



INTRODUCTION TO DATA VISUALIZATION WITH PYTHON

Introduction to Data Visualization with Python

Reminder: Line plots

```
In [1]: import numpy as np

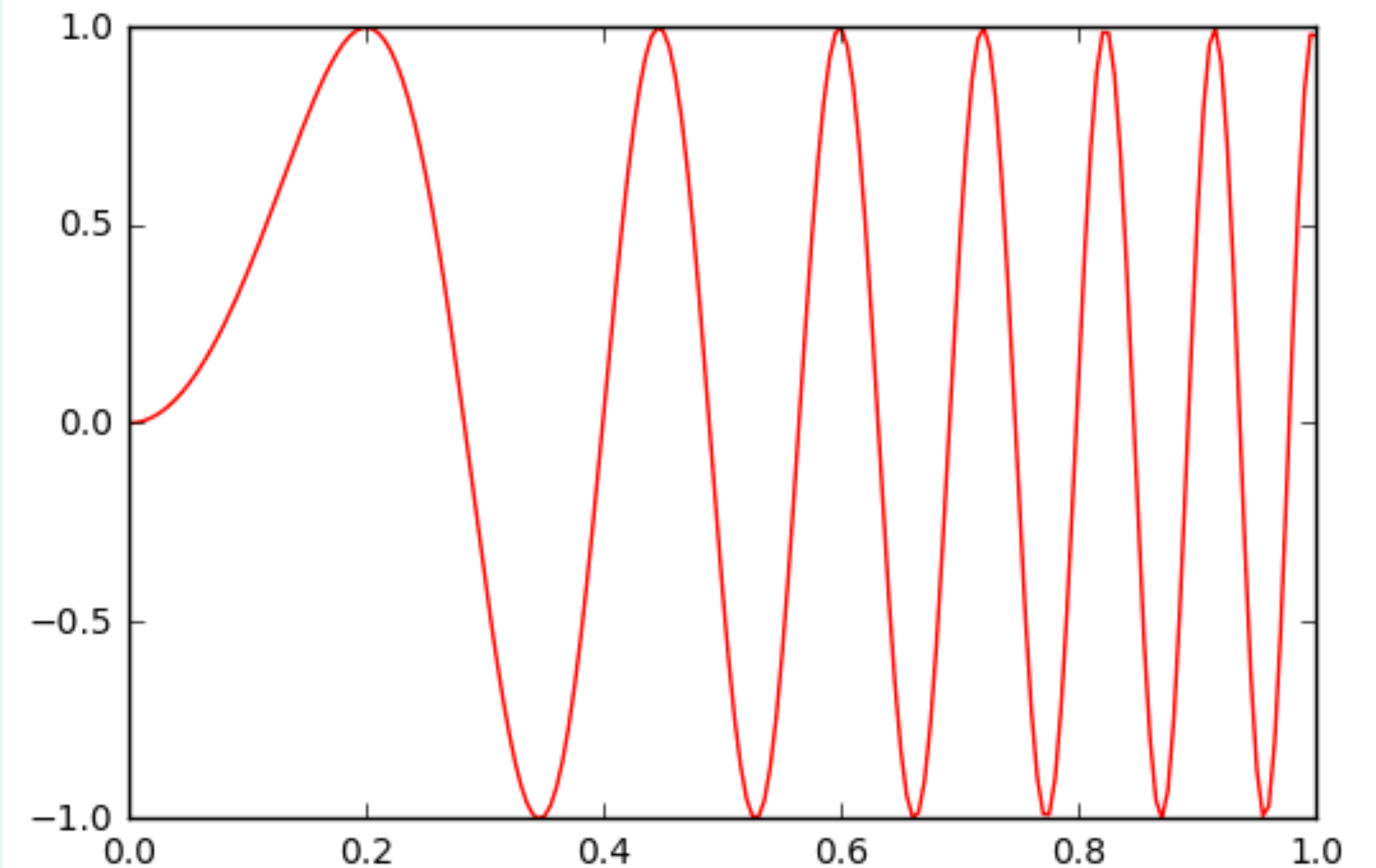
In [2]: import matplotlib.pyplot as plt

In [3]: x = np.linspace(0, 1, 201)

In [4]: y = np.sin((2*np.pi*x)**2)

In [5]: plt.plot(x, y, 'red')

In [6]: plt.show()
```



Reminder: Scatter plots

```
In [1]: import numpy as np

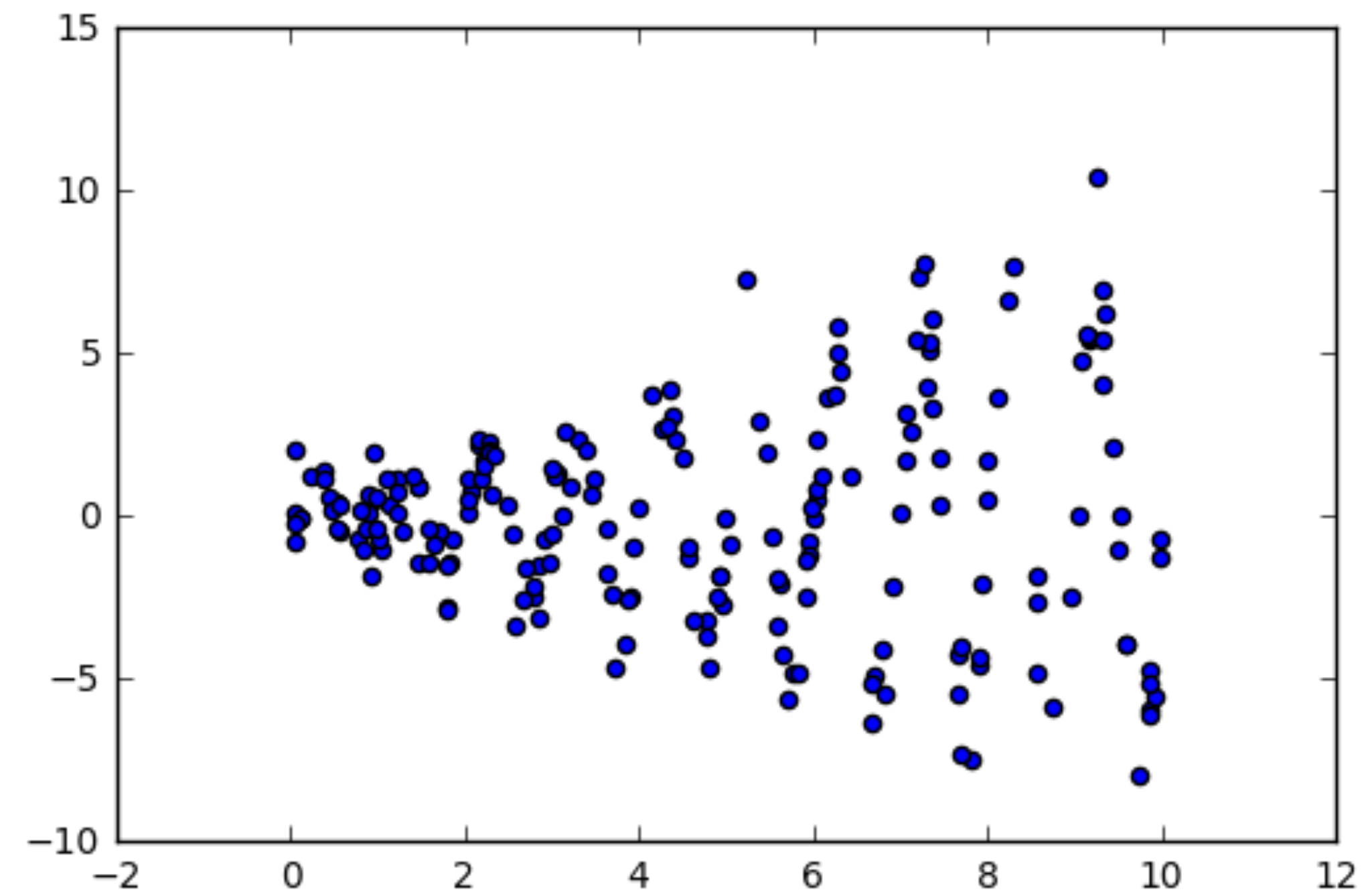
In [2]: import matplotlib.pyplot as plt

In [3]: x = 10*np.random.rand(200,1)

In [4]: y = (0.2 + 0.8*x) * np.sin(2*np.pi*x) + \
...:      np.random.randn(200,1)

In [5]: plt.scatter(x,y)

In [6]: plt.show()
```



