```
# This is formatted as code
```

Stock Price Prediction

```
# Import Packages
import requests
import pandas as pd
from fbprophet import Prophet
import time
import numpy as np

# Turn off scientific notation
pd.set_option('display.float_format', lambda x: '%.5f' % x)


# Import data from Alpha Advantage for selected stock
# Add 30 second delay to prevent reaching API limit of 5 calls per minute

# Create list of stock tickers to loop over
tickers = ['DFS','JPM','AXP','C','BAC','USB','WFC']

# Create URL for AlphaVantage API call
apiKey = 'MH7YI4PH913XPSUP'
func = 'TIME_SERIES_DAILY'

#Create empty dataframe to store results of all tickers
df = pd.DataFrame()

# Loop over tickers and concatenate results to dataframe
for i in tickers:
  # Create empty dataframe to store results of loop
  df_tmp = pd.DataFrame()
  df_temp = pd.read_csv('https://www.alphavantage.co/query?function='+func+'&symbol='+i+'&api
)
  df_temp['ticker'] = i
  df = pd.concat([df, df_temp], axis=0)

  # Wait 30 seconds before next running loop
  time.sleep(30)


# Write data to CSV for use later
df.to_csv('stock_data.csv')


# View data sample
df.head()
```

	timestamp	open	high	low	close	volume	ticker
0	2022-07-26	99.00000	100.16000	98.09000	98.36000	1567767	DFS
1	2022-07-25	100.00000	100.81000	98.21000	100.02000	2002694	DFS
2	2022-07-22	99.59000	101.30000	99.07000	100.00000	2633650	DFS
3	2022-07-21	102.01000	103.14000	98.30000	100.00000	6521437	DFS
4	2022-07-20	108.49000	109.94500	107.96000	109.80000	2425198	DFS

```
# View data shape
df.shape
```

```
(38126, 7)
```

```
# Verify all data has been selected
df['ticker'].value_counts()
```

```
JPM    5720
AXP    5720
C      5720
BAC    5720
USB    5720
WFC    5720
DFS    3806
Name: ticker, dtype: int64
```

```
# Check date ranges of selected tickers
for i in tickers:
  print(i)
  tmp = df[df.ticker==i]
  print('Minimum Date in Data '+str(min(tmp['timestamp'])))
  print('Maximum Date in Data '+str(max(tmp['timestamp'])))
```

```
DFS
Minimum Date in Data 2007-06-14
Maximum Date in Data 2022-07-26
JPM
Minimum Date in Data 1999-11-01
Maximum Date in Data 2022-07-26
AXP
Minimum Date in Data 1999-11-01
Maximum Date in Data 2022-07-26
C
Minimum Date in Data 1999-11-01
Maximum Date in Data 2022-07-26
BAC
Minimum Date in Data 1999-11-01
Maximum Date in Data 2022-07-26
USB
```

```
     Minimum Date in Data 1999-11-01
     Maximum Date in Data 2022-07-26
     WFC
     Minimum Date in Data 1999-11-01
     Maximum Date in Data 2022-07-26
```

```
# Check Format of date field
df['timestamp'].dtype
```

```
     dtype('O')
```

```
# Convert timestamp to datetime data type
df['timestamp'] = df['timestamp'].astype('datetime64[ns]')
```

```
# Check Format of date field after change
df['timestamp'].dtype
```

```
     dtype('<M8[ns]')
```

```
# Check output of changed date field
df['timestamp']
```

```
     0      2022-07-26
     1      2022-07-25
     2      2022-07-22
     3      2022-07-21
     4      2022-07-20
               ...
     5715   1999-11-05
     5716   1999-11-04
     5717   1999-11-03
     5718   1999-11-02
     5719   1999-11-01
     Name: timestamp, Length: 38126, dtype: datetime64[ns]
```

```
# Create dataframe to analyze close value
df = df[['ticker','close','timestamp']]
```

