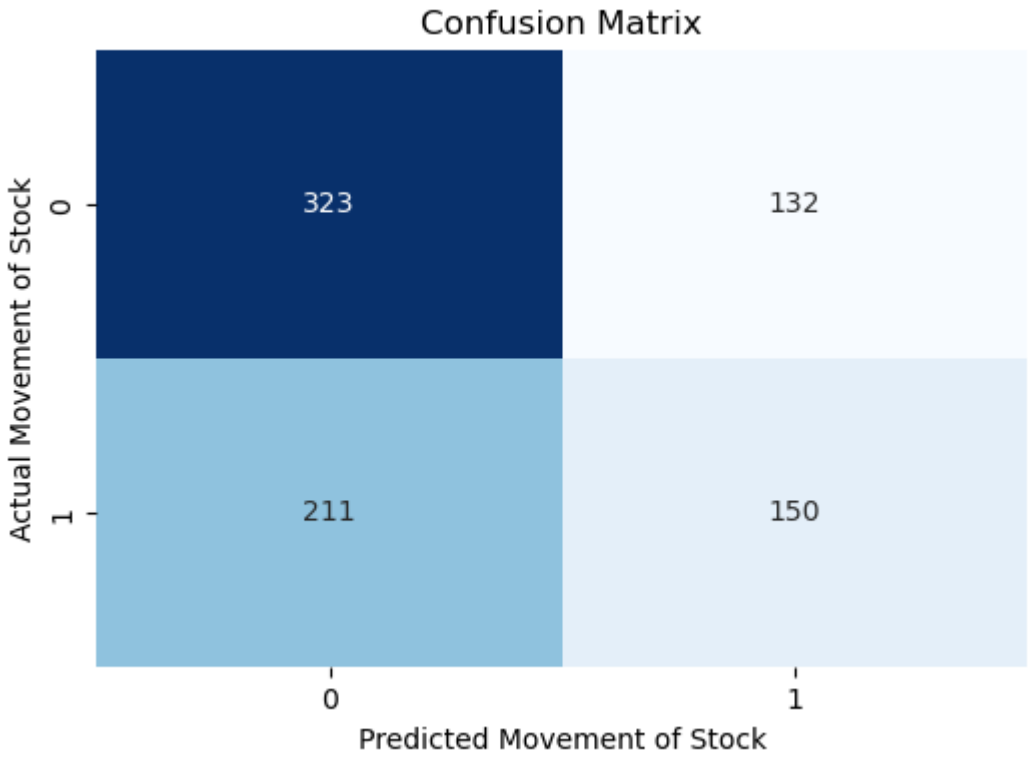
In [42]:
```
# You can proceed to fit and evaluate the logistic regression model as before
log_reg_Model_1 = LogisticRegression()
log_reg_Model_1.fit(predictors_train, y_train)

# Make predictions on the test set
y_pred_log_reg_Model_1 = log_reg_Model_1.predict(predictors_test)

# Calculate accuracy
Accuracy_of_log_reg_Model_1 = accuracy_score(y_test, y_pred_log_reg_Model_1)

# Calculate confusion matrix
confusion_matrix_of_log_reg_Model_1 = confusion_matrix(y_test, y_pred_log_reg_Model_1)

print("Confusion Matrix:")
print(confusion_matrix_of_log_reg_Model_1)
print("Accuracy of LogReg Model 1:", Accuracy_of_log_reg_Model_1)
```

```
Confusion Matrix:
[[323 132]
 [211 150]]
Accuracy of LogReg Model 1: 0.5796568627450981
```

Visualising the Confusion Matrix for Logistic Regression with Sentiment Polarity

In [43]:
```
# Create a heatmap for the confusion matrix
plt.figure(figsize=(6, 4))
sns.heatmap(confusion_matrix_of_log_reg_Model_1, annot=True, fmt='d', cmap='Blues', cb
```

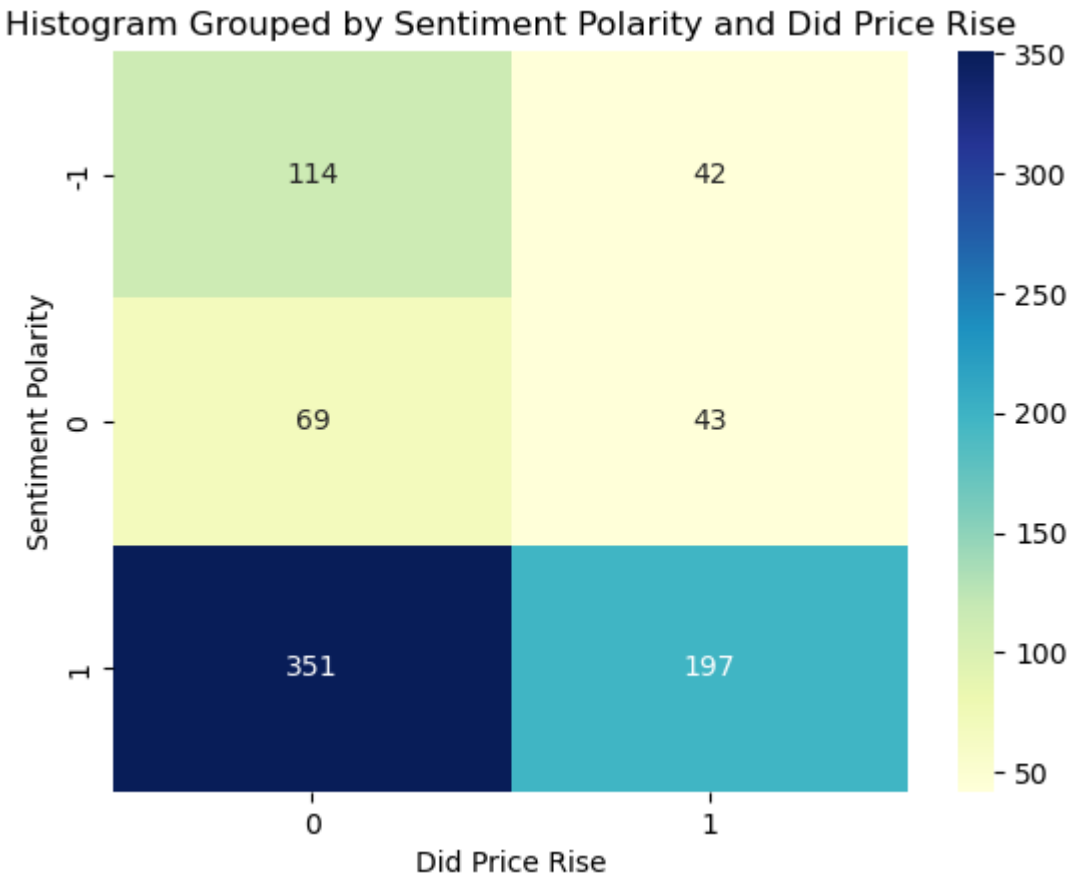
```
# Add labels and title
plt.xlabel('Predicted Movement of Stock')
plt.ylabel('Actual Movement of Stock')
plt.title('Confusion Matrix')

# Show the plot
plt.show()
```