Reminder: Histograms

```
In [1]: import numpy as np

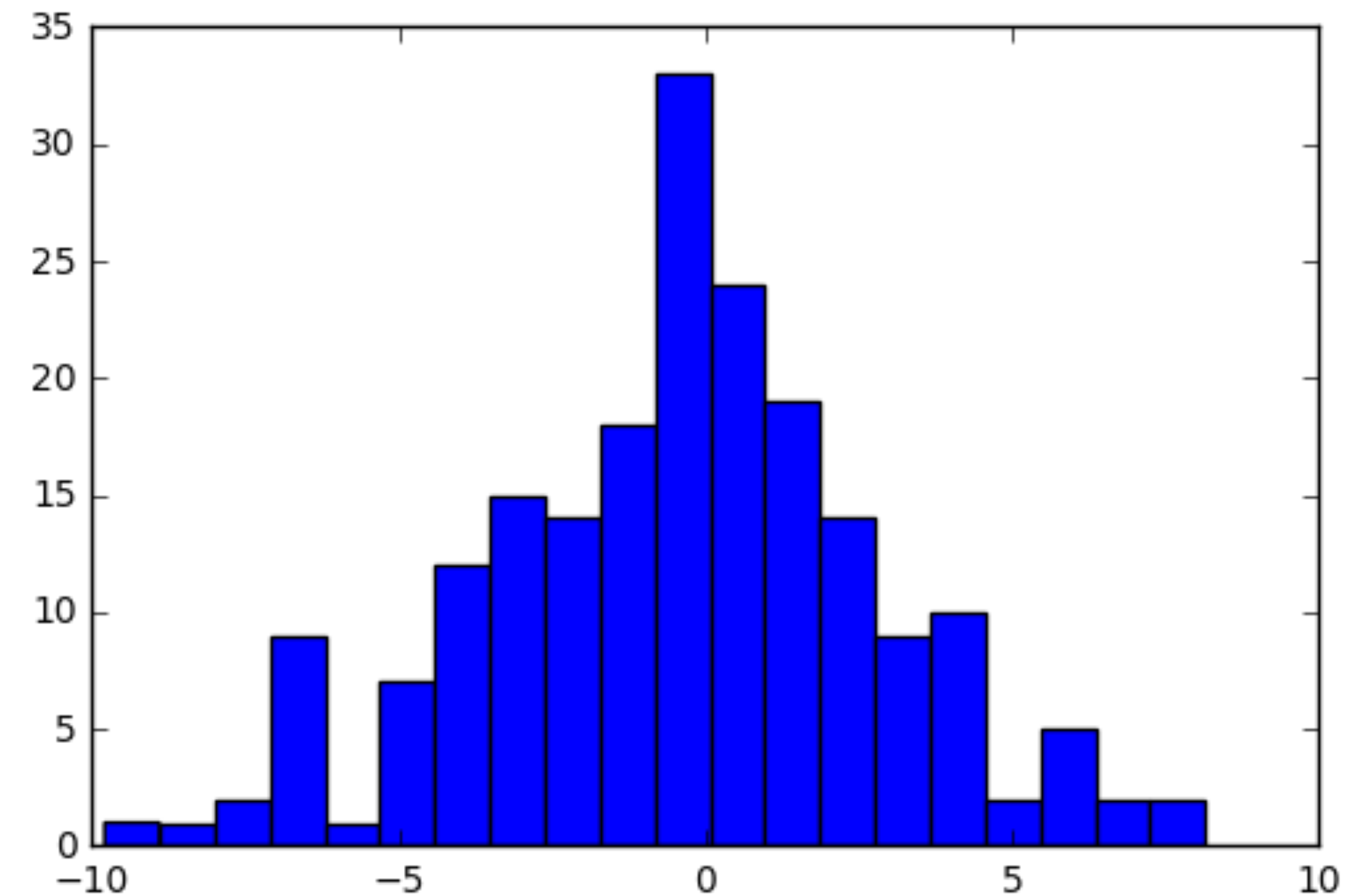
In [2]: import matplotlib.pyplot as plt

In [3]: x = 10*np.random.rand(200,1)

In [4]: y = (0.2 + 0.8*x) * \
...:      np.sin(2*np.pi*x) + \
...:      np.random.randn(200,1)

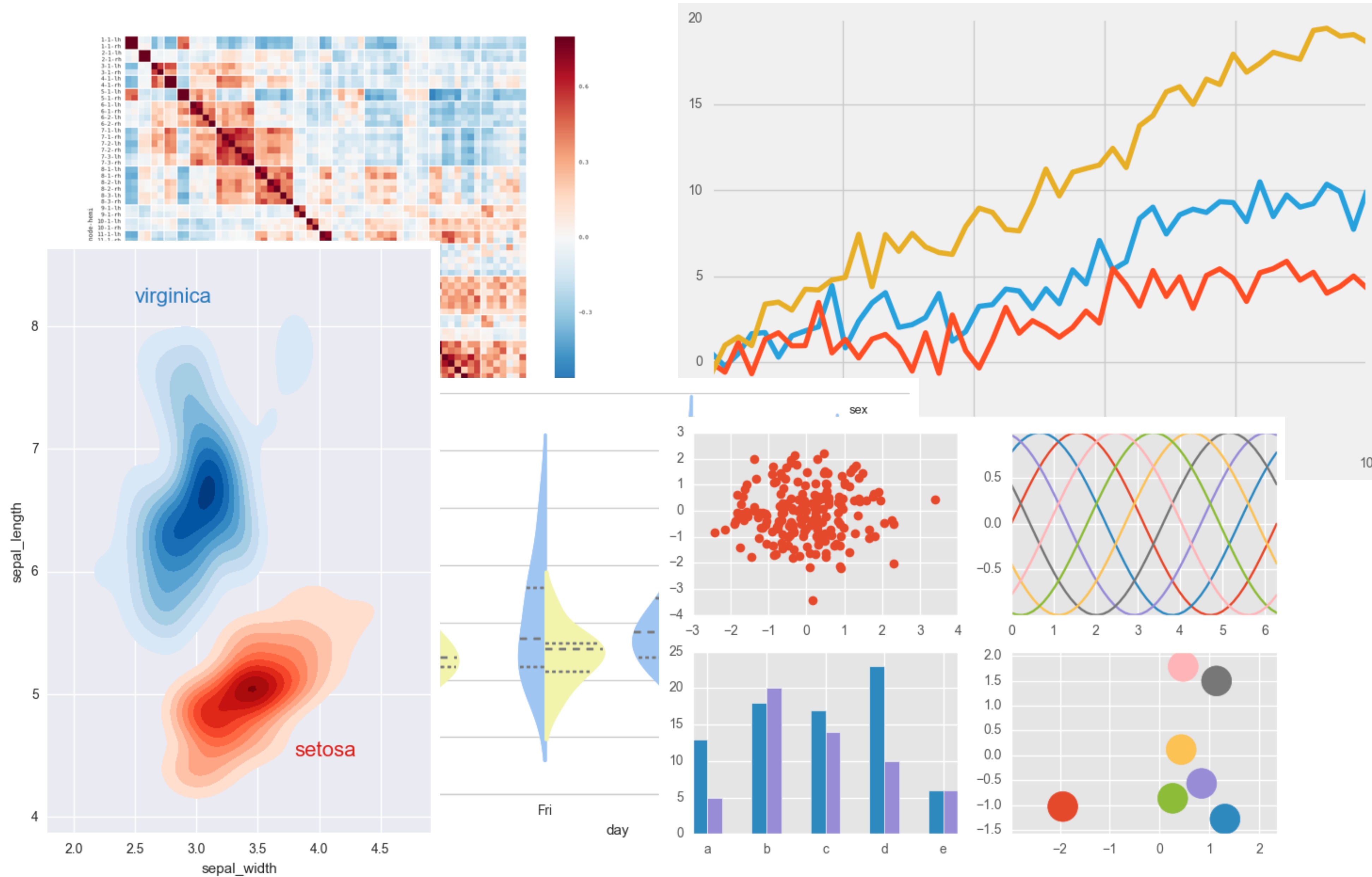
In [5]: plt.hist(y, bins=20)

In [6]: plt.show()
```



What you will learn

- Customizing of plots: axes, annotations, legends
- Overlaying multiple plots and subplots
- Visualizing 2D arrays, 2D data sets
- Working with color maps
- Producing statistical graphics
- Plotting time series
- Working with images





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**See you in
the course!**



INTRODUCTION TO DATA VISUALIZATION WITH PYTHON

Plotting multiple graphs



Strategies

- Plotting many graphs on common axes
- Creating axes within a figure
- Creating subplots within a figure

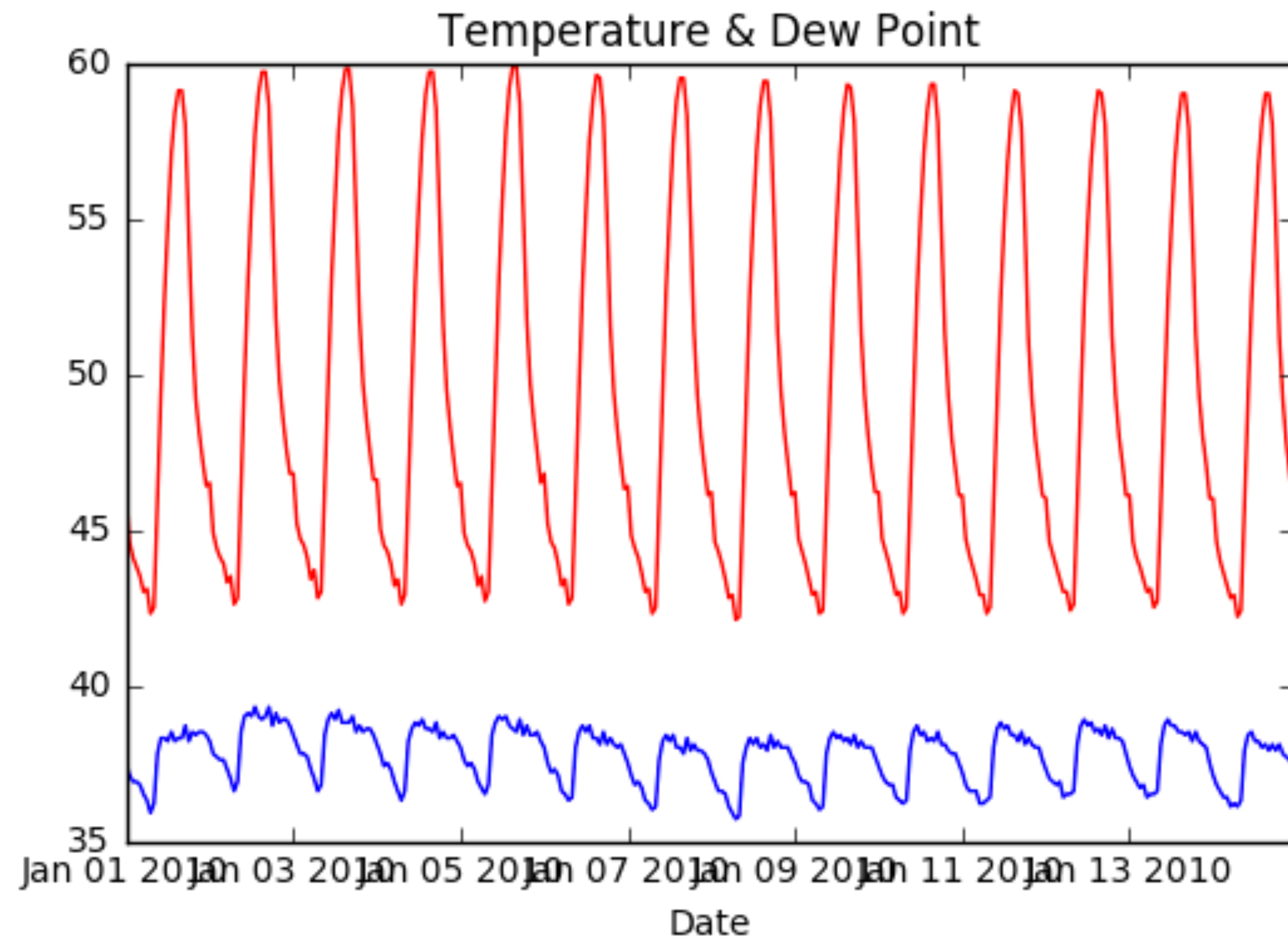


Graphs on common axes

```
In [1]: import matplotlib.pyplot as plt  
  
In [2]: plt.plot(t, temperature, 'red')  
  
In [3]: plt.plot(t, dewpoint, 'blue') # Appears on same axes  
  
In [4]: plt.xlabel('Date')  
  
In [5]: plt.title('Temperature & Dew Point')  
  
In [6]: plt.show() # Renders plot objects to screen
```



Graphs on common axes





Using axes()

```
In [1]: plt.axes([0.05,0.05,0.425,0.9])
```

```
In [2]: plt.plot(t, temperature, 'red')
```

```
In [3]: plt.xlabel('Date')
```

```
In [4]: plt.title('Temperature')
```

```
In [5]: plt.axes([0.525,0.05,0.425,0.9])
```

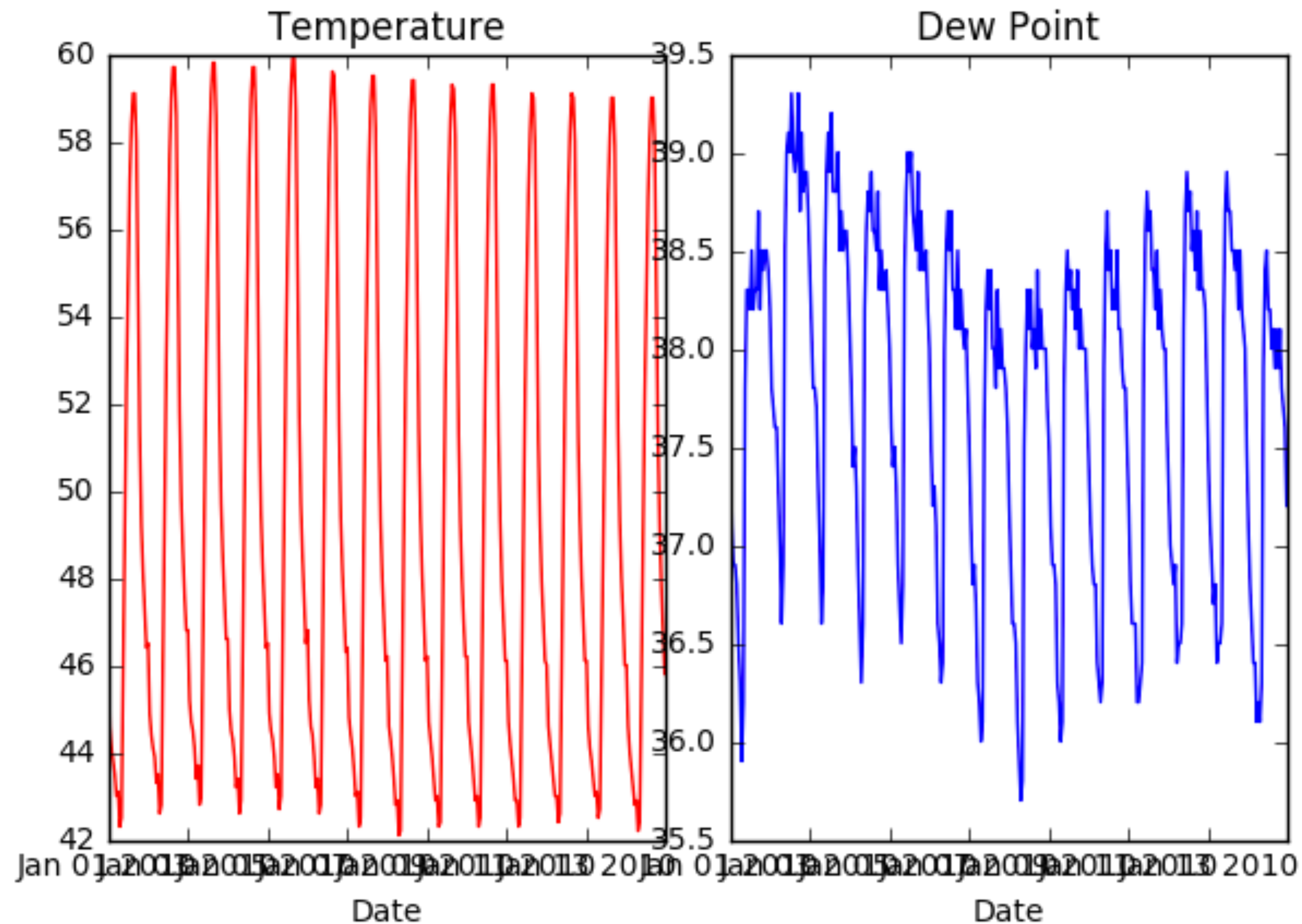
```
In [6]: plt.plot(t, dewpoint, 'blue')
```

```
In [7]: plt.xlabel('Date')
```

```
In [8]: plt.title('Dew Point')
```

```
In [9]: plt.show()
```

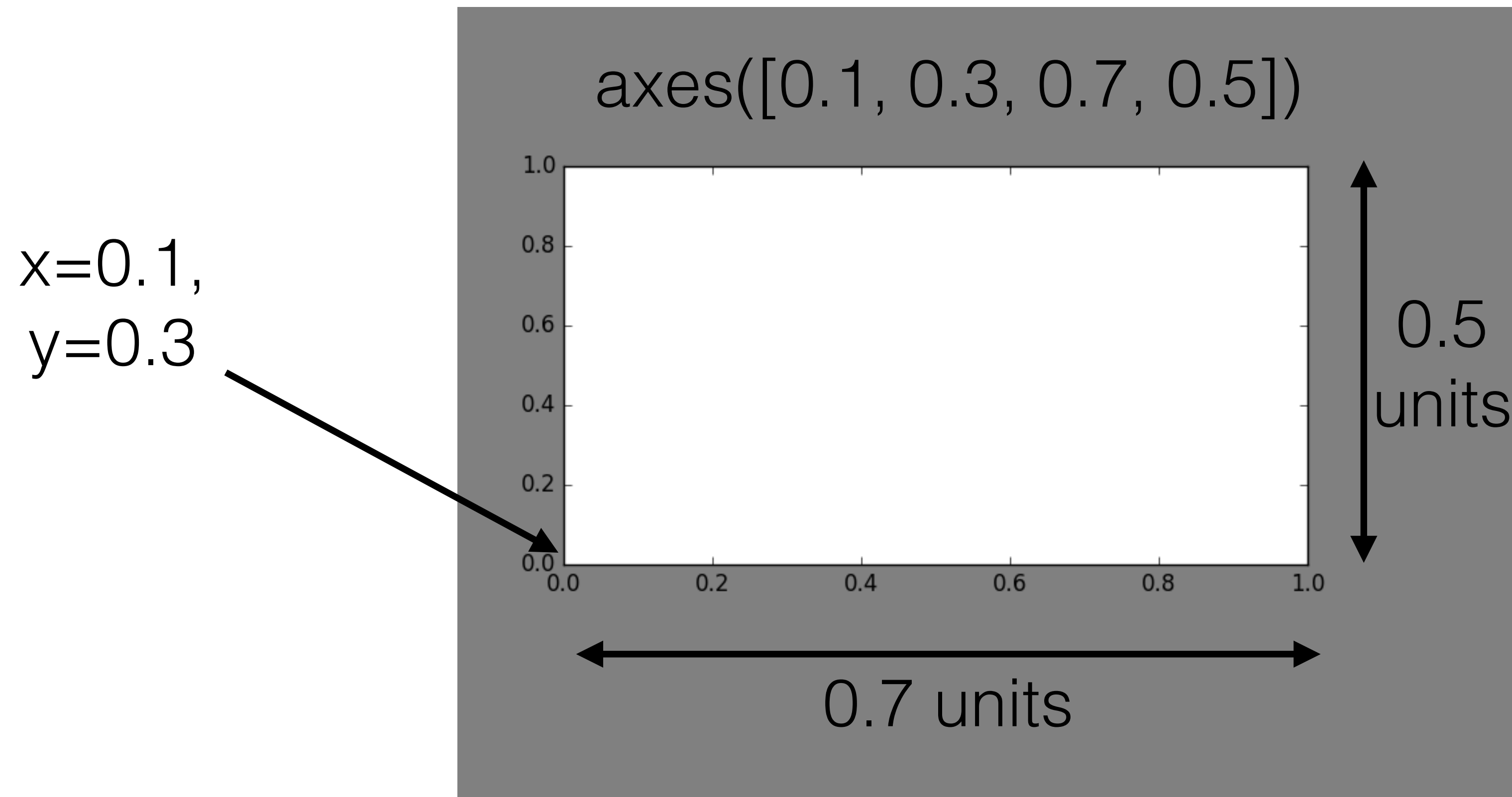
Using axes()





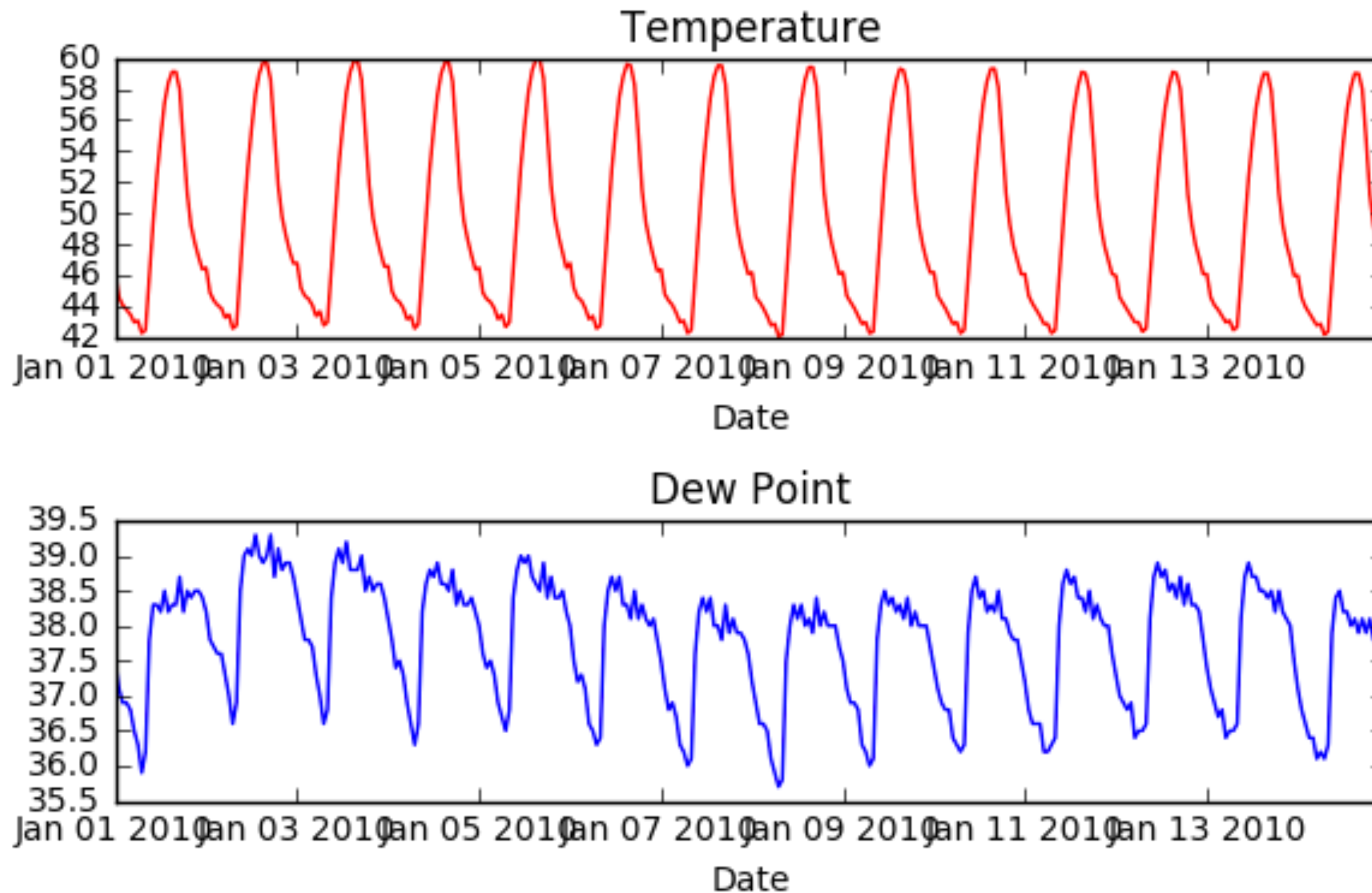
The `axes()` command

- Syntax: `axes([x_lo, y_lo, width, height])`
- Units between 0 and 1 (figure dimensions)





Using subplot()





Using subplot()

```
In [1]: plt.subplot(2, 1, 1)

In [2]: plt.plot(t, temperature, 'red')

In [3]: plt.xlabel('Date')

In [4]: plt.title('Temperature')

In [5]: plt.subplot(2, 1, 2)

In [6]: plt.plot(t, dewpoint, 'blue')

In [7]: plt.xlabel('Date')

In [8]: plt.title('Dew Point')

In [9]: plt.tight_layout()

In [10]: plt.show()
```



The subplot() command

- Syntax: subplot(nrows, ncols, subplot)
- Subplot ordering:
 - Row-wise from top left
 - Indexed from 1



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Let's practice!



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Customizing axes



Controlling axis extents

- `axis([xmin, xmax, ymin, ymax])` sets axis extents
- Control over individual axis extents
 - `xlim([xmin, xmax])`
 - `ylim([ymin, ymax])`
- Can use tuples, lists for extents
 - e.g., `xlim((-2, 3))` works
 - e.g., `xlim([-2, 3])` works also



GDP over time

```
In [1]: import matplotlib.pyplot as plt
```

```
In [2]: plt.plot(yr, gdp)
```

```
In [3]: plt.xlabel('Year')
```

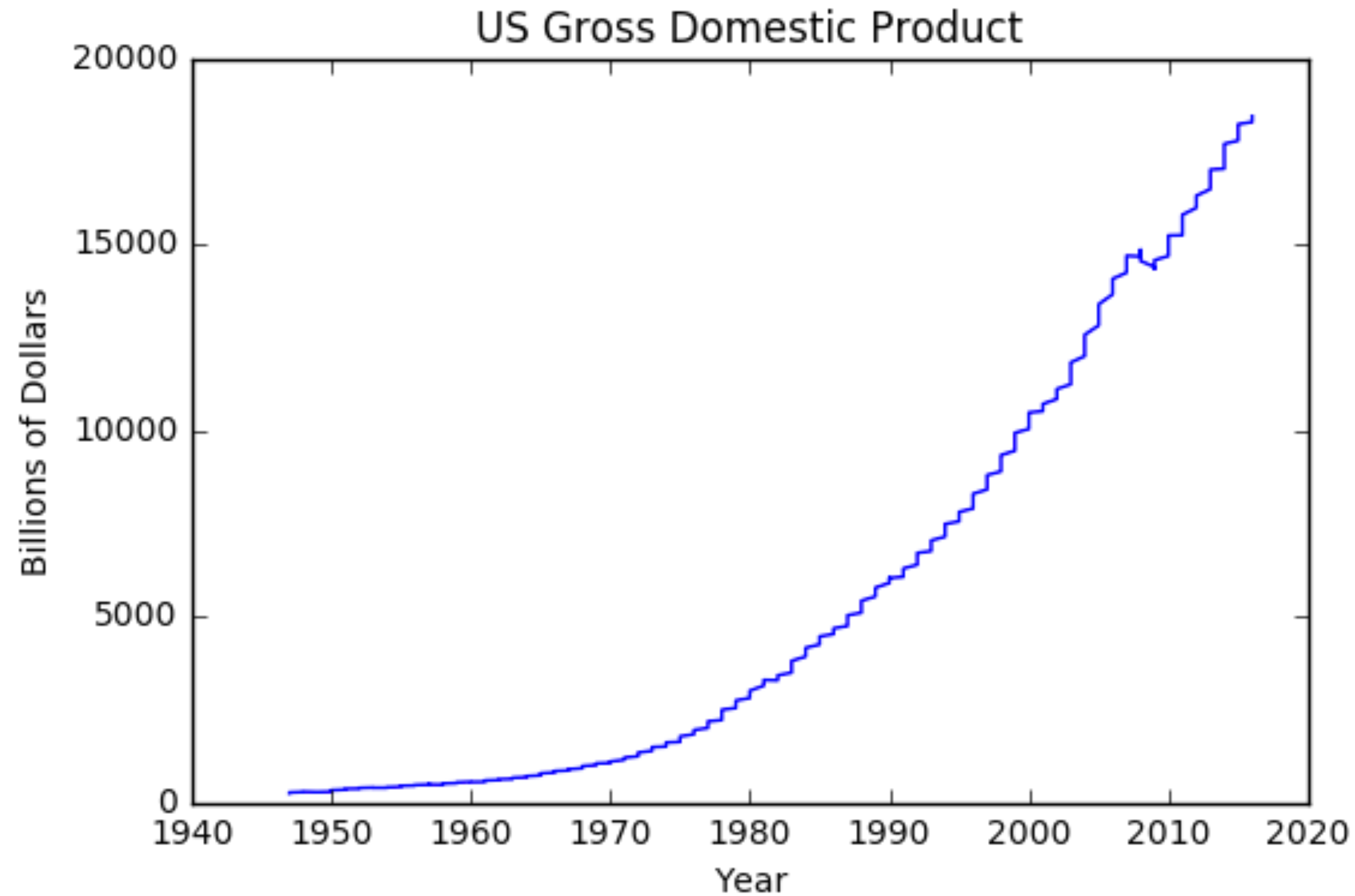
```
In [4]: plt.ylabel('Billions of Dollars')
```

```
In [5]: plt.title('US Gross Domestic Product')
```

```
In [6]: plt.show()
```



GDP over time





Using xlim()

```
In [1]: plt.plot(yr, gdp)
```

```
In [2]: plt.xlabel('Year')
```

```
In [3]: plt.ylabel('Billions of Dollars')
```

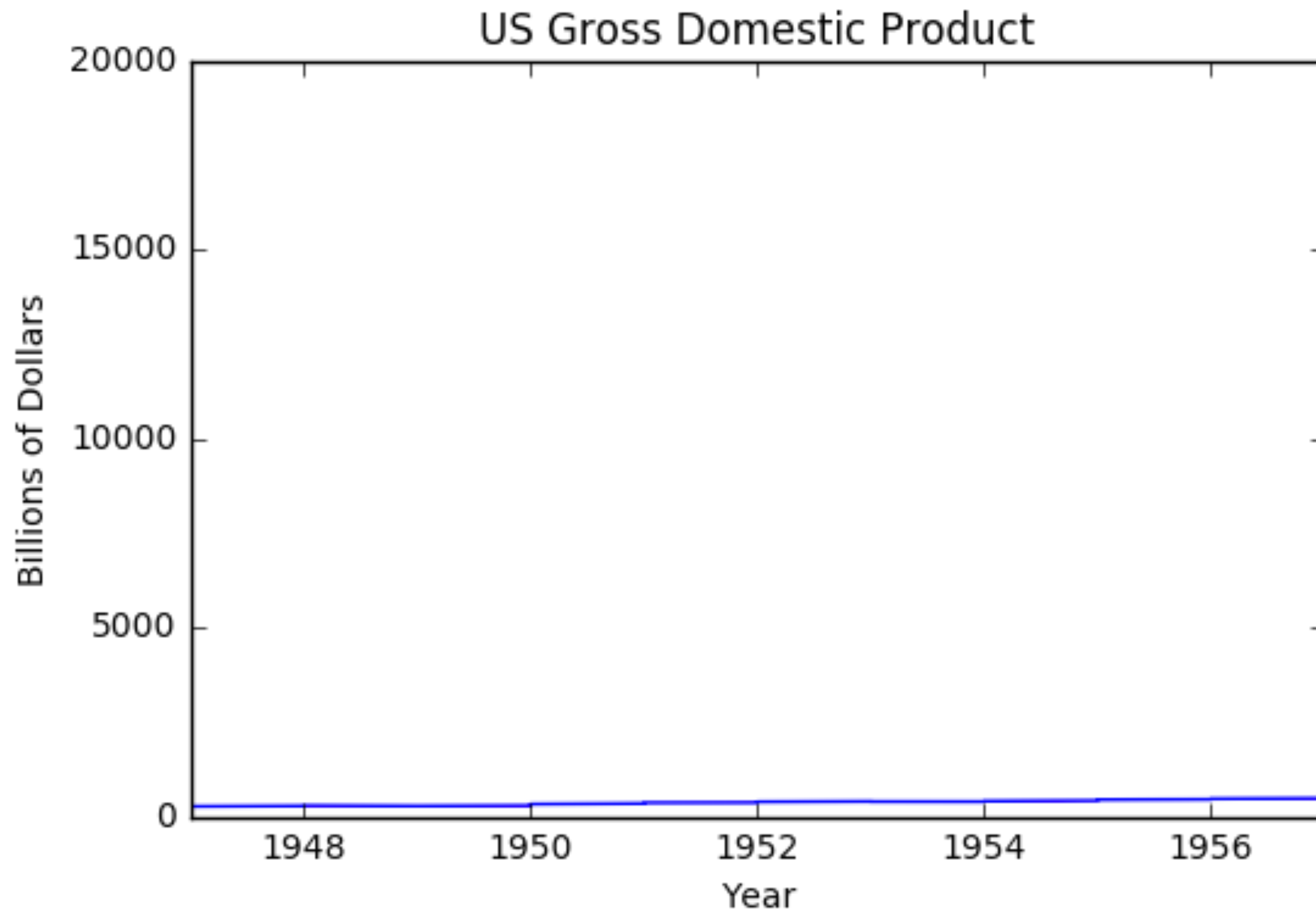
```
In [4]: plt.title('US Gross Domestic Product')
```

```
In [5]: plt.xlim((1947, 1957))
```

```
In [6]: plt.show()
```



Using xlim()





Using xlim() & ylim()

```
In [1]: plt.plot(yr, gdp)
```

```
In [2]: plt.xlabel('Year')
```

```
In [3]: plt.ylabel('Billions of Dollars')
```

```
In [4]: plt.title('US Gross Domestic Product')
```

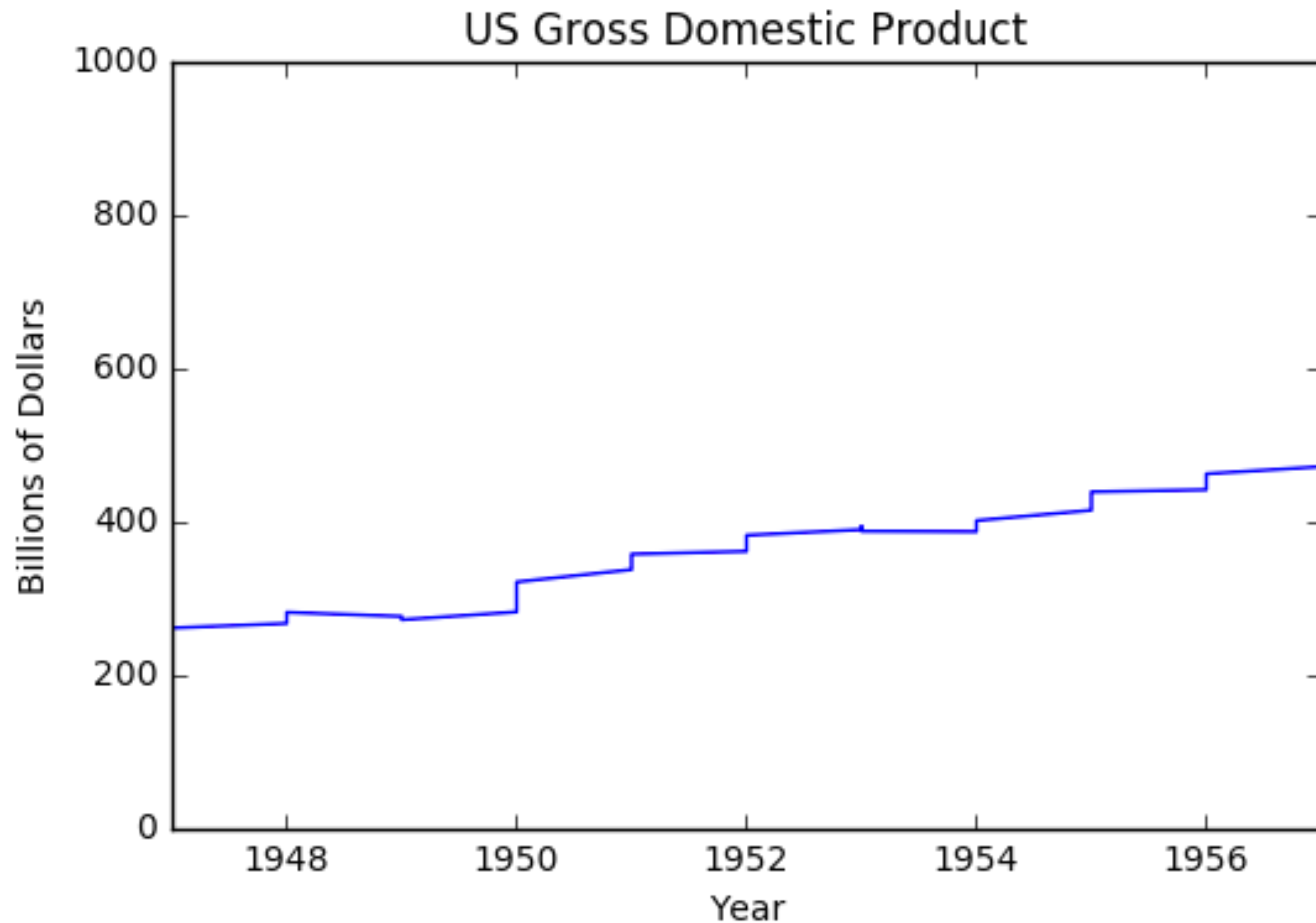
```
In [5]: plt.xlim((1947, 1957))
```

```
In [6]: plt.ylim((0, 1000))
```

```
In [7]: plt.show()
```



Using xlim() & ylim()





Using axis()

```
In [1]: plt.plot(yr, gdp)
```

```
In [2]: plt.xlabel('Year')
```

```
In [3]: plt.ylabel('Billions of Dollars')
```

