

Review of pandas DataFrames

PANDAS FOUNDATIONS



Dhavide Aruliah
Director of Training, Anaconda

pandas DataFrames

- Example: DataFrame of Apple Stock data

Date	Open	High	Low	Close	Volume	Adj Close
2014-09-16	99.80	101.26	98.89	100.86	66818200	100.86
2014-09-15	102.81	103.05	101.44	101.63	61216500	101.63
2014-09-12	101.21	102.19	101.08	101.66	62626100	101.66
...

Indexes and columns

```
import pandas as pd  
type(AAPL)
```

```
pandas.core.frame.DataFrame
```

```
AAPL.shape
```

```
(8514, 6)
```

```
AAPL.columns
```

```
Index(['Open', 'High', 'Low', 'Close', 'Volume', 'Adj Close'], dtype='object')
```

```
type(AAPL.columns)
```

```
pandas.indexes.base.Index
```

Indexes and columns

```
AAPL.index
```

```
DatetimeIndex(['2014-09-16', '2014-09-15', '2014-09-12',
                 '2014-09-11', '2014-09-10', '2014-09-09',
                 '2014-09-08', '2014-09-05', '2014-09-04',
                 '2014-09-03',
                 ...
                 '1980-12-26', '1980-12-24', '1980-12-23',
                 '1980-12-22', '1980-12-19', '1980-12-18',
                 '1980-12-17', '1980-12-16', '1980-12-15',
                 '1980-12-12'],
                dtype='datetime64[ns]', name='Date', length=8514,
                freq=None)
```

```
type(AAPL.index)
```

```
pandas.tseries.index.DatetimeIndex
```

Slicing

```
AAPL.iloc[:5,:]
```

	Open	High	Low	Close	Volume	Adj Close
Date						
2014-09-16	99.80	101.26	98.89	100.86	66818200	100.86
2014-09-15	102.81	103.05	101.44	101.63	61216500	101.63
2014-09-12	101.21	102.19	101.08	101.66	62626100	101.66
2014-09-11	100.41	101.44	99.62	101.43	62353100	101.43
2014-09-10	98.01	101.11	97.76	101.00	100741900	101.00

```
AAPL.iloc[-5:,:]
```

	Open	High	Low	Close	Volume	Adj Close
Date						
1980-12-18	26.63	26.75	26.63	26.63	18362400	0.41
1980-12-17	25.87	26.00	25.87	25.87	21610400	0.40
1980-12-16	25.37	25.37	25.25	25.25	26432000	0.39
1980-12-15	27.38	27.38	27.25	27.25	43971200	0.42
1980-12-12	28.75	28.87	28.75	28.75	117258400	0.45

head()

```
AAPL.head(5)
```

	Open	High	Low	Close	Volume	Adj Close
Date						
2014-09-16	99.80	101.26	98.89	100.86	66818200	100.86
2014-09-15	102.81	103.05	101.44	101.63	61216500	101.63
2014-09-12	101.21	102.19	101.08	101.66	62626100	101.66
2014-09-11	100.41	101.44	99.62	101.43	62353100	101.43
2014-09-10	98.01	101.11	97.76	101.00	100741900	101.00

```
AAPL.head(2)
```

	Open	High	Low	Close	Volume	Adj Close
Date						
2014-09-16	99.80	101.26	98.89	100.86	66818200	100.86
2014-09-15	102.81	103.05	101.44	101.63	61216500	101.63

tail()

```
AAPL.tail()
```

	Open	High	Low	Close	Volume	Adj Close
Date						
1980-12-18	26.63	26.75	26.63	26.63	18362400	0.41
1980-12-17	25.87	26.00	25.87	25.87	21610400	0.40
1980-12-16	25.37	25.37	25.25	25.25	26432000	0.39
1980-12-15	27.38	27.38	27.25	27.25	43971200	0.42
1980-12-12	28.75	28.87	28.75	28.75	117258400	0.45

```
AAPL.tail(3)
```

	Open	High	Low	Close	Volume	Adj Close
Date						
1980-12-16	25.37	25.37	25.25	25.25	26432000	0.39
1980-12-15	27.38	27.38	27.25	27.25	43971200	0.42
1980-12-12	28.75	28.87	28.75	28.75	117258400	0.45

info()

```
AAPL.info()
```

```
<class 'pandas.core.frame.DataFrame'>  
DatetimeIndex: 8514 entries, 2014-09-16 to 1980-12-12  
Data columns (total 6 columns):  
Open            8514 non-null float64  
High            8514 non-null float64  
Low             8514 non-null float64  
Close           8514 non-null float64  
Volume          8514 non-null int64  
Adj Close       8514 non-null float64  
dtypes: float64(5), int64(1)  
memory usage: 465.6 KB
```

Broadcasting

- Assigning scalar value to column slice broadcasts value to each row.

```
import numpy as np  
AAPL.iloc[::3, -1] = np.nan
```

```
AAPL.head(6)
```

	Open	High	Low	Close	Volume	Adj Close
Date						
2014-09-16	99.80	101.26	98.89	100.86	66818200	NaN
2014-09-15	102.81	103.05	101.44	101.63	61216500	101.63
2014-09-12	101.21	102.19	101.08	101.66	62626100	101.66
2014-09-11	100.41	101.44	99.62	101.43	62353100	NaN
2014-09-10	98.01	101.11	97.76	101.00	100741900	101.00
2014-09-09	99.08	103.08	96.14	97.99	189560600	97.99
2014-09-08	99.30	99.31	98.05	98.36	46277800	NaN

Broadcasting

```
AAPL.info()
```

```
<class 'pandas.core.frame.DataFrame'>
DatetimeIndex: 8514 entries, 2014-09-16 to 1980-12-12
Data columns (total 6 columns):
Open            8514 non-null float64
High            8514 non-null float64
Low             8514 non-null float64
Close           8514 non-null float64
Volume          8514 non-null int64
Adj Close       5676 non-null float64
dtypes: float64(5), int64(1)
memory usage: 465.6 KB
```

Series

```
low = AAPL['Low']  
type(low)
```

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

```
low.head()
```

```
Date  
2014-09-16    98.89  
2014-09-15   101.44  
2014-09-12   101.08  
2014-09-11   99.62  
2014-09-10   97.76  
Name: Low, dtype: float64
```

```
lows = low.values  
type(lows)
```

```
numpy.ndarray
```

Let's practice!