Creating dataframe which has predited labels and corresponding Sentiment polarity

In [44]:
```
# Assuming you have the 'Sentiment_Polarity' column in the 'predictors_test' dataframe
# Get the indices of the test set
test_indices = predictors_test.index

# Create a dataframe with the predicted datapoints and their corresponding sentiment p
predicted_data_with_sentiment = pd.DataFrame({
    'Predicted': y_pred_log_reg_Model_1,
    'Sentiment_Polarity': predictors.loc[test_indices, 'Sentiment']
})
```

In [45]:
```
# Create a crosstab to get the counts for each combination of 'Sentiment_Polarity' and
cross_tab = pd.crosstab(predicted_data_with_sentiment['Sentiment_Polarity'], predicted

# Plot the heatmap
sns.heatmap(cross_tab, annot=True, fmt='d', cmap='YlGnBu', cbar=True)
plt.xlabel('Did Price Rise')
plt.ylabel('Sentiment Polarity')
plt.title('Histogram Grouped by Sentiment Polarity and Did Price Rise')
plt.show()
```



Results

- The accuracy of the model is approximately 60%. This means that the model's overall performance is moderate, as it correctly predicts around 60% of the instances in the dataset.
- From the confusion matrix, we can observe that the model is better at predicting instances where the price did not rise or remained the same (negative class) compared to instances where the price actually rose (positive class). It has a higher number of true negatives than true positives. However, it is struggling with correctly predicting instances of price rise (true positives) and is also prone to false positives in such cases.
- From the histogram above, we observe that though the sentiment is positive (1), the model does not predicts price rise. One of the reason for this occurence maybe that the several datapoints with positive sentiment would have encountered price decrease. This increase chaos in the model which in turn leads to decrease in accuracy.
- Here,The model's correctly maps positive sentiment to price rise. But, the accuracy is low because though the model correctly maps class variablle to sentimnet, the actual movement of stock is totally different.

Taking data_for_analysis_2 and spliting into training and testing

- data_for_analysis_2 has Sentiment Score.

In [46]:
```
data_for_analysis_2 = grouped_df[['Sentiment Score', '% change in index', '20_Day_MA',
data_for_analysis_2
```

Out[46]:

	Sentiment Score	% change in index	20_Day_MA	Did Price Rise
0	-0.3182	0.404700	136.462494	1
1	-0.9788	-2.182956	135.113747	1
2	0.8519	-2.182956	135.113747	1
3	0.0000	0.661574	135.939625	1
4	0.7096	1.166575	137.384499	0
...	...	...	...	...
4077	0.6344	-0.136326	157.563000	0
4078	0.5504	-0.343302	160.738001	0
4079	0.0000	-0.583852	164.828500	1
4080	0.5719	-0.523248	158.512501	0
4081	0.0000	-0.523248	158.512501	0

4078 rows × 4 columns

In [47]:
```
y1 = data_for_analysis_2['Did Price Rise']
predictors = data_for_analysis_2.drop(['Did Price Rise'], axis=1)
predictors_train, predictors_test, y_train, y_test = train_test_split(predictors, y1,
predictors_train
```

Out[47]:

	Sentiment Score	% change in index	20_Day_MA
3438	-0.8628	-2.911893	305.999169
1476	0.8861	1.834607	287.428233
1442	-0.6369	-1.631217	292.896298
1796	0.4215	0.292817	281.138625
1785	0.3400	1.749817	270.903391
...	...	...	...
126	0.0000	-0.645034	135.969701
490	0.2023	-0.980783	166.347314
3654	0.7717	1.744787	231.761667
3975	0.5489	-1.025258	291.716504
3935	0.6249	2.002795	290.981502