View Stats of Data

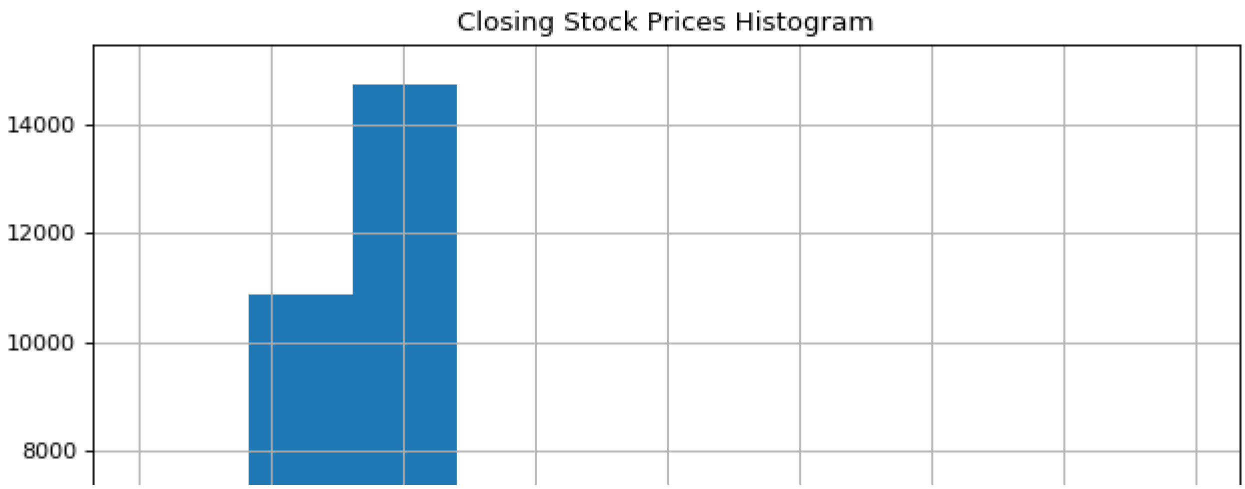
```
# View statistical details of all tickers

# Initialize DataFrame with statistics on closing column for all stock
df_desc = df.describe()
df_desc.rename(columns={'close':'all'},inplace = True)
```

```
# Add columns to DataFrame with statistics on closing column for each stock
for i in tickers:
  df_n = df[(df.ticker==i)]
  df_n_desc = df_n.describe()
  df_n_desc.rename(columns={'close':i},inplace = True)
  df_desc = pd.concat([df_desc, df_n_desc], axis=1)

print("Closing Stock Price Summary Statistics")
df_desc
```

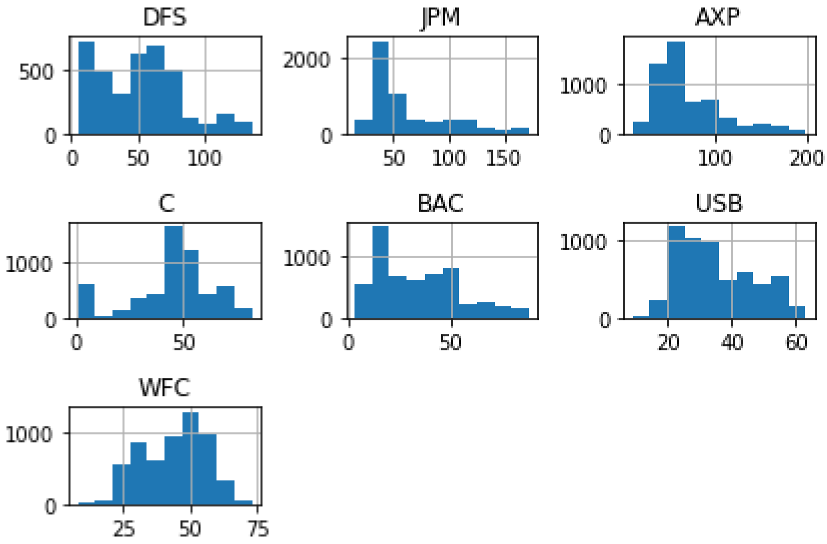
```
Closing Stock Price Summary Statistics
```

	all	DFS	JPM	AXP	C	BAC	USB
count	38126.00000	3806.00000	5720.00000	5720.00000	5720.00000	5720.00000	5720.00000
mean	49.14313	51.81464	62.96439	71.42865	45.09183	34.45394	35.16919
std	28.54789	30.36424	35.01464	37.00227	18.97208	20.86484	11.86619
min	1.02000	4.89000	15.45000	10.26000	1.02000	3.14000	8.82000
25%	30.97250	23.41000	38.49000	45.80000	37.98750	15.75000	25.03750
50%	45.81000	54.27000	47.36000	57.71500	48.27000	29.92000	32.44000
75%	57.74000	70.57500	83.91750	89.76250	54.88000	48.27250	43.67000
max	198.38000	135.38000	171.78000	198.38000	81.91000	89.01000	63.25000

```
# View Histogram of Data
import matplotlib.pyplot as plt
from matplotlib.pyplot import figure

figure(figsize=(8, 6), dpi=80)

df['close'].hist()
plt.title('Closing Stock Prices Histogram')
plt.tight_layout()
plt.show()
```

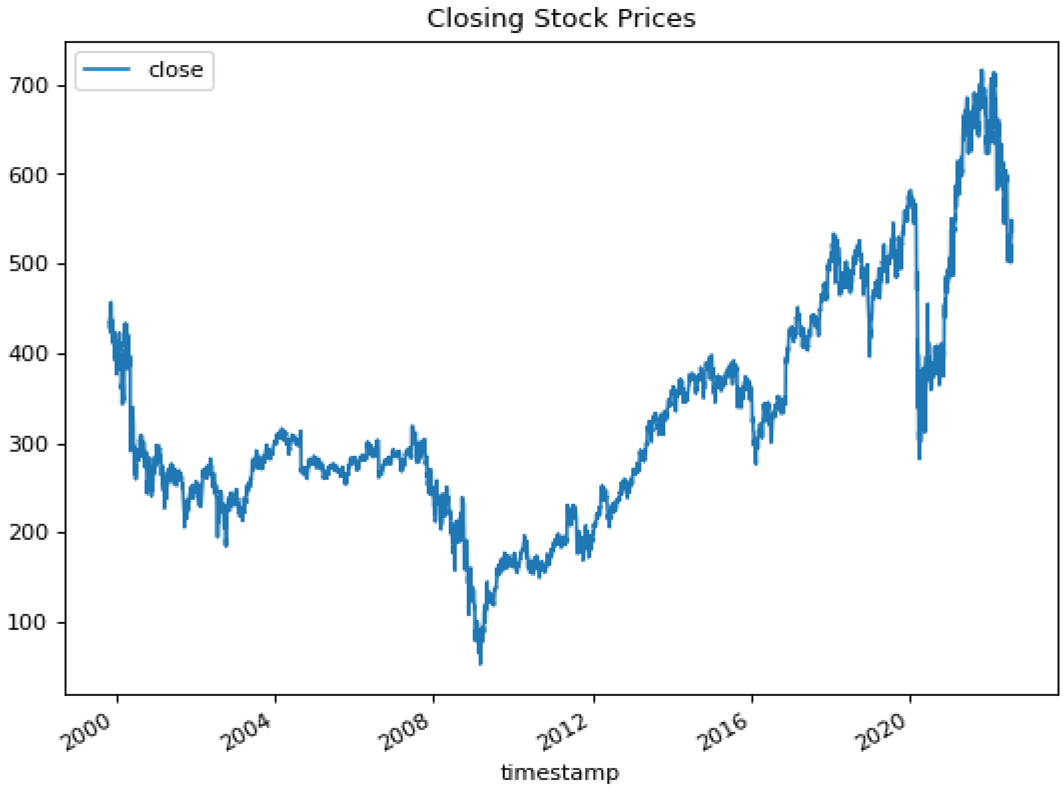


```
# View histogram for each stock
n=1
for i in tickers:
  df_n = df[(df.ticker==i)]
  plt.subplot(3,3,n)
  df_n['close'].hist()
  plt.title(i)
  plt.tight_layout()
  n=n+1

plt.show()
```



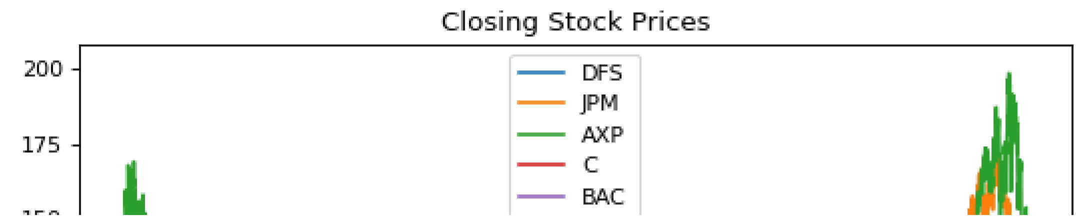
```
# Plot closing prices for all stocks over time
figure(figsize=(8, 6), dpi=80)

ax = plt.gca()
df_sum = df.groupby(['timestamp']).sum()
df_sum = df_sum.reset_index()

df_sum.plot(kind='line',x='timestamp',y='close', ax=ax, title='Closing Stock Prices')
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7fb299e24650>
```



```
# Plot closing prices for each stock over time
figure(figsize=(8, 6), dpi=80)

ax = plt.gca()

for i in tickers:
  df_n = df[(df.ticker==i)]
  df_n.plot(kind='line',x='timestamp',y='close',label=i, ax=ax, title='Closing Stock Prices')

plt.legend(tickers)
```

```
<matplotlib.legend.Legend at 0x7fb299ff49d0>
```



Model

```
df.head()
```

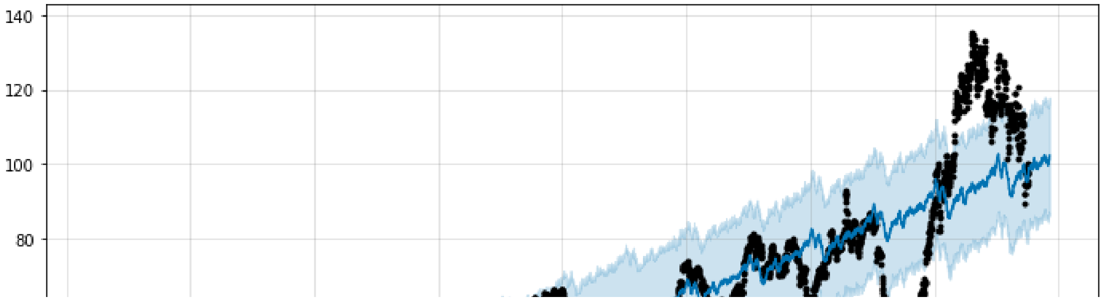
	ticker	close	timestamp
0	DFS	98.36000	2022-07-26
1	DFS	100.02000	2022-07-25
2	DFS	100.00000	2022-07-22
3	DFS	100.00000	2022-07-21
4	DFS	109.80000	2022-07-20

```
# Make dataframe for each stock for model
d = {}
for i in tickers:
  d[i] = df[(df.ticker==i)]
  d[i] = d[i][['timestamp','close']]
  d[i].columns = ['ds','y']



# Create Stock Market Holiday Schedule :

mlk = pd.DataFrame({
  'holiday': 'mlk',
  'ds': pd.to_datetime(['2008-01-21','2009-01-19','2010-01-18','2011-01-17'
                        ,'2012-01-16','2013-01-21','2014-01-20','2015-01-19'
                        ,'2016-01-18','2017-01-16','2018-01-15','2019-01-21'
                        ,'2020-01-20','2021-01-18','2022-01-17'])
})


presday = pd.DataFrame({
  'holiday': 'presday',
  'ds': pd.to_datetime(['2008-02-18','2009-02-16','2010-02-15','2011-02-21'
                        ,'2012-02-20','2013-02-18','2014-02-17','2015-02-16'
                        ,'2016-02-15','2017-02-20','2018-02-19','2019-02-18'
                        ,'2020-02-17','2021-02-15','2022-02-21'])
})

goodfriday = pd.DataFrame({
  'holiday': 'goodfriday',
  'ds': pd.to_datetime(['2008-03-21','2009-04-10','2010-04-02','2011-04-22'
                        ,'2012-04-06','2013-03-29','2014-04-18','2015-04-03'
                        ,'2016-03-25','2017-04-14','2018-03-30','2019-04-19'
                        ,'2020-04-10','2021-04-02','2022-04-15'])
})

memorial = pd.DataFrame({
  'holiday': 'memorial',
  'ds': pd.to_datetime(['2008-05-26','2009-05-25','2010-05-31','2011-05-30'
                        ,'2012-05-28','2013-05-27','2014-05-26','2015-05-25'
                        ,'2016-05-30','2017-05-29','2018-05-28','2019-05-27'
                        ,'2020-05-25','2021-05-31','2022-05-30'])
})

juneteenth = pd.DataFrame({
  'holiday': 'juneteenth',
  'ds': pd.to_datetime(['2021-06-18','2009-05-20'])
})

independece = pd.DataFrame({
  'holiday': 'independece',
  'ds': pd.to_datetime(['2008-07-04','2009-07-03','2010-07-05','2011-07-04'
                        ,'2012-07-04','2013-07-04','2014-07-04','2015-07-03'
                        ,'2016-07-04','2017-07-04','2018-07-04','2019-07-04'
                        ,'2020-07-03','2021-07-05','2022-07-04'])
})

thanksgiving = pd.DataFrame({
  'holiday': 'thanksgiving',
  'ds': pd.to_datetime(['2008-11-27','2009-11-26','2010-11-25','2011-11-24'
                        ,'2012-11-22','2013-11-28','2014-11-27','2015-11-26'
                        ,'2016-11-24','2017-11-23','2018-11-22','2019-11-28'
                        ,'2020-11-26','2021-11-25','2022-11-24']),
                        'lower_window': 0,
                        'upper_window': 1
})


christmas = pd.DataFrame({
  'holiday': 'Christmas',
  'ds': pd.to_datetime(['2008-12-25','2009-12-25','2010-12-25','2011-12-25'
                        ,'2012-12-25','2013-12-25','2014-12-25','2015-12-25'
                        ,'2016-12-25','2017-12-25','2018-12-25','2019-12-25'
                        ,'2020-12-25','2021-12-25','2022-12-25']),
                        'lower_window': -1,
                        'upper_window': 0
})
```

```
holidays = pd.concat((mlk, presday, goodfriday, memorial, juneteenth,
                      independece, thanksgiving, christmas))


# Split data into train and test

from statsmodels.tools.eval_measures import rmse
from datetime import datetime

def mean_absolute_percentage_error(y_true, y_pred):
    y_true, y_pred = np.array(y_true), np.array(y_pred)
    return np.mean(np.abs((y_true - y_pred) / y_true))

def stock_pred(data, iterations, dt):
  global results
  results_tmp = pd.DataFrame()
  test_len = iterations
  df_test = data[:test_len]
  df_train = data[test_len:]

  print("**********Stock: "+ i +"**********")
  print("----Training Data ----")
  print("Training data size: "+str(len(df_train)))
  print("Training Min Date: "+str(min(df_train['ds'])))
  print("Training Max Date: "+str(max(df_train['ds'])))

  print("""
  ----Testing Data ----""")
  df_test_min = min(df_test['ds'])
  df_test_max = max(df_test['ds'])
  print("Testing data size: "+str(len(df_test)))
  print("Testing Min Date: "+str(df_test_min))
  print("Testing Max Date: "+str(df_test_max))


  ##### Model

  m = Prophet(
    growth='linear',
    #daily_seasonality=False,
    #weekly_seasonality=True,
    #yearly_seasonality=True,
    holidays=holidays,
    changepoint_prior_scale=0.001,
    seasonality_mode="multiplicative"
    ).add_seasonality(
      name='monthly',
      period=30.5,
      fourier_order=5
    ).add_seasonality(
      name='quarterly',
      period=365.25/4,
      fourier_order=5,
      prior_scale=15)
  m.fit(df_train)

  # Create dataframe with the dates we want to predict
  future = m.make_future_dataframe(periods=120, freq='D')

  # Eliminate weekends from the future dataframe
  future['day'] = future['ds'].dt.weekday
  future = future[future['day']<=4]

  forecast=m.predict(future)

  # Plotting
  m.plot(forecast, uncertainty=True)
  plt.show()

  ax=forecast.plot(x='ds',y='yhat',legend=True,label='predictions',figsize=(12,8))
  df_test.plot(x='ds',y='y',legend=True,label='True Test Data',ax=ax,xlim=(df_test_min,df_tes
  plt.show()

  y_pred = forecast.iloc[-iterations:]['yhat']
  y_true = df_test['y']

  ## Scoring Model
  RMSE =   rmse(y_pred, y_true)
  MAPE = mean_absolute_percentage_error(y_pred, y_true)

  dt = datetime.strptime(dt, '%Y-%m-%d')
  n_preds = forecast[forecast['ds']>=dt]

  tempdict = {
      'stock': i,
      'RMSE': RMSE,
      'MAPE': MAPE,
      'actual_dt': data['ds'].head(1),
      'actual': data['y'].head(1),

      'forecast_1_dt': n_preds['ds'].iloc[1],
      'forecast_1': n_preds['yhat'].iloc[1],

      'forecast_2_dt': n_preds['ds'].iloc[2],
      'forecast_2': n_preds['yhat'].iloc[2],

      'forecast_3_dt': n_preds['ds'].iloc[3],
      'forecast_3': n_preds['yhat'].iloc[3],
  }
```

```
  results_tmp = pd.DataFrame(tempdict, index=[0])

  print("RMSE: "+str(RMSE))
  print('MAPE: '+str(MAPE))

  print(results_tmp)
  print("--------------")
  print(data['ds'].loc[data['ds']==dt])
  results = pd.concat([results,results_tmp])



results = pd.DataFrame()

for i in d:
  stock_pred(d[i],10, '2022-07-26')
```

```
INFO:fbprophet:Disabling daily seasonality. Run prophet with daily_seasona
**********Stock: DFS**********
----Training Data ----
Training data size: 3796
Training Min Date: 2007-06-14 00:00:00
Training Max Date: 2022-07-12 00:00:00

  ----Testing Data ----
Testing data size: 10
Testing Min Date: 2022-07-13 00:00:00
Testing Max Date: 2022-07-26 00:00:00
```



```
results
```

	stock	RMSE	MAPE	actual_dt	actual	forecast_1_dt	forecast_1
0	DFS	4.45558	0.03345	2022-07-26	98.36000	2022-07-27	99.97981
0	JPM	40.69932	0.26367	2022-07-26	113.42000	2022-07-27	146.53384
0	AXP	10.92461	0.05475	2022-07-26	149.83000	2022-07-27	148.03265
0	C	23.58177	0.31773	2022-07-26	51.40000	2022-07-27	74.92827

```
results['FC_1_diff']= results['forecast_1'] - results['actual']
results['FC_2_diff']= results['forecast_2'] - results['actual']
results['FC_3_diff']= results['forecast_3'] - results['actual']

results['3_day_gain_avg'] = (results['FC_1_diff'] + results['FC_2_diff'] + results['FC_3_diff
```

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```
results
```

	stock	RMSE	MAPE	actual_dt	actual	forecast_1_dt	forecast_1
0	DFS	4.45558	0.03345	2022-07-26	98.36000	2022-07-27	99.97981
0	JPM	40.69932	0.26367	2022-07-26	113.42000	2022-07-27	146.53384
0	AXP	10.92461	0.05475	2022-07-26	149.83000	2022-07-27	148.03265
0	C	23.58177	0.31773	2022-07-26	51.40000	2022-07-27	74.92827