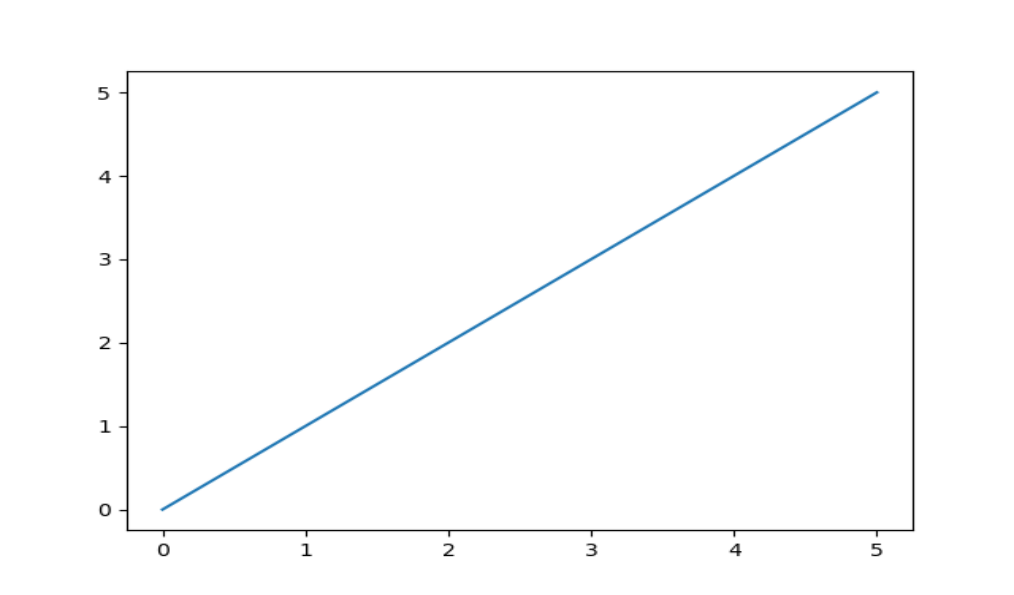
Matplotlib Library

What is Matplotlib?

- Matplotlib is a low level graph plotting library in python that serves as a visualization utility.
- Matplotlib was created by John D. Hunter.
- Matplotlib is open source and we can use it freely.
- Matplotlib is mostly written in python, a few segments are written in C, Objective-C and Javascript for Platform compatibility.



Installation of Matplotlib

- If you have Python and PIP already installed on a system, then installation of Matplotlib is very easy.
- Install it using this command:

```
C:\Users\Your Name>pip install matplotlib
```

Import Matplotlib

- Once Matplotlib is installed, import it in your applications by adding the `import` *module* statement:

```
import matplotlib
```

Now Matplotlib is imported and ready to use:

Checking Matplotlib Version

The version string is stored under `__version__` attribute.

```
import matplotlib

print(matplotlib.__version__)
```

Matplotlib Pyplot

- Most of the Matplotlib utilities lies under the `pyplot` submodule, and are usually imported under the `plt` alias:

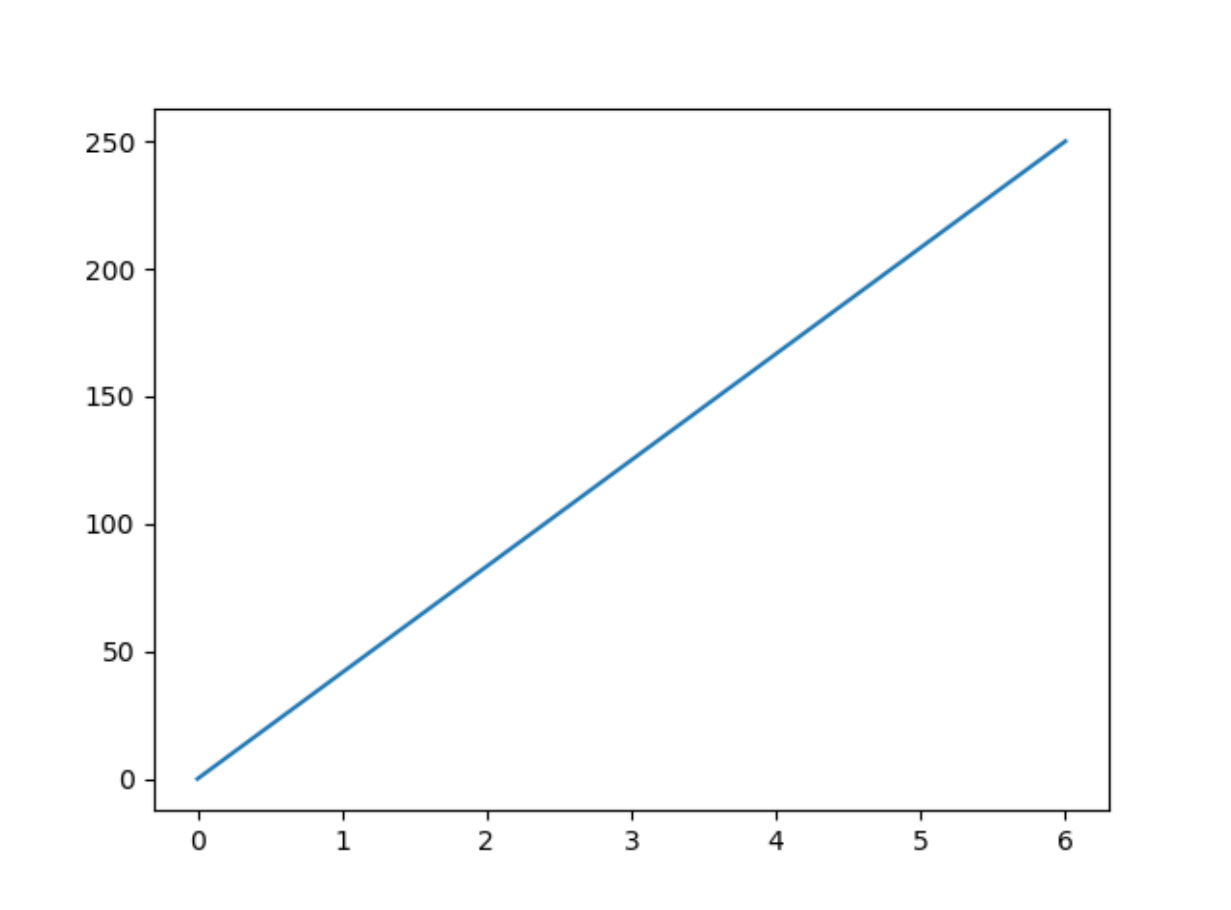
```
import matplotlib.pyplot as plt
```

Now the Pyplot package can be referred to as `plt`

Example

Draw a line in a diagram from position (0,0) to position (6,250):

```
import matplotlib.pyplot as plt
import numpy as np

xpoints = np.array([0, 6])
ypoints = np.array([0, 250])

plt.plot(xpoints, ypoints)
plt.show()
```



Plotting x and y points

- The `plot()` function is used to draw points (markers) in a diagram.
- By default, the `plot()` function draws a line from point to point.
- The function takes parameters for specifying points in the diagram.
- Parameter 1 is an array containing the points on the **x-axis**.
- Parameter 2 is an array containing the points on the **y-axis**.
- If we need to plot a line from (1, 3) to (8, 10), we have to pass two arrays [1, 8] and [3, 10] to the plot function.

- The **x-axis** is the horizontal axis.
- The **y-axis** is the vertical axis.

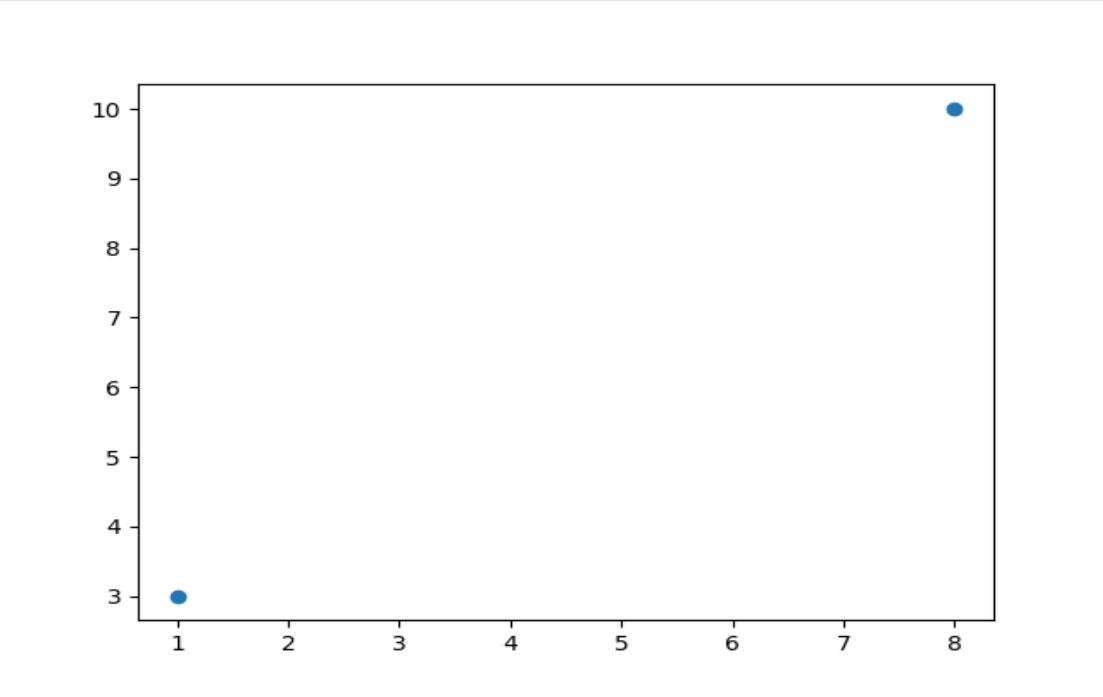
Plotting Without Line

- To plot only the markers, you can use *shortcut string notation* parameter 'o', which means 'rings'.

Example

Draw two points in the diagram, one at position (1, 3) and one in position (8, 10):

```
import matplotlib.pyplot as plt
import numpy as np

xpoints = np.array([1, 8])
ypoints = np.array([3, 10])

plt.plot(xpoints, ypoints, 'o')
plt.show()
```



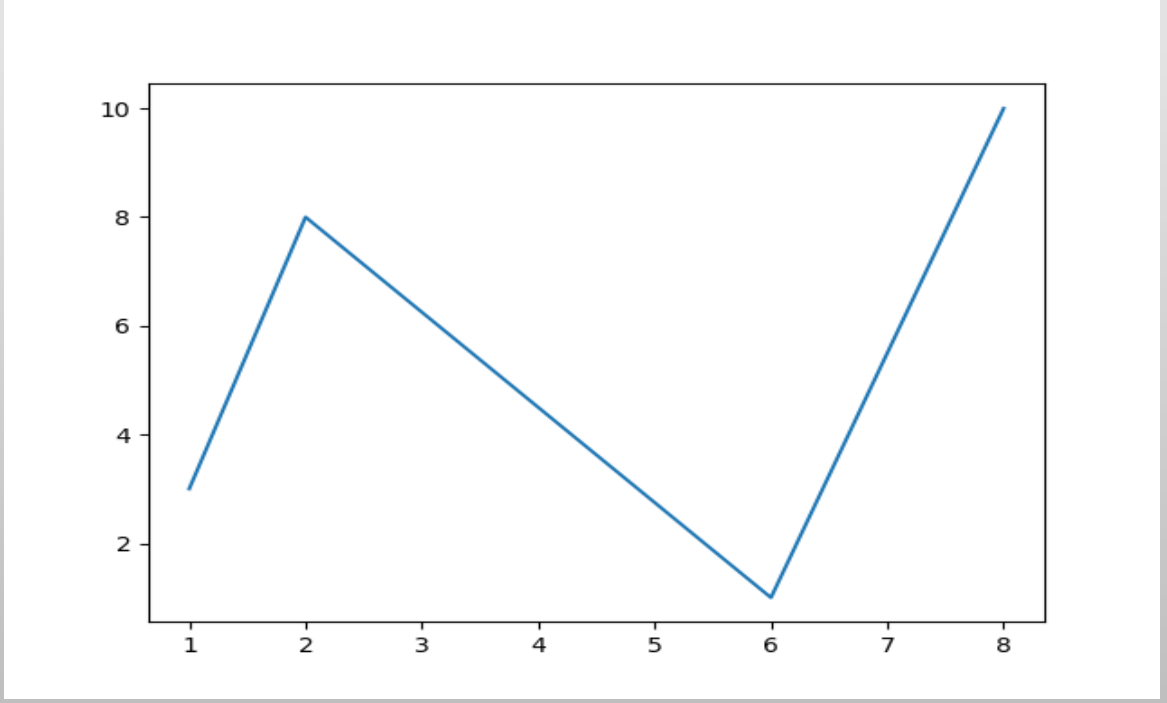
Multiple Points

- You can plot as many points as you like, just make sure you have the same number of points in both axis.

Example

Draw a line in a diagram from position (1, 3) to (2, 8) then to (6, 1) and finally to position (8, 10):

```
import matplotlib.pyplot as plt
import numpy as np

xpoints = np.array([1, 2, 6, 8])
ypoints = np.array([3, 8, 1, 10])

plt.plot(xpoints, ypoints)
plt.show()
```



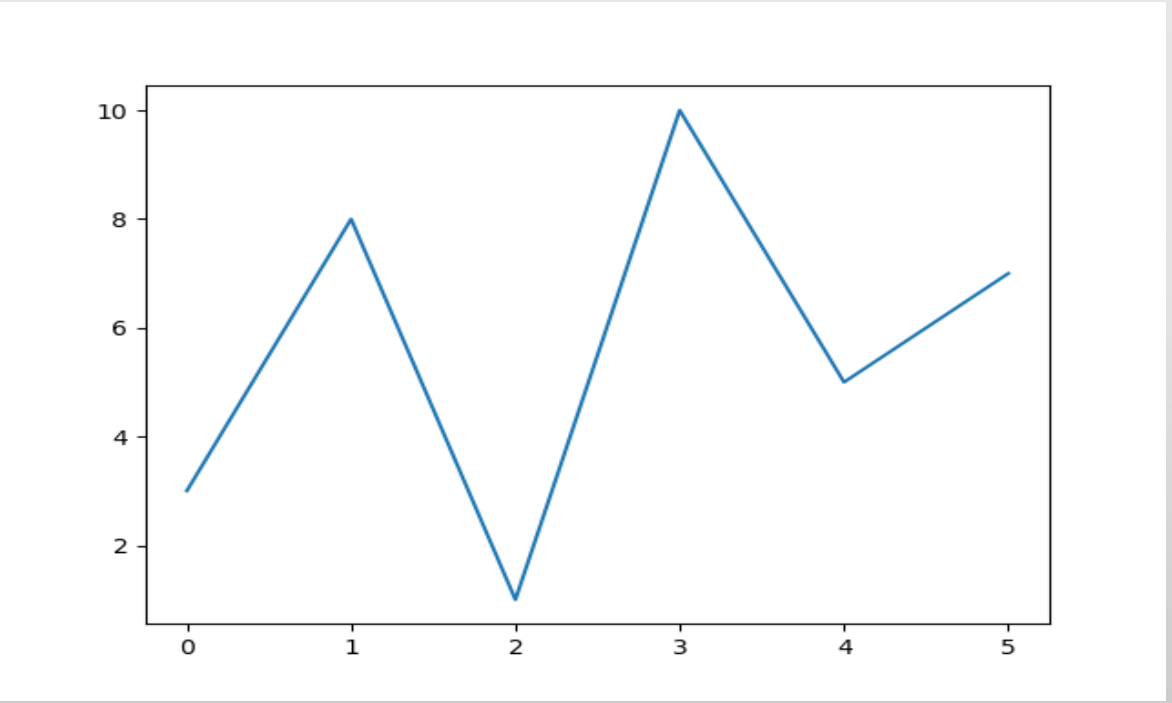
Default X-Points

- If we do not specify the points in the x-axis, they will get the default values 0, 1, 2, 3, (etc. depending on the length of the y-points.

Example

Plotting without x-points:

```
import matplotlib.pyplot as plt
import numpy as np

ypoints = np.array([3, 8, 1, 10, 5, 7])

plt.plot(ypoints)
plt.show()
```



The **x-points** in the example above is [0, 1, 2, 3, 4, 5].

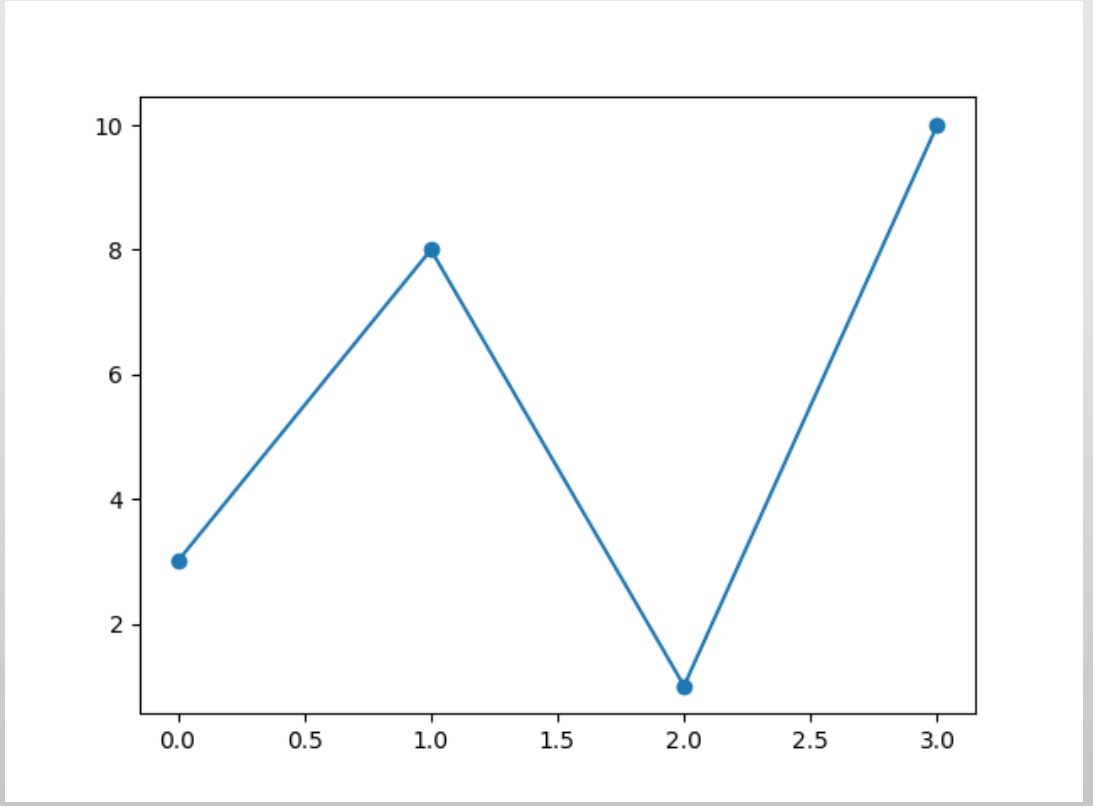
Matplotlib Markers

- You can use the keyword argument `marker` to emphasize each point with a specified marker:

Example

Mark each point with a circle:

```
import matplotlib.pyplot as plt
import numpy as np

ypoints = np.array([3, 8, 1, 10])

plt.plot(ypoints, marker = 'o')
plt.show()
```



Marker Reference

Marker	Description
'o'	Circle
'*'	Star
'.'	Point
','	Pixel
'x'	X
'X'	X (filled)
'+'	Plus
'P'	Plus (filled)
's'	Square
'D'	Diamond
'd'	Diamond (thin)
'p'	Pentagon

'H'	Hexagon
'h'	Hexagon
'v'	Triangle Down
'^'	Triangle Up
'<'	Triangle Left
'>'	Triangle Right
'1'	Tri Down
'2'	Tri Up
'3'	Tri Left
'4'	Tri Right
'|'	Vline
'_'	Hline

Format Strings `fmt`

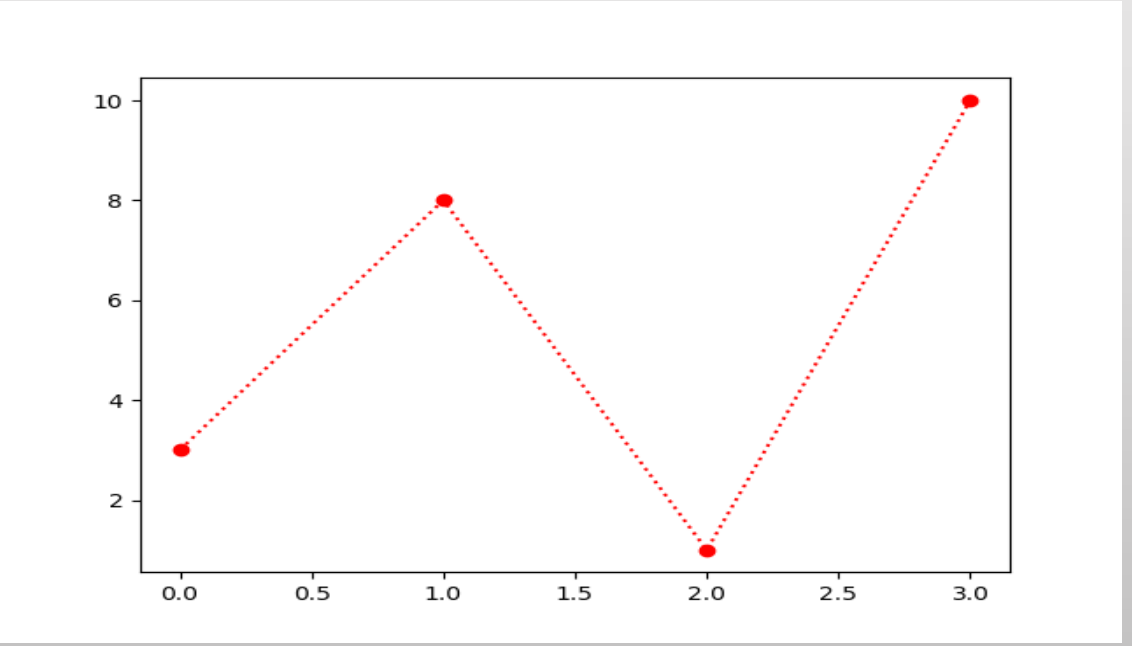
- You can use also use the *shortcut string notation* parameter to specify the marker.
- This parameter is also called `fmt` , and is written with this syntax:

marker|line|color

Example

Mark each point with a circle:

```
import matplotlib.pyplot as plt
import numpy as np

ypoints = np.array([3, 8, 1, 10])

plt.plot(ypoints, 'o:r')
plt.show()
```



Line Reference

- The line value can be one of the following:

Line Syntax	**Description**
'-'	Solid line
':'	Dotted line
'--'	Dashed line
'-.'	Dashed/dotted line

Color Reference

- The short color value can be one of the following:

Color Syntax	Description
'r'	Red
'g'	Green
'b'	Blue
'c'	Cyan
'm'	Magenta
'y'	Yellow
'k'	Black
'w'	White

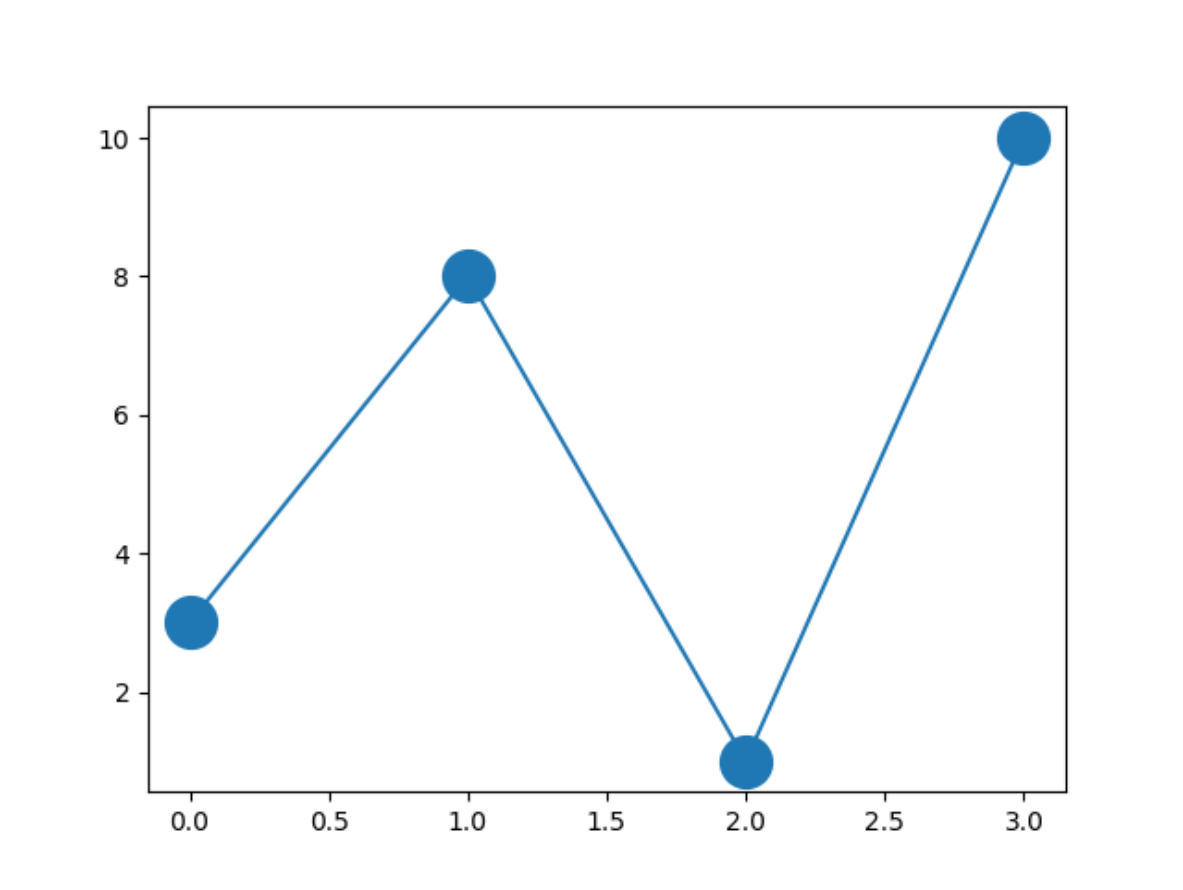
Marker Size

- You can use the keyword argument `markersize` or the shorter version, `ms` to set the size of the markers:

Example

Set the size of the markers to 20:

```
import matplotlib.pyplot as plt
import numpy as np

ypoints = np.array([3, 8, 1, 10])

plt.plot(ypoints, marker = 'o', ms = 20)
plt.show()
```



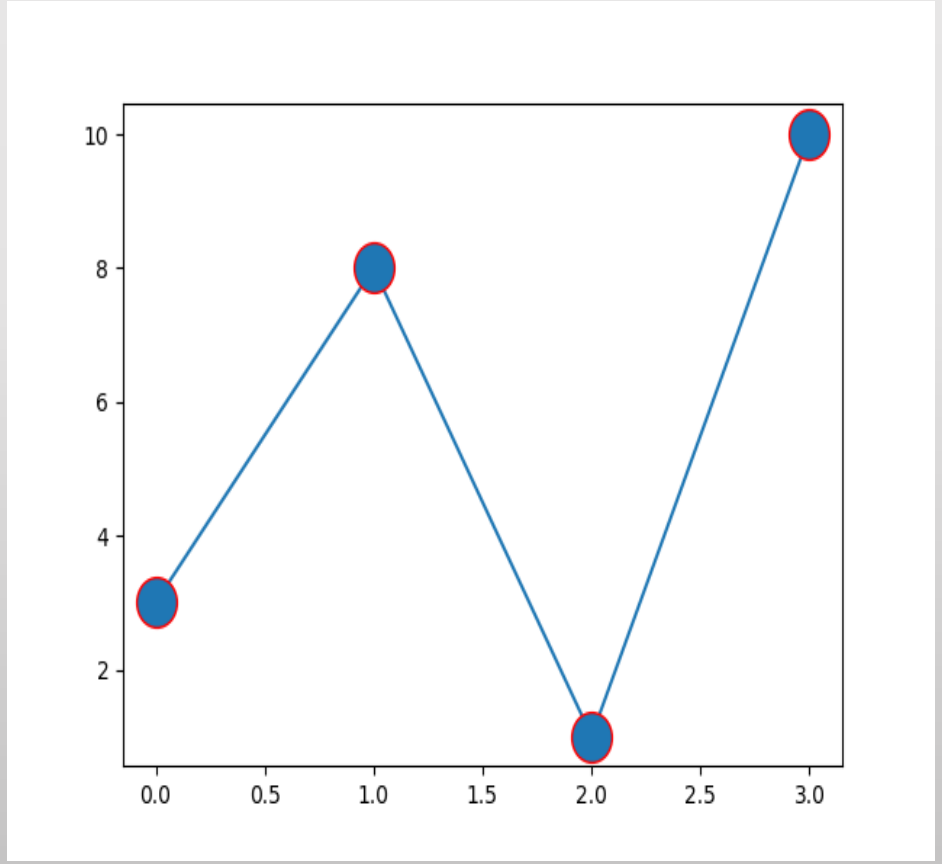
Marker Color

- You can use the keyword argument `markeredgecolor` or the shorter `mec` to set the color of the *edge* of the markers:

Example

Set the EDGE color to red:

```
import matplotlib.pyplot as plt
import numpy as np

ypoints = np.array([3, 8, 1, 10])

plt.plot(ypoints, marker = 'o', ms = 20, mec = 'r')
plt.show()
```

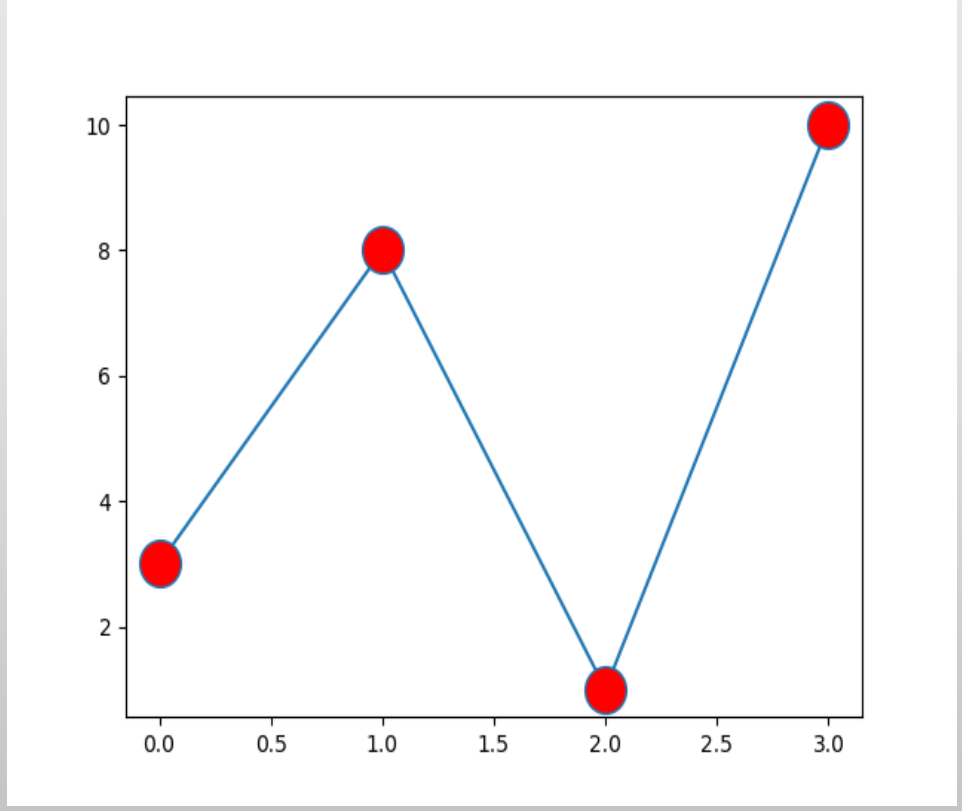


- You can use the keyword argument `markerfacecolor` or the shorter `mfc` to set the color inside the edge of the markers:

Example

Set the FACE color to red:

```
import matplotlib.pyplot as plt
import numpy as np

ypoints = np.array([3, 8, 1, 10])

plt.plot(ypoints, marker = 'o', ms = 20, mfc = 'r')
plt.show()
```



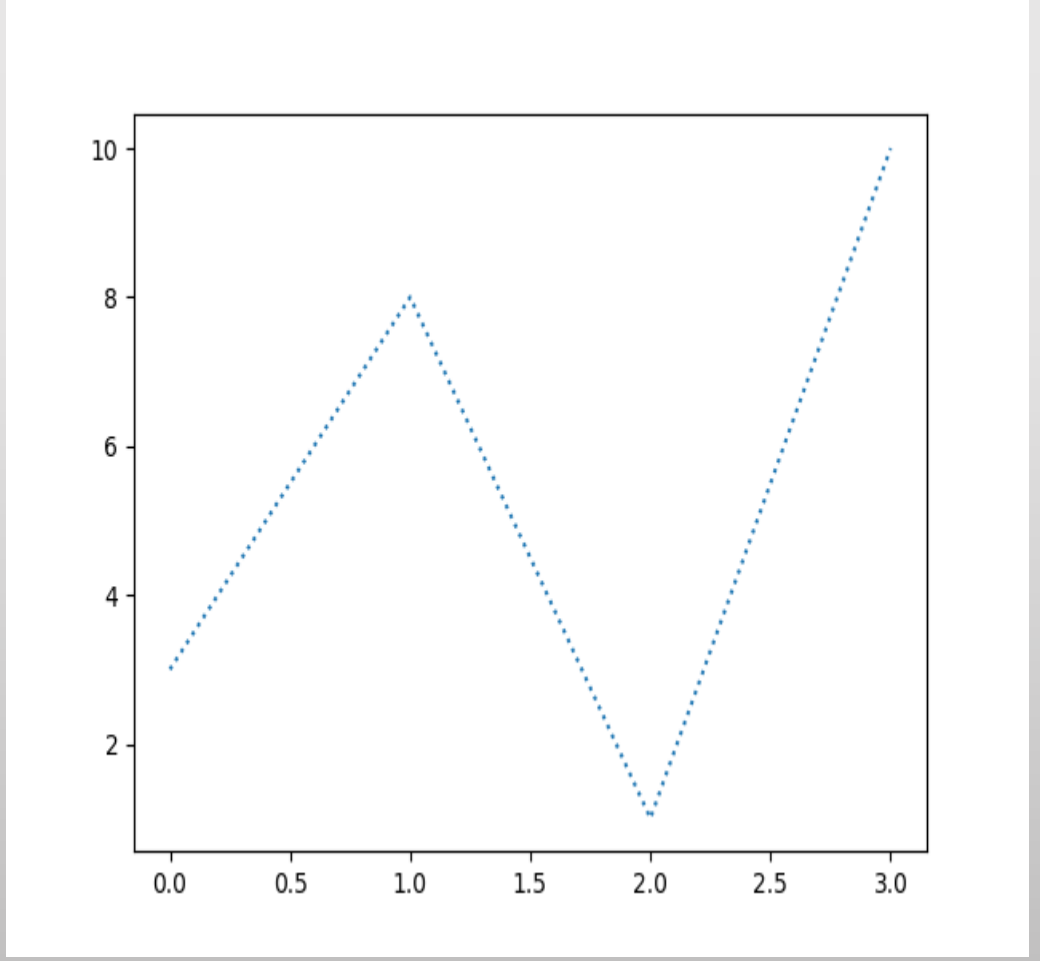
Matplotlib Line

- You can use the keyword argument `linestyle` , or shorter `ls` , to change the style of the plotted line:

Example

Use a dotted line:

```
import matplotlib.pyplot as plt
import numpy as np

ypoints = np.array([3, 8, 1, 10])

plt.plot(ypoints, linestyle = 'dotted')
plt.show()
```



Line Styles

- You can choose any of these styles:

Style	Or
'solid' (default)	'-'
'dotted'	':'
'dashed'	'--'
'dashdot'	'-.'
'None'	'' or ' '

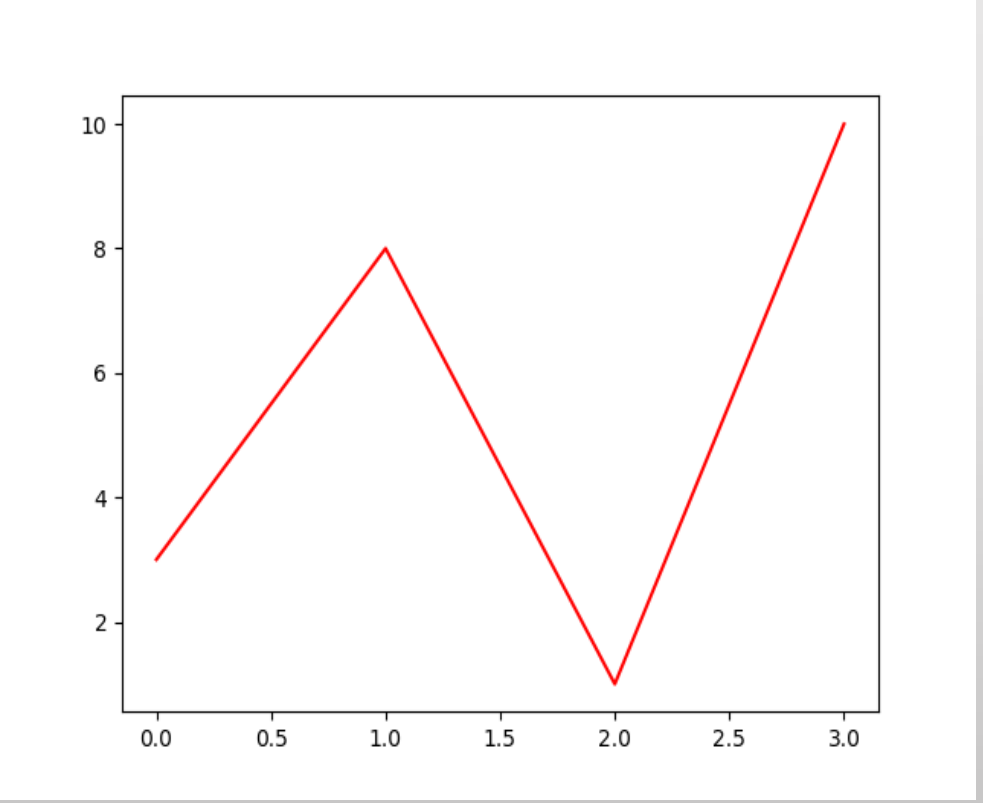
Line Color

- You can use the keyword argument `color` or the shorter `c` to set the color of the line:

Example

Set the line color to red:

```
import matplotlib.pyplot as plt
import numpy as np

ypoints = np.array([3, 8, 1, 10])

plt.plot(ypoints, color = 'r')
plt.show()
```



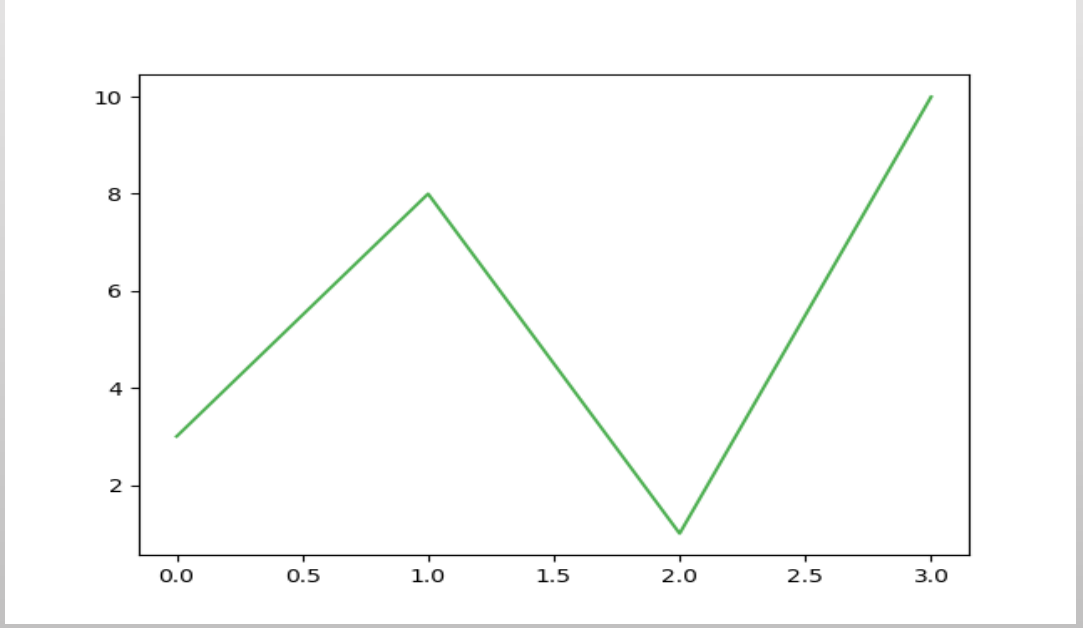
Hexadecimal Colors

- Hexadecimal color values are also supported in all browsers.
- A hexadecimal color is specified with: #RRGGBB.
- RR (red), GG (green) and BB (blue) are hexadecimal integers between 00 and FF specifying the intensity of the color.
- For example, #0000FF is displayed as blue, because the blue component is set to its highest value (FF) and the others are set to 00.

Example

Plot with a beautiful green line:

```
plt.plot(ypoints, c = '#4CAF50')
```



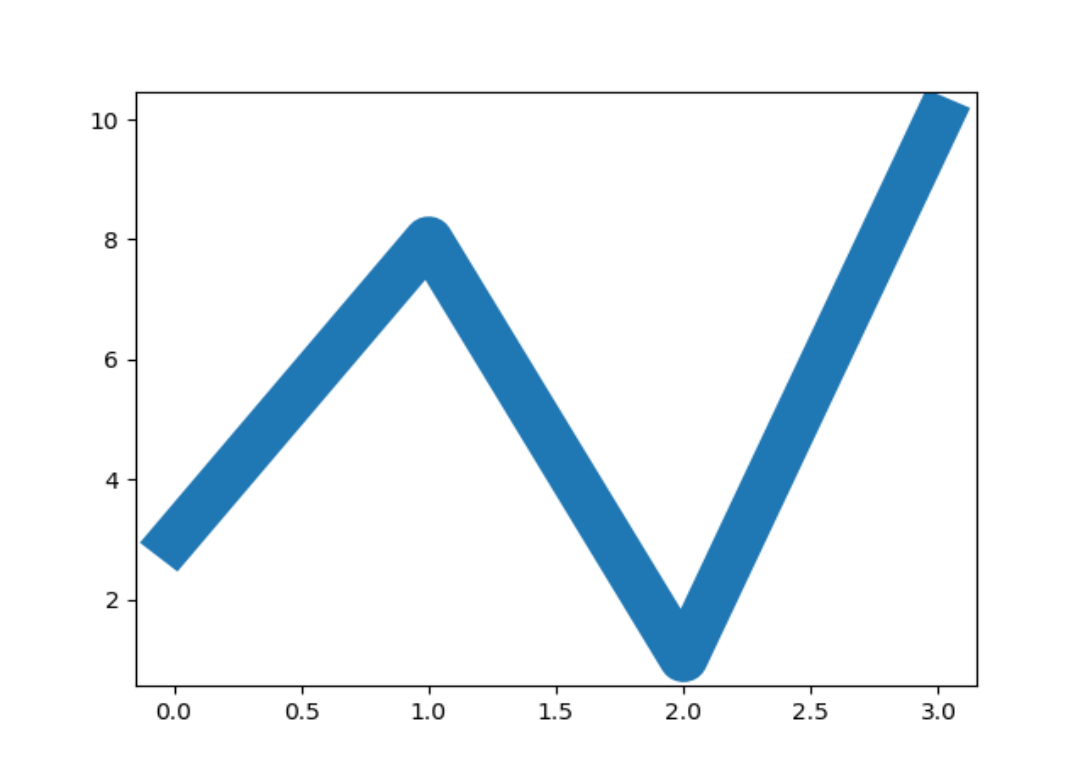
Line Width

- You can use the keyword argument `linewidth` or the shorter `lw` to change the width of the line.
- The value is a floating number, in points:

Example

Plot with a 20.5pt wide line:

```
import matplotlib.pyplot as plt
import numpy as np

ypoints = np.array([3, 8, 1, 10])

plt.plot(ypoints, linewidth = '20.5')
plt.show()
```



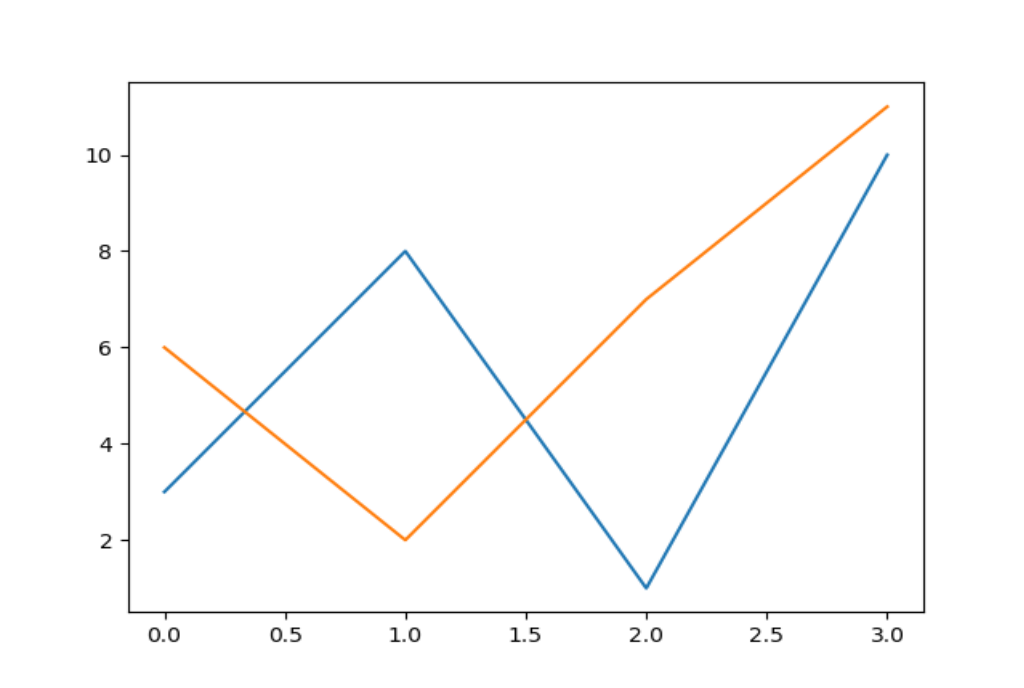
Multiple Lines

- You can plot as many lines as you like by simply adding more `plt.plot()` functions:

Example

Draw two lines by specifying a `plt.plot()` function for each line:

```
import matplotlib.pyplot as plt
import numpy as np

y1 = np.array([3, 8, 1, 10])
y2 = np.array([6, 2, 7, 11])

plt.plot(y1)
plt.plot(y2)

plt.show()
```

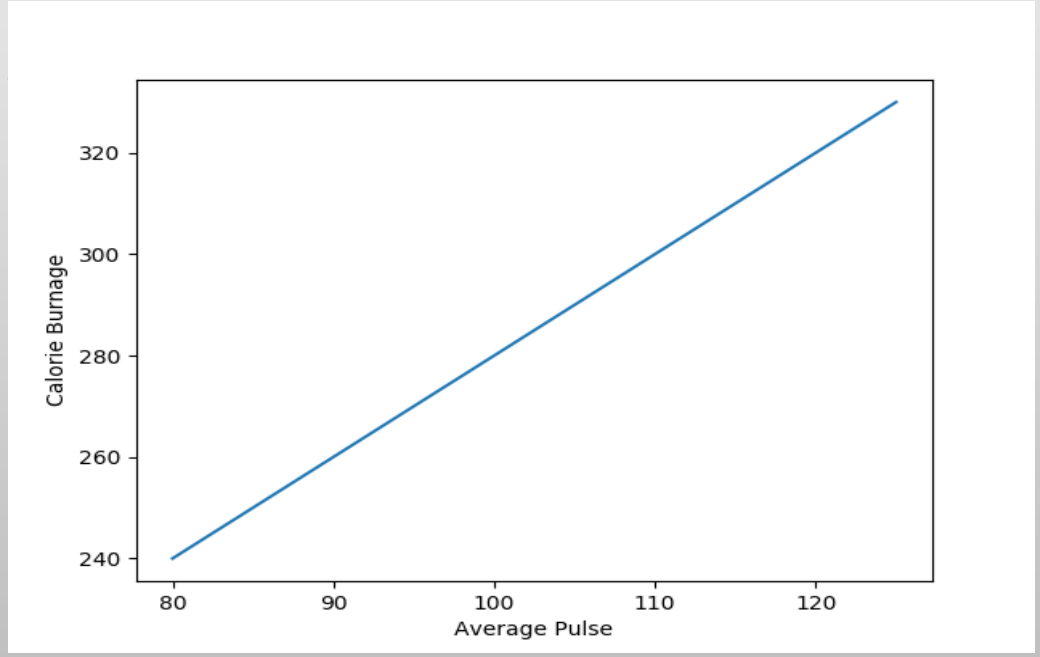


Matplotlib Labels and Title

- With Pyplot, you can use the `xlabel()` and `ylabel()` functions to set a label for the x- and y-axis.

Example

```
import numpy as np
import matplotlib.pyplot as plt

x = np.array([80, 85, 90, 95, 100, 105, 110, 115
y = np.array([240, 250, 260, 270, 280, 290, 300,

plt.plot(x, y)

plt.xlabel("Average Pulse")
plt.ylabel("Calorie Burnage")

plt.show()
```

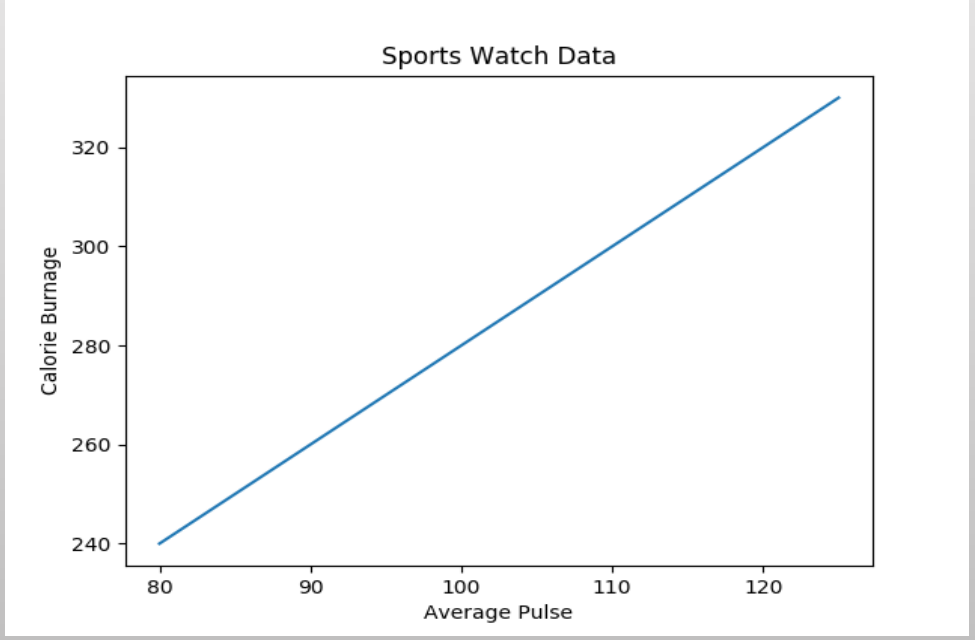


Create a Title for a Plot

- With Pyplot, you can use the `title()` function to set a title for the plot.

Example

```
import numpy as np
import matplotlib.pyplot as plt

x = np.array([80, 85, 90, 95, 100, 105, 110, 115, 120, 125])
y = np.array([240, 250, 260, 270, 280, 290, 300, 310, 320, 330])

plt.plot(x, y)

plt.title("Sports Watch Data")
plt.xlabel("Average Pulse")
plt.ylabel("Calorie Burnage")

plt.show()
```

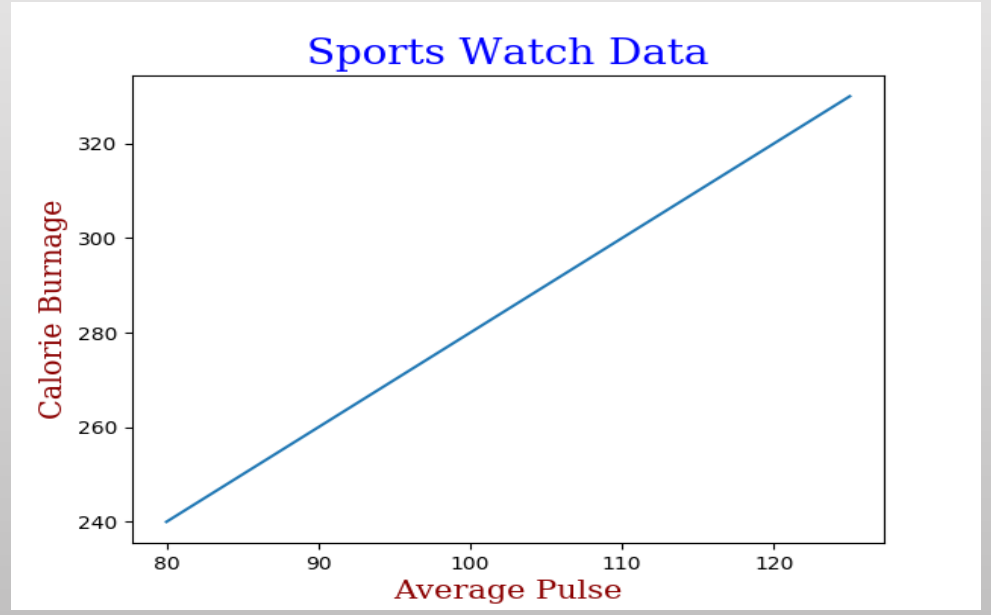


Set Font Properties for Title and Labels

- You can use the `fontdict` parameter in `xlabel()`, `ylabel()`, and `title()` to set font properties for the title and labels.

Example

```
import numpy as np
import matplotlib.pyplot as plt

x = np.array([80, 85, 90, 95, 100, 105, 110, 115, 120, 125])
y = np.array([240, 250, 260, 270, 280, 290, 300, 310, 320, 330])

font1 = {'family':'serif','color':'blue','size':20}
font2 = {'family':'serif','color':'darkred','size':15}

plt.title("Sports Watch Data", fontdict = font1)
plt.xlabel("Average Pulse", fontdict = font2)
plt.ylabel("Calorie Burnage", fontdict = font2)

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

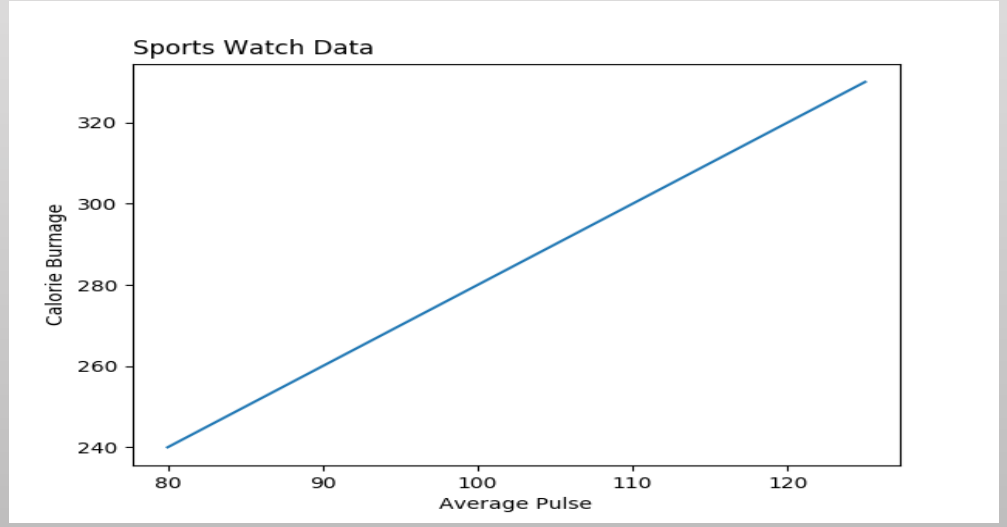


Position the Title

- You can use the `loc` parameter in `title()` to position the title.
- Legal values are: 'left', 'right', and 'center'. Default value is 'center'.

Example

```
import numpy as np
import matplotlib.pyplot as plt

x = np.array([80, 85, 90, 95, 100, 105, 110, 115, 120, 125])
y = np.array([240, 250, 260, 270, 280, 290, 300, 310, 320, 330])

plt.title("Sports Watch Data", loc = 'left')
plt.xlabel("Average Pulse")
plt.ylabel("Calorie Burnage")

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

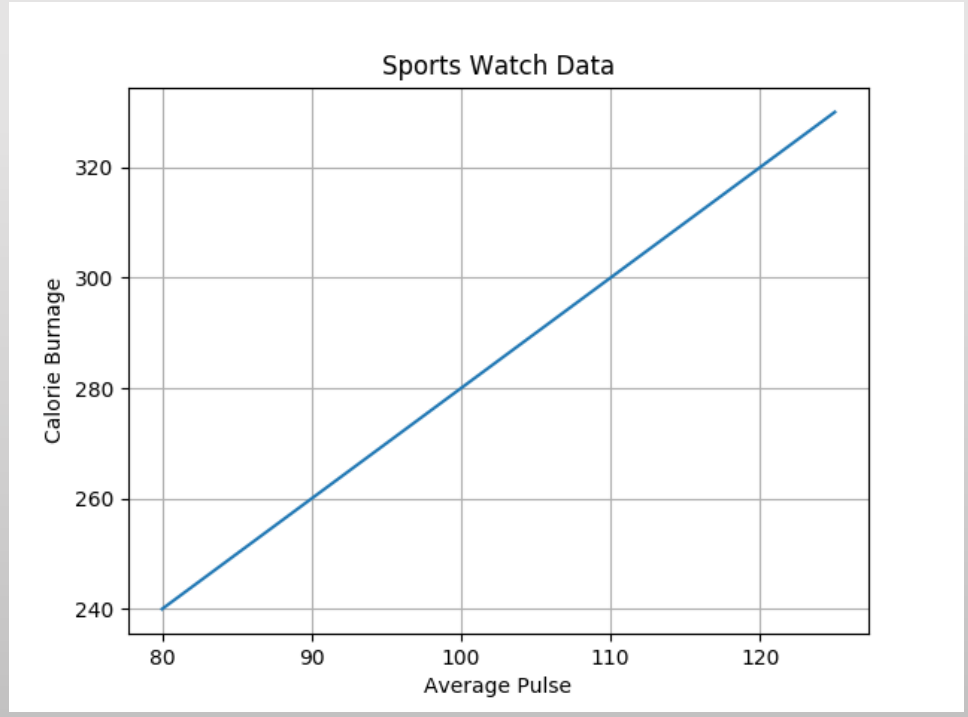


Add Grid Lines to a Plot

- With Pyplot, you can use the `grid()` function to add grid lines to the plot.

Example

```
import numpy as np
import matplotlib.pyplot as plt

x = np.array([80, 85, 90, 95, 100, 105, 110, 115, 120, 125])
y = np.array([240, 250, 260, 270, 280, 290, 300, 310, 320, 330])

plt.title("Sports Watch Data")
plt.xlabel("Average Pulse")
plt.ylabel("Calorie Burnage")

plt.plot(x, y)

plt.grid()

plt.show()
```

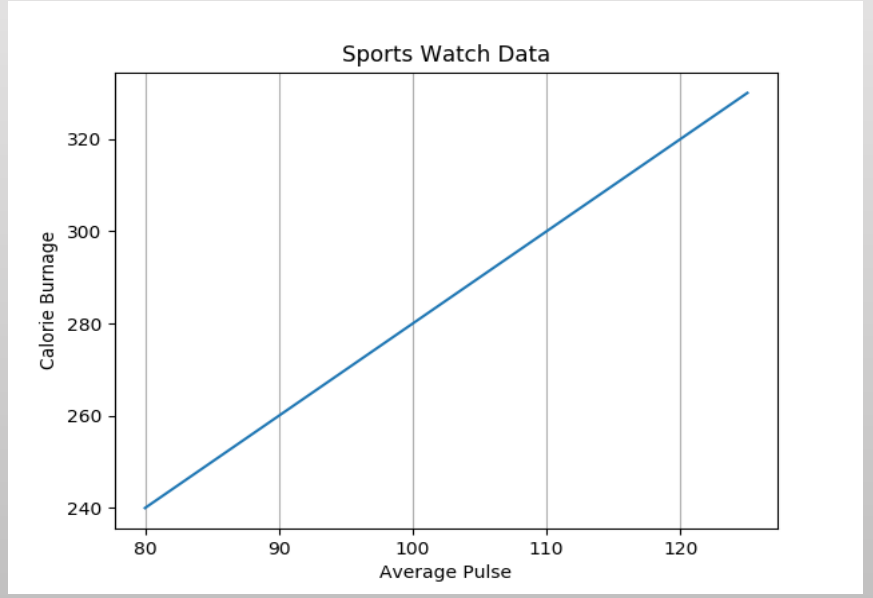


Specify Which Grid Lines to Display

- You can use the `axis` parameter in the `grid()` function to specify which grid lines to display.
- Legal values are: 'x', 'y', and 'both'. Default value is 'both'.

Example

```
import numpy as np
import matplotlib.pyplot as plt

x = np.array([80, 85, 90, 95, 100, 105, 110, 115, 120, 125])
y = np.array([240, 250, 260, 270, 280, 290, 300, 310, 320, 330])

plt.title("Sports Watch Data")
plt.xlabel("Average Pulse")
plt.ylabel("Calorie Burnage")

plt.plot(x, y)

plt.grid(axis = 'x')

plt.show()
```



Set Line Properties for the Grid

- You can also set the line properties of the grid, like this: grid(color = '*color*', linestyle = '*linestyle*', linewidth = *number*).

Example

```
import numpy as np
import matplotlib.pyplot as plt

x = np.array([80, 85, 90, 95, 100, 105, 110, 115, 120, 125])
y = np.array([240, 250, 260, 270, 280, 290, 300, 310, 320, 33

plt.title("Sports Watch Data")
plt.xlabel("Average Pulse")
plt.ylabel("Calorie Burnage")

plt.plot(x, y)

plt.grid(color = 'green', linestyle = '--', linewidth = 0.5)

plt.show()
```

Display Multiple Plots

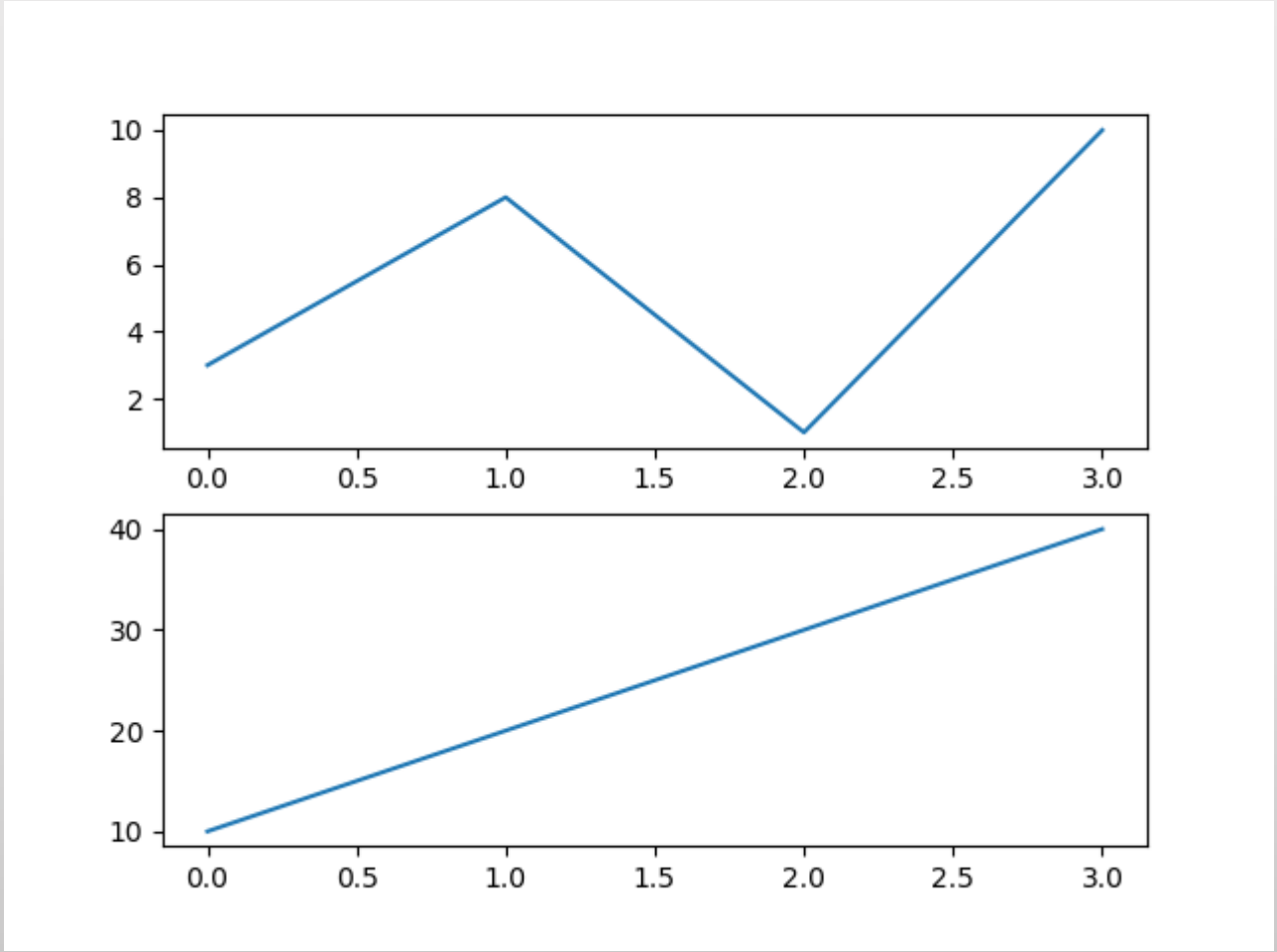
- With the `subplots()` function you can draw multiple plots in one figure:
- The `subplots()` function takes three arguments that describes the layout of the figure.
- The layout is organized in rows and columns, which are represented by the *first* and *second* argument.
- The third argument represents the index of the current plot.

```
plt.subplot(1, 2, 1)
#the figure has 1 row, 2 columns, and this plot is the first plot.
```

```
plt.subplot(1, 2, 2)
#the figure has 1 row, 2 columns, and this plot is the second plot.
```

Example

```
import matplotlib.pyplot as plt
import numpy as np

#plot 1:
x = np.array([0, 1, 2, 3])
y = np.array([3, 8, 1, 10])

plt.subplot(2, 1, 1)
plt.plot(x,y)

#plot 2:
x = np.array([0, 1, 2, 3])
y = np.array([10, 20, 30, 40])

plt.subplot(2, 1, 2)
plt.plot(x,y)

plt.show()
```

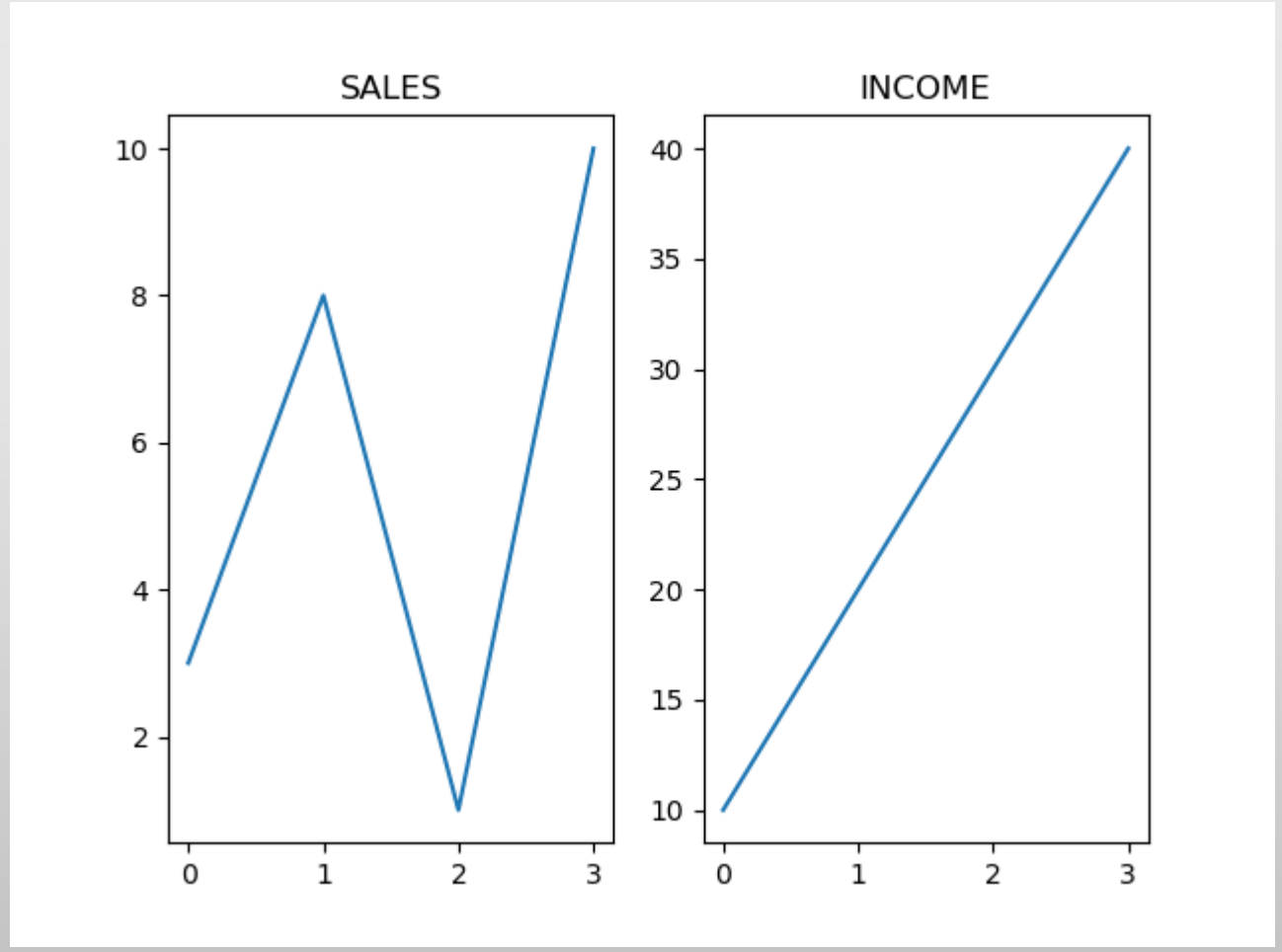


Title

- You can add a title to each plot with the `title()` function:

Example

```
import matplotlib.pyplot as plt
import numpy as np

#plot 1:
x = np.array([0, 1, 2, 3])
y = np.array([3, 8, 1, 10])

plt.subplot(1, 2, 1)
plt.plot(x,y)
plt.title("SALES")

#plot 2:
x = np.array([0, 1, 2, 3])
y = np.array([10, 20, 30, 40])

plt.subplot(1, 2, 2)
plt.plot(x,y)
plt.title("INCOME")

plt.show()
```

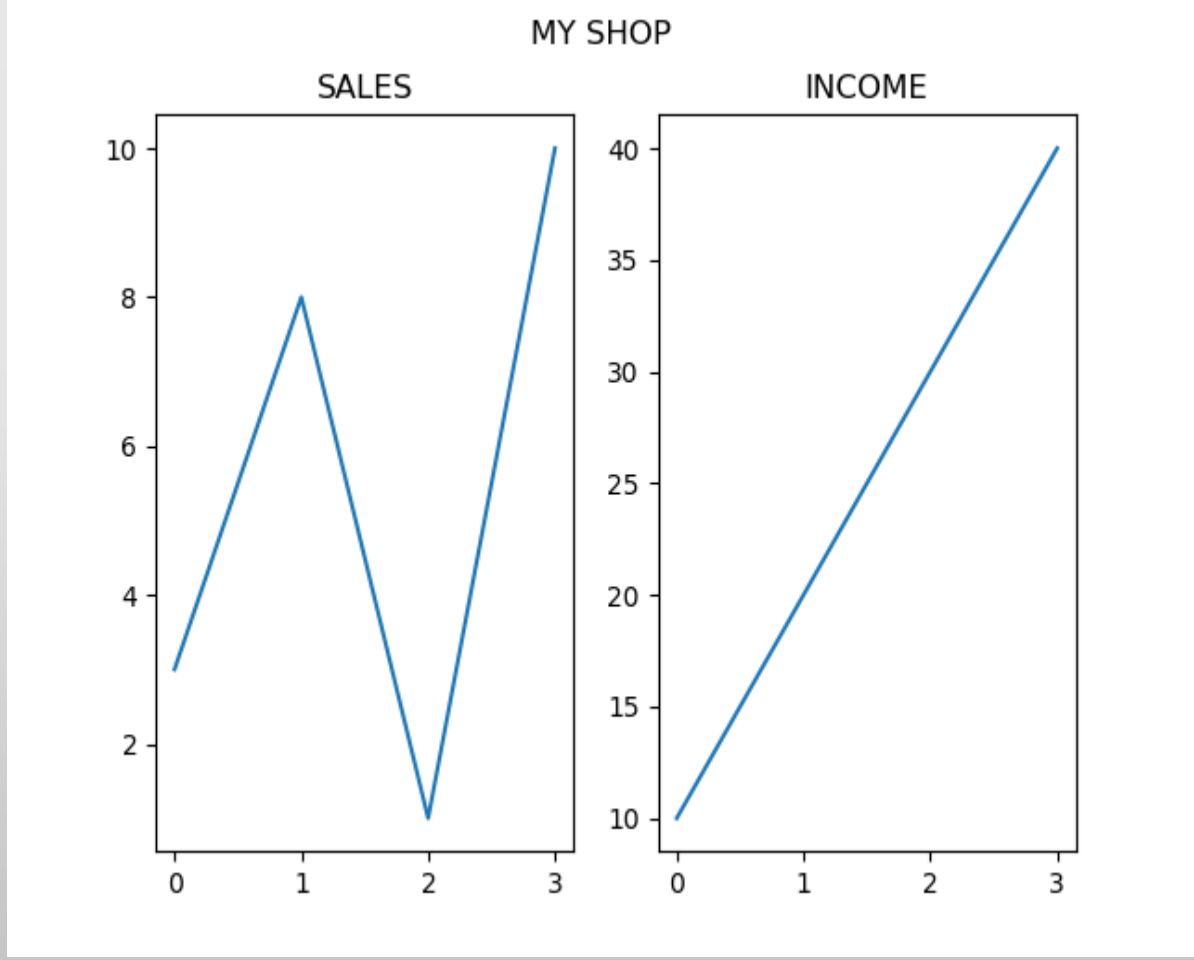


Super Title

- You can add a title to the entire figure with the `suptitle()` function:

Example

```
import matplotlib.pyplot as plt
import numpy as np

#plot 1:
x = np.array([0, 1, 2, 3])
y = np.array([3, 8, 1, 10])

plt.subplot(1, 2, 1)
plt.plot(x,y)
plt.title("SALES")

#plot 2:
x = np.array([0, 1, 2, 3])
y = np.array([10, 20, 30, 40])

plt.subplot(1, 2, 2)
plt.plot(x,y)
plt.title("INCOME")

plt.suptitle("MY SHOP")
plt.show()
```

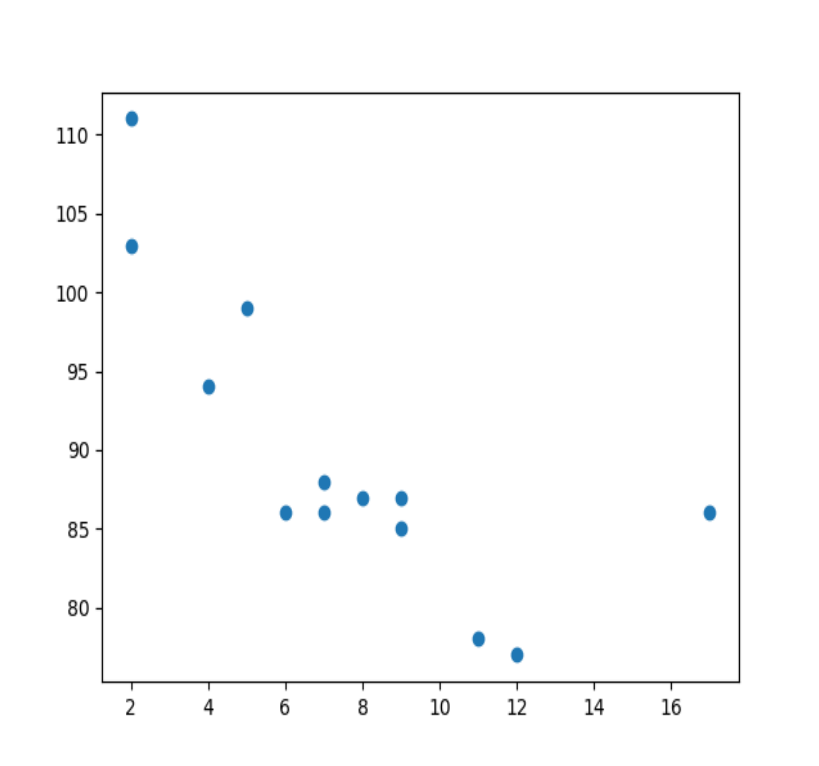


Creating Scatter Plots

- With Pyplot, you can use the `scatter()` function to draw a scatter plot.
- The `scatter()` function plots one dot for each observation. It needs two arrays of the same length, one for the values of the x-axis, and one for values on the y-axis:

Example

```
import matplotlib.pyplot as plt
import numpy as np

x = np.array([5,7,8,7,2,17,2,9,4,11,12,9,6])
y = np.array([99,86,87,88,111,86,103,87,94,78,77,85,86])

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

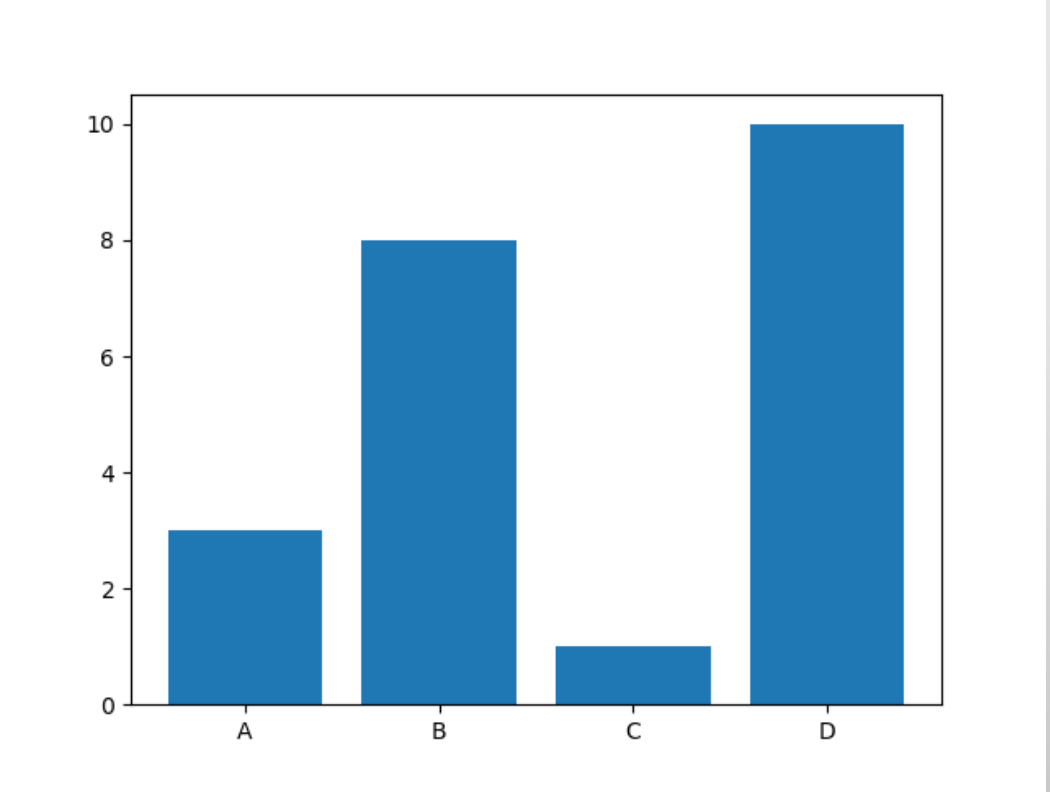


Creating Bars

- With Pyplot, you can use the `bar()` function to draw bar graphs:

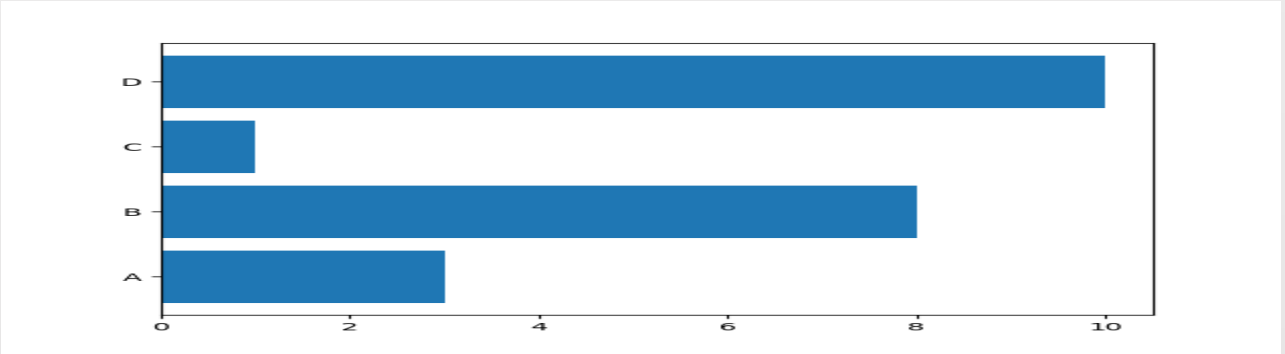
Example

```
import matplotlib.pyplot as plt
import numpy as np

x = np.array(["A", "B", "C", "D"])
y = np.array([3, 8, 1, 10])

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



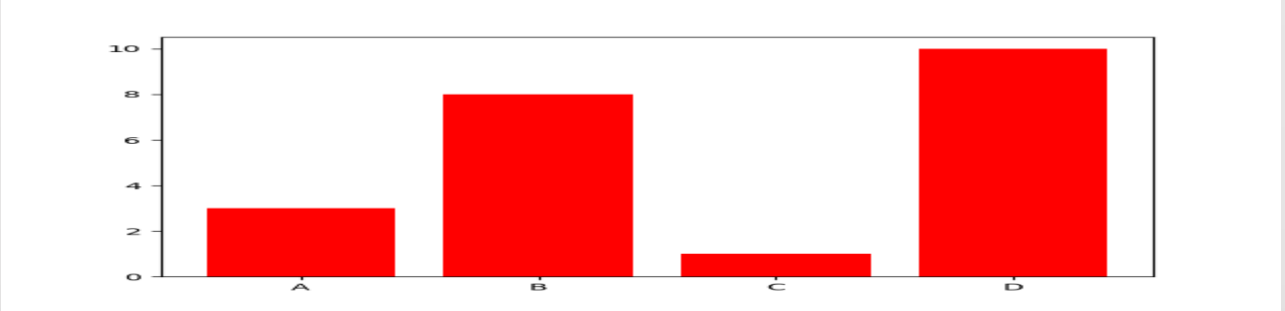
Horizontal Bars

```
plt.barh(x, y)
```



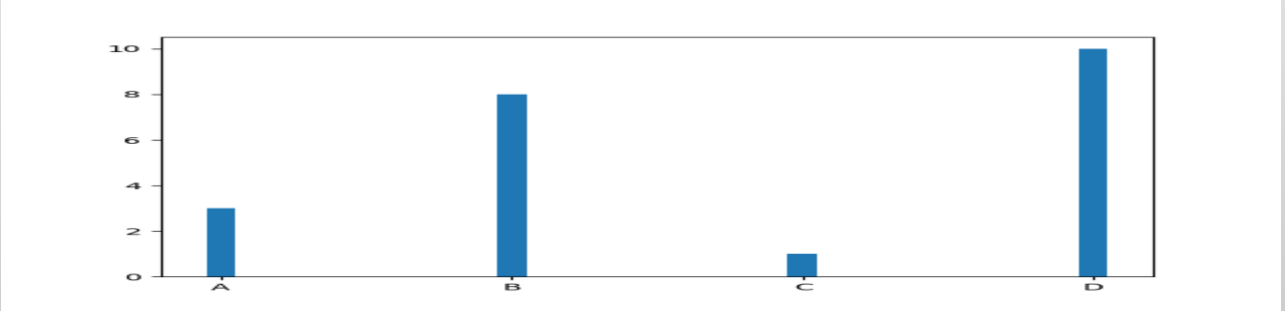
Bar Color

```
plt.bar(x, y, color = "red")
```



Bar Width

```
plt.bar(x, y, width = 0.1)
```



Creating Pie Charts

- With Pyplot, you can use the `pie()` function to draw pie charts:

Example

```
import matplotlib.pyplot as plt
import numpy as np

y = np.array([35, 25, 25, 15])

plt.pie(y)
plt.show()
```

Labels

- Add labels to the pie chart with the `label` parameter.

Example

```
y = np.array([35, 25, 25, 15])
mylabels = ["Apples", "Bananas", "Cherries", "Dates"]

plt.pie(y, labels = mylabels)
plt.show()
```