3262 rows × 3 columns

Fitting Logistic Regression Model with Sentiment Score on the

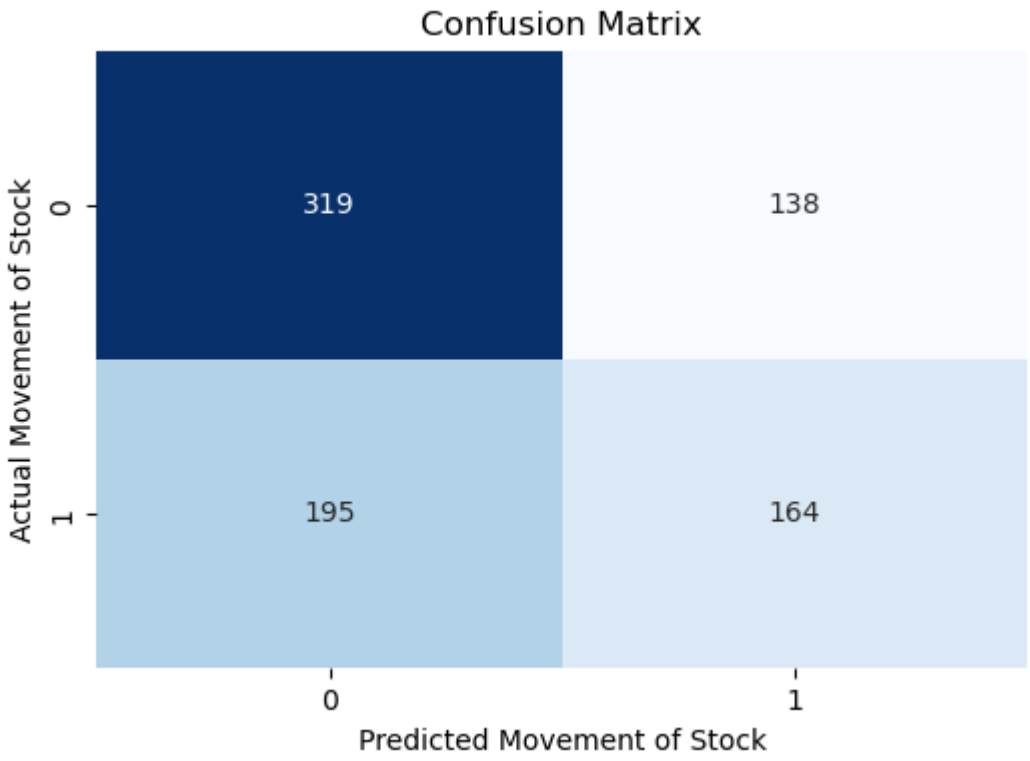
training data and predicting the values of testing dataset

In [48]:
```
# You can proceed to fit and evaluate the logistic regression model as before
log_reg_Model_2 = LogisticRegression()
log_reg_Model_2.fit(predictors_train, y_train)

# Make predictions on the test set
y_pred_log_reg_Model_2 = log_reg_Model_2.predict(predictors_test)

# Calculate accuracy
Accuracy_of_log_reg_Model_2 = accuracy_score(y_test, y_pred_log_reg_Model_2)

# Calculate confusion matrix
confusion_matrix_of_log_reg_Model_2 = confusion_matrix(y_test, y_pred_log_reg_Model_2)

print("Confusion Matrix:")
print(confusion_matrix_of_log_reg_Model_2)
print("Accuracy of LogReg Model 2:", Accuracy_of_log_reg_Model_2)
```

```
Confusion Matrix:
[[319 138]
 [195 164]]
Accuracy of LogReg Model 2: 0.5919117647058824
```

Visualising Confusion Matrix for Model 2

In [49]:
```
# Create a heatmap for the confusion matrix
plt.figure(figsize=(6, 4))
sns.heatmap(confusion_matrix_of_log_reg_Model_2, annot=True, fmt='d', cmap='Blues', cb

# Add labels and title
plt.xlabel('Predicted Movement of Stock')
plt.ylabel('Actual Movement of Stock')
plt.title('Confusion Matrix')

# Show the plot
plt.show()
```



In [50]:
```
# Get the indices of the test set
test_indices = predictors_test.index

# Create a dataframe with the predicted datapoints and their corresponding sentiment p
predicted_data_with_sentiment = pd.DataFrame({
    'Predicted': y_pred_log_reg_Model_2,
    'Sentiment_Polarity': predictors.loc[test_indices, 'Sentiment Score']
})
predicted_data_with_sentiment
```

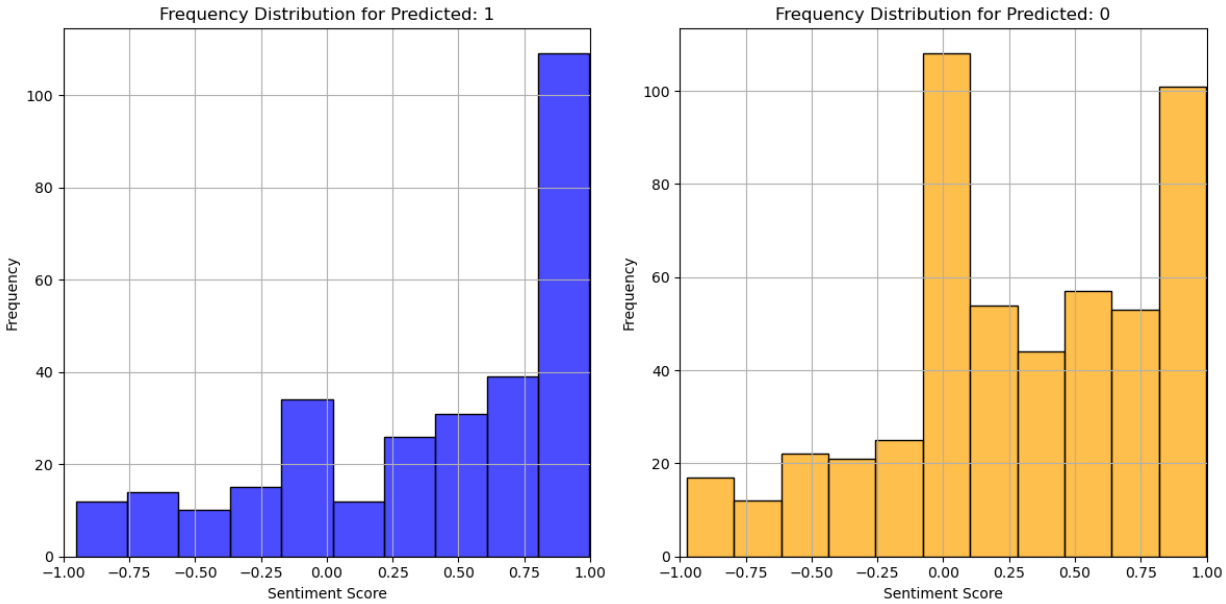
Out[50]:

	Predicted	Sentiment_Polarity
3929	1	-0.1765
172	0	0.0000
2002	0	0.6249
3059	1	0.8519
3214	1	0.9705
...	...	...
3868	1	0.1024
2206	0	0.6264
2302	0	0.5859
1451	0	0.2263
1566	1	0.2544

816 rows × 2 columns

Frequency Distribution by semtiment score, grouped by prediction labels (Did it rise or not

In [51]:
```
# Create a DataFrame combining the predicted values and the 'Sentiment Score' from the
result_df = pd.DataFrame({
    'Predicted Did Price': y_pred_log_reg_Model_2,
    'Sentiment Score': predictors_test['Sentiment Score']
})

# Separate the data into two DataFrames based on predicted values '1' as 'Yes' and '0
yes_predictions = result_df[result_df['Predicted Did Price'] == 1]
no_predictions = result_df[result_df['Predicted Did Price'] == 0]

# Create a figure with two subplots
fig, axes = plt.subplots(1, 2, figsize=(12, 6))

# Plot the frequency distribution for predicted 'Yes'
sns.histplot(data=yes_predictions, x='Sentiment Score', bins='auto', color='blue', alp
axes[0].set_title('Frequency Distribution for Predicted: 1')
axes[0].set_xlabel('Sentiment Score')
axes[0].set_ylabel('Frequency')
axes[0].grid(True)
axes[0].set_xlim(-1, 1)

# Plot the frequency distribution for predicted 'No'
sns.histplot(data=no_predictions, x='Sentiment Score', bins='auto', color='orange', al
axes[1].set_title('Frequency Distribution for Predicted: 0')
axes[1].set_xlabel('Sentiment Score')
axes[1].set_ylabel('Frequency')
axes[1].grid(True)
axes[1].set_xlim(-1, 1)

# Adjust layout to prevent overlapping
plt.tight_layout()

plt.show()
```



Results

- From the confusion matrix, we can observe that the model is better at predicting instances where the price did not rise or remained the same (negative class) compared to instances where the price actually rose (positive class). It has a higher number of true negatives than true positives. However, it is struggling with correctly predicting instances of price rise (true positives) and is also prone to false positives in such cases.
- Frequency distribution graph have been plotted after grouping the predictions on basis of the predction of class variable. Frequency distribution for class variable = 1 (predictiong price rise) shows that as expected sentiment score > 0 which depicts positive sentiment bias predicts the price rise but frequency distribution for class variable = 0 shows contrary results then expected. We expect that this plot should skewed towards the negative sentiment score (negative sentiment score maps to decrease in price (y=0)) but it is skewed towards positive sentiment score.

Naïve Bayes Model

Naïve Bayes Model with Sentiment Polarity

In [52]:
```
data_for_analysis_3 = grouped_df[['Sentiment', '% change in index', '20_Day_MA','Did P
data_for_analysis_3
```

Out[52]:

	Sentiment	% change in index	20_Day_MA	Did Price Rise
0	-1	0.404700	136.462494	1
1	-1	-2.182956	135.113747	1
2	1	-2.182956	135.113747	1
3	0	0.661574	135.939625	1
4	1	1.166575	137.384499	0
...	...	...	...	...
4077	1	-0.136326	157.563000	0
4078	1	-0.343302	160.738001	0
4079	0	-0.583852	164.828500	1
4080	1	-0.523248	158.512501	0
4081	0	-0.523248	158.512501	0

4078 rows × 4 columns

In [53]:
```
y1 = data_for_analysis_3['Did Price Rise']
predictors = data_for_analysis_3.drop(['Did Price Rise'], axis=1)
predictors_train, predictors_test, y_train, y_test = train_test_split(predictors, y1,
predictors_train
```

Out[53]:

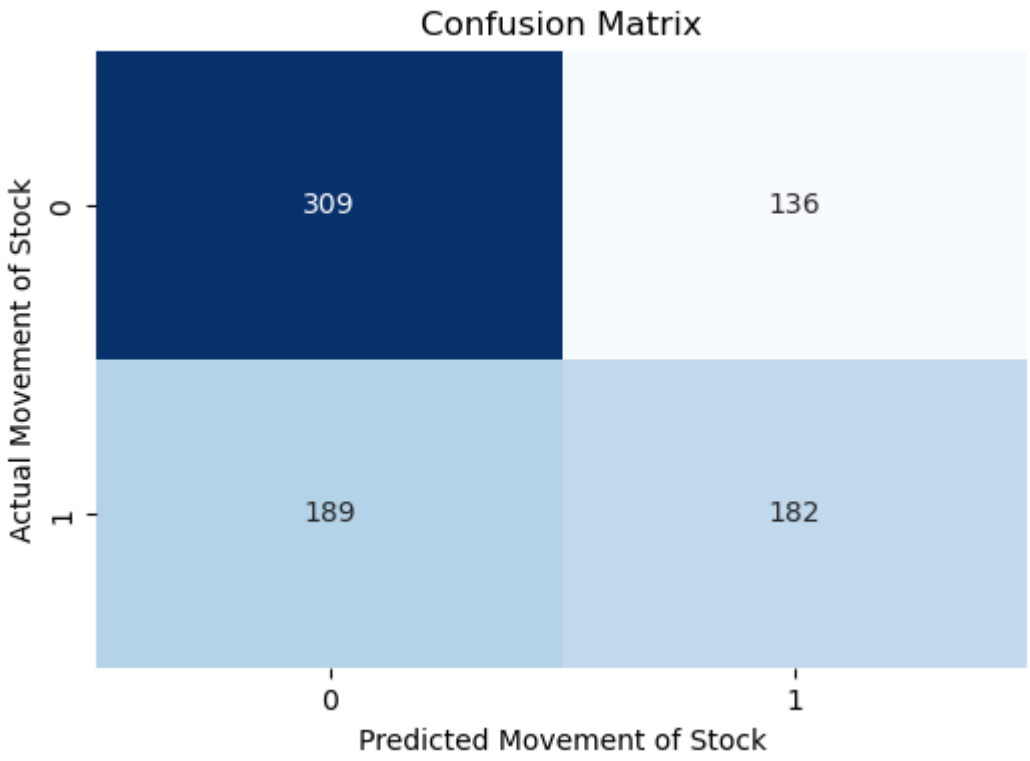
	Sentiment	% change in index	20_Day_MA
998	-1	-0.383452	150.821407
2794	1	0.804899	361.517331
235	1	-0.120901	111.709076
161	1	2.143675	136.786275
3649	1	0.901586	231.834167
...	...	...	...
2510	1	-0.423247	135.290706
2110	-1	-1.630615	153.313509
1640	1	-0.462407	262.955926
1804	1	-0.755543	274.773196
1041	-1	-1.206253	162.626887

