```
import numpy as np
import pandas as pd
```

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.

+ Code + Text

> **Installation of Matplotlib**

- First, we should ensure that, **Python** and **PIP** are installed in the system, then can install matplotlib using the following pip command:

```
pip install matplotlib
```

> **Import Matplotlib:**

- After successful installation of **matplotlib**, we can import it using the following import module statement:

```
import matplotlib
```

```
import matplotlib
```

> **Checking Matplotlib Version**

- The version string is stored under **__version__** attribute.

```
import matplotlib

print(matplotlib.__version__)
```

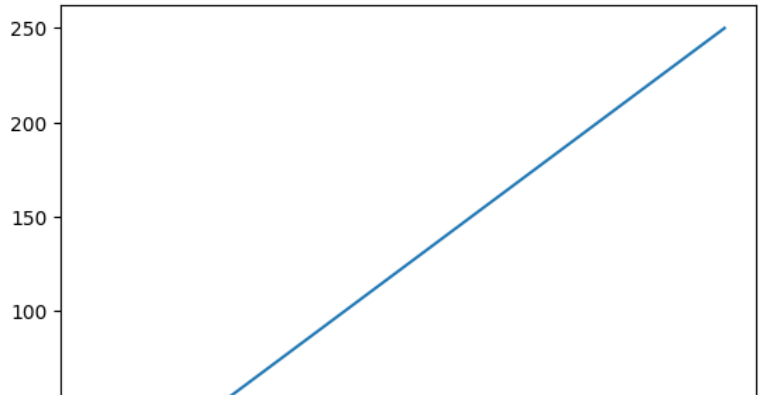
```
3.7.2
```

Matplotlib Pyplot

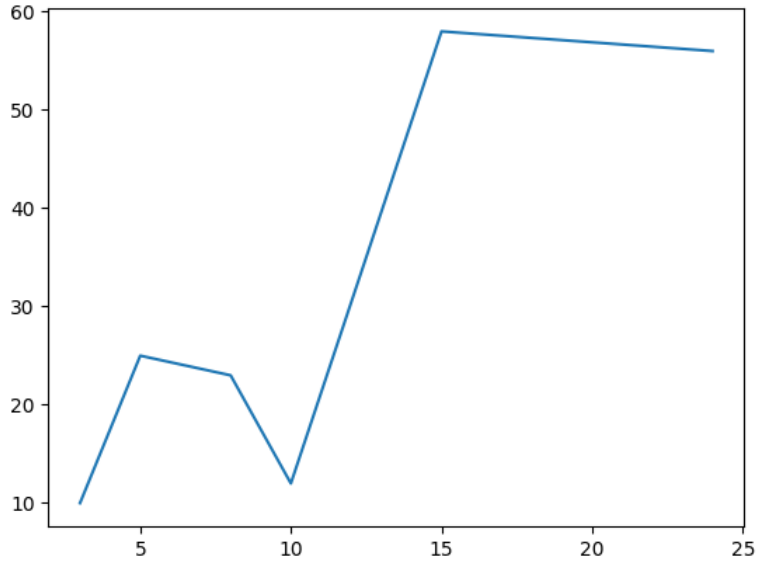
> **Pyplot**

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

```
import matplotlib.pyplot as plt


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

# From these points, can draw straight line
xpoints = np.array([0, 6])
ypoints = np.array([0, 250])

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



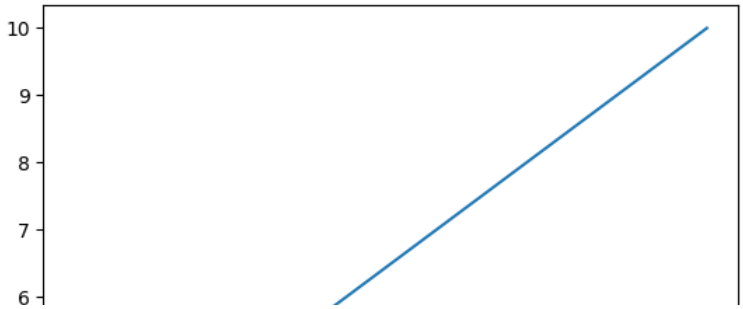

```
# plotting points, which are not in a straight line

x_pts = np.array([3, 5, 8, 10, 15, 24])
y_pts = np.array([10, 25, 23, 12, 58, 56])

plt.plot(x_pts, y_pts)
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.

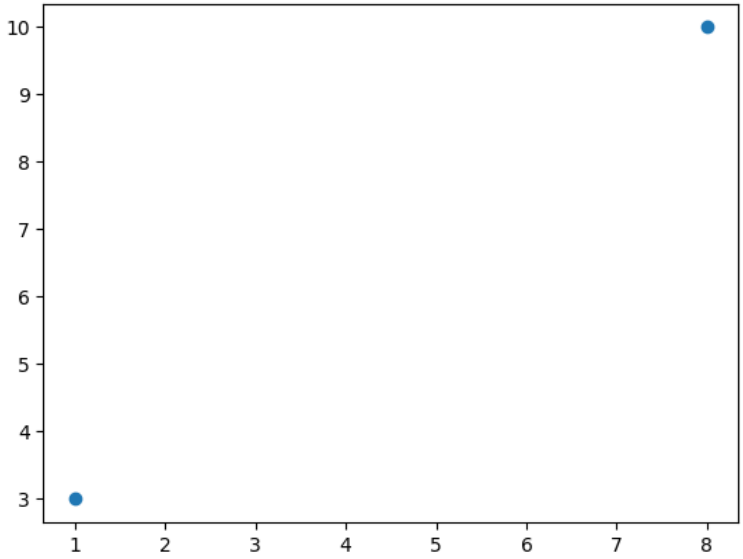
```
# Draw straight line between 2 points (1,3) and (8,10)

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

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



> **Plotting Without Line:**

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

```
# Just mark 2 points at the places: (1,3) and (8,10)

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

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

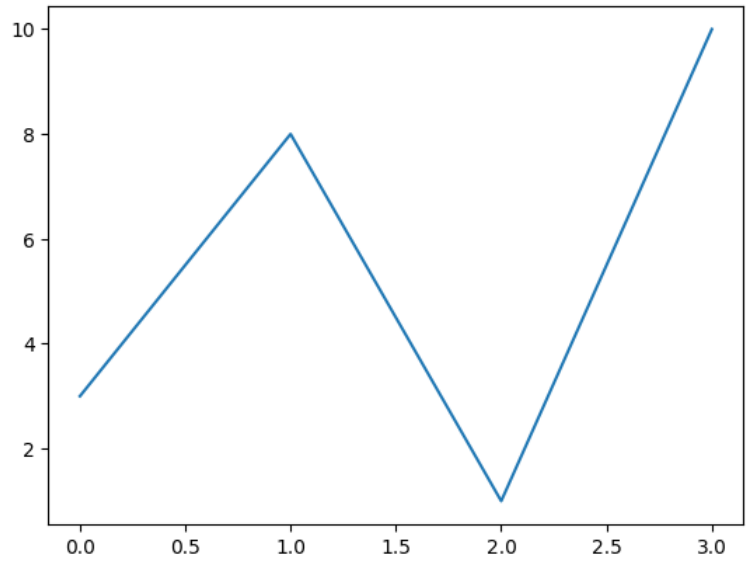


> **Multiple Points:**

- We can plot any number of points on the graph, just have to be esure, that both arrays have same number of points.

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

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

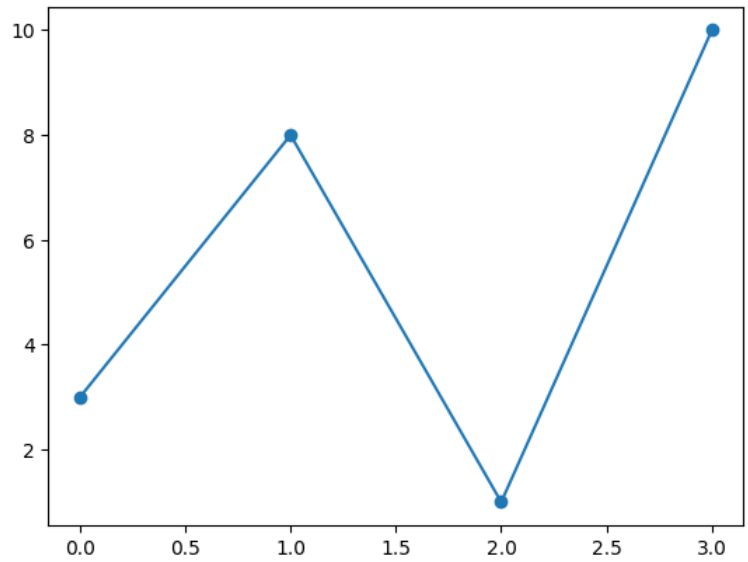

```
ypoints = np.array([3, 8, 1, 10])

# If we give only one arg, then considered as y_pts, and
# x-axis contains nums from 0 till length of the y_pts array
plt.plot(ypoints)
plt.show()
```



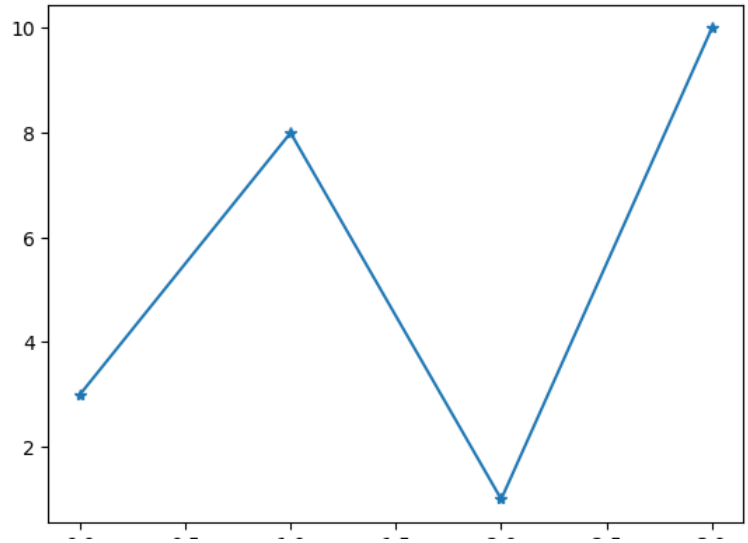
Matplotlib Markers

- We can use the keyword argument **marker** to emphasize each point with a specified marker.

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

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




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

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



> **Marker Types:**

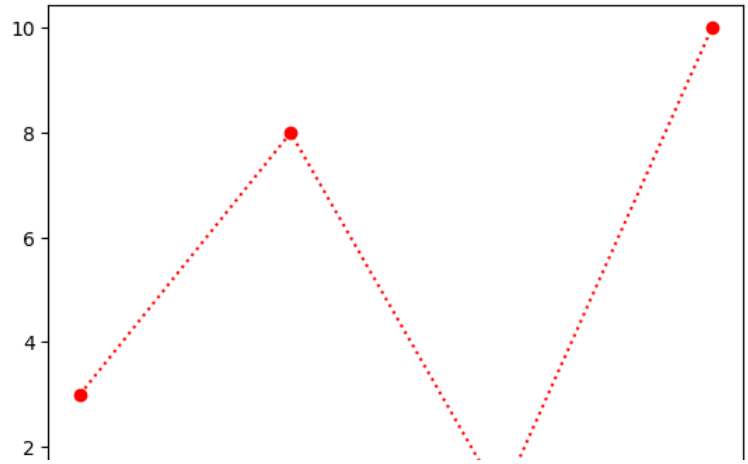
- **'o'** Circle
- **'*'** Star
- **'.'** Point
- **','** Pixel
- **'x'** X
- **'X'** X (filled)
- **'+'** Plus
- **'P'** Plus (filled)
- **'s'** Square
- **'D'** Diamond
- **'d'** Diamond (thin)
- **'p'** Pentagon
- **'H'** Hexagon
- **'h'** Hexagon
- **'v'** Triangle Down
- **'^'** Triangle Up
- **'<'** Triangle Left
- **'>'** Triangle Right
- **'1'** Tri Down
- **'2'** Tri Up
- **'3'** Tri Left
- **'4'** Tri Right
- '|' Vline
- '_' Hline

> **Format Strings fmt:**

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

```
marker|line|color
```

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

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



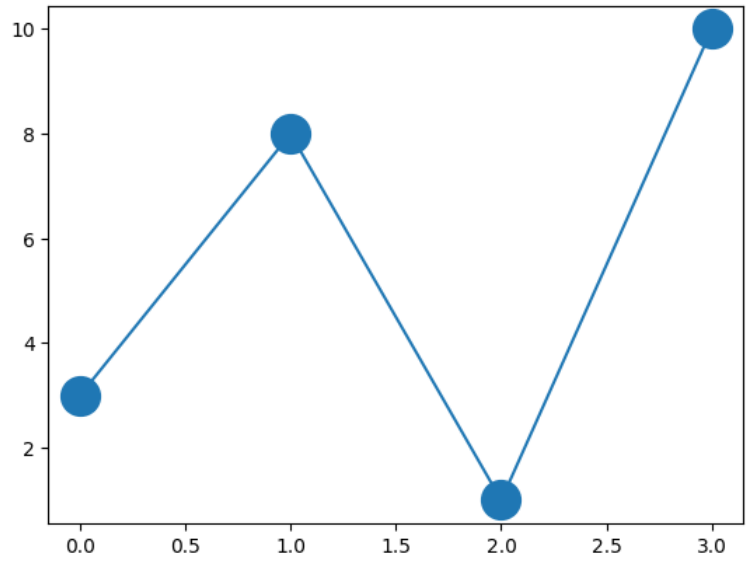
> **Line Values:**

- '-' Solid line
- ':' Dotted line
- '--' Dashed line
- '-.' Dashed/dotted line

> **Marker Size:**

- We can use the keyword argument **markersize** or the shorter version, **ms** to set the size of the markers.

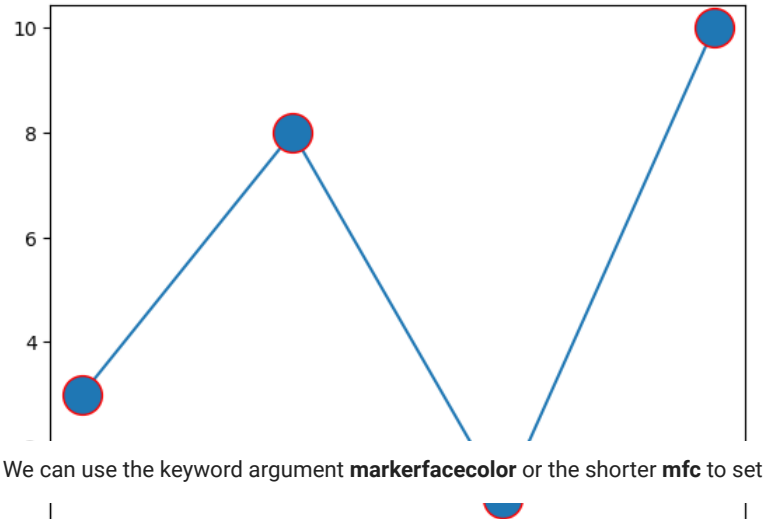
```
ypoints = np.array([3, 8, 1, 10])

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



> **Marker Color:**

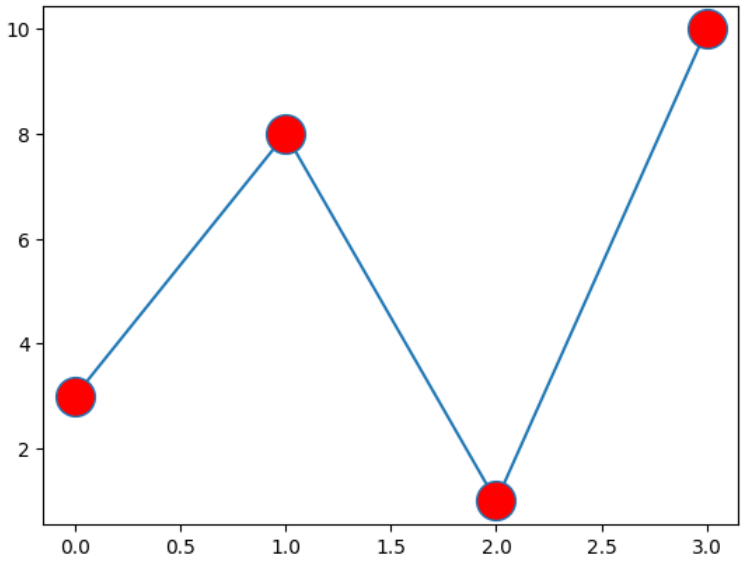
- We can use the keyword argument **markeredgecolor** or the shorter **mec** to set the color of the edge of the markers.

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

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



- We can use the keyword argument **markerfacecolor** or the shorter **mfc** to set the color inside the edge of the markers.

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

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

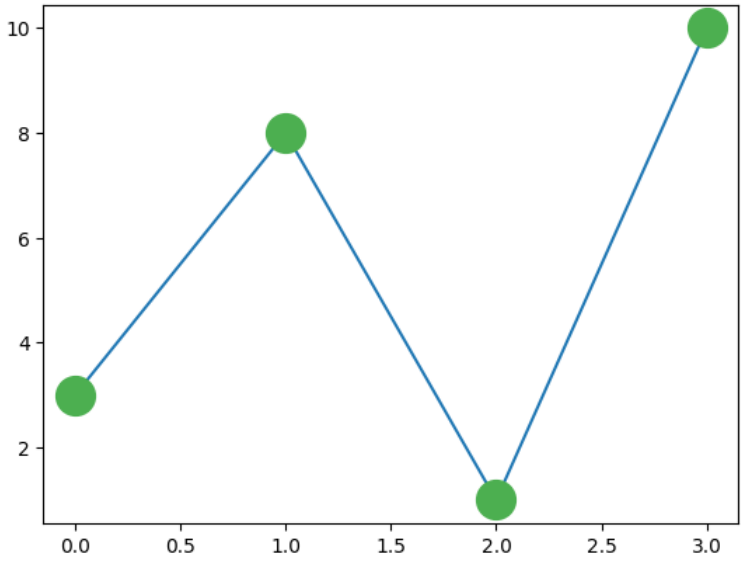


- Use both the **mec** and **mfc** arguments to color the entire marker.

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

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

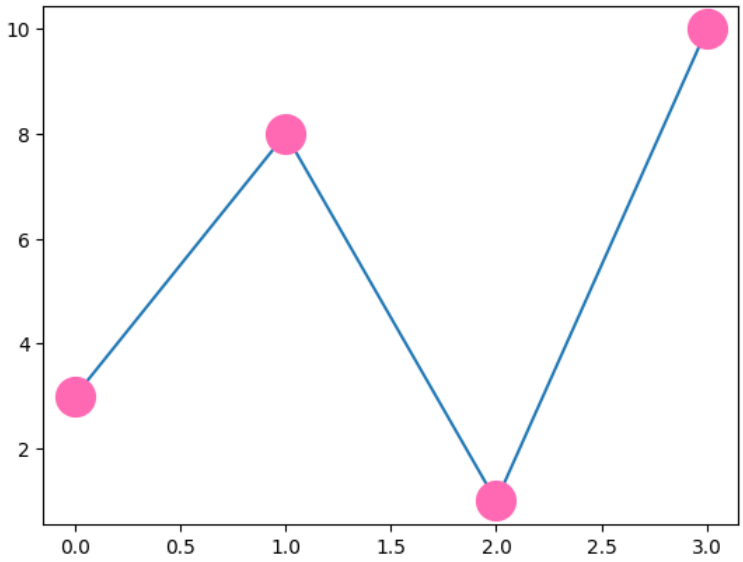
- Use of Hexadecimal color values:

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

plt.plot(ypoints, marker = 'o', ms = 20, mec = '#4CAF50', mfc = '#4CAF50')
plt.show()
```



- Use of supported color names:

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

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

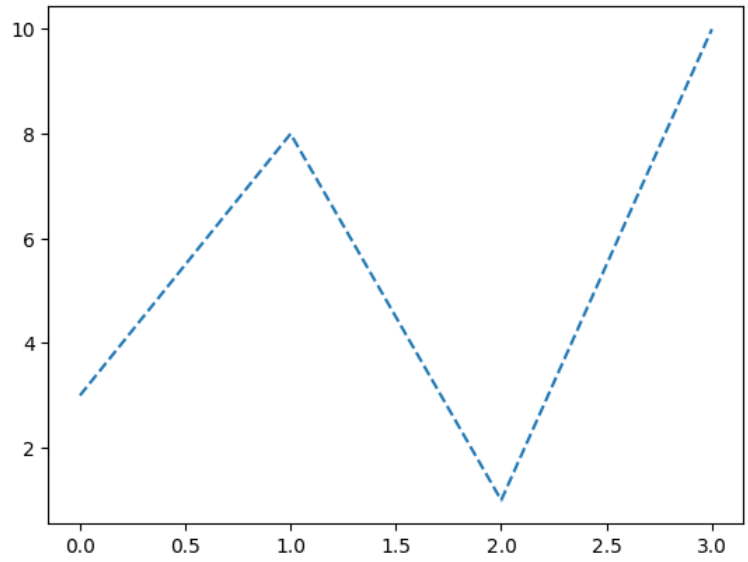


Matplotlib Line

> **Linestyle:**

- We can use the keyword argument **linestyle**, or shorter **ls**, to change the style of the plotted line.

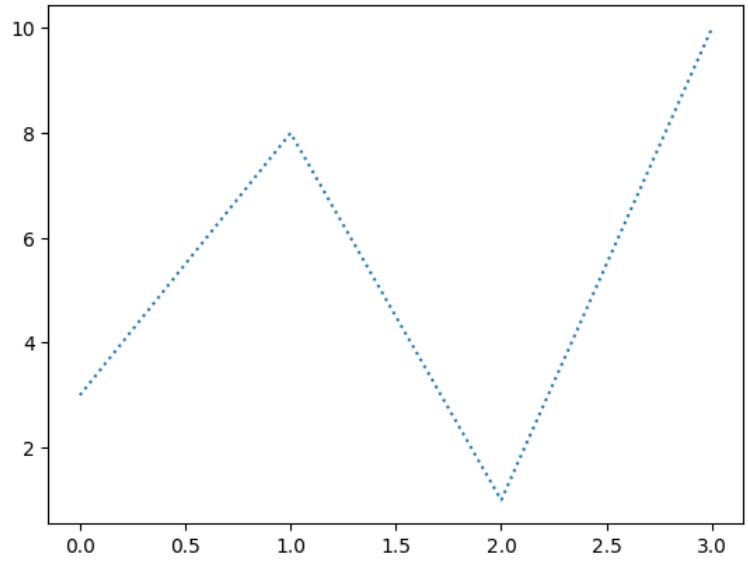
```
ypoints = np.array([3, 8, 1, 10])

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



> **Shorter Syntax:**

- The line style can be written in a shorter syntax:
  - **linestyle** can be written as **ls**.
  - **dotted** can be written as **:**.
  - **dashed** can be written as **--**.

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

plt.plot(ypoints, ls = ':')
plt.show()
```



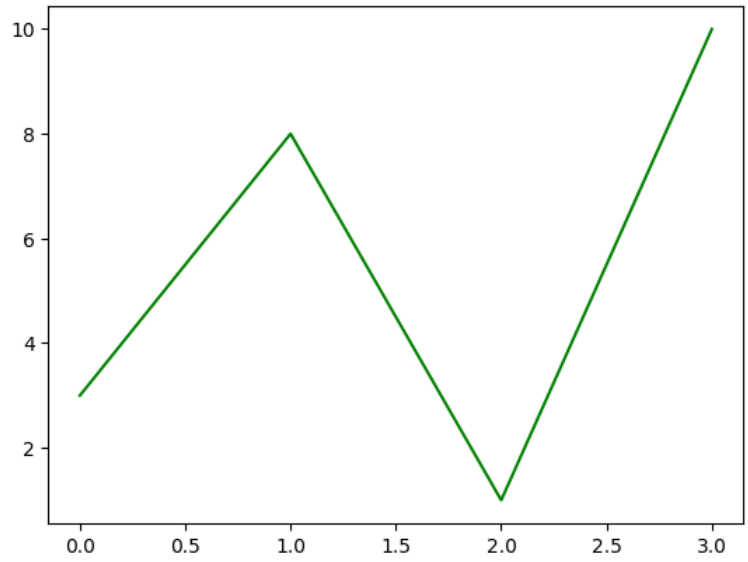
> **Line Styles**

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

> **Line Color:**

- We can use the keyword argument **color** or the shorter **c** to set the color of the line.

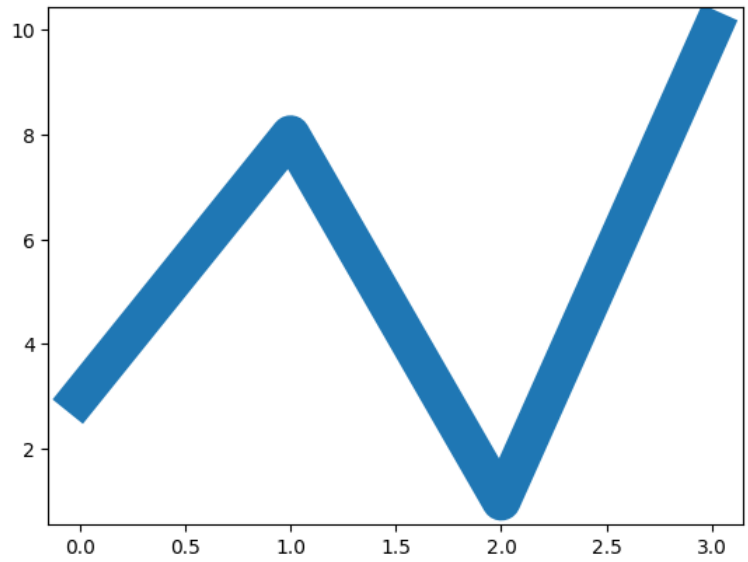
```
ypoints = np.array([3, 8, 1, 10])

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



> **Line Width:**

- We 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.

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

plt.plot(ypoints, linewidth = '20')
plt.show()
```

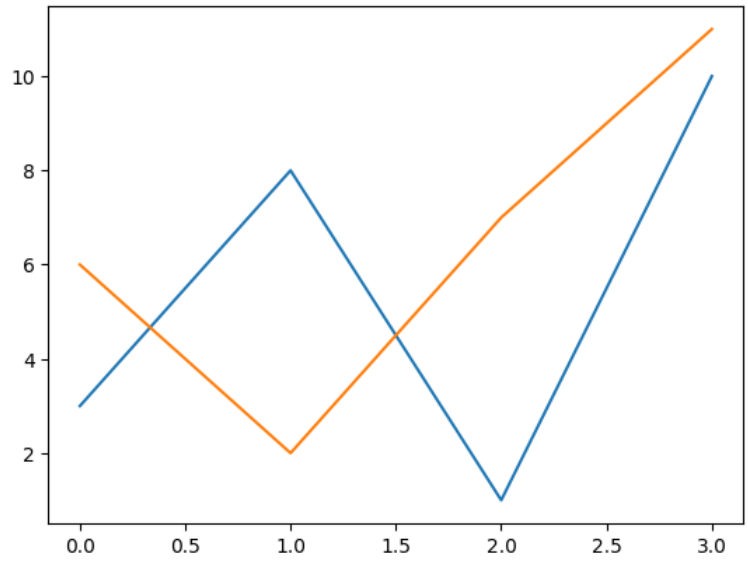


> **Multiple Lines in Single Plot:**

- We can plot as many lines, by adding **plt.plot()** block.

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

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

plt.show()
```

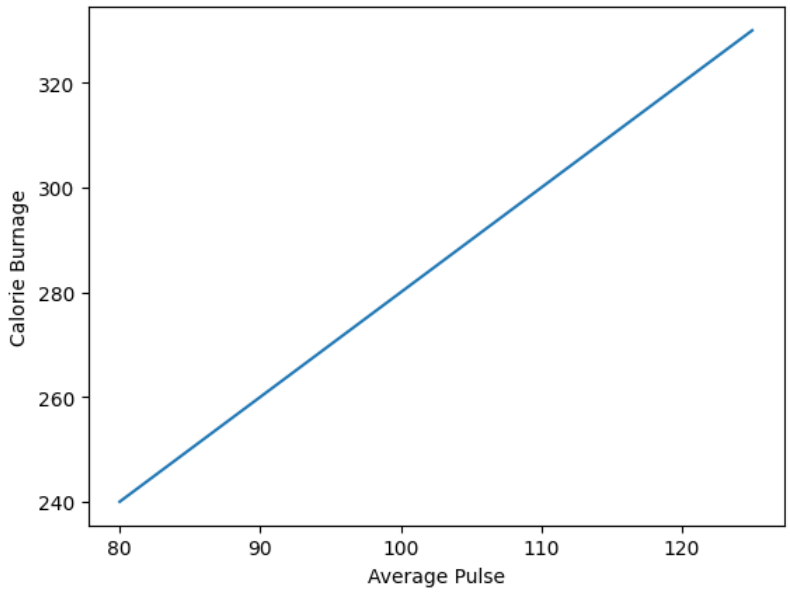


Matplotlib Labels and Title

> **Create Labels for a Plot:**

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

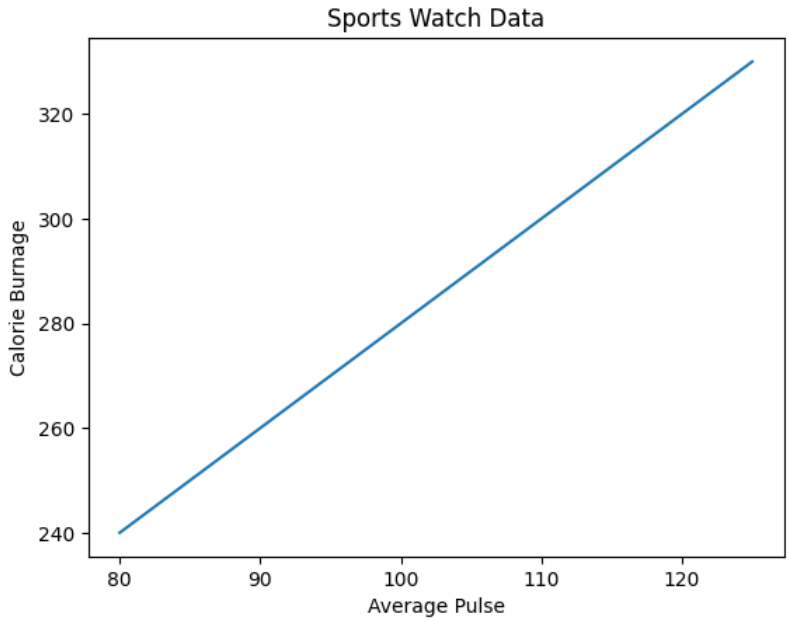
```
x = np.array([80, 85, 90, 95, 100, 105, 110, 115, 120, 125])
y = np.array([240, 250, 260, 270, 280, 290, 300, 310, 320, 330])

plt.plot(x, y)

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

plt.show()
```



> **Create a Title for a Plot:**

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

```
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:**

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

```
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()
```

Sports Watch Data

> **Position the Title:**

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

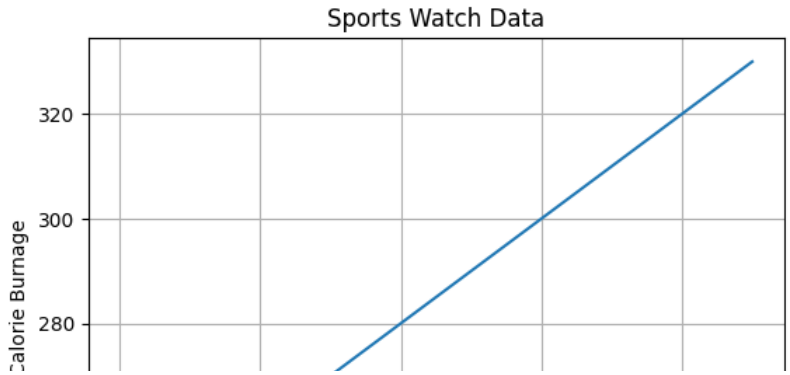
```
x = np.array([80, 85, 90, 95, 100, 105, 110, 115, 120, 125])
y = np.array([240, 250, 260, 270, 280, 290, 300, 310, 320, 330])

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

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

Matplotlib Adding Grid Lines

> **Add Grid Lines to a Plot:**

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

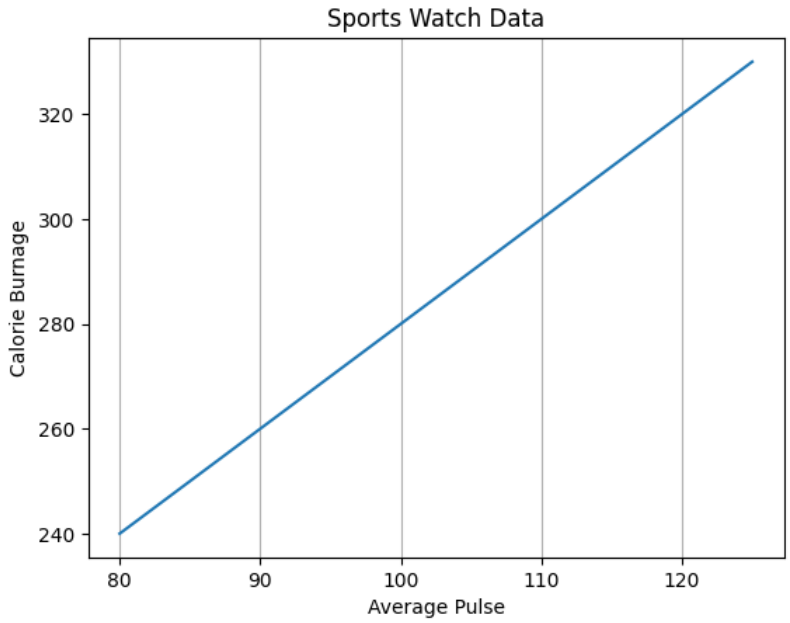
```
x = np.array([80, 85, 90, 95, 100, 105, 110, 115, 120, 125])
y = np.array([240, 250, 260, 270, 280, 290, 300, 310, 320, 330])

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'.

```
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()
```



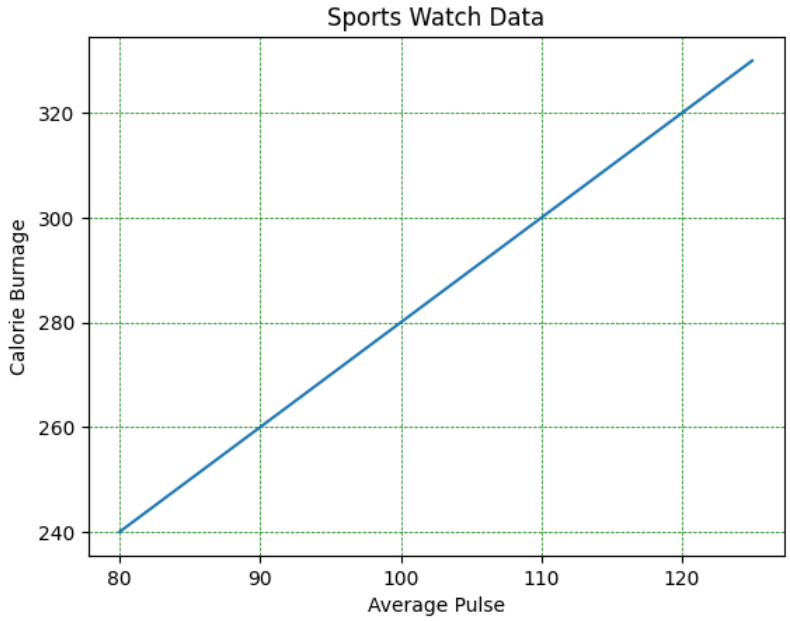
> **Set Line Properties for the Grid:**

- We can also set the line properties of the grid, like the following command:

```
grid(color = 'color', linestyle = 'linestyle', linewidth = number).
```

```
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(color = 'green', linestyle = '--', linewidth = 0.5)

plt.show()
```

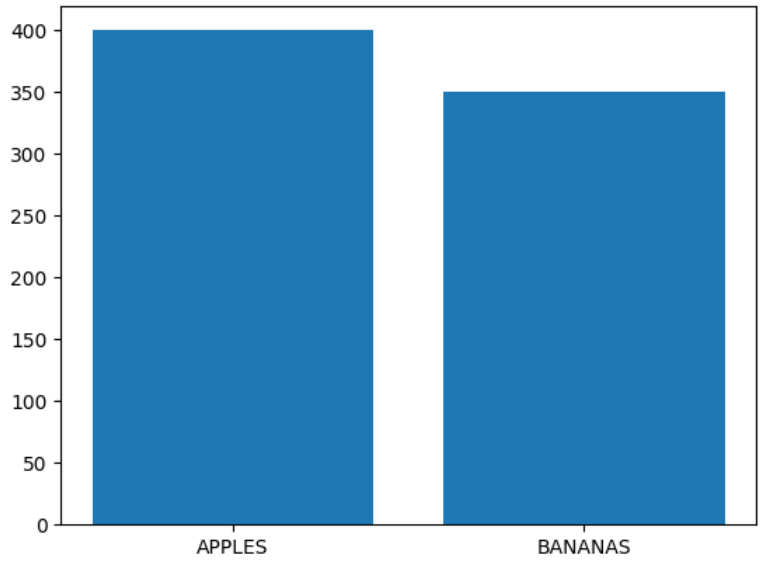


Matplotlib Bars

- The **bar()** function takes arguments that describes the layout of the bars.
- The categories and their values represented by the first and second argument as arrays.

```
x = ["APPLES", "BANANAS"]
y = [400, 350]
plt.bar(x, y)
```

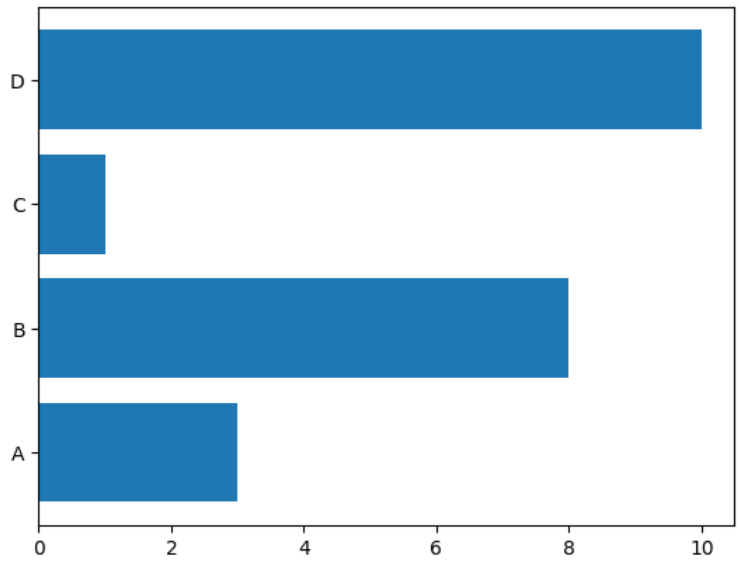
```
<BarContainer object of 2 artists>
```



> **Horizontal Bars:**

- If want the bars to be displayed horizontally instead of vertically, use the **barh()** function.

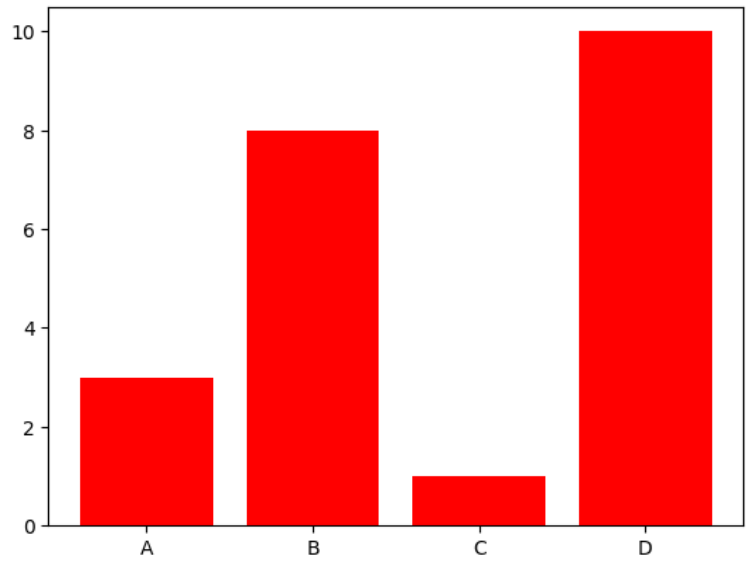
```
x = np.array(["A", "B", "C", "D"])
y = np.array([3, 8, 1, 10])

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



> **Bar Color:**

- The **bar()** and **barh()** take the keyword argument **color** to set the color of the bars.

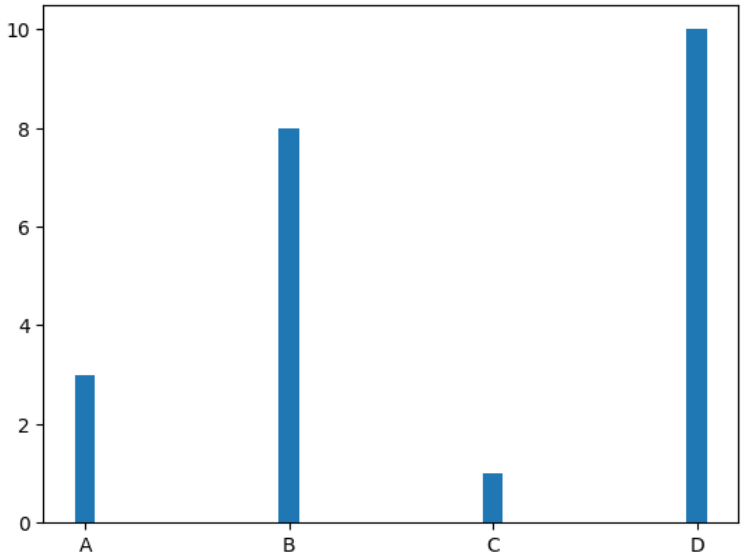
```
x = np.array(["A", "B", "C", "D"])
y = np.array([3, 8, 1, 10])

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



> **Bar Width:**

- The **bar()** takes the keyword argument **width** to set the width of the bars.
- The default width value is 0.8.
- **Note:** For horizontal bars, use **height** instead of width.

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

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



> **Bar Height:**

- The **barh()** takes the keyword argument **height** to set the height of the bars.
- The default height value is **0.8**

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

plt.barh(x, y, height = 0.1)
plt.show()
```