Hands-on Activity 9.2 Customized Visualizations using Seaborn

Instructions:

Create a Python notebook to answer all shown procedures, exercises and analysis in this section.

Resources:

Download the following datasets: fb_stock_prices_2018.csv Download fb_stock_prices_2018.csv, earthquakes-1.csvDownload earthquakes-1.csv Procedures:

9.4 Introduction to Seaborn

9.5 Formatting Plots

9.6 Customizing Visualizations

Data Analysis:

Provide comments on output from the procedures. Supplementary Activity:

Using the CSV files provided and what we have learned so far in this module complete the following exercises:

Using seaborn, create a heatmap to visualize the correlation coefficients between earthquake magnitude and whether there was a tsunami with the magType of mb. Create a box plot of Facebook volume traded and closing prices, and draw reference lines for the bounds of a Tukey fence with a multiplier of 1.5. The bounds will be at Q1 - 1.5 * IQR and Q3 + 1.5 * IQR. Be sure to use the quantile() method on the data to make this easier. (Pick whichever orientation you prefer for the plot, but make sure to use subplots.) Fill in the area between the bounds in the plot from exercise #2. Use axvspan() to shade a rectangle from '2018-07-25' to '2018-07-31', which marks the large decline in Facebook price on a line plot of the closing price. Using the Facebook stock price data, annotate the following three events on a line plot of the closing price: Disappointing user growth announced after close on July 25, 2018 Cambridge Analytica story breaks on March 19, 2018 (when it affected the market) FTC launches investigation on March 20, 2018 Modify the reg_resid_plots() function to use a matplotlib colormap instead of cycling between two colors. Remember, for this use case, we should pick a qualitative colormap or make our own. Summary/Conclusion:

Provide a summary of your learnings and the conclusion for this activity.

Start of 9.4

Introduction to Seaborn

About the Data In this notebook, we will be working with 2 datasets: Facebook's stock price throughout 2018 (obtained using the stock_analysis package)

Earthquake data from September 18, 2018 - October 13, 2018 (obtained from the US Geological Survey (USGS) using the USGS API)

```
%matplotlib inline
import matplotlib.pyplot as plt
import numpy as np
import seaborn as sns
import pandas as pd
fb = pd.read_csv(
 'fb_stock_prices_2018.csv', index_col='date', parse_dates=True
)
quakes = pd.read_csv('earthquakes-1.csv')
```

Categorical data

A 7.5 magnitude earthquake on September 28, 2018 near Palu, Indonesia caused a devastating tsunami afterwards. Let's take a look at some visualizations to understand what magTypes are used in Indonesia, the range of magnitudes there, and how many of the earthquakes are accompanied by a tsunami.

```
quakes.assign(
 time=lambda x: pd.to_datetime(x.time, unit='ms')
).set_index('time').loc['2018-09-28'].query(
 "parsed_place == 'Indonesia' and tsunami == 1 and mag == 7.5"
)
```

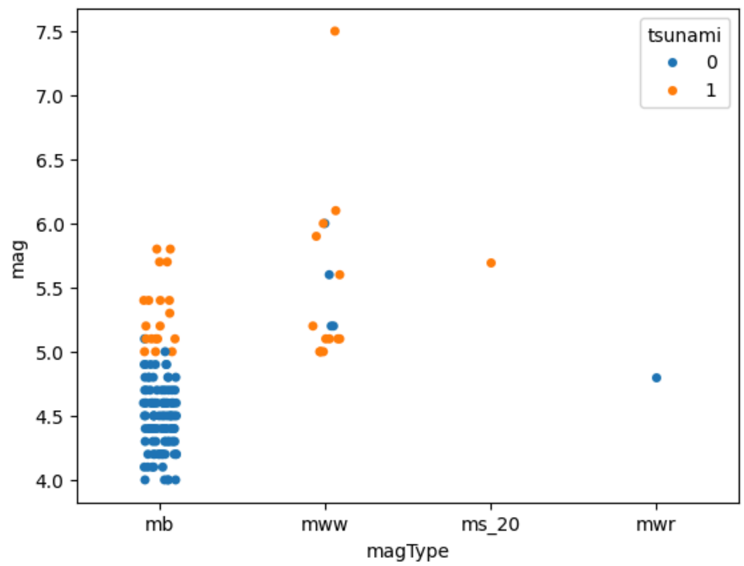
	mag	magType	place	tsunami	parsed_place
time					
2018-09-28 10:02:43.480	7.5	mww	78km N of Palu, Indonesia	1	Indonesia

stripplot()

The stripplot() function helps us visualize categorical data on one axis and numerical data on the other. We also now have the option of coloring our points using a column of our data (with the hue parameter). Using a strip plot, we can see points for each earthquake that was measured with a given magType and what its magnitude was; however, it isn't too easy to see density of the points due to overlap:

```
sns.stripplot(
 x='magType',
 y='mag',
 hue='tsunami',
 data=quakes.query('parsed_place == "Indonesia"')
)
```

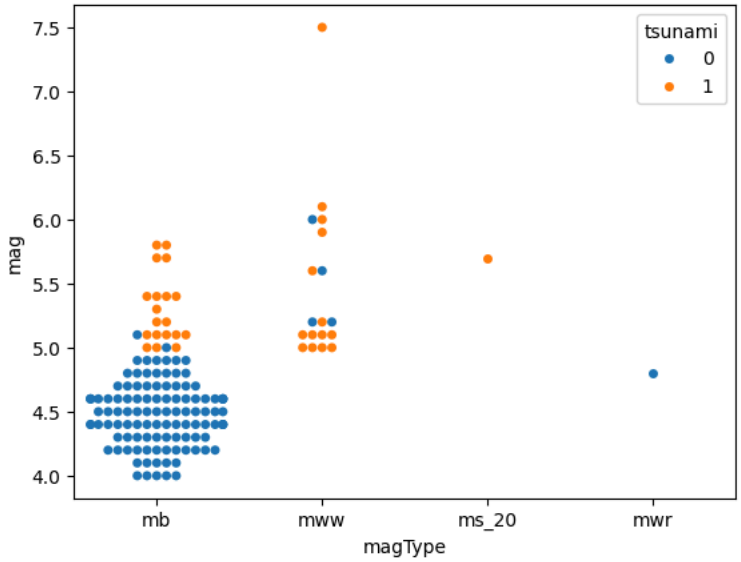
```
<Axes: xlabel='magType', ylabel='mag'>
```



swarmplot() The bee swarm plot helps address this issue be keeping the points from overlapping. Notice how many more points we can see for the blue section of the mb magType :

```
sns.swarmplot(
 x='magType',
 y='mag',
 hue='tsunami',
 data=quakes.query('parsed_place == "Indonesia"')
)
```

```
<Axes: xlabel='magType', ylabel='mag'>
/usr/local/lib/python3.11/dist-packages/seaborn/categorical.py:3399: UserWarning: 10.2% of the points cannot be placed; you may want to
  warnings.warn(msg, UserWarning)
```

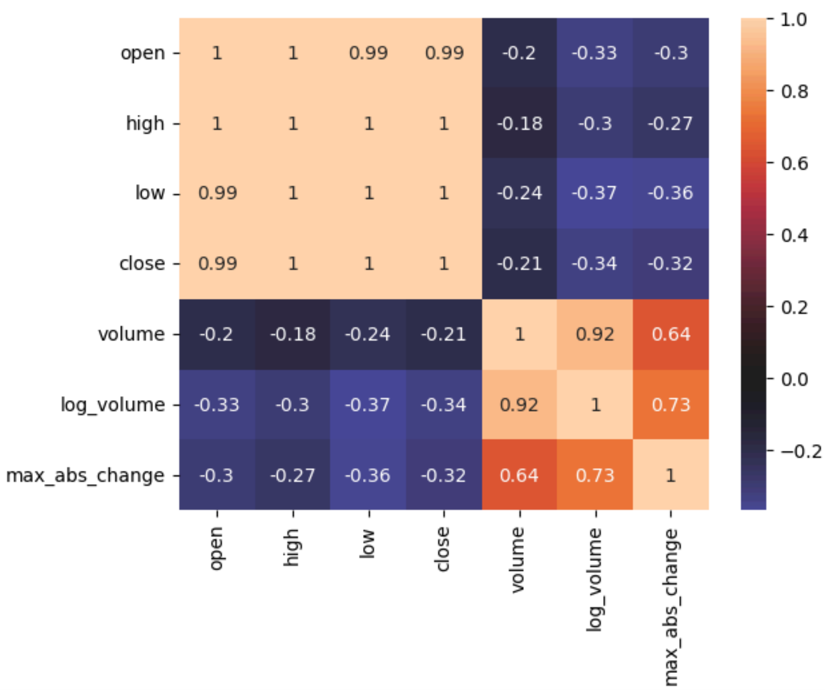


Correlations and Heatmaps

heatmap() An easier way to create correlation matrix is to use seaborn :

```
sns.heatmap(
 fb.sort_index().assign(
 log_volume=np.log(fb.volume),
 max_abs_change=fb.high - fb.low
).corr(),

 annot=True, center=0
)
```

```
<Axes: >
```

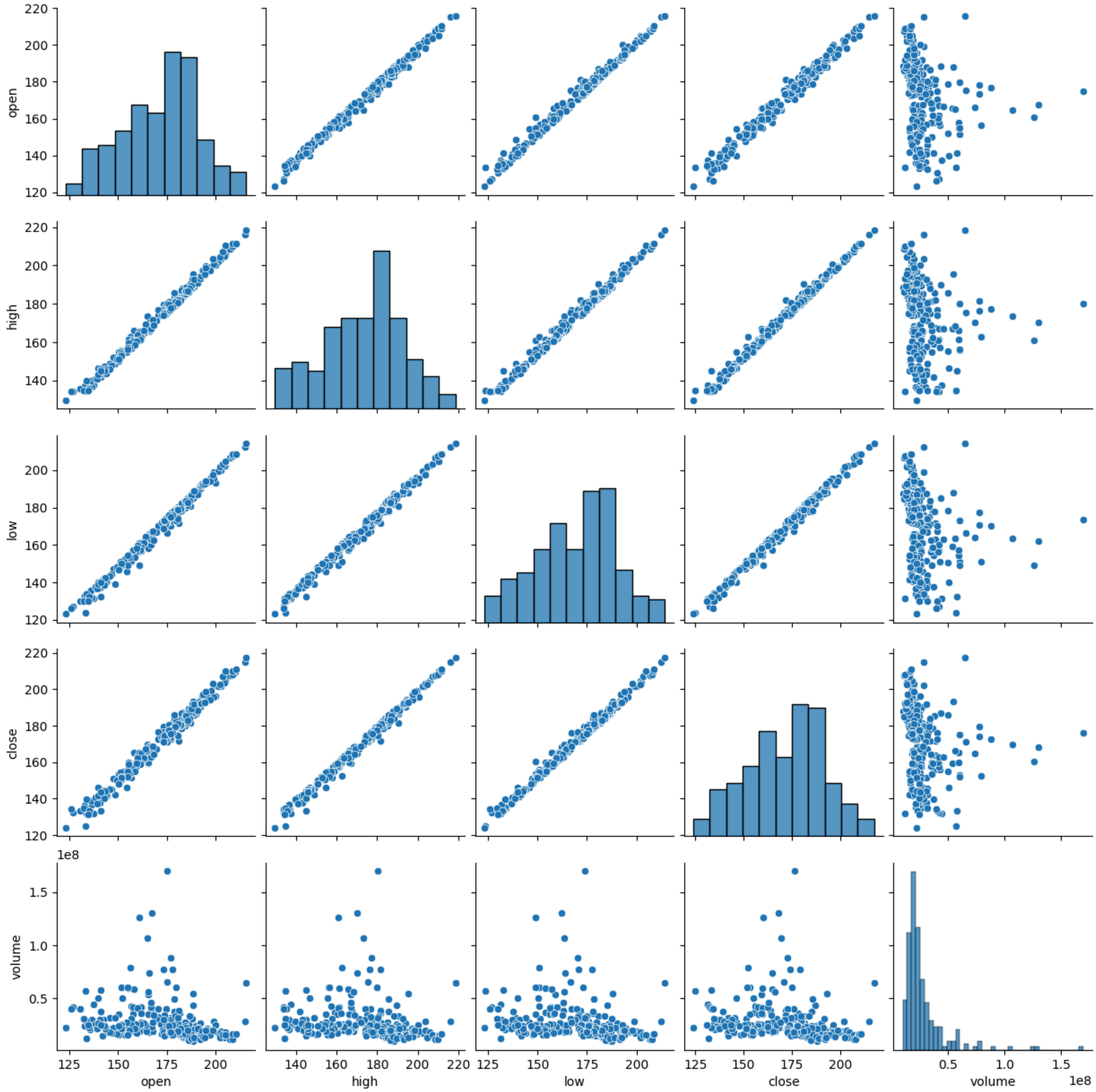


pairplot()

The pair plot is seaborn's answer to the scatter matrix we saw in the pandas subplotting notebook:

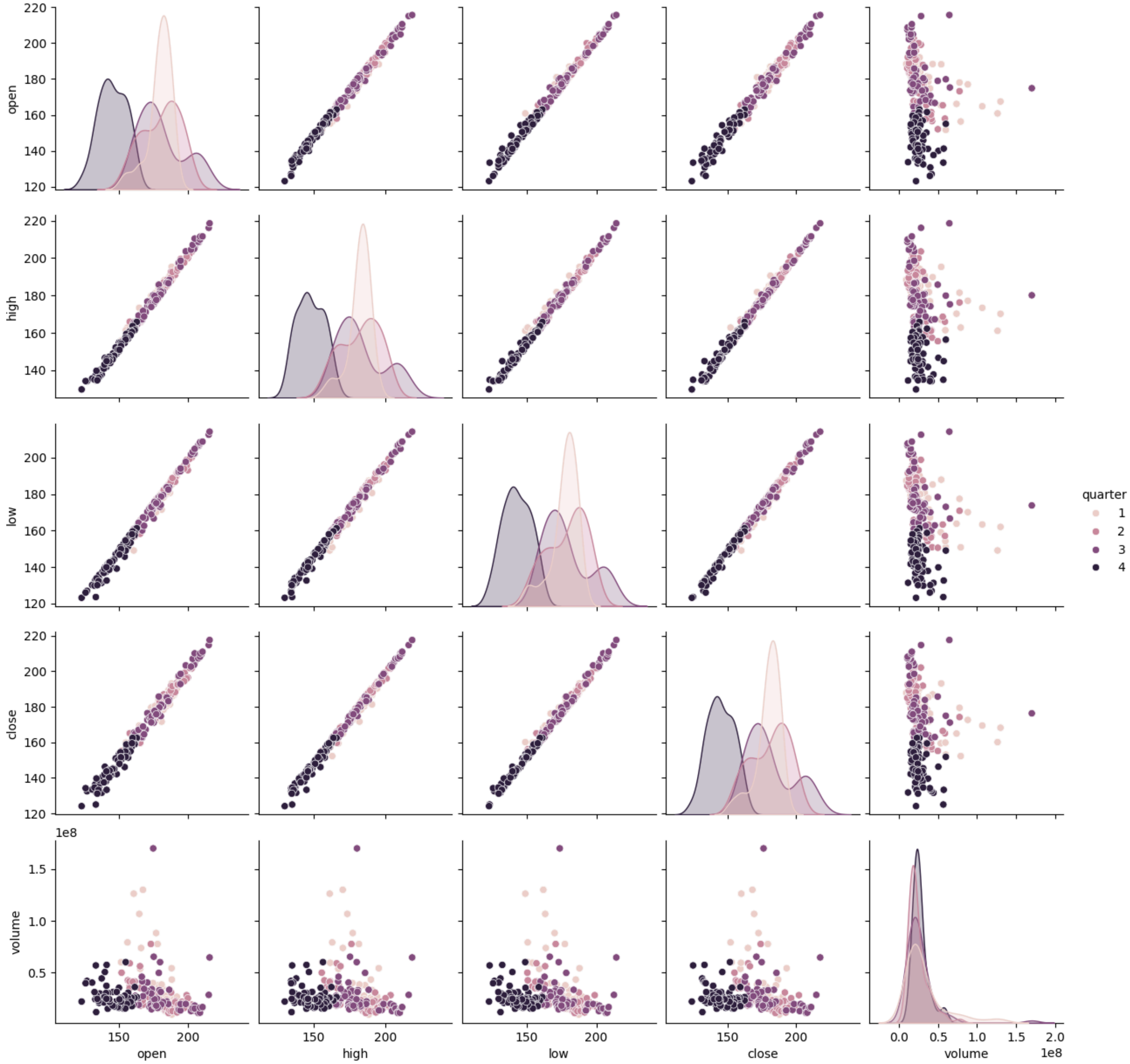
```
sns.pairplot(fb)
```

```
<seaborn.axisgrid.PairGrid at 0x7b83a90a5a90>
```




```
sns.pairplot(
 fb.assign(quarter=lambda x: x.index.quarter),
 diag_kind='kde',
 hue='quarter'
)
```

```
<seaborn.axisgrid.PairGrid at 0x7b83a1f00290>
```



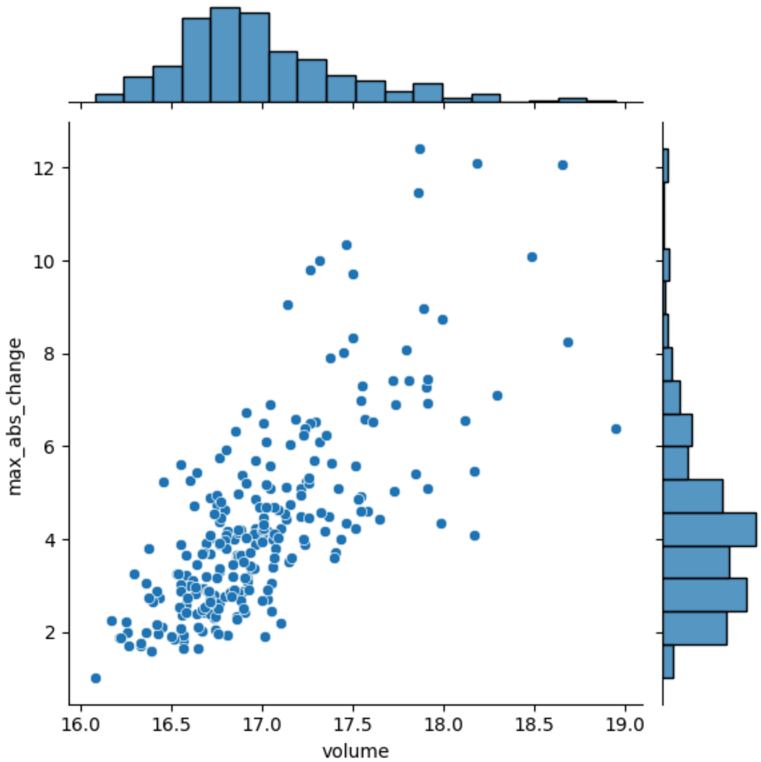
jointplot()

The joint plot allows us to visualize the relationship between two variables, like a scatter plot. However, we get the added benefit of being able to visualize their distributions at the same time (as a histogram or KDE). The default options give us a scatter plot in the center and histograms on the sides:

```
sns.jointplot(
 x='volume',
```

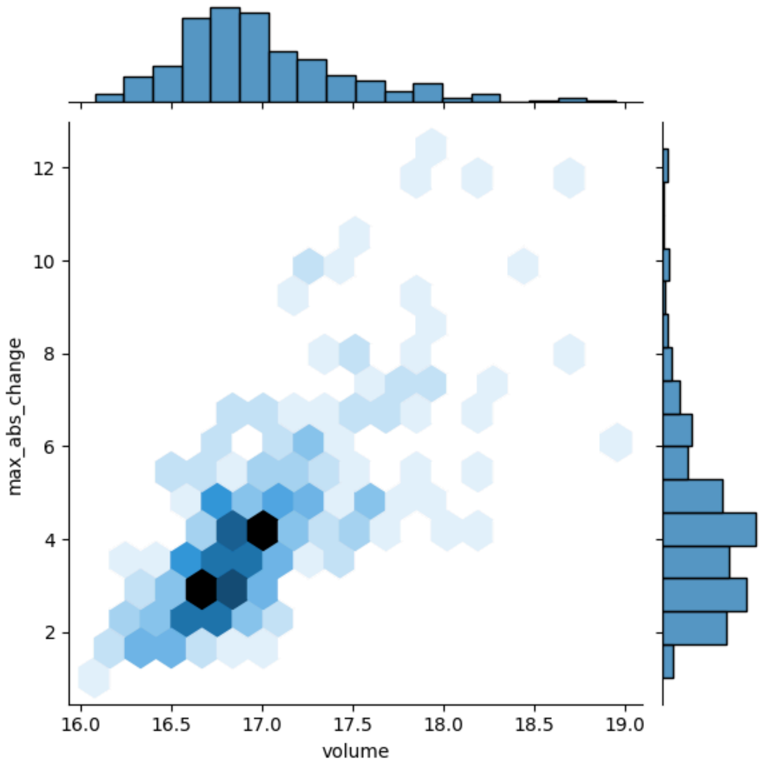
```
 y='max_abs_change',
 data=fb.assign(
 volume=np.log(fb.volume),
 max_abs_change=fb.high - fb.low
 )
)
```

```
<seaborn.axisgrid.JointGrid at 0x7b839bd43410>
```



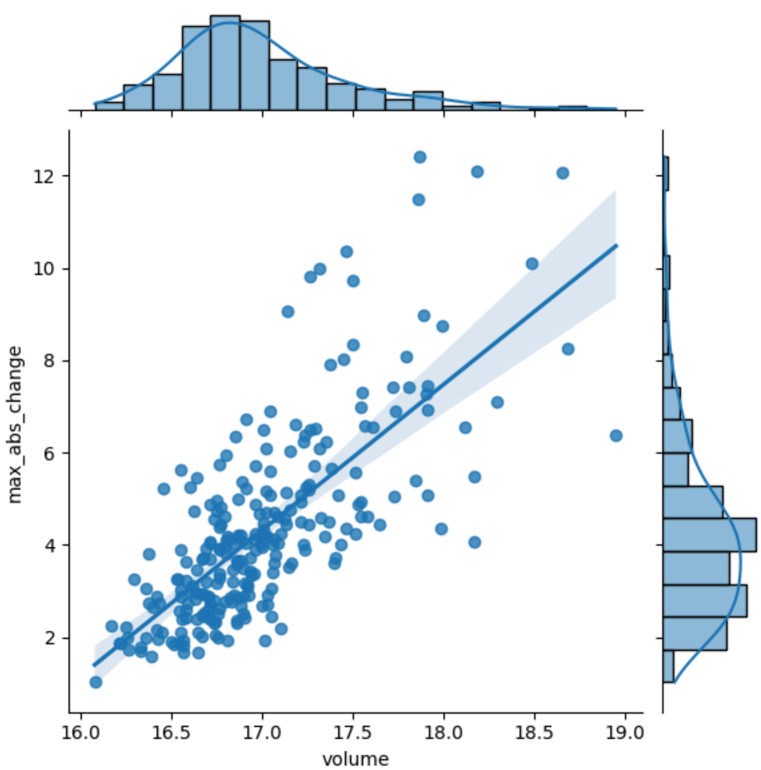

```
sns.jointplot(
 x='volume',
 y='max_abs_change',
 kind='hex',
 data=fb.assign(
 volume=np.log(fb.volume),
 max_abs_change=fb.high - fb.low
 )
)
```

<seaborn.axisgrid.JointGrid at 0x7b8398939c50>



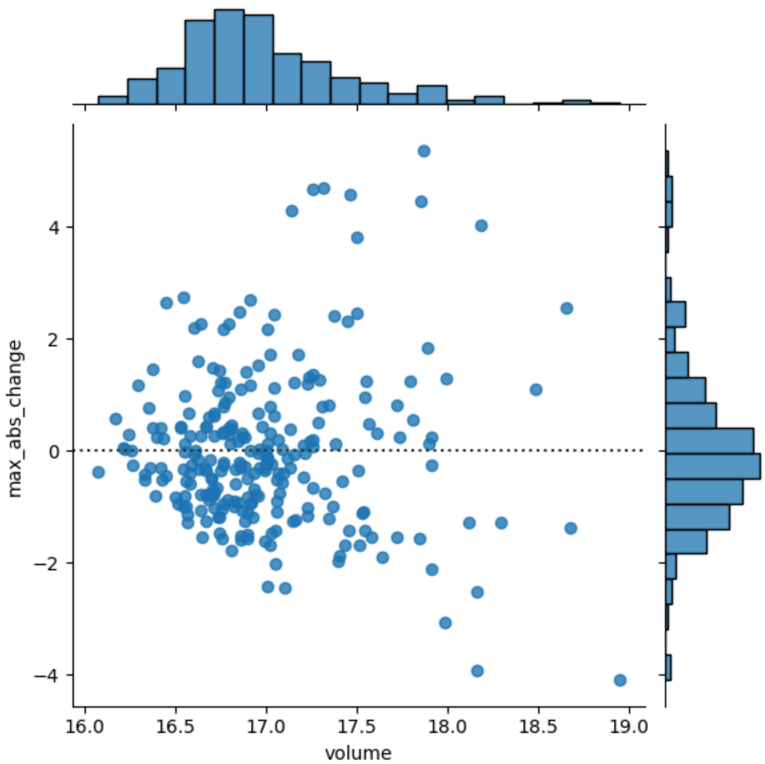

```
sns.jointplot(
 x='volume',
 y='max_abs_change',
 kind='reg',
 data=fb.assign(
 volume=np.log(fb.volume),
 max_abs_change=fb.high - fb.low
 )
)
```

<seaborn.axisgrid.JointGrid at 0x7b8398ec9d50>



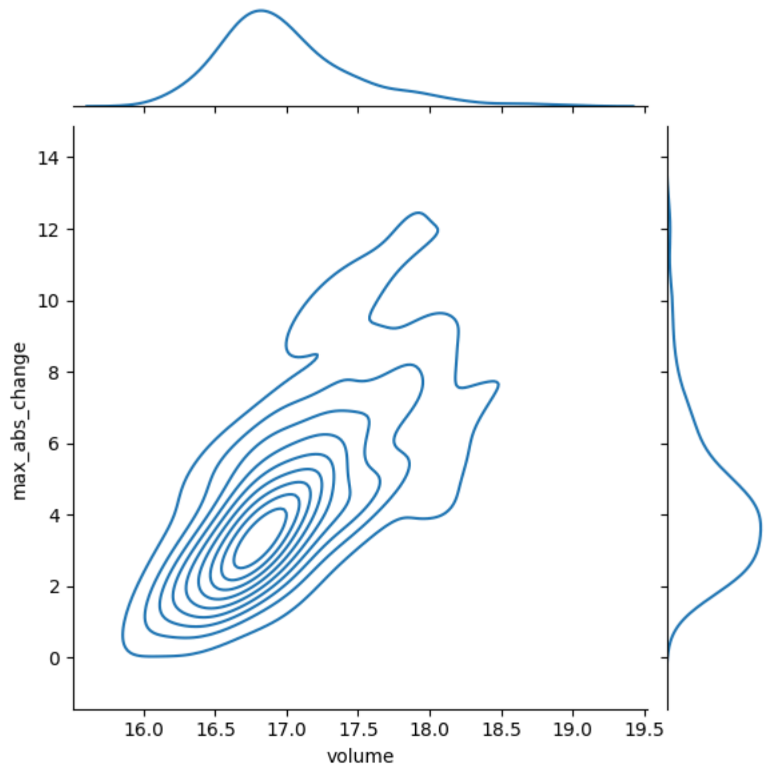
```
sns.jointplot(
 x='volume',
 y='max_abs_change',
 kind='resid',
 data=fb.assign(
 volume=np.log(fb.volume),
 max_abs_change=fb.high - fb.low
 )
)
```

<seaborn.axisgrid.JointGrid at 0x7b8398c81d50>




```
sns.jointplot(
 x='volume',
 y='max_abs_change',
 kind='kde',
 data=fb.assign(
 volume=np.log(fb.volume),
 max_abs_change=fb.high - fb.low
 )
)
```

```
<seaborn.axisgrid.JointGrid at 0x7b8398ba9d90>
```



Regression plots

We are going to use seaborn to visualize a linear regression between the log of the volume traded in Facebook stock and the maximum absolute daily change (daily high stock price - daily low stock price). To do so, we first need to isolate this data:

```
_reg_data = fb.assign(
 volume=np.log(fb.volume),
 max_abs_change=fb.high - fb.low
).iloc[:,-2:]
```

```
import itertools
```

itertools gives us efficient iterators. Iterators are objects that we loop over, exhausting them. This is an iterator from itertools ; notice how the second loop doesn't do anything:

```
iterator = itertools.repeat("I'm an iterator", 1)
for i in iterator:
 print(f'-->{i}')
print('This printed once because the iterator has been exhausted')
for i in iterator:
 print(f'-->{i}')
```

```
-->I'm an iterator
This printed once because the iterator has been exhausted
```

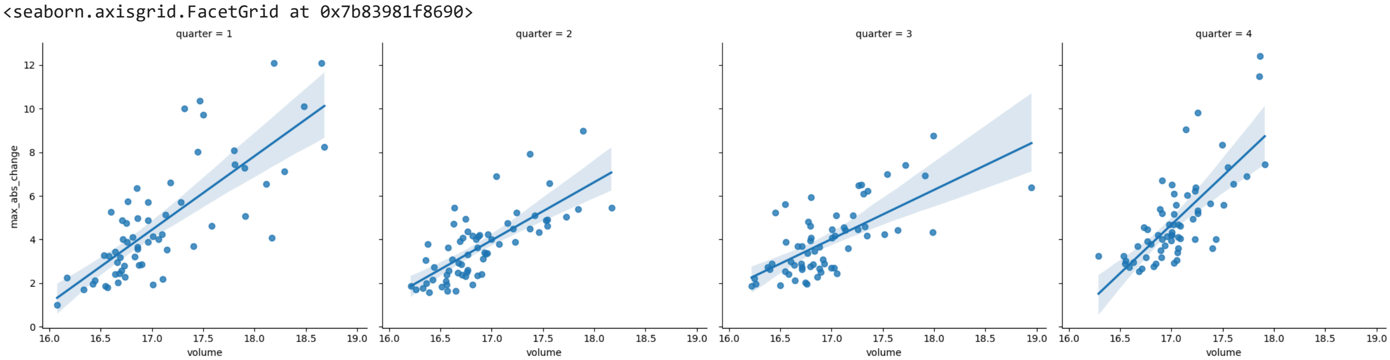
```
iterable = list(itertools.repeat("I'm an iterable", 1))
for i in iterable:
 print(f'-->{i}')
print('This prints again because it\'s an iterable:')
for i in iterable:
 print(f'-->{i}')
```

```
-->I'm an iterable
This prints again because it's an iterable:
-->I'm an iterable
```

The reg_resid_plots() function from the reg_resid_plot.py module in this folder uses regplot() and residplot() from seaborn along with itertools to plot the regression and residuals side-by-side:

```
sns.lmplot(
 x='volume',
 y='max_abs_change',
 data=fb.assign(
 volume=np.log(fb.volume),
 max_abs_change=fb.high - fb.low,
 quarter=lambda x: x.index.quarter
 ),
 col='quarter'
)
```

```
<seaborn.axisgrid.FacetGrid at 0x7b83981f8690>
```



Distributions

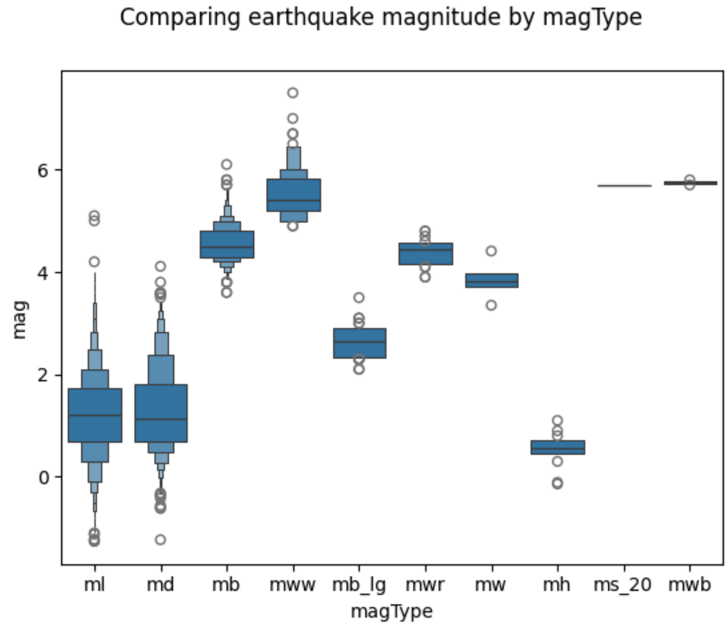
Seaborn provides some new plot types for visualizing distributions in additional to its own versions of the plot types we discussed in chapter 5 (in this notebook).

boxenplot()

The boxenplot is a box plot that shows additional quantiles:

```
sns.boxenplot(
 x='magType', y='mag', data=quakes[['magType', 'mag']]
)
plt.suptitle('Comparing earthquake magnitude by magType')
```

```
Text(0.5, 0.98, 'Comparing earthquake magnitude by magType')
```

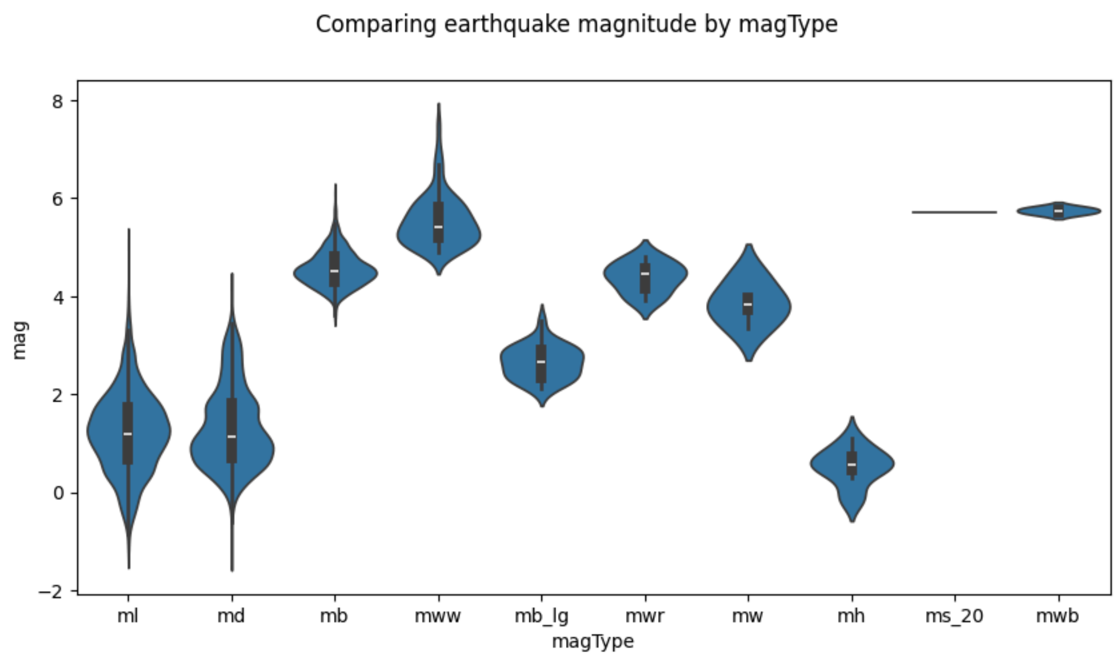


violinplot()

Box plots lose some information about the distribution, so we can use violin plots which combine box plots and KDEs:

```
fig, axes = plt.subplots(figsize=(10, 5))
sns.violinplot(
 x='magType', y='mag', data=quakes[['magType', 'mag']],
 ax=axes, scale='width' # all violins have same width
)
plt.suptitle('Comparing earthquake magnitude by magType')
```

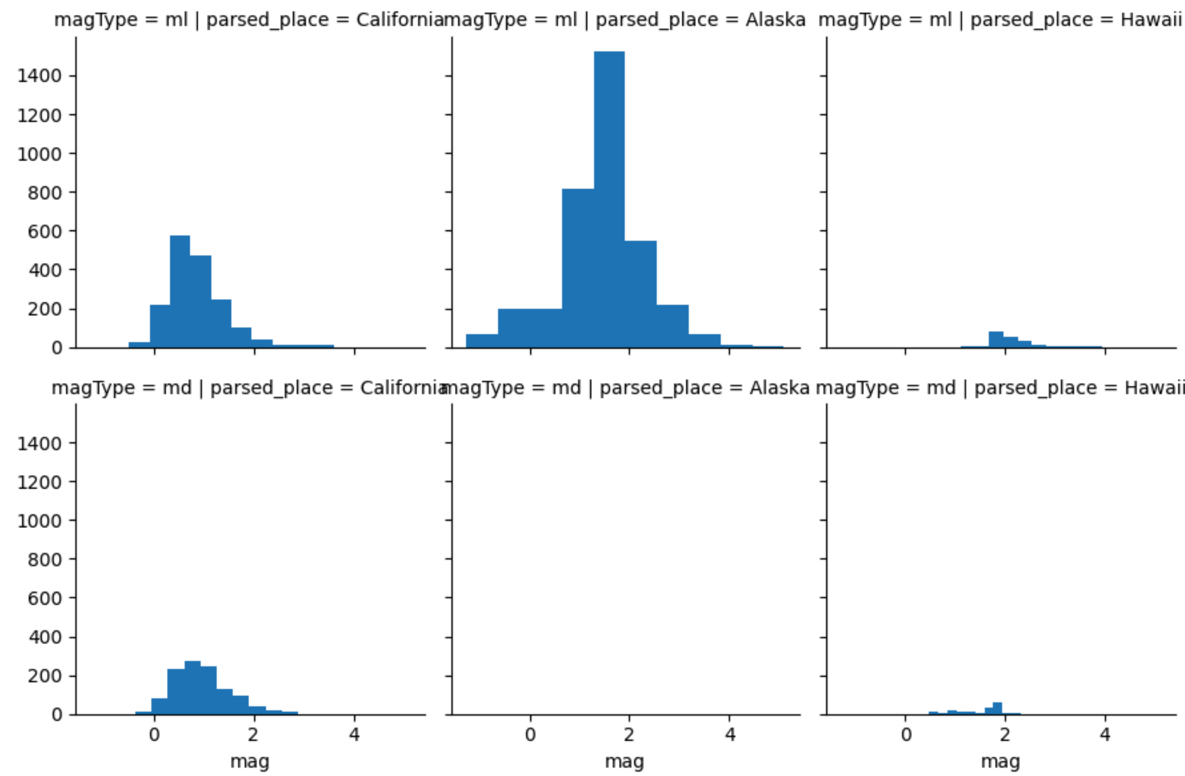
```
<ipython-input-38-bd4e17637bf6>:2: FutureWarning:

The `scale` parameter has been renamed and will be removed in v0.15.0. Pass `density_norm='width'` for the same effect.
  sns.violinplot(
Text(0.5, 0.98, 'Comparing earthquake magnitude by magType')
```



Faceting

We can create subplots across subsets of our data by faceting. First, we create a FacetGrid specifying how to layout the plots (which categorical column goes along the rows and which one along the columns). Then, we call the map() method of the FacetGrid and pass in the plotting function we want to use (along with any additional arguments). Let's make histograms showing the distribution of earthquake magnitude in California, Alaska, and Hawaii faceted by magType and parse_placed :

```
g = sns.FacetGrid(
 quakes[
 (quakes.parsed_place.isin([
 'California', 'Alaska', 'Hawaii'
 ]))\
 & (quakes.magType.isin(['ml', 'md']))
 ],
 row='magType',
 col='parsed_place'
)
g = g.map(plt.hist, 'mag')
```



Start of HOA 9.5

Formatting Plots

About the Data

In this notebook, we will be working with Facebook's stock price throughout 2018 (obtained using the stock_analysis package).

```
%matplotlib inline
import matplotlib.pyplot as plt
import numpy as np
import pandas as pd
import seaborn as sns
fb = pd.read_csv(
 'fb_stock_prices_2018.csv', index_col='date', parse_dates=True
)
```

Titles and Axis Labels

plt.suptitle() adds a title to plots and subplots

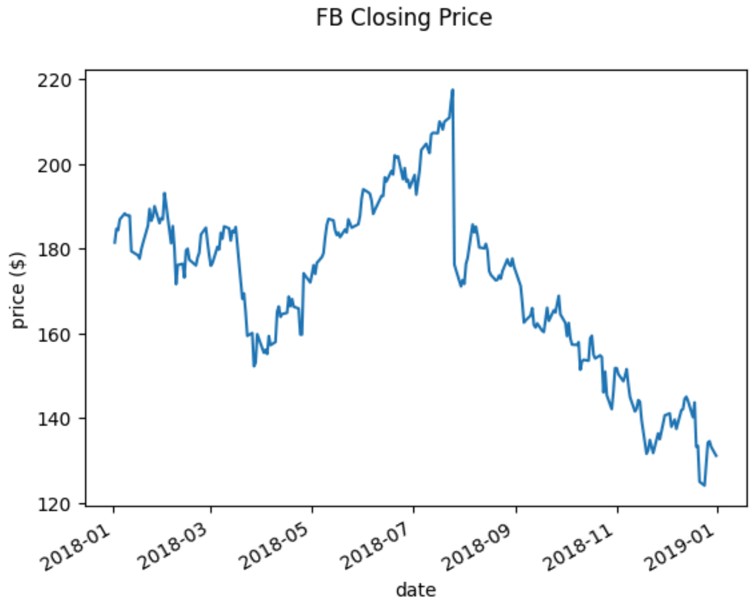
plt.title() adds a title to a single plot. Note if you use subplots, it will only put the title on the last subplot, so you will need to use plt.suptitle()

plt.xlabel() labels the x-axis

plt.ylabel() labels the y-axis

```
fb.close.plot()
plt.suptitle('FB Closing Price')
plt.xlabel('date')
plt.ylabel('price ($)')
```

```
Text(0, 0.5, 'price ($)')
```

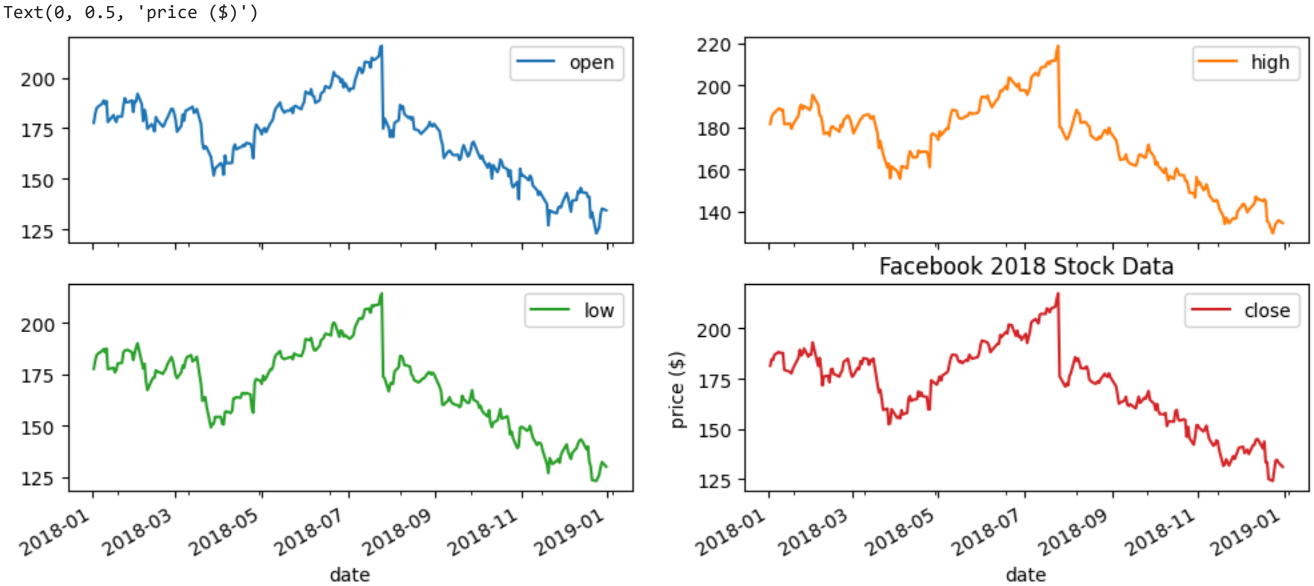


plt.suptitle() vs. plt.title()

Check out what happens when we call plt.title() with subplots:

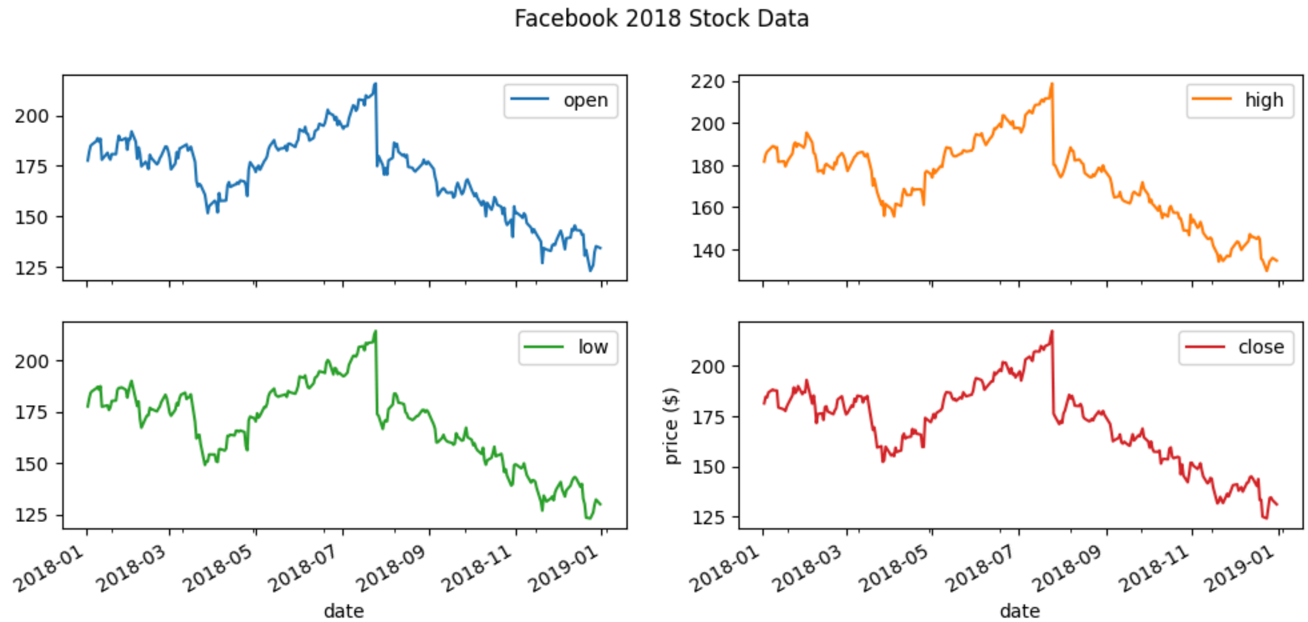
```
fb.iloc[:,:4].plot(subplots=True, layout=(2, 2), figsize=(12, 5))
plt.title('Facebook 2018 Stock Data')
plt.xlabel('date')
plt.ylabel('price ($)')
```

```
Text(0, 0.5, 'price ($)')
```




```
fb.iloc[:,:4].plot(subplots=True, layout=(2, 2), figsize=(12, 5))
plt.suptitle('Facebook 2018 Stock Data')
plt.xlabel('date')
plt.ylabel('price ($)')
```

```
Text(0, 0.5, 'price ($)')
```

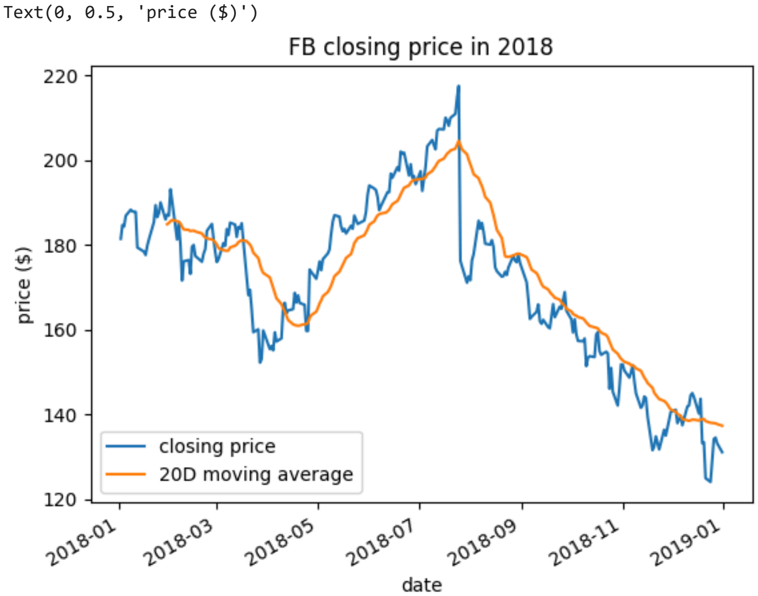


Legends

plt.legend() adds a legend to the plot. We can specify where to place it with the loc parameter:

```
fb.assign(
 ma=lambda x: x.close.rolling(20).mean()
).plot(
 y=['close', 'ma'],
 title='FB closing price in 2018',
 label=['closing price', '20D moving average']
)
plt.legend(loc='lower left')
plt.ylabel('price ($)')
```

```
Text(0, 0.5, 'price ($)')
```



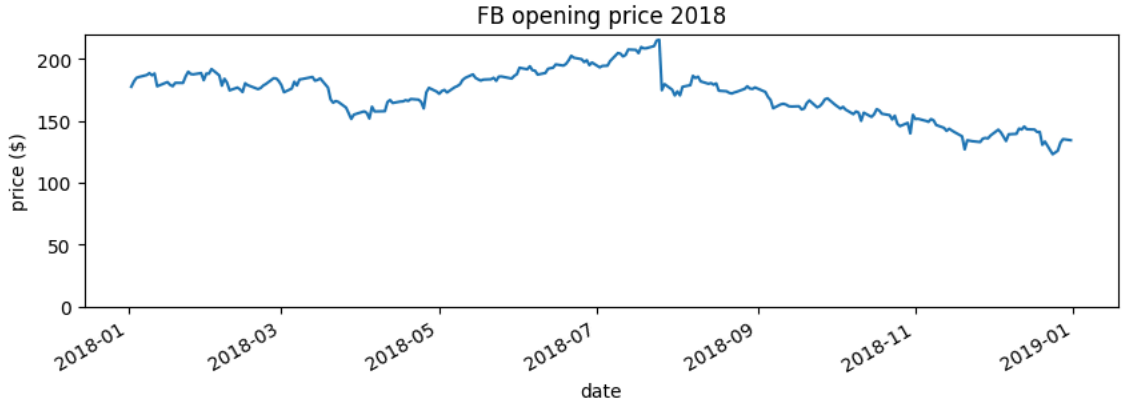
Formatting Axes

Specifying axis limits

plt.xlim() and plt.ylim() can be used to specify the minimum and maximum values for the axis. Passing None will have matplotlib determine the limit.

```
fb.open.plot(figsize=(10, 3), title='FB opening price 2018')
plt.ylim(0, None)
plt.ylabel('price ($)')
```

```
Text(0, 0.5, 'price ($)')
```

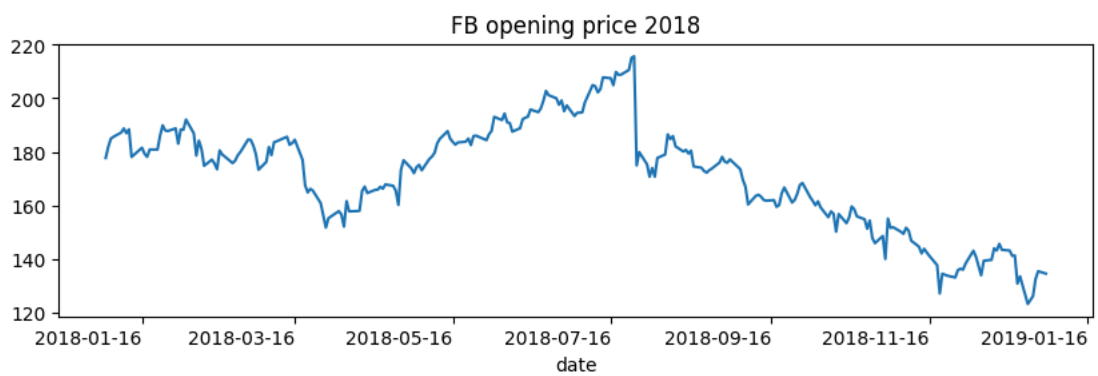


Formatting the Axis Ticks

We can use plt.xticks() and plt.yticks() to provide tick labels and specify, which ticks to show. Here, we show every other month:

```
import calendar
fb.open.plot(figsize=(10, 3), rot=0, title='FB opening price 2018')
locs, labels = plt.xticks()
plt.xticks(locs + 15 , calendar.month_name[1::2])
plt.ylabel('price ($)')
```

```
---------------------------------------------------------------------------
ValueError                                Traceback (most recent call last)
<ipython-input-49-49f9a03c7ca6> in <cell line: 0>()
      2 fb.open.plot(figsize=(10, 3), rot=0, title='FB opening price 2018')
      3 locs, labels = plt.xticks()
----> 4 plt.xticks(locs + 15 , calendar.month_name[1::2])
      5 plt.ylabel('price ($)')

                                    2 frames
/usr/local/lib/python3.11/dist-packages/matplotlib/axis.py in set_ticklabels(self, labels, minor, fontdict, **kwargs)
   2115             # remove all tick labels, so only error for > 0 labels
   2116             if len(locator.locs) != len(labels) and len(labels) != 0:
-> 2117                 raise ValueError(
   2118                     "The number of FixedLocator locations"
   2119                     f" ({len(locator.locs)}), usually from a call to"

ValueError: The number of FixedLocator locations (7), usually from a call to set_ticks, does not match the number of labels (6).
```



Using ticker

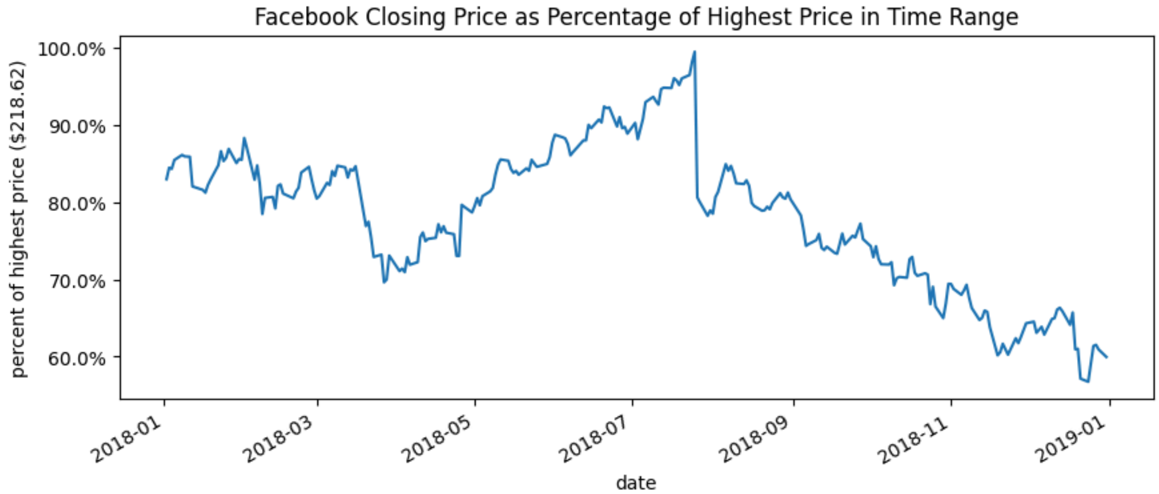
PercentFormatter

We can use ticker.PercentFormatter and specify the denominator (xmax) to use when calculating the percentages. This gets passed to the set_major_formatter() method of the xaxis or yaxis on the Axes .

```
import matplotlib.ticker as ticker
ax = fb.close.plot(
```

```
ax = fb.close.plot(
 figsize=(10, 4),
 title='Facebook Closing Price as Percentage of Highest Price in Time Range'
)
ax.yaxis.set_major_formatter(
 ticker.PercentFormatter(xmax=fb.high.max())
)
ax.set_yticks([
 fb.high.max()*pct for pct in np.linspace(0.6, 1, num=5)
]) # show round percentages only (60%, 80%, etc.)
ax.set_ylabel(f'percent of highest price (${fb.high.max()})')
```

```
Text(0, 0.5, 'percent of highest price ($218.62)')
```

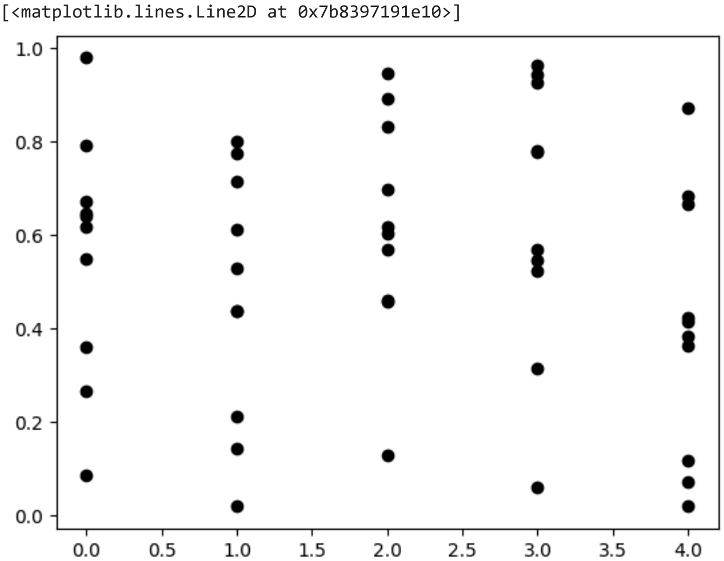


MultipleLocator

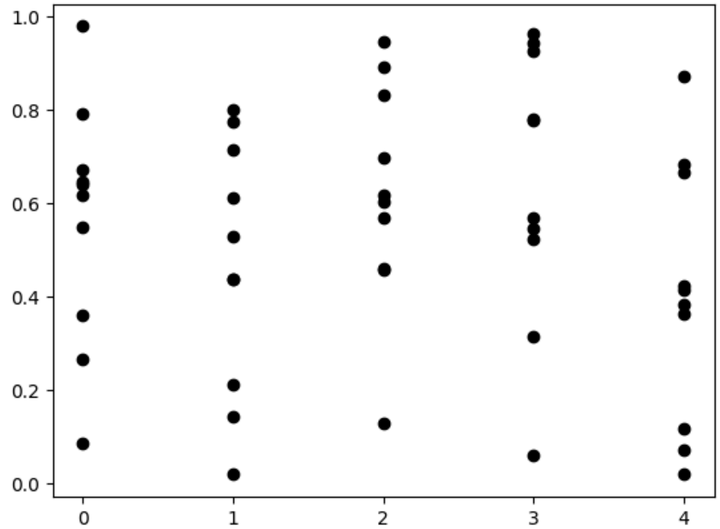
Say we have the following data. The points only take on integer values for x .

```
fig, ax = plt.subplots(1, 1)
np.random.seed(0)
ax.plot(np.tile(np.arange(0, 5), 10), np.random.rand(50), 'ko')
```

```
[<matplotlib.lines.Line2D at 0x7b8397191e10>]
```




```
fig, ax = plt.subplots(1, 1)
np.random.seed(0)
ax.plot(np.tile(np.arange(0, 5), 10), np.random.rand(50), 'ko')
ax.get_xaxis().set_major_locator(
 ticker.MultipleLocator(base=1)
)
```



Start of HOA 9.6

pandas.plotting subpackage

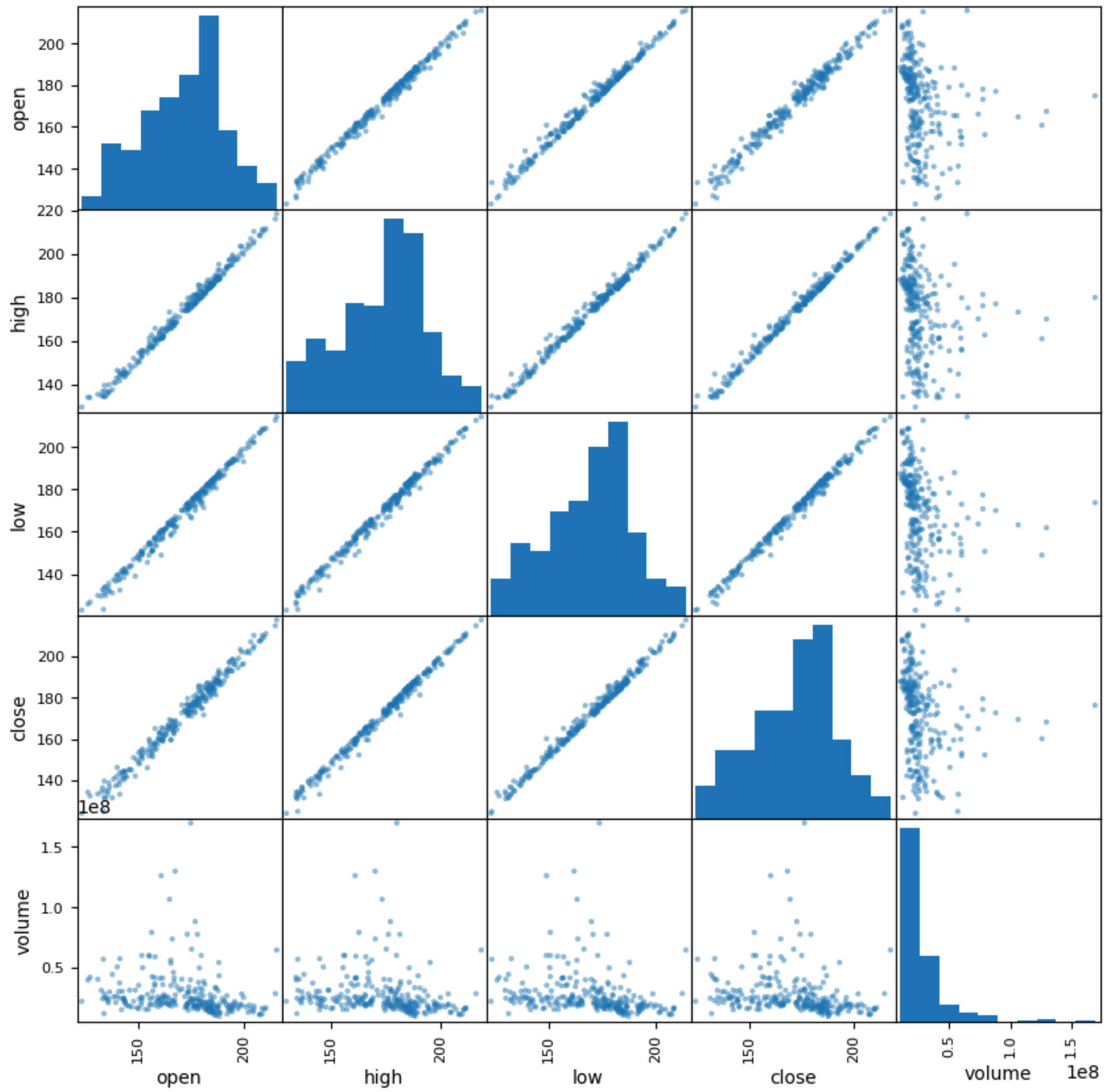
Pandas provides some extra plotting functions for a few select plot types. About the Data In this notebook, we will be working with Facebook's stock price throughout 2018 (obtained using the stock_analysis package).

```
%matplotlib inline
import matplotlib.pyplot as plt
import numpy as np
import pandas as pd
fb = pd.read_csv(
 'fb_stock_prices_2018.csv', index_col='date', parse_dates=True
)
```

Scatter matrix

```
from pandas.plotting import scatter_matrix
scatter_matrix(fb, figsize=(10, 10))
```

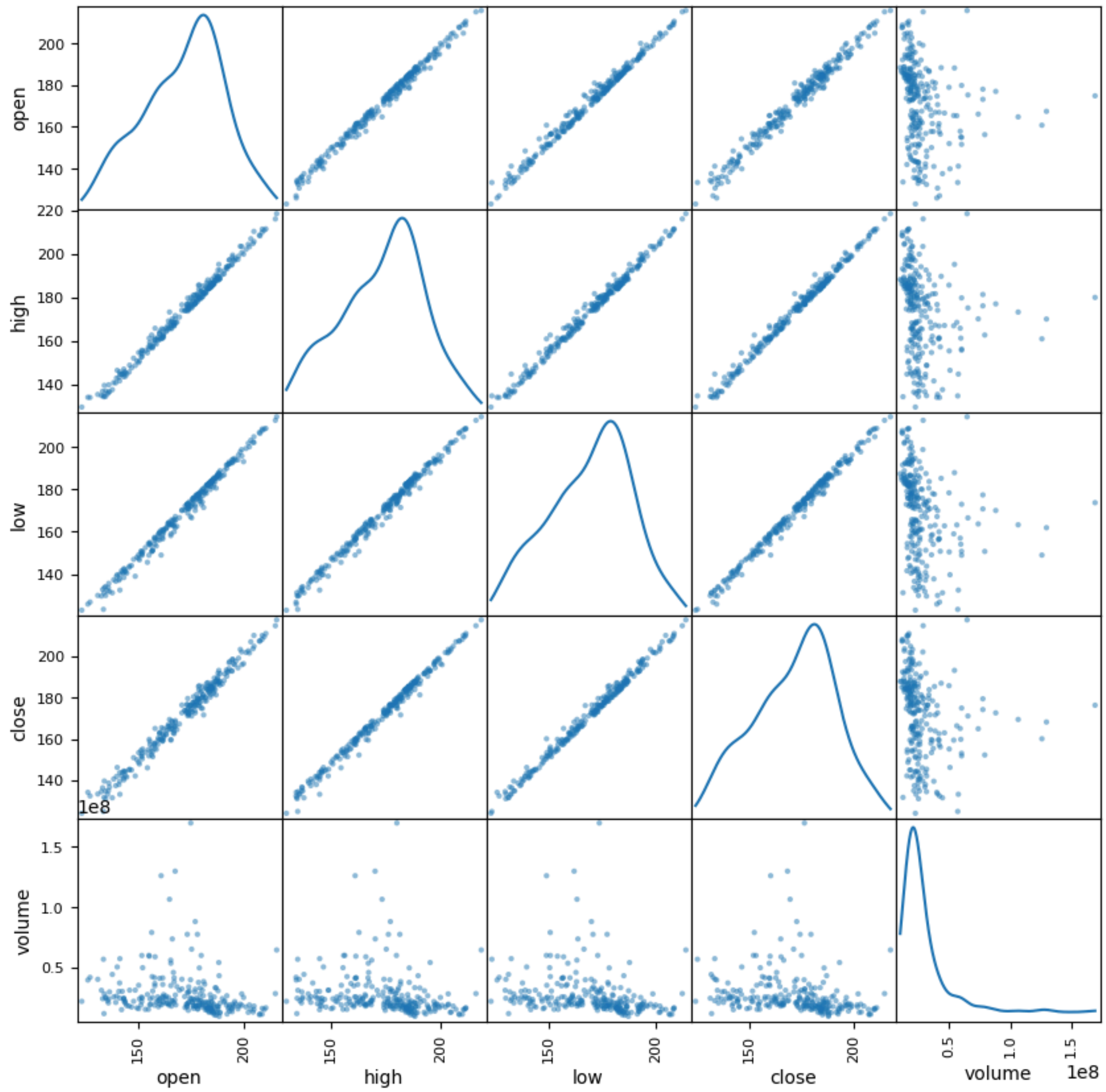
```
array([[<Axes: xlabel='open', ylabel='open'>,
        <Axes: xlabel='high', ylabel='open'>,
        <Axes: xlabel='low', ylabel='open'>,
        <Axes: xlabel='close', ylabel='open'>,
        <Axes: xlabel='volume', ylabel='open'>],
       [<Axes: xlabel='open', ylabel='high'>,
        <Axes: xlabel='high', ylabel='high'>,
        <Axes: xlabel='low', ylabel='high'>,
        <Axes: xlabel='close', ylabel='high'>,
        <Axes: xlabel='volume', ylabel='high'>],
       [<Axes: xlabel='open', ylabel='low'>,
        <Axes: xlabel='high', ylabel='low'>,
        <Axes: xlabel='low', ylabel='low'>,
        <Axes: xlabel='close', ylabel='low'>,
        <Axes: xlabel='volume', ylabel='low'>],
       [<Axes: xlabel='open', ylabel='close'>,
        <Axes: xlabel='high', ylabel='close'>,
        <Axes: xlabel='low', ylabel='close'>,
        <Axes: xlabel='close', ylabel='close'>,
        <Axes: xlabel='volume', ylabel='close'>],
       [<Axes: xlabel='open', ylabel='volume'>,
        <Axes: xlabel='high', ylabel='volume'>,
        <Axes: xlabel='low', ylabel='volume'>,
        <Axes: xlabel='close', ylabel='volume'>,
        <Axes: xlabel='volume', ylabel='volume'>]], dtype=object)
```



Changing the diagonal from histograms to KDE:

```
scatter_matrix(fb, figsize=(10, 10), diagonal='kde')
```

```
array([[<Axes: xlabel='open', ylabel='open'>,
        <Axes: xlabel='high', ylabel='open'>,
        <Axes: xlabel='low', ylabel='open'>,
        <Axes: xlabel='close', ylabel='open'>,
        <Axes: xlabel='volume', ylabel='open'>],
       [<Axes: xlabel='open', ylabel='high'>,
        <Axes: xlabel='high', ylabel='high'>,
        <Axes: xlabel='low', ylabel='high'>,
        <Axes: xlabel='close', ylabel='high'>,
        <Axes: xlabel='volume', ylabel='high'>],
       [<Axes: xlabel='open', ylabel='low'>,
        <Axes: xlabel='high', ylabel='low'>,
        <Axes: xlabel='low', ylabel='low'>,
        <Axes: xlabel='close', ylabel='low'>,
        <Axes: xlabel='volume', ylabel='low'>],
       [<Axes: xlabel='open', ylabel='close'>,
        <Axes: xlabel='high', ylabel='close'>,
        <Axes: xlabel='low', ylabel='close'>,
        <Axes: xlabel='close', ylabel='close'>,
        <Axes: xlabel='volume', ylabel='close'>],
       [<Axes: xlabel='open', ylabel='volume'>,
        <Axes: xlabel='high', ylabel='volume'>,
        <Axes: xlabel='low', ylabel='volume'>,
        <Axes: xlabel='close', ylabel='volume'>,
        <Axes: xlabel='volume', ylabel='volume'>]], dtype=object)
```

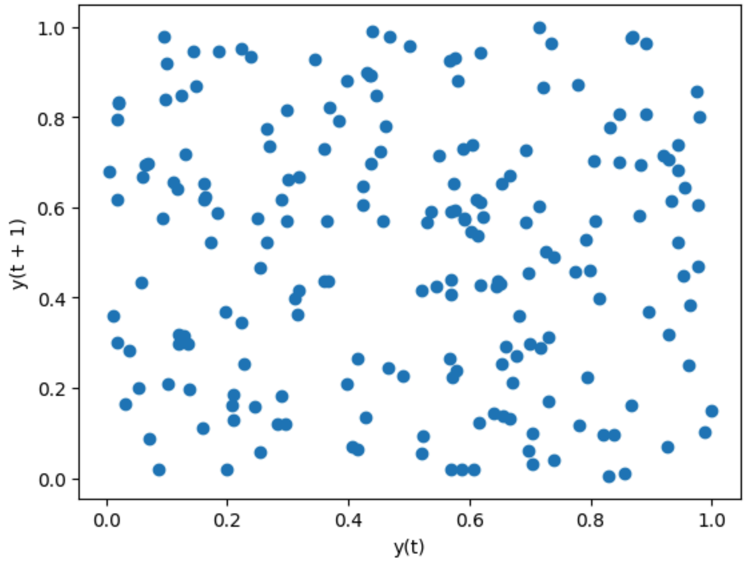


Lag plot

Lag plots let us see how the variable correlations with past observations of itself. Random data has no pattern:

```
from pandas.plotting import lag_plot
np.random.seed(0) # make this repeatable
lag_plot(pd.Series(np.random.random(size=200)))
```

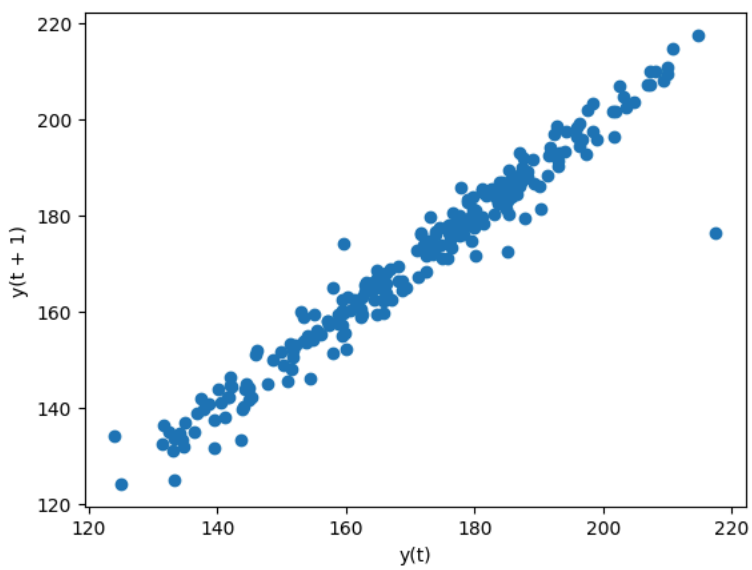
```
<Axes: xlabel='y(t)', ylabel='y(t + 1)'>
```



Data with some level of correlation to itself (autocorrelation) may have patterns. Stock prices are highly auto-correlated:

```
lag_plot(fb.close)
```

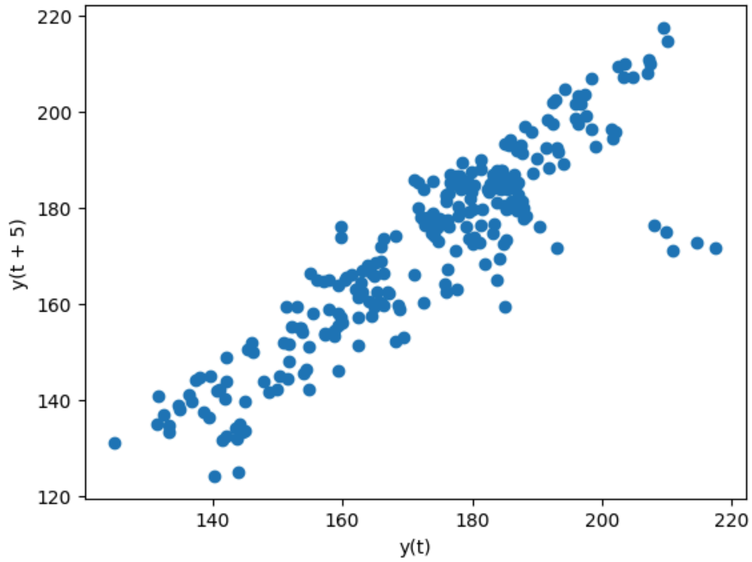
```
<Axes: xlabel='y(t)', ylabel='y(t + 1)'>
```



The default lag is 1, but we can alter this with the lag parameter. Let's look at a 5 day lag (a week of trading activity):

```
lag_plot(fb.close, lag=5)
```

```
<Axes: xlabel='y(t)', ylabel='y(t + 5)'>
```

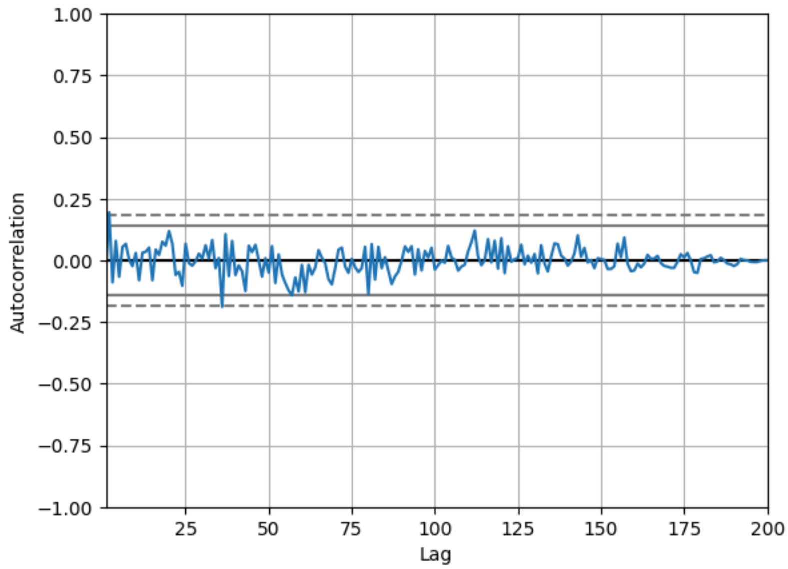


Autocorrelation plots

We can use the autocorrelation plot to see if this relationship may be meaningful or just noise. Random data will not have any significant autocorrelation (it stays within the bounds below):

```
from pandas.plotting import autocorrelation_plot
np.random.seed(0) # make this repeatable
autocorrelation_plot(pd.Series(np.random.random(size=200)))
```

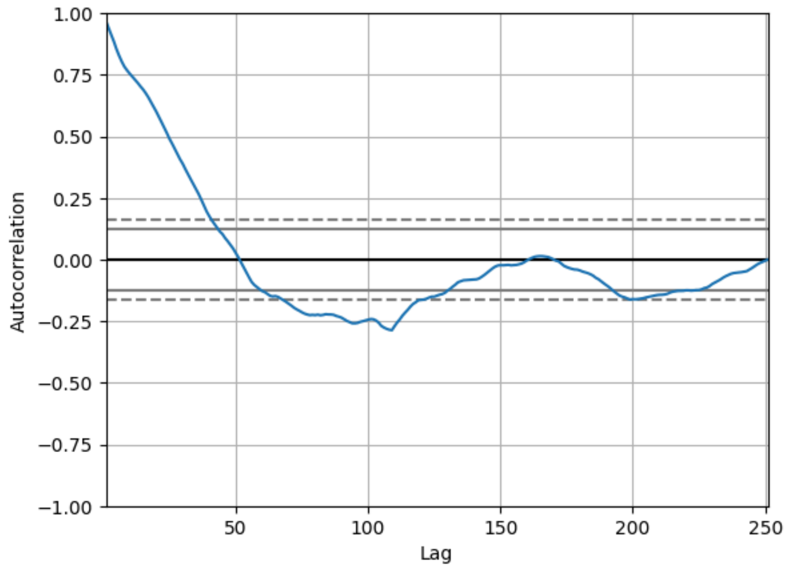
```
<Axes: xlabel='Lag', ylabel='Autocorrelation'>
```



Stock data, on the other hand, does have significant autocorrelation:

```
autocorrelation_plot(fb.close)
```

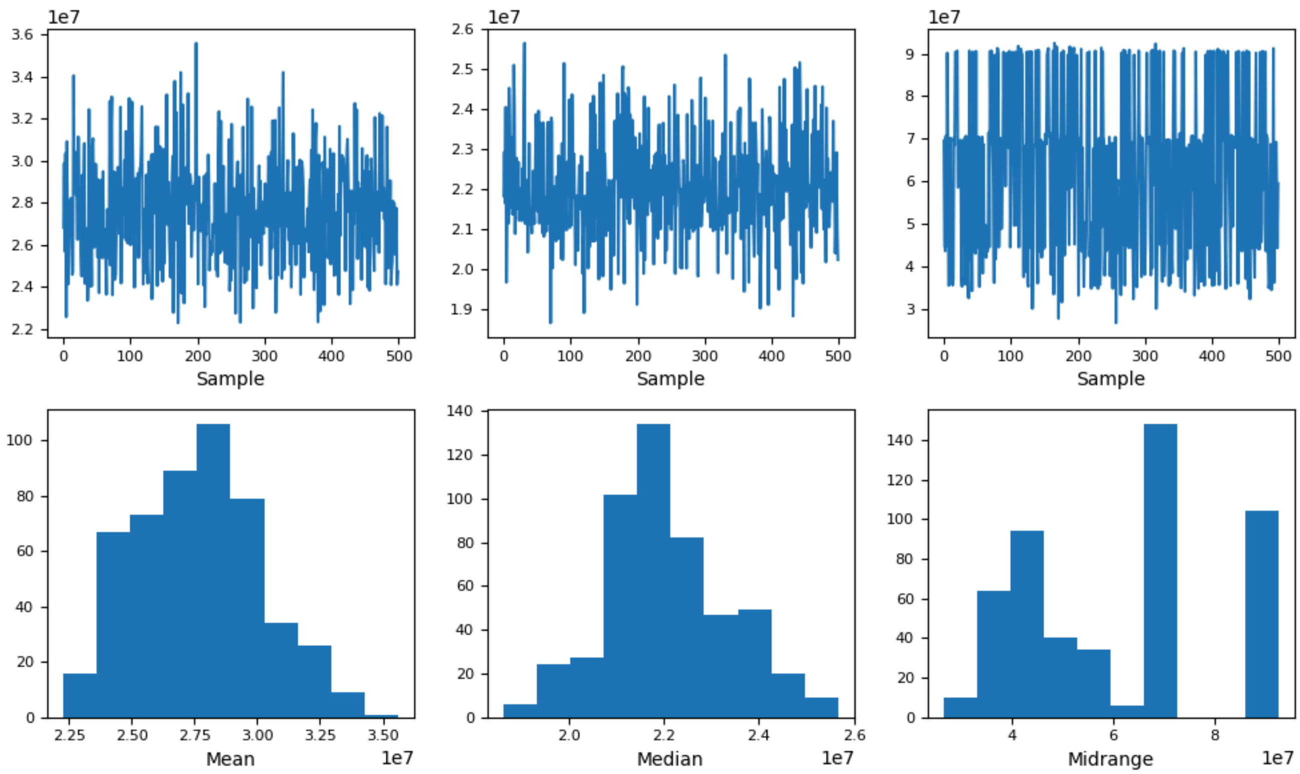
<Axes: xlabel='Lag', ylabel='Autocorrelation'>



Bootstrap plot

This plot helps us understand the uncertainty in our summary statistics:

```
from pandas.plotting import bootstrap_plot
fig = bootstrap_plot(fb.volume, fig=plt.figure(figsize=(10, 6)))
```



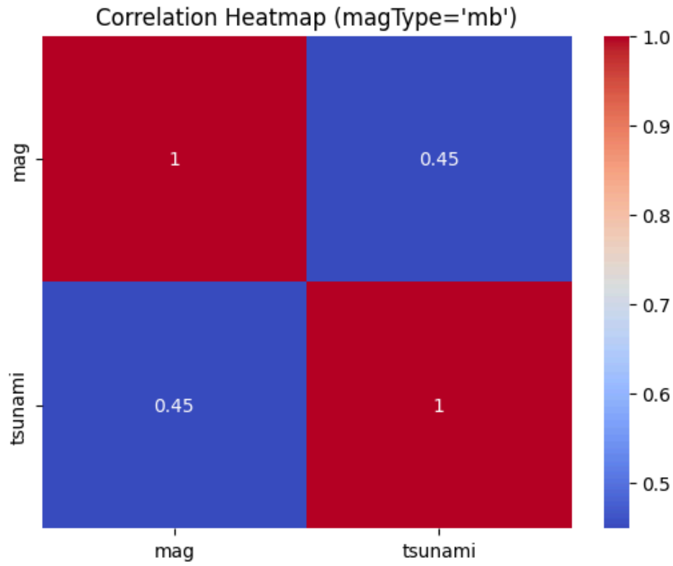
Start of supplementary Activity

```
# Finish the following exercises using the supplied CSV files and the knowledge we have gained thus far in this module:

import pandas as pd
import seaborn as sns
import matplotlib.pyplot as plt
%matplotlib inline
```

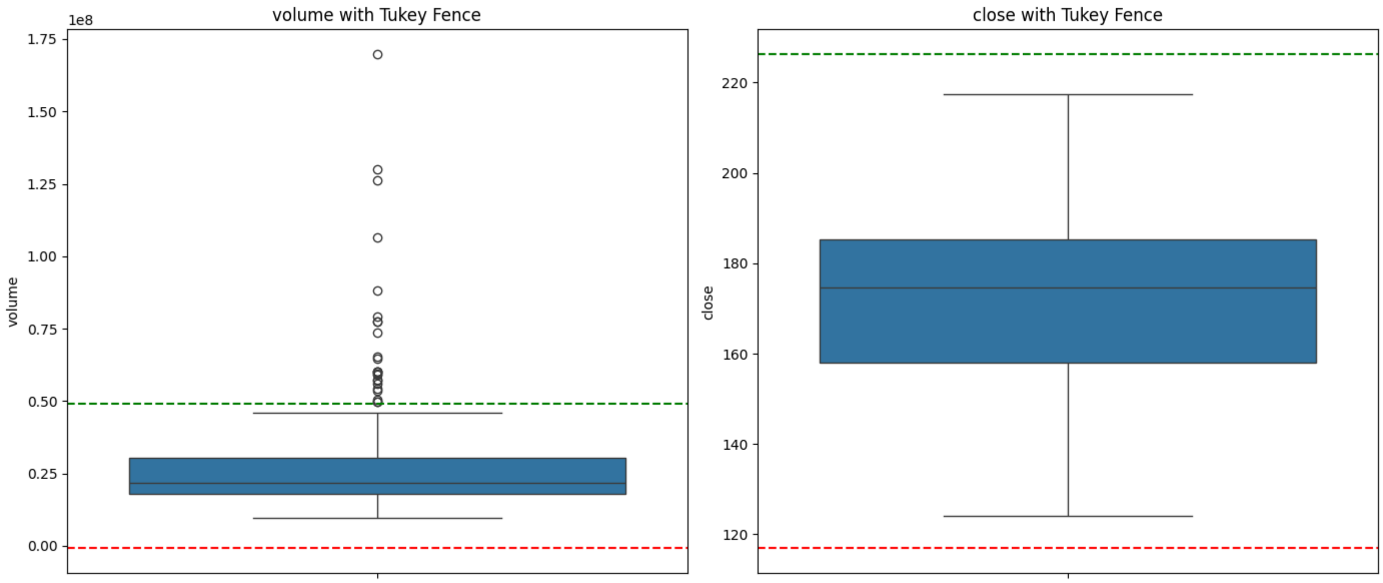
```
# 1. Using seaborn, create a heatmap to visualize the correlation coefficients between earthquake magnitude and whether there was a tsunami w
```

```
# 1. Using seaborn, create a heatmap to visualize the correlation coefficients between earthquake magnitude and whether there was a tsunami w

# Load  data
df = pd.read_csv("earthquakes-1.csv")

# Filter 'mb'
mb_df = df[df['magType'] == 'mb']

# Compute correlations
corr = mb_df[['mag', 'tsunami']].corr()

# Plot heatmap
sns.heatmap(corr, annot=True, cmap="coolwarm")
plt.title("Correlation Heatmap (magType='mb')")
```

```
Text(0.5, 1.0, "Correlation Heatmap (magType='mb')")
```




```
# 2. Create a box plot of Facebook volume traded and closing prices, and draw reference lines for the bounds of a Tukey fence with a multipl

import numpy as np

fb = pd.read_csv("fb_stock_prices_2018.csv", index_col='date', parse_dates=True)

fig, axes = plt.subplots(1, 2, figsize=(14, 6))

for i, col in enumerate(['volume', 'close']):
    q1 = fb[col].quantile(0.25)
    q3 = fb[col].quantile(0.75)
    iqr = q3 - q1
    lower = q1 - 1.5 * iqr
    upper = q3 + 1.5 * iqr

    sns.boxplot(y=fb[col], ax=axes[i])
    axes[i].axhline(lower, color='red', linestyle='--')
    axes[i].axhline(upper, color='green', linestyle='--')
    axes[i].set_title(f'{col} with Tukey Fence')

plt.tight_layout()
```




```
# 3. Fill in the area between the bounds in the plot from exercise #2.

fig, ax = plt.subplots(figsize=(6, 6))

col = 'close'
q1 = fb[col].quantile(0.25)
q3 = fb[col].quantile(0.75)
iqr = q3 - q1
lower = q1 - 1.5 * iqr
upper = q3 + 1.5 * iqr

sns.boxplot(y=fb[col], ax=ax)
ax.axhline(lower, color='red', linestyle='--')
ax.axhline(upper, color='green', linestyle='--')
ax.fill_betweenx(y=[lower, upper], x1=0, x2=1, color='lightblue', alpha=0.3, transform=ax.get_yaxis_transform())

ax.set_title('Facebook Close Price with Filled Tukey Range')
```