3262 rows × 3 columns

In [54]:
```
# Build the Naive Bayes model (Gaussian Naive Bayes)
nb_model_1 = GaussianNB()

# Train the model on the training data
nb_model_1.fit(predictors_train, y_train)

# Make predictions on the test set
y_pred_nb_model_1 = nb_model_1.predict(predictors_test)

# Evaluate the model
Accuracy_of_nb_Model_1 = accuracy_score(y_test, y_pred_nb_model_1)
confusion_matrix_of_nb_Model_1 = confusion_matrix(y_test, y_pred_nb_model_1)

print("Confusion Matrix:")
print(confusion_matrix_of_nb_Model_1)
print("Accuracy of Naive Bayes Model 1:", Accuracy_of_nb_Model_1)
```

```
Confusion Matrix:
[[309 136]
 [189 182]]
Accuracy of Naive Bayes Model 1: 0.6017156862745098
```

In [55]:
```
# Create a heatmap for the confusion matrix
plt.figure(figsize=(6, 4))
sns.heatmap(confusion_matrix_of_nb_Model_1, annot=True, fmt='d', cmap='Blues', cbar=Fa

# Add labels and title
plt.xlabel('Predicted Movement of Stock')
plt.ylabel('Actual Movement of Stock')
plt.title('Confusion Matrix')

# Show the plot
plt.show()
```



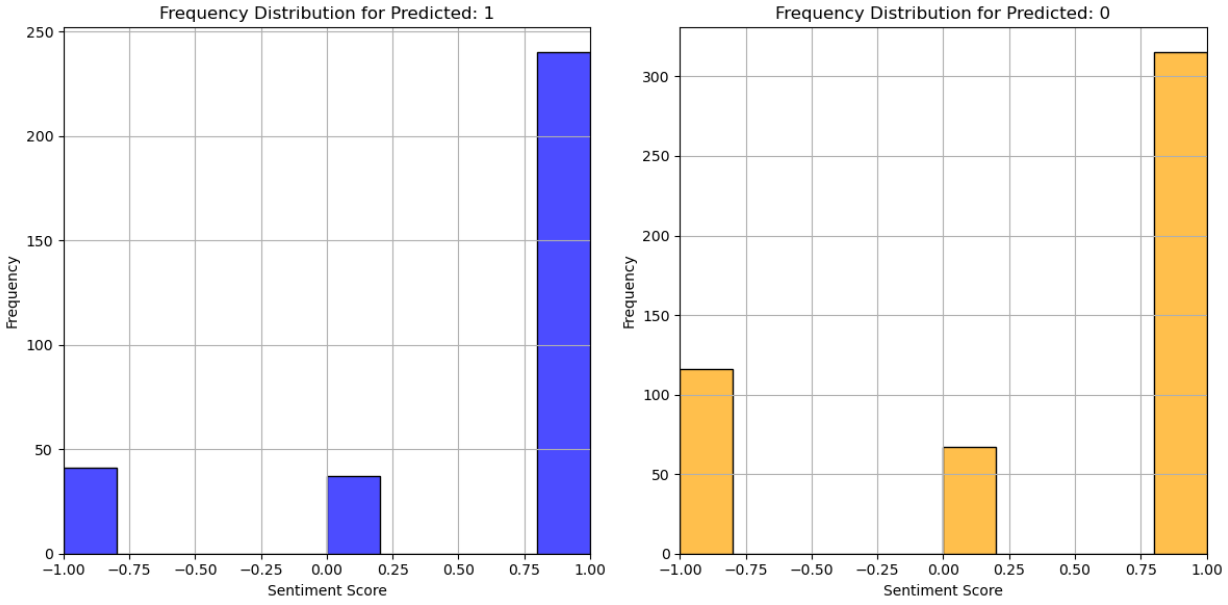
In [56]:
```
# Assuming you have the 'Sentiment_Polarity' column in the 'predictors_test' datafram
# Get the indices of the test set
test_indices = predictors_test.index

# Create a dataframe with the predicted datapoints and their corresponding sentiment p
predicted_data_with_sentiment = pd.DataFrame({
    'Predicted': y_pred_nb_model_1,
    'Sentiment_Polarity': predictors.loc[test_indices, 'Sentiment']
})
predicted_data_with_sentiment
```

Out[56]:

	Predicted	Sentiment_Polarity
268	1	1
809	0	-1
1510	0	1
2632	1	1
86	0	0
...	...	...
1498	1	-1
4049	0	1
2143	0	1
2810	0	1
1366	0	-1

