Group2_FinalProject

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1 Introduction to Machine Learning and AI

2 Final-Project Thinking about Purchasing Stock Case Study

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3.1 Import relevant packages

[1]:

```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sn
import datetime
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import MinMaxScaler
from sklearn.ensemble import RandomForestRegressor, AdaBoostRegressor,␣
 ↪GradientBoostingRegressor
from sklearn.linear_model import LinearRegression
from sklearn.tree import DecisionTreeRegressor
from sklearn.neighbors import KNeighborsRegressor
from sklearn.svm import SVR

plt.style.use('ggplot')
```

3.2 Import the data set

[2]:

```
FILE1 = "csv_file\Apple.csv"
FILE2 = "csv_file\Microsoft.csv"
df_apple = pd.read_csv(FILE1)
df_microsoft = pd.read_csv(FILE2)
```

3.3 Data Cleansing

[3]:

```
print(df_apple.isnull().any())
print(df_microsoft.isnull().any())
# No value is missing in these 2 data sets
```

```
Date         False
Open         False
High         False
Low          False
Close        False
Adj Close    False
Volume       False
dtype: bool
Date         False
Open         False
High         False
Low          False
Close        False
Adj Close    False
Volume       False
dtype: bool
```

3.3.1 Drop 2020 data

[4]:

```
df_apple = df_apple[df_apple["Date"].str.contains("2020") == False]
df_microsoft = df_microsoft[df_microsoft["Date"].str.contains("2020") == False]
# The 2020 data is not needed at all due to COVID-19 impacts.
```

3.3.2 Turn the date into index

[5]:

```
df_apple['Date'] = pd.to_datetime(df_apple.Date, format='%Y-%m-%d')
df_apple.index = df_apple['Date']

df_microsoft['Date'] = pd.to_datetime(df_microsoft.Date, format='%Y-%m-%d')
df_microsoft.index = df_microsoft['Date']
```

3.3.3 The basic info of Apple stock

[6]:

```
print(df_apple.info())
print(df_apple.describe())
print(df_apple.head())
print(df_apple.corr())
print(df_apple.columns)
```

```
<class 'pandas.core.frame.DataFrame'>
DatetimeIndex: 10248 entries, 1980-12-12 to 2022-08-05
Data columns (total 7 columns):
 #   Column     Non-Null Count  Dtype
---  ------     --------------  -----
 0   Date       10248 non-null  datetime64[ns]
 1   Open       10248 non-null  float64
 2   High       10248 non-null  float64
 3   Low        10248 non-null  float64
 4   Close      10248 non-null  float64
 5   Adj Close  10248 non-null  float64
 6   Volume     10248 non-null  int64
dtypes: datetime64[ns](1), float64(5), int64(1)
memory usage: 640.5 KB
None
               Open          High           Low         Close     Adj Close  \
count  10248.000000  10248.000000  10248.000000  10248.000000  10248.000000
mean      13.199479     13.339672     13.061867     13.206506     12.570622
std       30.388313     30.738308     30.062666     30.418153     30.107344
min        0.049665      0.049665      0.049107      0.049107      0.038276
25%        0.276786      0.283549      0.269208      0.276786      0.231130
50%        0.453437      0.462054      0.444911      0.453125      0.374543
75%       12.492678     12.591964     12.394285     12.515179     10.685858
max      182.630005    182.940002    179.119995    182.009995    181.259933

             Volume
count  1.024800e+04
mean   3.342945e+08
std    3.414985e+08
min    0.000000e+00
25%    1.238944e+08
50%    2.226140e+08
75%    4.182024e+08
max    7.421641e+09
                 Date      Open      High       Low     Close  Adj Close  \
Date
1980-12-12 1980-12-12  0.128348  0.128906  0.128348  0.128348   0.100039
1980-12-15 1980-12-15  0.122210  0.122210  0.121652  0.121652   0.094820
1980-12-16 1980-12-16  0.113281  0.113281  0.112723  0.112723   0.087861
1980-12-17 1980-12-17  0.115513  0.116071  0.115513  0.115513   0.090035
1980-12-18 1980-12-18  0.118862  0.119420  0.118862  0.118862   0.092646

               Volume
Date
1980-12-12  469033600
1980-12-15  175884800
1980-12-16  105728000
1980-12-17   86441600
1980-12-18   73449600
               Open      High       Low     Close  Adj Close    Volume
Open       1.000000  0.999952  0.999941  0.999869   0.999482 -0.184787
High       0.999952  1.000000  0.999932  0.999938   0.999584 -0.184237
Low        0.999941  0.999932  1.000000  0.999939   0.999535 -0.185668
Close      0.999869  0.999938  0.999939  1.000000   0.999625 -0.184960
Adj Close  0.999482  0.999584  0.999535  0.999625   1.000000 -0.187985
Volume    -0.184787 -0.184237 -0.185668 -0.184960  -0.187985  1.000000
Index(['Date', 'Open', 'High', 'Low', 'Close', 'Adj Close', 'Volume'],
dtype='object')
```

3.3.4 The basic info of Microsoft stock

[7]:

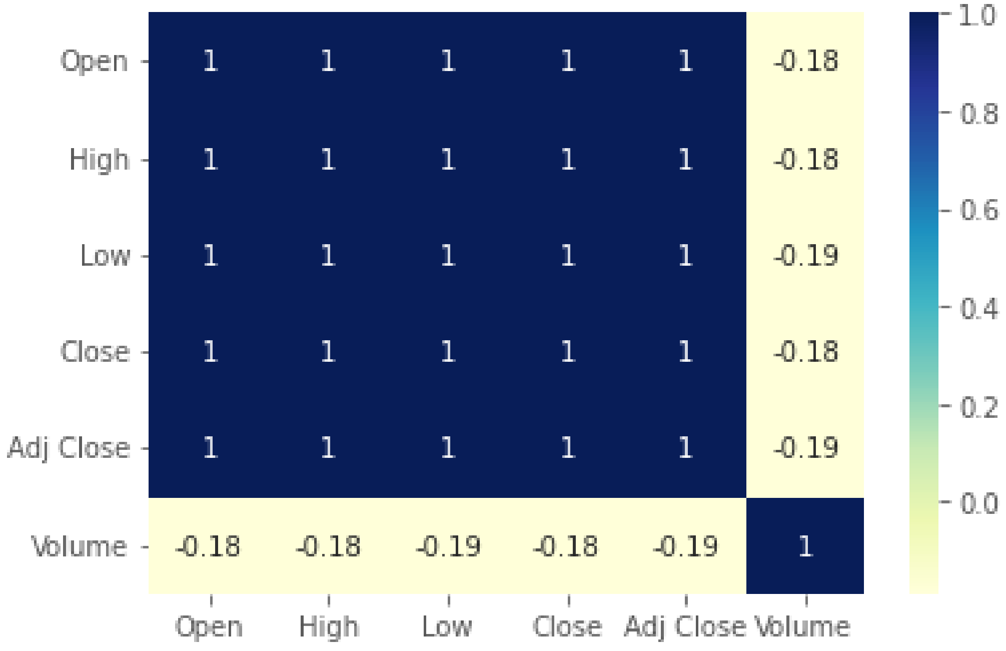
```
print(df_microsoft.info())
print(df_microsoft.describe())
print(df_microsoft.head())
print(df_microsoft.corr())
print(df_microsoft.columns)
```

```
<class 'pandas.core.frame.DataFrame'>
DatetimeIndex: 8922 entries, 1986-03-13 to 2022-08-05
Data columns (total 7 columns):
 #   Column     Non-Null Count  Dtype
---  ------     --------------  -----
 0   Date       8922 non-null   datetime64[ns]
 1   Open       8922 non-null   float64
 2   High       8922 non-null   float64
 3   Low        8922 non-null   float64
 4   Close      8922 non-null   float64
 5   Adj Close  8922 non-null   float64
 6   Volume     8922 non-null   int64
dtypes: datetime64[ns](1), float64(5), int64(1)
memory usage: 557.6 KB
None
              Open         High          Low        Close    Adj Close  \
count  8922.000000  8922.000000  8922.000000  8922.000000  8922.000000
mean     39.405219    39.813412    38.982464    39.412798    34.235384
std      59.241808    59.807334    58.622170    59.252423    59.453134
min       0.088542     0.092014     0.088542     0.090278     0.056745
25%       3.894531     3.945313     3.856445     3.894531     2.447927
50%      26.670000    26.940001    26.365001    26.650000    18.612948
75%      37.577501    37.867500    37.197501    37.525937    27.645862
max     344.619995   349.670013   342.200012   343.109985   341.606354

             Volume
count  8.922000e+03
mean   5.905367e+07
std    3.864768e+07
min    2.304000e+06
25%    3.495510e+07
50%    5.226045e+07
75%    7.294255e+07
max    1.031789e+09
                 Date      Open      High       Low     Close  Adj Close  \
Date
1986-03-13 1986-03-13  0.088542  0.101563  0.088542  0.097222   0.061109
1986-03-14 1986-03-14  0.097222  0.102431  0.097222  0.100694   0.063292
```

