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K. J. Somaiya College of Engineering, Mumbai-77
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Department of Science and Humanities



Batch: C-5(3)

Roll No: 55

Experiment / assignment / tutorial No.

Grade: AA / AB / BB / BC / CC / CD / DD

Signature of the Staff In-charge with date

TITLE: To demonstrate Matplotlib library in python by studying its key features and its functions

AIM: Write a program to demonstrate matplotlib visualization functions using datasets

OUTCOME: Student will be able to:

CO1: Formulate problem statement and develop the logic (algorithm/flowchart) for its solution.

CO5: Illustrate the use of Python packages.

AIM: Write a program to explore the Matplotlib library

Resource Needed: Python IDE

Theory:

What is Matplotlib?

1. Matplotlib

Matplotlib is a data visualization library and 2-D plotting library of Python. It was initially released in 2003 and it is the most popular and widely-used plotting library in the Python community. It comes with an interactive environment across multiple platforms. Matplotlib can be used in Python scripts, the Python and IPython shells, the Jupyter notebook, web application servers, etc. It can be

used to embed plots into applications using various GUI toolkits like Tkinter, GTK+, wxPython, Qt, etc. So you can use Matplotlib to create plots, bar charts, pie charts, histograms, scatterplots, error charts, power spectra, stemplots, and whatever other visualization charts you want! The Pyplot module also provides a MATLAB-like interface that is just as versatile and useful as MATLAB while being free and open source.



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2. Plotly

Plotly is a free open-source graphing library that can be used to form data visualizations. Plotly (plotly.py) is built on top of the Plotly JavaScript library (plotly.js) and can be used to create web-based data visualizations that can be displayed in Jupyter notebooks or web applications using Dash or saved as individual HTML files. Plotly provides more than 40 unique chart types like scatter plots, histograms, line charts, bar charts, pie charts, error bars, box plots, multiple axes, sparklines, dendrograms, 3-D charts, etc. Plotly also provides contour plots, which are not that common in other data visualization libraries. In addition to all this, Plotly can be used offline with no internet connection

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.

Syntax:

`matplotlib.pyplot.plot(*args, scalex=True, scaley=True, data=None, **kwargs)`

- x, y: These parameters are the horizontal and vertical coordinates of the data points. x values are optional.
- fmt: This parameter is optional and it contains the string value.
- data: This parameter is optional and it is an object with labeled data.

This returns the following:

lines: This returns the list of Line2D objects representing the plotted data.

Example:-

Program	Output:
Draw a line in a diagram from position (1,3) to position (8,10)	

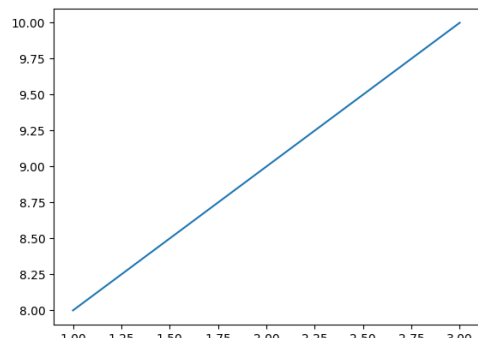


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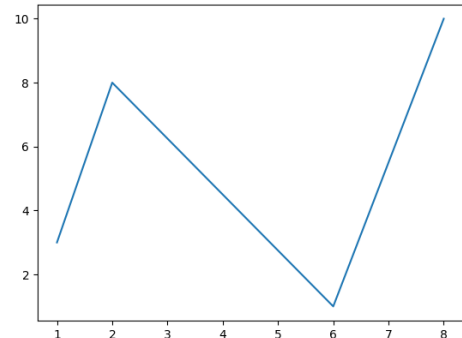
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Program	Output:
<pre>import matplotlib.pyplot as plt import numpy as np xpoints = np.array([1,3]) ypoints = np.array([8, 10]) plt.plot(xpoints,ypoints) plt.show()</pre>	

1) Multiple Points

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

Program	Output:
<pre>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()</pre>	

2) Matplotlib Line

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

Following are the linestyles available in *matplotlib*:

Using *linestyle* Argument:

- Solid
- Dashed
- Dotted



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- Dashdot
- None

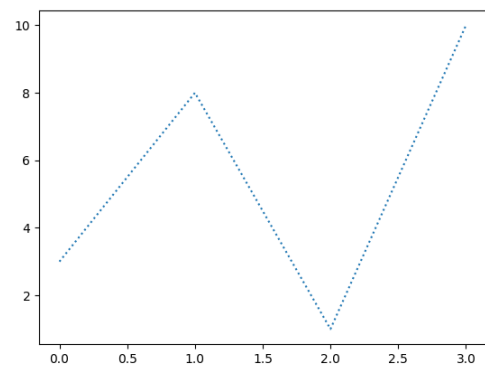
Syntax: plt.plot(xdata, ydata, linestyle='dotted')

Program

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()
```

Output:



3)Matplotlib Labels and

Title a.Create Labels for

a Plot

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

The label () function in the pyplot module of the matplotlib library sets the label for the x-axis.

Syntax: matplotlib.pyplot.xlabel(xlabel, fontdict=None, labelpad=None, **kwargs)

b. Create a Title for a Plot

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

Program

Output:



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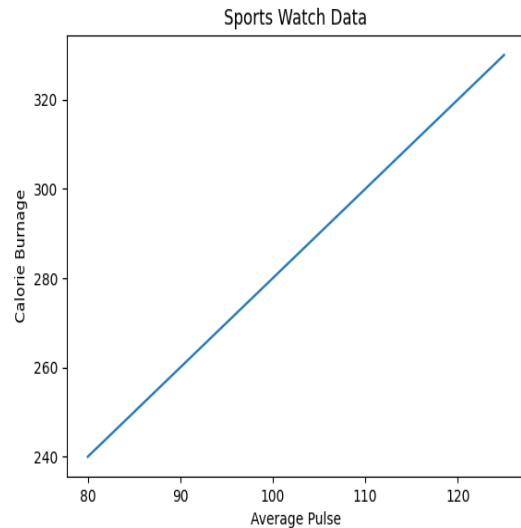
```
import numpy as np
import matplotlib.pyplot as plt
```

```
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")
)
```



4) Matplotlib Scatter

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:

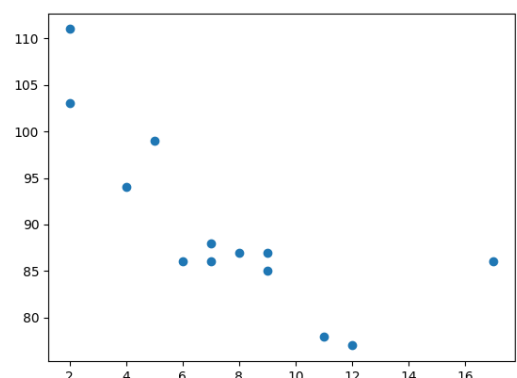
Syntax:-- `matplotlib.pyplot.scatter(x_axis_data, y_axis_data, s=None, c=None, marker=None, cmap=None, vmin=None, vmax=None, alpha=None, linewidths=None, edgecolors=None)`

- **x_axis_data**- An array containing x-axis data
- **y_axis_data**- An array containing y-axis data
- **s**- marker size (can be scalar or array of size equal to size of x or y)
- **c**- color of sequence of colors for markers
- **marker**- marker style
- **cmap**- cmap name
- **linewidths**- width of marker border
- **edgecolor**- marker border color
- **alpha**- blending value, between 0 (transparent) and 1 (opaque)

Except `x_axis_data` and `y_axis_data` all other parameters are optional and their default value is `None`. Below are the scatter plot examples with various parameters.