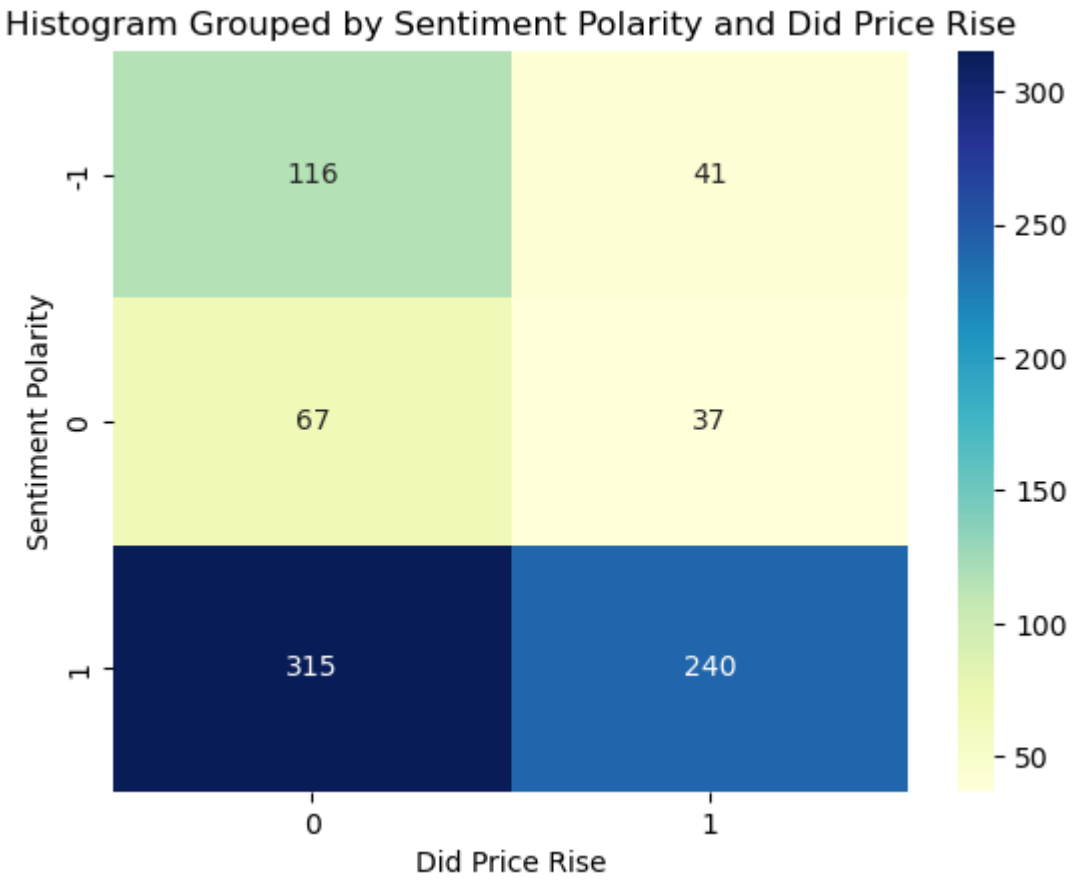
816 rows × 2 columns

In [57]:
```
# Create a DataFrame combining the predicted values and the 'Sentiment Score' from the
result_df = pd.DataFrame({
    'Predicted Did Price': y_pred_nb_model_1,
    'Sentiment Score': predictors_test['Sentiment']
})

# Separate the data into two DataFrames based on predicted values '1' as 'Yes' and '0
yes_predictions = result_df[result_df['Predicted Did Price'] == 1]
no_predictions = result_df[result_df['Predicted Did Price'] == 0]

# Create a figure with two subplots
fig, axes = plt.subplots(1, 2, figsize=(12, 6))

# Plot the frequency distribution for predicted '1'
sns.histplot(data=yes_predictions, x='Sentiment Score', bins='auto', color='blue', alp
axes[0].set_title('Frequency Distribution for Predicted: 1')
axes[0].set_xlabel('Sentiment Score')
axes[0].set_ylabel('Frequency')
axes[0].grid(True)
axes[0].set_xlim(-1, 1)

# Plot the frequency distribution for predicted '0'
sns.histplot(data=no_predictions, x='Sentiment Score', bins='auto', color='orange', al
axes[1].set_title('Frequency Distribution for Predicted: 0')
axes[1].set_xlabel('Sentiment Score')
axes[1].set_ylabel('Frequency')
axes[1].grid(True)
axes[1].set_xlim(-1, 1)

# Adjust layout to prevent overlapping
plt.tight_layout()

plt.show()
```



In [58]:
```
# Create a crosstab to get the counts for each combination of 'Sentiment_Polarity' and
cross_tab = pd.crosstab(predicted_data_with_sentiment['Sentiment_Polarity'], predicted

# Plot the heatmap
sns.heatmap(cross_tab, annot=True, fmt='d', cmap='YlGnBu', cbar=True)
```

```
plt.xlabel('Did Price Rise')
plt.ylabel('Sentiment Polarity')
plt.title('Histogram Grouped by Sentiment Polarity and Did Price Rise')
plt.show()
```



Results

- The Naïve Bayes model and the logistic regression model yield similar accuracy results. However, both models exhibit a similar issue: they predict class label '0' even when the sentiment polarity is positive. We anticipated the models to predict a price increase when the sentiment polarity is positive and vice versa, predicting a price decrease when the polarity is negative. This indicates that the models are not fully capturing the relationship between sentiment and price movements, requiring further improvements to achieve the desired predictions.

Naïve Bayes Model with Sentiment Score

In [59]:
```
data_for_analysis_4 = grouped_df[['Sentiment Score', '% change in index', '20_Day_MA',
data_for_analysis_4
```

Out[59]:

	Sentiment Score	% change in index	20_Day_MA	Did Price Rise
0	-0.3182	0.404700	136.462494	1
1	-0.9788	-2.182956	135.113747	1
2	0.8519	-2.182956	135.113747	1
3	0.0000	0.661574	135.939625	1
4	0.7096	1.166575	137.384499	0
...	...	...	...	...
4077	0.6344	-0.136326	157.563000	0
4078	0.5504	-0.343302	160.738001	0
4079	0.0000	-0.583852	164.828500	1
4080	0.5719	-0.523248	158.512501	0
4081	0.0000	-0.523248	158.512501	0

4078 rows × 4 columns

In [60]:
```
y1 = data_for_analysis_4['Did Price Rise']
predictors = data_for_analysis_4.drop(['Did Price Rise'], axis=1)
predictors_train, predictors_test, y_train, y_test = train_test_split(predictors, y1,
predictors_train
```

Out[60]:

	Sentiment Score	% change in index	20_Day_MA
1312	0.0000	-0.670988	328.475082
991	0.0000	-0.142516	149.904383
379	0.0000	0.442074	145.164587
735	0.5994	-1.439505	168.341478
2410	0.3818	2.121358	139.117219
...	...	...	...
2765	0.6124	-1.635301	372.088664
2751	0.9070	0.403368	372.687997
2052	0.0000	1.729094	154.371637
287	0.0000	-1.157676	117.655500
2680	0.9172	0.213282	336.059834