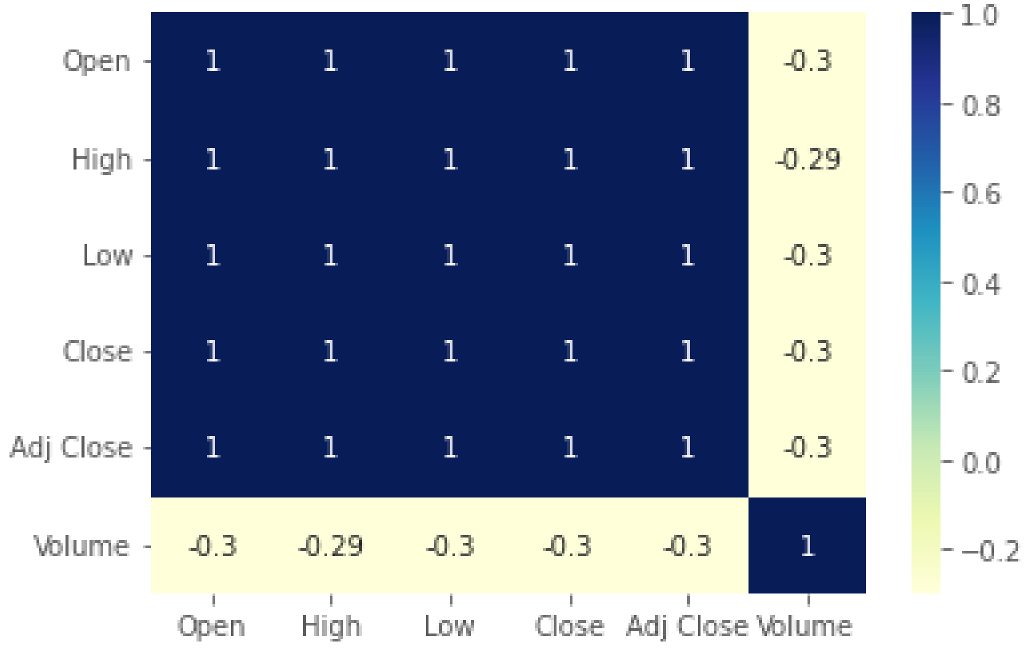
```
1986-03-17 1986-03-17  0.100694  0.103299  0.100694  0.102431   0.064384
1986-03-18 1986-03-18  0.102431  0.103299  0.098958  0.099826   0.062746
1986-03-19 1986-03-19  0.099826  0.100694  0.097222  0.098090   0.061655

                Volume
Date
1986-03-13  1031788800
1986-03-14   308160000
1986-03-17   133171200
1986-03-18    67766400
1986-03-19    47894400
               Open      High       Low     Close  Adj Close    Volume
Open       1.000000  0.999945  0.999928  0.999858   0.997435 -0.296073
High       0.999945  1.000000  0.999912  0.999930   0.997438 -0.294727
Low        0.999928  0.999912  1.000000  0.999934   0.997565 -0.297676
Close      0.999858  0.999930  0.999934  1.000000   0.997576 -0.296285
Adj Close  0.997435  0.997438  0.997565  0.997576   1.000000 -0.298094
Volume    -0.296073 -0.294727 -0.297676 -0.296285  -0.298094  1.000000
Index(['Date', 'Open', 'High', 'Low', 'Close', 'Adj Close', 'Volume'],
dtype='object')
```

3.3.5 check the correlations through heatmap

```
[8]: dataplot = sn.heatmap(df_apple.corr(), cmap='YlGnBu', annot=True)
```



[9]:
```
dataplot = sn.heatmap(df_microsoft.corr(), cmap='YlGnBu', annot=True)
```

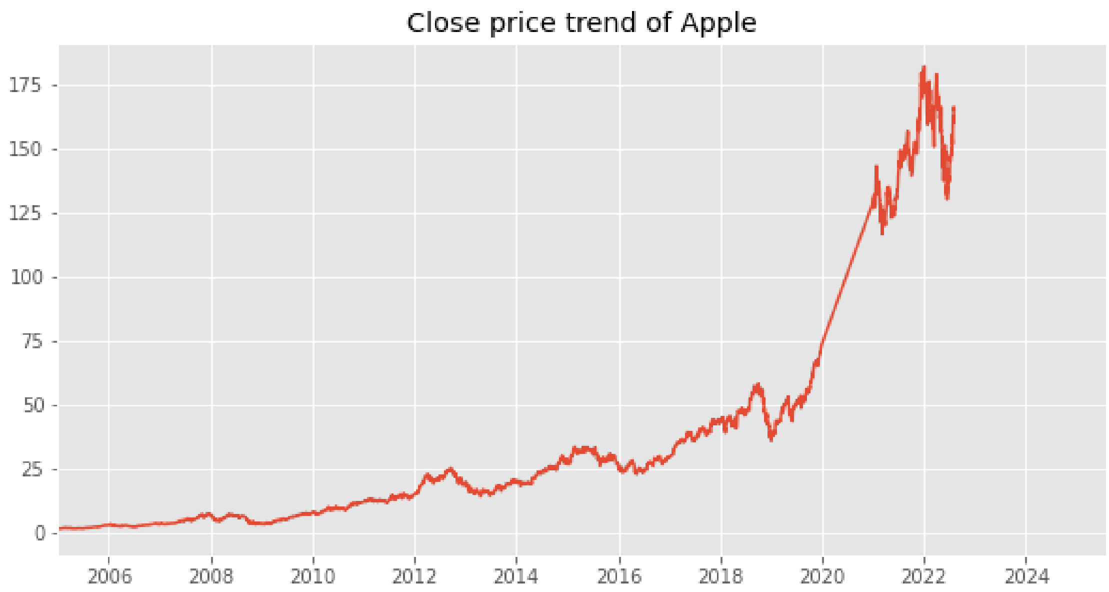


4 Analysis

4.1 Check the trend by close price

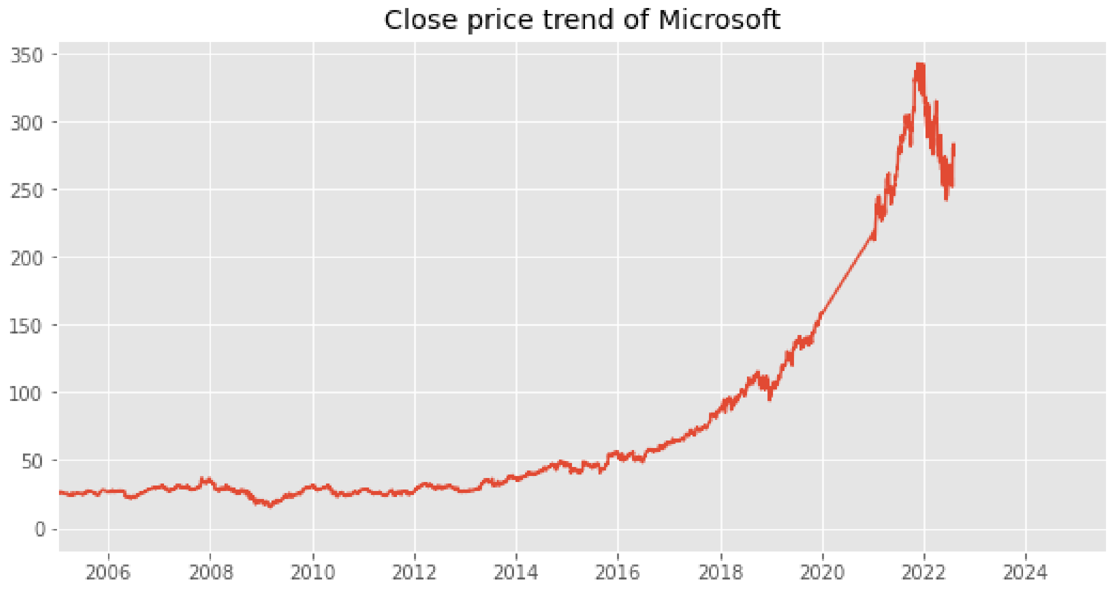
[10]:
```
plt.figure(figsize=(10, 5))
plt.title('Close price trend of Apple')
plt.grid(True)
dstart = datetime.datetime(2005, 1, 1)
dstop = datetime.datetime(2025, 8, 1)
plt.xlim(dstart, dstop)
plt.plot(df_apple['Close'], label='Close Price history')
```

[10]:
```
[<matplotlib.lines.Line2D at 0x15297ee8ac0>]
```



```
[11]: plt.figure(figsize=(10, 5))
      plt.title('Close price trend of Microsoft')
      plt.grid(True)
      dstart = datetime.datetime(2005, 1, 1)
      dstop = datetime.datetime(2025, 8, 1)
      plt.xlim(dstart, dstop)
      plt.plot(df_microsoft['Close'], label='Close Price history')
```

```
[11]: [<matplotlib.lines.Line2D at 0x15297f7f0d0>]
```



