Data Visualization with Python

July 29, 2023

[1]:
```
import pandas as pd
import matplotlib.pyplot as plt

# reading the database
data = pd.read_csv("data/tips.csv")

# printing the top 10 rows
display(data.head(5))
```

	total_bill	tip	sex	smoker	day	time	size
0	16.99	1.01	Female	No	Sun	Dinner	2
1	10.34	1.66	Male	No	Sun	Dinner	3
2	21.01	3.50	Male	No	Sun	Dinner	3
3	23.68	3.31	Male	No	Sun	Dinner	2
4	24.59	3.61	Female	No	Sun	Dinner	4

0.1 Scatter Plot

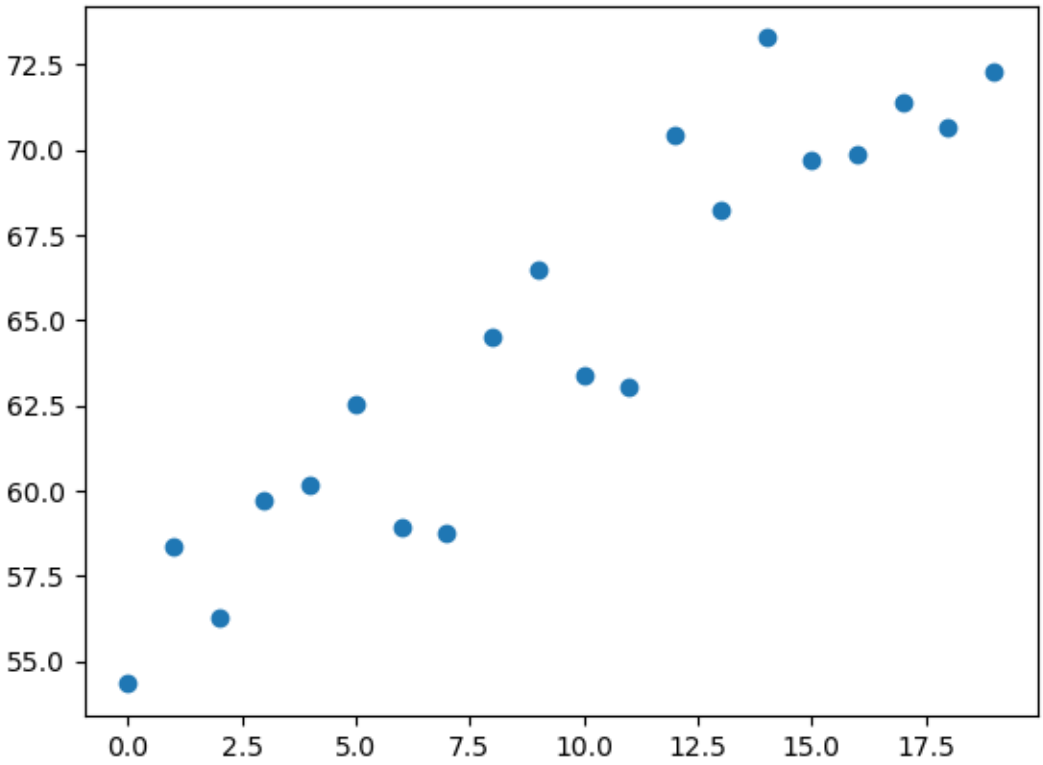
Scatter plots are used to observe relationships between variables and uses dots to represent the relationship between them.

Purpose: Displaying relationships between variables.

matplotlib function: `scatter(x, y)`

- x, y: The values for the two variables.

[2]:
```
import numpy as np

# value gen
x = range(20)
y = np.arange(50, 70) + (np.random.random(20) * 10)

# plot
# adding figure
plt.figure()

plt.scatter(x, y)
plt.show()
```

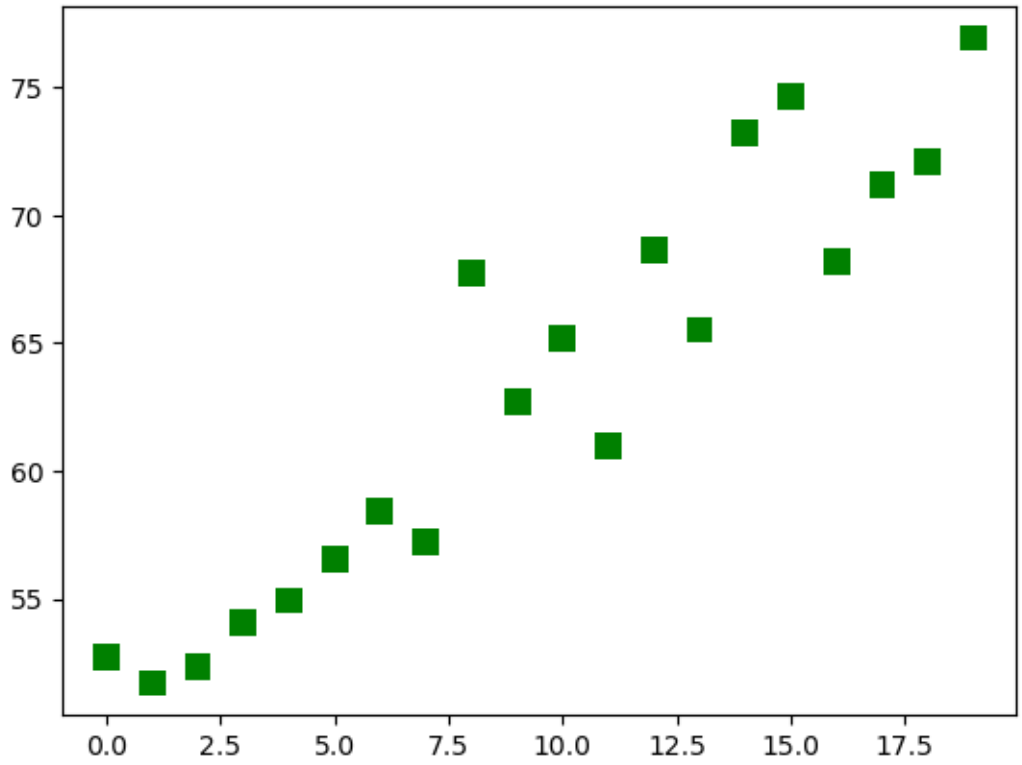


Commonly used parameters:

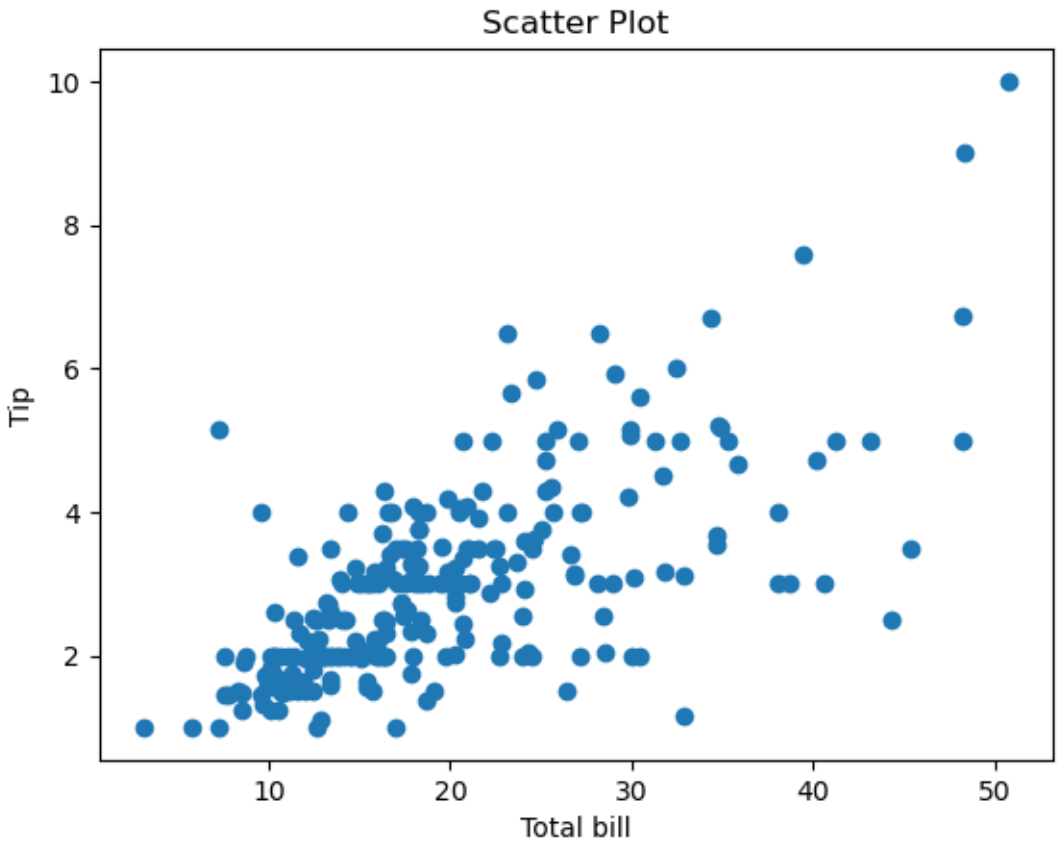
- `c`: Set the color of the markers.
- `s`: Set the size of the markers.
- `marker`: Set the marker style, e.g., circles, triangles, or squares.
- `edgecolor`: Set the color of the lines on the edges of the markers.

[3]:
```
import matplotlib.pyplot as plt
import numpy as np

x = np.arange(20)
y = np.arange(50, 70) + (np.random.random(20) * 10.)

plt.figure()

plt.scatter(x,
            y,
            c='green',
            s=100,
            marker='s',
            edgecolor='none')
```

```
plt.show()
```



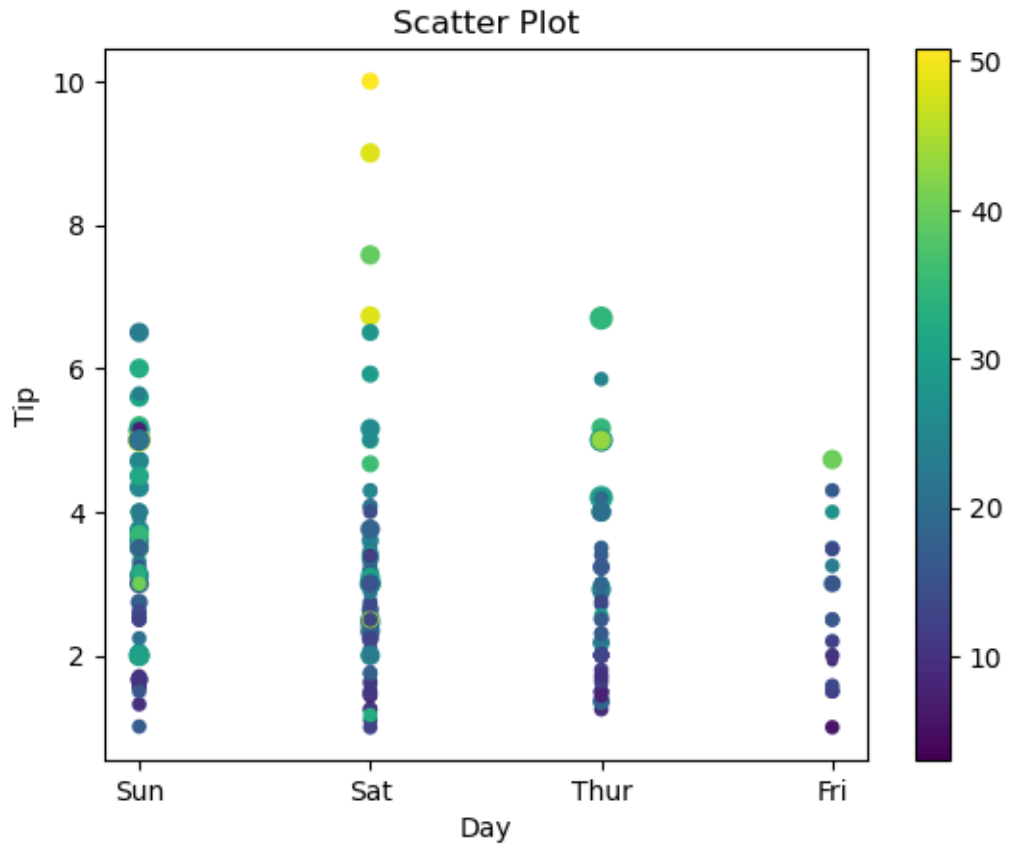
[4]:
```
import matplotlib.pyplot as plt

plt.figure()
# Scatter plot with day against tip
plt.scatter(data['total_bill'], data['tip'])

# Adding Title to the Plot
plt.title("Scatter Plot")

# Setting the X and Y labels
plt.xlabel('Total bill')
plt.ylabel('Tip')

plt.show()
```



This graph can be more meaningful if we can add colors and also change the size of the points. We can do this by using the c and s parameter respectively of the scatter function. We can also show the color bar using the colorbar() method.

[5]:
```
import pandas as pd
import matplotlib.pyplot as plt


# # reading the database
# data = pd.read_csv("data/tips.csv")

# Scatter plot with day against tip
plt.scatter(data['day'],
            data['tip'],
            s=data['size']*10,
            c=data['total_bill'])

# Adding Title to the Plot
plt.title("Scatter Plot")
```

```
# Setting the X and Y labels
plt.xlabel('Day')
plt.ylabel('Tip')

plt.colorbar()

plt.show()
```



1 ## Line Chart

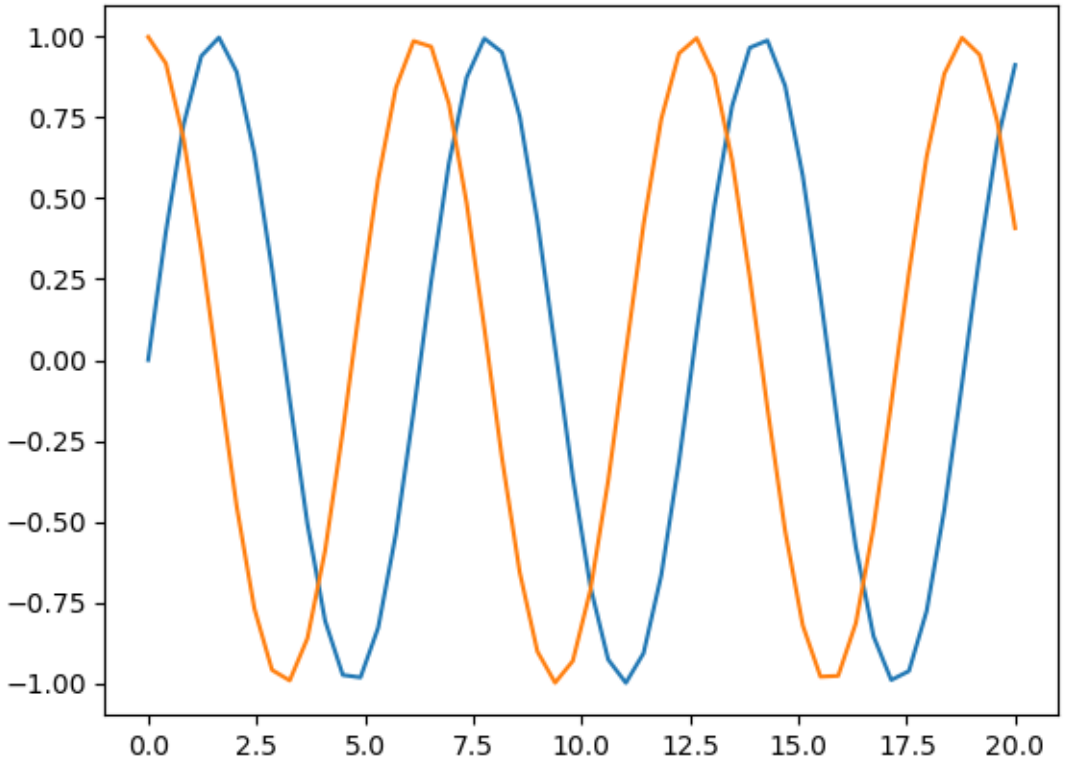
Purpose: Showing trends in data – usually time series data with many time points.

matplotlib function: `plot(x, y)`

- x: The x-coordinates of the lines or markers.
- y: The y-coordinates of the lines or markers.

[6]:
```
import numpy as np
# data gen
x = np.linspace(0, 20)
```

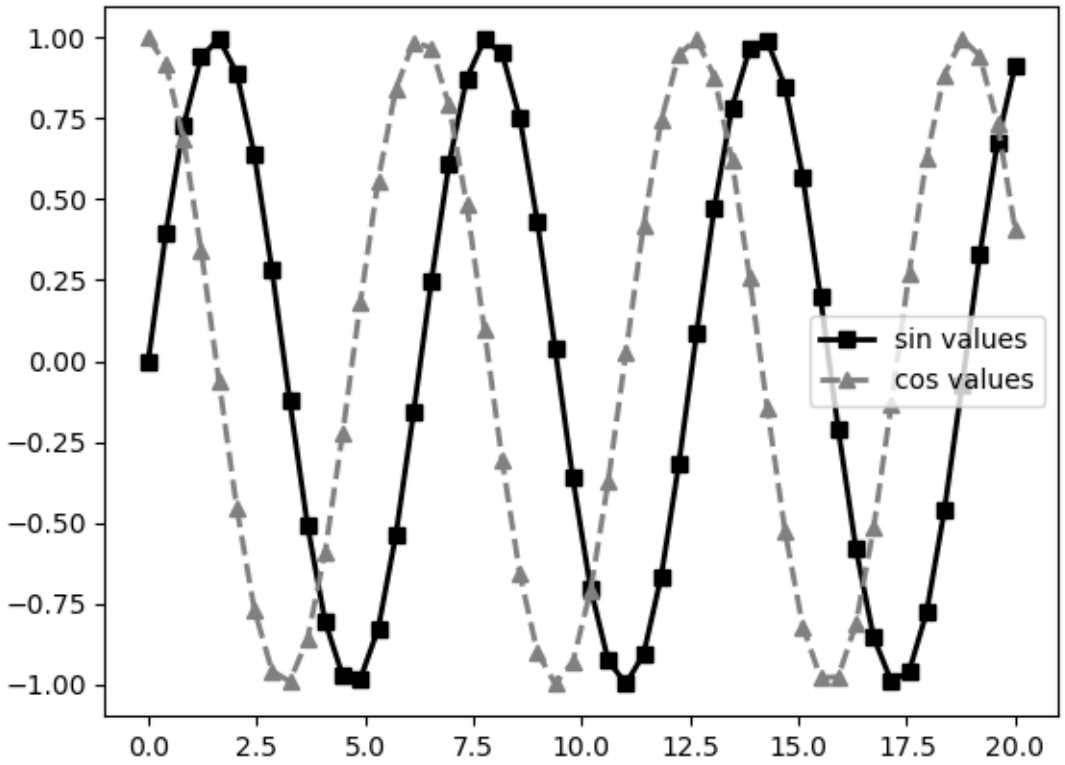
```
y1 = np.sin(x)
y2 = np.cos(x)

# plot
plt.figure()
# line chart
plt.plot(x, y1)
plt.plot(x, y2)
plt.show()
```



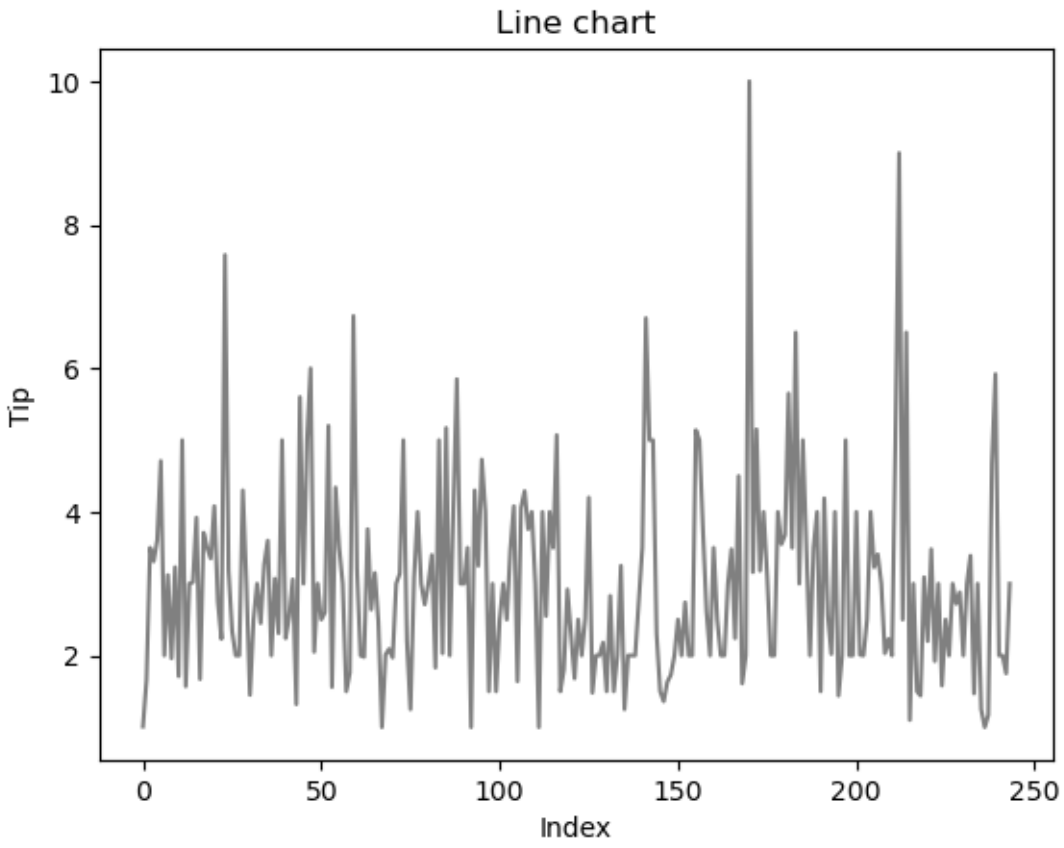
Commonly used parameters:

- `color`: Set the color of the line.
- `linestyle`: Set the line style, e.g., solid, dashed, or none.
- `linewidth`: Set the line thickness.
- `marker`: Set the marker style, e.g., circles, triangles, or none.
- `markersize`: Set the marker size.
- `label`: Set the label for the line that will show up in the legend.

[7]:
```
# data gen.
x = np.linspace(0, 20)
y1 = np.sin(x)
y2 = np.cos(x)

# plot
plt.figure()

plt.plot(x, y1,
         color='black',
         linestyle='-',
         linewidth=2,
         marker='s',
         markersize=6,
         label='sin values')

plt.plot(x, y2,
         color='gray',
         linestyle='--',
         linewidth=2,
         marker='^',
         markersize=6,
         label='cos values')

plt.legend()
plt.show()
```



[8]:
```
import pandas as pd
import matplotlib.pyplot as plt

# # reading the database
# data = pd.read_csv("data/tips.csv")
plt.figure()
# Line plot with day against tip
plt.plot(data['tip'], color='gray')

# Adding Title to the Plot
plt.title("Line chart")

# Setting the X and Y labels
plt.xlabel('Index')
plt.ylabel('Tip')

plt.show()
```



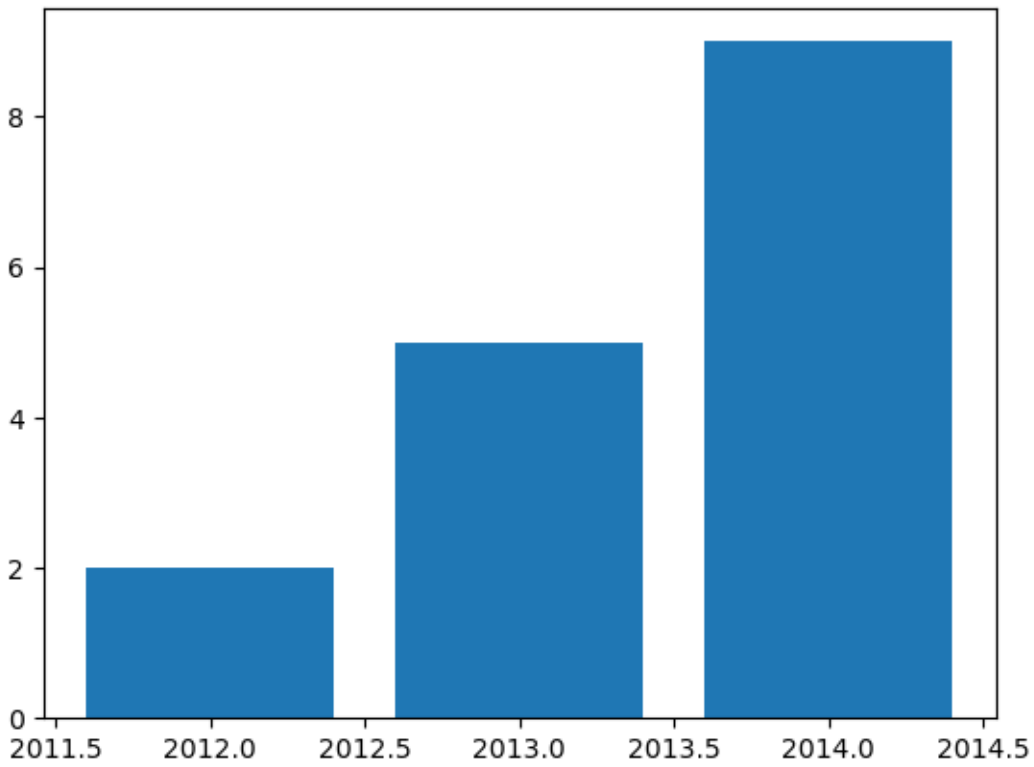
1.1 Bar Chart

Purpose: Comparing categories **OR** showing temporal trends in data with few (< 4) time points.

matplotlib function: `bar(left, height)`

- `left`: The x coordinate(s) of the left sides of the bars.
- `height`: The height(s) of the bars.

[9]:
```
years = np.arange(2012, 2015)
values = [2, 5, 9]

plt.figure()

plt.bar(years, values)

plt.show()
```

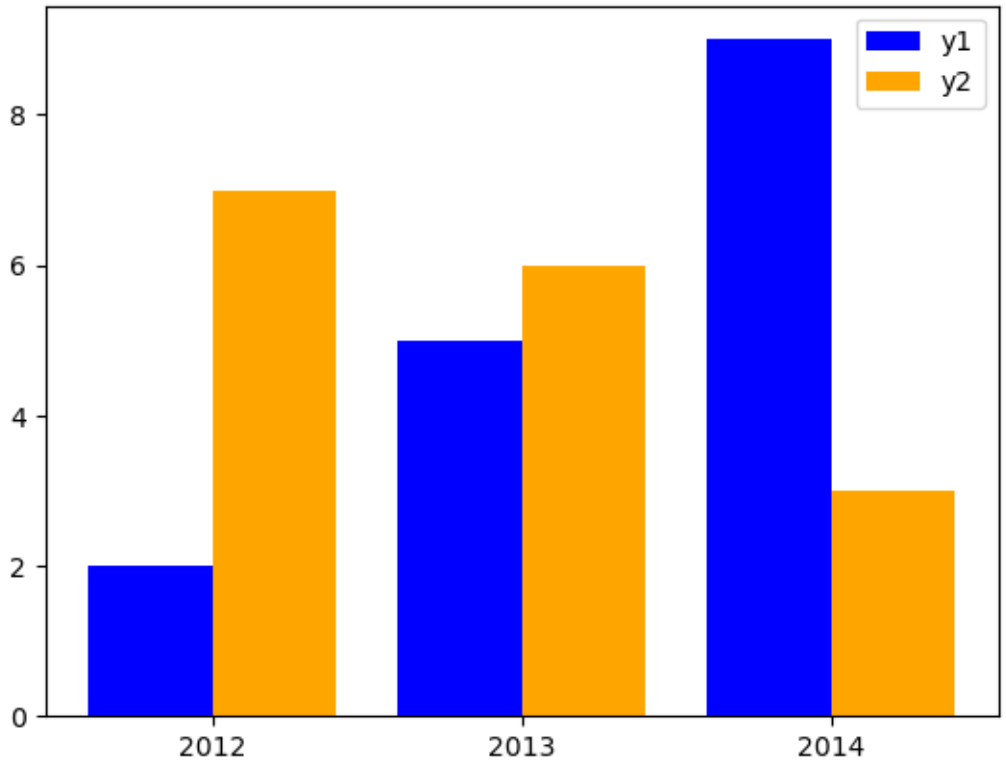


Commonly used parameters:

- `color`: Set the color of the bars.
- `edgecolor`: Set the color of the lines on the edges of the bars.
- `width`: Set the width of the bars.
- `align`: Set the alignment of the bars, e.g., center them on the x coordinate(s).
- `label`: Set the label for the bar that will show up in the legend.

[10]:
```
years = np.arange(2012, 2015)
category1_values = [2, 5, 9]
category2_values = [7, 6, 3]

plt.figure()

plt.bar(years - 0.2,
        category1_values,
        color='blue',
        edgecolor='none',
        width=0.4,
        align='center',
        label='y1')
```

```
plt.bar(years + 0.2,
        category2_values,
        color='orange',
        edgecolor='none',
        width=0.4,
        align='center',
        label='y2')

plt.xticks(years, [str(year) for year in years])

plt.legend()
plt.show()
```

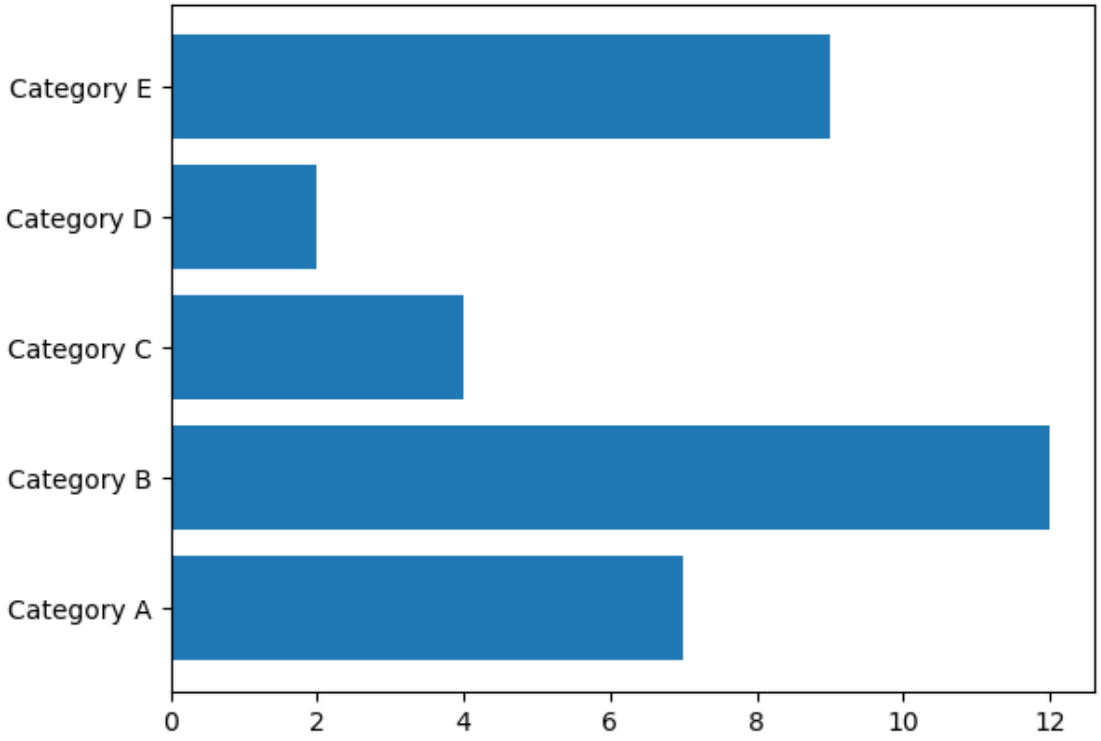


Purpose: Comparing categories.

matplotlib function: `barh(bottom, width)`

- `bottom`: The y coordinate(s) of the bars.
- `width`: The width(s) of the bars.

[11]:
```
categories = ['A', 'B', 'C', 'D', 'E']
values = [7, 12, 4, 2, 9]

# print(np.arange(len(categories)))
plt.figure()
plt.barh(np.arange(len(categories)), values)

plt.yticks(np.arange(len(categories)),
           [f'Category {x}' for x in categories])
plt.show()
```

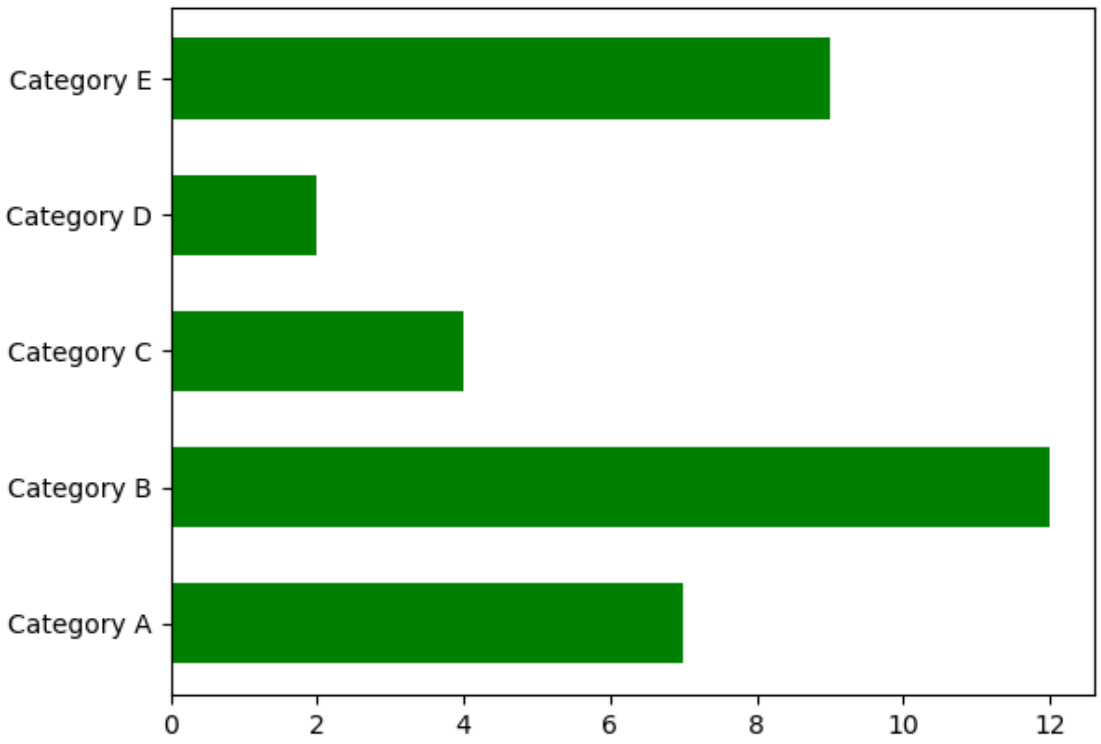


Commonly used parameters:

- `color`: Set the color of the bars.
- `edgecolor`: Set the color of the lines on the edges of the bars.
- `height`: Set the height of the bars.
- `align`: Set the alignment of the bars, e.g., center them on the y coordinate(s).

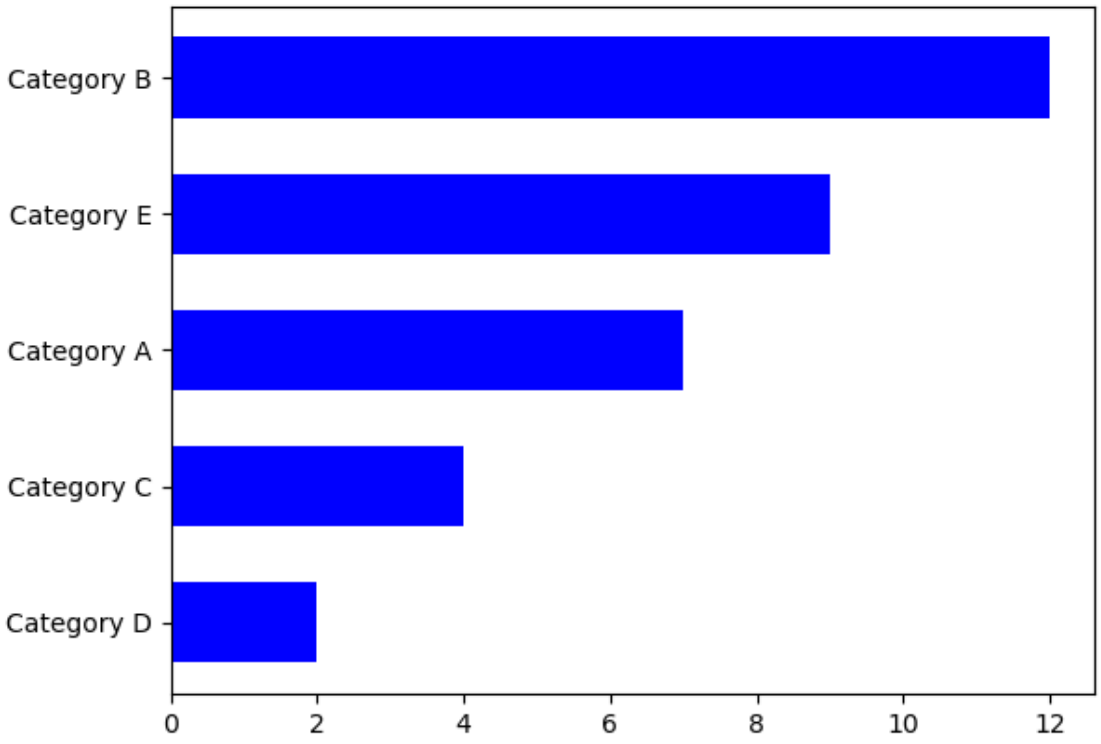
[12]:
```
categories = ['A', 'B', 'C', 'D', 'E']
values = [7, 12, 4, 2, 9]

plt.figure()
```

```
plt.barh(np.arange(len(categories)),
         values,
         color='green',
         edgecolor='none',
         height=0.6,
         align='center')

plt.yticks(np.arange(len(categories)),
           ['Category {}'.format(x) for x in categories])
plt.show()
```



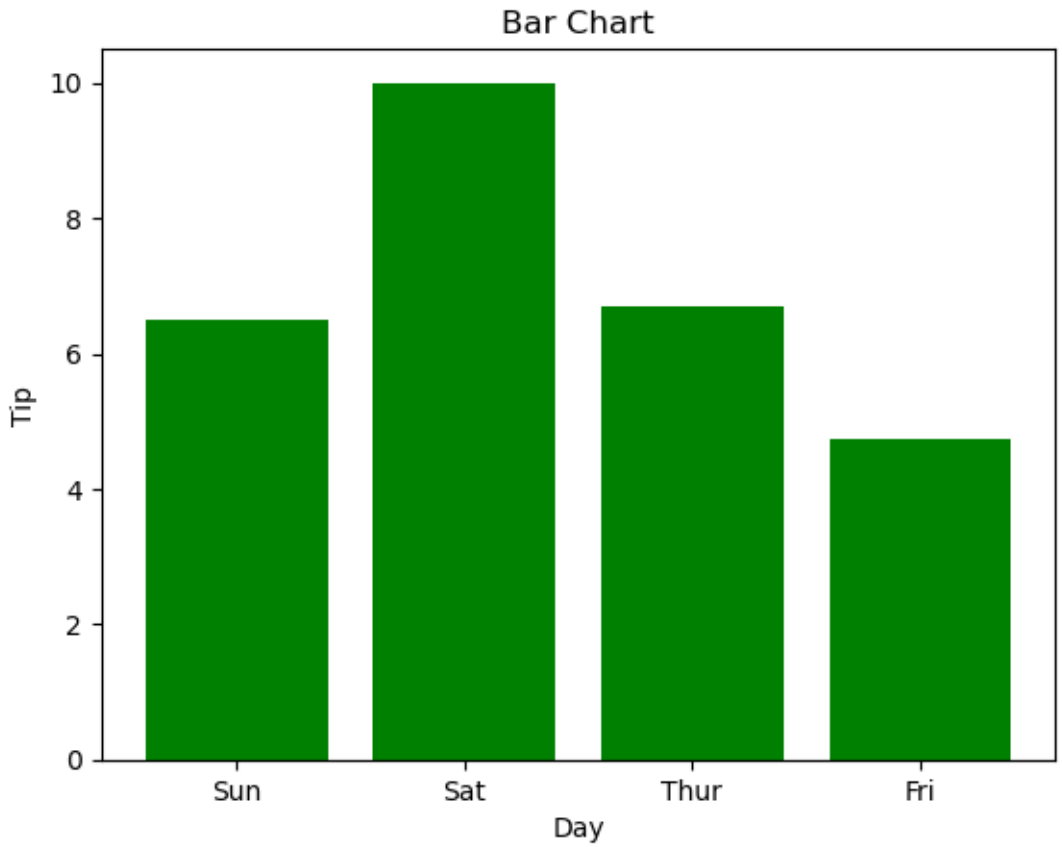
[13]:
```
import pandas as pd

categories = ['A', 'B', 'C', 'D', 'E']
values = [7, 12, 4, 2, 9]

# convert to dataframe
category_values = pd.DataFrame({'categories': categories,
                                'values': values})

# category values wise sorted
```

```
category_values.sort_values(by='values', ascending=True, inplace=True)

categories = category_values['categories'].values
values = category_values['values'].values

# plot
plt.figure()

plt.barh(np.arange(len(categories)),
         values,
         color='blue',
         edgecolor='none',
         height=0.6,
         align='center')

plt.yticks(np.arange(len(categories)),
           ['Category {}'.format(x) for x in categories])
plt.show()
```



[14]:
```
# Bar chart with day against tip
plt.bar(data['day'], data['tip'], color='green')
```

```
plt.title("Bar Chart")

# Setting the X and Y labels
plt.xlabel('Day')
plt.ylabel('Tip')

plt.show()
```



2 Pie charts

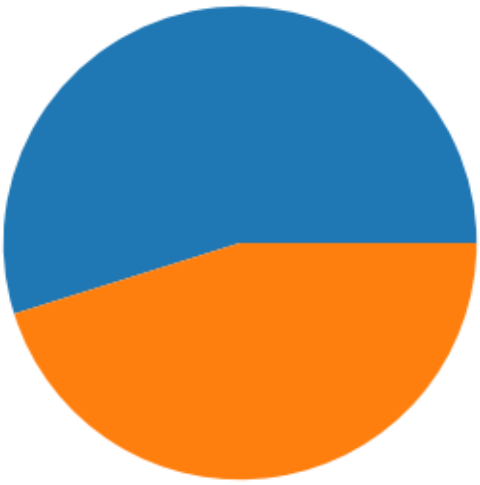
Purpose: Displaying a simple proportion.

matplotlib function: `pie(sizes)`

- `sizes`: The size of the wedges as either a fraction or number.

[15]:
```
counts = [17, 14]

plt.figure(figsize=(4, 4))
```

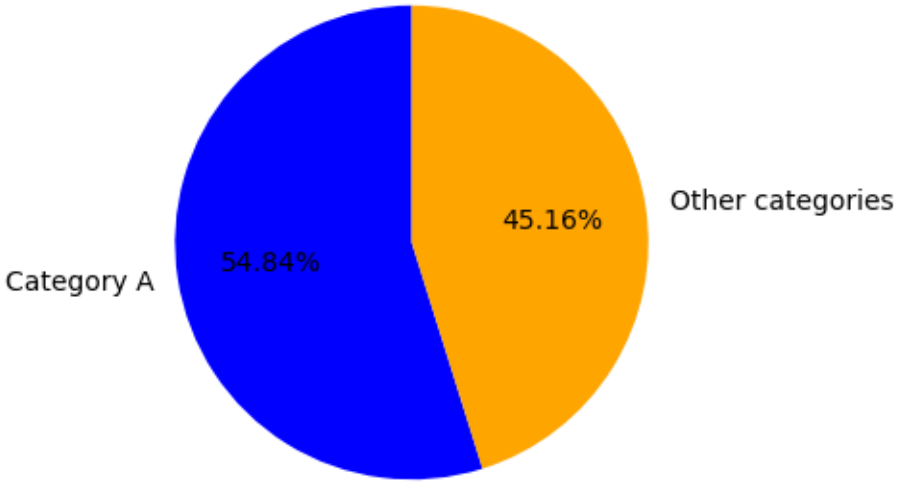
```
plt.pie(counts)
plt.show()
```



Commonly used parameters:

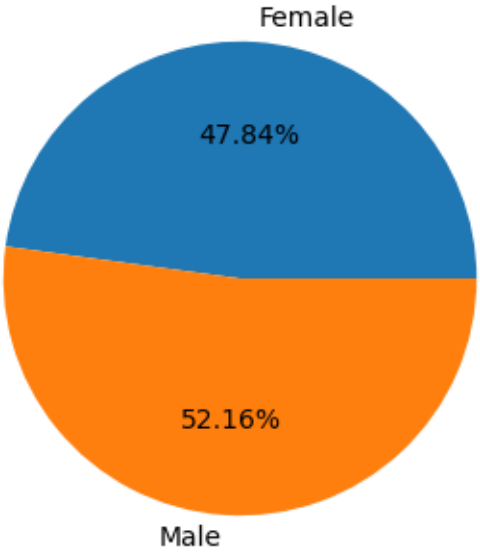
- `colors`: Set the colors of the wedges.
- `labels`: Set the labels of the wedges.
- `startangle`: Set the angle that the wedges start at.
- `autopct`: Set the percentage display format of the wedges.

[16]:
```
counts = [17, 14]

plt.figure(figsize=(4, 4))

plt.pie(counts,
        colors=['blue', 'orange'],
        labels=['Category A', 'Other categories'],
        startangle=90,
        autopct='%1.2f%%')
plt.show()
```



[17]:
```
grp_data = data.groupby('sex').tip.mean().reset_index()
print(grp_data)
plt.figure(figsize=(4, 4))

plt.pie(grp_data.tip, labels=grp_data.sex, autopct='%1.2f%%')
plt.show()
```

```
      sex       tip
0  Female  2.833448
1    Male  3.089618
```



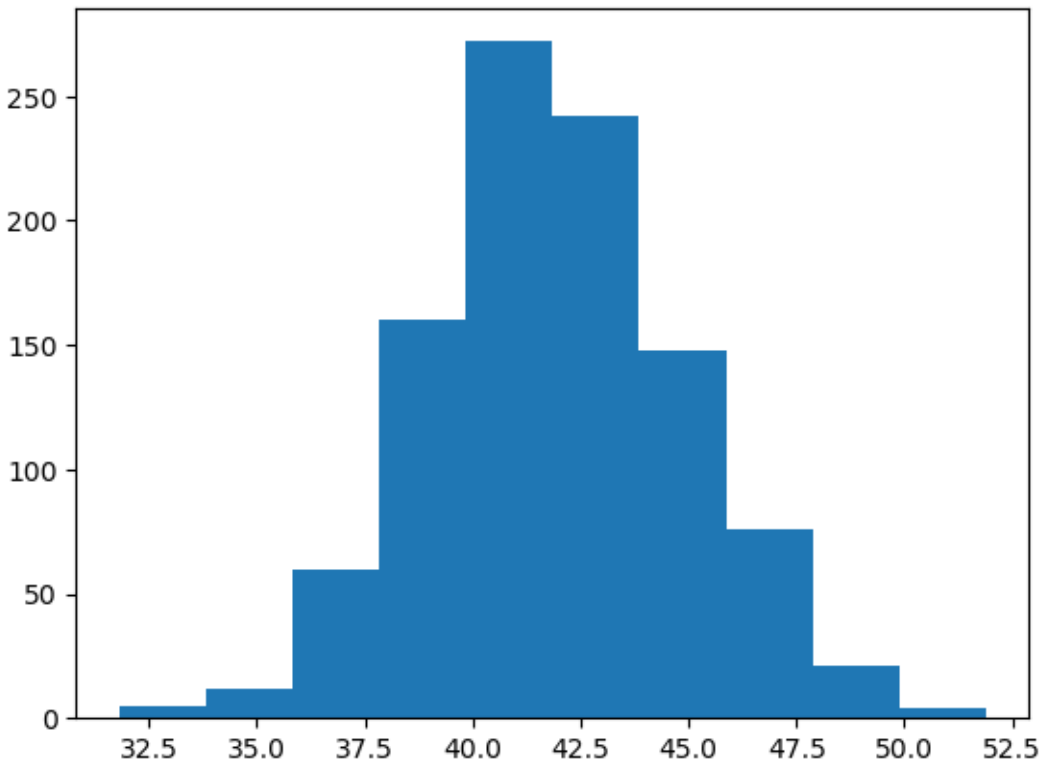
2.1 Histogram

Purpose: Showing the spread of a data column.

matplotlib function: `hist(x)`

- `x`: List of values to display the distribution of.

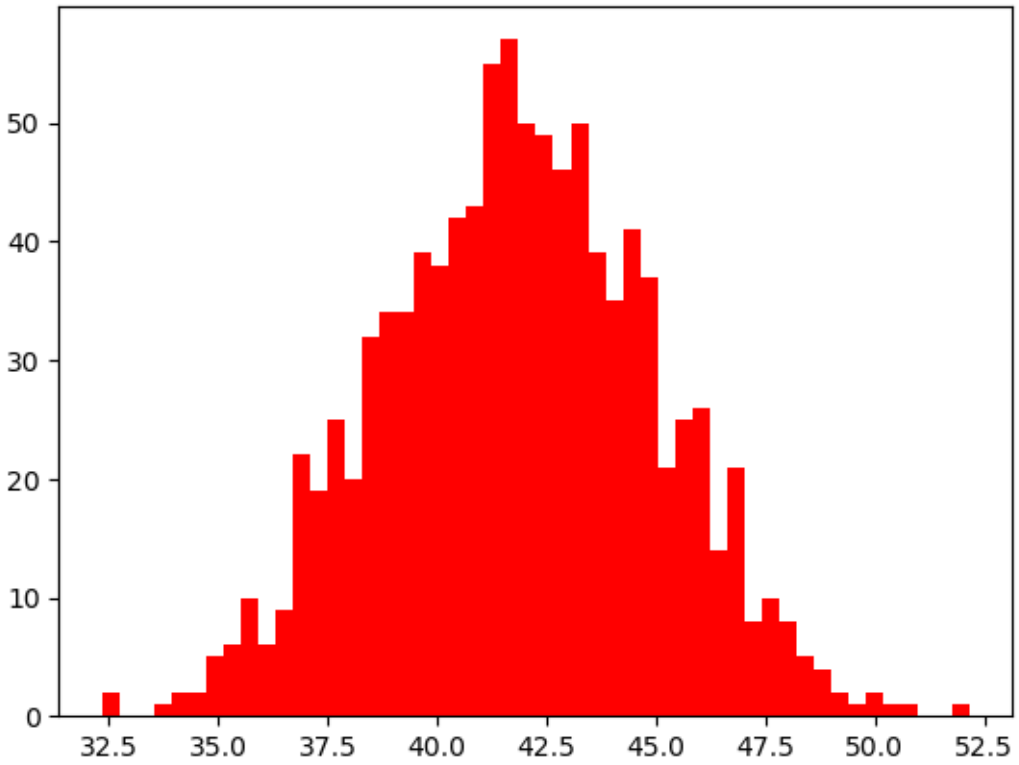
[18]:
```
column_data = np.random.normal(42, 3, 1000)

plt.figure()

plt.hist(column_data)
plt.show()
```



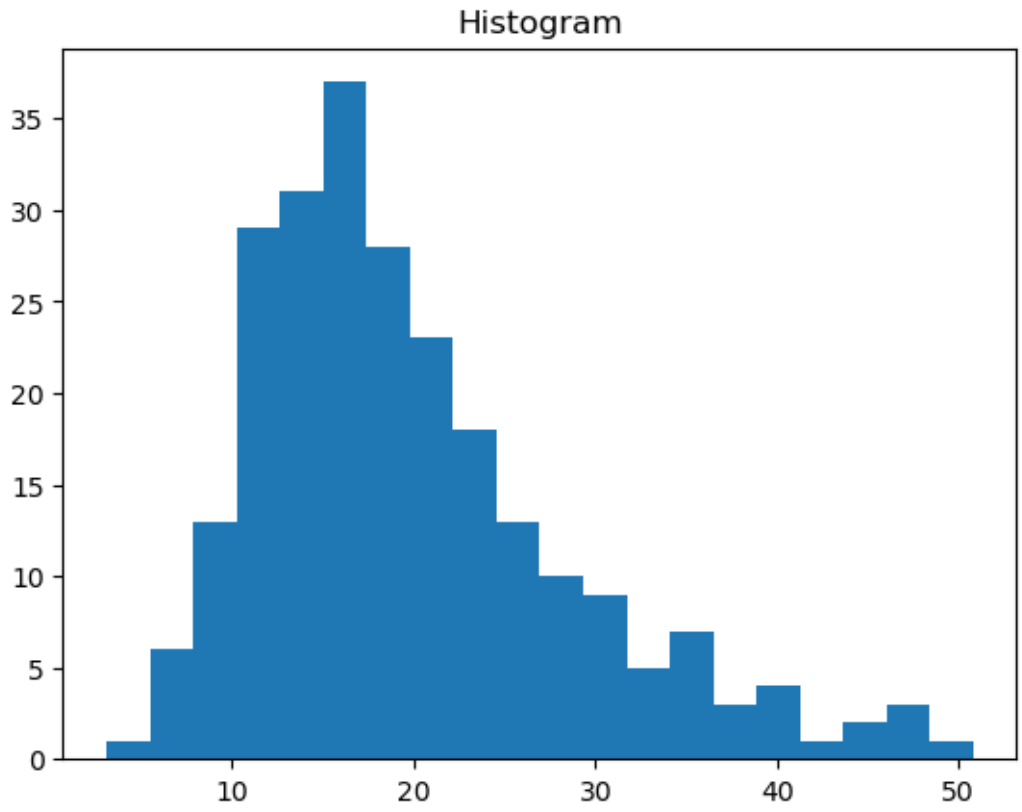
Commonly used parameters:

- `color`: Set the color of the bars in the histogram.
- `bins`: Set the number of bins to display in the histogram, or specify specific bins.

[19]:
```
column_data = np.random.normal(42, 3, 1000)

plt.figure()

plt.hist(column_data,
         color='red',
         bins=50)
plt.show()
```



[20]:
```
import pandas as pd
import matplotlib.pyplot as plt


# # reading the database
# data = pd.read_csv("tips.csv")

# hostogram of total_bills
plt.hist(data['total_bill'], bins=20)

plt.title("Histogram")

# Adding the legends
plt.show()
```



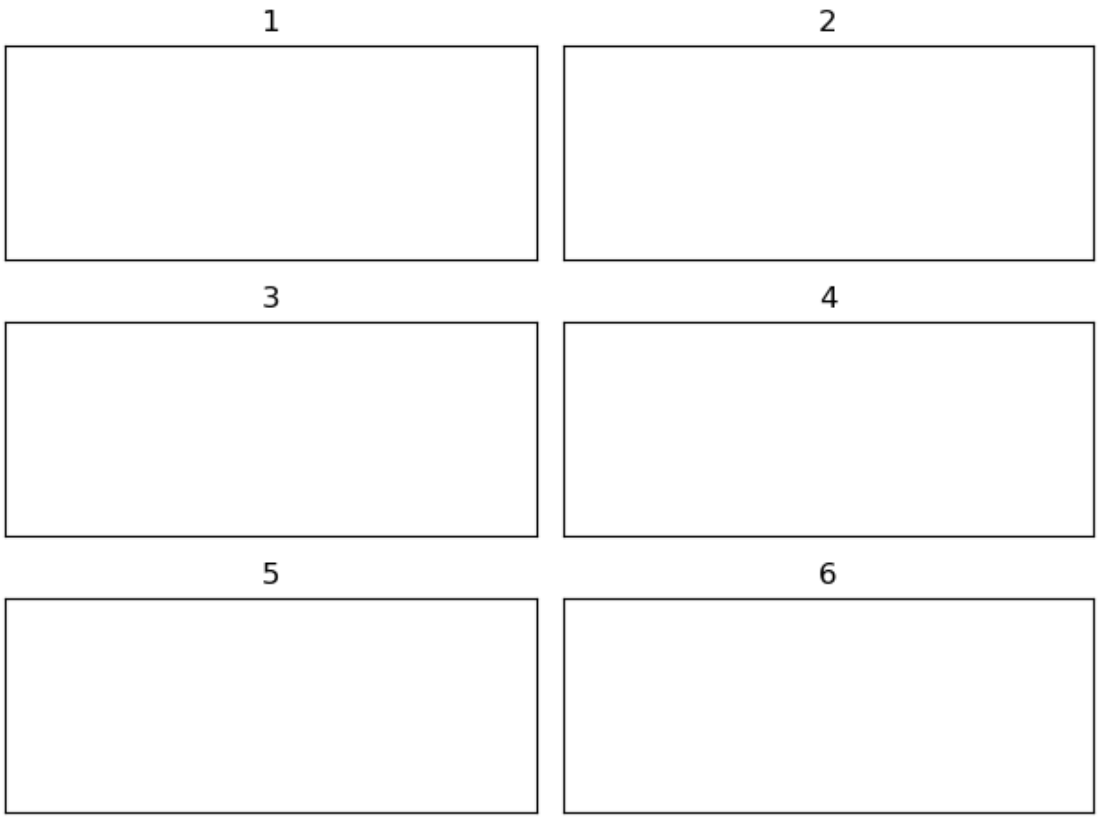
3 Subplots

Purpose: Allows you to place multiple charts in a figure.

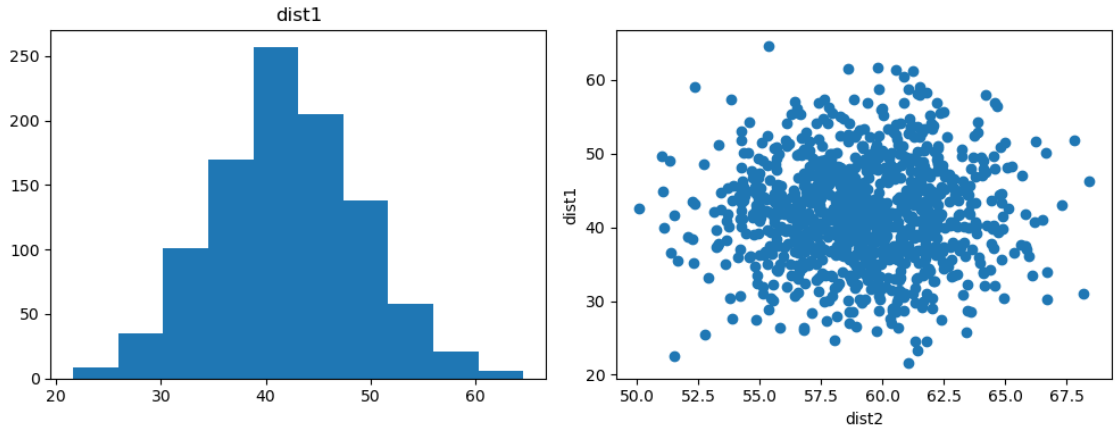
matplotlib function: `subplot(nrows, ncols, plot_number)`

- `nrows`: The number of rows in the figure.
- `ncols`: The number of columns in the figure.
- `plot_number`: The placement of the chart (starts at 1).

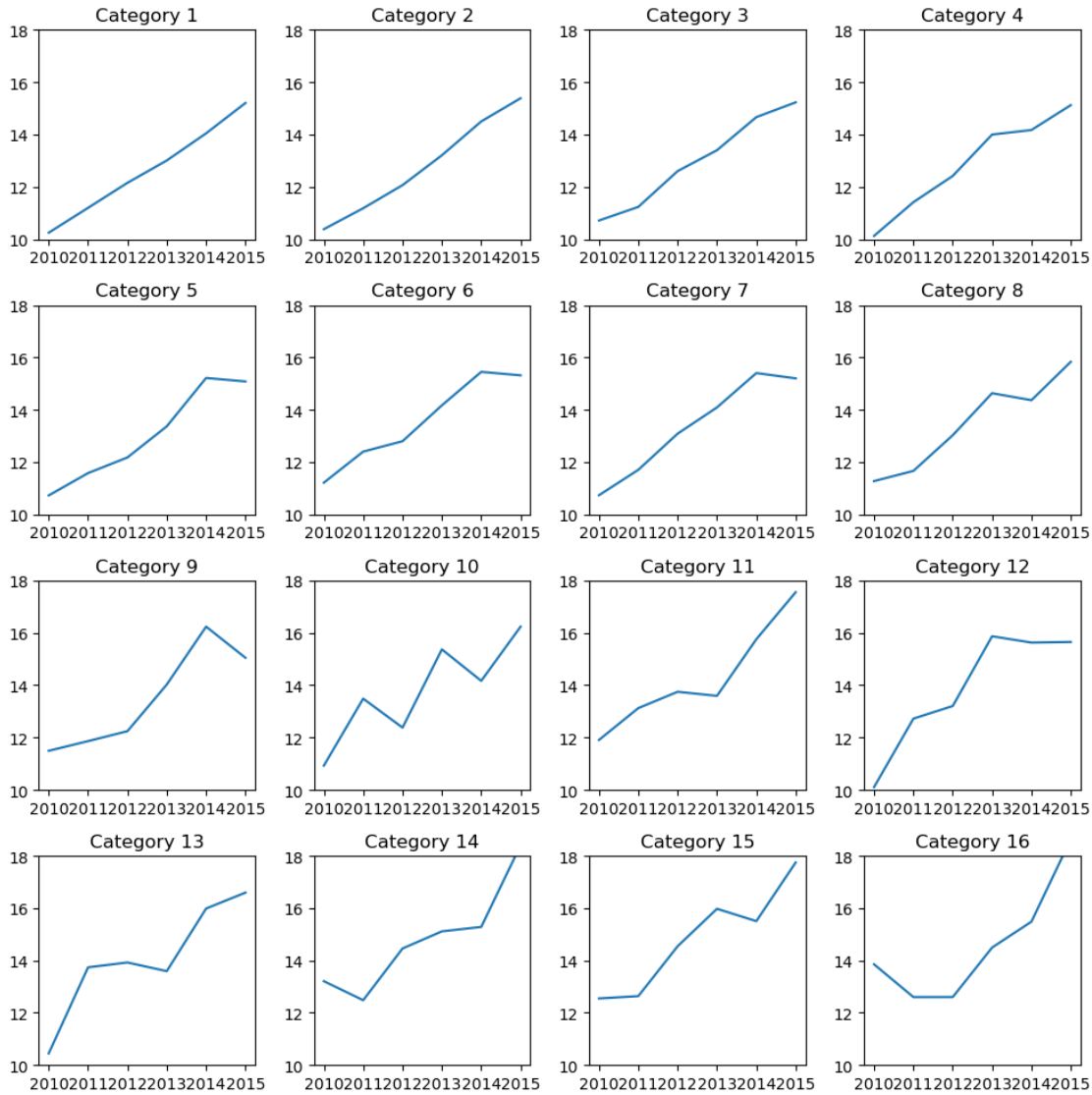
[21]:
```
plt.figure()

for i in range(1, 7):
    plt.subplot(3, 2, i)
    plt.title(i)
    plt.xticks([])
    plt.yticks([])

plt.tight_layout()
```



[22]:
```
dist1 = np.random.normal(42, 7, 1000)
dist2 = np.random.normal(59, 3, 1000)

plt.figure(figsize=(10, 4))

plt.subplot(1, 2, 1)
plt.hist(dist1)
plt.title('dist1')

plt.subplot(1, 2, 2)
plt.scatter(dist2, dist1)
plt.xlabel('dist2')
plt.ylabel('dist1')

plt.tight_layout()
```



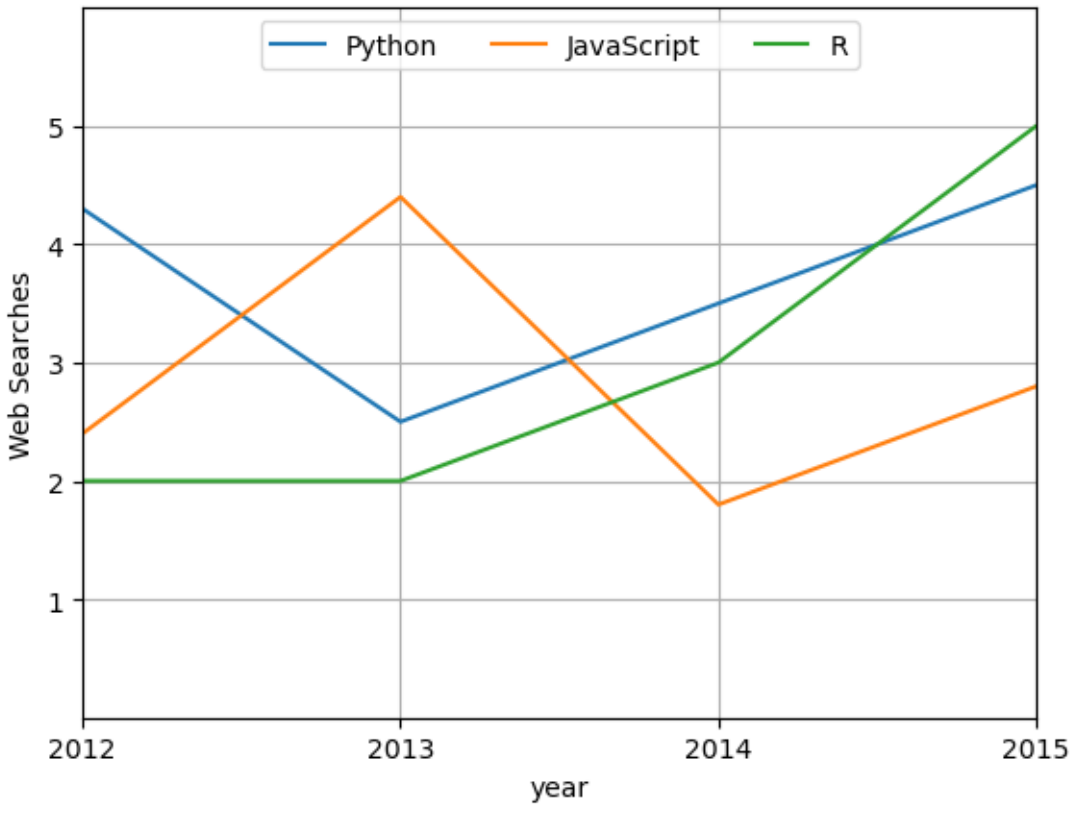
[23]:
```
years = np.arange(2010, 2016)

plt.figure(figsize=(10, 10))

for category_num in range(1, 17):
    plt.subplot(4, 4, category_num)
    y_vals = np.arange(10, 16) + (np.random.random(6) * category_num / 4.)
    plt.plot(years, y_vals)
    plt.ylim(10, 18)
    plt.xticks(years, [str(year) for year in years])
    plt.title('Category {}'.format(category_num))

plt.tight_layout()
```



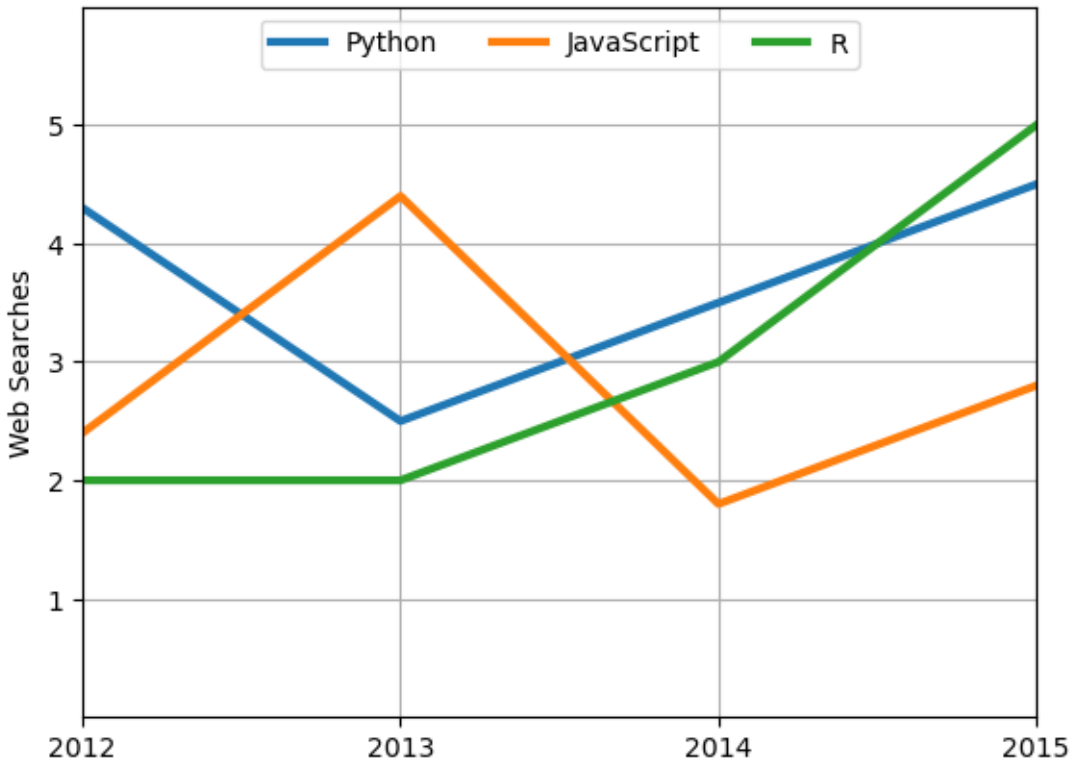
3.1 Styles

[24]:
```
import matplotlib.pyplot as plt
# data
x1_values = [2012, 2013, 2014, 2015]
y1_values = [4.3, 2.5, 3.5, 4.5]

x2_values = [2012, 2013, 2014, 2015]
y2_values = [2.4, 4.4, 1.8, 2.8]

x3_values = [2012, 2013, 2014, 2015]
y3_values = [2, 2, 3, 5]
```

```
# plot
plt.figure()
plt.plot(x1_values, y1_values, label='Python')
plt.plot(x2_values, y2_values, label='JavaScript')
plt.plot(x3_values, y3_values, label='R')

plt.xlim(2012, 2015)
plt.ylim(0, 6)
plt.xticks([2012, 2013, 2014, 2015], ['2012', '2013', '2014', '2015'])
plt.yticks([1, 2, 3, 4, 5])

plt.xlabel('year')
plt.ylabel('Web Searches')

plt.legend(loc='upper center', ncol=3)
plt.grid(True)

plt.savefig('web-searches.png', dpi=150)
```



[25]:
```
plt.figure()
plt.plot(x1_values, y1_values, label='Python', lw=3, color='#1f77b4')
plt.plot(x2_values, y2_values, label='JavaScript', lw=3, color='#ff7f0e')
plt.plot(x3_values, y3_values, label='R', lw=3, color='#2ca02c')

plt.xlim(2012, 2015)
plt.ylim(0, 6)
plt.xticks([2012, 2013, 2014, 2015], ['2012', '2013', '2014', '2015'])
plt.yticks([1, 2, 3, 4, 5])

plt.xlabel('')
plt.ylabel('Web Searches')

plt.legend(loc='upper center', ncol=3)
# plt.legend(loc='lower center', ncol=3)
plt.grid(True)

plt.savefig('web-searches.png', dpi=150)
```



4 Advanced Visualization

[26]:
```
import pandas as pd
from matplotlib import pyplot as plt
import seaborn as sns
```

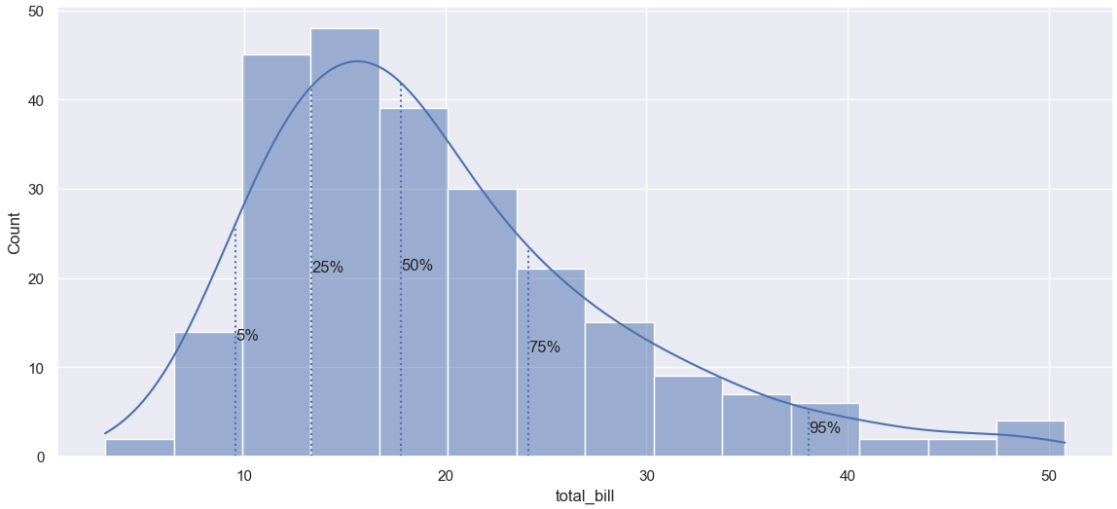
[27]:
```
df = pd.read_csv('data/tips.csv')
df
```

[27]:

	total_bill	tip	sex	smoker	day	time	size
0	16.99	1.01	Female	No	Sun	Dinner	2
1	10.34	1.66	Male	No	Sun	Dinner	3
2	21.01	3.50	Male	No	Sun	Dinner	3
3	23.68	3.31	Male	No	Sun	Dinner	2
4	24.59	3.61	Female	No	Sun	Dinner	4
..	…	…	…	…	…	…	…
239	29.03	5.92	Male	No	Sat	Dinner	3
240	27.18	2.00	Female	Yes	Sat	Dinner	2
241	22.67	2.00	Male	Yes	Sat	Dinner	2
242	17.82	1.75	Male	No	Sat	Dinner	2
243	18.78	3.00	Female	No	Thur	Dinner	2

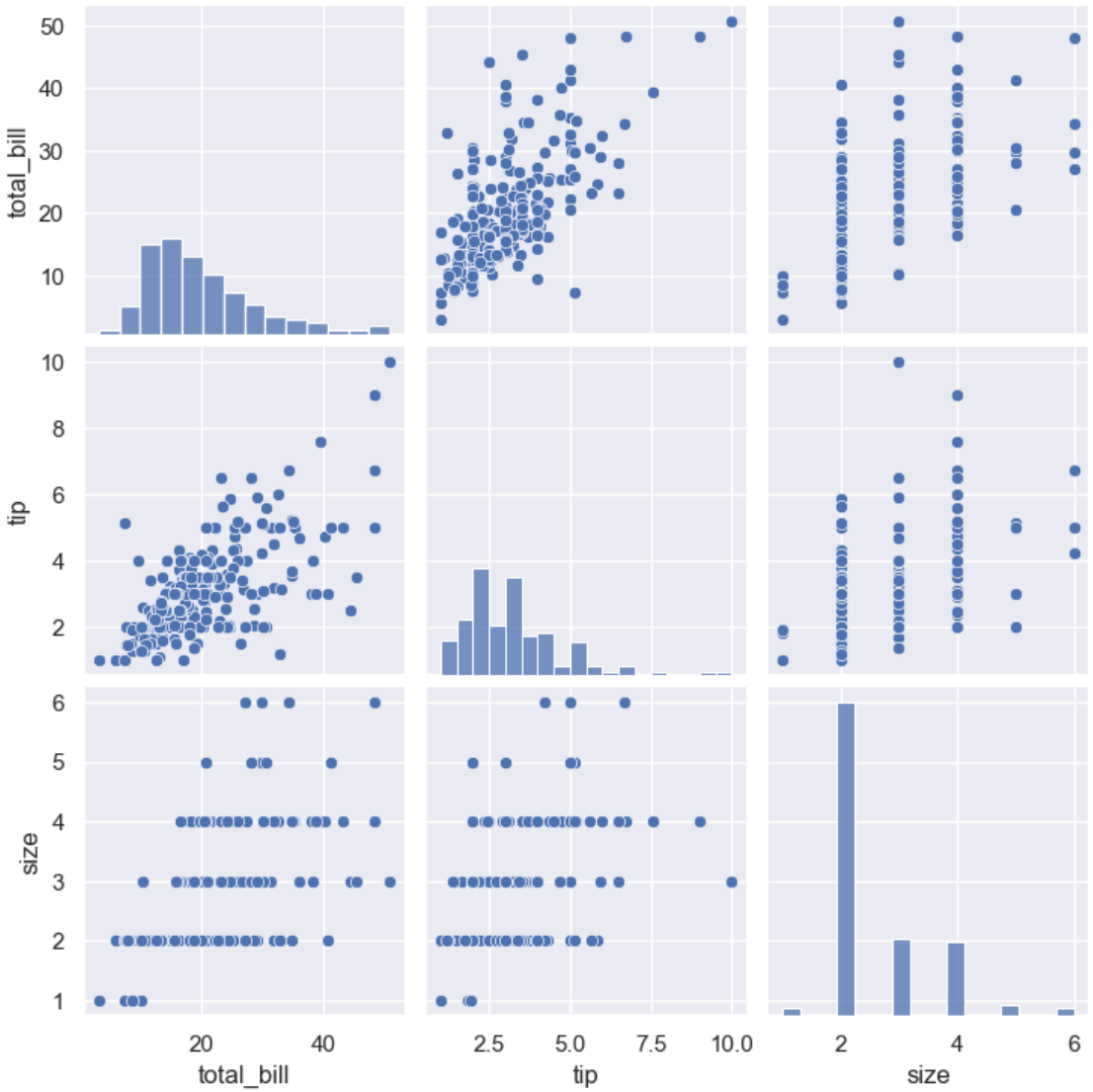
[244 rows x 7 columns]

[28]:
```
import numpy as np

sns.set(rc = {'figure.figsize':(14, 6)})
ax = sns.histplot(x = data['total_bill'], kde=True)

quant_5 = data['total_bill'].quantile(0.05)
quant_25 = data['total_bill'].quantile(0.25)
quant_50 = data['total_bill'].quantile(0.5)
quant_75 = data['total_bill'].quantile(0.75)
quant_95 = data['total_bill'].quantile(0.95)
quant_dict = {'5%': quant_5, '25%': quant_25, '50%': quant_50, '75%': quant_75,␣
 ↪'95%': quant_95}

kdeline = ax.lines[0]
xs = kdeline.get_xdata()
ys = kdeline.get_ydata()

for key, value in quant_dict.items():
    height = np.interp(value, xs, ys)
    ax.vlines(value, 0, height,  ls=':')
    ax.text(value , height * 0.5, key, rotation=0)

plt.show()
```



4.0.1 Pairplot

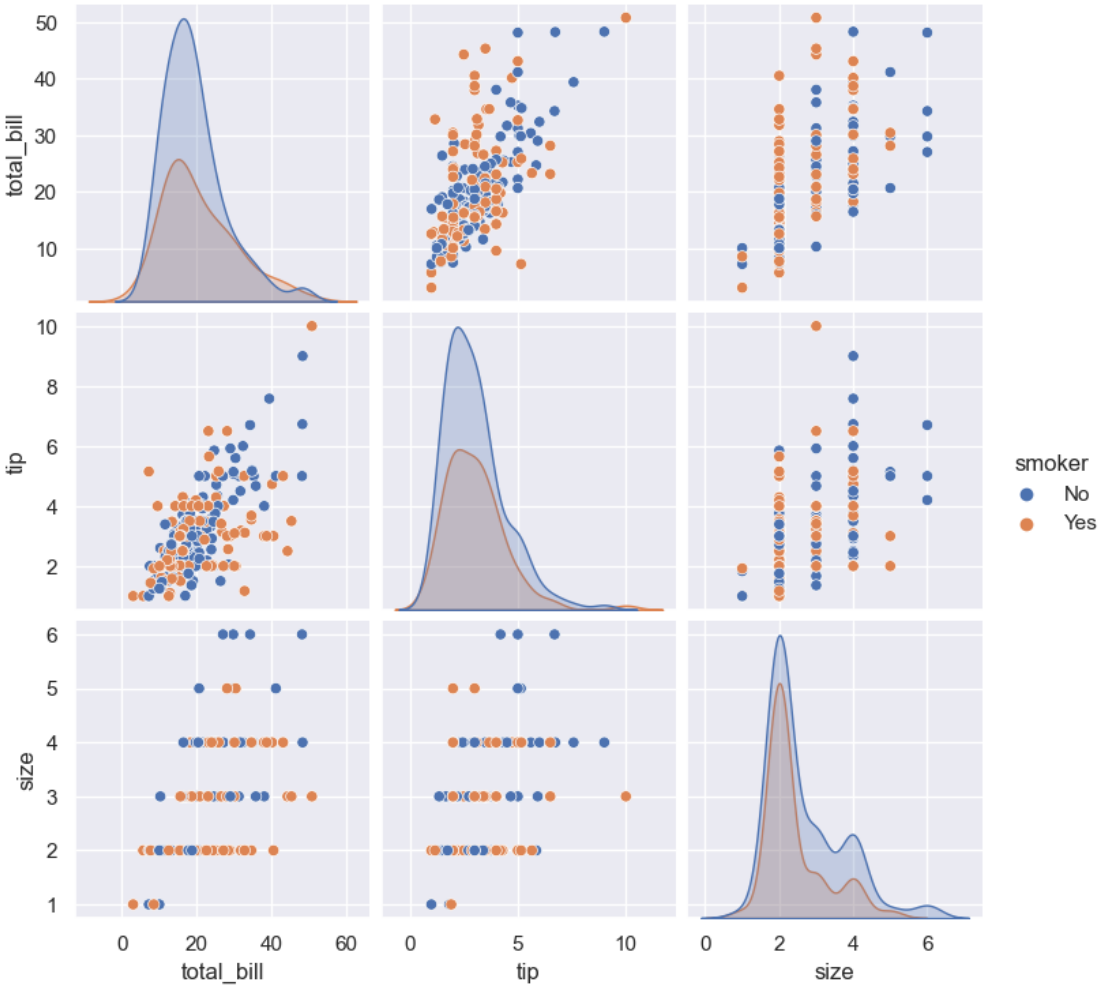
[29]:
```
sns.pairplot(df)
plt.show()
```



[30]:
```
df.value_counts('smoker')
```

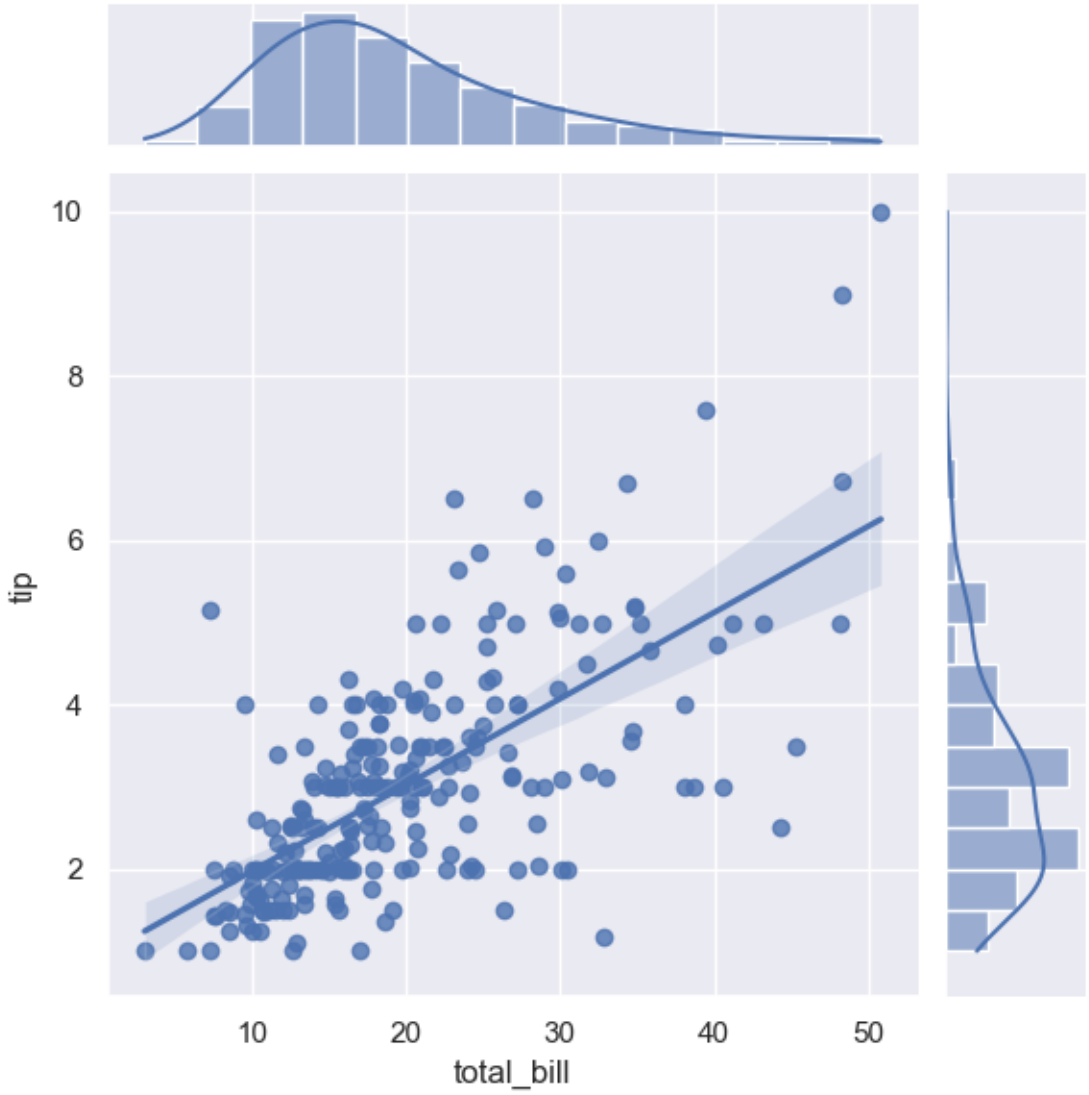
[30]:
```
smoker
No     151
Yes     93
dtype: int64
```

[31]:
```
sns.pairplot(df, hue='smoker')
plt.show()
```



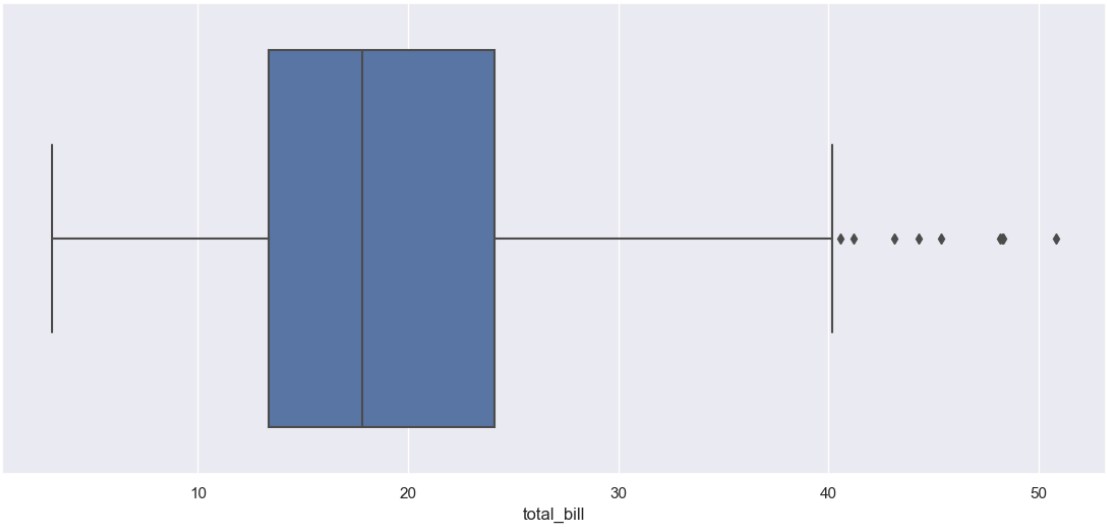
4.0.2 Linear regression with distributions

[32]:
```
sns.jointplot(x="total_bill", y="tip", data=df, kind="reg")
plt.show()
```

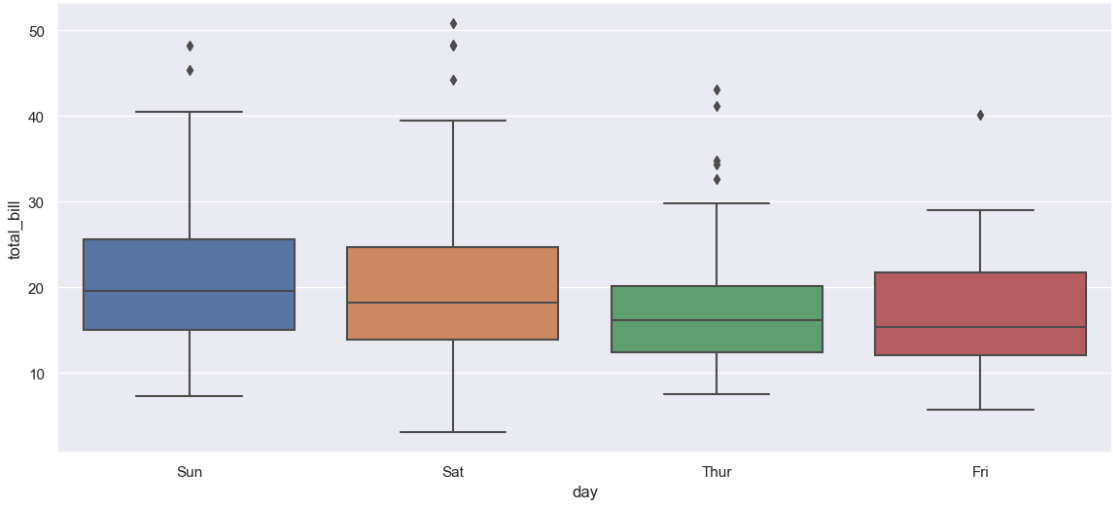


4.0.3 Box Plot

[33]:
```
sns.boxplot(x=df["total_bill"])
plt.show()
```



[34]:
```
sns.boxplot(x="day", y="total_bill", data=df)
plt.show()
```



4.0.4 Heatmap

[35]:
```
# Load the example flights dataset and convert to long-form
flights_long = sns.load_dataset("flights")
flights_long
```

[35]:
```
     year month  passengers
0    1949   Jan         112
```

```
1    1949   Feb         118
2    1949   Mar         132
3    1949   Apr         129
4    1949   May         121
..    …    …          …
139  1960   Aug         606
140  1960   Sep         508
141  1960   Oct         461
142  1960   Nov         390
143  1960   Dec         432

[144 rows x 3 columns]
```

[36]:
```
flights = flights_long.pivot("month", "year", "passengers")
flights
```

```
C:\Users\88019\AppData\Local\Temp\ipykernel_7132\254108779.py:1: FutureWarning:
In a future version of pandas all arguments of DataFrame.pivot will be keyword-
only.
  flights = flights_long.pivot("month", "year", "passengers")
```

[36]:

year	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960
month												
Jan	112	115	145	171	196	204	242	284	315	340	360	417
Feb	118	126	150	180	196	188	233	277	301	318	342	391
Mar	132	141	178	193	236	235	267	317	356	362	406	419
Apr	129	135	163	181	235	227	269	313	348	348	396	461
May	121	125	172	183	229	234	270	318	355	363	420	472
Jun	135	149	178	218	243	264	315	374	422	435	472	535
Jul	148	170	199	230	264	302	364	413	465	491	548	622
Aug	148	170	199	242	272	293	347	405	467	505	559	606
Sep	136	158	184	209	237	259	312	355	404	404	463	508
Oct	119	133	162	191	211	229	274	306	347	359	407	461
Nov	104	114	146	172	180	203	237	271	305	310	362	390
Dec	118	140	166	194	201	229	278	306	336	337	405	432

[37]:
```
# Draw a heatmap with the numeric values in each cell
f, ax = plt.subplots(figsize=(16, 8))
sns.heatmap(flights, annot=True, fmt=".0f")
plt.show()
```

Visit this page to learn more -> https://seaborn.pydata.org/examples/index.html