Simple Scatter Plots

Another **commonly used plot type** is the simple **scatter plot,** a close cousin of the line plot.

Instead of points being joined by line segments, here the points are **represented individually** with a dot, circle, or other shape.

We'll start by setting up the notebook for plotting and importing the packages we will use:

In [ ]:
```
%matplotlib inline
import matplotlib.pyplot as plt
plt.style.use('seaborn-whitegrid')
import numpy as np
```

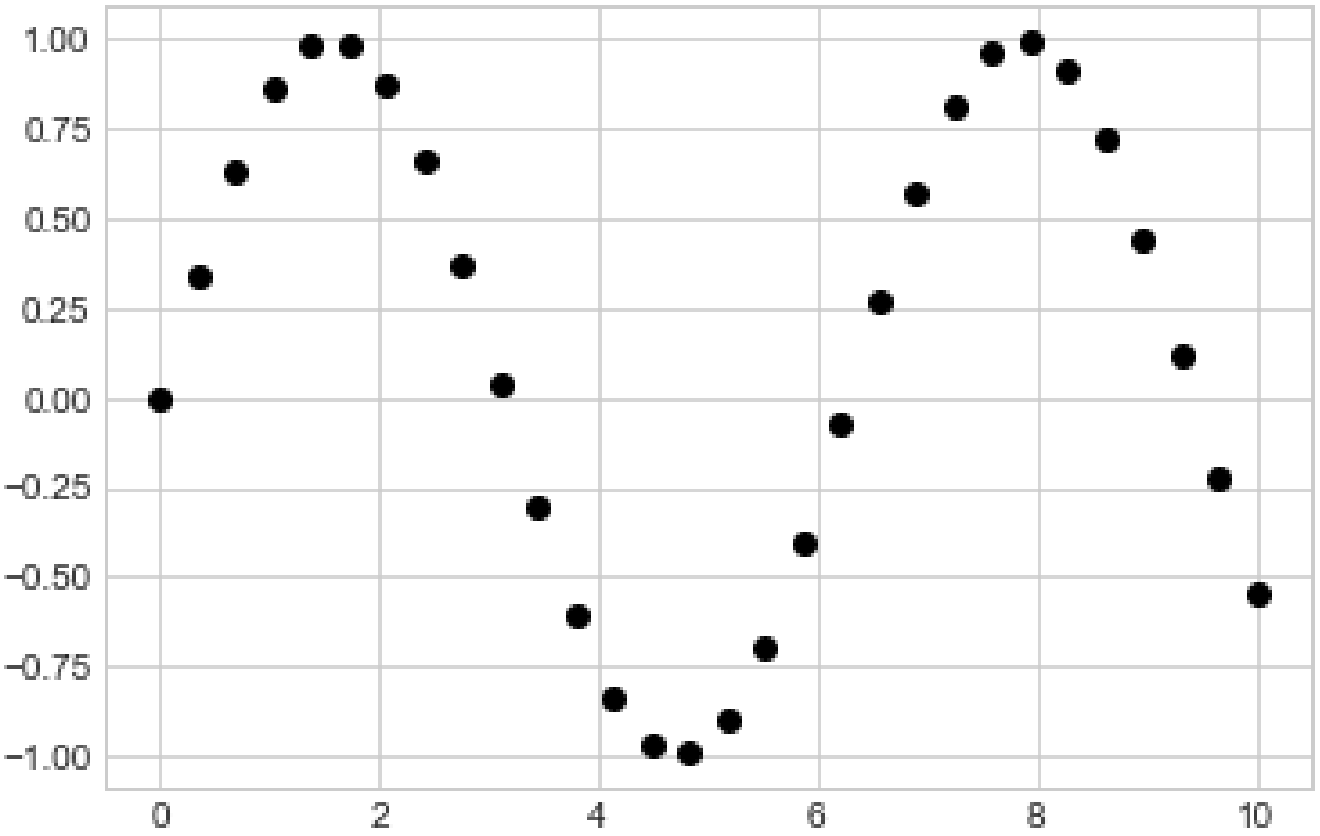
Scatter Plots with plt.plot

In the previous chapter we looked at using `plt.plot` / `ax.plot` to produce line plots.

It turns out that this **same function** can produce scatter plots as well (see the following figure):

In [ ]:
```
x = np.linspace(0, 10, 30)
y = np.sin(x)

plt.plot(x, y, 'o', color='black');
```

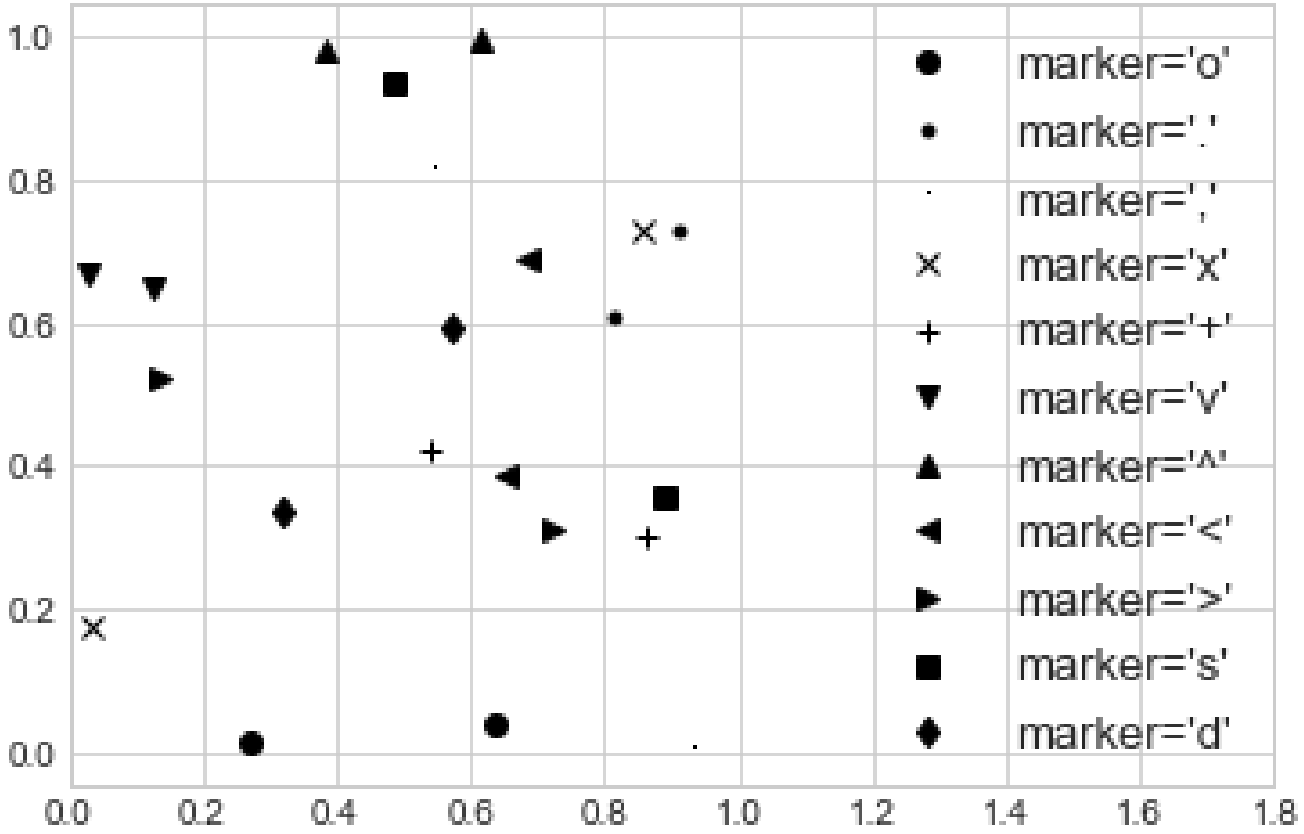


The **third argument** in the function call is a character that represents the **type of symbol** used for the plotting.

Just as you can specify options such as `'-'` or `'--'` to control the line style,

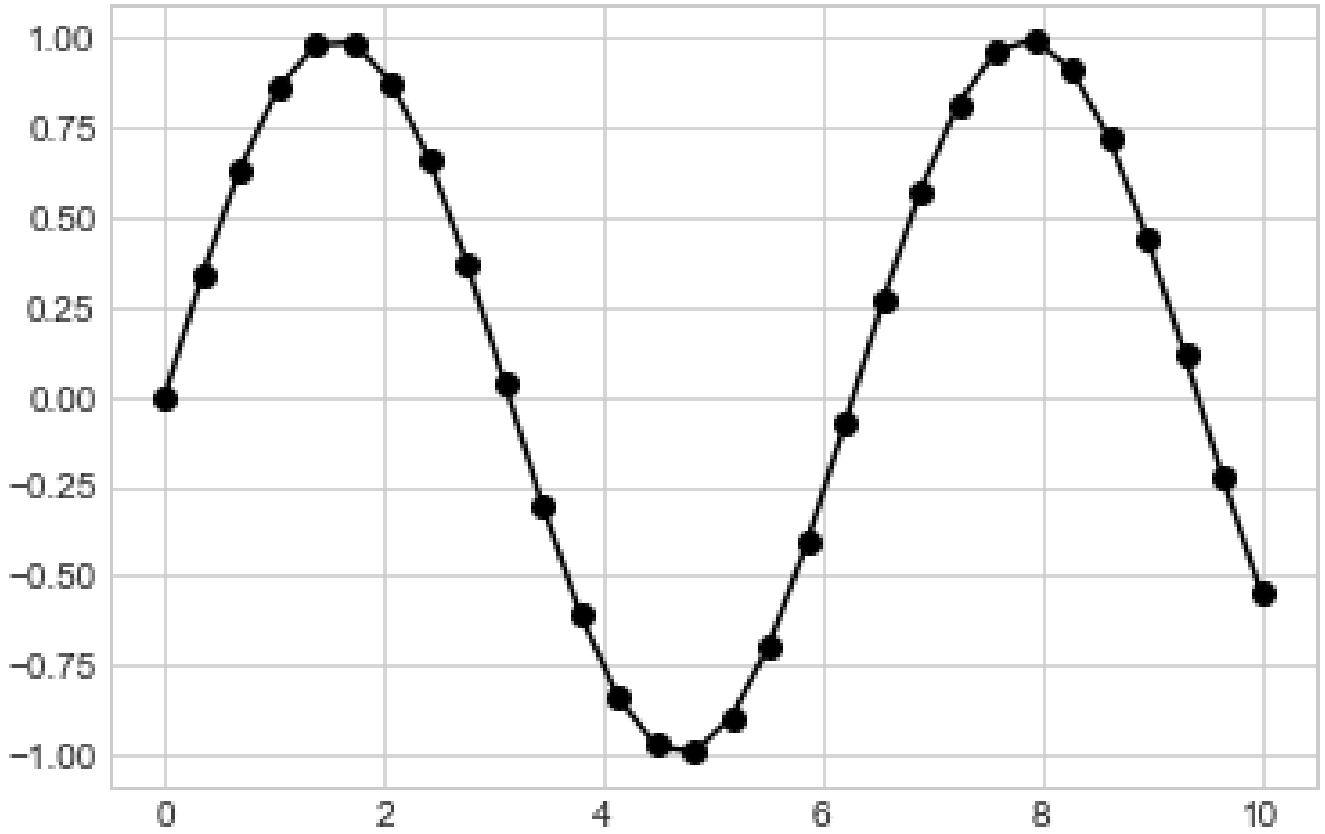
the marker style has its own set of **short string codes.**

In [ ]:
```
rng = np.random.default_rng(0)
for marker in ['o', '.', ',', 'x', '+', 'v', '^', '<', '>',
    plt.plot(rng.random(2), rng.random(2), marker, color='bla
             label="marker='{0}'".format(marker))
plt.legend(numpoints=1, fontsize=13)
plt.xlim(0, 1.8);
```



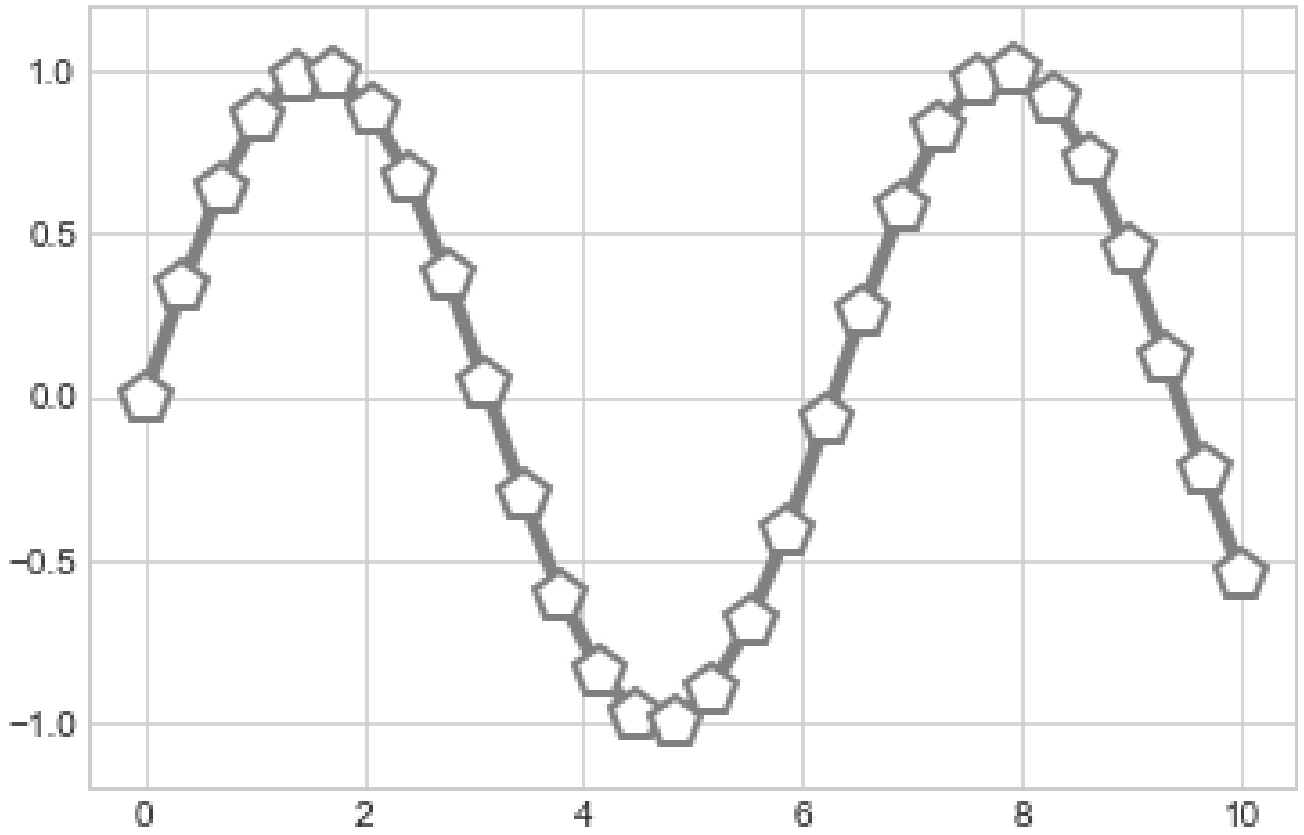
For even more possibilities, these character codes can be **used together with line** and color codes to plot points along with a line connecting them (see the following figure):

In [ ]:
```
plt.plot(x, y, '-ok');
```



Additional keyword arguments to `plt.plot` specify a wide range of properties of the lines and markers, as you can see in the following figure:

In [ ]:
```
plt.plot(x, y, '-p', color='gray',
         markersize=15, linewidth=4,
         markerfacecolor='white',
         markeredgecolor='gray',
         markeredgewidth=2)
plt.ylim(-1.2, 1.2);
```

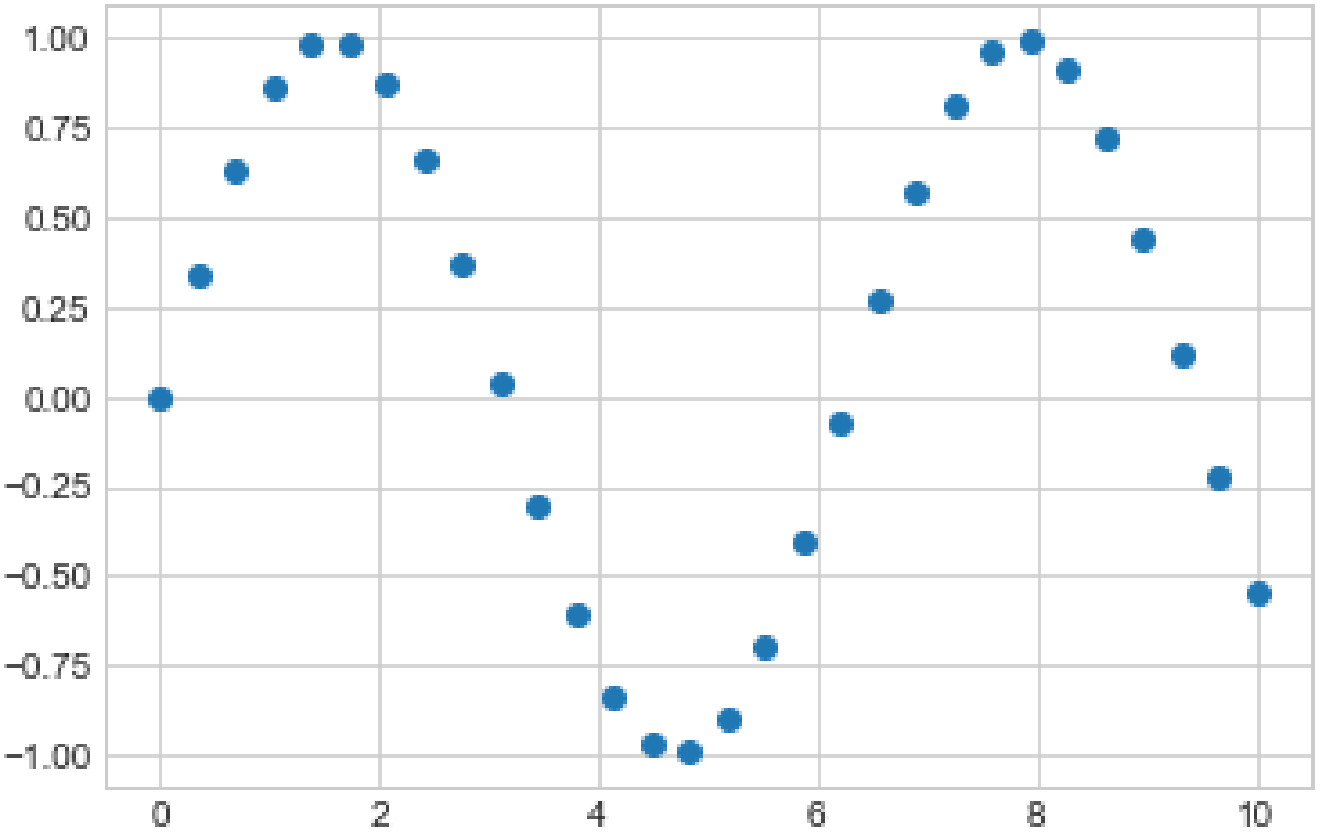


These kinds of options make `plt.plot` the primary workhorse for two-dimensional plots in Matplotlib.

Scatter Plots with plt.scatter

A second, more powerful method of creating scatter plots is the `plt.scatter` function, which can be used very similarly to the `plt.plot` function (see the following figure):

In [ ]:
```
plt.scatter(x, y, marker='o');
```



The **primary difference** of `plt.scatter` from `plt.plot`

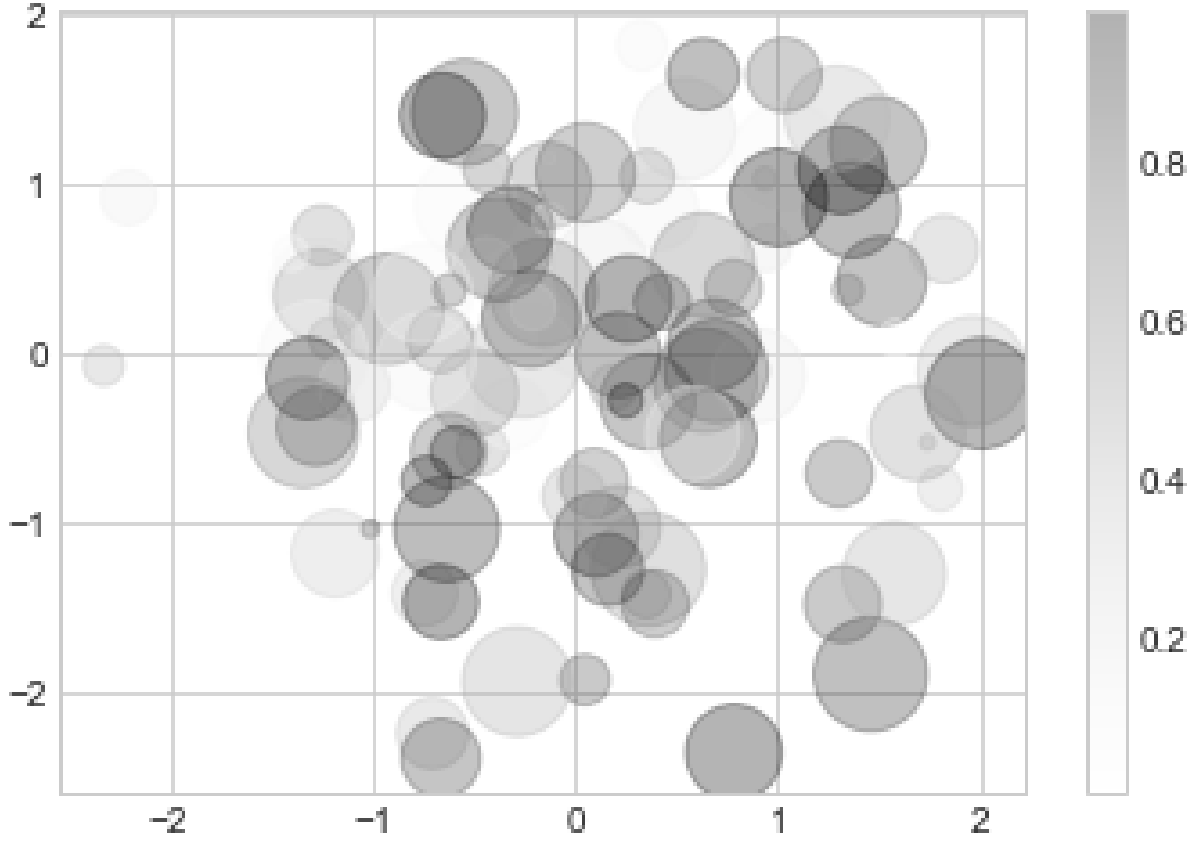
is that it can be used to create scatter plots where the **properties of each individual point** (size, face color, edge color, etc.) can be individually controlled or mapped to data.

Let's show this by creating a random scatter plot with points of many colors and sizes.

In order to better see the **overlapping results,** we'll also use the `alpha` keyword to **adjust the transparency level** (see the following figure):

In [ ]:
```
rng = np.random.default_rng(0)
x = rng.normal(size=100)
y = rng.normal(size=100)
colors = rng.random(100)
sizes = 1000 * rng.random(100)

plt.scatter(x, y, c=colors, s=sizes, alpha=0.3)
plt.colorbar();  # show color scale
```



Notice that the **color argument** is automatically mapped to a color scale (shown here by the `colorbar` command),

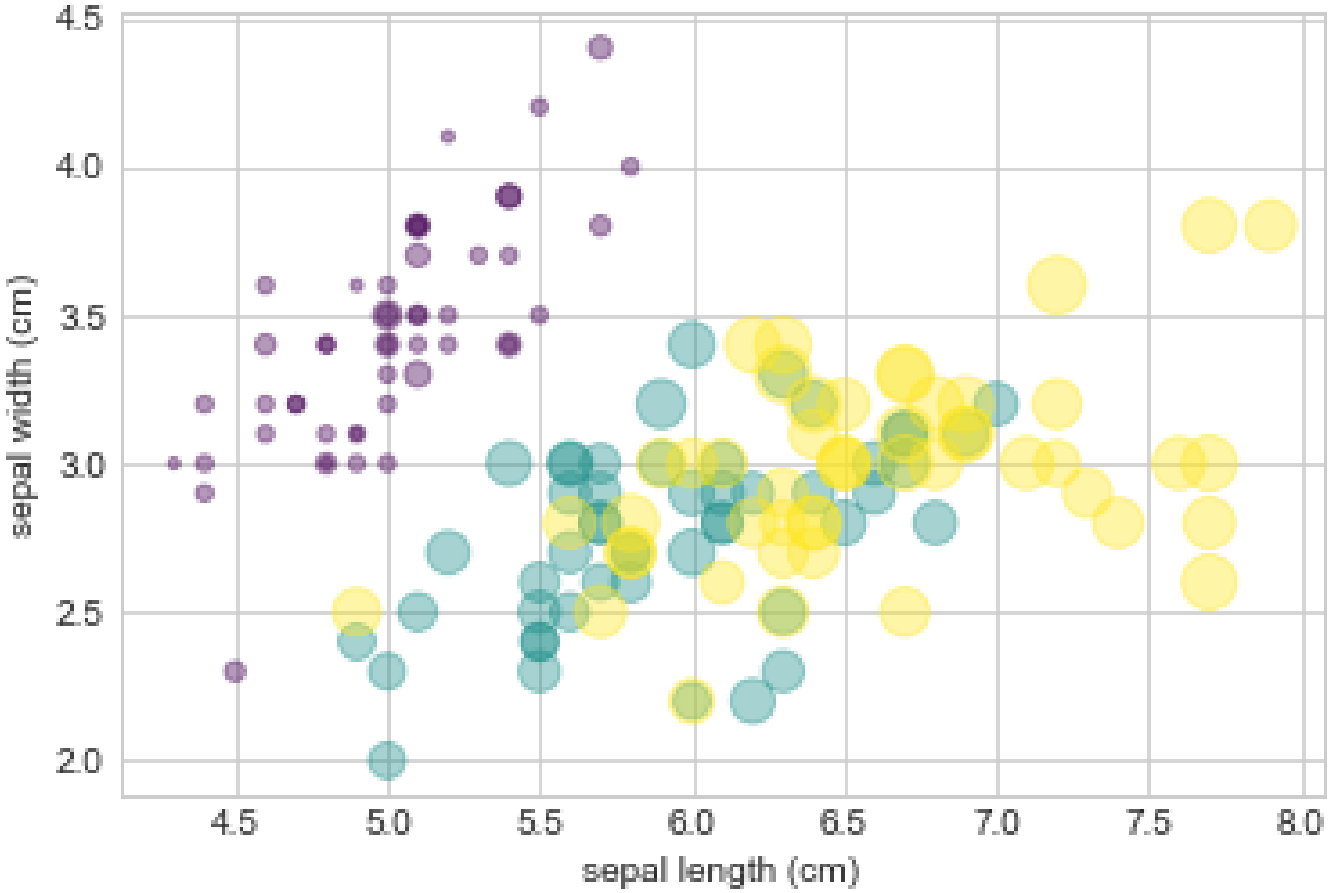
and that the **size argument** is given in pixels.

In this way, the **color and size** of points can be used to **convey information** in the visualization, in order to **visualize multidimensional data.**

For example, we might use the **Iris dataset** from Scikit-Learn, where each sample is one of three types of flowers that has had the size of its petals and sepals carefully measured (see the following figure):

In [ ]:
```
from sklearn.datasets import load_iris
iris = load_iris()
features = iris.data.T

plt.scatter(features[0], features[1], alpha=0.4,
            s=100*features[3], c=iris.target, cmap='viridis')
plt.xlabel(iris.feature_names[0])
plt.ylabel(iris.feature_names[1]);
```



We can see that this scatter plot has given us the ability to **simultaneously explore four different dimensions of the data:**

the (*x*, *y*) location of each point corresponds to the **sepal length and width,**

the size of the point is related to the **petal width,**

and the color is related to the particular **species** of flower.

Multicolor and multifeature scatter plots like this can be useful for both **exploration** and **presentation** of data.

plot Versus scatter: A Note on Efficiency

Aside from the different features available in `plt.plot` and `plt.scatter`, why might you **choose to use one over the other?**

While it doesn't matter as much for **small amounts of data,** as datasets get larger than a few thousand points, `plt.plot` can be noticeably more efficient than `plt.scatter`.

The reason is that `plt.scatter` has the capability to **render** a different size and/or color **for each point,** so the renderer must do the extra work of constructing each point individually.

With `plt.plot`, on the other hand, the **markers for each point are guaranteed to be identical,** so the work of determining the appearance of the points is done only once for the entire set of data.

For **large datasets,** this difference can lead to vastly different performance, and for this reason, `plt.plot` should be preferred over `plt.scatter` for large datasets.