```
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()
```





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Add Grid Lines to a Plot

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

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

x = np.array([80, 85, 90, 95, 100, 105, 110,
115, 120, 125])

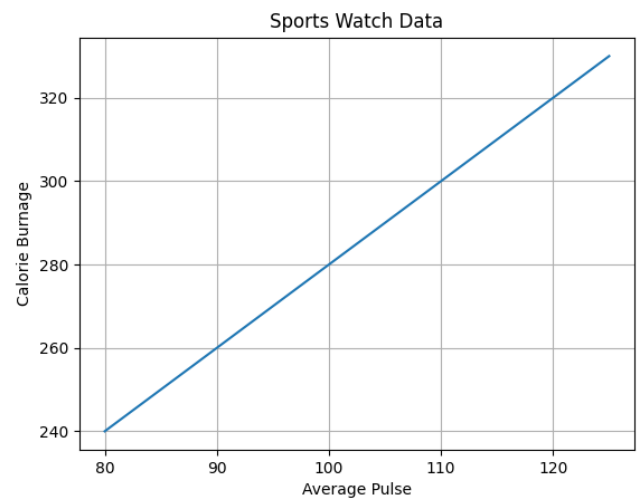
y =
np.array([240, 250, 260, 270, 280, 290, 300,
310, 320, 330]
)

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

plt.plot(x, y)

plt.grid()

plt.show()
```



5) Display Multiple Plots

With the `subplot()` function you can draw multiple plots in one figure.

```
subplot(nrows, ncols, index, **kwargs)
```

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.



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Program:-

```
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)
```

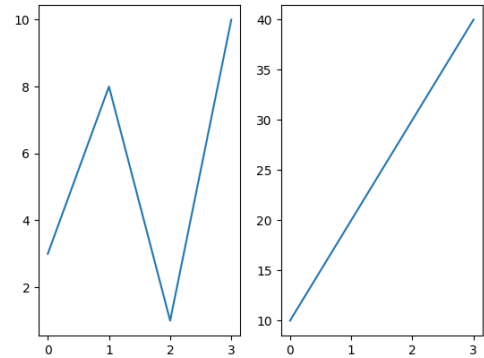
#plot 2:

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

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

```
plt.show()
```

Output:--



```
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)
```

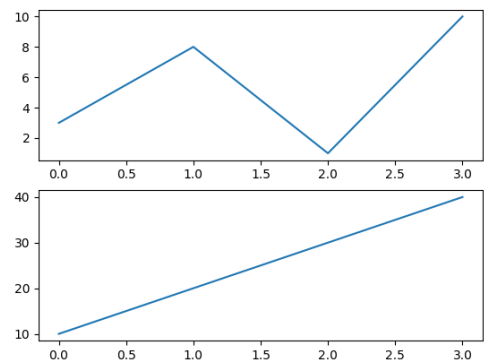
#plot 2:

```
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()
```

Output:--



6) Creating Bars

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



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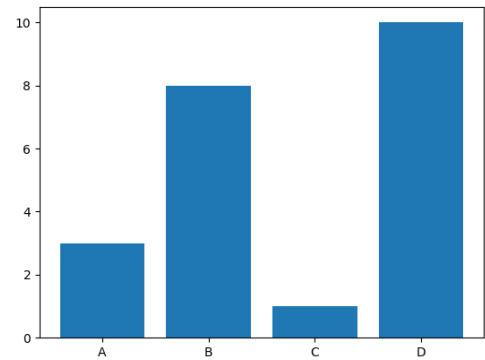


```
import matplotlib.pyplot as plt  
import numpy as np
```

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

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

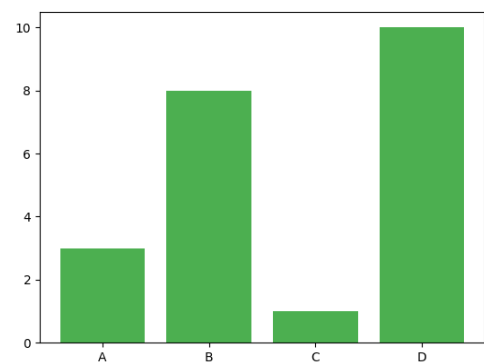
Output:--



```
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, color = "#4CAF50")  
plt.show()
```





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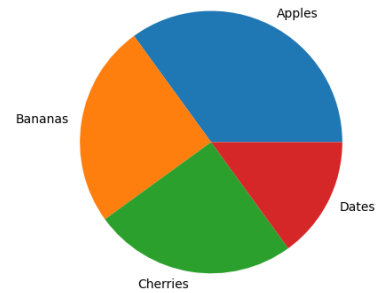
7) Creating Pie Chart with Labels:

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

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

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

Output:



Problem Definition:

Note:-- All plots should be labeled on the X-axis and Y-axis with a Grid for each program.

1. Write a Python program to draw a line using given axis values with suitable labels in the x-axis, y-axis, and title.

Implementation of Question 1:

```
# Question 1

import matplotlib.pyplot as plt

def draw_line(x_values, y_values):
    plt.figure()
    plt.plot(x_values, y_values, marker='*', color='r', label='Line')

    plt.xlabel('X-axis Label') # To add labels to the axis
    plt.ylabel('Y-axis Label')

    plt.title('Line Plot Example') # To add title to plot

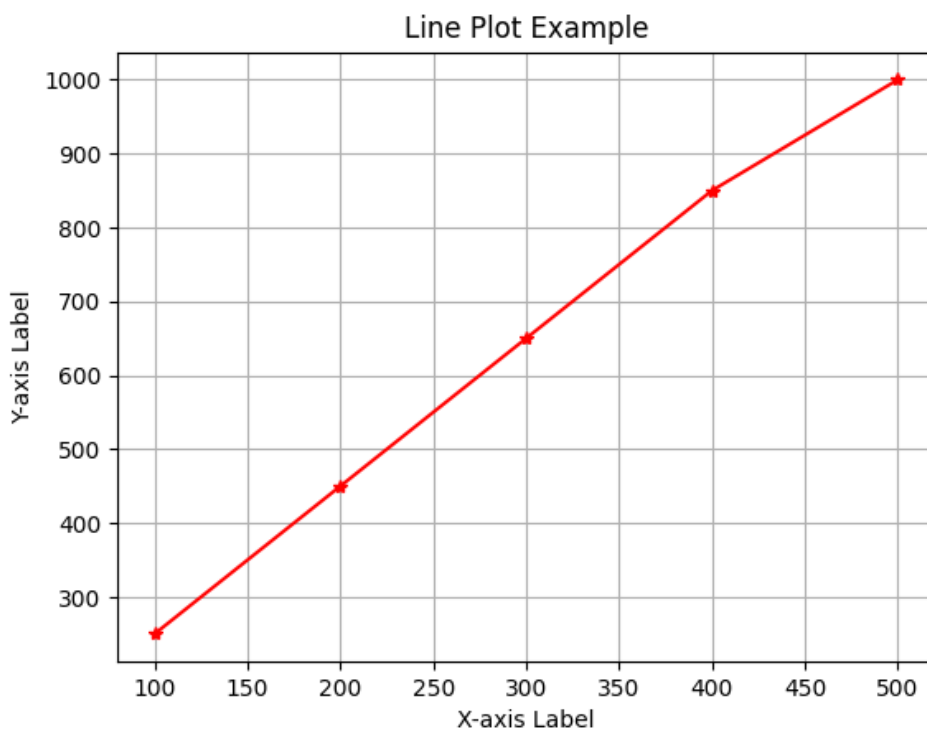
    plt.grid(True)

    plt.show()

x_values = [100, 200, 300, 400, 500]
y_values = [250, 450, 650, 850, 1000]

draw_line(x_values, y_values) # Call function
```

Output for Question 1:





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2] a) Write Python programming to display a bar chart of the popularity of programming Languages. Also, draw a Pie chart for popularity Data values. Sample data:

Programming languages: Java, Python, PHP, JavaScript, C#, C++

Popularity: 22.2, 17.6, 8.8, 8, 7.7, 6.7

b) Write a Python program to display a horizontal bar chart showing the popularity of programming languages. **Hint: use the `bar()` function**

Implementation of Question 2 (a and b)

```
# Question 2(a and b)

import matplotlib.pyplot as plt

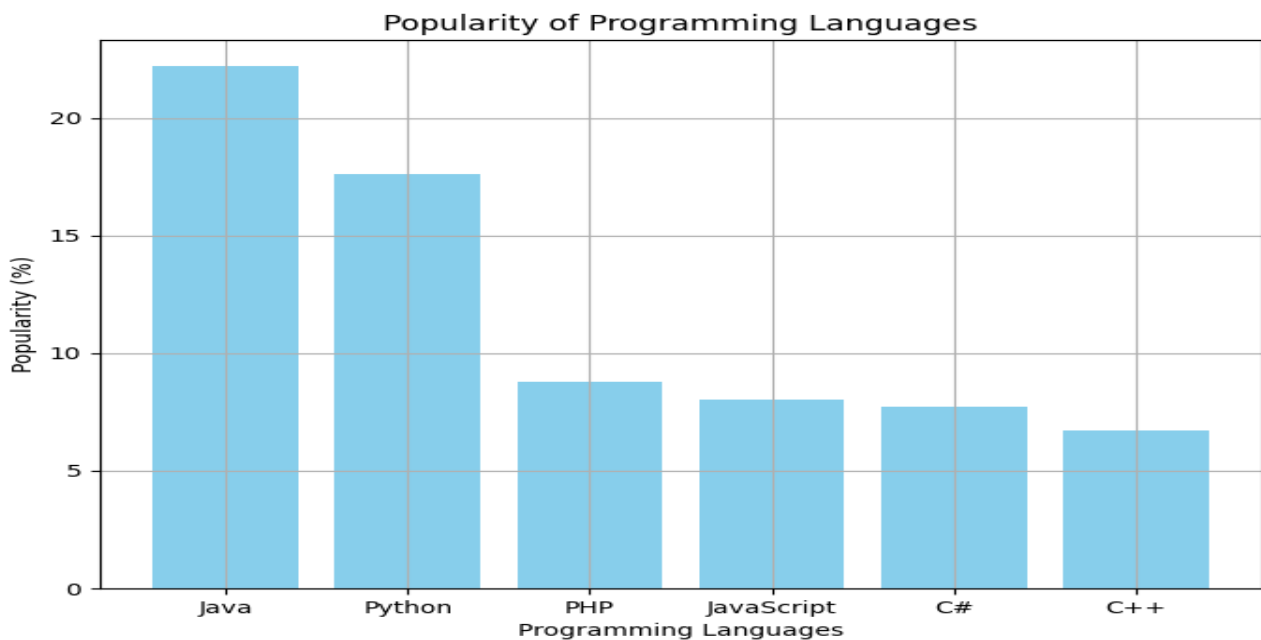
languages = ['Java', 'Python', 'PHP', 'JavaScript', 'C#', 'C++'] # Inputting Data
popularity = [22.2, 17.6, 8.8, 8, 7.7, 6.7]

def display_bar_chart(languages, popularity):
    # For bar chart
    plt.figure(figsize=(8, 6))
    plt.bar(languages, popularity, color='skyblue')
    plt.xlabel('Programming Languages')
    plt.ylabel('Popularity (%)')
    plt.title('Popularity of Programming Languages')
    plt.grid(True)
    plt.show()

def display_pie_chart(languages, popularity):
    # For pie chart
    plt.figure(figsize=(8, 6))
    plt.pie(popularity, labels=languages, autopct='%1.1f%%', startangle=140, colors=['gold', 'yellowgreen', 'lavender', 'lightskyblue', 'lightpink', 'lightgreen'])
    plt.title('Popularity Distribution of Programming Languages')
    plt.axis('equal')
    plt.show()

display_bar_chart(languages, popularity)
display_pie_chart(languages, popularity)
```

Output of Question 2 (a and b)





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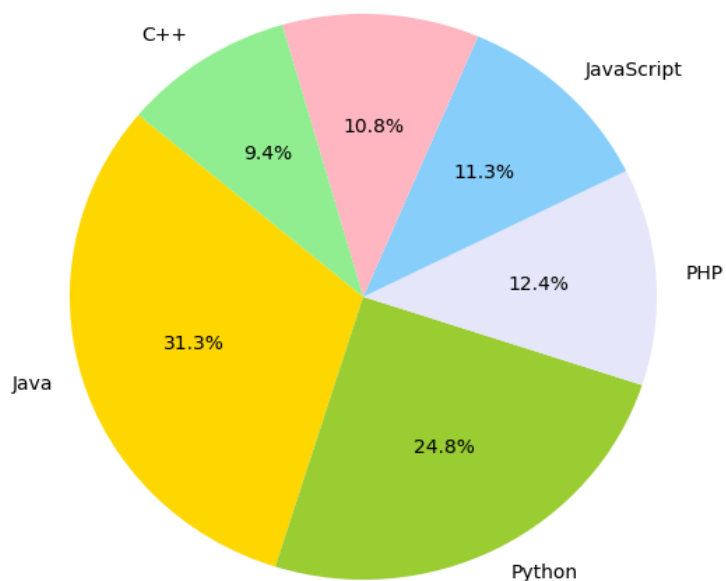
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Popularity Distribution of Programming Languages



- 3) Prepare a dataset using list as **Weight** and **height** parameters for your batch students and draw a scatter plot with appropriate label and title.

Implementation of Question 3:

```
# Question 3

import matplotlib.pyplot as plt

students_data = {
    "Weight (kg)": [35, 40, 45, 50, 55, 60, 65, 70, 75, 80],
    "Height (cm)": [140, 145, 150, 155, 160, 165, 170, 175, 180, 185],
}

weights = students_data["Weight (kg)"]
heights = students_data["Height (cm)"]

plt.figure(figsize=(8, 6))
plt.scatter(weights, heights, color='m', marker='^')

plt.title("Weight vs Height of Students", fontsize=14)
plt.xlabel("Weight (kg)", fontsize=12)
plt.ylabel("Height (cm)", fontsize=12)
plt.grid(True, linestyle='-', alpha=0.6)

plt.show()
```

Output for Question 3:



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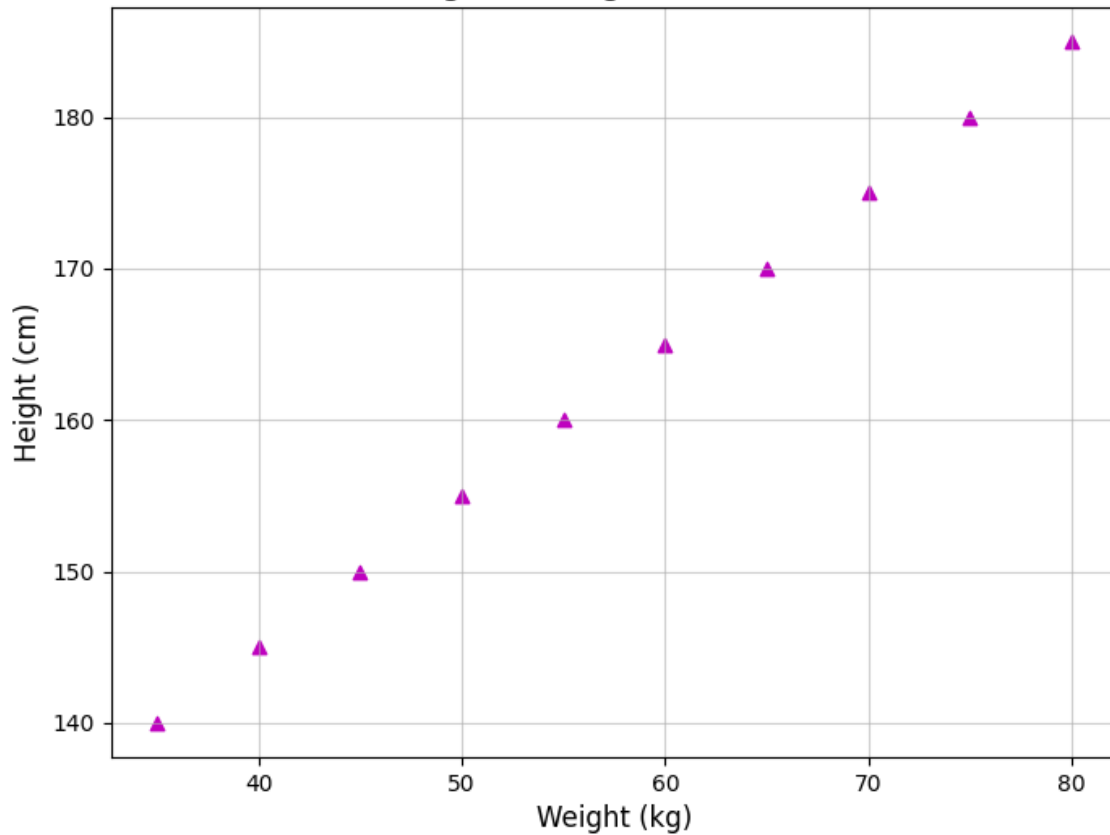
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T R U S T

Weight vs Height of Students



Activate



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Post Lab Questions:--

- 1) Considering datasets of your choice, create and explain the utility of the following charts:

Swarn chart Pair chart Pair grid Facet Grid Scatter plot	Regression plot Count plot Bar plot Violin plot Heat map
--	--

Ans. Swarn chart:-

A swarm chart is a type of scatter plot that displays the distribution of data points along a single axis.

Code:-

```
p1.py > ...
1  import seaborn as sns
2  import matplotlib.pyplot as plt
3
4  # Load sample dataset
5  tips = sns.load_dataset('tips')
6
7  # Create a swarm plot
8  sns.swarmplot(x='day', y='total_bill', data=tips)
9  plt.title('Swarm Plot of Total Bill by Day')
10 plt.show()
11
```

Output:-



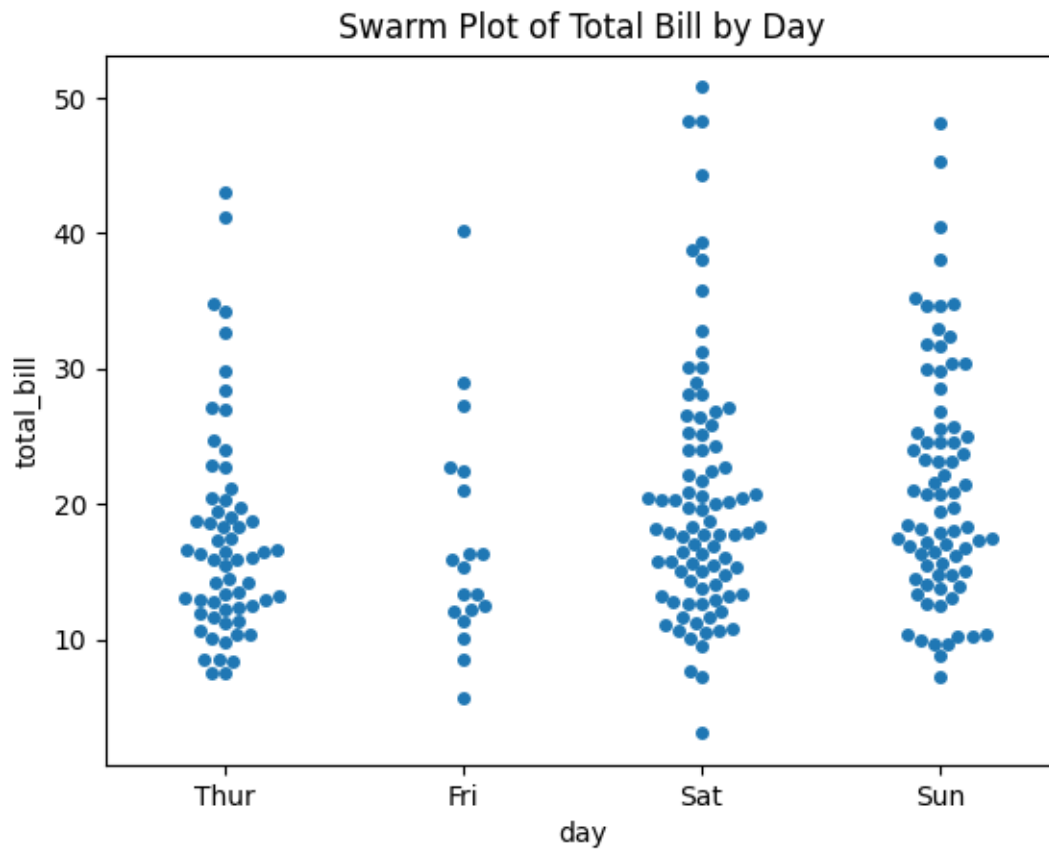
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Pair chart:-

A pair plot is a matrix of scatter plots that shows pairwise relationships between variables in a dataset.

Code:-



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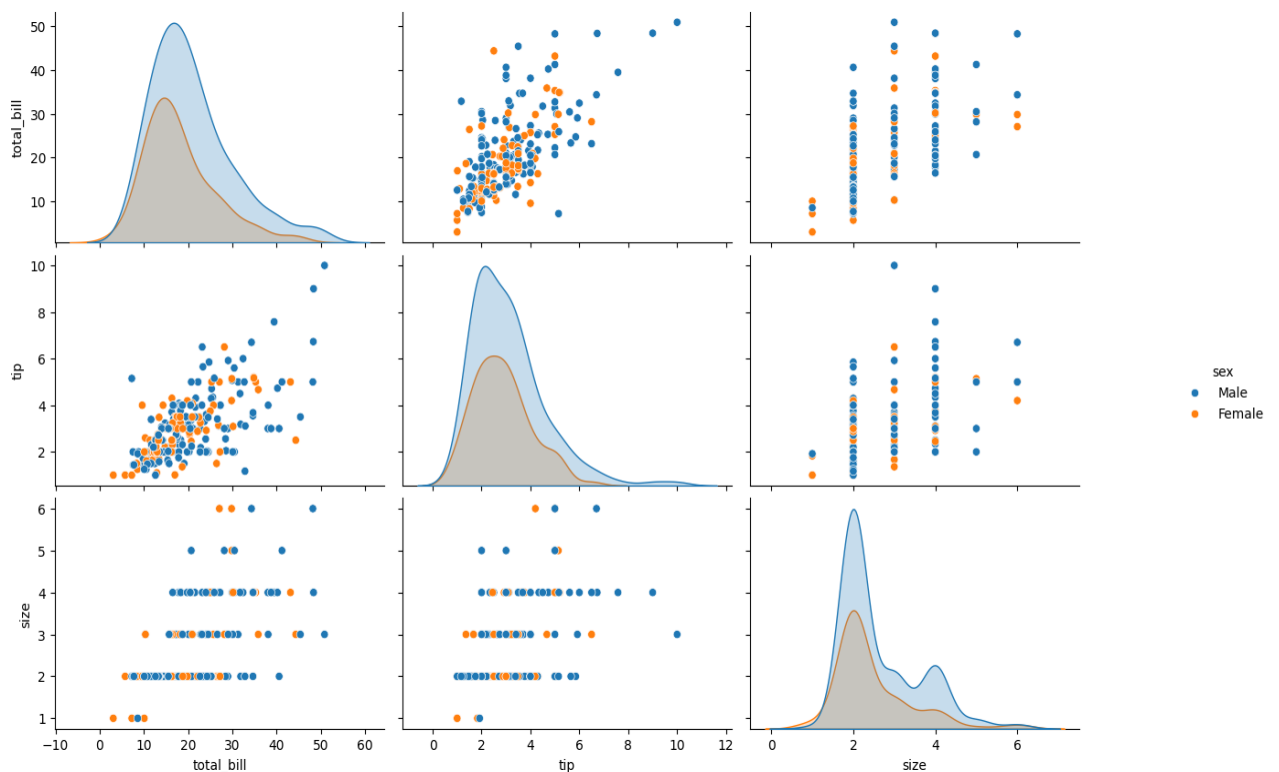
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```
p1.py > ...  
1 import seaborn as sns  
2 import matplotlib.pyplot as plt  
3  
4 # Load sample dataset  
5 tips = sns.load_dataset('tips')  
6  
7 # Create a pair plot  
8 sns.pairplot(tips, hue='gender')  
9 plt.suptitle('Pair Plot of Tips Dataset', y=1.02)  
10 plt.show()  
11
```

Output:-





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Pair grid:-

pair grid is an extension of the pair plot, offering more customization.

Code:-

```
1  import seaborn as sns
2  import matplotlib.pyplot as plt
3
4  # Load sample dataset
5  tips = sns.load_dataset('tips')
6
7  # Create a pair grid
8  g = sns.PairGrid(tips, hue='sex')
9  g = g.map_diag(sns.histplot)
10 g = g.map_offdiag(sns.scatterplot)
11 g.add_legend()
12 plt.suptitle('Pair Grid of Tips Dataset', y=1.02)
13 plt.show()
14
```

Output:-

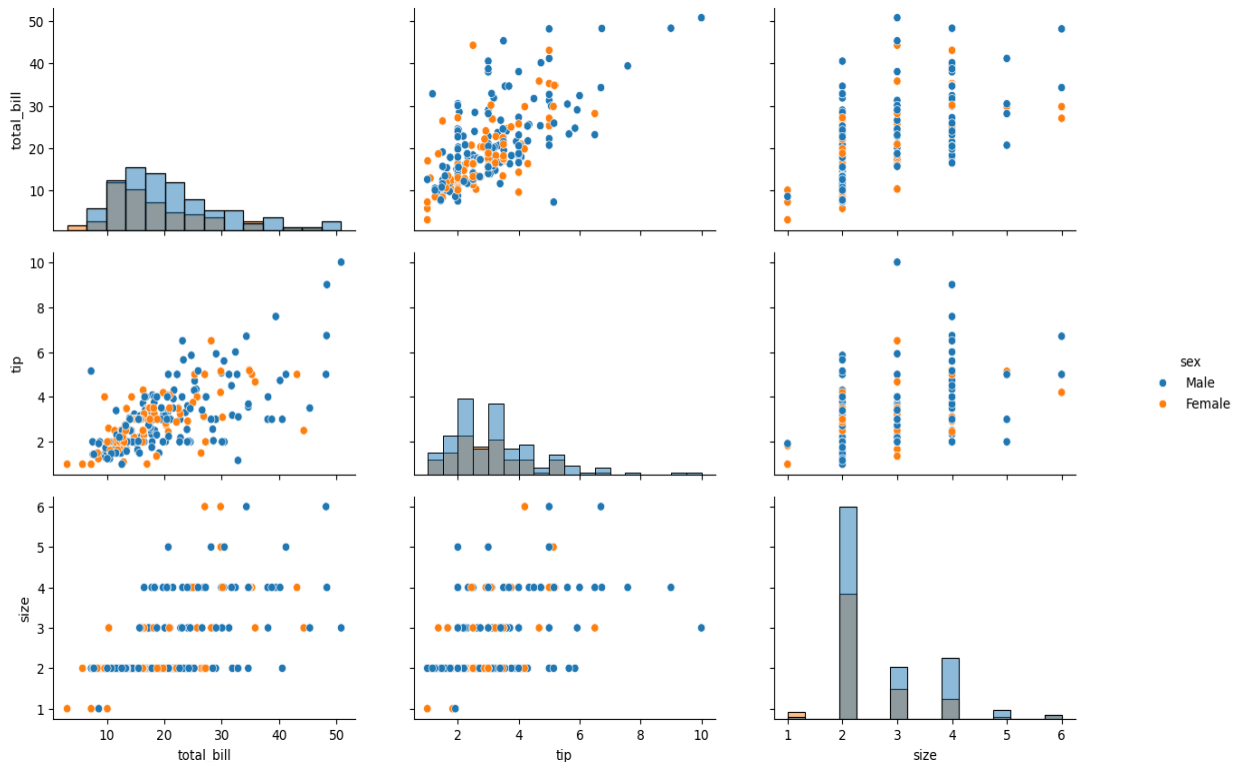


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Facet Grid:-

facet_grid is a type of multi-plot grid that shows multiple plots based on combinations of features in the dataset.

Code:-

```
1  import seaborn as sns
2  import matplotlib.pyplot as plt
3
4  # Load sample dataset
5  tips = sns.load_dataset('tips')
6
7  # Create a facet grid
8  g = sns.FacetGrid(tips, col='time', row='sex', margin_titles=True)
9  g.map(sns.scatterplot, 'total_bill', 'tip')
10 plt.suptitle('Facet Grid of Tips Dataset', y=1.02)
11 plt.show()
12
```

Output:-



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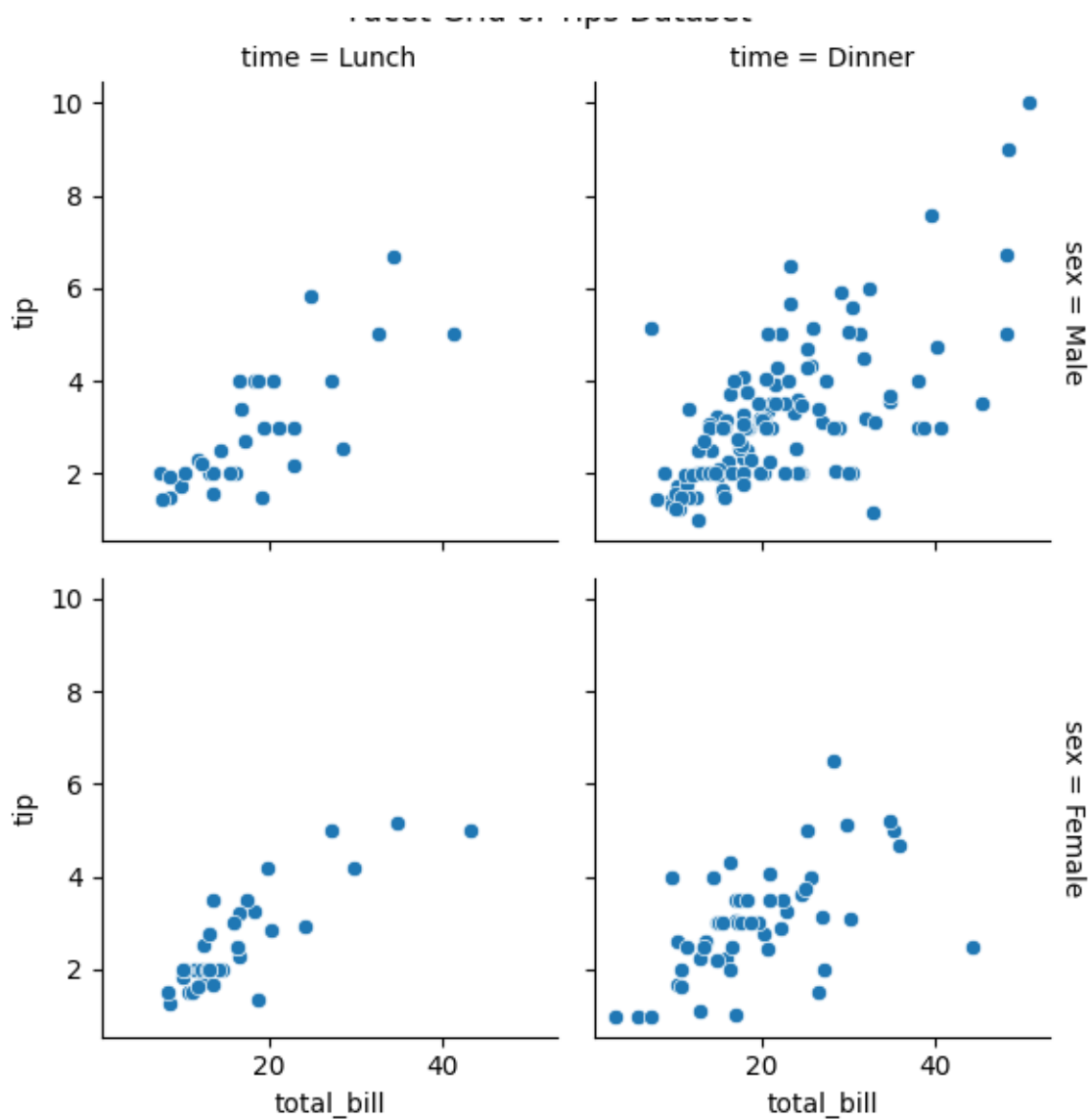
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Scatter plot:-

A scatter plot is a type of plot that uses Cartesian coordinates to display values for two variables.

Code:-



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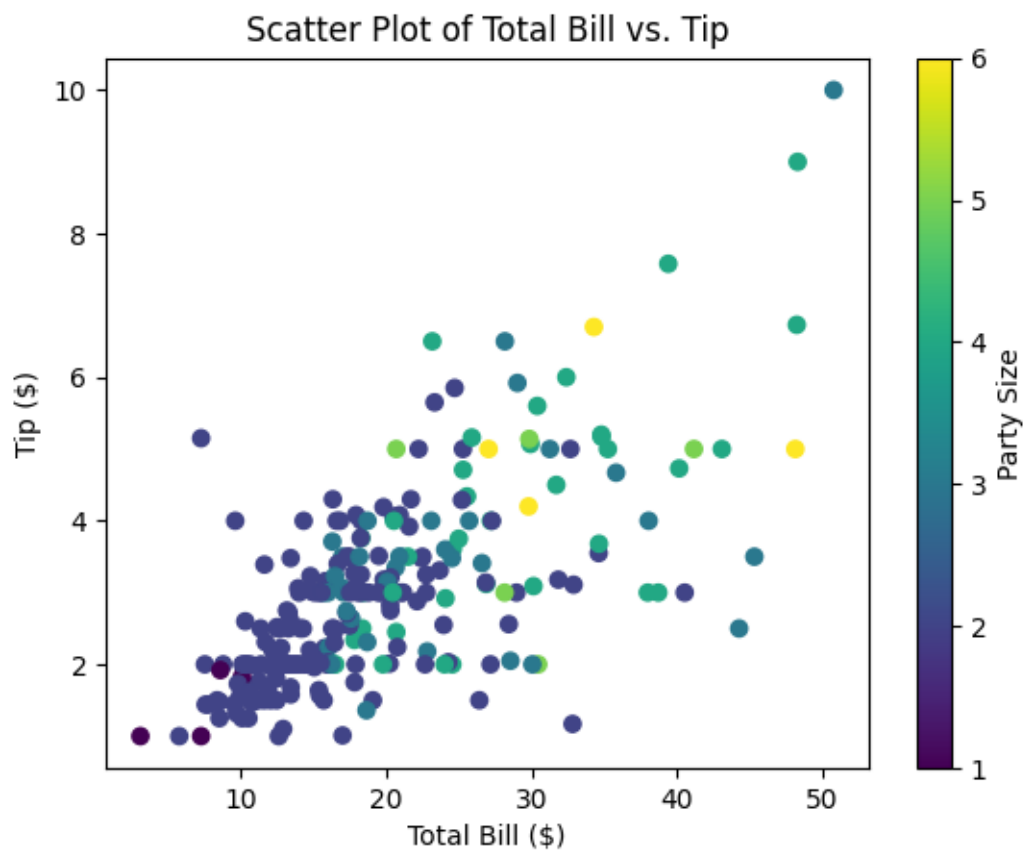
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```
p1.py > ...
1  import matplotlib.pyplot as plt
2  import seaborn as sns
3
4  # Load sample dataset
5  tips = sns.load_dataset('tips')
6
7  # Create a scatter plot
8  plt.scatter(tips['total_bill'], tips['tip'], c=tips['size'], cmap='viridis')
9  plt.title('Scatter Plot of Total Bill vs. Tip')
10 plt.xlabel('Total Bill ($)')
11 plt.ylabel('Tip ($)')
12 plt.colorbar(label='Party Size')
13 plt.show()
14
```

Output:-





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Regression plot:-

A regression plot is used to visualize the relationship between two continuous variables and includes a regression line that best fits the data points.

Code:-

```
p1.py > ...  
1  import seaborn as sns  
2  import matplotlib.pyplot as plt  
3  
4  # Load sample dataset  
5  tips = sns.load_dataset('tips')  
6  
7  # Create a regression plot  
8  sns.regplot(x='total_bill', y='tip', data=tips)  
9  plt.title('Regression Plot of Total Bill vs. Tip')  
10 plt.show()  
11
```

Output:-



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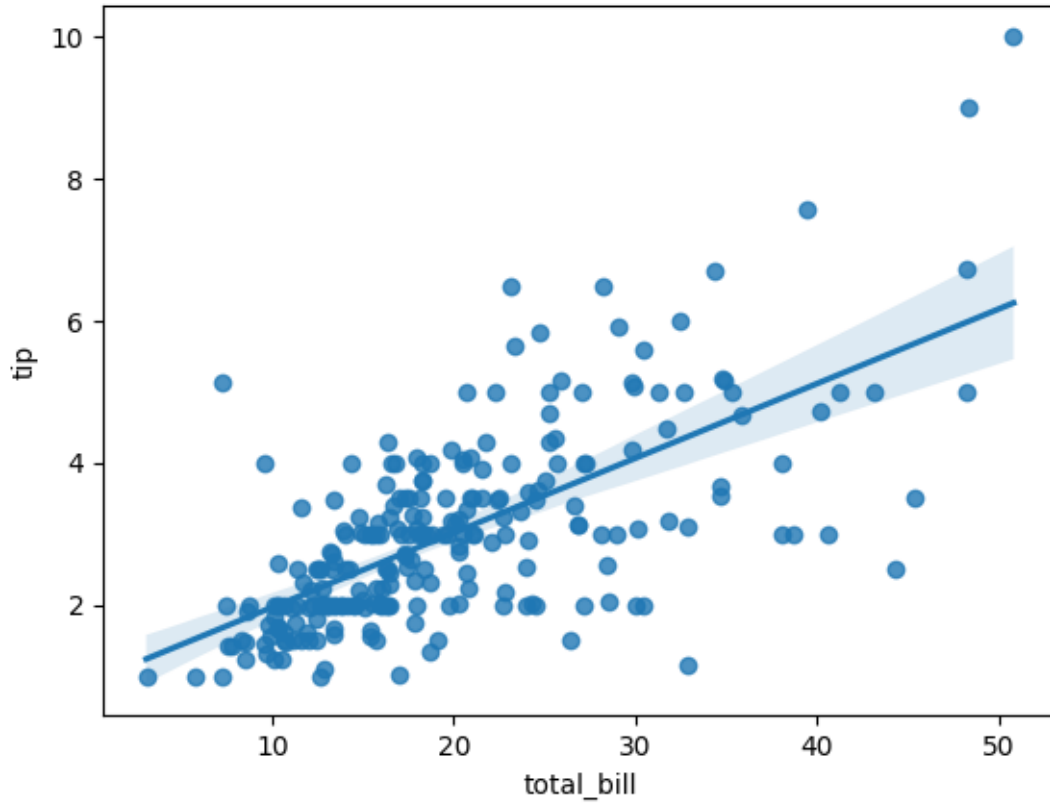
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Regression Plot of Total Bill vs. Tip



Count plot:-

A count plot is used to show the counts of observations in each categorical bin using bars.

Code:-



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```
p1.py > ...  
1  import seaborn as sns  
2  import matplotlib.pyplot as plt  
3  
4  # Load sample dataset  
5  tips = sns.load_dataset('tips')  
6  
7  # Create a count plot  
8  sns.countplot(x='day', data=tips)  
9  plt.title('Count Plot of Days')  
10 plt.show()  
11
```

Output:-



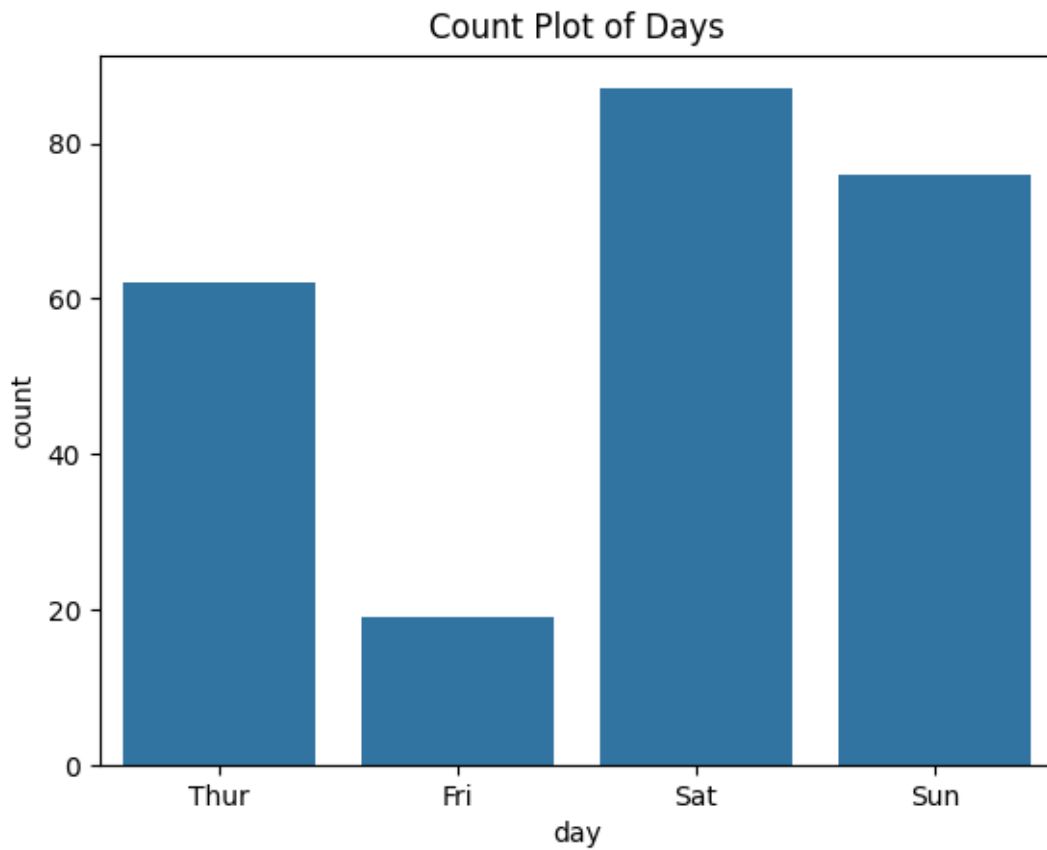
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Bar plot:-

A bar plot displays data with rectangular bars with lengths proportional to the values they represent.

Code:-



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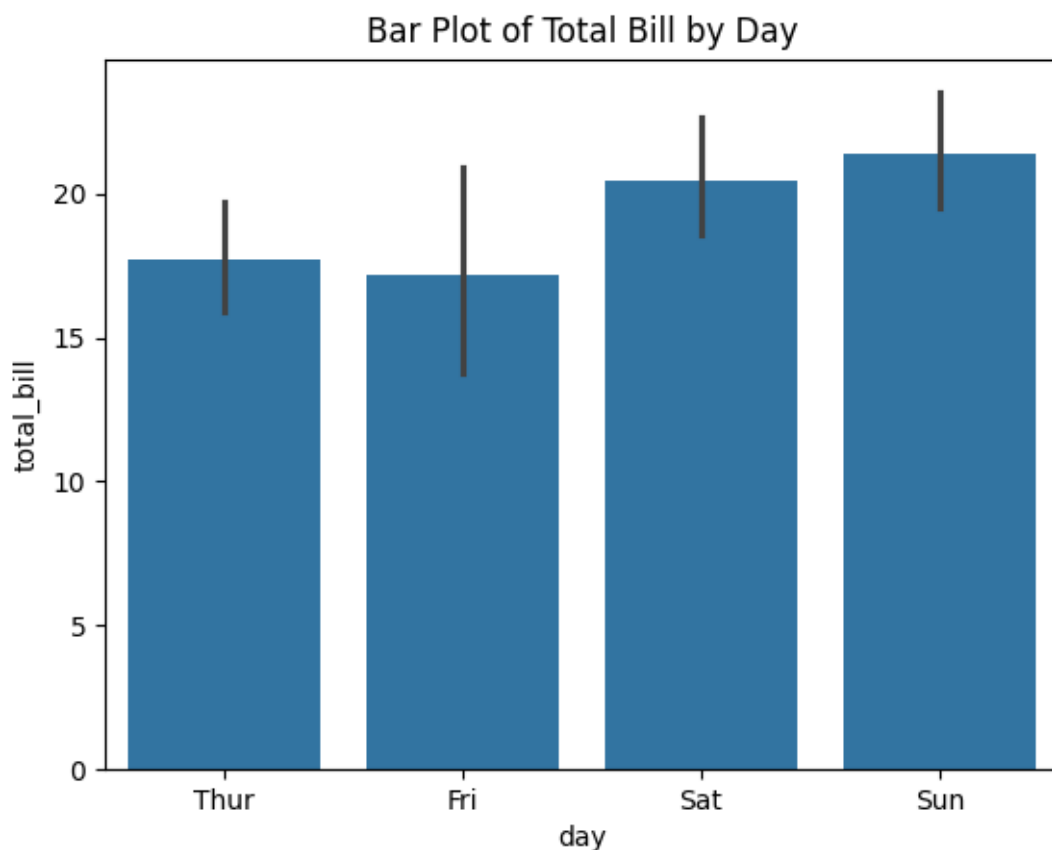
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```
p1.py > ...  
1  import seaborn as sns  
2  import matplotlib.pyplot as plt  
3  
4  # Load sample dataset  
5  tips = sns.load_dataset('tips')  
6  
7  # Create a bar plot  
8  sns.barplot(x='day', y='total_bill', data=tips)  
9  plt.title('Bar Plot of Total Bill by Day')  
10 plt.show()  
11
```

Output:-





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Violin plot:-

A violin plot is a method of plotting numeric data. It is similar to a box plot, but with a rotated kernel density plot on each side.

Code:-

```
p1.py > ...  
1  import seaborn as sns  
2  import matplotlib.pyplot as plt  
3  
4  # Load sample dataset  
5  tips = sns.load_dataset('tips')  
6  
7  # Create a violin plot  
8  sns.violinplot(x='day', y='total_bill', data=tips)  
9  plt.title('Violin Plot of Total Bill by Day')  
10 plt.show()  
11
```

Output:-



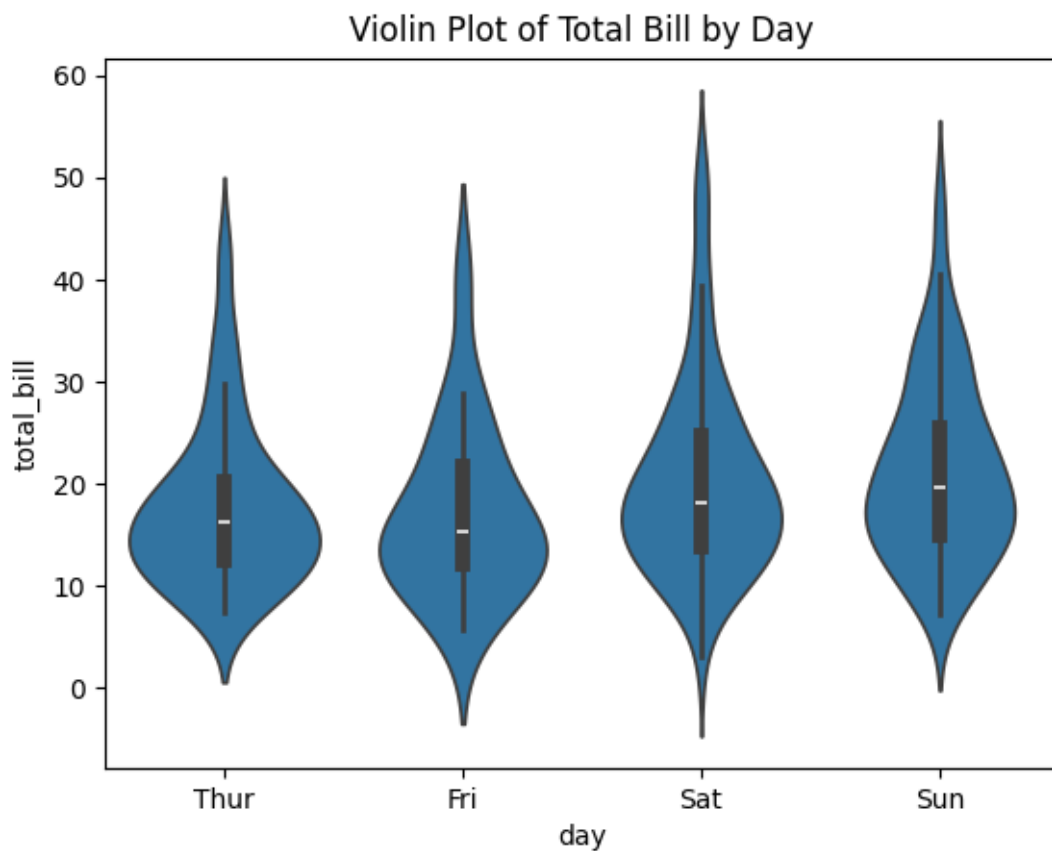
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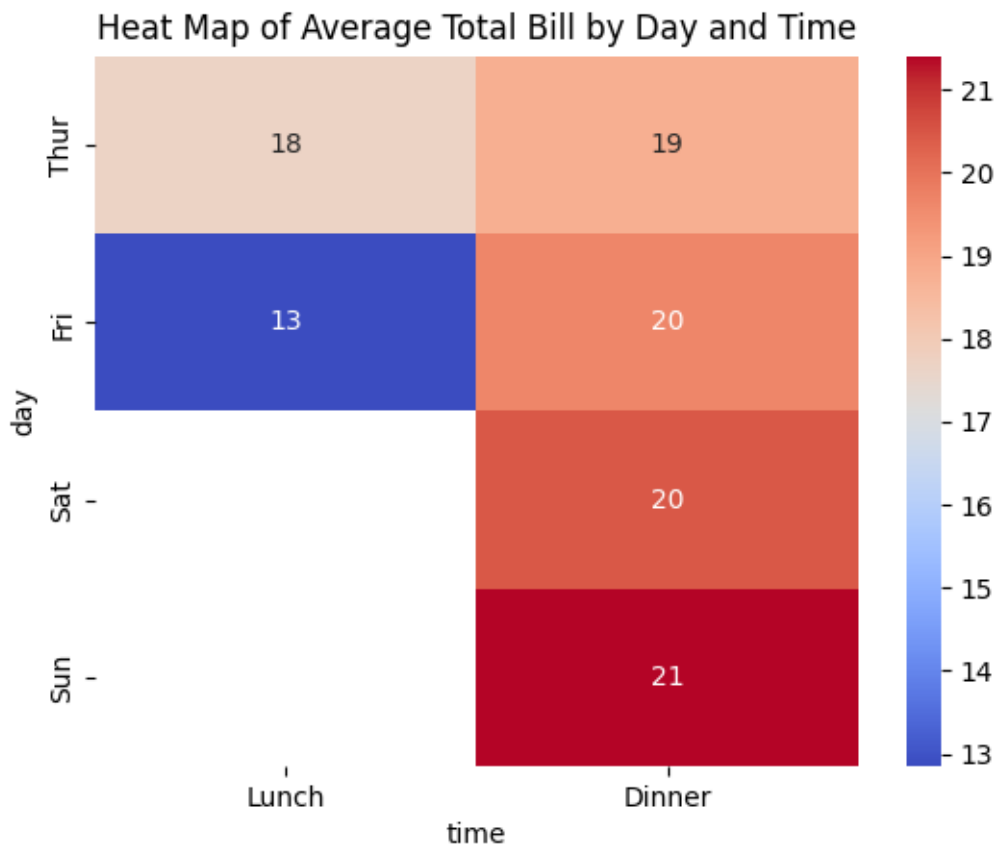
Heat map:-

A heat map is a data visualization technique that shows the magnitude of a phenomenon as color in two dimensions.

Code:-

```
p1.py > ...
1  import seaborn as sns
2  import matplotlib.pyplot as plt
3  import numpy as np
4
5  # Load sample dataset
6  tips = sns.load_dataset('tips')
7
8  # Create a pivot table
9  pivot_table = tips.pivot_table(values='total_bill', index='day', columns='time', aggfunc=np.mean)
10
11 # Create a heat map
12 sns.heatmap(pivot_table, annot=True, cmap='coolwarm')
13 plt.title('Heat Map of Average Total Bill by Day and Time')
14 plt.show()
15
```

Output:-



2) What is the Seaborn library? What are the Different categories of plot in Seaborn?

Ans. It is a type of data visualization library that allows programmers to create and visualize various datasets.

Different categories of plot in seaborn are as follows:

Pair chart	Regression plot
Count plot	Bar plot
Violin plot	Heat map
Pair grid	Facet Grid
Scatter plot	

Conclusion: In this unit we learned about matplotlib and seaborn library. Matplotlib in python is used to create and visualize various datasets, we learned to create graphs and charts, 2-D plotting, title creation, grid for plots, bar graphs, pie charts and scatter plots.



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Books/ Journals/ Websites referred:

1. [Matplotlib Plotting \(w3schools.com\)](https://www.w3schools.com/matplotlib/) – Reference website.
2. Reema Thareja, Python Programming: Using Problem-Solving Approach, Oxford University Press, First Edition 2017, India
3. Sheetal Taneja and Naveen Kumar, Python Programming: A modular Approach, Pearson India, Second Edition 2018, India

Date:

Signature of faculty in-charge