3262 rows × 3 columns

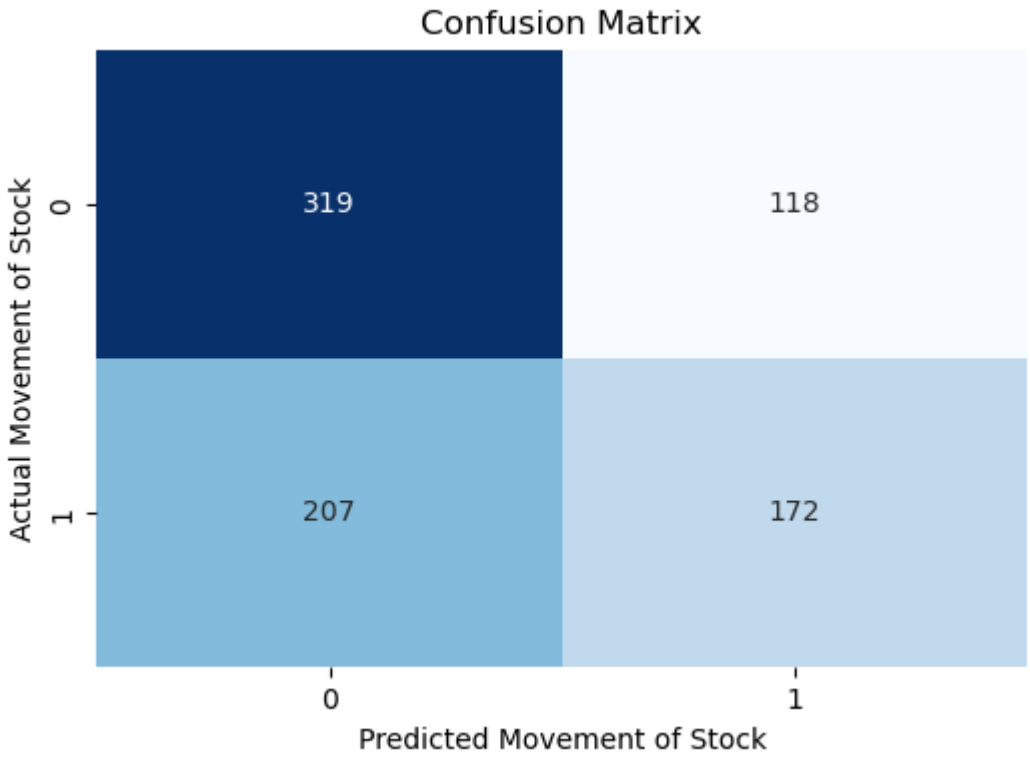
In [61]:
```
# Build the Naive Bayes model (Gaussian Naive Bayes)
nb_model_2 = GaussianNB()

# Train the model on the training data
nb_model_2.fit(predictors_train, y_train)
```

```
# Make predictions on the test set
y_pred_nb_model_2 = nb_model_2.predict(predictors_test)

# Evaluate the model
Accuracy_of_nb_Model_2 = accuracy_score(y_test, y_pred_nb_model_2)
confusion_matrix_of_nb_Model_2 = confusion_matrix(y_test, y_pred_nb_model_2)

print("Confusion Matrix:")
print(confusion_matrix_of_nb_Model_2)
print("Accuracy of Naive Bayes Model 2:", Accuracy_of_nb_Model_2)
```

```
Confusion Matrix:
[[319 118]
 [207 172]]
Accuracy of Naive Bayes Model 2: 0.6017156862745098
```

In [62]:

```
# Create a heatmap for the confusion matrix
plt.figure(figsize=(6, 4))
sns.heatmap(confusion_matrix_of_nb_Model_2, annot=True, fmt='d', cmap='Blues', cbar=Fa

# Add labels and title
plt.xlabel('Predicted Movement of Stock')
plt.ylabel('Actual Movement of Stock')
plt.title('Confusion Matrix')

# Show the plot
plt.show()
```



In [63]:

```
# Assuming you have the 'Sentiment_Polarity' column in the 'predictors_test' datafram
# Get the indices of the test set
test_indices = predictors_test.index

# Create a dataframe with the predicted datapoints and their corresponding sentiment p
predicted_data_with_sentiment = pd.DataFrame({
    'Predicted': y_pred_nb_model_2,
```

```
    'Sentiment_Polarity': predictors.loc[test_indices, 'Sentiment Score']
})
predicted_data_with_sentiment
```

Out[63]:

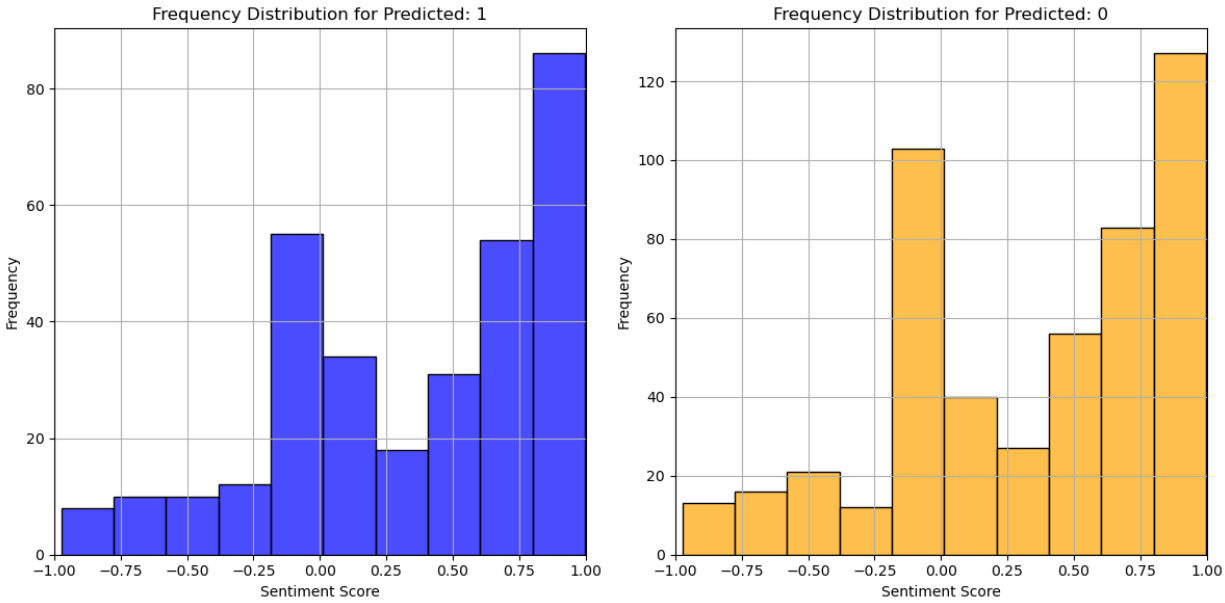
	Predicted	Sentiment_Polarity
1656	1	0.6486
1910	0	0.6858
3427	0	0.9142
437	0	0.0000
1706	1	0.0000
...	...	...
723	0	0.2500
2843	0	0.6124
923	0	0.0000
3099	0	0.7349
1827	0	0.8151