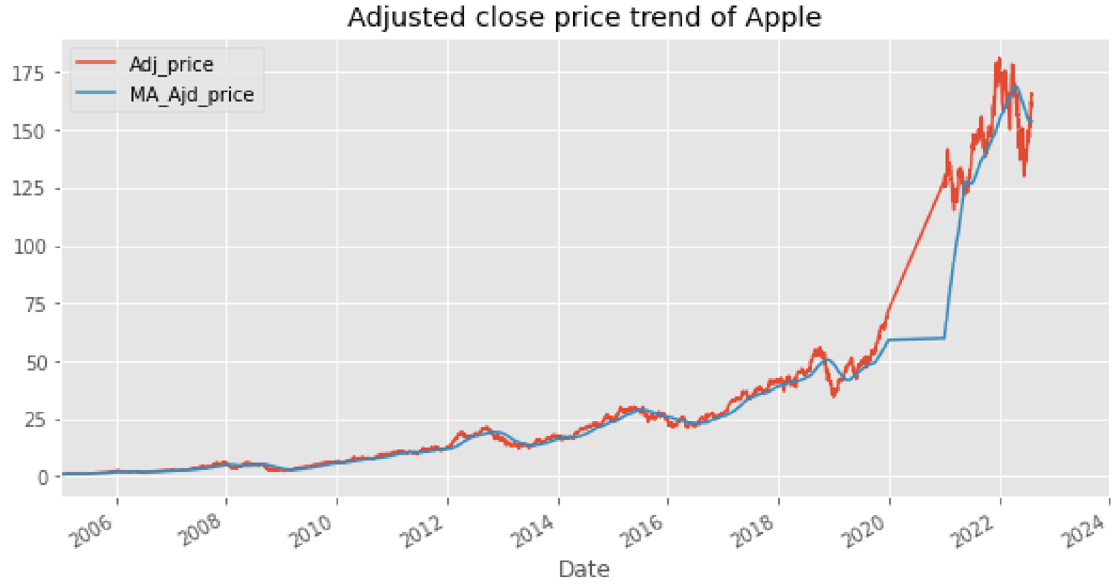
4.2 Check the trend by MA of adjusted price

[12]:

```
adj_price = df_apple['Adj Close']

plt.figure(figsize=(10, 5))
plt.title('Adjusted close price trend of Apple')
plt.grid(True)
MA_adj_price = adj_price.rolling(window=100).mean()
dstart = datetime.datetime(2005, 1, 1)
dstop = datetime.datetime(2024, 1, 1)
plt.xlim(dstart, dstop)
adj_price.plot(label='Adj_price')
MA_adj_price.plot(label='MA_Ajd_price')
plt.legend()
#plt.savefig(r'C:\Users\Marsy\Desktop\1.png',dpi=300, bbox_inches='tight')
```

[12]:

```
<matplotlib.legend.Legend at 0x15298fb3100>
```

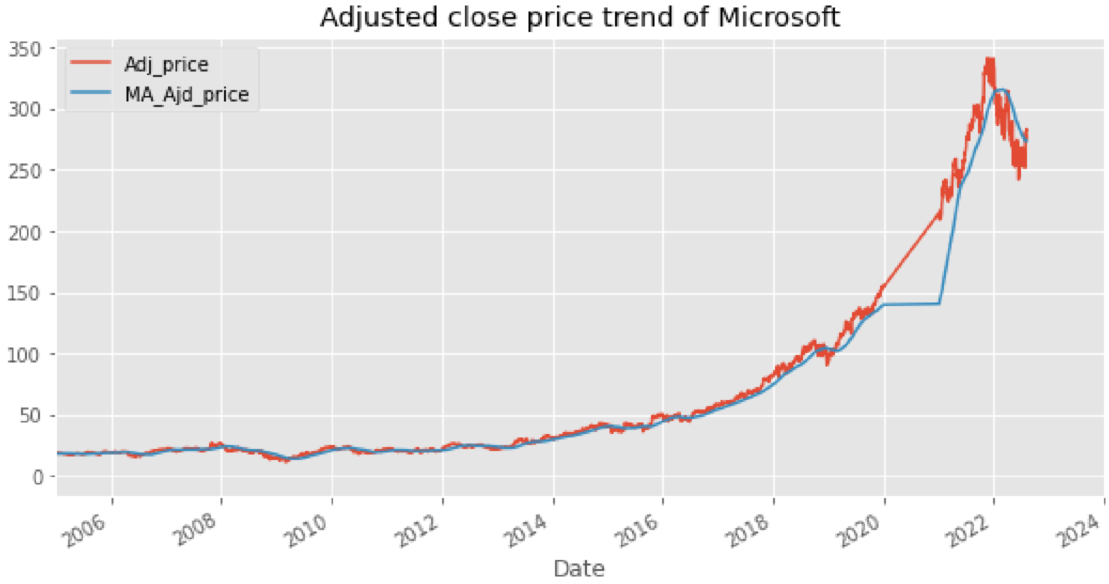


[13]:

```
adj_price = df_microsoft['Adj Close']

plt.figure(figsize=(10, 5))
plt.title('Adjusted close price trend of Microsoft')
plt.grid(True)
MA_adj_price = adj_price.rolling(window=100).mean()
```

```
dstart = datetime.datetime(2005, 1, 1)
dstop = datetime.datetime(2024, 1, 1)
plt.xlim(dstart, dstop)
adj_price.plot(label='Adj_price')
MA_adj_price.plot(label='MA_Ajd_price')
plt.legend()
# plt.savefig(r'C:\Users\Marsy\Desktop\2.png',dpi=300, bbox_inches='tight')
```

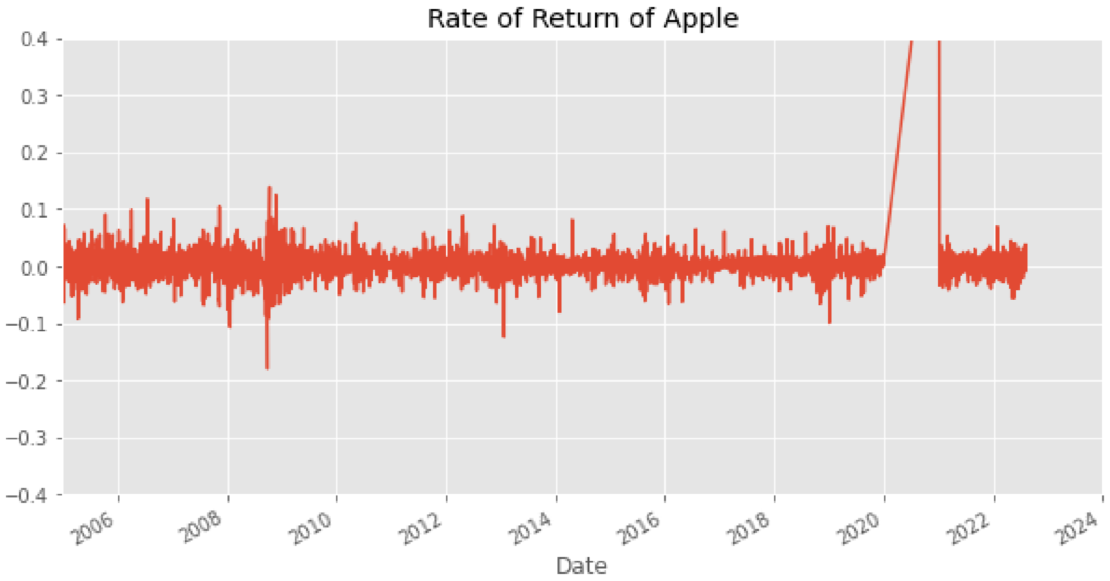
```
[13]: <matplotlib.legend.Legend at 0x15295d0f2e0>
```



4.3 Calculate the Rate of Return by Adj Close

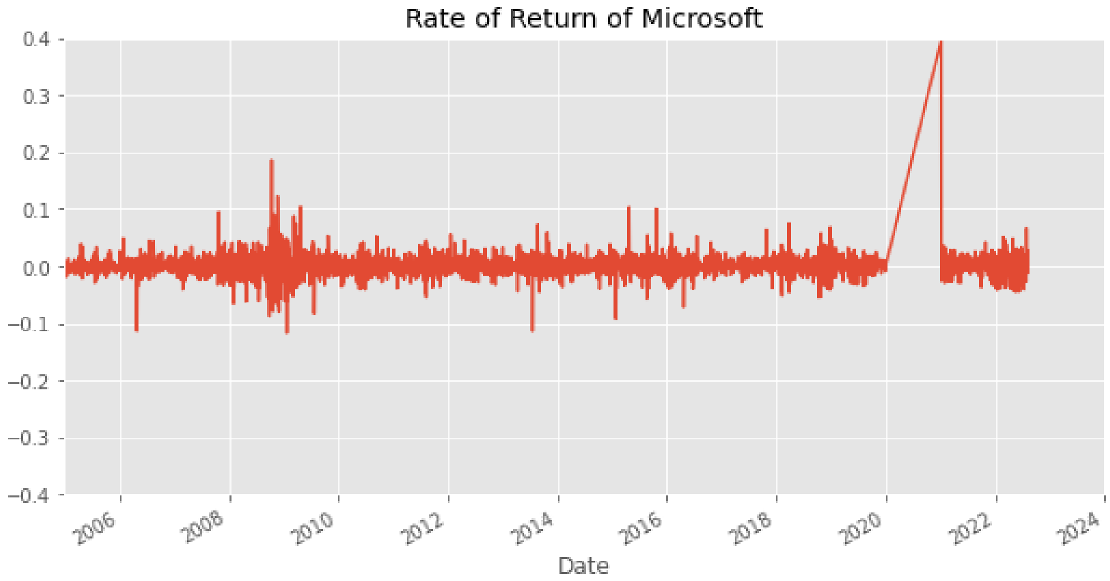
[14]:
```
adj_price = df_apple['Adj Close']

plt.figure(figsize=(10, 5))
plt.title('Rate of Return of Apple')
plt.grid(True)
AP_ror = adj_price / adj_price.shift(1) - 1
dstart = datetime.datetime(2005, 1, 1)
dstop = datetime.datetime(2024, 1, 1)
plt.xlim(dstart, dstop)
plt.ylim([-0.4, 0.4])
AP_ror.plot()
```

```
[14]: <AxesSubplot:title={'center':'Rate of Return of Apple'}, xlabel='Date'>
```



```
[15]: adj_price = df_microsoft['Adj Close']

      plt.figure(figsize=(10, 5))
      plt.title('Rate of Return of Microsoft')
      plt.grid(True)
      MS_ror = adj_price / adj_price.shift(1) - 1
      dstart = datetime.datetime(2005, 1, 1)
      dstop = datetime.datetime(2024, 1, 1)
      plt.xlim(dstart, dstop)
      plt.ylim([-0.4, 0.4])
      MS_ror.plot()
```