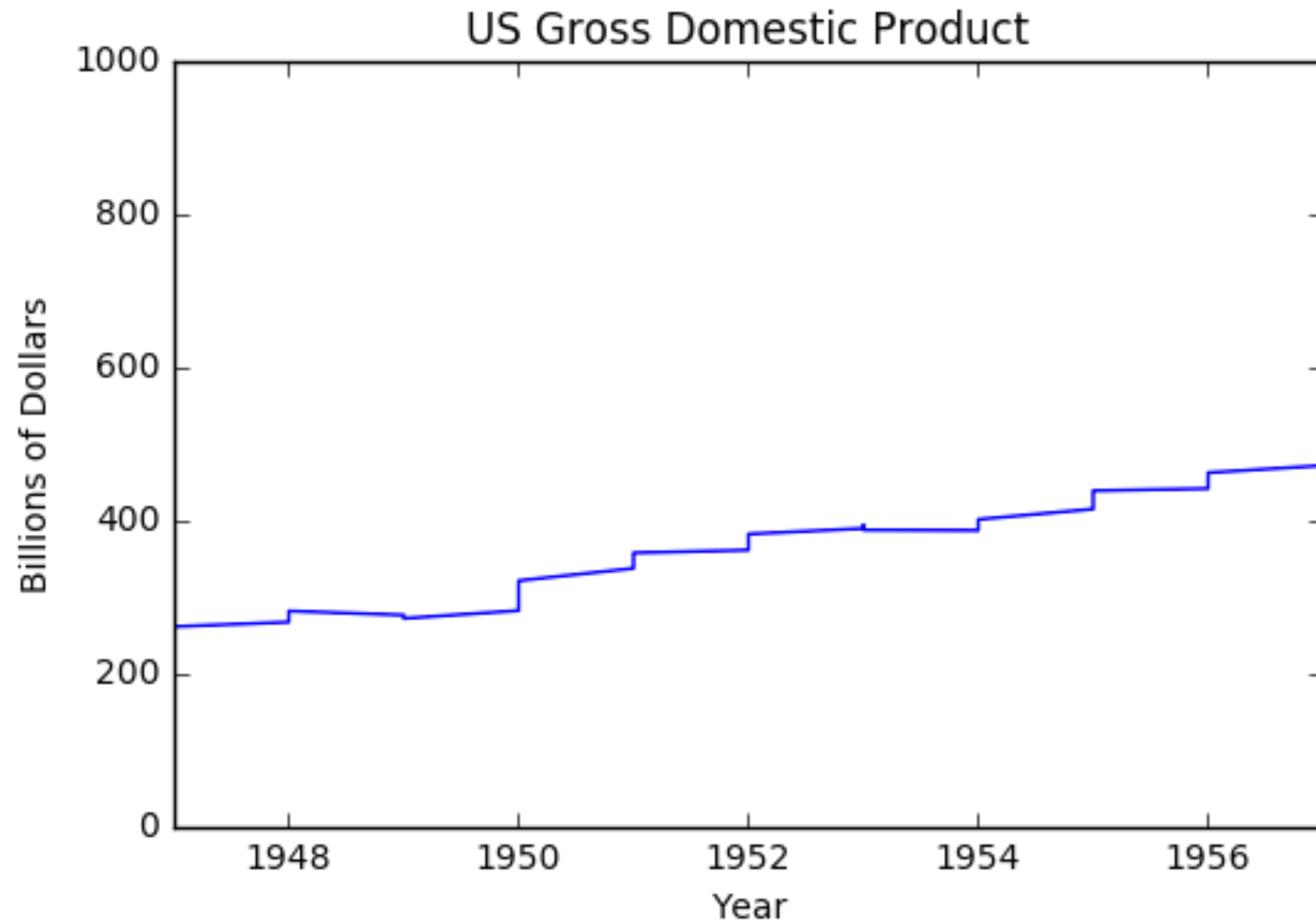
```
In [4]: plt.title('US Gross Domestic Product')
```

```
In [5]: plt.axis((1947, 1957, 0, 600))
```

```
In [6]: plt.show()
```



Using axis()



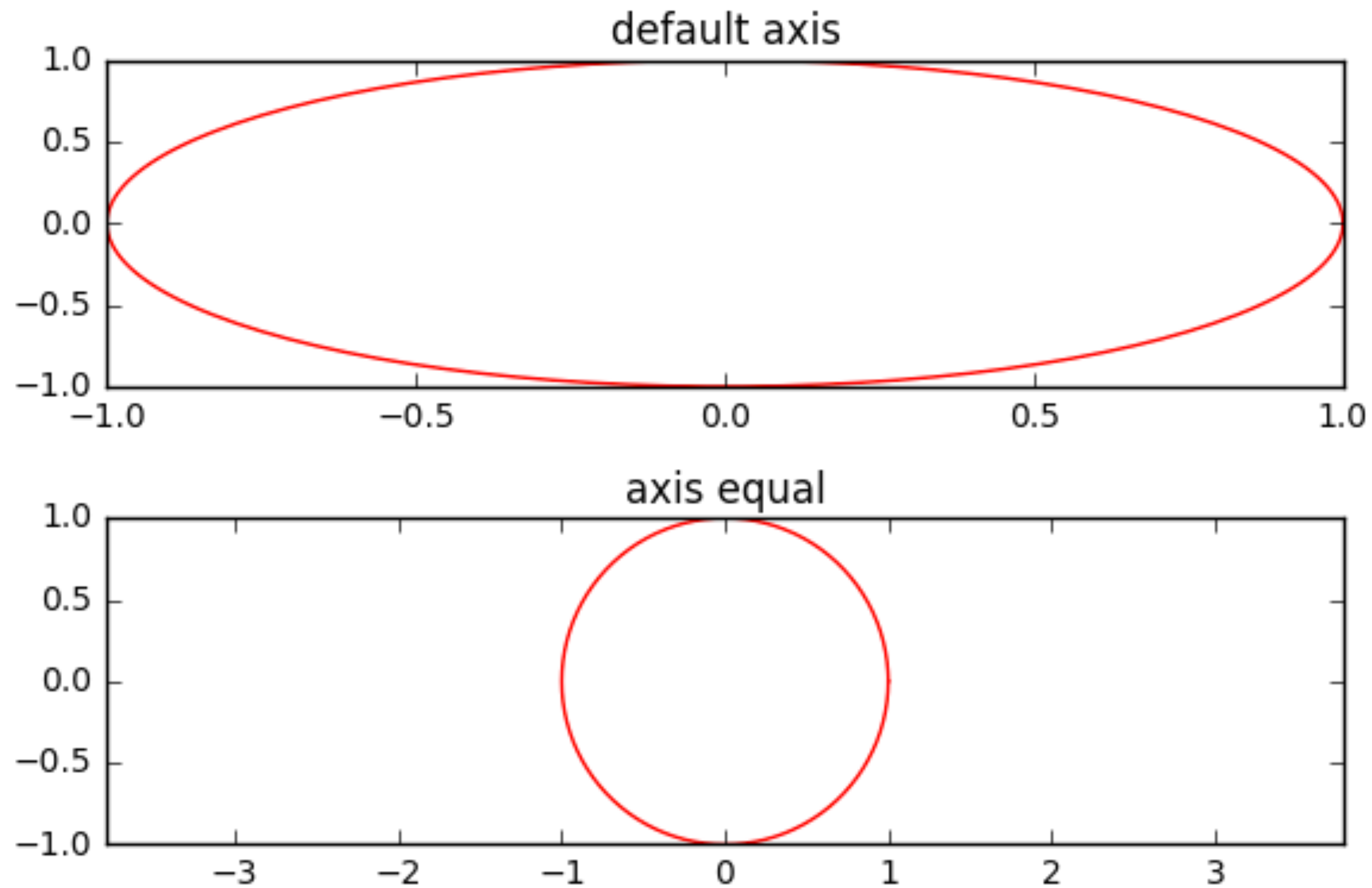


Other axis() options

Invocation	Result
<code>axis('off')</code>	turns off axis lines, labels
<code>axis('equal')</code>	equal scaling on x, y axes
<code>axis('square')</code>	forces square plot
<code>axis('tight')</code>	sets <code>xlim()</code> , <code>ylim()</code> to show all data



Using axis('equal')





Using `axis('equal')`

```
In [1]: plt.subplot(2, 1, 1)
```

```
In [2]: plt.plot(x, y, 'red')
```

```
In [3]: plt.title('default axis')
```

```
In [4]: plt.subplot(2, 1, 2)
```

```
In [5]: plt.plot(x, y, 'red')
```

```
In [6]: plt.axis('equal')
```

```
In [7]: plt.title('axis equal')
```

```
In [8]: plt.tight_layout()
```

```
In [9]: plt.show()
```



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Let's practice!

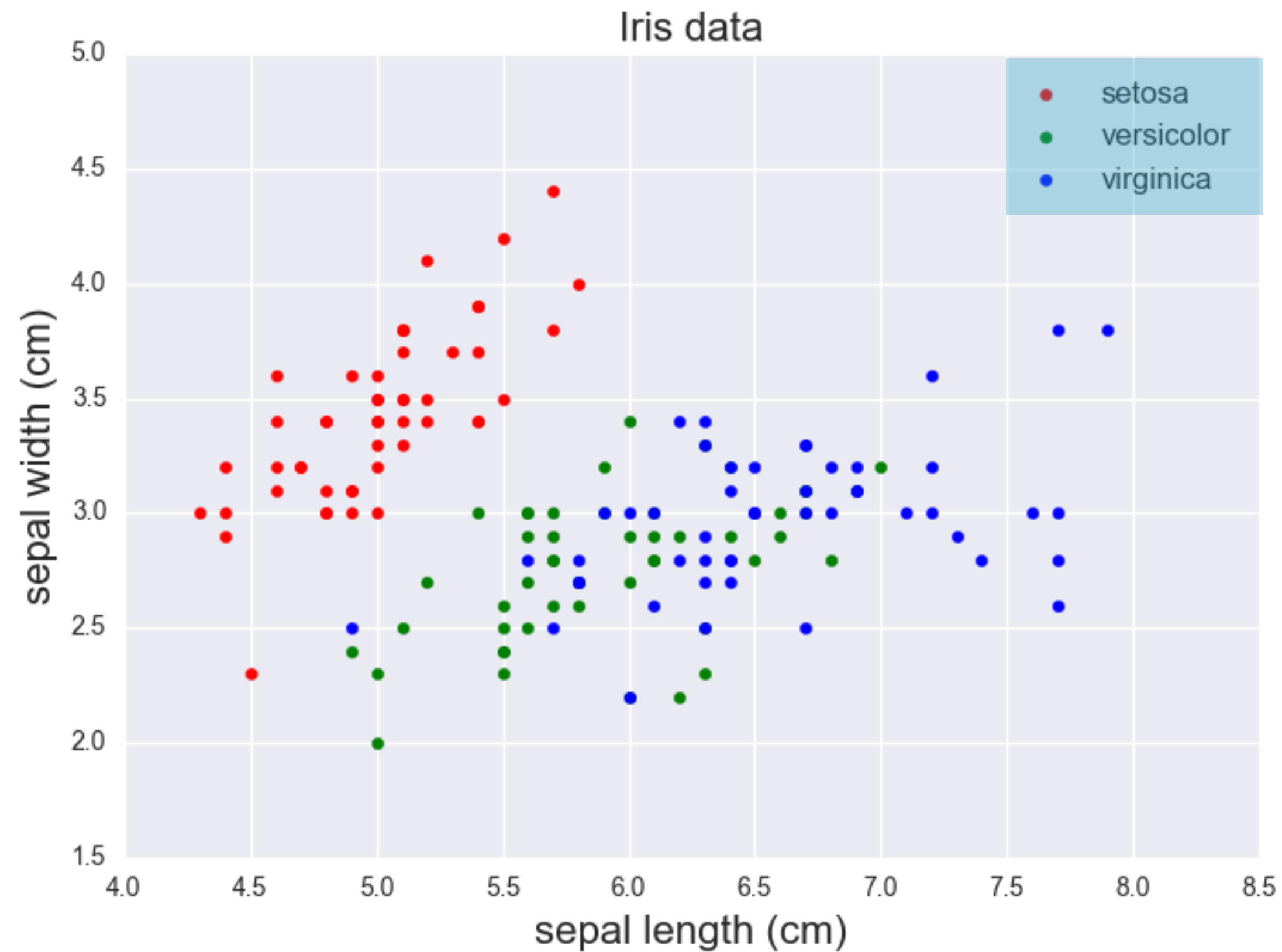


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Legends, annotations, and styles

Legends

- provide labels for overlaid points and curves





Using legend()

```
In [1]: import matplotlib.pyplot as plt
```

```
In [2]: plt.scatter(setosa_len, setosa_wid,  
....:               marker='o', color='red', label='setosa')
```

```
In [3]: plt.scatter(versicolor_len, versicolor_wid,  
....:               marker='o', color='green', label='versicolor')
```

```
In [4]: plt.scatter(virginica_len, virginica_wid,  
....:               marker='o', color='blue', label='virginica')
```



Using legend()

```
In [5]: plt.legend(loc='upper right')
```

```
In [6]: plt.title('Iris data')
```

```
In [7]: plt.xlabel('sepal length (cm)')
```

```
In [8]: plt.ylabel('sepal width (cm)')
```

```
In [9]: plt.show()
```



Legend locations

string	code	string	code	string	code
'upper left'	2	'upper center'	9	'upper right'	1
'center left'	6	'center'	10	'center right'	7
'lower left'	3	'lower center'	8	'lower right'	4
'best'	0			'right'	5

Plot annotations

- Text labels and arrows using `annotate()` method
- Flexible specification of coordinates
- Keyword `arrowprops`: dict of arrow properties
 - `width`
 - `color`
 - `etc.`



Using `annotate()` for text

```
In [1]: plt.annotate('setosa', xy=(5.0, 3.5))
```

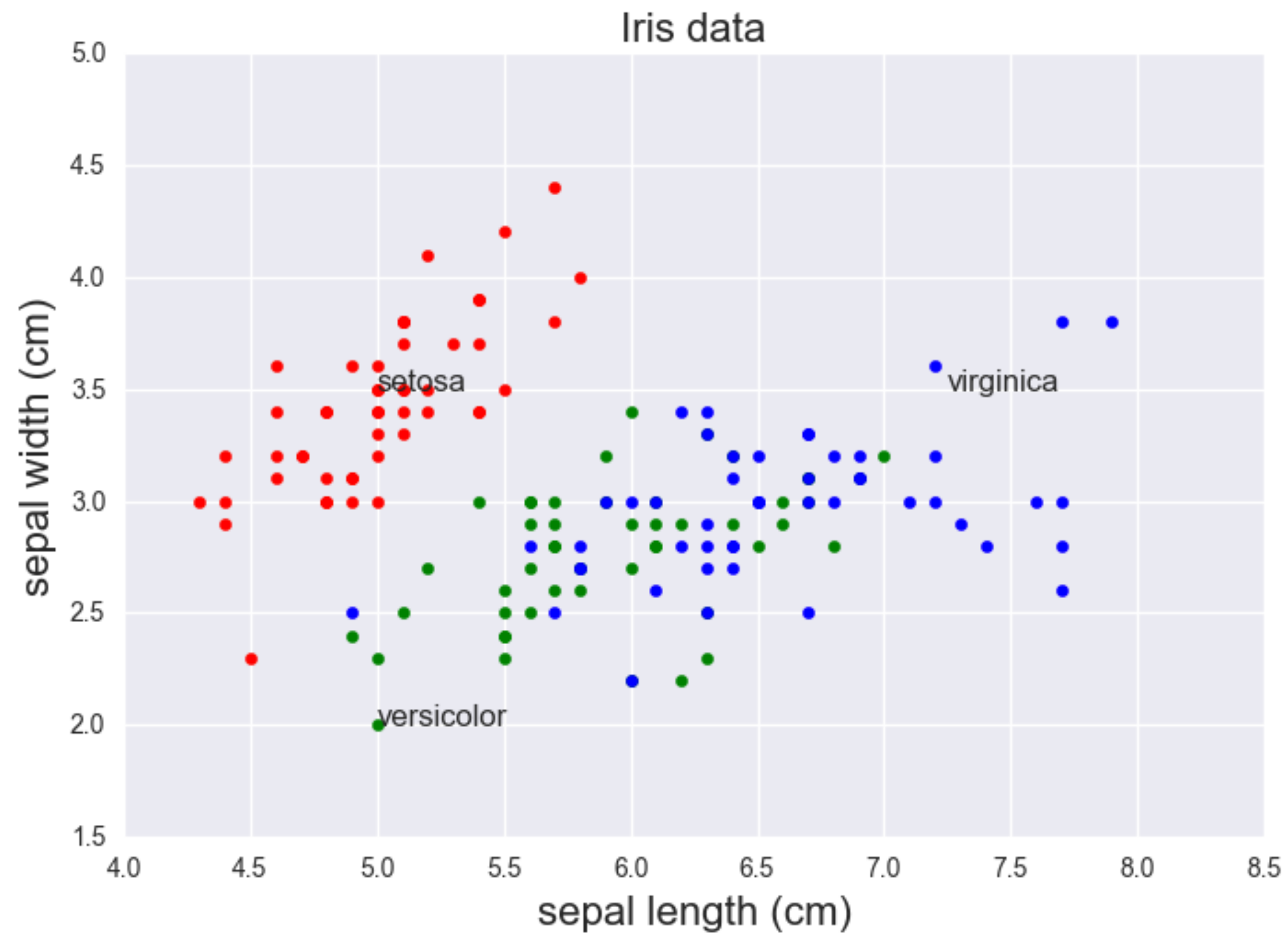
```
In [2]: plt.annotate('virginica', xy=(7.25, 3.5))
```

```
In [3]: plt.annotate('versicolor', xy=(5.0, 2.0))
```

```
In [4]: plt.show()
```



Using `annotate()` for text

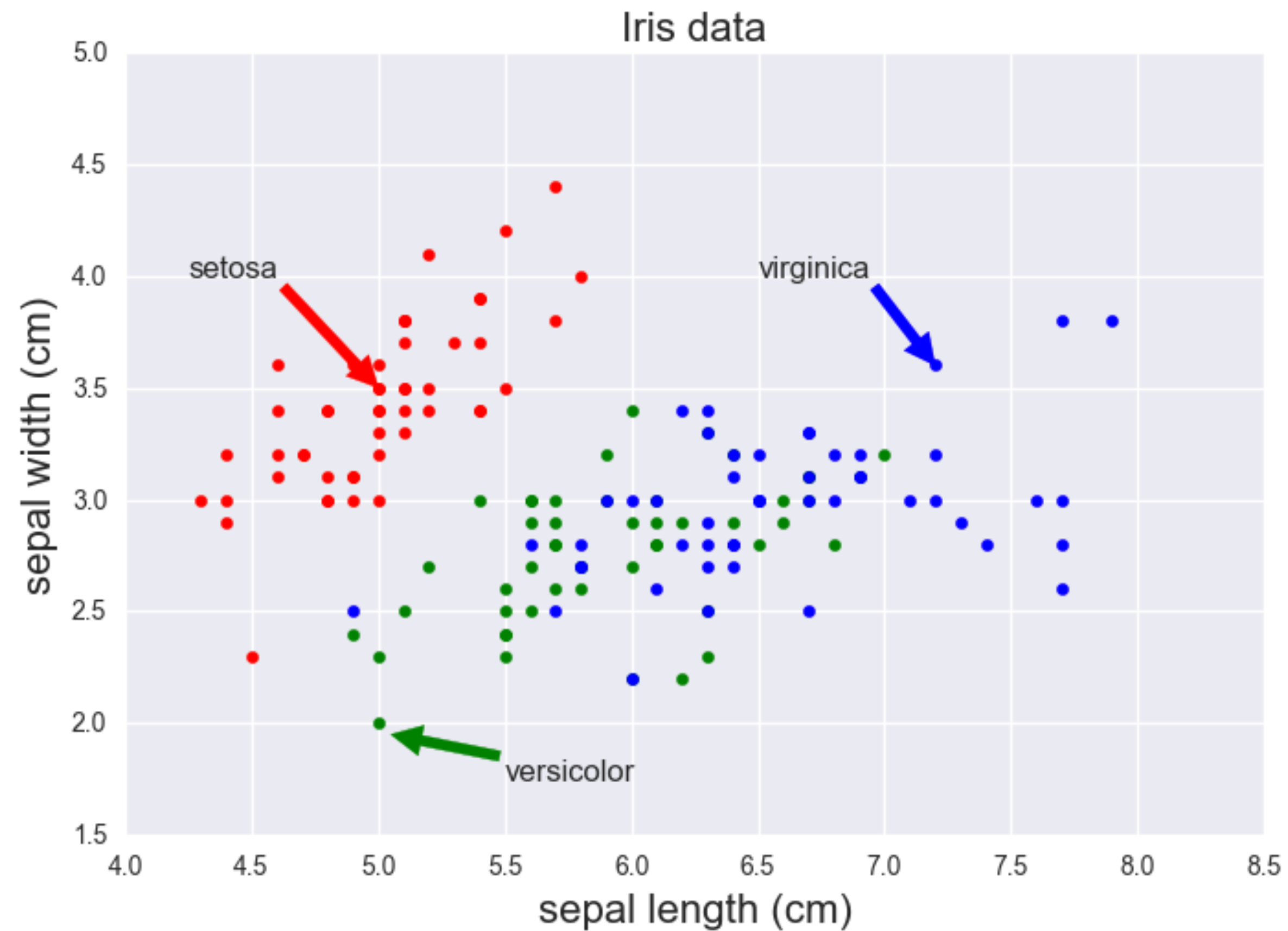




Options for `annotate()`

option	description
<code>s</code>	text of label
<code>xy</code>	coordinates to annotate
<code>xytext</code>	coordinates of label
<code>arrowprops</code>	controls drawing of arrow

Using `annotate()` for arrows





Using `annotate()` for arrows

```
In [1]: plt.annotate('setosa', xy=(5.0, 3.5),  
....:                xytext=(4.25, 4.0), arrowprops={'color': 'red'})  
  
In [2]: plt.annotate('virginica', xy=(7.2, 3.6),  
....:                xytext=(6.5, 4.0), arrowprops={'color': 'blue'})  
  
In [3]: plt.annotate('versicolor', xy=(5.05, 1.95),  
....:                xytext=(5.5, 1.75),  
....:                arrowprops={'color': 'green'})  
  
In [4]: plt.show()
```

Working with plot styles

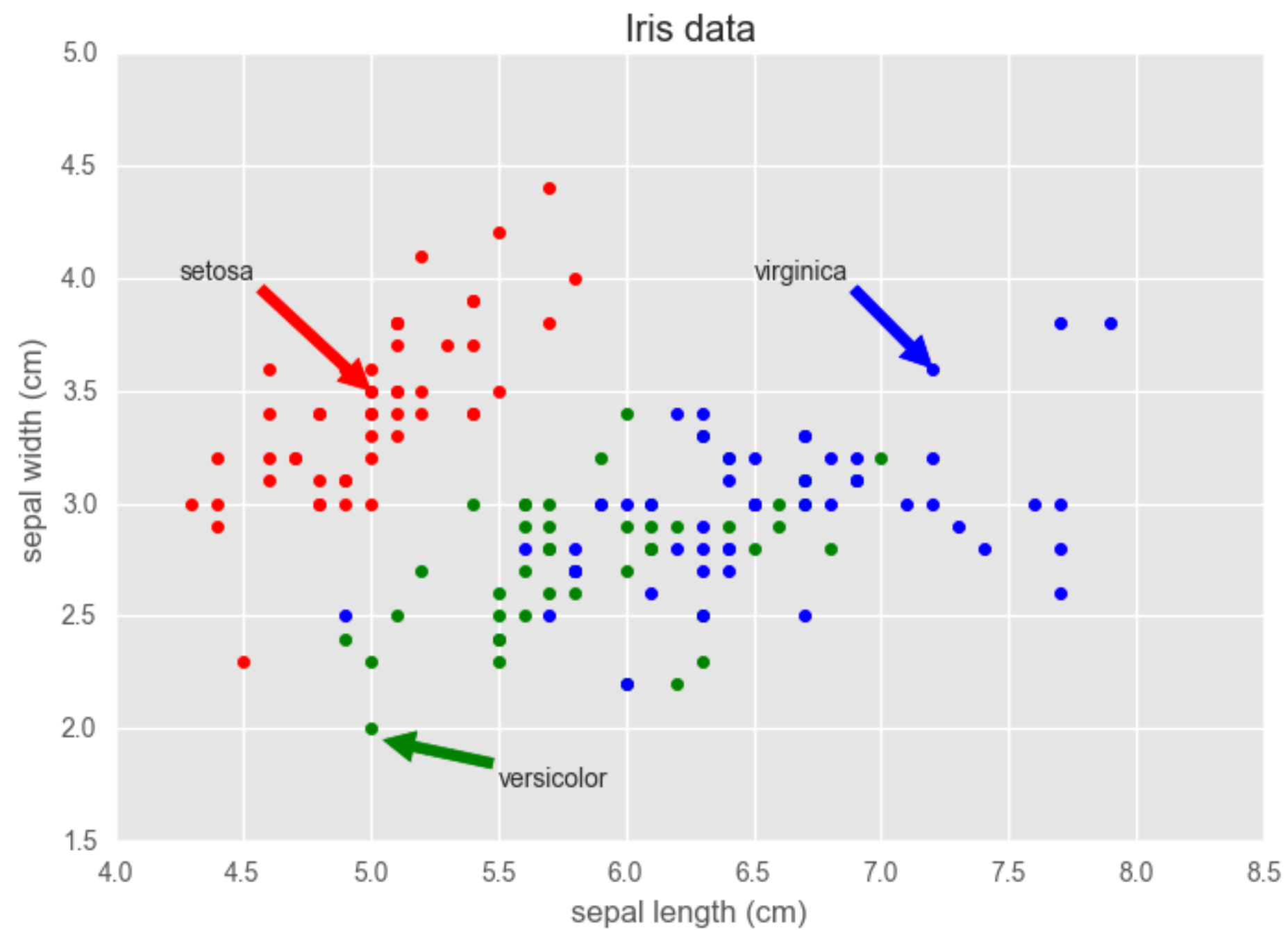
- Style sheets in Matplotlib
- Defaults for lines, points, backgrounds, etc.
- Switch styles globally with `plt.style.use()`
- `plt.style.available`: list of styles



ggplot style

```
In [1]: import matplotlib.pyplot as plt
```

```
In [2]: plt.style.use('ggplot')
```

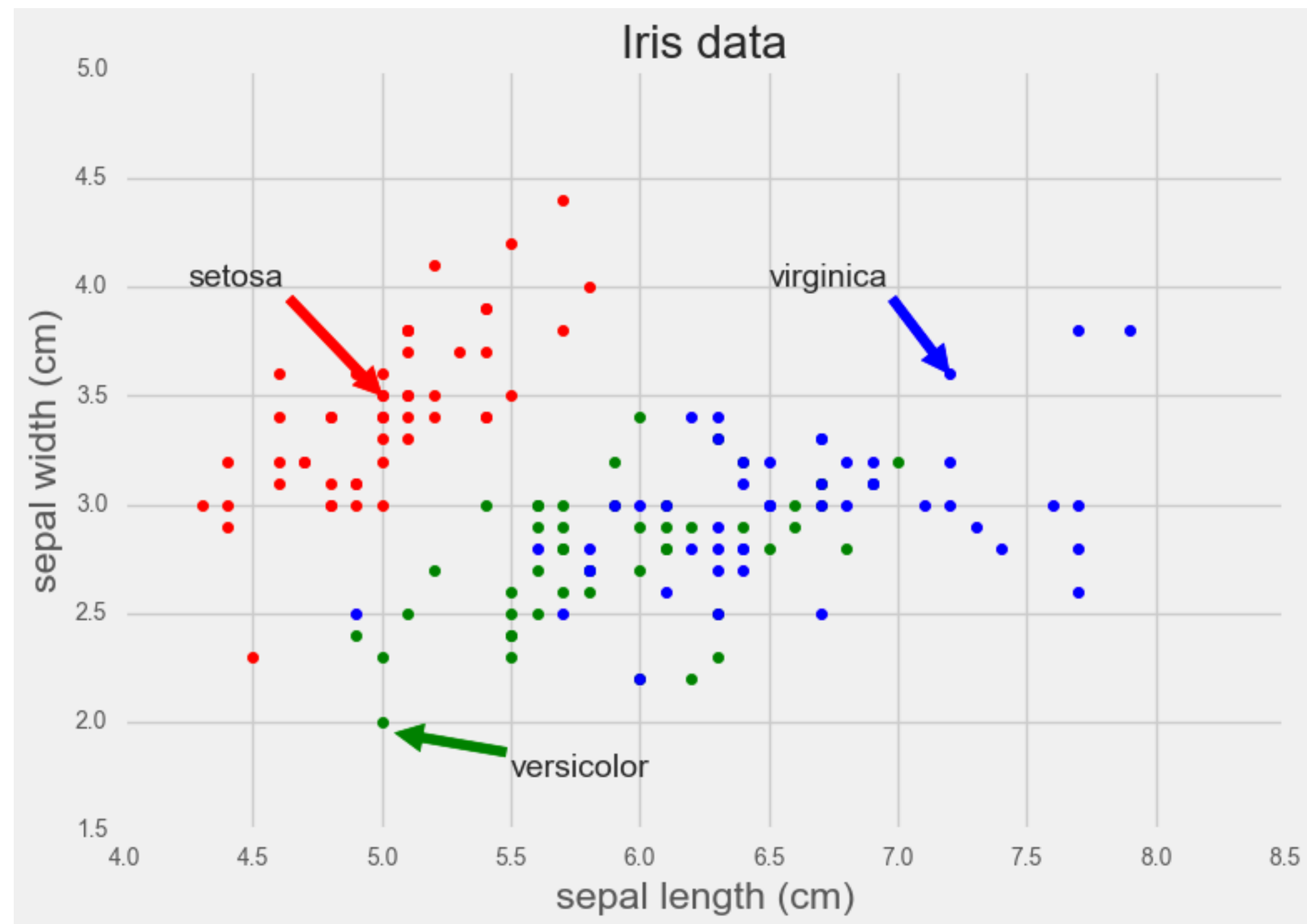




fivethirtyeight style

```
In [1]: import matplotlib.pyplot as plt
```

```
In [2]: plt.style.use('fivethirtyeight')
```





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Let's practice!