PANDAS FOUNDATIONS

Building DataFrames from scratch

PANDAS FOUNDATIONS



Dhavide Aruliah
Director of Training, Anaconda

DataFrames from CSV files

```
import pandas as pd  
users = pd.read_csv('datasets/users.csv', index_col=0)  
print(users)
```

	weekday	city	visitors	signups
0	Sun	Austin	139	7
1	Sun	Dallas	237	12
2	Mon	Austin	326	3
3	Mon	Dallas	456	5

DataFrames from dict (1)

```
import pandas as pd  
data = {'weekday': ['Sun', 'Sun', 'Mon', 'Mon'],  
        'city': ['Austin', 'Dallas', 'Austin', 'Dallas'],  
        'visitors': [139, 237, 326, 456],  
        'signups': [7, 12, 3, 5]}  
users = pd.DataFrame(data)  
print(users)
```

	weekday	city	visitors	signups
0	Sun	Austin	139	7
1	Sun	Dallas	237	12
2	Mon	Austin	326	3
3	Mon	Dallas	456	5

DataFrames from dict (2)

```
import pandas as pd

cities = ['Austin', 'Dallas', 'Austin', 'Dallas']

signups = [7, 12, 3, 5]

visitors = [139, 237, 326, 456]

weekdays = ['Sun', 'Sun', 'Mon', 'Mon']

list_labels = ['city', 'signups', 'visitors', 'weekday']

list_cols = [cities, signups, visitors, weekdays]

zipped = list(zip(list_labels, list_cols))
```

DataFrames from dict (3)

```
print(zipped)
```

```
[('city', ['Austin', 'Dallas', 'Austin', 'Dallas']),
('signups', [7, 12, 3, 5]),
('visitors', [139, 237, 326, 456]),
('weekday', ['Sun', 'Sun', 'Mon', 'Mon'])]
```

```
data = dict(zipped)
users = pd.DataFrame(data)
print(users)
```

```
  weekday    city  visitors  signups
0      Sun  Austin       139        7
1      Sun   Dallas       237       12
2     Mon  Austin       326        3
3     Mon   Dallas       456        5
```

Broadcasting

```
users['fees'] = 0 # Broadcasts to entire column  
print(users)
```

	city	signups	visitors	weekday	fees
0	Austin	7	139	Sun	0
1	Dallas	12	237	Sun	0
2	Austin	3	326	Mon	0
3	Dallas	5	456	Mon	0

Broadcasting with a dict

```
import pandas as pd  
heights = [ 59.0, 65.2, 62.9, 65.4, 63.7, 65.7, 64.1 ]  
data = {'height': heights, 'sex': 'M'}  
results = pd.DataFrame(data)  
print(results)
```

```
height sex  
0      59.0   M  
1      65.2   M  
2      62.9   M  
3      65.4   M  
4      63.7   M  
5      65.7   M  
6      64.1   M
```

Index and columns

```
results.columns = ['height (in)', 'sex']
results.index = ['A', 'B', 'C', 'D', 'E', 'F', 'G']
print(results)
```

	height (in)	sex
A	59.0	M
B	65.2	M
C	62.9	M
D	65.4	M
E	63.7	M
F	65.7	M
G	64.1	M

Let's practice!

PANDAS FOUNDATIONS

Importing & exporting data

PANDAS FOUNDATIONS



Dhavide Aruliah
Director of Training, Anaconda

Original CSV file

- Dataset: Sunspot observations collected from SILSO

```
1818,01,01,1818.004, -1,1  
1818,01,02,1818.007, -1,1  
1818,01,03,1818.010, -1,1  
1818,01,04,1818.012, -1,1  
1818,01,05,1818.015, -1,1  
1818,01,06,1818.018, -1,1  
...
```

¹ Source: SILSO, Daily total sunspot number
(<http://www.sidc.be/silso/info&ssntodaily>)

Datasets from CSV files

```
import pandas as pd  
filepath = 'ISSN_D_tot.csv'  
sunspots = pd.read_csv(filepath)  
sunspots.info()
```

```
<class 'pandas.core.frame.DataFrame'>  
RangeIndex: 71921 entries, 0 to 71920  
Data columns (total 6 columns):  
1818      71921 non-null int64  
01        71921 non-null int64  
01.1      71921 non-null int64  
1818.004   71921 non-null float64  
-1        71921 non-null int64  
1         71921 non-null int64  
dtypes: float64(1), int64(5)  
memory usage: 3.3 MB
```

Datasets from CSV files

```
sunspots.iloc[10:20, :]
```

```
   1818  01  01.1  1818.004    -1   1
10  1818    1     12  1818.034    -1   1
11  1818    1     13  1818.037    22   1
12  1818    1     14  1818.040    -1   1
13  1818    1     15  1818.042    -1   1
14  1818    1     16  1818.045    -1   1
15  1818    1     17  1818.048    46   1
16  1818    1     18  1818.051    59   1
17  1818    1     19  1818.053    63   1
18  1818    1     20  1818.056    -1   1
19  1818    1     21  1818.059    -1   1
```

Problems

- CSV file has no column headers
 - Columns 0-2: Gregorian date (year, month, day)
 - Column 3: Date as fraction as year
 - Column 4: Daily total sunspot number
 - Column 5: Definitive/provisional indicator (1 or 0)
- Missing values in column 4: indicated by -1
- Dates representation inconvenient

Using header keyword

```
sunspots = pd.read_csv(filepath, header=None)  
sunspots.iloc[10:20, :]
```

	0	1	2	3	4	5
10	1818	1	11	1818.031	-1	1
11	1818	1	12	1818.034	-1	1
12	1818	1	13	1818.037	22	1
13	1818	1	14	1818.040	-1	1
14	1818	1	15	1818.042	-1	1
15	1818	1	16	1818.045	-1	1
16	1818	1	17	1818.048	46	1
17	1818	1	18	1818.051	59	1
18	1818	1	19	1818.053	63	1
19	1818	1	20	1818.056	-1	1

Using names keyword

```
col_names = ['year', 'month', 'day', 'dec_date',
             'sunspots', 'definite']
sunspots = pd.read_csv(filepath, header=None,
                       names=col_names)
sunspots.iloc[10:20, :]
```

	year	month	day	dec_date	sunspots	definite
10	1818	1	11	1818.031	-1	1
11	1818	1	12	1818.034	-1	1
12	1818	1	13	1818.037	22	1
13	1818	1	14	1818.040	-1	1
14	1818	1	15	1818.042	-1	1
15	1818	1	16	1818.045	-1	1
16	1818	1	17	1818.048	46	1
17	1818	1	18	1818.051	59	1
18	1818	1	19	1818.053	63	1
19	1818	1	20	1818.056	-1	1

Using na_values keyword (1)

```
sunspots = pd.read_csv(filepath, header=None,  
                      names=col_names, na_values='-1')  
sunspots.iloc[10:20, :]
```

	year	month	day	dec_date	sunspots	definite
10	1818	1	11	1818.031	-1	1
11	1818	1	12	1818.034	-1	1
12	1818	1	13	1818.037	22	1
13	1818	1	14	1818.040	-1	1
14	1818	1	15	1818.042	-1	1
15	1818	1	16	1818.045	-1	1
16	1818	1	17	1818.048	46	1
17	1818	1	18	1818.051	59	1
18	1818	1	19	1818.053	63	1
19	1818	1	20	1818.056	-1	1

Using na_values keyword (2)

```
sunspots = pd.read_csv(filepath, header=None,  
                      names=col_names, na_values=' -1 ')  
sunspots.iloc[10:20, :]
```

	year	month	day	dec_date	sunspots	definite
10	1818	1	11	1818.031	NaN	1
11	1818	1	12	1818.034	NaN	1
12	1818	1	13	1818.037	22.0	1
13	1818	1	14	1818.040	NaN	1
14	1818	1	15	1818.042	NaN	1
15	1818	1	16	1818.045	NaN	1
16	1818	1	17	1818.048	46.0	1
17	1818	1	18	1818.051	59.0	1
18	1818	1	19	1818.053	63.0	1
19	1818	1	20	1818.056	NaN	1

Using na_values keyword (3)

```
sunspots = pd.read_csv(filepath, header=None,  
                      names=col_names, na_values={'sunspots':[-1]})  
sunspots.iloc[10:20, :]
```

	year	month	day	dec_date	sunspots	definite
10	1818	1	11	1818.031	NaN	1
11	1818	1	12	1818.034	NaN	1
12	1818	1	13	1818.037	22.0	1
13	1818	1	14	1818.040	NaN	1
14	1818	1	15	1818.042	NaN	1
15	1818	1	16	1818.045	NaN	1
16	1818	1	17	1818.048	46.0	1
17	1818	1	18	1818.051	59.0	1
18	1818	1	19	1818.053	63.0	1
19	1818	1	20	1818.056	NaN	1

Using parse_dates keyword

```
sunspots = pd.read_csv(filepath, header=None,  
                      names=col_names, na_values={'sunspots':[-1]},  
                      parse_dates=[[0, 1, 2]])  
sunspots.iloc[10:20, :]
```

	year_month_day	dec_date	sunspots	definite
10	1818-01-11	1818.031	NaN	1
11	1818-01-12	1818.034	NaN	1
12	1818-01-13	1818.037	22.0	1
13	1818-01-14	1818.040	NaN	1
14	1818-01-15	1818.042	NaN	1
15	1818-01-16	1818.045	NaN	1
16	1818-01-17	1818.048	46.0	1
17	1818-01-18	1818.051	59.0	1
18	1818-01-19	1818.053	63.0	1
19	1818-01-20	1818.056	NaN	1

Inspecting DataFrame

```
sunspots.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 71922 entries, 0 to 71921
Data columns (total 4 columns):
year_month_day    71922 non-null datetime64[ns]
dec_date          71922 non-null float64
sunspots          68675 non-null float64
definite          71922 non-null int64
dtypes: datetime64[ns](1), float64(2), int64(1)
memory usage: 2.2 MB
```

Using dates as index

```
sunspots.index = sunspots['year_month_day']
sunspots.index.name = 'date'
sunspots.info()
```

```
<class 'pandas.core.frame.DataFrame'>
DatetimeIndex: 71922 entries, 1818-01-01 to 2014-11-30
Data columns (total 4 columns):
year_month_day    71922 non-null datetime64[ns]
dec_date          71922 non-null float64
sunspots          68675 non-null float64
definite          71922 non-null int64
dtypes: datetime64[ns](1), float64(2), int64(1)
memory usage: 2.7 MB
```

Trimming redundant columns

```
cols = ['sunspots', 'definite']
sunspots = sunspots[cols]
sunspots.iloc[10:20, :]
```

```
sunspots  definite
date
1818-01-11      NaN      1
1818-01-12      NaN      1
1818-01-13     22.0      1
1818-01-14      NaN      1
1818-01-15      NaN      1
1818-01-16      NaN      1
1818-01-17     46.0      1
1818-01-18     59.0      1
1818-01-19     63.0      1
1818-01-20      NaN      1
```

Writing files

```
out_csv = 'sunspots.csv'  
sunspots.to_csv(out_csv)
```

```
out_tsv = 'sunspots.tsv'  
sunspots.to_csv(out_tsv, sep='\t')
```

```
out_xlsx = 'sunspots.xlsx'  
sunspots.to_excel(out_xlsx)
```

Let's practice!

PANDAS FOUNDATIONS

Plotting with pandas

PANDAS FOUNDATIONS



Dhavide Aruliah

Director of Training, Anaconda

AAPL stock data

```
import pandas as pd
import matplotlib.pyplot as plt
aapl = pd.read_csv('aapl.csv', index_col='date',
                    parse_dates=True)
aapl.head(6)
```

	adj_close	close	high	low	open	volume
date						
2000-03-01	31.68	130.31	132.06	118.50	118.56	38478000
2000-03-02	29.66	122.00	127.94	120.69	127.00	11136800
2000-03-03	31.12	128.00	128.23	120.00	124.87	11565200
2000-03-06	30.56	125.69	129.13	125.00	126.00	7520000
2000-03-07	29.87	122.87	127.44	121.12	126.44	9767600
2000-03-08	29.66	122.00	123.94	118.56	122.87	9690800

Plotting arrays (matplotlib)

```
close_arr = aapl['close'].values  
type(close_arr)
```

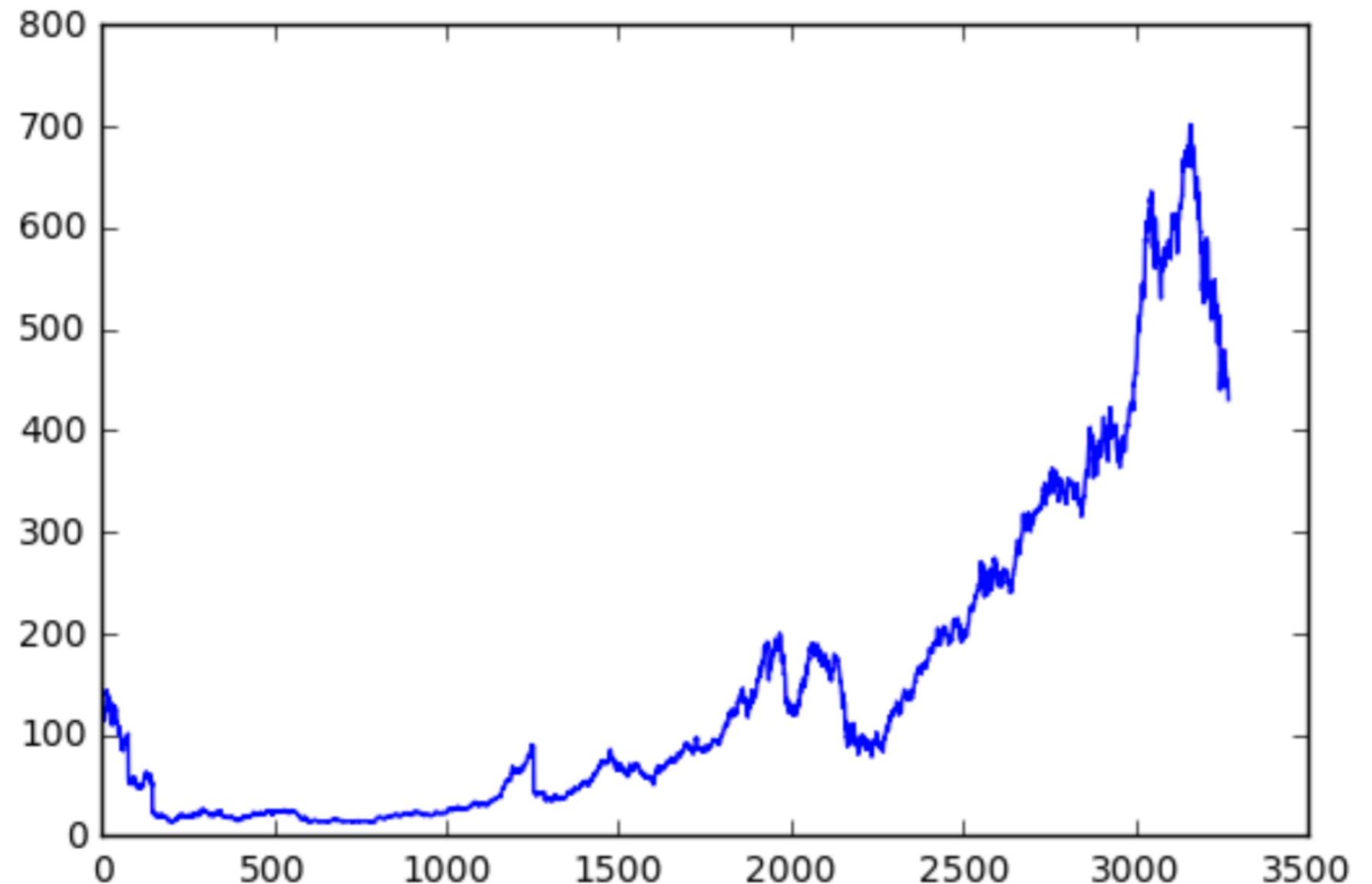
```
numpy.ndarray
```

```
plt.plot(close_arr)
```

```
[<matplotlib.lines.Line2D at 0x115550358>]
```

```
plt.show()
```

Plotting arrays (matplotlib)



Plotting Series (matplotlib)

```
close_series = aapl['close']
type(close_series)
```

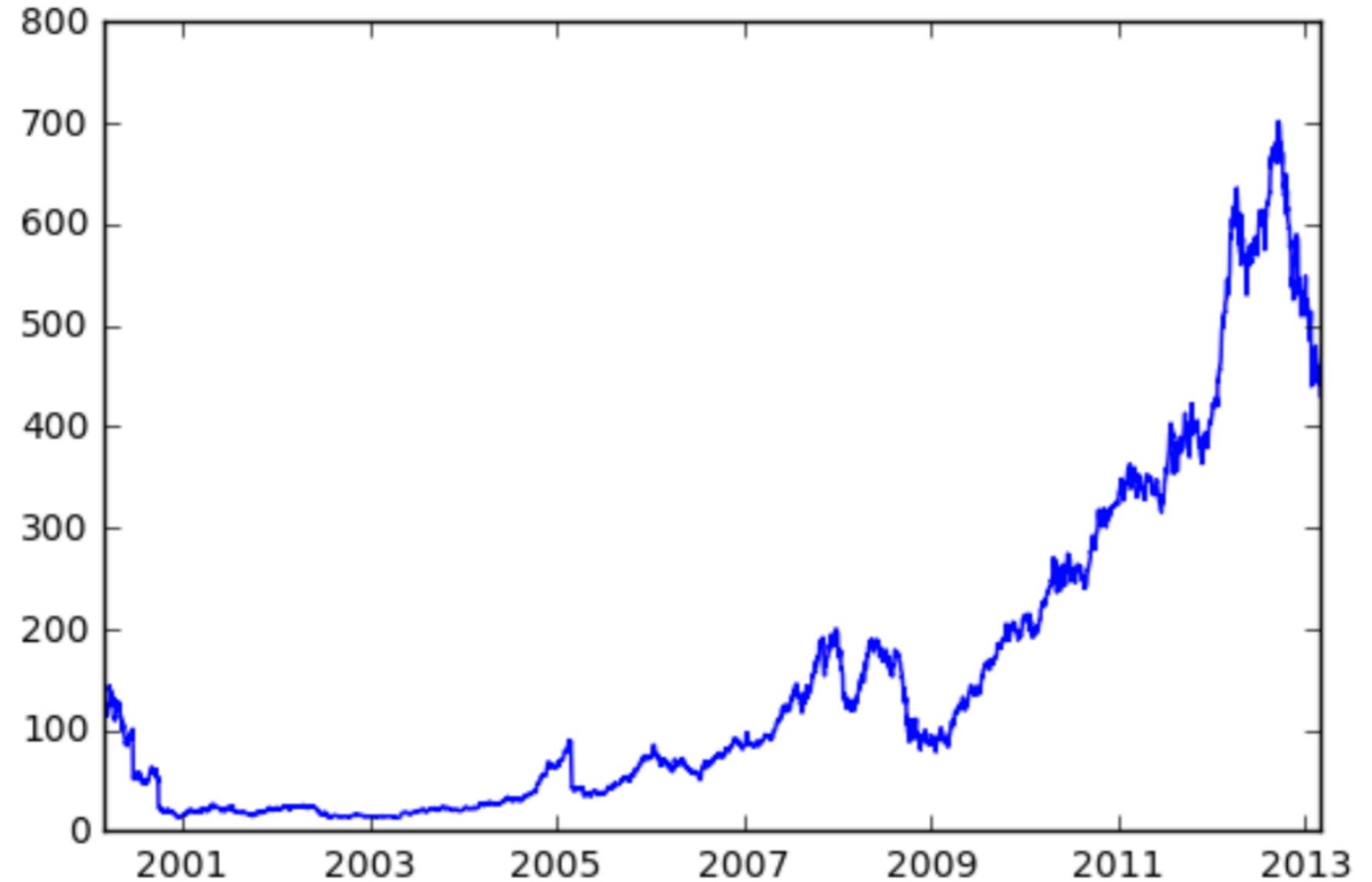
```
pandas.core.series.Series
```

```
plt.plot(close_series)
```

```
[<matplotlib.lines.Line2D at 0x11801cd30>]
```

```
plt.show()
```

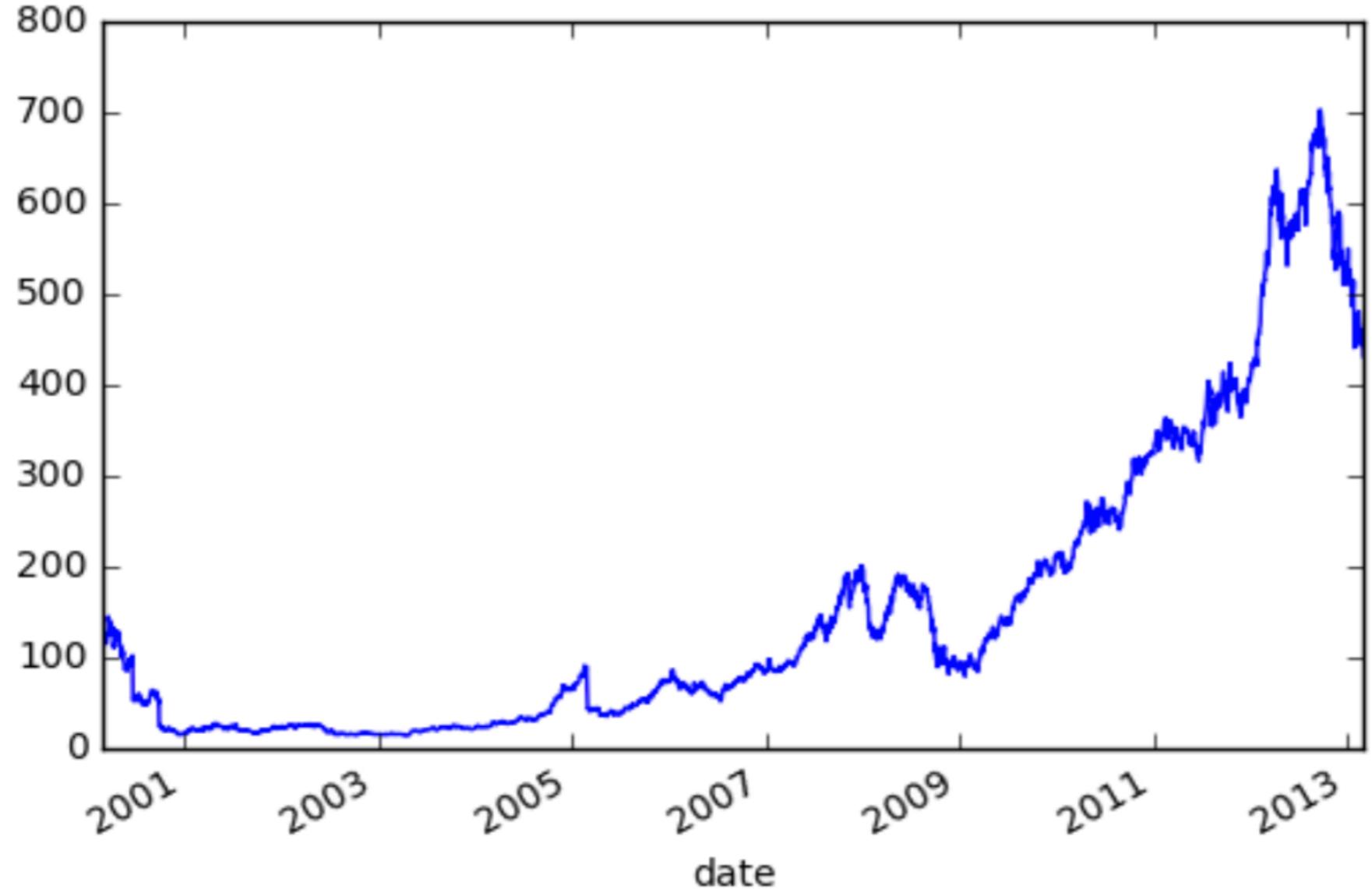
Plotting Series (matplotlib)



Plotting Series (pandas)

```
close_series.plot() # plots Series directly  
plt.show()
```

Plotting Series (pandas)



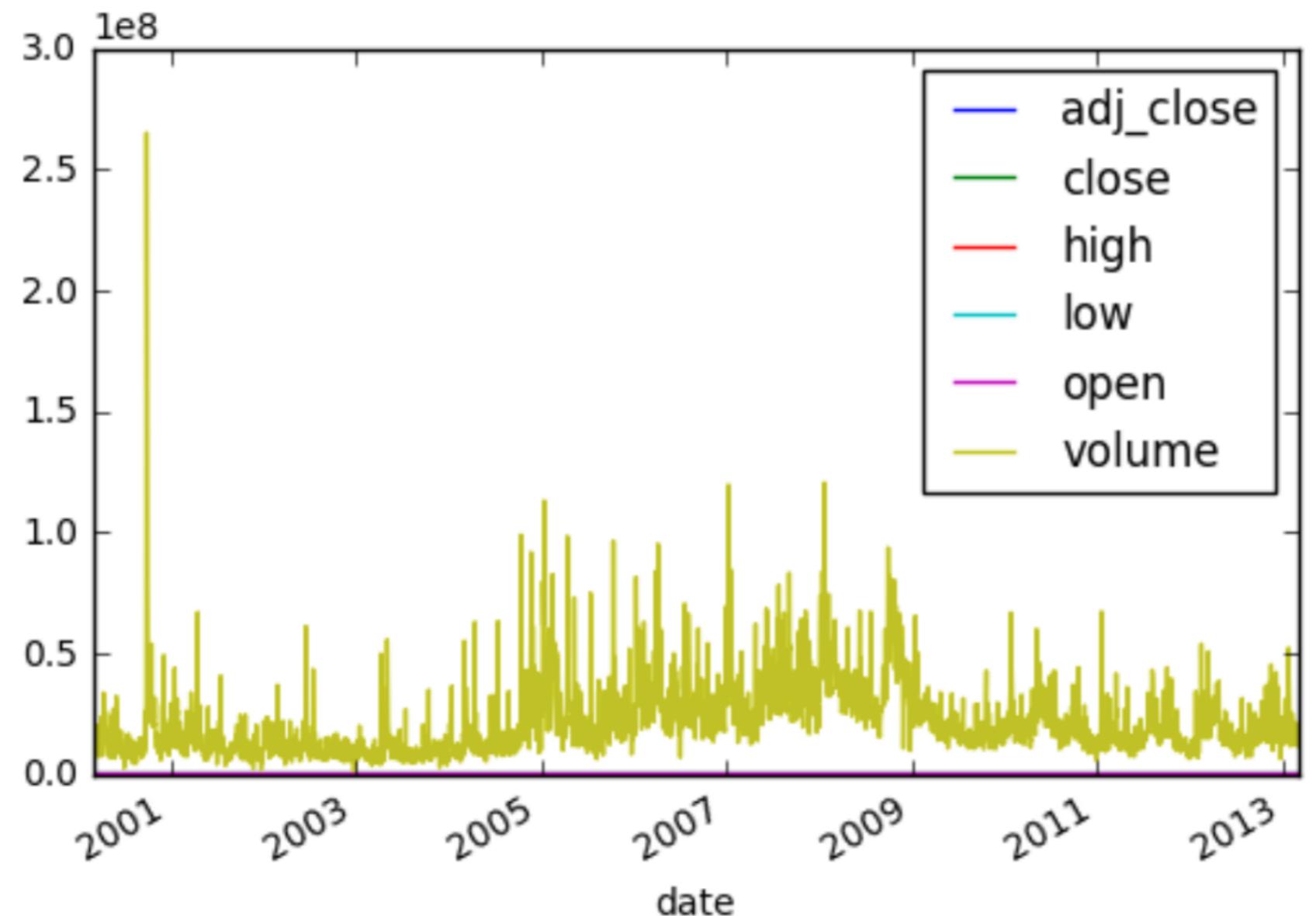
Plotting DataFrames (pandas)

```
aapl.plot() # plots all Series at once
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x118039b38>
```

```
plt.show()
```

Plotting DataFrames (pandas)



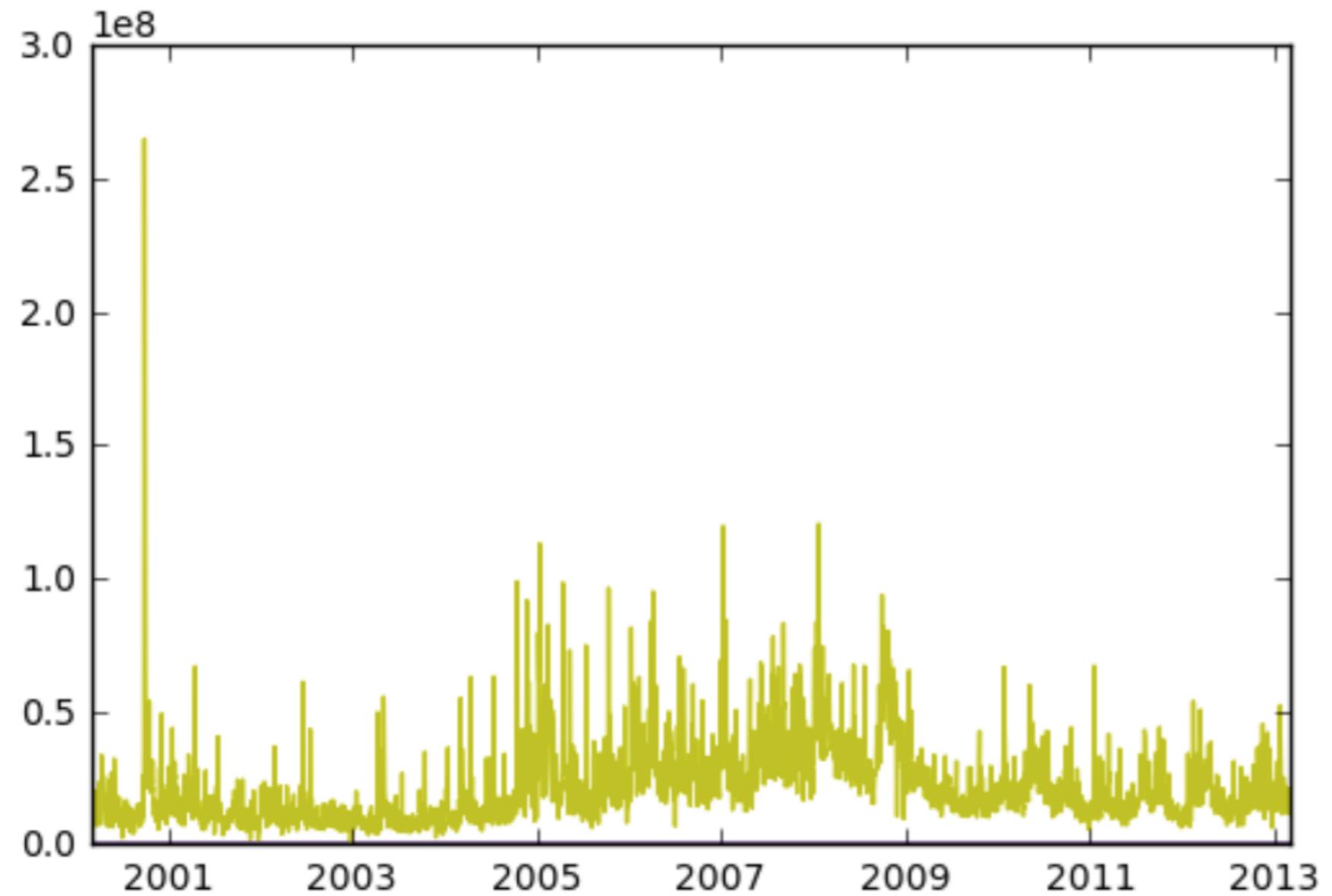
Plotting DataFrames (matplotlib)

```
plt.plot(aapl) # plots all columns at once
```

```
<matplotlib.lines.Line2D at 0x1156290f0>,
<matplotlib.lines.Line2D at 0x1156525f8>,
<matplotlib.lines.Line2D at 0x1156527f0>,
<matplotlib.lines.Line2D at 0x1156529e8>,
<matplotlib.lines.Line2D at 0x115652be0>,
<matplotlib.lines.Line2D at 0x115652dd8>
```

```
plt.show()
```

Plotting DataFrames (matplotlib)



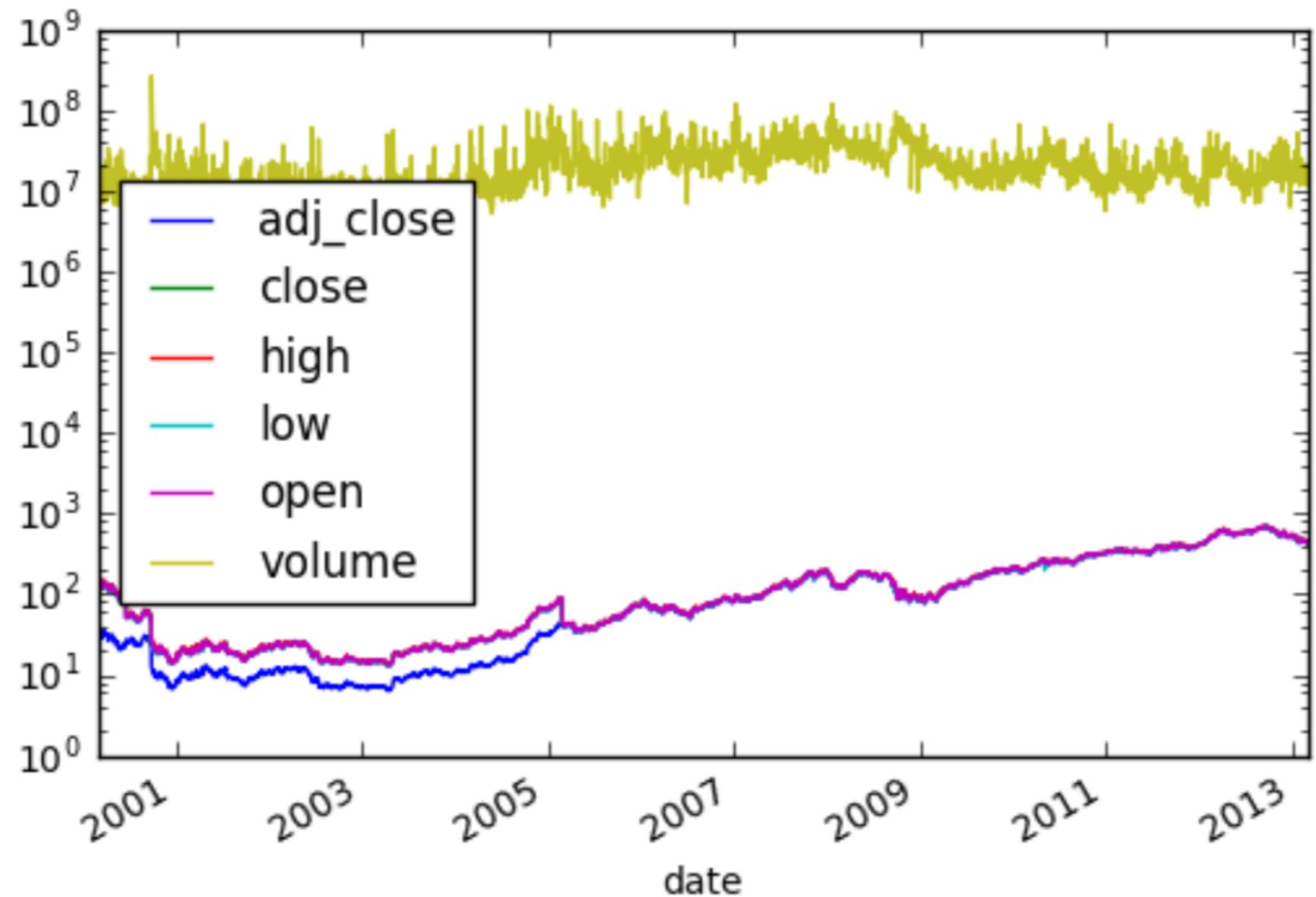
Fixing scales

```
aapl.plot()
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x118afe048>
```

```
plt.yscale('log') # logarithmic scale on vertical axis  
plt.show()
```

Fixing scales



Customizing plots

```
aapl['open'].plot(color='b', style='.-', legend=True)
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x11a17db38>
```

```
aapl['close'].plot(color='r', style='.', legend=True)
```

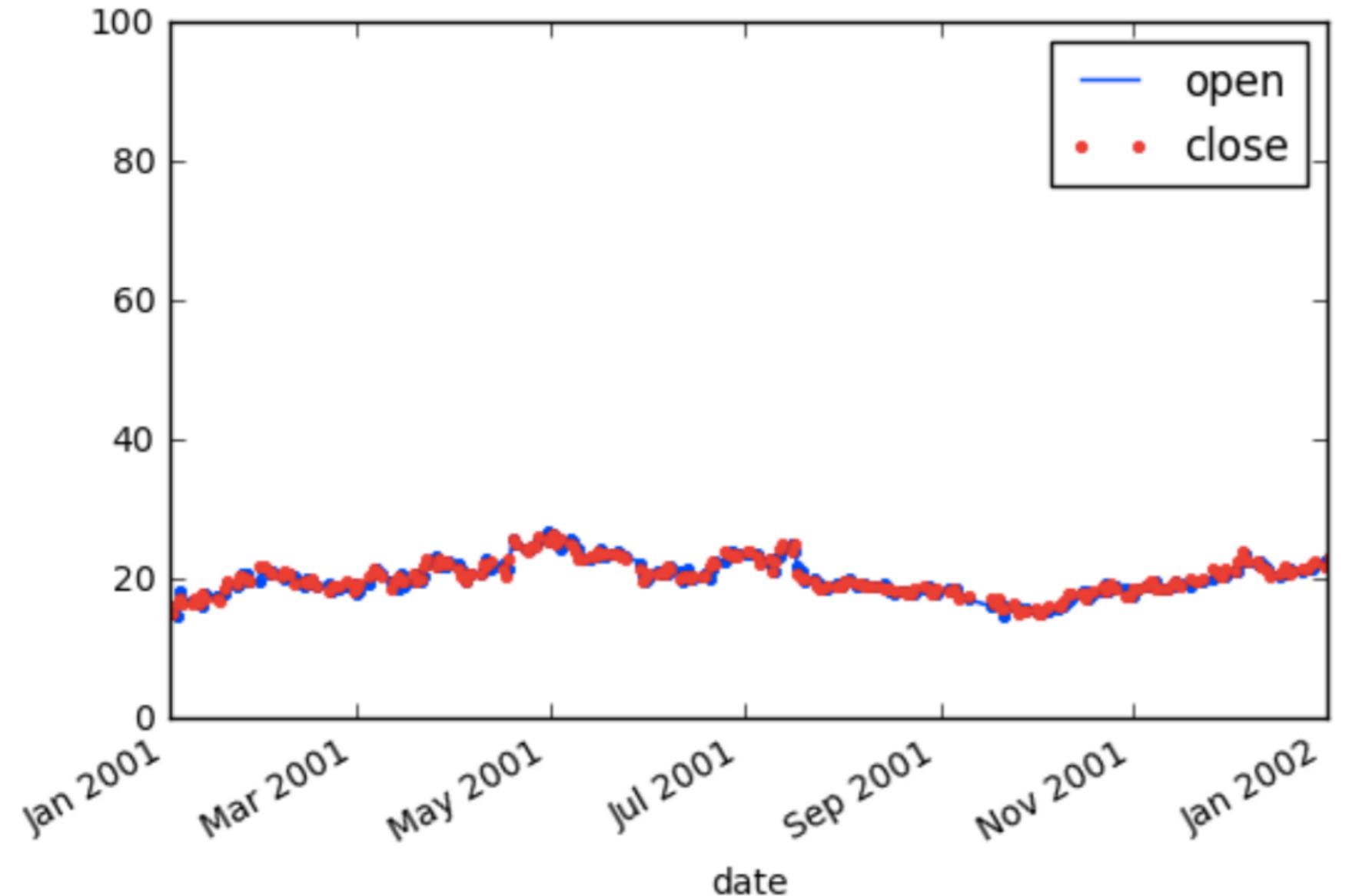
```
<matplotlib.axes._subplots.AxesSubplot at 0x11a17db38>
```

```
plt.axis(('2001', '2002', 0, 100))
```

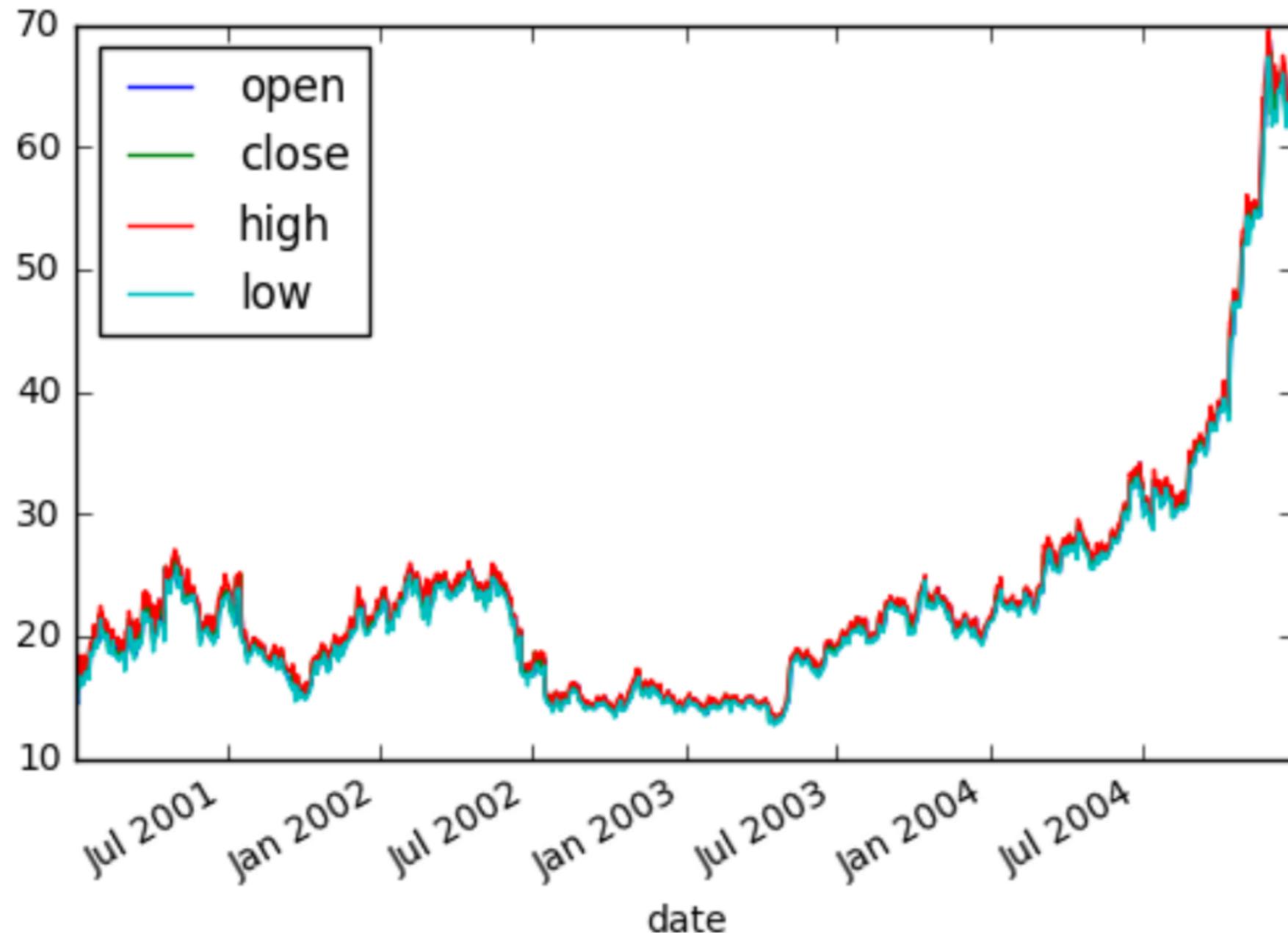
```
'2001', '2002', 0, 100)
```

```
plt.show()
```

Customizing plots



Saving plots



Saving plots

```
aapl.loc['2001':'2004',['open', 'close', 'high',  
'low']].plot()
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x11ab42978>
```

```
plt.savefig('aapl.png')  
plt.savefig('aapl.jpg')  
plt.savefig('aapl.pdf')  
plt.show()
```

Let's practice!

PANDAS FOUNDATIONS