816 rows × 2 columns

In [64]:

```
# Create a DataFrame combining the predicted values and the 'Sentiment Score' from the
result_df = pd.DataFrame({
    'Predicted Did Price': y_pred_nb_model_1,
    'Sentiment Score': predictors_test['Sentiment Score']
})

# Separate the data into two DataFrames based on predicted values '1' as 'Yes' and '0
yes_predictions = result_df[result_df['Predicted Did Price'] == 1]
no_predictions = result_df[result_df['Predicted Did Price'] == 0]

# Create a figure with two subplots
fig, axes = plt.subplots(1, 2, figsize=(12, 6))

# Plot the frequency distribution for predicted '1'
sns.histplot(data=yes_predictions, x='Sentiment Score', bins='auto', color='blue', alp
axes[0].set_title('Frequency Distribution for Predicted: 1')
axes[0].set_xlabel('Sentiment Score')
axes[0].set_ylabel('Frequency')
axes[0].grid(True)
axes[0].set_xlim(-1, 1)

# Plot the frequency distribution for predicted '0'
sns.histplot(data=no_predictions, x='Sentiment Score', bins='auto', color='orange', al
axes[1].set_title('Frequency Distribution for Predicted: 0')
axes[1].set_xlabel('Sentiment Score')
axes[1].set_ylabel('Frequency')
axes[1].grid(True)
axes[1].set_xlim(-1, 1)

# Adjust layout to prevent overlapping
plt.tight_layout()
```

```
plt.show()
```



Results from Naïve Bayes Model with Sentiment Score

- The current model exhibits an accuracy ranging from 55% to 60%, and most of the incorrect predictions are due to false positives.
- Regarding the frequency distribution graph, it illustrates the sentiment score distribution for class label '1' (representing price increase) and class label '0' (representing price decrease). In the frequency distribution of class label '1', we anticipate that the majority of data points will have sentiment scores greater than 0, indicating positive sentiment in the grouped tweets. The distribution confirms this expectation, as it is skewed towards positive sentiment scores.
- However, in the frequency distribution with class label '0', we observe an unexpected skew towards positive sentiment scores rather than being skewed towards the negative sentiment side. This suggests that for a significant number of data points with positive sentiment, the model predicts '0' (price decrease).

Possible Improvements :

- Due to the unsatisfactory performance of both the Logistic Regression and Naïve Bayes models on the data, it would be prudent to investigate whether there is any data imbalance present.
- Considering the limited number of features (only 3), we can explore the addition of new features that can help infer from the data where positive sentiments did not result in a price increase.

- To enrich the model, we can also incorporate additional features such as user influence, the number of tweets related to a stock, and the number of likes received on those tweets. These features might offer valuable information to enhance the predictive capabilities of the model.

- Once we achieve the desired accuracy level with these improvements, we can explore transitioning from binary classification, which predicts price movement, to stock price prediction. This transition would require adapting the model to handle regression tasks, where the model predicts the actual price values rather than binary price movements.

- It is crucial to perform thorough data analysis to identify any data imbalances that might be affecting the models' performance. Addressing data imbalances can lead to better model generalization and more accurate predictions.

- Feature engineering plays a vital role in enhancing model performance. By creating new features that capture meaningful relationships between sentiment, price movements, and other relevant variables, we can potentially gain deeper insights and improve prediction accuracy.

- Introducing user influence, tweet count, and likes as features can provide additional context to the model. Users with high influence might have a more significant impact on stock perceptions, and the number of tweets and likes could represent the level of public engagement.

- Once the models show promising accuracy levels, it is essential to validate their performance on unseen data (e.g., using cross-validation or a separate test set) to ensure robustness and avoid overfitting.

- As we transition to stock price prediction, we need to consider time-series aspects of the data. Time lags, temporal patterns, and seasonality might significantly influence stock prices, requiring the utilization of appropriate time-series modeling techniques.

- Continuous monitoring and updating of the model will be necessary to adapt to changing market conditions, news, and sentiment trends.

Appendix

[1] https://www.kaggle.com/datasets/equinxx/stock-tweets-for-sentiment-analysis-and-prediction by HANNA YUKHYMENKO

[2] Mittal, A., & Goel, A.. Stock Prediction Using Twitter Sentiment Analysis. Unpublished manuscript, Stanford University. Retrieved from [http://cs230.stanford.edu/projects_fall_2021/reports/103158402.pdf]

[3] Singh, S., & Kaur, A. (2022). Twitter sentiment analysis for stock prediction. Paper presented at the 2nd International Conference on "Advancement in Electronics & Communication

Engineering (AECE 2022)", July 14-15, 2022.

[4] Yahoo Finance—Stock Market Live, Quotes, Business & Finance News (n.d.). https://finance.yahoo.com/

In [ ]: