PYTHON INTERNSHIP MANUAL

Batch A - 2025

Week#10 (Matplotlib for Data Visualization)

Important Instructions:

- Read the manual carefully and understand every topic before starting the assignment.
- Follow the deadlines properly; marks will be deducted for late submissions.
- Avoid to use AI Tools and make your own logic.
- Completing all tasks in the assignment is compulsory to receive full marks.

- **Manual Posted Date:**

  10th May, 2025 (Saturday)

- **Assignment-6 Deadline:**

  15th May, 2025 (Thursday 11:59pm)

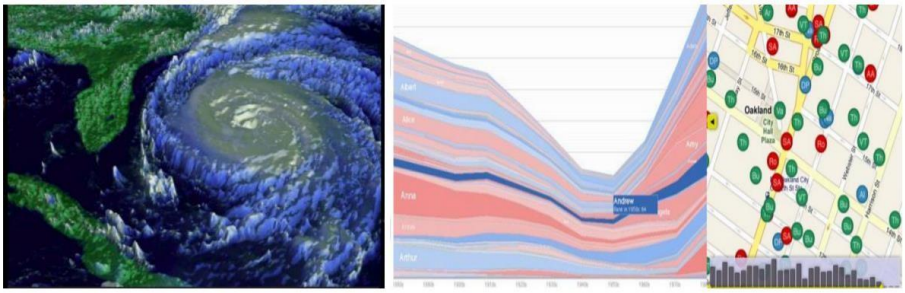
Data Visualization

Data visualization is all about understanding data by placing it in a visual context (e.g. graphs, charts, etc.) so that patterns, trends and correlations can be exposed that might not otherwise be detected.

Data visualization is visual representation of data for exploration, discovery, and insight of data.

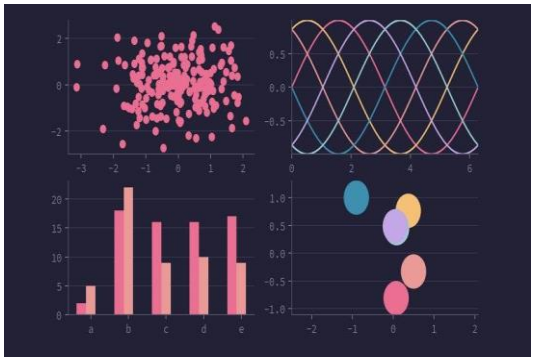
Interactive component provides more insight as compared to a static image.

For example:



Matplotlib Library for Data Visualization

Matplotlib is a Python library used to create charts and graphs. For example:



- Line Plot
- Scatter Plot
- Bar Chart
- Histogram
- Pie Chart
- Box Plot
- Violin Plot

Using Matplotlib Library for Data Visualization

To use matplotlib in python, firstly we need to import that into our environment like this:
from matplotlib import pyplot as
plt OR
import matplotlib.pyplot as plt
This will help us in creating many types of charts and graphs that we will study in this lab.

Line Graphs

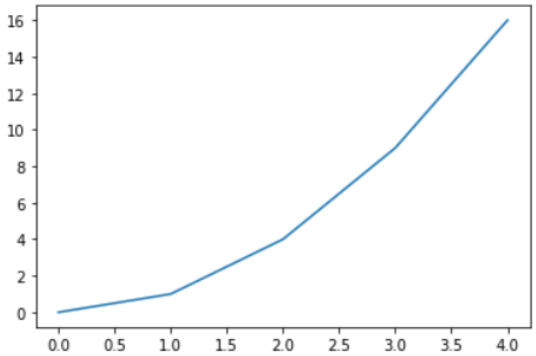
➢ Basic Line Plot

Line graphs are helpful for visualizing how a variable changes over time.
Some possible data that would be displayed with a line graph:

- Average prices of gasoline over the past decade.
- Weight of an individual over the past couple of months.
- Average temperature along a line of longitude over different latitudes

Using Matplotlib methods, the following code will create a simple line graph using .plot() and display it using .show():

```
from matplotlib import pyplot as plt

x_values=[0,1,2,3,4]
y_values=[0,1,4,9,16]

plt.plot(x_values,y_values)
plt.show()
```

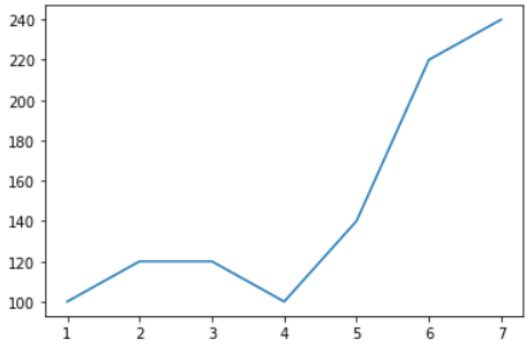


➢ Example - 1

We are going to make a simple graph representing someone's spending on lunch over the past week.
First, define two lists, days and money spent, that contain the following integers:

Days	Money Spent
1	100
2	120
3	120
4	100
5	140
6	220
7	240

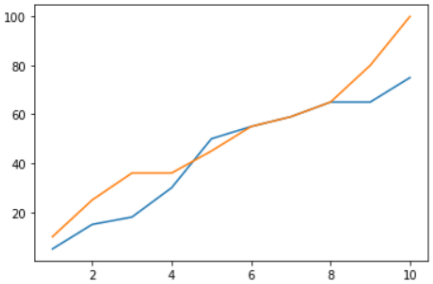
```
from matplotlib import pyplot as plt

days = range(1,8) # days = [1, 2, 3, 4, 5, 6, 7]

money_spent = [100, 120, 120, 100, 140, 220, 240]

plt.plot(days, money_spent)

plt.show()
```



➢ Multiple Line Graphs

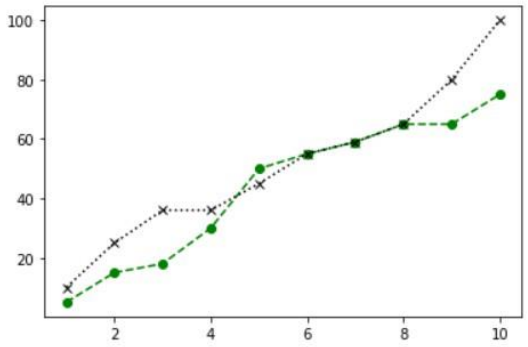
We can also have multiple line plots displayed on the same set of axes. This can be very useful if we want to compare two datasets with the same scale and axis categories
Matplotlib will automatically place the two lines on the same axes and give them different colors if you call plt.plot() twice.

```
from matplotlib import pyplot as plt

overs=[1,2,3,4,5,6,7,8,9,10]
Pakistan=[5,15,18,30,50,55,59,65,65,75]
Australia=[10,25,36,36,45,55,59,65,80,100]
plt.plot(overs, Pakistan)
plt.plot(overs, Australia)

plt.show()
```



➢ Changing Line Styles

```
from matplotlib import pyplot as plt

overs=[1,2,3,4,5,6,7,8,9,10]
Pakistan=[5,15,18,30,50,55,59,65,65,75]
NewZealand=[10,25,36,36,45,55,59,65,80,100]
plt.plot(overs, Pakistan,color='g',linestyle='--',marker='o')
plt.plot(overs, NewZealand ,color='black',linestyle=':',marker='x')

plt.show()
```



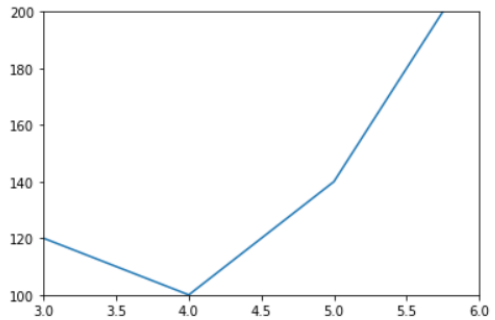
➢ Axis and Labels

Sometimes, it can be helpful to zoom in or out of the plot, especially if there is some detail we want to address. To zoom, we can use plt.axis().

We use plt.axis() by feeding it a list as input. This list should contain:

- The minimum x-value displayed
- The maximum x-value displayed
- The minimum y-value displayed
- The maximum y-value displayed

```
from matplotlib import pyplot as plt
days = range(1,8) # days = [1, 2, 3, 4, 5, 6, 7]
money_spent = [100, 120, 120, 100, 140, 220, 240]
plt.plot(days, money_spent)
plt.axis([3,6,100,200]) #x-min,x-max,y-min,y-max
plt.show()
```



➢ Example - 2

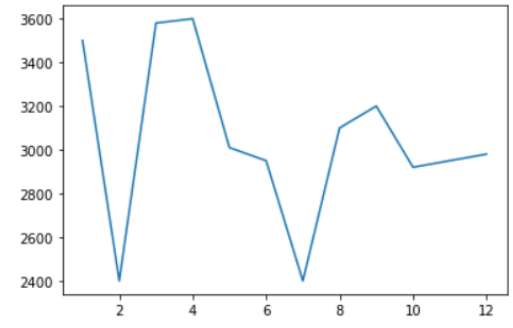
We have plotted a line representing someone's spending on coffee over the past 12 years.

Years	Spending
1	3500
2	2400
3	3580
4	3600
5	3010
6	2950
7	2400
8	3100
9	3200
10	2920
11	2950
12	2980

Use plt.axis() to modify the axes so that the x-axis goes from 1 to 12, and the y-axis goes from 2900 to 3100.

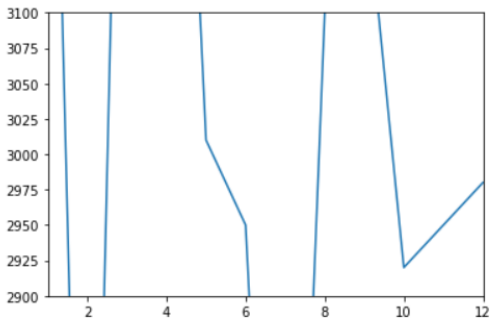
Original Graph:

```
from matplotlib import pyplot as plt
x = range(1,13)
y = [3500, 2400, 3580, 3600, 3010, 2950, 2400, 3100, 3200,
2920, 2950, 2980]
plt.plot(x, y)
plt.show()
```

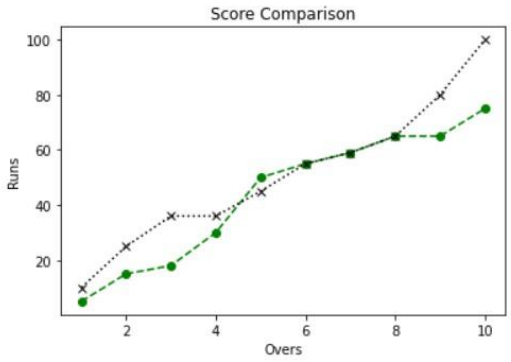


Modified Graph:

```
from matplotlib import pyplot as plt
x = range(1,13)
y = [3500, 2400, 3580, 3600, 3010, 2950, 2400, 3100, 3200
2920, 2950, 2980]
plt.plot(x, y)
plt.axis([1,12,2900,3100])
plt.show()
```

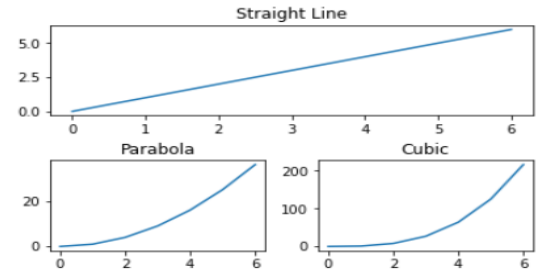


```
from matplotlib import pyplot as plt
overs=[1,2,3,4,5,6,7,8,9,10]
Pakistan=[5,15,18,30,50,55,59,65,65,75]
NewZealand=[10,25,36,36,45,55,59,65,80,100]
plt.plot(overs, Pakistan,color='g',linestyle='--',marker='o')
plt.plot(overs, NewZealand ,color='black',linestyle=':',marker='x')
plt.title("Score Comparison")
plt.xlabel("Overs")
plt.ylabel("Runs")
plt.show()
```



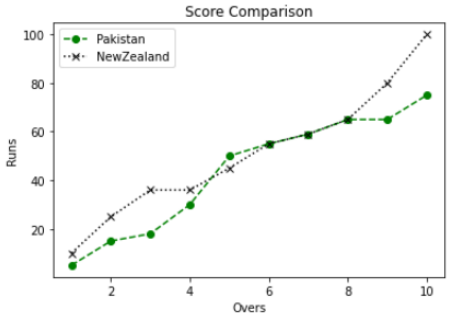
➢ Example – 3 (Straight Line, Cubic and Parabola)

```
from matplotlib import pyplot as plt
x = range(7)
straight_line = [0, 1, 2, 3, 4, 5, 6]
parabola = [0, 1, 4, 9, 16, 25, 36]
cubic = [0, 1, 8, 27, 64, 125, 216]
# Subplot 1
plt.subplot(2, 1, 1)
plt.title("Straight Line")
plt.plot(x, straight_line)
# Subplot 2
plt.subplot(2, 2, 3)
plt.title("Parabola")
plt.plot(x, parabola)
# Subplot 3
plt.subplot(2, 2, 4)
plt.plot(x, cubic)
plt.title("Cubic")
plt.subplots_adjust(hspace=0.5,wspace=0.25, bottom=0.2)
plt.show()
```



➢ Legends

```
from matplotlib import pyplot as plt
overs=[1,2,3,4,5,6,7,8,9,10]
Pakistan=[5,15,18,30,50,55,59,65,65,75]
NewZealand=[10,25,36,36,45,55,59,65,80,100]
plt.plot(overs, Pakistan,color='g',linestyle='--',marker='o')
plt.plot(overs, NewZealand ,color='black',linestyle=':',marker='x')
plt.legend(['Pakistan', 'NewZealand'])
plt.title("Score Comparison")
plt.xlabel("Overs")
plt.ylabel("Runs")
plt.show()
```

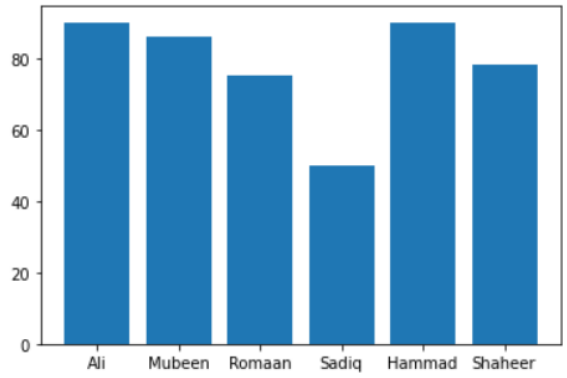


Sometimes, it’s easier to label each line as we create it.
If we want, we can use the keyword label inside of plt.plot().
If we choose to do this, we don’t pass any labels into plt.legend().

➢ Bargraphs

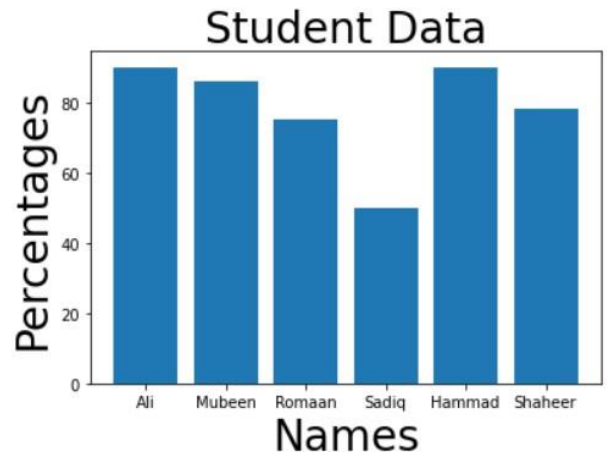
- **Creating a bargraph:**

```
import matplotlib.pyplot as plt
names=["Ali","Mubeen","Romaan","Sadiq","Hammad","Shaheer"] #storing values that will be shown on x-axis
percentages=[90,86,75,50,90,78] ##storing values that will be shown on y-axis
plt.bar(names,percentages) #x-axis, y-axis
plt.show()
```



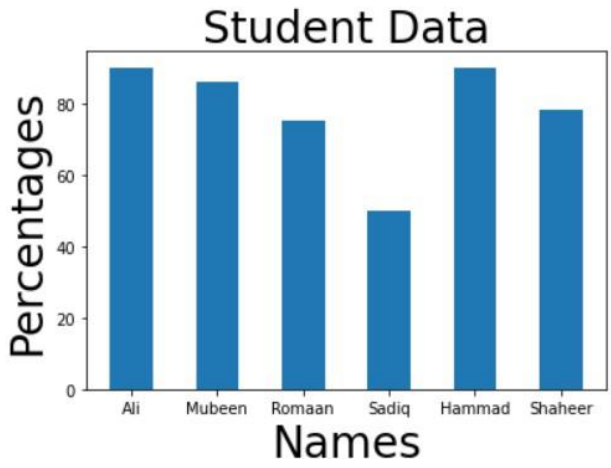
- **Adding titles and axis labels to the bargraph**

```
import matplotlib.pyplot as plt
names=["Ali","Mubeen","Romaan","Sadiq","Hammad","Shaheer"] #storing values that will be shown on x-axis
percentages=[90,86,75,50,90,78] ##storing values that will be shown on y-axis
plt.xlabel("Names",fontsize=28) #fontsize is optional
plt.ylabel("Percentages",fontsize=28) #fontsize is optional
plt.title("Student Data", fontsize=28) #fontsize is optional
plt.bar(names,percentages) #x-axis, y-axis
plt.show()
```



- **Adjusting the width**

```
import matplotlib.pyplot as plt
names=["Ali","Mubeen","Romaan","Sadiq","Hammad","Shaheer"] #storing values that will be shown on x-axis
percentages=[90,86,75,50,90,78] ##storing values that will be shown on y-axis
plt.xlabel("Names",fontsize=28) #fontsize is optional
plt.ylabel("Percentages",fontsize=28) #fontsize is optional
plt.title("Student Data", fontsize=28) #fontsize is optional
plt.bar(names,percentages,width=0.5) #x-axis, y-axis
plt.show()
```

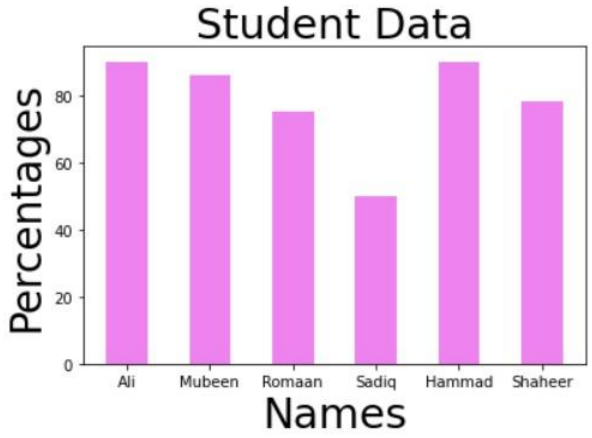


Values for width adjustment are normally given in a range of 0 – 1. However, a value greater than 1 is also acceptable, but, it will make all the bars overlap each other.

- **Color Adjustment**
  You can use any of the 140 supported color names (https://www.w3schools.com/colors/colors_names.asp).

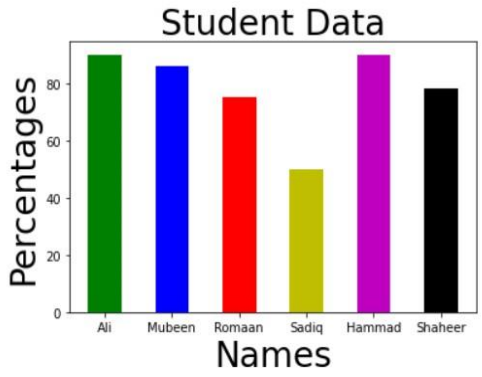
❖ **Single color:**

```
import matplotlib.pyplot as plt
names=["Ali","Mubeen","Romaan","Sadiq","Hammad","Shaheer"] #storing values that will be shown on x-axis
percentages=[90,86,75,50,90,78] ##storing values that will be shown on y-axis
plt.xlabel("Names",fontsize=28) #fontsize is optional
plt.ylabel("Percentages",fontsize=28) #fontsize is optional
plt.title("Student Data", fontsize=28) #fontsize is optional
plt.bar(names,percentages,width=0.5, color='violet') #x-axis, y-axis
plt.show()
```



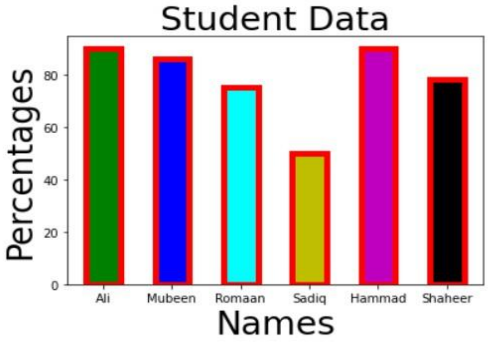
❖ Multiple colors:

```
import matplotlib.pyplot as plt
names=["Ali","Mubeen","Romaan","Sadiq","Hammad","Shaheer"] #storing values that will be shown on x-axis
percentages=[90,86,75,50,90,78] ##storing values that will be shown on y-axis
plt.xlabel("Names",fontsize=28) #fontsize is optional
plt.ylabel("Percentages",fontsize=28) #fontsize is optional
plt.title("Student Data", fontsize=28) #fontsize is optional
colors=['g','b','r','y','m','black']
plt.bar(names,percentages,width=0.5, color=colors) #x-axis, y-axis
plt.show()
```



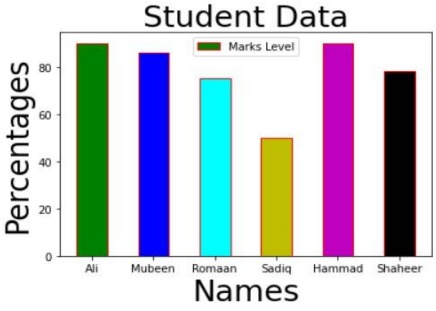
❖ Edge Coloring (Making Outlines):

```
import matplotlib.pyplot as plt
names=["Ali","Mubeen","Romaan","Sadiq","Hammad","Shaheer"] #storing values that will be shown on x-axis
percentages=[90,86,75,50,90,78] ##storing values that will be shown on y-axis
plt.xlabel("Names",fontsize=28) #fontsize is optional
plt.ylabel("Percentages",fontsize=28) #fontsize is optional
plt.title("Student Data", fontsize=28) #fontsize is optional
colors=['g','b','aqua','y','m','black']
plt.bar(names,percentages,width=0.5, color=colors,edgecolor='red',linewidth=5) #x-axis, y-axis
plt.show()
```



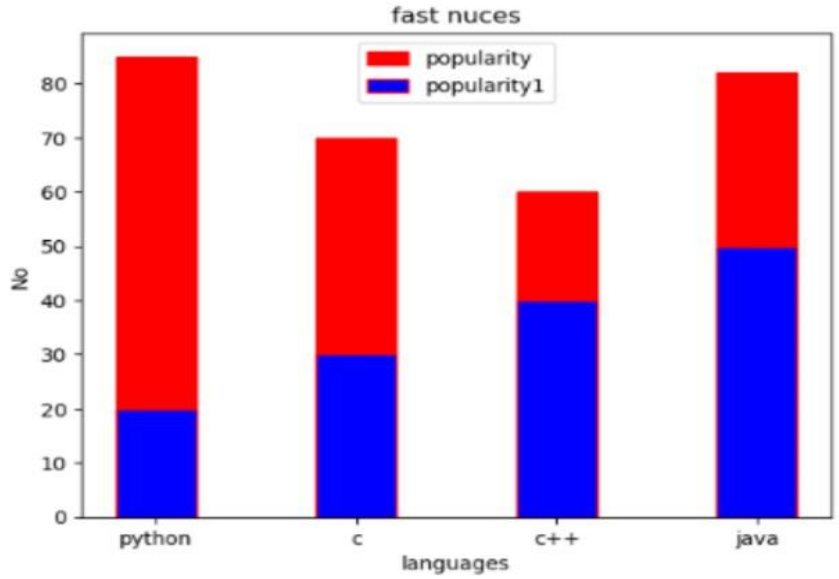
❖ Adding Legends:

```
import matplotlib.pyplot as plt
names=["Ali","Mubeen","Romaan","Sadiq","Hammad","Shaheer"] #storing values that will be shown on x-axis
percentages=[90,86,75,50,90,78] ##storing values that will be shown on y-axis
plt.xlabel("Names",fontsize=28) #fontsize is optional
plt.ylabel("Percentages",fontsize=28) #fontsize is optional
plt.title("Student Data", fontsize=28) #fontsize is optional
colors=['g','b','aqua','y','m','black']
plt.bar(names,percentages,width=0.5, color=colors,edgecolor='red',linewidth=1,label="Marks Level") #x-axis, y-axis
plt.legend()
plt.show()
```



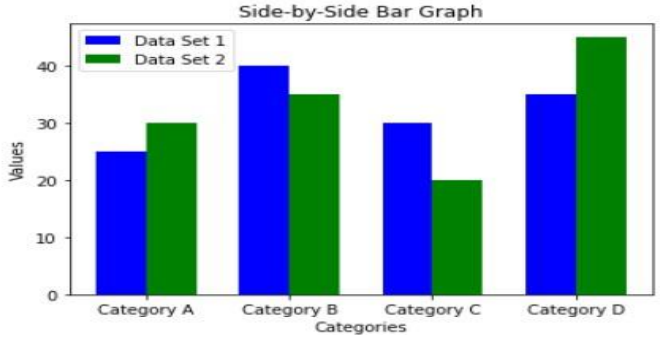
- **Multiple Bargraphs**

```
#Multiple bar graphs

x = ["python", "c", "c++", "java"]
y = [85,70,60,82]
z = [20, 30, 40, 50]
plt.xlabel("languages", fontsize = 10)
plt.ylabel("No")
plt.title("fast nuces")
c = ["y","b","m","g"]
plt.bar(x,y, width = 0.4, color="r", edgecolor="r",linewidth=1, label = "popularity")
plt.bar(x,z, width = 0.4, color="b", edgecolor="r",linewidth=1, label = "popularity1"
plt.legend()
plt.show()
```



❖ **Side – by – Side Bargraphs:**

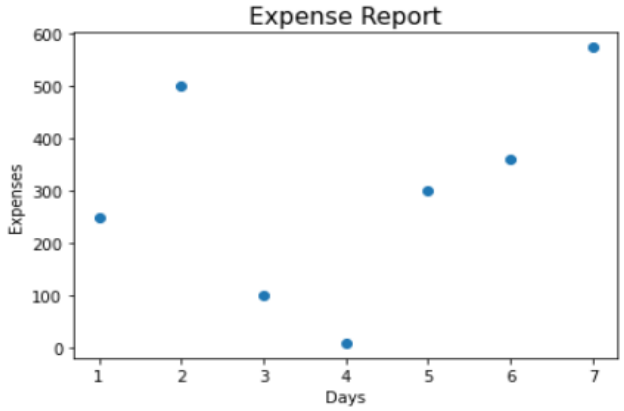
```
import matplotlib.pyplot as plt
import numpy as np
# Sample data
categories = ['Category A', 'Category B', 'Category C', 'Category D']
data_set1 = [25, 40, 30, 35]
data_set2 = [30, 35, 20, 45]
# Set the width of each bar
bar_width = 0.35
# Generate an array of equally spaced values for the x-axis
x = np.arange(len(categories))
# Create the side-by-side bars
plt.bar(x - bar_width/2, data_set1, bar_width, label='Data Set 1', color='blue')
plt.bar(x + bar_width/2, data_set2, bar_width, label='Data Set 2', color='green')
# Add labels and title
plt.xlabel('Categories')
plt.ylabel('Values')
plt.title('Side-by-Side Bar Graph')
plt.xticks(x, categories)
plt.legend()
# Display the graph
plt.show()
```



➢ Scatterplots

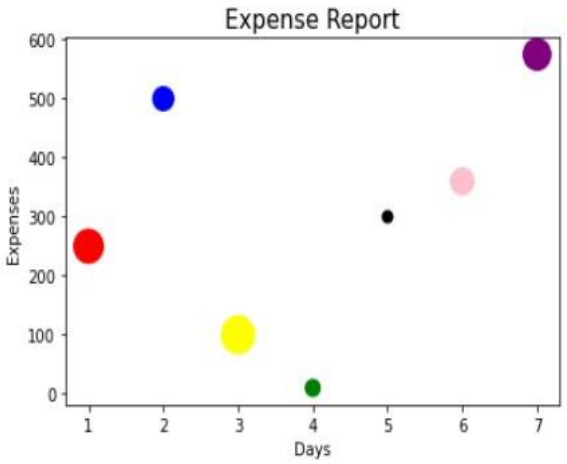
- **Creating a scatterplot:**

```
import matplotlib.pyplot as plt
days_of_week=[1,2,3,4,5,6,7]
expenses=[250,500,100,10,300,360,575]
plt.scatter(days_of_week,expenses)
plt.xlabel('Days')
plt.ylabel('Expenses')
plt.title("Expense Report",fontsize=15)
plt.show()
```



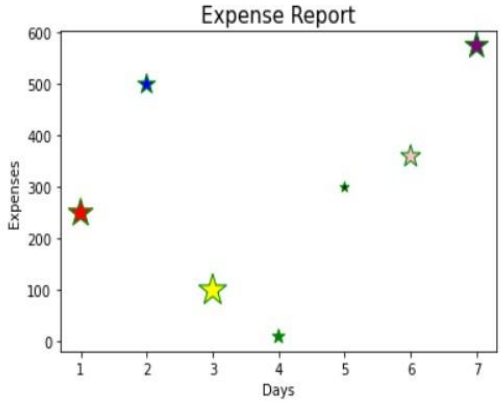
- **Colors & sizes:**

```
import matplotlib.pyplot as plt
days_of_week=[1,2,3,4,5,6,7]
expenses=[250,500,100,10,300,360,575]
sizes=[400,200,500,100,50,250,350] #storing sizes for each value to be plotted
colors=['red','blue','yellow','green','black','pink','purple'] #storing colors for each value to be plotted
plt.scatter(days_of_week,expenses, s=sizes,c=colors) #'s' is the deafult attribute for size and 'c' for colors
plt.xlabel('Days')
plt.ylabel('Expenses')
plt.title("Expense Report",fontsize=15)
plt.show()
```



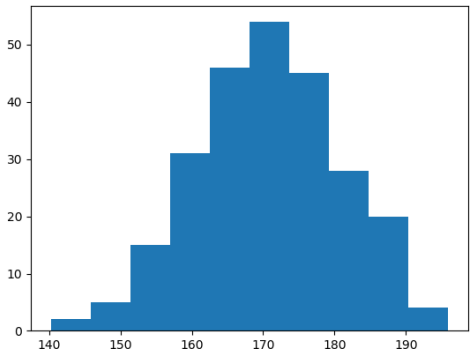
- **Changing Markers:**

```
import matplotlib.pyplot as plt
days_of_week=[1,2,3,4,5,6,7]
expenses=[250,500,100,10,300,360,575]
sizes=[400,200,500,100,50,250,350] #storing sizes for each value to be plotted
colors=['red','blue','yellow','green','black','pink','purple'] #storing colors for each value to be plotted
plt.scatter(days_of_week,expenses,s=sizes,c=colors,marker="*", edgecolor='g') #marker attribute changes display of scatterplot
plt.xlabel('Days')
plt.ylabel('Expenses')
plt.title("Expense Report",fontsize=15)
plt.show()
```



➢ Histograms

A histogram is a graph showing frequency distributions. It is a graph showing the number of observations within each given interval.
Example: Say you ask for the height of 250 people; you might end up with a histogram like this:

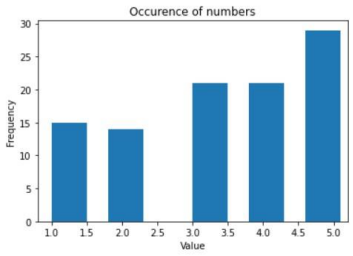


You can read from the histogram that there are approximately:
2 people from 140 to 145cm
5 people from 145 to 150cm
15 people from 151 to 156cm
31 people from 157 to 162cm
46 people from 163 to 168cm
53 people from 168 to 173cm
45 people from 173 to 178cm
28 people from 179 to 184cm
21 people from 185 to 190cm
4 people from 190 to 195cm

- **Creating a histogram:**

```
import matplotlib.pyplot as plt

values = [5, 5, 5, 4, 1, 3, 3, 2, 1, 4, 2, 2, 5, 5, 5, 5, 5, 5, 1, 4, 1, 3, 4, 1, 3, 4, 2, 5, 1, 4, 1, 2, 4, 4, 4, 4,
          5, 4, 5, 5, 3, 2, 3, 5, 2, 3, 1, 1, 5, 2, 1, 5, 3, 3, 3, 1, 3, 2, 3, 4, 4, 3, 5, 4, 4, 5, 3, 3, 4, 5, 1, 1, 3,
          4, 3, 5, 3, 5, 5, 2, 2, 1, 2, 4, 5, 3, 1, 5, 5, 5, 2, 5, 4, 5, 2, 3, 4, 4, 3]
# Print the array
print(values)
plt.hist(values,width=0.5)
plt.title('Occurence of numbers')
plt.xlabel('Value')
plt.ylabel('Frequency')
# Display the histogram
plt.show()
```

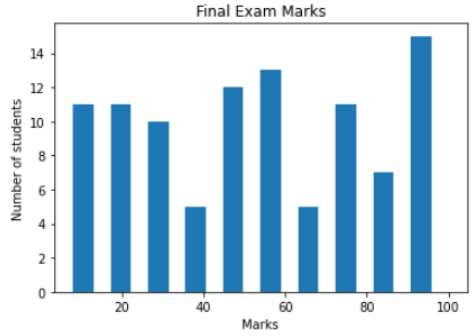
```
[5, 5, 5, 4, 1, 3, 3, 2, 1, 4, 2, 2, 5, 5, 5, 5, 5, 5, 1, 4, 1, 3, 4, 1, 3, 4, 2, 5, 1, 4, 1, 2, 4, 4, 4, 4, 5, 4, 5, 5, 3,
2, 3, 5, 2, 3, 1, 1, 5, 2, 1, 5, 3, 3, 3, 1, 3, 2, 3, 4, 4, 3, 5, 4, 4, 5, 3, 3, 4, 5, 1, 1, 3, 4, 3, 5, 3, 5, 5, 2, 2, 1, 2,
4, 5, 3, 1, 5, 5, 5, 2, 5, 4, 5, 2, 3, 4, 4, 3]
```



Another Example:

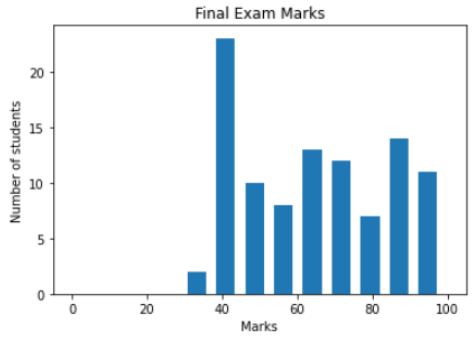
```
import matplotlib.pyplot as plt

std_marks = [50, 48, 41, 100, 38, 19, 46, 54, 61, 61, 20, 22, 52, 45, 13, 8, 19, 55, 66, 21, 27, 94, 36, 38, 88, 23, 78, 33,
          92, 51, 95, 66, 97, 74, 92, 76, 91, 17, 57, 68, 19, 31, 13, 79, 72, 35, 62, 79, 81, 29, 23, 11, 52, 98, 95, 45,
          98, 13, 84, 54, 13, 75, 63, 10, 96, 93, 53, 86, 22, 58, 59, 68, 91, 62, 84, 80, 45, 91, 19, 91, 15, 79, 55, 33,
          29, 24, 79, 87, 55, 17, 33, 82, 90, 43, 50, 13, 45, 32, 74, 33]
# Print the array
print(values)
plt.hist(values,width=5)
plt.title('Final Exam Marks')
plt.xlabel('Marks')
plt.ylabel('Number of students')
# Display the histogram
plt.show()
```

```
[50, 48, 41, 100, 38, 19, 46, 54, 61, 61, 20, 22, 52, 45, 13, 8, 19, 55, 66, 21, 27, 94, 36, 38, 88, 23, 78, 33, 92, 51, 95, 6
6, 97, 74, 92, 76, 91, 17, 57, 68, 19, 31, 13, 79, 72, 35, 62, 79, 81, 29, 23, 11, 52, 98, 95, 45, 98, 13, 84, 54, 13, 75, 63,
10, 96, 93, 53, 86, 22, 58, 59, 68, 91, 62, 84, 80, 45, 91, 19, 91, 15, 79, 55, 33, 29, 24, 79, 87, 55, 17, 33, 82, 90, 43, 50,
13, 45, 32, 74, 33]
```



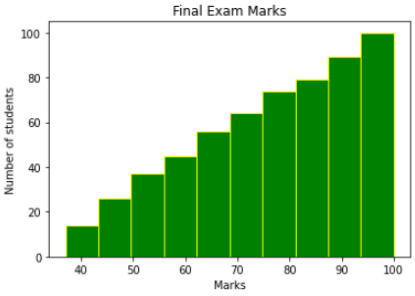
```
import matplotlib.pyplot as plt

std_marks = [63, 41, 84, 97, 99, 46, 56, 91, 75, 43, 40, 92, 90, 75, 99, 43, 97, 51, 51, 44, 46, 62, 68, 72, 89, 65, 58, 97,
             76, 62, 50, 63, 46, 45, 92, 96, 94, 89, 37, 52, 45, 79, 46, 78, 90, 46, 94, 52, 73, 95, 42, 81, 59, 72, 41, 100,
             41, 73, 81, 87, 43, 76, 96, 46, 60, 53, 67, 54, 74, 91, 40, 65, 46, 67, 37, 81, 85, 60, 40, 66, 47, 63, 89, 87,
             53, 39, 72, 54, 74, 66, 59, 77, 40, 73, 63, 45, 52, 88, 85, 51]
# Print the array
print(values)
plt.hist(values,"auto",(0,100),width=5)
plt.title('Final Exam Marks')
plt.xlabel('Marks')
plt.ylabel('Number of students')
# Display the histogram
plt.show()
```

```
[63, 41, 84, 97, 99, 46, 56, 91, 75, 43, 40, 92, 90, 75, 99, 43, 97, 51, 51, 44, 46, 62, 68, 72, 89, 65, 58, 97, 76, 62, 50, 6
3, 46, 45, 92, 96, 94, 89, 37, 52, 45, 79, 46, 78, 90, 46, 94, 52, 73, 95, 42, 81, 59, 72, 41, 100, 41, 73, 81, 87, 43, 76, 96,
46, 60, 53, 67, 54, 74, 91, 40, 65, 46, 67, 37, 81, 85, 60, 40, 66, 47, 63, 89, 87, 53, 39, 72, 54, 74, 66, 59, 77, 40, 73, 63,
45, 52, 88, 85, 51]
```




```
import matplotlib.pyplot as plt

std_marks = [63, 41, 84, 97, 99, 46, 56, 91, 75, 43, 40, 92, 90, 75, 99, 43, 97, 51, 51, 44, 46, 62, 68, 72, 89, 65, 58, 97,
             76, 62, 50, 63, 46, 45, 92, 96, 94, 89, 37, 52, 45, 79, 46, 78, 90, 46, 94, 52, 73, 95, 42, 81, 59, 72, 41, 100,
             41, 73, 81, 87, 43, 76, 96, 46, 60, 53, 67, 54, 74, 91, 40, 65, 46, 67, 37, 81, 85, 60, 40, 66, 47, 63, 89, 87,
             53, 39, 72, 54, 74, 66, 59, 77, 40, 73, 63, 45, 52, 88, 85, 51]
# Print the array
print(values)
plt.hist(values, bins=10, edgecolor="yellow", color="green",cumulative=1) #bins reduce bars in histogram based on range
plt.title('Final Exam Marks')
plt.xlabel('Marks')
plt.ylabel('Number of students')
# Display the histogram
plt.show()
```

```
[63, 41, 84, 97, 99, 46, 56, 91, 75, 43, 40, 92, 90, 75, 99, 43, 97, 51, 51, 44, 46, 62, 68, 72, 89, 65, 58, 97, 76, 62, 50, 6
3, 46, 45, 92, 96, 94, 89, 37, 52, 45, 79, 46, 78, 90, 46, 94, 52, 73, 95, 42, 81, 59, 72, 41, 100, 41, 73, 81, 87, 43, 76, 96,
46, 60, 53, 67, 54, 74, 91, 40, 65, 46, 67, 37, 81, 85, 60, 40, 66, 47, 63, 89, 87, 53, 39, 72, 54, 74, 66, 59, 77, 40, 73, 63,
45, 52, 88, 85, 51]
```



Here, the bins = 10, i.e the number of bins to be created is 10. Setting bins to an integer creates bins of equal size or width. As the bin size is changed so then the bin width would be changed.

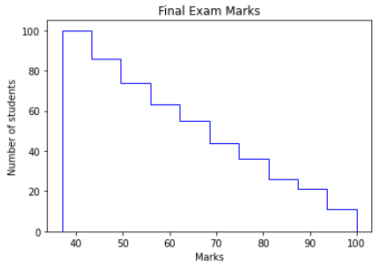
In the plt.hist function from the Matplotlib library, the cumulative parameter controls whether the histogram should be cumulative or not. When cumulative is set to -1, it means that the histogram will be cumulative, but it will be displayed with the opposite orientation.

A cumulative histogram displays the cumulative distribution of a dataset, showing how the data accumulates over a range of values. The values on the x-axis represent the data points, and the y-axis represents the cumulative count or proportion. Default value is ‘none’.

- cumulative=1: A regular cumulative histogram, starting from the lowest value and accumulating towards higher values.
- cumulative=-1: A cumulative histogram but displayed in reverse order, starting from the highest value and accumulating towards lower values.
- cumulative=None (or omitted): The default behavior, which is a standard histogram.
- **Setting type in a histogram:**

```
import matplotlib.pyplot as plt

std_marks = [63, 41, 84, 97, 99, 46, 56, 91, 75, 43, 40, 92, 90, 75, 99, 43, 97, 51, 51, 44, 46, 62, 68, 72, 89, 65, 58, 97,
             76, 62, 50, 63, 46, 45, 92, 96, 94, 89, 37, 52, 45, 79, 46, 78, 90, 46, 94, 52, 73, 95, 42, 81, 59, 72, 41, 100,
             41, 73, 81, 87, 43, 76, 96, 46, 60, 53, 67, 54, 74, 91, 40, 65, 46, 67, 37, 81, 85, 60, 40, 66, 47, 63, 89, 87,
             53, 39, 72, 54, 74, 66, 59, 77, 40, 73, 63, 45, 52, 88, 85, 51]
# Print the array
print(values)
plt.hist(values, bins=10, edgecolor="blue", color="green",cumulative=-1, histtype="step")
plt.title('Final Exam Marks')
plt.xlabel('Marks')
plt.ylabel('Number of students')
# Display the histogram
plt.show()
```

```
[63, 41, 84, 97, 99, 46, 56, 91, 75, 43, 40, 92, 90, 75, 99, 43, 97, 51, 51, 44, 46, 62, 68, 72, 89, 65, 58, 97, 76, 62, 50, 6
3, 46, 45, 92, 96, 94, 89, 37, 52, 45, 79, 46, 78, 90, 46, 94, 52, 73, 95, 42, 81, 59, 72, 41, 100, 41, 73, 81, 87, 43, 76, 96,
46, 60, 53, 67, 54, 74, 91, 40, 65, 46, 67, 37, 81, 85, 60, 40, 66, 47, 63, 89, 87, 53, 39, 72, 54, 74, 66, 59, 77, 40, 73, 63,
45, 52, 88, 85, 51]
```

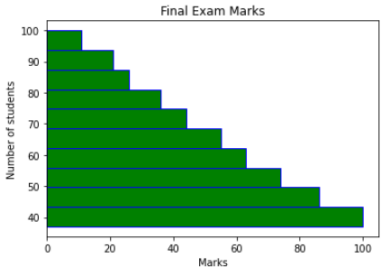


histtype : This parameter is an optional parameter and it is used to draw type of histogram. {‘bar’, ‘barstacked’, ‘step’, ‘stepfilled’}

- **Changing orientation in a histogram:**

```
import matplotlib.pyplot as plt

std_marks = [63, 41, 84, 97, 99, 46, 56, 91, 75, 43, 40, 92, 90, 75, 99, 43, 97, 51, 51, 44, 46, 62, 68, 72, 89, 65, 58, 97,
             76, 62, 50, 63, 46, 45, 92, 96, 94, 89, 37, 52, 45, 79, 46, 78, 90, 46, 94, 52, 73, 95, 42, 81, 59, 72, 41, 100,
             41, 73, 81, 87, 43, 76, 96, 46, 60, 53, 67, 54, 74, 91, 40, 65, 46, 67, 37, 81, 85, 60, 40, 66, 47, 63, 89, 87,
             53, 39, 72, 54, 74, 66, 59, 77, 40, 73, 63, 45, 52, 88, 85, 51]
# Print the array
print(values)
plt.hist(values, bins=10, edgecolor="blue", color="green",cumulative=-1,orientation="horizontal" )
plt.title('Final Exam Marks')
plt.xlabel('Marks')
plt.ylabel('Number of students')
# Display the histogram
plt.show()
```

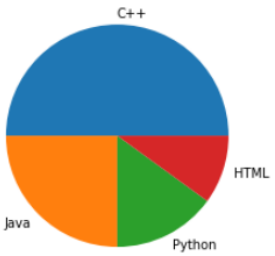
```
[63, 41, 84, 97, 99, 46, 56, 91, 75, 43, 40, 92, 90, 75, 99, 43, 97, 51, 51, 44, 46, 62, 68, 72, 89, 65, 58, 97, 76, 62, 50, 6
3, 46, 45, 92, 96, 94, 89, 37, 52, 45, 79, 46, 78, 90, 46, 94, 52, 73, 95, 42, 81, 59, 72, 41, 100, 41, 73, 81, 87, 43, 76, 96,
46, 60, 53, 67, 54, 74, 91, 40, 65, 46, 67, 37, 81, 85, 60, 40, 66, 47, 63, 89, 87, 53, 39, 72, 54, 74, 66, 59, 77, 40, 73, 63,
45, 52, 88, 85, 51]
```



➢ Pie Charts

- **Creating a pie chart:**

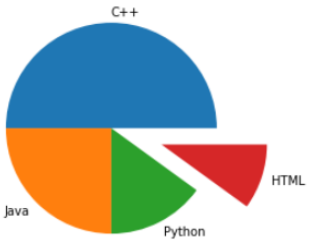
```
import matplotlib.pyplot as plt

popularityPercent = [50, 25, 15, 10]
labels=['C++','Java','Python','HTML']
plt.pie(popularityPercent,labels=labels)
plt.show()
```



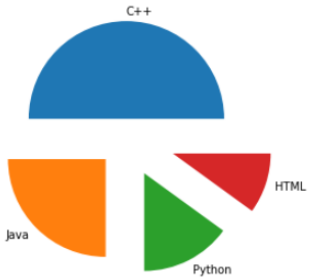
- **Exploding in a pie chart:**

Maybe you want one of the wedges to stand out? The explode parameter allows you to do that.
The explode parameter, if specified, and not None, must be an array with one value for each wedge.
Each value represents how far from the center each wedge is displayed:

```
import matplotlib.pyplot as plt

popularityPercent = [50, 25, 15, 10]
labels=['C++','Java','Python','HTML']
ex=[0,0,0,0.5]
plt.pie(popularityPercent,labels=labels,explode=ex)
plt.show()
```

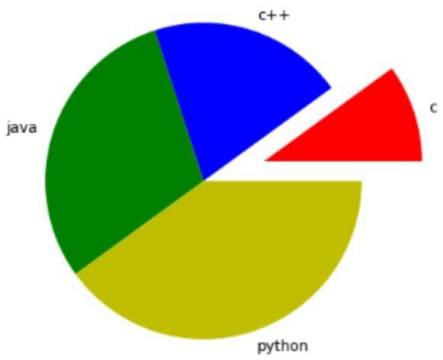



```
import matplotlib.pyplot as plt

popularityPercent = [50, 25, 15, 10]
labels=['C++','Java','Python','HTML']
ex=[0.2,0.3,0.4,0.5]
plt.pie(popularityPercent,labels=labels,explode=ex)
plt.show()
```



- **Color specification in a pie chart:**

```
x = [10,20,30,40]
y = ['c','c++','java','python']
ex = [0.4,0,0,0]
color = ["r","b","g","y"]
plt.pie(x, labels=y, explode = ex, colors = color)
plt.show()
```

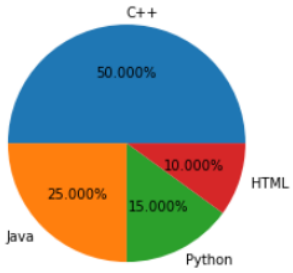


- **Assigning percentages in a pie chart:**

In Matplotlib's pie chart, the autopct parameter is used to label the individual slices of the pie with their numeric values and optionally format them as percentages. This parameter allows you to display the exact values or percentages of each slice on the chart.

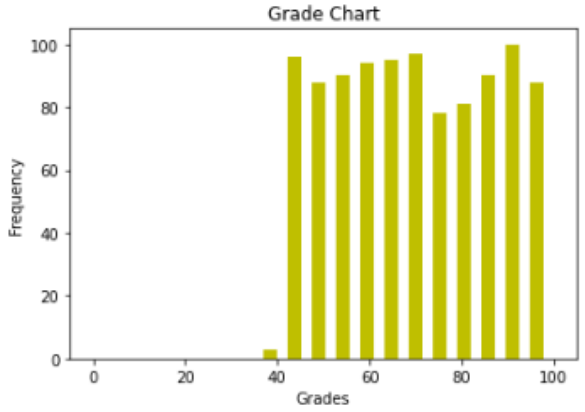
- If you set autopct=None or omit it, the chart won't display any labels.
- If you set autopct='%1.1f%%', it will display the percentages of each slice with one decimal place.
- If you set autopct='%1.2f%%', it will display the percentages of each slice with two decimal places.
- If you set autopct='%d', it will display the raw numeric value of each slice without decimal places.

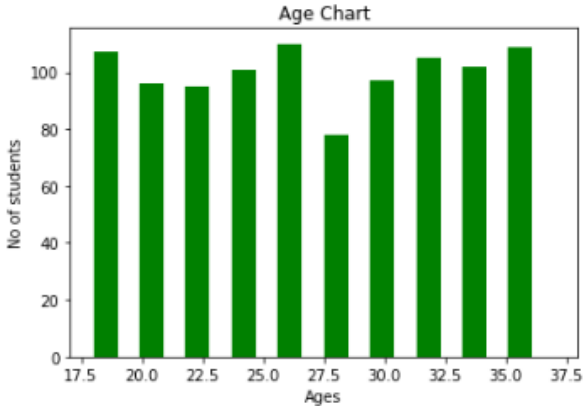
```
import matplotlib.pyplot as plt

popularityPercent = [50, 25, 15, 10]
labels=['C++','Java','Python','HTML']
plt.pie(popularityPercent,labels=labels,autopct="%1.3f%%")
plt.show()
```



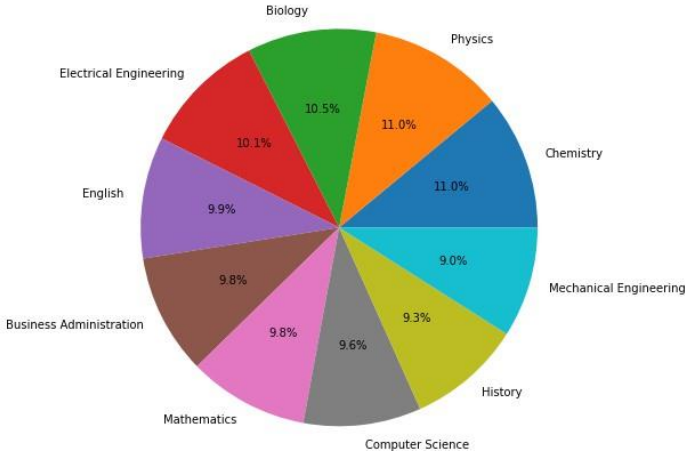
➢ Visualizing an actual dataset

```
import matplotlib.pyplot as plt
import pandas as pd
df=pd.read_csv(r'students_data.csv')

#Showing histogram for grade column
plt.hist(df['Grade'],"auto",(0,100),width=3,color='y')
plt.xlabel("Grades")
plt.ylabel("Frequency")
plt.title("Grade Chart")
plt.show()

#Showing a histogram for age column
plt.hist(df['Age'],width=1,color='g')
plt.xlabel("Ages")
plt.ylabel("No of students")
plt.title("Age Chart")
plt.show()
```

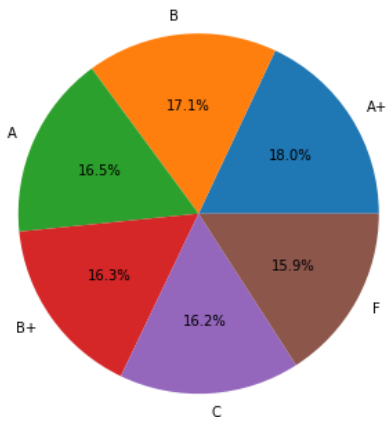




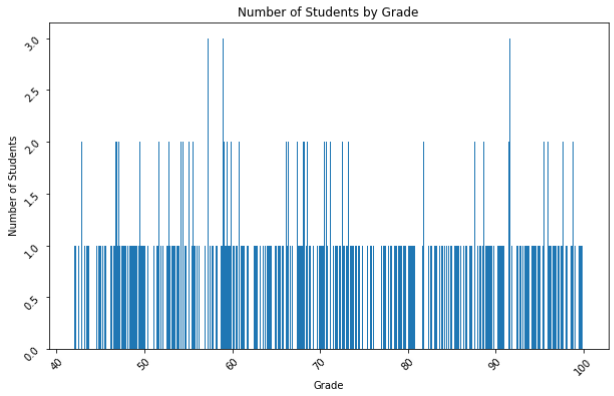
```python
#Plotting a pie chart for number of students in each department

import pandas as pd
import matplotlib.pyplot as plt
df=pd.read_csv(r'students_data.csv')
plt.figure(figsize=(8, 8))
department_counts = df['Department'].value_counts()
plt.pie(department_counts, labels=department_counts.index, autopct='%1.1f%%')
plt.show()
```



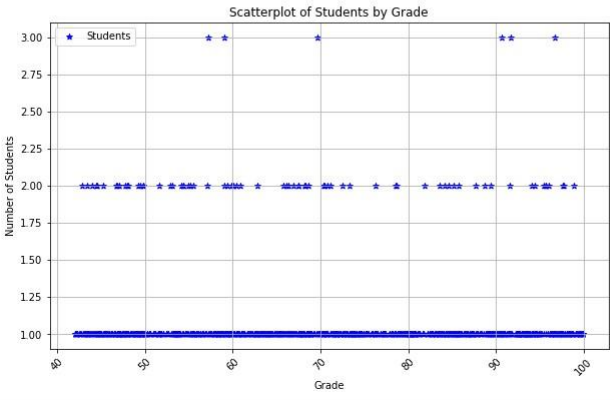

```python
import pandas as pd
import matplotlib.pyplot as plt
df=pd.read_csv(r'students_data.csv')
def assign_grade(percentage):
    if percentage >= 90:
        return "A+"
    elif percentage >= 80:
        return "A"
    elif percentage >= 70:
        return "B+"
    elif percentage >= 60:
        return "B"
    elif percentage >= 50:
        return "C"
    else:
        return "F"
df['Grades'] = df['Grade'].apply(assign_grade)
plt.figure(figsize=(6, 6))
grade_counts = df['Grades'].value_counts()
plt.pie(grade_counts, labels=grade_counts.index, autopct='%1.1f%%')
plt.show()
```



```python
import pandas as pd
import matplotlib.pyplot as plt

df=pd.read_csv(r'students_data.csv')
# Group the data by the 'Grade' column and count the number of students in each grade
grade_counts = df['Grade'].value_counts()
# Sort the grades in ascending order
sorted_grades = sorted(grade_counts.index)
# Get the corresponding student counts for the sorted grades
student_counts = [grade_counts[grade] for grade in sorted_grades]
# Create a bar graph
plt.figure(figsize=(10, 6))
plt.bar(sorted_grades, student_counts,width=0.05)
plt.xlabel('Grade')
plt.ylabel('Number of Students')
plt.title('Number of Students by Grade')
plt.xticks(rotation=45)  # Rotate x-axis labels for better readability
plt.yticks(rotation=45)
plt.show()
```




```python
import pandas as pd
import matplotlib.pyplot as plt

df=pd.read_csv(r'students_data.csv')
# Group the data by the 'Grade' column and count the number of students in each grade
grade_counts = df['Grade'].value_counts()
# Sort the grades in ascending order
sorted_grades = sorted(grade_counts.index)
# Get the corresponding student counts for the sorted grades
student_counts = [grade_counts[grade] for grade in sorted_grades]
# Create a scatterplot
plt.figure(figsize=(10, 6))
plt.scatter(sorted_grades, student_counts, marker='*', color='b', label='Students')
plt.xlabel('Grade')
plt.ylabel('Number of Students')
plt.title('Scatterplot of Students by Grade')
plt.xticks(rotation=45)  # Rotate x-axis labels for better readability
plt.legend()
plt.grid(True)
plt.show()
```



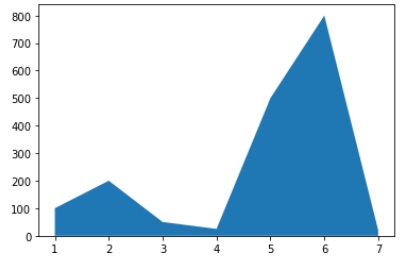
➢ Stackplot

A stack plot, also known as a stacked area chart, is a type of data visualization that is used to display multiple variables over a continuous interval, typically representing changes in those variables over time.

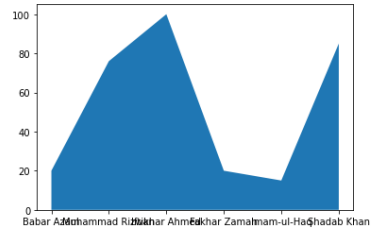
Stack plots are effective for visualizing data with multiple categories or components, allowing you to see the relative importance of each component and how it changes over time or along a continuous axis. They are commonly used in areas such as finance to represent the contributions of various sectors to a market index, in ecology to show the composition of different species in an ecosystem, and in many other fields where tracking the evolution of multiple components is important.

- **Examples:**

```
import matplotlib.pyplot as plt

days=[1,2,3,4,5,6,7]
expenses=[100,200,50,25,500,800,20]

plt.stackplot(days,expenses)
plt.show()
```




```
import matplotlib.pyplot as plt

Players=["Babar Azam","Muhammad Rizwan","Iftikhar Ahmed","Fakhar Zaman","Imam-ul-Haq","Shadab Khan"]
Runs=[20,76,100,20,15,85]

plt.stackplot(Players,Runs)
plt.show()
```




```
import matplotlib.pyplot as plt

Players=["Babar Azam","Muhammad Rizwan","Iftikhar Ahmed","Fakhar Zaman","Imam-ul-Haq","Shadab Khan"]
Runs_in_match1=[20,76,100,20,15,85]
Runs_in_match2=[100,20,36,0,15,5]
Runs_in_match3=[0,100,45,5,18,0]
l=["Match 1","Match 2","Match 3"]
plt.stackplot(Players,Runs_in_match1,Runs_in_match2,Runs_in_match3,labels=l)
plt.legend()
plt.show()
```