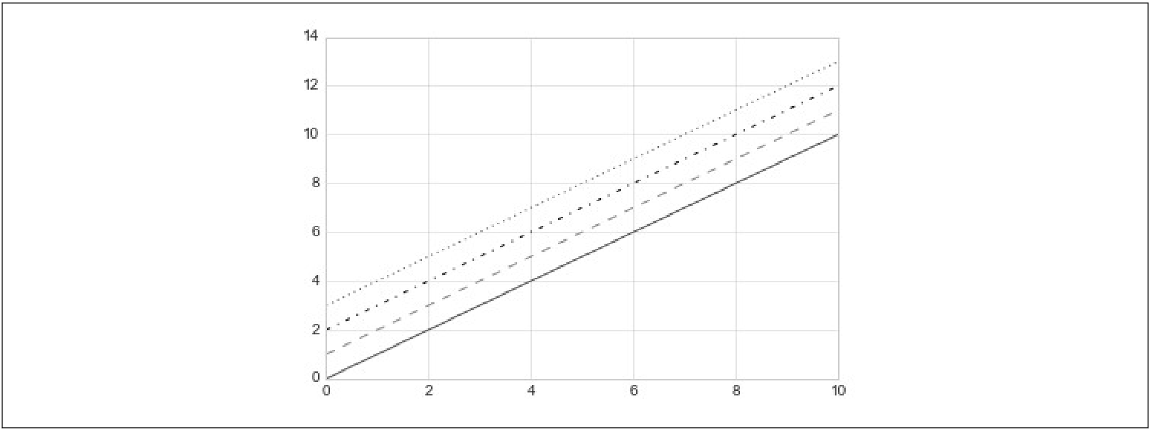

Figure 4-11. Controlling colors and styles with the shorthand syntax

These single-character color codes reflect the standard abbreviations in the RGB (Red/Green/Blue) and CMYK (Cyan/Magenta/Yellow/blacK) color systems, commonly used for digital color graphics.

There are many other keyword arguments that can be used to fine-tune the appearance of the plot; for more details, I'd suggest viewing the docstring of the `plt.plot()` function using IPython's help tools (see "Help and Documentation in IPython" on page 3).

Adjusting the Plot: Axes Limits

Matplotlib does a decent job of choosing default axes limits for your plot, but sometimes it's nice to have finer control. The most basic way to adjust axis limits is to use the `plt.xlim()` and `plt.ylim()` methods (Figure 4-12):

```
In[9]: plt.plot(x, np.sin(x))

       plt.xlim(-1, 11)
       plt.ylim(-1.5, 1.5);
```

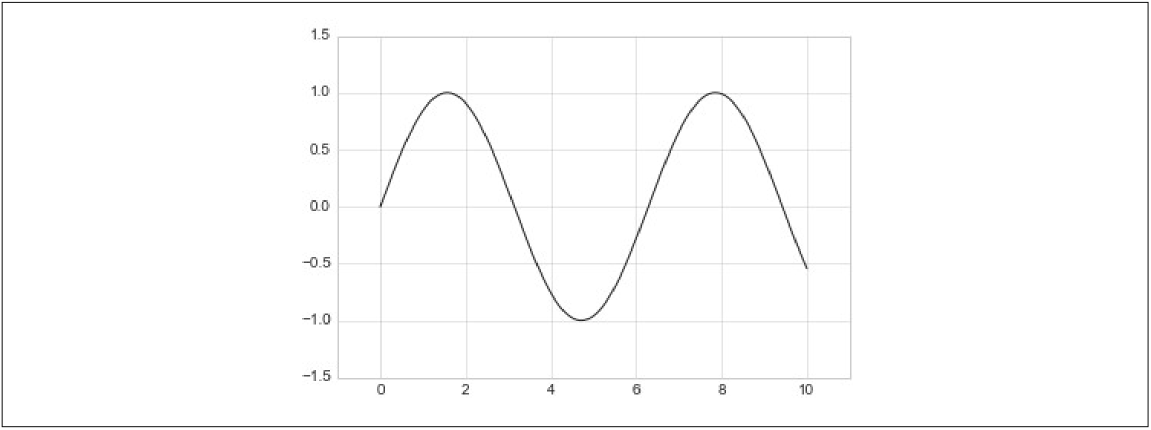

Figure 4-12. Example of setting axis limits

If for some reason you'd like either axis to be displayed in reverse, you can simply reverse the order of the arguments (Figure 4-13):

```
In[10]: plt.plot(x, np.sin(x))

        plt.xlim(10, 0)
        plt.ylim(1.2, -1.2);
```

