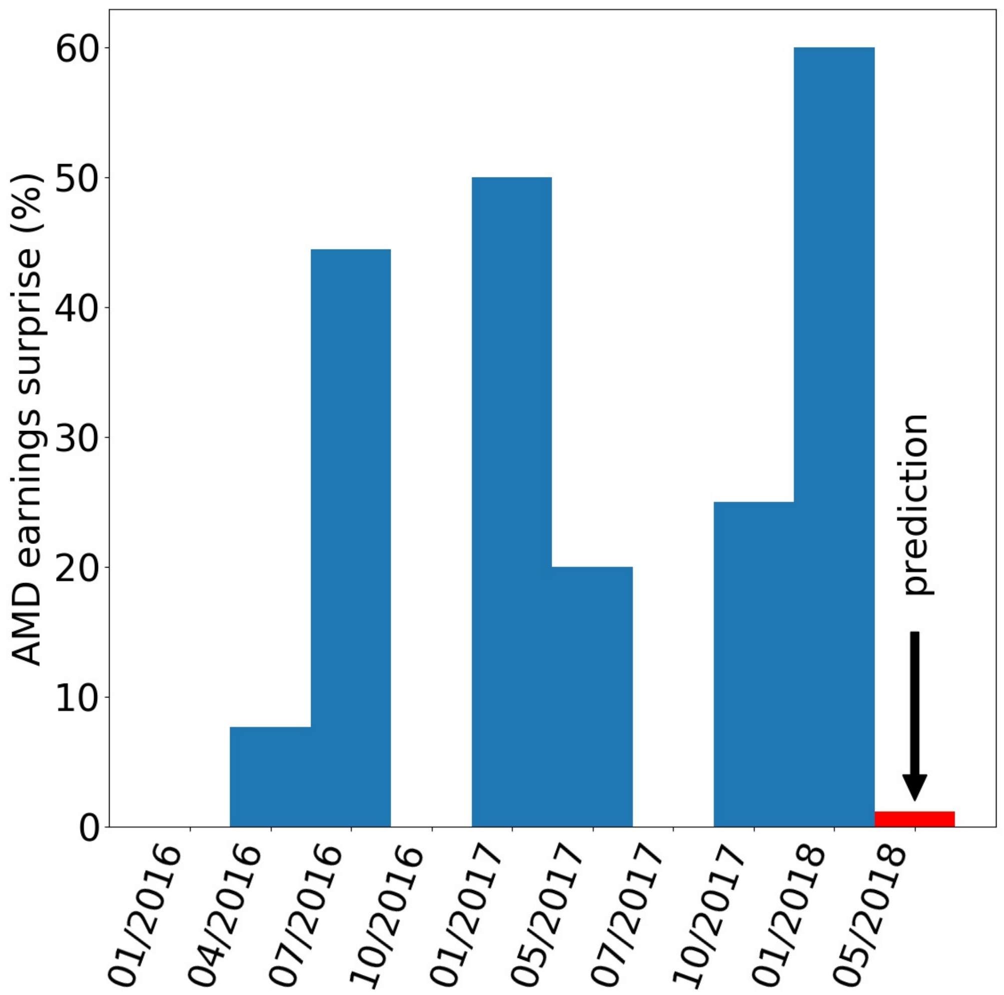
MACHINE LEARNING FOR FINANCE IN PYTHON

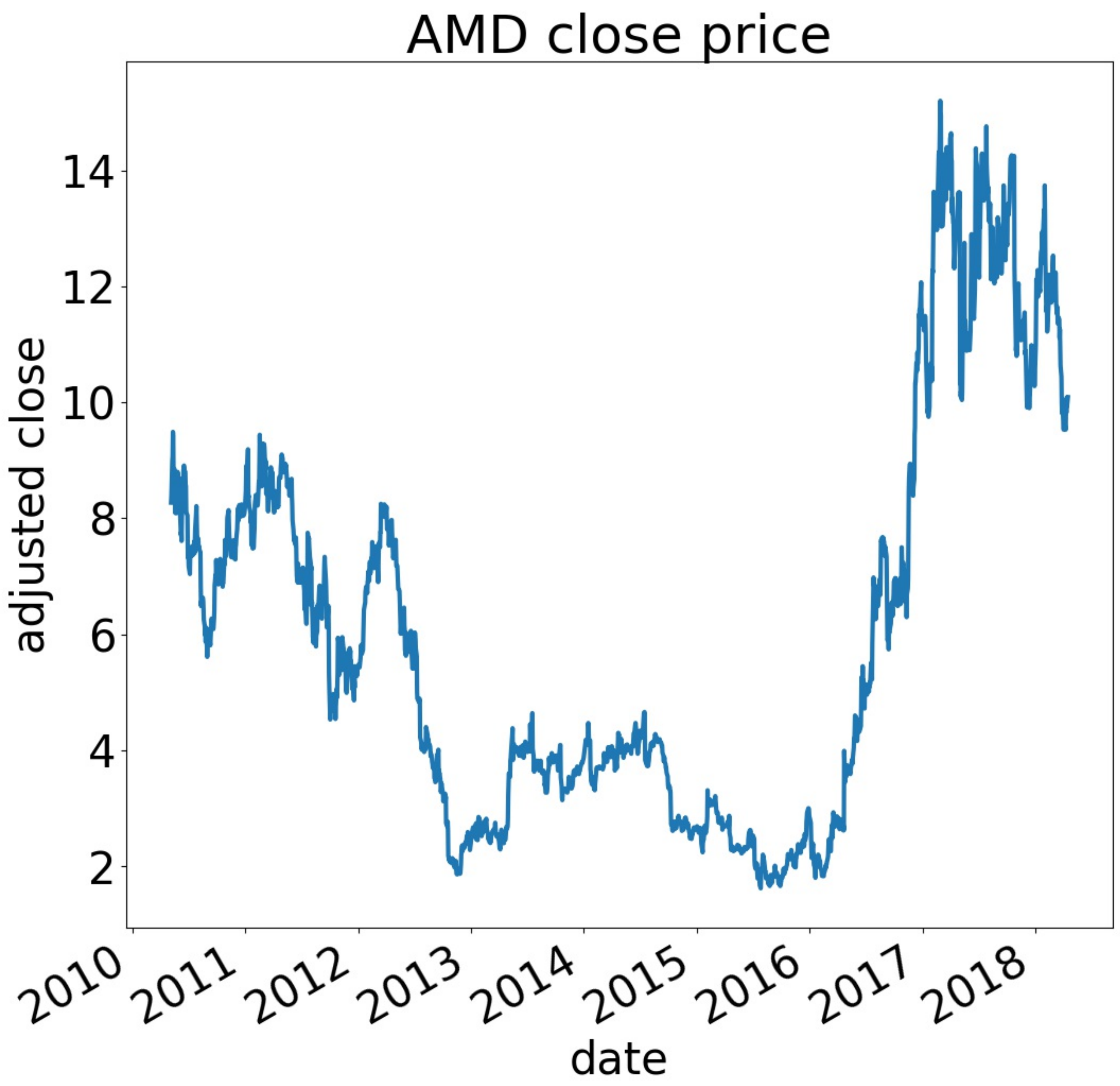
Machine learning for finance

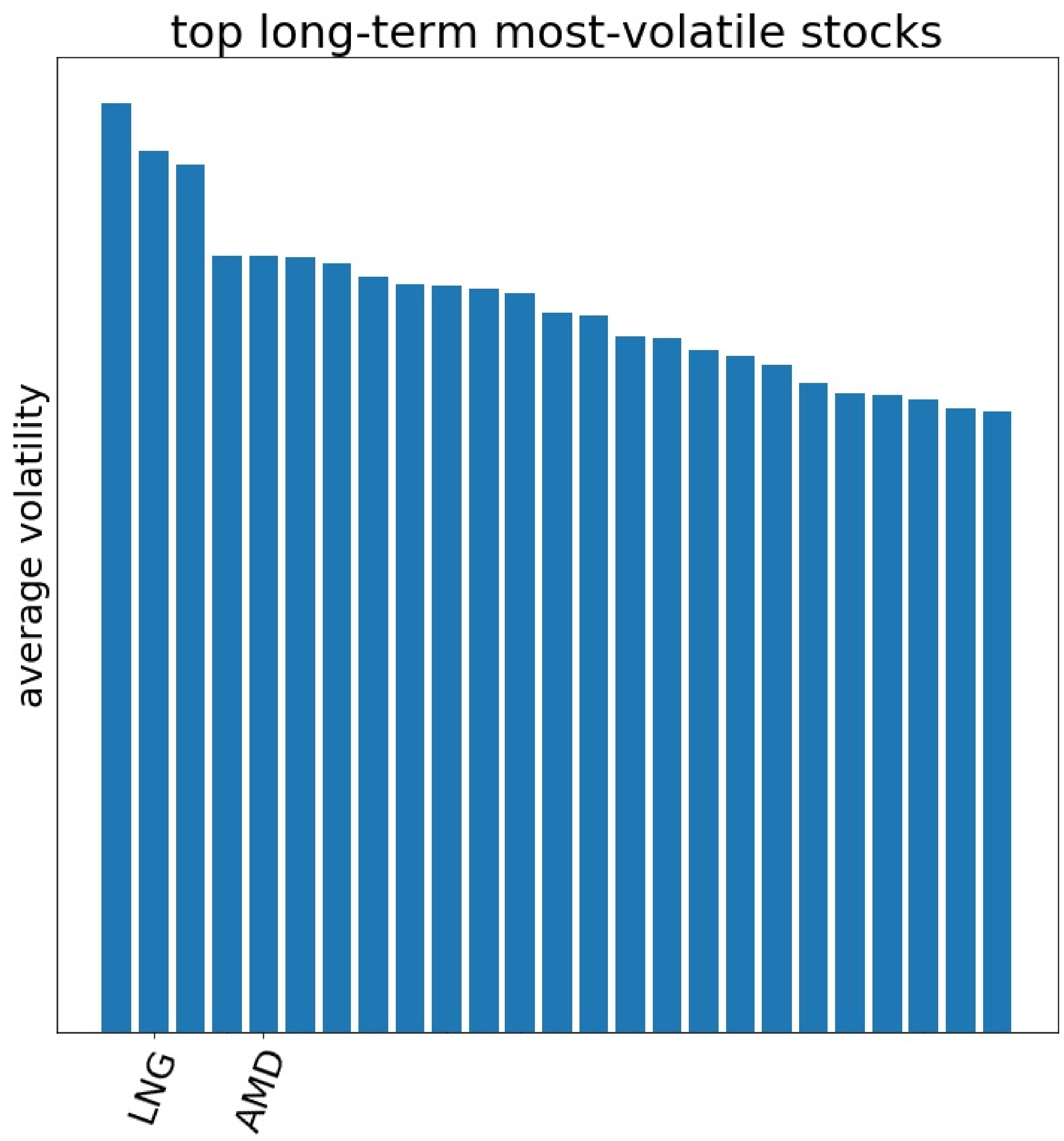
Nathan George
Data Science Professor

Machine Learning in Finance



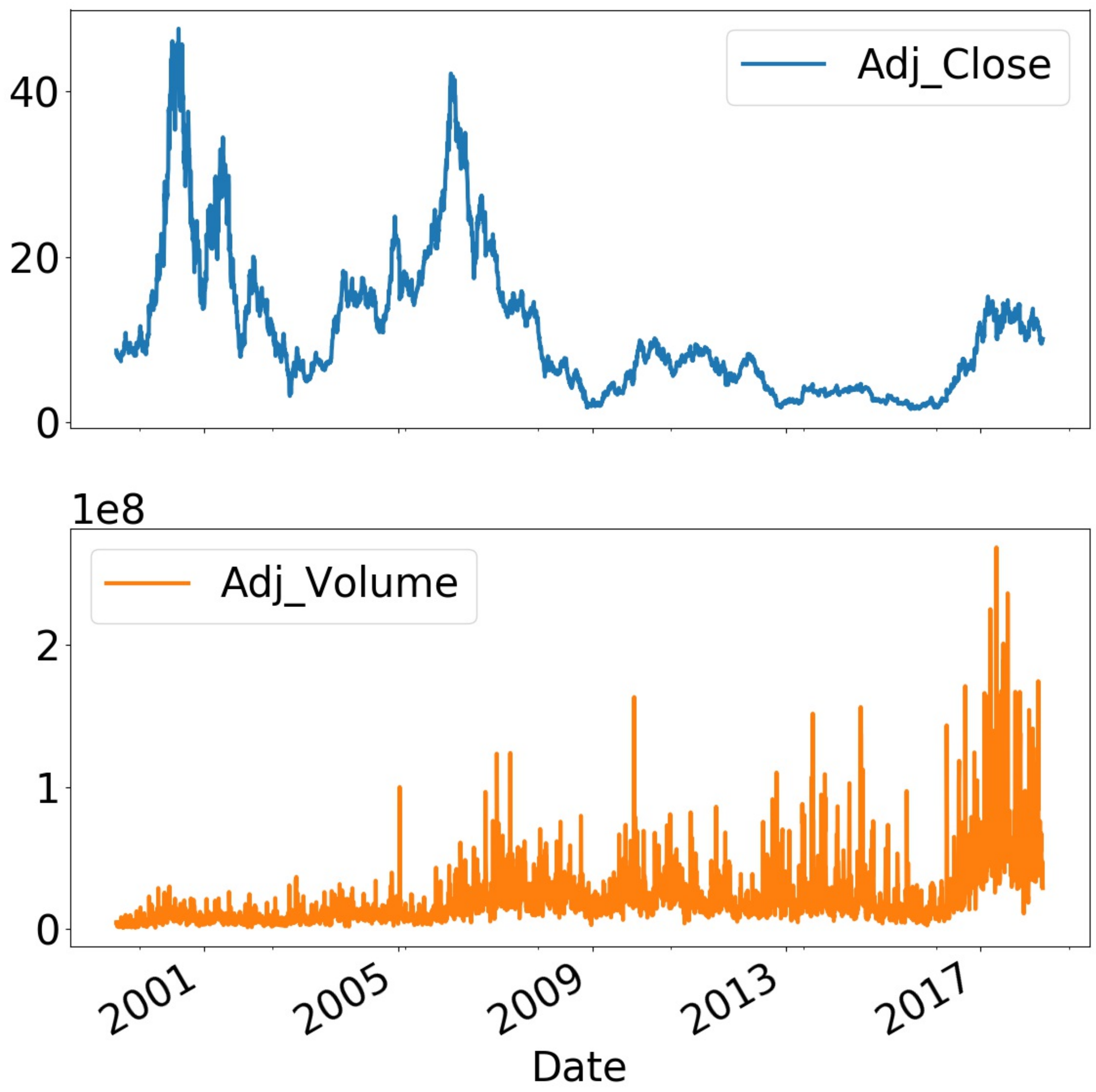
source: https://www.zacks.com/stock/quote/AMD
JPM report: http://valuesimplex.com/articles/JPM.pdf


AMD close price
adjusted close
14
12
10
8
6
4
2
2010
2011
2012
2013
2014
2015
2016
2017
2018
date


top long-term most-volatile stocks
average volatility
LNG
AMD

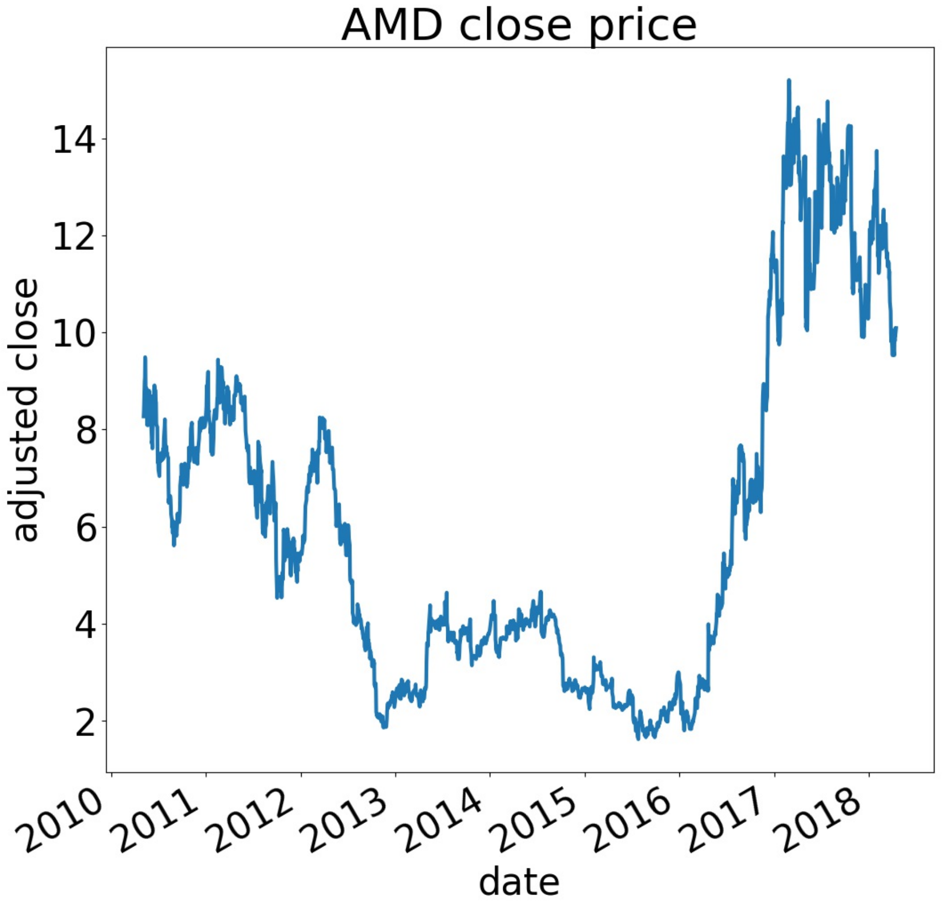
Understanding the data

```
print(amd_df.head())

            Adj_Close  Adj_Volume
Date
1999-03-10      8.690   4871800.0
1999-03-11      8.500   3566600.0
1999-03-12      8.250   4126800.0
1999-03-15      8.155   3006400.0
1999-03-16      8.500   3511400.0
```

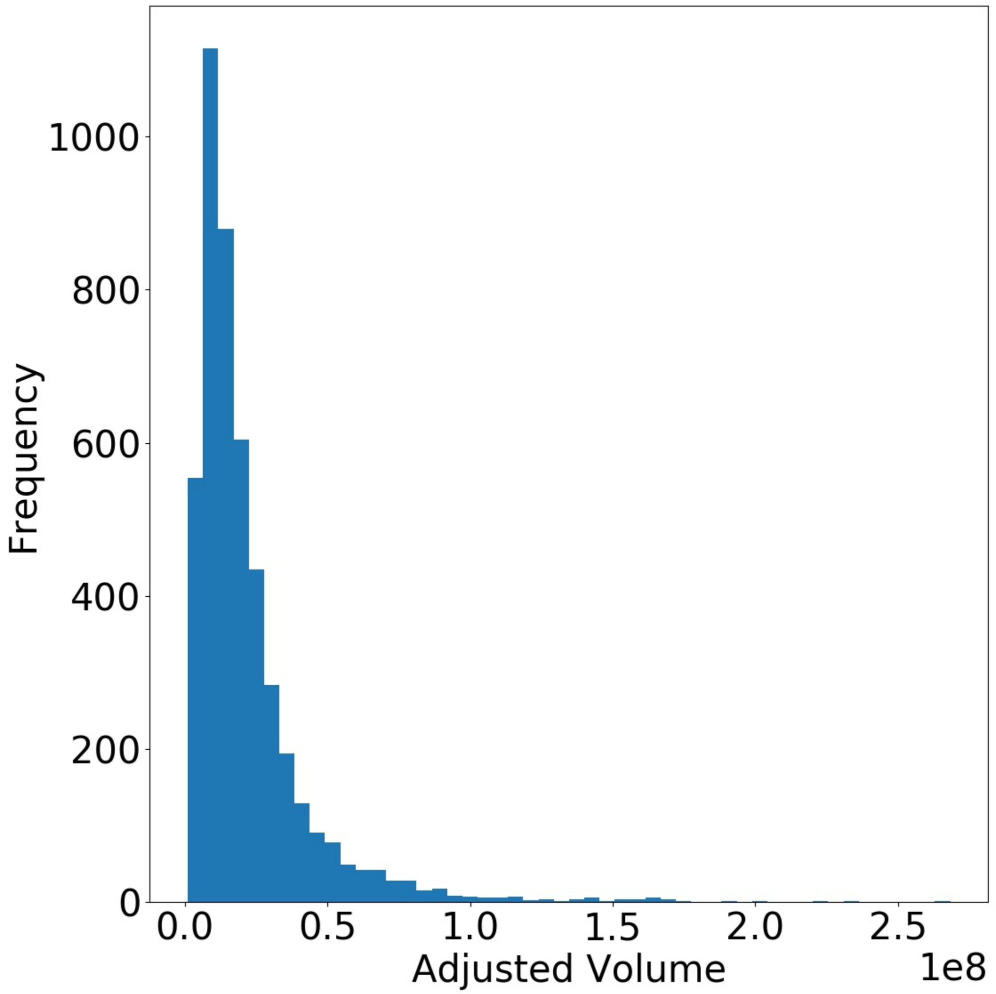

Adj_Close
40
20
0
1e8
Adj_Volume
2
1
0
2001
2005
2009
2013
2017
Date

EDA plots

```
amd_df['Adj_Close'].plot()
plt.show()
```

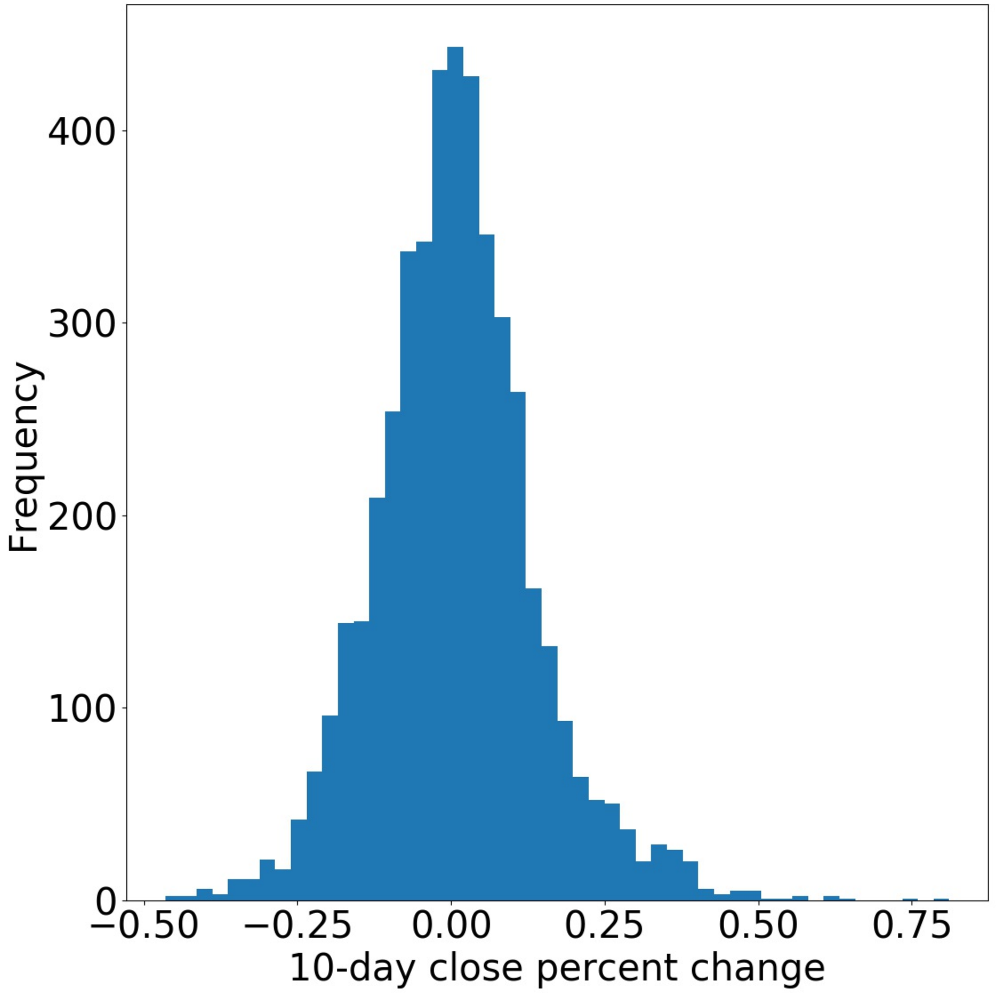



```
plt.clf()  # clears the plot area
vol = amd_df['Adj_Volume']
vol.plot.hist(bins=50)
plt.show()
```



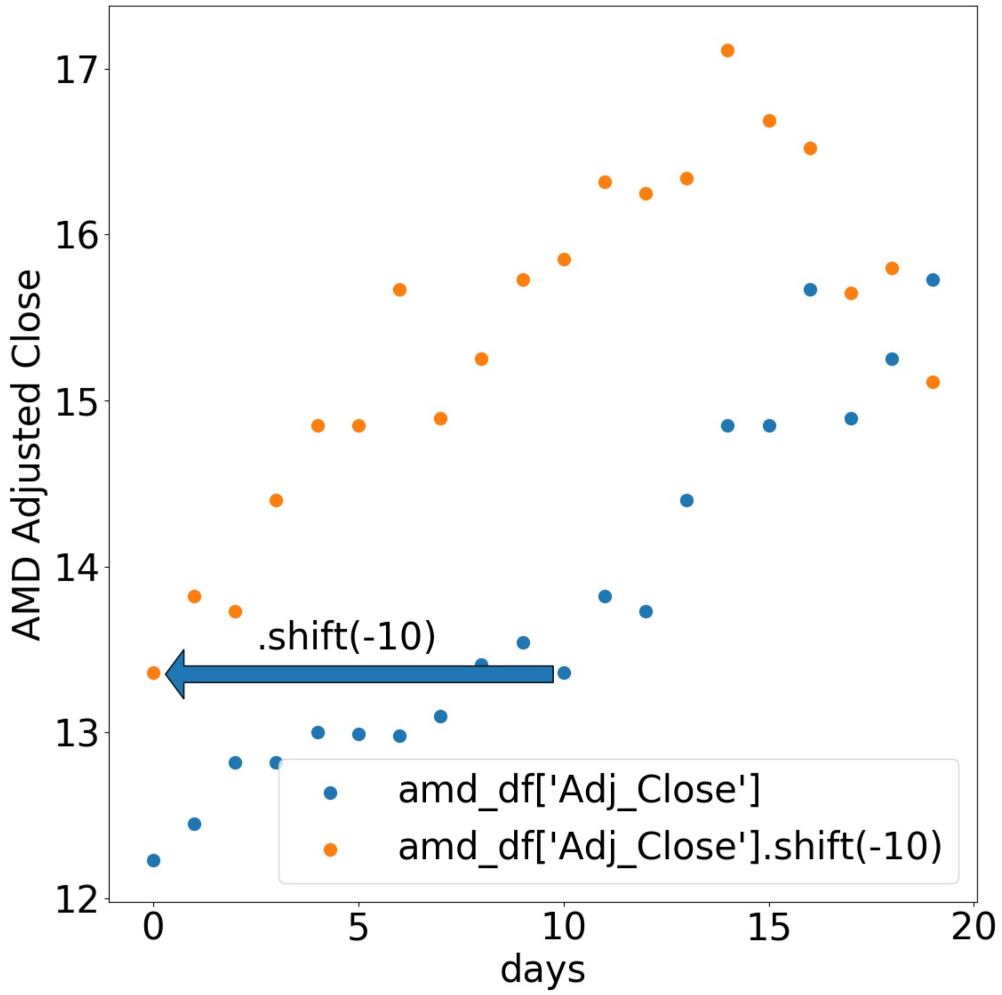
Price changes

```
amd_df['10d_close_pct'] = amd_df['Adj_Close'].pct_change(10)

amd_df['10d_close_pct'].plot.hist(bins=50)
plt.show()
```



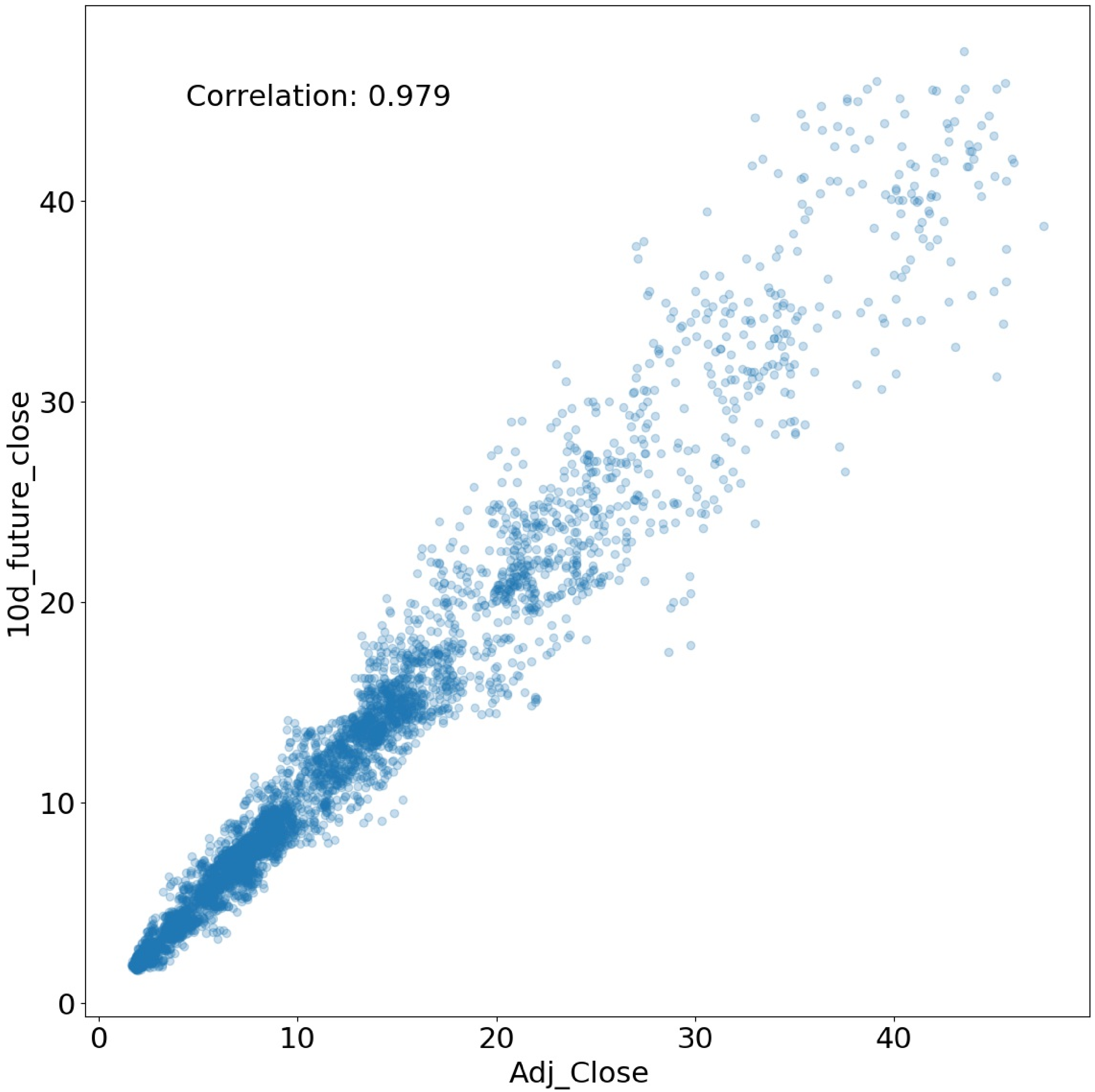
Shift data

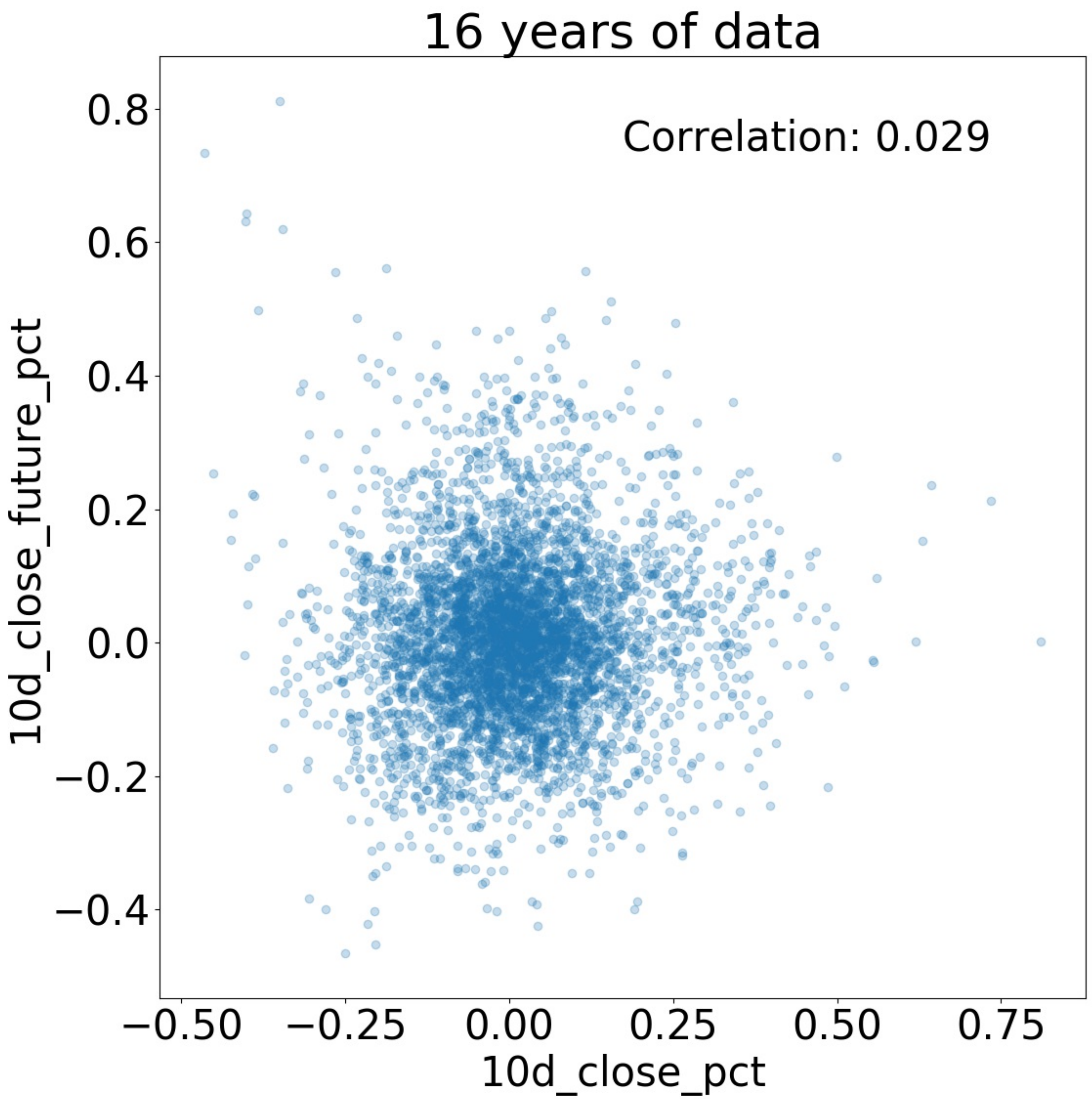
```
amd_df['10d_future_close'] = amd_df['Adj_Close'].shift(-10)

amd_df['10d_future_close_pct'] = amd_df['10d_future_close'].pct_change(10)
```

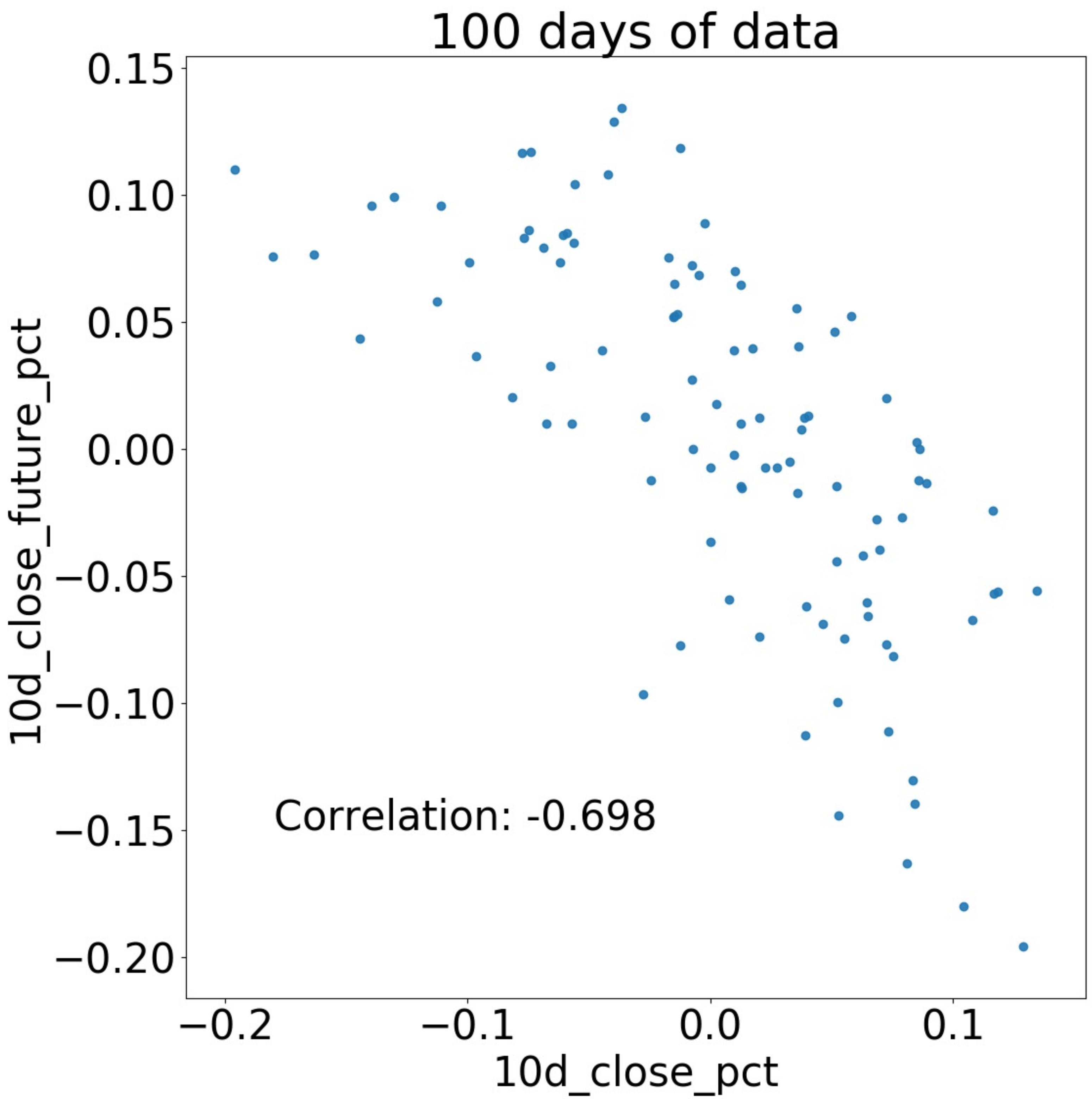


Correlations

```
corr = amd_df.corr()
print(corr)

                     10d_future_close_pct  10d_future_close  10d_close_pct  \
10d_future_close_pct              1.000000          0.070742       0.030402
10d_future_close                  0.070742          1.000000       0.082828
10d_close_pct                     0.030402          0.082828       1.000000
Adj_Close                        -0.083982          0.979345       0.073843
Adj_Volume                       -0.024456         -0.122473       0.044537

                     Adj_Close  Adj_Volume
10d_future_close_pct -0.083982   -0.024456
10d_future_close      0.979345   -0.122473
10d_close_pct         0.073843    0.044537
Adj_Close             1.000000   -0.119437
Adj_Volume           -0.119437    1.000000
```


Correlation: 0.979
10d_future_close
Adj_Close
0
10
20
30
40


16 years of data
Correlation: 0.029
10d_close_future_pct
10d_close_pct
0.8
0.6
0.4
0.2
0.0
−0.2
−0.4
−0.50
−0.25
0.00
0.25
0.50
0.75


100 days of data
0.15
0.10
0.05
0.00
−0.05
−0.10
−0.15
−0.20
10d_close_future_pct
Correlation: -0.698
−0.2
−0.1
0.0
0.1
10d_close_pct

MACHINE LEARNING FOR FINANCE IN PYTHON

Let's do some EDA!

MACHINE LEARNING FOR FINANCE IN PYTHON

Data transforms, features, and targets

Nathan George
Data Science Professor

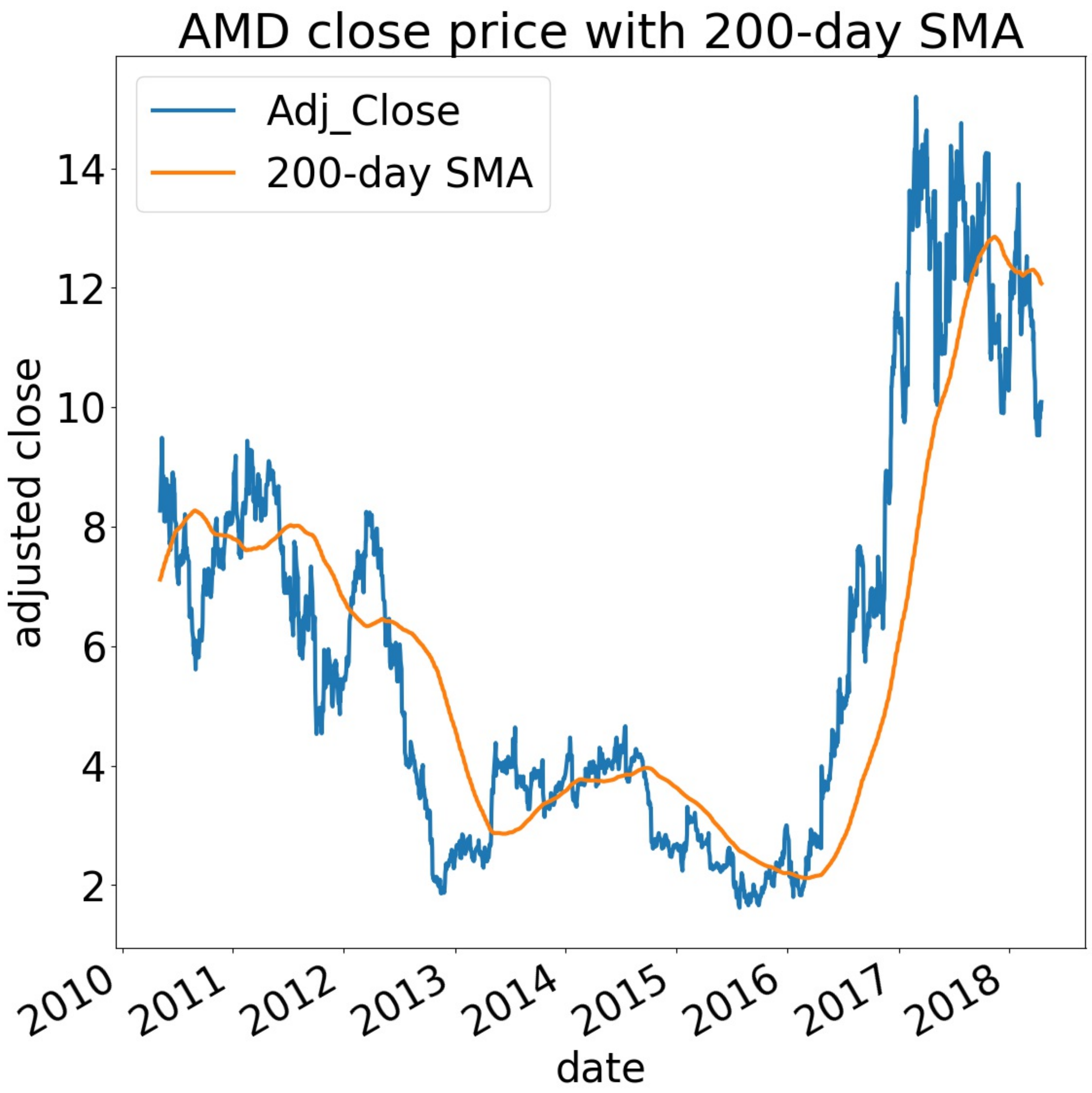
Making features and targets

```
features = amd_df[['10d_close_pct', 'Adj_Volume']]

targets = amd_df['10d_future_close_pct']

print(type(features))
```

```
pandas.core.series.DataFrame
```

```
print(type(targets))
```

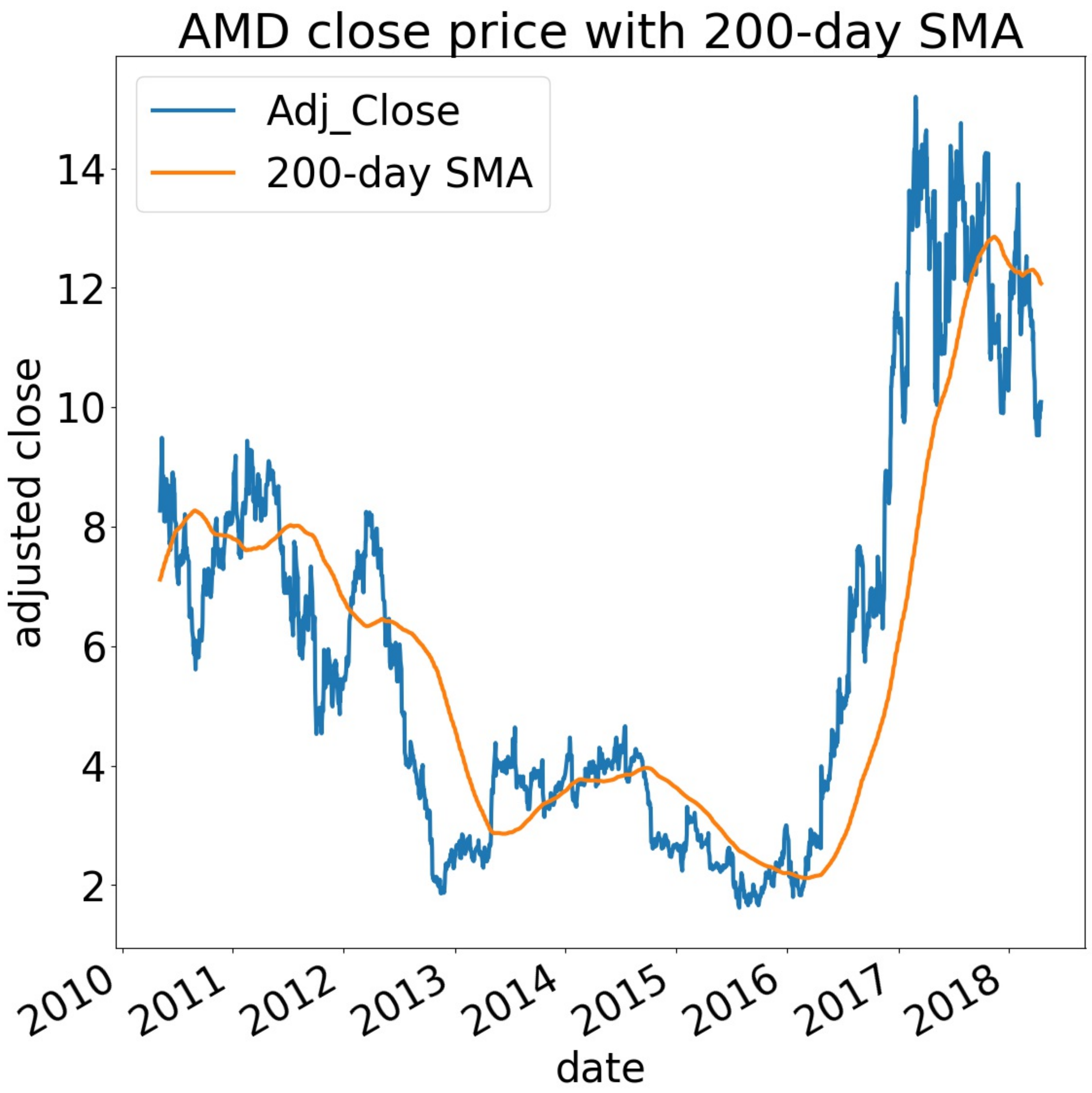
```
pandas.core.series.Series
```

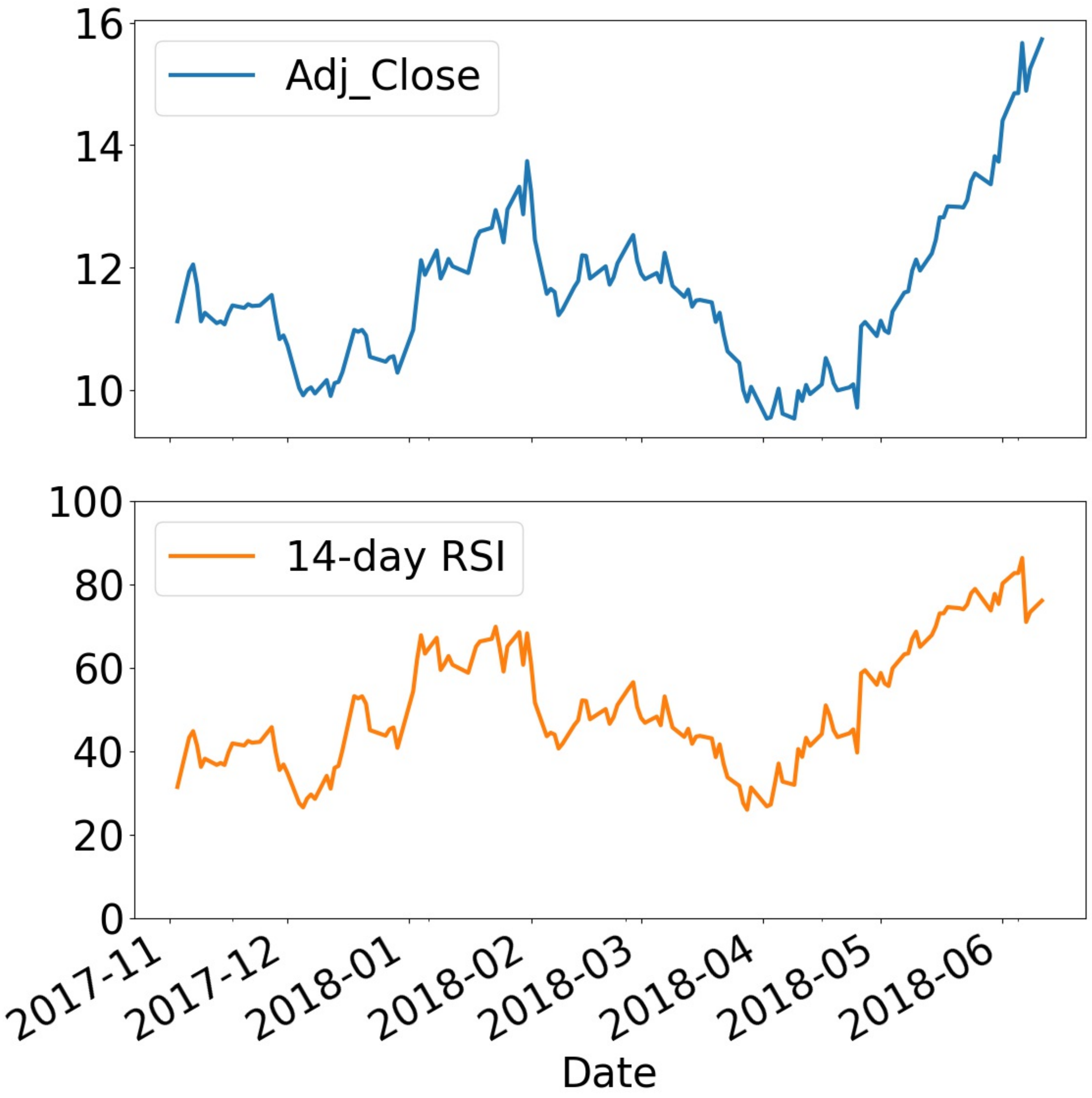

AMD close price with 200-day SMA
Adj_Close
200-day SMA
adjusted close
14
12
10
8
6
4
2
2010
2011
2012
2013
2014
2015
2016
2017
2018
date

Moving averages

Moving averages:

- use *n* past days to get average
- common values for *n*: 14, 50, 200


AMD close price with 200-day SMA
Adj_Close
200-day SMA
adjusted close
date
2
4
6
8
10
12
14
2010
2011
2012
2013
2014
2015
2016
2017
2018



Adj_Close
16
14
12
10
14-day RSI
100
80
60
40
20
0
2017-11
2017-12
2018-01
2018-02
2018-03
2018-04
2018-05
2018-06
Date

RSI equation

$$RSI = 100 - \frac{100}{1 + RS}$$

$$RS = \frac{\text{Average gain over } n \text{ periods}}{\text{Average loss over } n \text{ periods}}$$

Calculating SMA and RSI

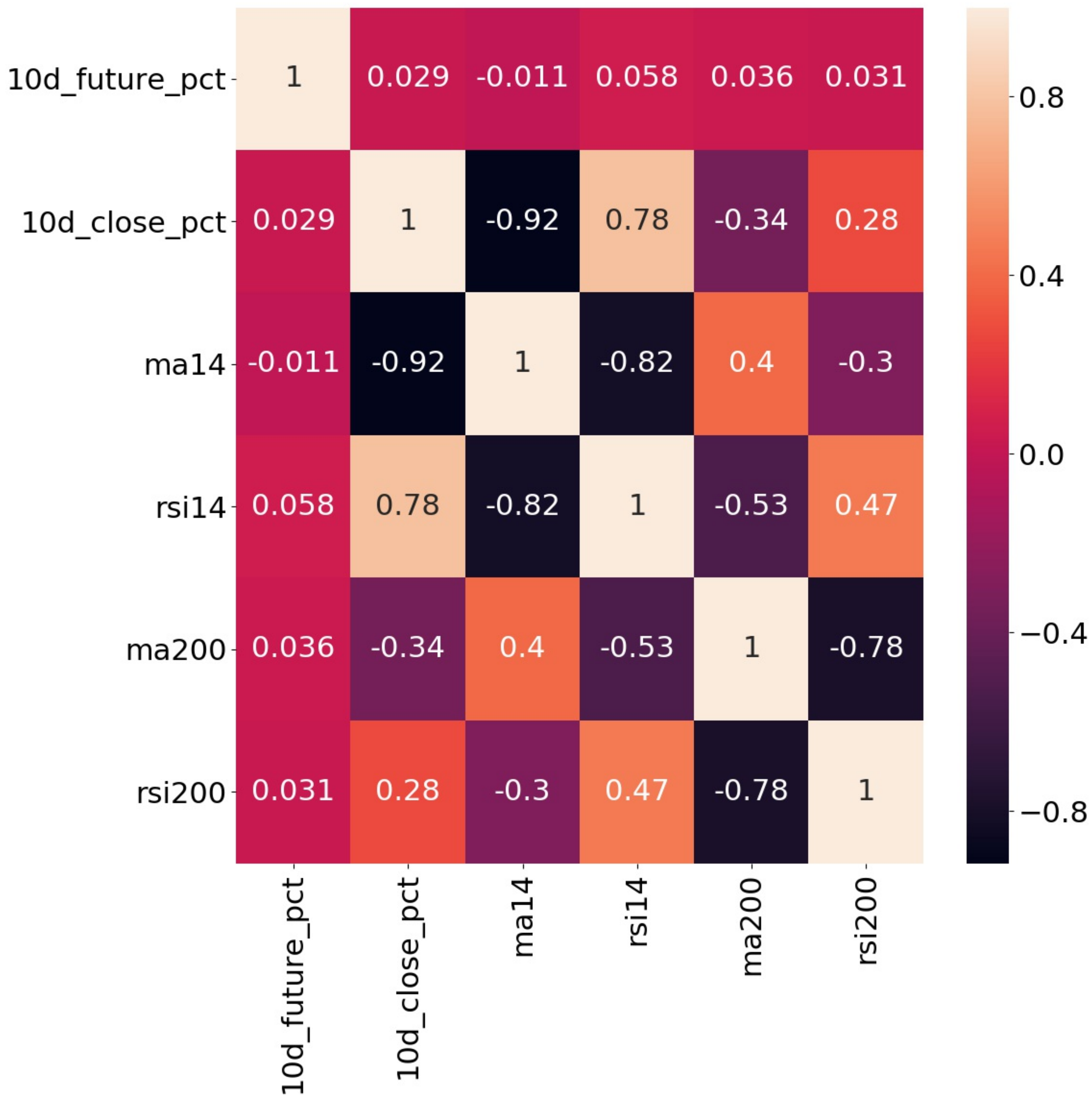
```
import talib

amd_df['ma200'] = talib.SMA(amd_df['Adj_Close'].values, timeperiod=200)

amd_df['rsi200'] = talib.RSI(amd_df['Adj_Close'].values, timeperiod=200)
```

Finally, our features

```
feature_names = ['10d_close_pct', 'ma200', 'rsi200']
features = amd_df[feature_names]
targets = amd_df['10d_future_close_pct']

feature_target_df = amd_df[feature_names + '10d_future_close_pct']
```

Check correlations

```
import seaborn as sns

corr = feature_target_df.corr()
sns.heatmap(corr, annot=True)
```


10d_future_pct
10d_close_pct
ma14
rsi14
ma200
rsi200
1 0.029 -0.011 0.058 0.036 0.031
0.029 1 -0.92 0.78 -0.34 0.28
-0.011 -0.92 1 -0.82 0.4 -0.3
0.058 0.78 -0.82 1 -0.53 0.47
0.036 -0.34 0.4 -0.53 1 -0.78
0.031 0.28 -0.3 0.47 -0.78 1
0.8
0.4
0.0
−0.4
−0.8

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Let's create features and targets!

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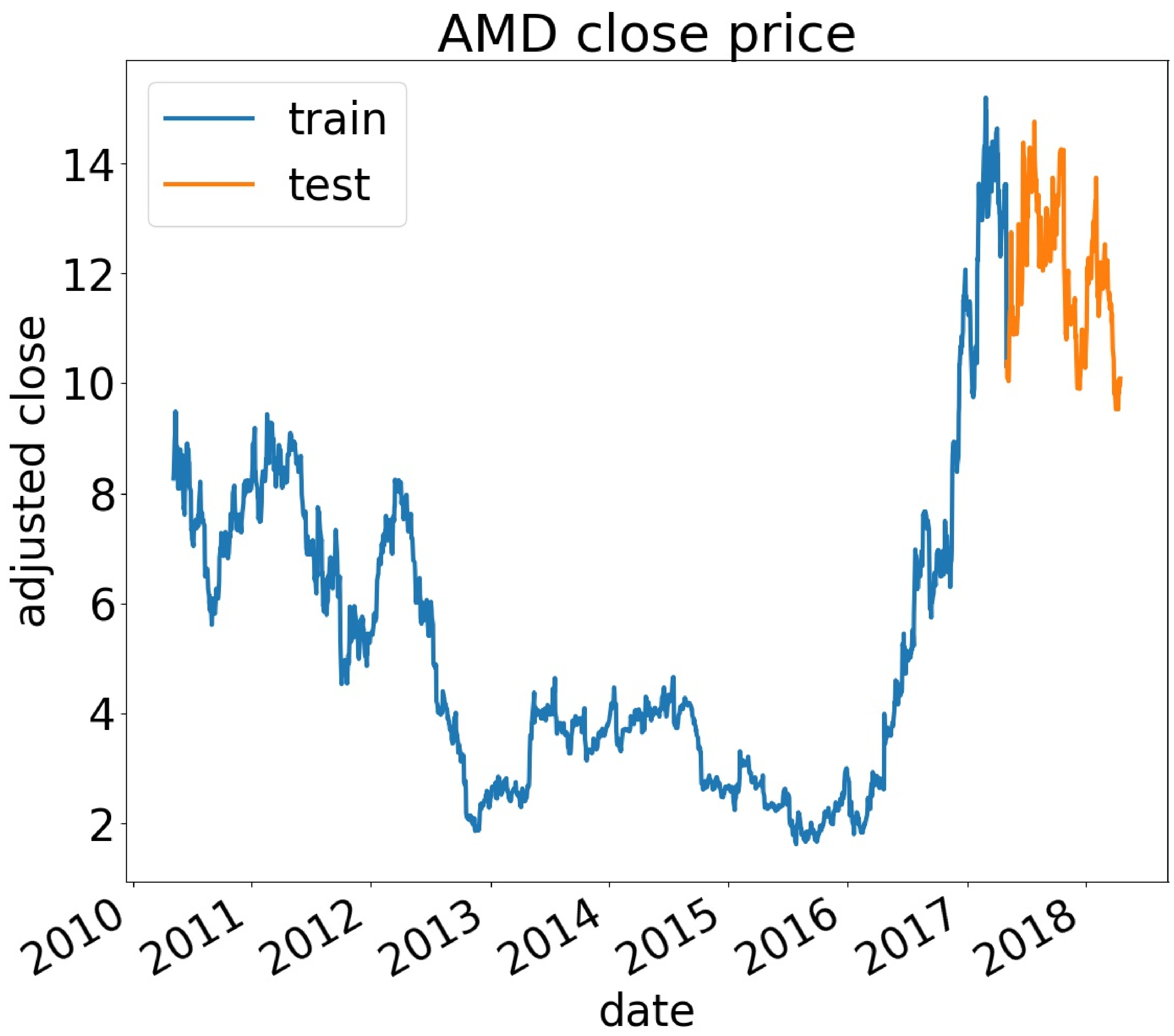
Linear modeling with financial data

Nathan George
Data Science Professor


AMD close price
train
test
adjusted close
2
4
6
8
10
12
14
2010
2011
2012
2013
2014
2015
2016
2017
2018
date

Make train and test sets

```
import statsmodels.api as sm

linear_features = sm.add_constant(features)

train_size = int(0.85 * targets.shape[0])

train_features = linear_features[:train_size]
train_targets = targets[:train_size]
test_features = linear_features[train_size:]
test_targets = targets[train_size:]
```

```
some_list[start:stop:step]
```

Linear modeling

```
model = sm.OLS(train_targets, train_features)

results = model.fit()
```

Linear modeling

```
print(results.summary())
```

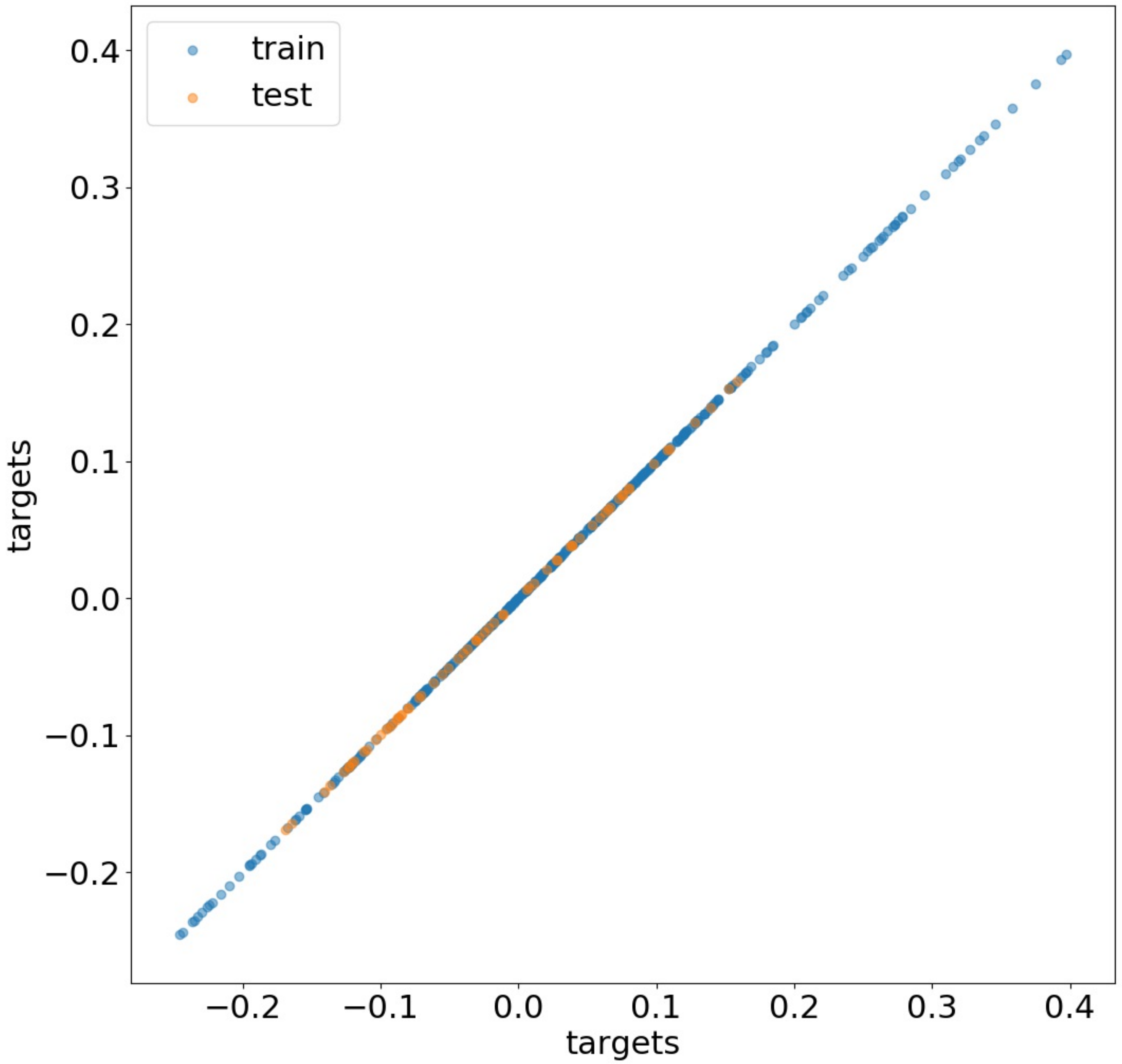
Linear modeling

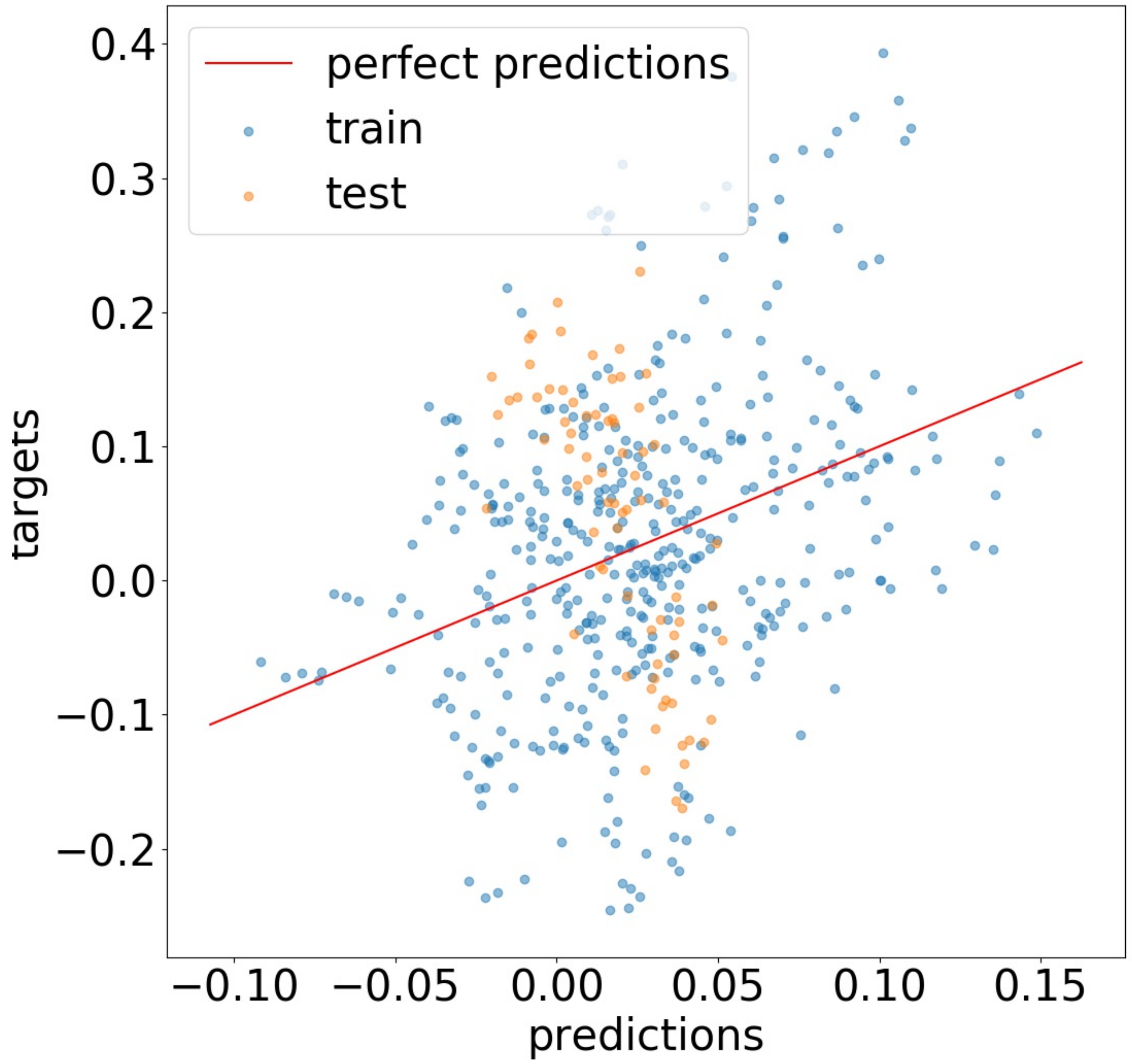
```
                            OLS Regression Results
==============================================================================
Dep. Variable:          10d_future_pct   R-squared:                       0.157
Model:                             OLS   Adj. R-squared:                  0.146
Method:                  Least Squares   F-statistic:                     15.55
Date:                 Thu, 19 Apr 2018   Prob (F-statistic):           4.79e-14
Time:                         11:41:05   Log-Likelihood:                 336.53
No. Observations:                  425   AIC:                            -661.1
Df Residuals:                      419   BIC:                            -636.8
Df Model:                            5
Covariance Type:             nonrobust
==============================================================================
                  coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
const           1.3305      0.323      4.117      0.000       0.695       1.966
10d_close_pct   0.0906      0.098      0.927      0.355      -0.102       0.283
ma14            0.3313      0.209      1.585      0.114      -0.080       0.742
rsi14          -0.0013      0.001     -1.044      0.297      -0.004       0.001
ma200          -0.4090      0.053     -7.712      0.000      -0.513      -0.305
rsi200         -0.0224      0.003     -6.610      0.000      -0.029      -0.016
==============================================================================
Omnibus:                         3.571   Durbin-Watson:                   0.209
Prob(Omnibus):                   0.168   Jarque-Bera (JB):                3.323
Skew:                            0.202   Prob(JB):                        0.190
Kurtosis:                        3.159   Cond. No.                     5.47e+03
```

p-values

```
print(results.pvalues)
```

```
const            4.630428e-05
10d_close_pct    3.546748e-01
ma14             1.136941e-01
rsi14            2.968699e-01
ma200            9.126405e-14
rsi200           1.169324e-10
```


train
test
targets
targets
0.4
0.3
0.2
0.1
0.0
−0.1
−0.2
−0.2 −0.1 0.0 0.1 0.2 0.3 0.4


perfect predictions
train
test
targets
predictions
0.4
0.3
0.2
0.1
0.0
−0.1
−0.2
−0.10
−0.05
0.00
0.05
0.10
0.15

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Time to fit a linear model!