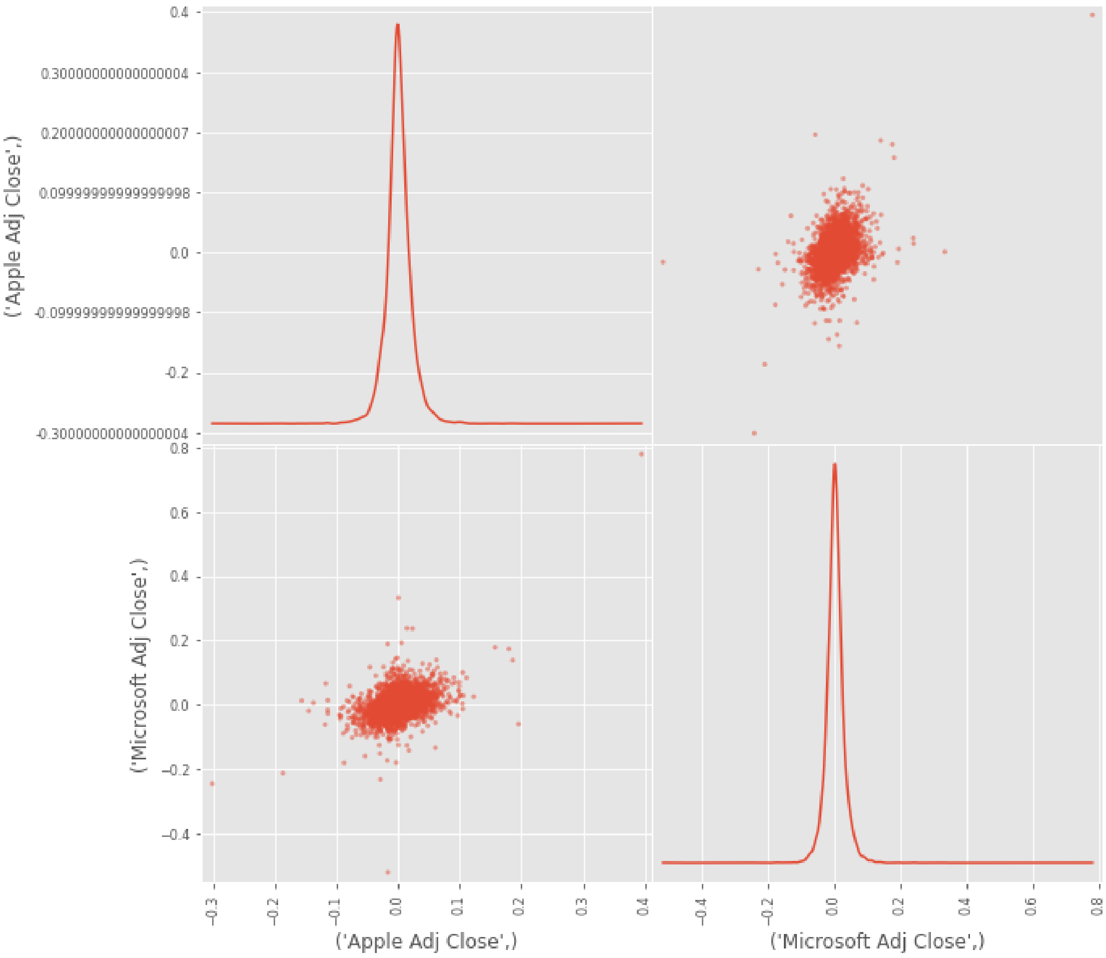
```
[15]: <AxesSubplot:title={'center':'Rate of Return of Microsoft'}, xlabel='Date'>
```



4.4 Check the correlation between stocks

[16]:
```
from pandas.plotting import scatter_matrix

df_adj = pd.concat([df_microsoft['Adj Close'], df_apple['Adj Close']], axis=1)
df_adj.columns = [['Apple Adj Close', 'Microsoft Adj Close']]
scatter_matrix(df_adj.pct_change(), diagonal='kde', figsize=(10, 10))
```

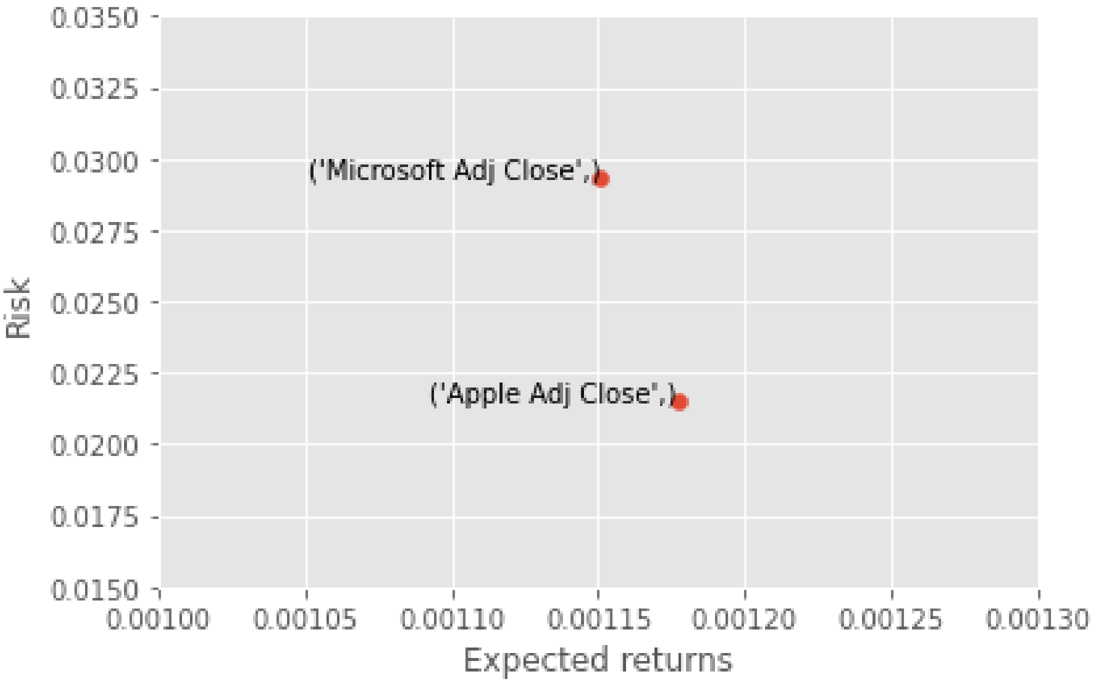
[16]:
```
array([[<AxesSubplot:xlabel="('Apple Adj Close',)", ylabel="('Apple Adj
Close',)">,
        <AxesSubplot:xlabel="('Microsoft Adj Close',)", ylabel="('Apple Adj
Close',)">],
       [<AxesSubplot:xlabel="('Apple Adj Close',)", ylabel="('Microsoft Adj
Close',)">,
        <AxesSubplot:xlabel="('Microsoft Adj Close',)", ylabel="('Microsoft Adj
Close',)">]],
      dtype=object)
```



4.5 Check the Expected Returns and Risk

```
[17]: pct_change = df_adj.pct_change()
      plt.scatter(pct_change.mean(), pct_change.std())
      plt.xlabel('Expected returns')
      plt.ylabel('Risk')
      for label, x, y in zip(pct_change.columns, pct_change.mean(), pct_change.std()):
          plt.text(x, y, label, ha='right')
      plt.xlim([0.001, 0.0013])
      plt.ylim([0.015, 0.035])
```

```
[17]: (0.015, 0.035)
```



4.6 Train the models to predict the trend of adjusted price

4.6.1 Step 1: Add new features

[18]:

```
# copy the original data
df_reg_apple = df_apple.copy().loc[:, ['Adj Close', 'Volume']]
df_reg_microsoft = df_microsoft.copy().loc[:, ['Adj Close', 'Volume']]

# define PCT_change
df_reg_apple['PCT_change'] = (df_apple['Close'] - df_apple['Open']) /␣
 ↪df_apple['Open'] * 100.0
df_reg_microsoft['PCT_change'] = (df_microsoft['Close'] - df_microsoft['Open'])␣
 ↪/ df_microsoft['Open'] * 100.0

# define HL_PCT
df_reg_apple['HL_PCT'] = ((df_apple['High'] - df_apple['Low']) /␣
 ↪df_apple['Close']) * 100.0
df_reg_microsoft['HL_PCT'] = ((df_microsoft['High'] - df_microsoft['Low']) /␣
 ↪df_microsoft['Close']) * 100.0

# define High_Low
df_reg_apple['High_Low'] = ((df_apple['High'] - df_apple['Low']) /␣
 ↪df_apple['Low']) * 100
```

```
df_reg_microsoft['High_Low'] = ((df_microsoft['High'] - df_microsoft['Low']) /␣
 ↪df_microsoft['Low']) * 100

# define Increase_Decrease
df_reg_apple['Increase_Decrease'] = np.where(df_apple['Volume'].shift(-1) >␣
 ↪df_apple['Volume'], 1, 0)
df_reg_microsoft['Increase_Decrease'] = np.where(df_microsoft['Volume'].
 ↪shift(-1) > df_microsoft['Volume'], 1, 0)

# define Buy_Sell_on_Open
df_reg_apple['Buy_Sell_on_Open'] = np.where(df_apple['Open'].shift(-1) >␣
 ↪df_apple['Open'], 1, 0)
df_reg_microsoft['Buy_Sell_on_Open'] = np.where(df_microsoft['Open'].shift(-1)␣
 ↪> df_microsoft['Open'], 1, 0)

# define Buy_Sell
df_reg_apple['Buy_Sell'] = np.where(df_apple['Adj Close'].shift(-1) >␣
 ↪df_apple['Adj Close'], 1, 0)
df_reg_microsoft['Buy_Sell'] = np.where(df_microsoft['Adj Close'].shift(-1) >␣
 ↪df_microsoft['Adj Close'], 1, 0)

# define Returns
df_reg_apple['Returns'] = df_apple['Adj Close'].pct_change()
df_reg_microsoft['Returns'] = df_microsoft['Adj Close'].pct_change()
```

[19]:

```
df_reg_apple.head()
```

[19]:

```
            Adj Close     Volume  PCT_change    HL_PCT  High_Low  \
Date
1980-12-12   0.100039  469033600    0.000000  0.434756  0.434756
1980-12-15   0.094820  175884800   -0.456591  0.458685  0.458685
1980-12-16   0.087861  105728000   -0.492580  0.495019  0.495019
1980-12-17   0.090035   86441600    0.000000  0.483063  0.483063
1980-12-18   0.092646   73449600    0.000000  0.469452  0.469452

            Increase_Decrease  Buy_Sell_on_Open  Buy_Sell   Returns
Date
1980-12-12                  0                 0         0       NaN
1980-12-15                  0                 0         0 -0.052170
1980-12-16                  0                 1         1 -0.073392
1980-12-17                  0                 1         1  0.024744
1980-12-18                  0                 1         1  0.029000
```

[20]:

```
df_reg_microsoft.head()
```

[20]:

```
            Adj Close      Volume  PCT_change     HL_PCT   High_Low  \
Date
```

```
1986-03-13   0.061109  1031788800    9.803257  13.393059  14.706015
1986-03-14   0.063292   308160000    3.571208   5.173099   5.357841
1986-03-17   0.064384   133171200    1.725028   2.543175   2.587046
1986-03-18   0.062746    67766400   -2.543175   4.348567   4.386710
1986-03-19   0.061655    47894400   -1.739026   3.539606   3.571208

            Increase_Decrease  Buy_Sell_on_Open  Buy_Sell   Returns
Date
1986-03-13                  0                 1         1       NaN
1986-03-14                  0                 1         1  0.035723
1986-03-17                  0                 1         0  0.017253
1986-03-18                  0                 0         0 -0.025441
1986-03-19                  1                 0         0 -0.017388
```

4.6.2 Step2: Preprocess the data set

[21]:

```
# drop the null values
df_reg_apple = df_reg_apple.dropna()
df_reg_microsoft = df_reg_microsoft.dropna()

# get the data between 2005-1-1 and 2022-8-1
df_reg_apple = df_reg_apple['2005-1-1':'2022-8-1']
df_reg_microsoft = df_reg_microsoft['2005-1-1':'2022-8-1']

x_apple = df_reg_apple.iloc[:, 1:8].values
x_microsoft = df_reg_microsoft.iloc[:, 1:8].values

y_apple = df_reg_apple['Adj Close'].values
y_microsoft = df_reg_microsoft['Adj Close'].values

# preprocessing
x_apple = MinMaxScaler().fit_transform(x_apple)
x_microsoft = MinMaxScaler().fit_transform(x_microsoft)

# train test split
x_apple_train, x_apple_test, y_apple_train, y_apple_test =␣
 ↪train_test_split(x_apple, y_apple,
                                                                              ␣
 ↪test_size=0.01,
                                                                              ␣
 ↪random_state=17,
                                                                              ␣
 ↪shuffle=True)

x_microsoft_train, x_microsoft_test, y_microsoft_train, y_microsoft_test =␣
 ↪train_test_split(x_microsoft, y_microsoft,
                                                                                  ␣
 ↪           test_size=0.01,
                                                                                  ␣
 ↪           random_state=17,
                                                                                  ␣
 ↪           shuffle=True)
```

[22]:

```
# Train the 7 modelS with Apple data
modelSVR_apple = SVR().fit(x_apple_train, y_apple_train)
modelRFR_apple = RandomForestRegressor().fit(x_apple_train, y_apple_train)
modelABR_apple = AdaBoostRegressor().fit(x_apple_train, y_apple_train)
modelGBR_apple = GradientBoostingRegressor().fit(x_apple_train, y_apple_train)
modelLR_apple = LinearRegression(n_jobs=-1).fit(x_apple_train, y_apple_train)
modelDTR_apple = DecisionTreeRegressor().fit(x_apple_train, y_apple_train)
modelKNR_apple = KNeighborsRegressor(n_neighbors=3).fit(x_apple_train,␣
 ↪y_apple_train)
```

[23]:

```
print('SVR:', modelSVR_apple.score(x_apple_test, y_apple_test))
print('RandomForestRegressor:', modelRFR_apple.score(x_apple_test,␣
 ↪y_apple_test))
print('AdaBoostRegressor:', modelABR_apple.score(x_apple_test, y_apple_test))
print('GradientBoostingRegressor:', modelGBR_apple.score(x_apple_test,␣
 ↪y_apple_test))
print('LinearRegression:', modelLR_apple.score(x_apple_test, y_apple_test))
print('DecisionTreeRegressor:', modelDTR_apple.score(x_apple_test,␣
 ↪y_apple_test))
print('KNeighborsRegressor:', modelKNR_apple.score(x_apple_test, y_apple_test))

# We can see that the RandomForestRegressor has the best score: 0.
 ↪9004766402249255
```

```
SVR: 0.1347301809273994
RandomForestRegressor: 0.9045680896500891
AdaBoostRegressor: 0.792415164212801
GradientBoostingRegressor: 0.8956349972426463
LinearRegression: 0.46750795307588877
DecisionTreeRegressor: 0.5033676509007793
KNeighborsRegressor: 0.7410970518931721
```

[24]:

```
# Train the 7 modelS with Apple data
modelSVR_apple = SVR().fit(x_microsoft_train, y_microsoft_train)
modelRFR_apple = RandomForestRegressor().fit(x_microsoft_train,␣
 ↪y_microsoft_train)
modelABR_apple = AdaBoostRegressor().fit(x_microsoft_train, y_microsoft_train)
modelGBR_apple = GradientBoostingRegressor().fit(x_microsoft_train,␣
 ↪y_microsoft_train)
```

```
modelLR_apple = LinearRegression(n_jobs=-1).fit(x_microsoft_train,␣
 ↪y_microsoft_train)
modelDTR_apple = DecisionTreeRegressor().fit(x_microsoft_train,␣
 ↪y_microsoft_train)
modelKNR_apple = KNeighborsRegressor(n_neighbors=3).fit(x_microsoft_train,␣
 ↪y_microsoft_train)
```

[25]:

```
print('SVR:', modelSVR_apple.score(x_microsoft_test, y_microsoft_test))
print('RandomForestRegressor:', modelRFR_apple.score(x_microsoft_test,␣
 ↪y_microsoft_test))
print('AdaBoostRegressor:', modelABR_apple.score(x_microsoft_test,␣
 ↪y_microsoft_test))
print('GradientBoostingRegressor:', modelGBR_apple.score(x_microsoft_test,␣
 ↪y_microsoft_test))
print('LinearRegression:', modelLR_apple.score(x_microsoft_test,␣
 ↪y_microsoft_test))
print('DecisionTreeRegressor:', modelDTR_apple.score(x_microsoft_test,␣
 ↪y_microsoft_test))
print('KNeighborsRegressor:', modelKNR_apple.score(x_microsoft_test,␣
 ↪y_microsoft_test))

# We can see that the GradientBoostingRegressor has the best score: 0.
 ↪6774150367473095
```

```
SVR: -0.11970083235958495
RandomForestRegressor: 0.7137133330004424
AdaBoostRegressor: 0.27864214333313353
GradientBoostingRegressor: 0.682938278500506
LinearRegression: 0.1651828307485914
DecisionTreeRegressor: -0.39646119529265733
KNeighborsRegressor: 0.318847926671497
```

It seems that the stock price of Apple is more predictable than microsoft.

4.7 Try to predict the adj close by date

[40]:

```
# preprocessing
df_reg_apple = df_apple.copy().loc[:, ['Adj Close']]
df_reg_apple = df_reg_apple['2005-1-1':'2022-8-1']

# encode the date type data
df_reg_apple = df_reg_apple.iloc[:, [0]].reset_index(drop=True)
y_apple_adj = df_reg_apple.values
x_apple_adj = df_reg_apple.index.values.reshape(-1, 1)
print(df_reg_apple)
x_apple_train, x_apple_test, y_apple_train, y_apple_test =␣
 ↪train_test_split(x_apple_adj, y_apple_adj,
                                                                            ␣
 ↪test_size=0.01,
                                                                            ␣
 ↪random_state=19)
```

```
       Adj Close
0       0.964983
1       0.974894
2       0.983432
3       0.984194
4       1.055854
…            …
4167  151.389725
4168  156.572510
4169  157.131744
4170  162.284576
4171  161.285965

[4172 rows x 1 columns]
```

[41]:
```
df_reg_microsoft = df_microsoft.copy().loc[:, ['Adj Close']]
df_reg_microsoft = df_reg_microsoft['2005-1-1':'2022-8-1']
df_reg_microsoft = df_reg_microsoft.iloc[:, [0]].reset_index(drop=True)
y_microsoft_adj = df_reg_microsoft.values
x_microsoft_adj = df_reg_microsoft.index.values.reshape(-1, 1)
print(df_reg_microsoft)

x_microsoft_train, x_microsoft_test, y_microsoft_train, y_microsoft_test =␣
 ↪train_test_split(x_microsoft_adj,
                                                                                ␣
 ↪            y_microsoft_adj,
                                                                                ␣
 ↪            test_size=0.01,
                                                                                ␣
 ↪            random_state=19)
```

```
       Adj Close
0      18.954119
1      19.025005
2      18.982471
3      18.961212
4      18.904505
…            …
4167  251.899994
4168  268.739990
4169  276.410004
4170  280.739990
4171  278.010010
```

```
[4172 rows x 1 columns]
```

[42]:

```
modelSVR_apple = SVR().fit(x_apple_train, y_apple_train)
modelRFR_apple = RandomForestRegressor().fit(x_apple_train, y_apple_train)
modelABR_apple = AdaBoostRegressor().fit(x_apple_train, y_apple_train)
modelGBR_apple = GradientBoostingRegressor().fit(x_apple_train, y_apple_train)
modelLR_apple = LinearRegression(n_jobs=-1).fit(x_apple_train, y_apple_train)
modelDTR_apple = DecisionTreeRegressor().fit(x_apple_train, y_apple_train)
modelKNR_apple = KNeighborsRegressor(n_neighbors=3).fit(x_apple_train,␣
 ↪y_apple_train)

print('SVR:', modelSVR_apple.score(x_apple_test, y_apple_test))
print('RandomForestRegressor:', modelRFR_apple.score(x_apple_test,␣
 ↪y_apple_test))
print('AdaBoostRegressor:', modelABR_apple.score(x_apple_test, y_apple_test))
print('GradientBoostingRegressor:', modelGBR_apple.score(x_apple_test,␣
 ↪y_apple_test))
print('LinearRegression:', modelLR_apple.score(x_apple_test, y_apple_test))
print('DecisionTreeRegressor:', modelDTR_apple.score(x_apple_test,␣
 ↪y_apple_test))
print('KNeighborsRegressor:', modelKNR_apple.score(x_apple_test, y_apple_test))
```

```
c:\Users\ormosia5\AppData\Local\Programs\Python\Python39\lib\site-
packages\sklearn\utils\validation.py:1111: DataConversionWarning: A column-
vector y was passed when a 1d array was expected. Please change the shape of y
to (n_samples, ), for example using ravel().
  y = column_or_1d(y, warn=True)
C:\Users\ormosia5\AppData\Local\Temp\ipykernel_89296\2841234155.py:2:
DataConversionWarning: A column-vector y was passed when a 1d array was
expected. Please change the shape of y to (n_samples,), for example using
ravel().
  modelRFR_apple = RandomForestRegressor().fit(x_apple_train, y_apple_train)
c:\Users\ormosia5\AppData\Local\Programs\Python\Python39\lib\site-
packages\sklearn\utils\validation.py:1111: DataConversionWarning: A column-
vector y was passed when a 1d array was expected. Please change the shape of y
to (n_samples, ), for example using ravel().
  y = column_or_1d(y, warn=True)
c:\Users\ormosia5\AppData\Local\Programs\Python\Python39\lib\site-
packages\sklearn\ensemble\_gb.py:570: DataConversionWarning: A column-vector y
was passed when a 1d array was expected. Please change the shape of y to
(n_samples, ), for example using ravel().
  y = column_or_1d(y, warn=True)
```

```
SVR: 0.9144209675551294
RandomForestRegressor: 0.9997784924262391
AdaBoostRegressor: 0.9858299713311238
GradientBoostingRegressor: 0.9991219486655357
```

```
LinearRegression: 0.6381134088091925
DecisionTreeRegressor: 0.999521941588286
KNeighborsRegressor: 0.9998237811047961
```

[43]:

```
modelSVR_microsoft = SVR().fit(x_microsoft_train, y_microsoft_train)
modelRFR_microsoft = RandomForestRegressor().fit(x_microsoft_train,␣
 ↪y_microsoft_train)
modelABR_microsoft = AdaBoostRegressor().fit(x_microsoft_train,␣
 ↪y_microsoft_train)
modelGBR_microsoft = GradientBoostingRegressor().fit(x_microsoft_train,␣
 ↪y_microsoft_train)
modelLR_microsoft = LinearRegression(n_jobs=-1).fit(x_microsoft_train,␣
 ↪y_microsoft_train)
modelDTR_microsoft = DecisionTreeRegressor().fit(x_microsoft_train,␣
 ↪y_microsoft_train)
modelKNR_microsoft = KNeighborsRegressor(n_neighbors=3).fit(x_microsoft_train,␣
 ↪y_microsoft_train)

print('SVR:', modelSVR_microsoft.score(x_microsoft_test, y_microsoft_test))
print('RandomForestRegressor:', modelRFR_microsoft.score(x_microsoft_test,␣
 ↪y_microsoft_test))
print('AdaBoostRegressor:', modelABR_microsoft.score(x_microsoft_test,␣
 ↪y_microsoft_test))
print('GradientBoostingRegressor:', modelGBR_microsoft.score(x_microsoft_test,␣
 ↪y_microsoft_test))
print('LinearRegression:', modelLR_microsoft.score(x_microsoft_test,␣
 ↪y_microsoft_test))
print('DecisionTreeRegressor:', modelDTR_microsoft.score(x_microsoft_test,␣
 ↪y_microsoft_test))
print('KNeighborsRegressor:', modelKNR_microsoft.score(x_microsoft_test,␣
 ↪y_microsoft_test))
```

```
c:\Users\ormosia5\AppData\Local\Programs\Python\Python39\lib\site-
packages\sklearn\utils\validation.py:1111: DataConversionWarning: A column-
vector y was passed when a 1d array was expected. Please change the shape of y
to (n_samples, ), for example using ravel().
  y = column_or_1d(y, warn=True)
C:\Users\ormosia5\AppData\Local\Temp\ipykernel_89296\68466821.py:2:
DataConversionWarning: A column-vector y was passed when a 1d array was
expected. Please change the shape of y to (n_samples,), for example using
ravel().
  modelRFR_microsoft = RandomForestRegressor().fit(x_microsoft_train,
y_microsoft_train)
c:\Users\ormosia5\AppData\Local\Programs\Python\Python39\lib\site-
packages\sklearn\utils\validation.py:1111: DataConversionWarning: A column-
vector y was passed when a 1d array was expected. Please change the shape of y
to (n_samples, ), for example using ravel().
```

```
  y = column_or_1d(y, warn=True)
c:\Users\ormosia5\AppData\Local\Programs\Python\Python39\lib\site-
packages\sklearn\ensemble\_gb.py:570: DataConversionWarning: A column-vector y
was passed when a 1d array was expected. Please change the shape of y to
(n_samples, ), for example using ravel().
  y = column_or_1d(y, warn=True)
```

```
SVR: 0.886046846266471
RandomForestRegressor: 0.9998783065001243
AdaBoostRegressor: 0.9884833648783818
GradientBoostingRegressor: 0.9997137079984763
LinearRegression: 0.6224787693482164
DecisionTreeRegressor: 0.9997133475396855
KNeighborsRegressor: 0.9998848066914476
```

[44]:

```python
# predict the next day adj close
apple_pred = modelRFR_apple.predict([[4172]])
microsoft_pred = modelRFR_microsoft.predict([[4172]])

print(apple_pred)
print(microsoft_pred)
```

```
[160.57425408]
[277.88970348]
```

[90]:

```python
# predict the next 15 days adj close

DAY = 15
Original_day = 4171

# apple predict and train itself
for i in range(Original_day, Original_day + DAY, 1):
    apple_pred = modelABR_apple.predict([[i]])
    x_apple_adj = np.append(x_apple_adj, [[i]], axis=0)
    y_apple_adj = np.append(y_apple_adj, [apple_pred], axis=0)
    modelABR_apple = AdaBoostRegressor().fit(x_apple_adj, y_apple_adj)

# Microsoft predict and train itself
for i in range(Original_day, Original_day + DAY, 1):
    microsoft_pred = modelABR_microsoft.predict([[i]])
    x_microsoft_adj = np.append(x_microsoft_adj, [[i]], axis=0)
    y_microsoft_adj = np.append(y_microsoft_adj, [microsoft_pred], axis=0)
    modelABR_microsoft = AdaBoostRegressor().fit(x_microsoft_adj,␣
  ↪y_microsoft_adj)
```

```
c:\Users\ormosia5\AppData\Local\Programs\Python\Python39\lib\site-
packages\sklearn\utils\validation.py:1111: DataConversionWarning: A column-
vector y was passed when a 1d array was expected. Please change the shape of y
to (n_samples, ), for example using ravel().
```

```
  y = column_or_1d(y, warn=True)
c:\Users\ormosia5\AppData\Local\Programs\Python\Python39\lib\site-
packages\sklearn\utils\validation.py:1111: DataConversionWarning: A column-
vector y was passed when a 1d array was expected. Please change the shape of y
to (n_samples, ), for example using ravel().
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to (n_samples, ), for example using ravel().
  y = column_or_1d(y, warn=True)
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packages\sklearn\utils\validation.py:1111: DataConversionWarning: A column-
vector y was passed when a 1d array was expected. Please change the shape of y
to (n_samples, ), for example using ravel().
  y = column_or_1d(y, warn=True)
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packages\sklearn\utils\validation.py:1111: DataConversionWarning: A column-
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  y = column_or_1d(y, warn=True)
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  y = column_or_1d(y, warn=True)
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  y = column_or_1d(y, warn=True)
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  y = column_or_1d(y, warn=True)
c:\Users\ormosia5\AppData\Local\Programs\Python\Python39\lib\site-
packages\sklearn\utils\validation.py:1111: DataConversionWarning: A column-
vector y was passed when a 1d array was expected. Please change the shape of y
to (n_samples, ), for example using ravel().
  y = column_or_1d(y, warn=True)
c:\Users\ormosia5\AppData\Local\Programs\Python\Python39\lib\site-
packages\sklearn\utils\validation.py:1111: DataConversionWarning: A column-
```

```
vector y was passed when a 1d array was expected. Please change the shape of y
to (n_samples, ), for example using ravel().
  y = column_or_1d(y, warn=True)
c:\Users\ormosia5\AppData\Local\Programs\Python\Python39\lib\site-
packages\sklearn\utils\validation.py:1111: DataConversionWarning: A column-
vector y was passed when a 1d array was expected. Please change the shape of y
to (n_samples, ), for example using ravel().
  y = column_or_1d(y, warn=True)
c:\Users\ormosia5\AppData\Local\Programs\Python\Python39\lib\site-
packages\sklearn\utils\validation.py:1111: DataConversionWarning: A column-
vector y was passed when a 1d array was expected. Please change the shape of y
to (n_samples, ), for example using ravel().
  y = column_or_1d(y, warn=True)
c:\Users\ormosia5\AppData\Local\Programs\Python\Python39\lib\site-
packages\sklearn\utils\validation.py:1111: DataConversionWarning: A column-
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to (n_samples, ), for example using ravel().
  y = column_or_1d(y, warn=True)
c:\Users\ormosia5\AppData\Local\Programs\Python\Python39\lib\site-
packages\sklearn\utils\validation.py:1111: DataConversionWarning: A column-
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  y = column_or_1d(y, warn=True)
c:\Users\ormosia5\AppData\Local\Programs\Python\Python39\lib\site-
packages\sklearn\utils\validation.py:1111: DataConversionWarning: A column-
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  y = column_or_1d(y, warn=True)
c:\Users\ormosia5\AppData\Local\Programs\Python\Python39\lib\site-
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to (n_samples, ), for example using ravel().
  y = column_or_1d(y, warn=True)
c:\Users\ormosia5\AppData\Local\Programs\Python\Python39\lib\site-
packages\sklearn\utils\validation.py:1111: DataConversionWarning: A column-
vector y was passed when a 1d array was expected. Please change the shape of y
to (n_samples, ), for example using ravel().
  y = column_or_1d(y, warn=True)
c:\Users\ormosia5\AppData\Local\Programs\Python\Python39\lib\site-
packages\sklearn\utils\validation.py:1111: DataConversionWarning: A column-
vector y was passed when a 1d array was expected. Please change the shape of y
to (n_samples, ), for example using ravel().
  y = column_or_1d(y, warn=True)
c:\Users\ormosia5\AppData\Local\Programs\Python\Python39\lib\site-
packages\sklearn\utils\validation.py:1111: DataConversionWarning: A column-
vector y was passed when a 1d array was expected. Please change the shape of y
to (n_samples, ), for example using ravel().
  y = column_or_1d(y, warn=True)
```

```
c:\Users\ormosia5\AppData\Local\Programs\Python\Python39\lib\site-
packages\sklearn\utils\validation.py:1111: DataConversionWarning: A column-
vector y was passed when a 1d array was expected. Please change the shape of y
to (n_samples, ), for example using ravel().
  y = column_or_1d(y, warn=True)
c:\Users\ormosia5\AppData\Local\Programs\Python\Python39\lib\site-
packages\sklearn\utils\validation.py:1111: DataConversionWarning: A column-
vector y was passed when a 1d array was expected. Please change the shape of y
to (n_samples, ), for example using ravel().
  y = column_or_1d(y, warn=True)
c:\Users\ormosia5\AppData\Local\Programs\Python\Python39\lib\site-
packages\sklearn\utils\validation.py:1111: DataConversionWarning: A column-
vector y was passed when a 1d array was expected. Please change the shape of y
to (n_samples, ), for example using ravel().
  y = column_or_1d(y, warn=True)
c:\Users\ormosia5\AppData\Local\Programs\Python\Python39\lib\site-
packages\sklearn\utils\validation.py:1111: DataConversionWarning: A column-
vector y was passed when a 1d array was expected. Please change the shape of y
to (n_samples, ), for example using ravel().
  y = column_or_1d(y, warn=True)
c:\Users\ormosia5\AppData\Local\Programs\Python\Python39\lib\site-
packages\sklearn\utils\validation.py:1111: DataConversionWarning: A column-
vector y was passed when a 1d array was expected. Please change the shape of y
to (n_samples, ), for example using ravel().
  y = column_or_1d(y, warn=True)
c:\Users\ormosia5\AppData\Local\Programs\Python\Python39\lib\site-
packages\sklearn\utils\validation.py:1111: DataConversionWarning: A column-
vector y was passed when a 1d array was expected. Please change the shape of y
to (n_samples, ), for example using ravel().
  y = column_or_1d(y, warn=True)
c:\Users\ormosia5\AppData\Local\Programs\Python\Python39\lib\site-
packages\sklearn\utils\validation.py:1111: DataConversionWarning: A column-
vector y was passed when a 1d array was expected. Please change the shape of y
to (n_samples, ), for example using ravel().
  y = column_or_1d(y, warn=True)
c:\Users\ormosia5\AppData\Local\Programs\Python\Python39\lib\site-
packages\sklearn\utils\validation.py:1111: DataConversionWarning: A column-
vector y was passed when a 1d array was expected. Please change the shape of y
to (n_samples, ), for example using ravel().
  y = column_or_1d(y, warn=True)
c:\Users\ormosia5\AppData\Local\Programs\Python\Python39\lib\site-
packages\sklearn\utils\validation.py:1111: DataConversionWarning: A column-
vector y was passed when a 1d array was expected. Please change the shape of y
to (n_samples, ), for example using ravel().
  y = column_or_1d(y, warn=True)
c:\Users\ormosia5\AppData\Local\Programs\Python\Python39\lib\site-
packages\sklearn\utils\validation.py:1111: DataConversionWarning: A column-
vector y was passed when a 1d array was expected. Please change the shape of y
```

```
to (n_samples, ), for example using ravel().
  y = column_or_1d(y, warn=True)
```

4.8 Compare two stock based on the prediction

[76]:

```
df_microsoft = pd.DataFrame(data = y_microsoft_adj, columns= ['Microsoft adj␣
 ↪close'])
df_apple = pd.DataFrame(data = y_apple_adj, columns= ['Apple adj close'])
df_pred = pd.concat([df_apple,df_microsoft],axis=1)
df_pred
```

[76]:

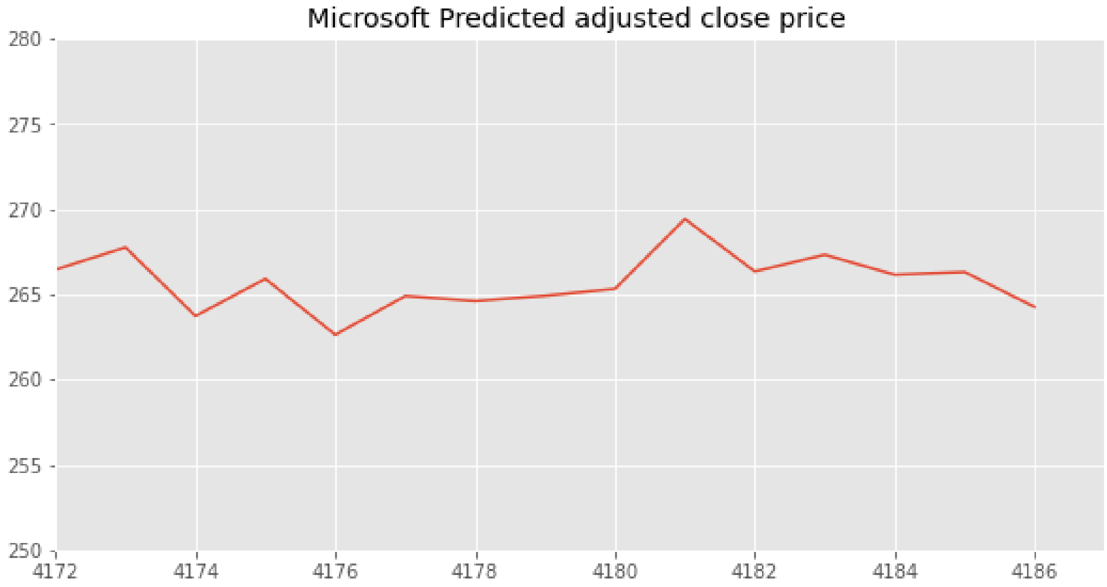
```
      Apple adj close  Microsoft adj close
0            0.964983            18.954119
1            0.974894            19.025005
2            0.983432            18.982471
3            0.984194            18.961212
4            1.055854            18.904505
…                 …                   …
4182       143.794045           266.344592
4183       145.911198           267.323606
4184       143.336767           266.146240
4185       146.803876           266.307767
4186       145.885122           264.262320

[4187 rows x 2 columns]
```

[103]:

```
plt.figure(figsize=(10, 5))
plt.title('Microsoft Predicted adjusted close price ')
plt.grid(True)
plt.xlim(4172, 4187)
plt.ylim(250, 280)
plt.plot(df_microsoft)
```

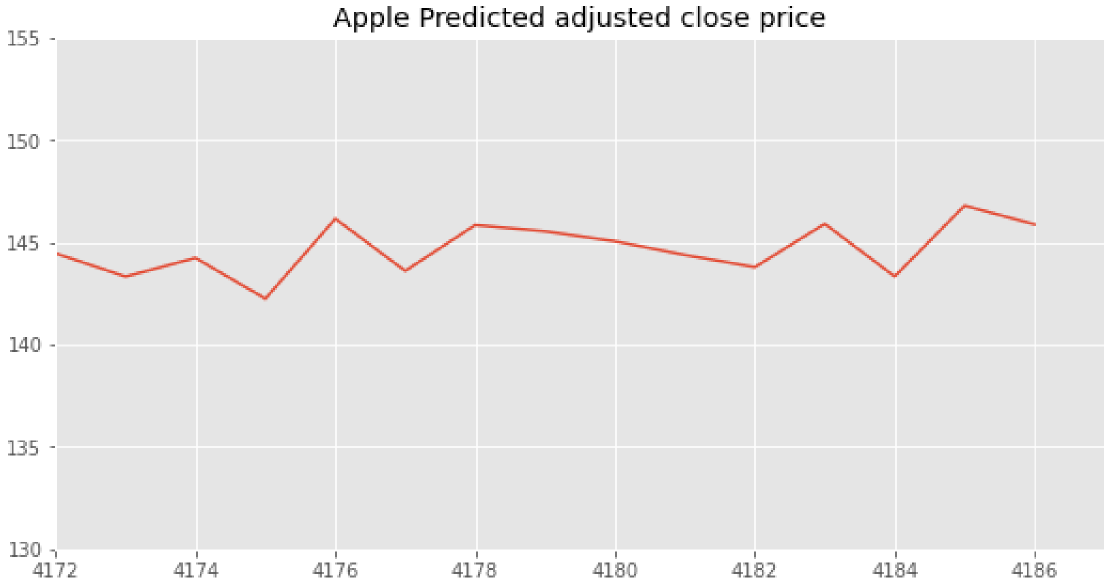
[103]:

```
[<matplotlib.lines.Line2D at 0x152a937e670>]
```



[106]:
```
plt.figure(figsize=(10, 5))
plt.title('Apple Predicted adjusted close price')
plt.grid(True)
plt.xlim(4172, 4187)
plt.ylim(130, 155)
plt.plot(df_apple)
```

[106]:
```
[<matplotlib.lines.Line2D at 0x152a94b5d90>]
```

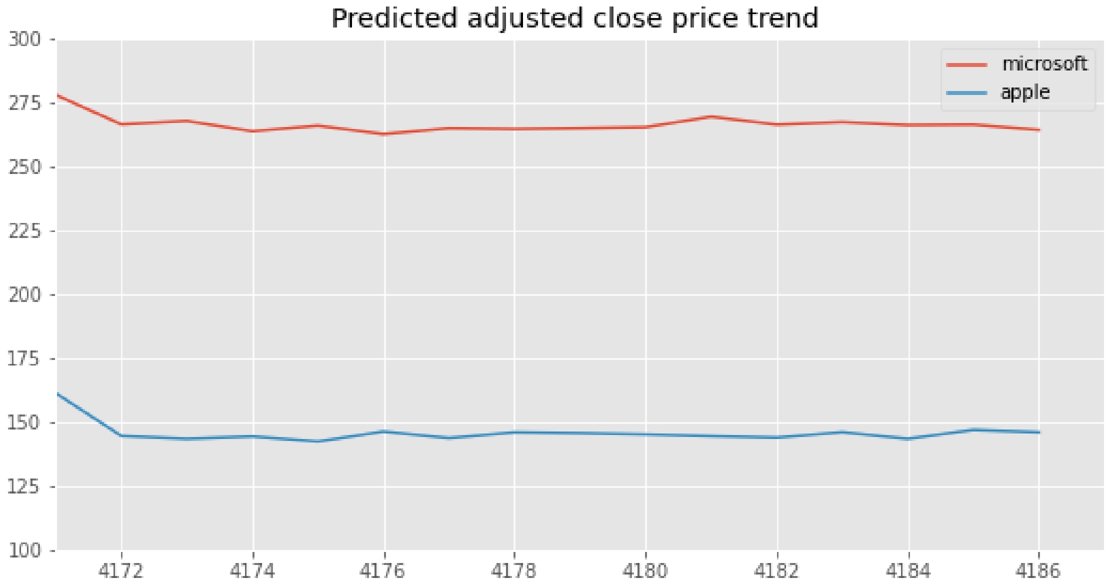


[108]:

```
plt.figure(figsize=(10, 5))
plt.title('Predicted adjusted close price trend ')
plt.grid(True)
plt.xlim(4171, 4187)
plt.ylim(100, 300)
plt.plot(df_microsoft,label = 'microsoft')
plt.plot(df_apple,label = 'apple')
plt.legend()
```

[108]:

```
<matplotlib.legend.Legend at 0x152a958b310>
```

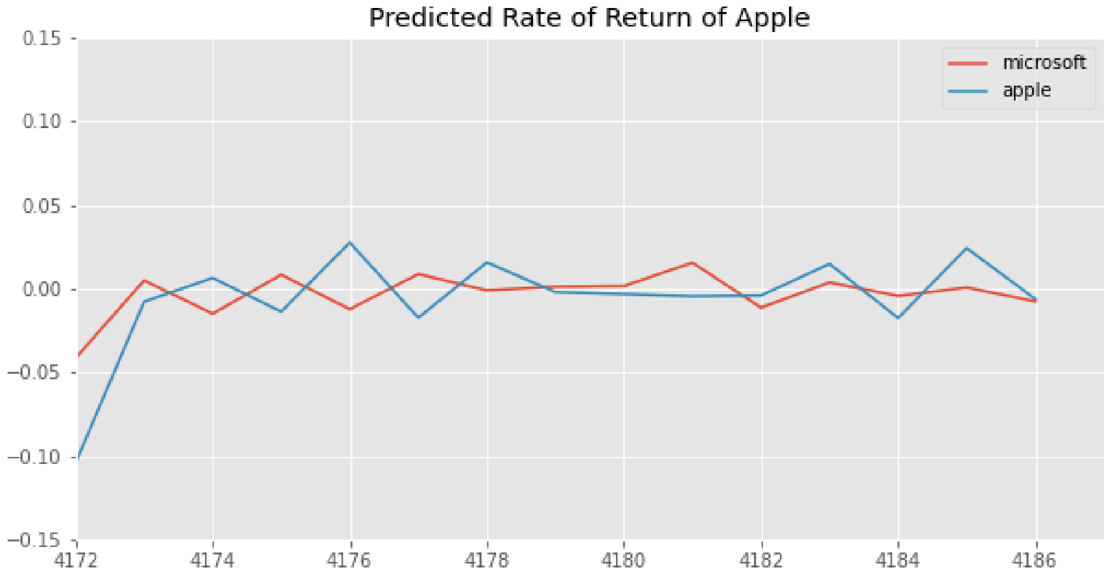


[89]:

```
adj_apple = df_apple['Apple adj close']
AP_ror = adj_apple / adj_apple.shift(1) - 1
adj_microsoft= df_microsoft['Microsoft adj close']
MS_ror = adj_microsoft / adj_microsoft.shift(1) - 1
plt.figure(figsize=(10, 5))
plt.title('Predicted Rate of Return of Apple')
plt.grid(True)
plt.xlim(4172, 4187)
plt.ylim([-0.15, 0.15])
plt.plot(MS_ror,label = 'microsoft')
plt.plot(AP_ror,label = 'apple')
plt.legend()
```

[89]:

```
<matplotlib.legend.Legend at 0x152a7dba0a0>
```


Predicted Rate of Return of Apple
microsoft
apple
0.15
0.10
0.05
0.00
−0.05
−0.10
−0.15
4172
4174
4176
4178
4180
4182
4184
4186