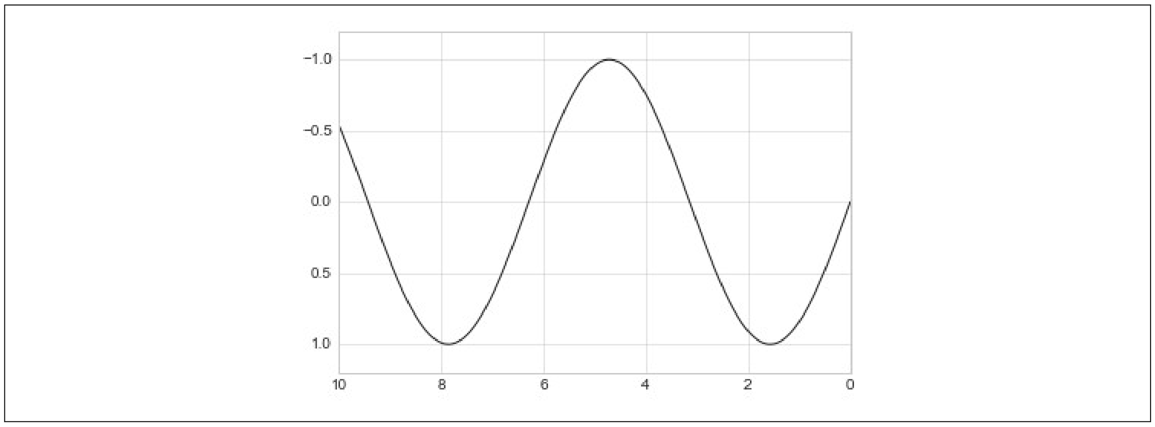

Figure 4-13. Example of reversing the y-axis

A useful related method is `plt.axis()` (note here the potential confusion between *axes* with an *e*, and *axis* with an *i*). The `plt.axis()` method allows you to set the `x` and `y` limits with a single call, by passing a list that specifies `[xmin, xmax, ymin, ymax]` (Figure 4-14):

```
In[11]: plt.plot(x, np.sin(x))
        plt.axis([-1, 11, -1.5, 1.5]);
```

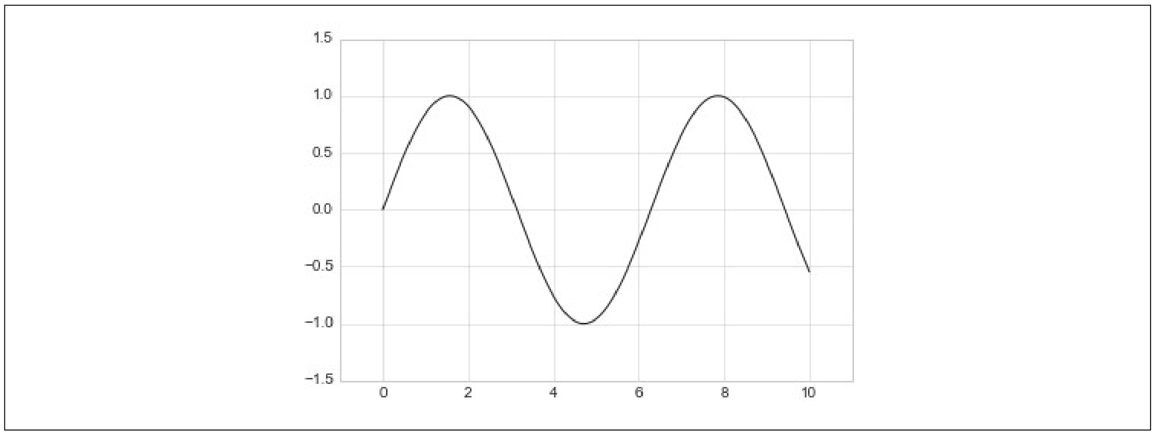

Figure 4-14. Setting the axis limits with plt.axis

The `plt.axis()` method goes even beyond this, allowing you to do things like automatically tighten the bounds around the current plot (Figure 4-15):

```
In[12]: plt.plot(x, np.sin(x))
        plt.axis('tight');
```

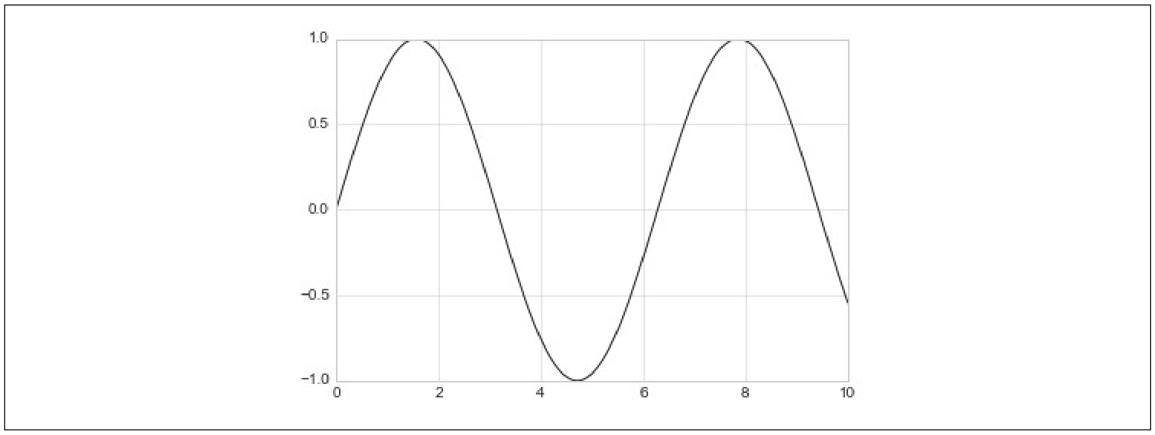

Figure 4-15. Example of a "tight" layout

It allows even higher-level specifications, such as ensuring an equal aspect ratio so that on your screen, one unit in `x` is equal to one unit in `y` (Figure 4-16):

```
In[13]: plt.plot(x, np.sin(x))
        plt.axis('equal');
```

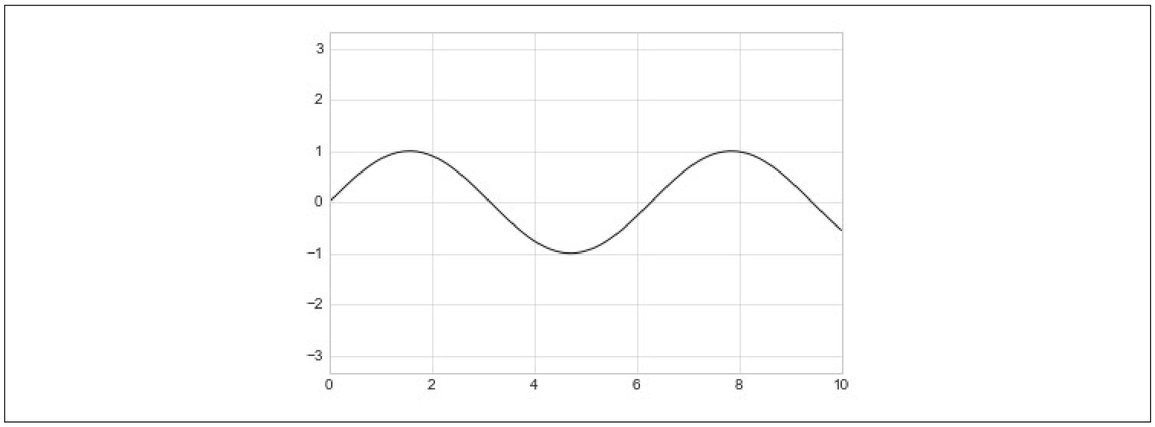

Figure 4-16. Example of an "equal" layout, with units matched to the output resolution

For more information on axis limits and the other capabilities of the `plt.axis()` method, refer to the `plt.axis()` docstring.

Labeling Plots

As the last piece of this section, we'll briefly look at the labeling of plots: titles, axis labels, and simple legends.

Titles and axis labels are the simplest such labels—there are methods that can be used to quickly set them (Figure 4-17):

```
In[14]: plt.plot(x, np.sin(x))
        plt.title("A Sine Curve")
        plt.xlabel("x")
        plt.ylabel("sin(x)");
```

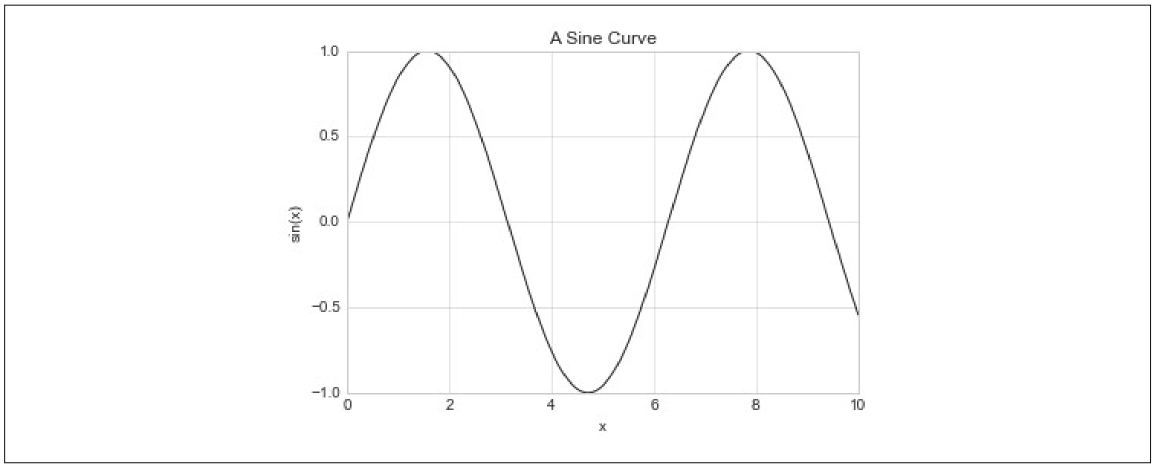

Figure 4-17. Examples of axis labels and title

You can adjust the position, size, and style of these labels using optional arguments to the function. For more information, see the Matplotlib documentation and the docstrings of each of these functions.

When multiple lines are being shown within a single axes, it can be useful to create a plot legend that labels each line type. Again, Matplotlib has a built-in way of quickly creating such a legend. It is done via the (you guessed it) `plt.legend()` method. Though there are several valid ways of using this, I find it easiest to specify the label of each line using the `label` keyword of the plot function (Figure 4-18):

```
In[15]: plt.plot(x, np.sin(x), '-g', label='sin(x)')
        plt.plot(x, np.cos(x), ':b', label='cos(x)')
        plt.axis('equal')

        plt.legend();
```

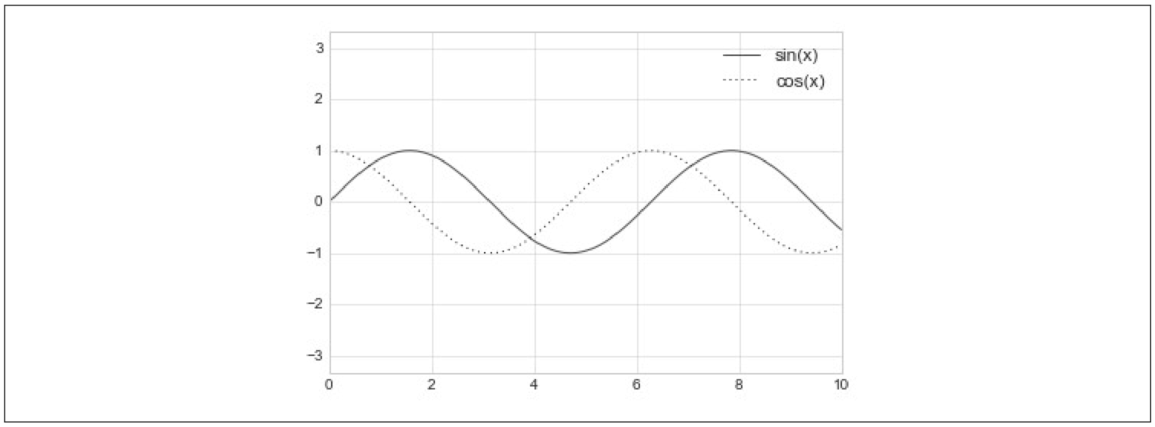

Figure 4-18. Plot legend example

As you can see, the `plt.legend()` function keeps track of the line style and color, and matches these with the correct label. More information on specifying and formatting plot legends can be found in the `plt.legend()` docstring; additionally, we will cover some more advanced legend options in "Customizing Plot Legends" on page 249.

Matplotlib Gotchas

While most `plt` functions translate directly to `ax` methods (such as `plt.plot()` → `ax.plot()`, `plt.legend()` → `ax.legend()`, etc.), this is not the case for all commands. In particular, functions to set limits, labels, and titles are slightly modified. For transitioning between MATLAB-style functions and object-oriented methods, make the following changes:

- `plt.xlabel()` → `ax.set_xlabel()`
- `plt.ylabel()` → `ax.set_ylabel()`
- `plt.xlim()` → `ax.set_xlim()`
- `plt.ylim()` → `ax.set_ylim()`
- `plt.title()` → `ax.set_title()`

In the object-oriented interface to plotting, rather than calling these functions individually, it is often more convenient to use the `ax.set()` method to set all these properties at once (Figure 4-19):

```
In[16]: ax = plt.axes()
        ax.plot(x, np.sin(x))
        ax.set(xlim=(0, 10), ylim=(-2, 2),
               xlabel='x', ylabel='sin(x)',
               title='A Simple Plot');
```

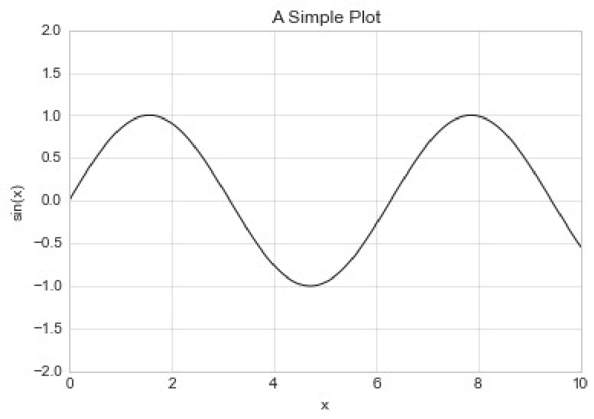

Figure 4-19. Example of using ax.set to set multiple properties at once

options available in these functions, refer to their docstrings. If you are interested in three-dimensional visualizations of this type of data, see "Three-Dimensional Plotting in Matplotlib" on page 290.

Histograms, Binnings, and Density

A simple histogram can be a great first step in understanding a dataset. Earlier, we saw a preview of Matplotlib's histogram function (see "Comparisons, Masks, and Boolean Logic" on page 70), which creates a basic histogram in one line, once the normal boilerplate imports are done (Figure 4-35):

```
In[1]: %matplotlib inline
       import numpy as np
       import matplotlib.pyplot as plt
       plt.style.use('seaborn-white')

       data = np.random.randn(1000)
```

```
In[2]: plt.hist(data);
```

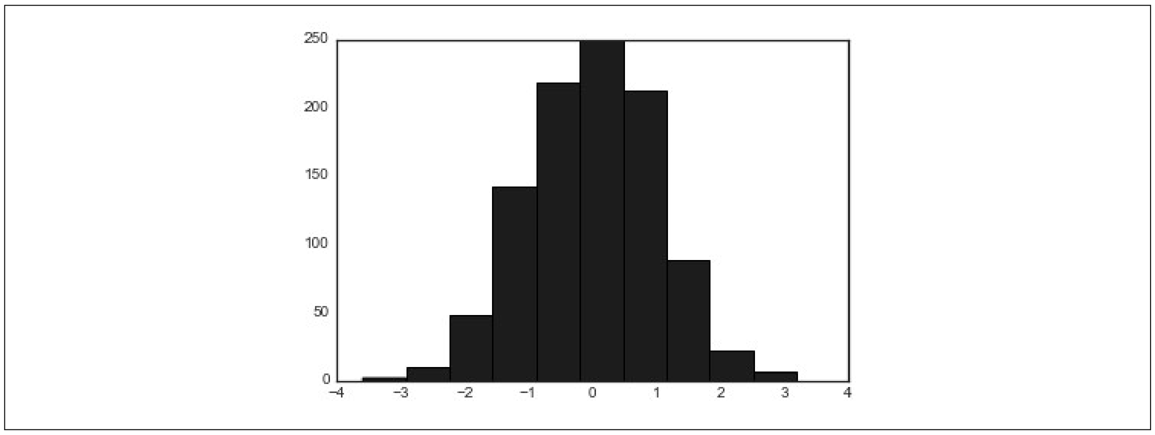

Figure 4-35. A simple histogram

The `hist()` function has many options to tune both the calculation and the display; here's an example of a more customized histogram (Figure 4-36):

```
In[3]: plt.hist(data, bins=30, normed=True, alpha=0.5,
                histtype='stepfilled', color='steelblue',
                edgecolor='none');
```

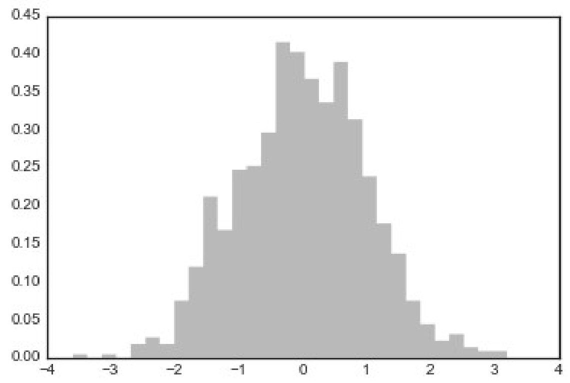

Figure 4-36. A customized histogram

The `plt.hist` docstring has more information on other customization options available. I find this combination of `histtype='stepfilled'` along with some transparency `alpha` to be very useful when comparing histograms of several distributions (Figure 4-37):

```
In[4]: x1 = np.random.normal(0, 0.8, 1000)
       x2 = np.random.normal(-2, 1, 1000)
       x3 = np.random.normal(3, 2, 1000)

       kwargs = dict(histtype='stepfilled', alpha=0.3, normed=True, bins=40)

       plt.hist(x1, **kwargs)
       plt.hist(x2, **kwargs)
       plt.hist(x3, **kwargs);
```

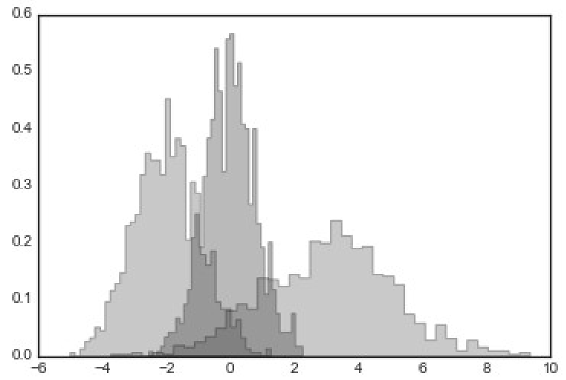

Figure 4-37. Over-plotting multiple histograms

If you would like to simply compute the histogram (that is, count the number of points in a given bin) and not display it, the `np.histogram()` function is available: