# UNIT I

## Introduction to Data Analytics:

Data and its importance, data analytic and its types, importance of data analytics

## Python Fundamentals:

Python Language Basics, Jupyter Notebook, Introduction to pandas, Data Structures, Essential Functionality

## Central Tendency and Dispersion:

Visual Representation of the Data, Measures of Central Tendency, Dispersion

## Reference Books:


1. McKinney, W. (2012). Python for data analysis: Data wrangling with Pandas, NumPy, and IPython. " O'Reilly Media, Inc.".
2. Swaroop, C. H. (2003). A Byte of Python. Python Tutorial.
3. Ken Black, sixth Editing. Business Statistics for Contemporary Decision Making. “John Wiley & Sons, Inc”.
4. Anderson Sweeney Williams (2011). Statistics for Business and Economics. “Cengage Learning”.

## Course Outcomes

- Use of  statistical tools and techniques in analyzing the different dimensions of data
- Knowing different functions and packages in Python for data interpretation
- Getting hands on experience in model building using data tools
- Calculating the estimate of variation using ANOVA methods
- Getting out different classifiers with Precision and recall methods

## Data Analytics

- Data is getting generated at a massive rate, by the minute.
- Organizations, on the other hand, are trying to explore every opportunity to make sense of this data.
- This is where Data analytics has become crucial in running a business successfully.
- It is commonly used in companies to drive profit and business growth.
- **What is Data analytics** is the process of exploring and analyzing large datasets to make predictions and boost data-driven decision making.
- Data analytics allows us to **collect, clean, and transform data** to **derive meaningful insights**.
- It helps to answer questions, test hypotheses, or challenge theories.

**Data analytics refers to the process of examining, cleaning, transforming, and modeling data to extract useful information, draw conclusions, and support decision-making.**

**It involves the use of various techniques, tools, and technologies to analyze and interpret large sets of data, uncover patterns, trends, and insights, and make informed business or research decisions.**

## Applications of Data Analytics

❖ Data analytics is used in most sectors of businesses. Here are some primary areas where data analytics does its magic:

- Data analytics is used in the banking and e-commerce industries to detect **fraudulent transactions**.
- The healthcare sector uses data analytics to improve patient health by detecting diseases before they happen. It is commonly used for **cancer detection**.
- Data analytics finds its usage in inventory management to keep track of different items.
- Logistics companies use data analytics to ensure faster delivery of products by optimizing vehicle routes.
- Marketing professionals use analytics to reach out to the right customers and perform targeted marketing to increase ROI (Return on Investment).
- Data analytics can be used for city planning, to build smart cities.
- **The applications of data analytics continue to expand as technology advances and organizations recognize the value of leveraging data for informed decision-making.**
- Data analytics finds applications across a wide range of industries and sectors due to its ability to derive meaningful insights from large volumes of data.

- Here are some key applications of data analytics:
- **Business Intelligence (BI):**
- Organizations use data analytics to gain insights into their operations, customer behavior, and market trends. BI tools help in visualizing data and making informed business decisions.
- **Financial Analysis:**
- In finance, data analytics is employed for fraud detection, risk management, portfolio optimization, and predicting market trends. It helps financial institutions make data-driven decisions to maximize returns and minimize risks.
- **Healthcare Analytics:**
- In healthcare, data analytics is used for patient care improvement, resource optimization, fraud detection, and predicting disease outbreaks. It aids in personalized medicine and contributes to medical research.
- **Marketing and Customer Analytics:**
- Businesses use data analytics to analyze customer behavior, preferences, and trends. This information helps in targeted marketing campaigns, customer segmentation, and improving overall customer experience.

- **Supply Chain and Logistics:**
- Data analytics optimizes supply chain processes by predicting demand, managing inventory efficiently, and improving overall logistics and distribution.
- **Human Resources (HR) Analytics:**
- HR departments use analytics for talent acquisition, employee performance analysis, workforce planning, and employee retention strategies.
- **Social Media Analytics:**
- Companies analyze social media data to understand customer sentiment, track brand mentions, and measure the effectiveness of marketing campaigns. This information is valuable for shaping marketing strategies and brand management.
- **Cybersecurity:**
- Data analytics helps in identifying and preventing security threats by analyzing patterns and anomalies in network data. It enhances the ability to detect and respond to cyberattacks in real-time.
- **Education Analytics:**
- Educational institutions use data analytics for student performance analysis, personalized learning, and predicting dropout rates. It aids in optimizing educational programs and resources.

- **Smart Cities:**
- Cities use data analytics to improve urban planning, traffic management, energy consumption, and public services. It contributes to creating more efficient and sustainable urban environments
- **Sports Analytics:**
- Sports teams utilize data analytics for player performance analysis, injury prevention, and strategic decision-making. It enhances coaching strategies and team management.
- **Manufacturing and Quality Control:**
- Data analytics is applied in manufacturing for quality control, predictive maintenance, and process optimization. It helps identify inefficiencies and improve overall production processes.

## Why is Data Analytics important?

- Data Analytics has a key role in improving your business as it is used to gather hidden insights, generate reports, perform market analysis, and improve business requirements.
- Data analytics is important because it helps businesses optimize their performances. Implementing it into the business model means companies can help reduce costs by identifying more efficient ways of doing business and by storing large amounts of data
- Data analysis helps businesses acquire relevant, accurate information, suitable for developing future marketing strategies, business plans, and realigning the company's vision or mission.
- Data analytics is important to understand trends and patterns from the massive amounts of data that are being collected. It helps optimize business performance, forecast future results, understand audiences, and reduce costs.
- Data analytics is the process of examining, transforming, and interpreting data to uncover meaningful patterns, insights, and trends. It is important because it enables organizations to make data-driven decisions, improve operational efficiency, identify opportunities, and gain a competitive edge.

- **Data analytics gives a company a cost-effective solution**. Even it will help them to improvise the decisions making process. The sectors like manufacturing, media, healthcare, real estate, and others require data analytics techniques and tools
- **The scope of data analytics** science involves extracting insights and patterns from data to drive decision-making and gain a competitive advantage. Data Analytics is a powerful discipline that transforms raw data into actionable insights, driving informed decision-making and fostering innovation across industries.
- Data analytics future growth is expected to continue to the increasing amount of data being generated, the growing importance of data-driven decision-making in businesses, and the continued development of big data and AI technologies
- **Data analytics and data analytics bootcamp is a huge industry and is predicted to keep growing. It is expected to touch US$11.87 billion by 2026 as it keeps growing at a steady pace. This industry will disrupt the market, causing a great shift in it and bringing several job opportunities with it.**

## What is the role of Data Analytics?

- **Data analytics help a business optimize its performance, perform more efficiently, maximize profit, or make more strategically-guided decisions. The techniques and processes of data analytics have been automated into mechanical processes and algorithms that work over raw data for human consumption.**
- Data analytics is the science of analyzing raw data to make conclusions about information, helping businesses optimize their performance, make more efficient decisions, and maximize profits. The role of data analytics is to provide insights and support decision-making processes in various industries. Key aspects of data analytics include.
- **Gathering and cleaning data:** Data analysts collect data through various methods, such as conducting surveys, tracking visitor characteristics on a company website, or buying data sets from data collection specialists. They also clean the data to maintain its quality by removing duplicates, errors, or outliers

- **Interpreting data:** Analysts find patterns or trends in data that can help answer specific problems or questions. They use statistical analysis, graphical modeling, and other techniques to extract valuable insights from the data.

- **Data visualization:** Data analysts create visualizations like charts and graphs to represent data in an easy-to-understand format. This helps stakeholders, including company leadership, understand the importance of the insights.

- **Communicating findings:** Analysts present their findings to interested parties, such as executives and managers, using reports and presentations. They also use various tools to make their work more accurate and efficient during data analysis

- **Data analytics is important because it helps businesses optimize their performance, improve efficiency, and make more strategically-guided decisions. It is used in various industries, including banking and finance, where it is used to predict market trends and assess risk. Data analytics also plays a crucial role in detecting and preventing fraud to improve efficiency and reduce risk for organizations**

❖ **Some common tools used in data analytics include:**

❖ **Jupyter Notebook:** A web-based interactive computing environment that allows users to create and share documents that contain live code, equations, visualizations, and narrative text.

❖ **Apache Spark:** A fast and general-purpose cluster-computing system that can process large data sets with high speed and efficiency.

❖ **Google Cloud AutoML:** A suite of machine learning products that allows users to build, train, and deploy custom machine learning models without requiring expertise in machine learning.

❖ **Statistical Analysis System (SAS) :** A software suite used for advanced analytics, multivariate analysis, business intelligence, data management, and predictive analytics.

❖ **Microsoft Power BI:** A business analytics tool that provides interactive visualizations and business intelligence capabilities with an interface simple enough for end-users to create their own reports and dashboards

- **Tableau:** A data visualization and business intelligence software that helps users create interactive, web-based dashboards and reports.

- **KNIME: Konstanz Information Miner:** An open-source data analytics platform that provides a user-friendly interface for data preprocessing, machine learning, and statistical analysis.

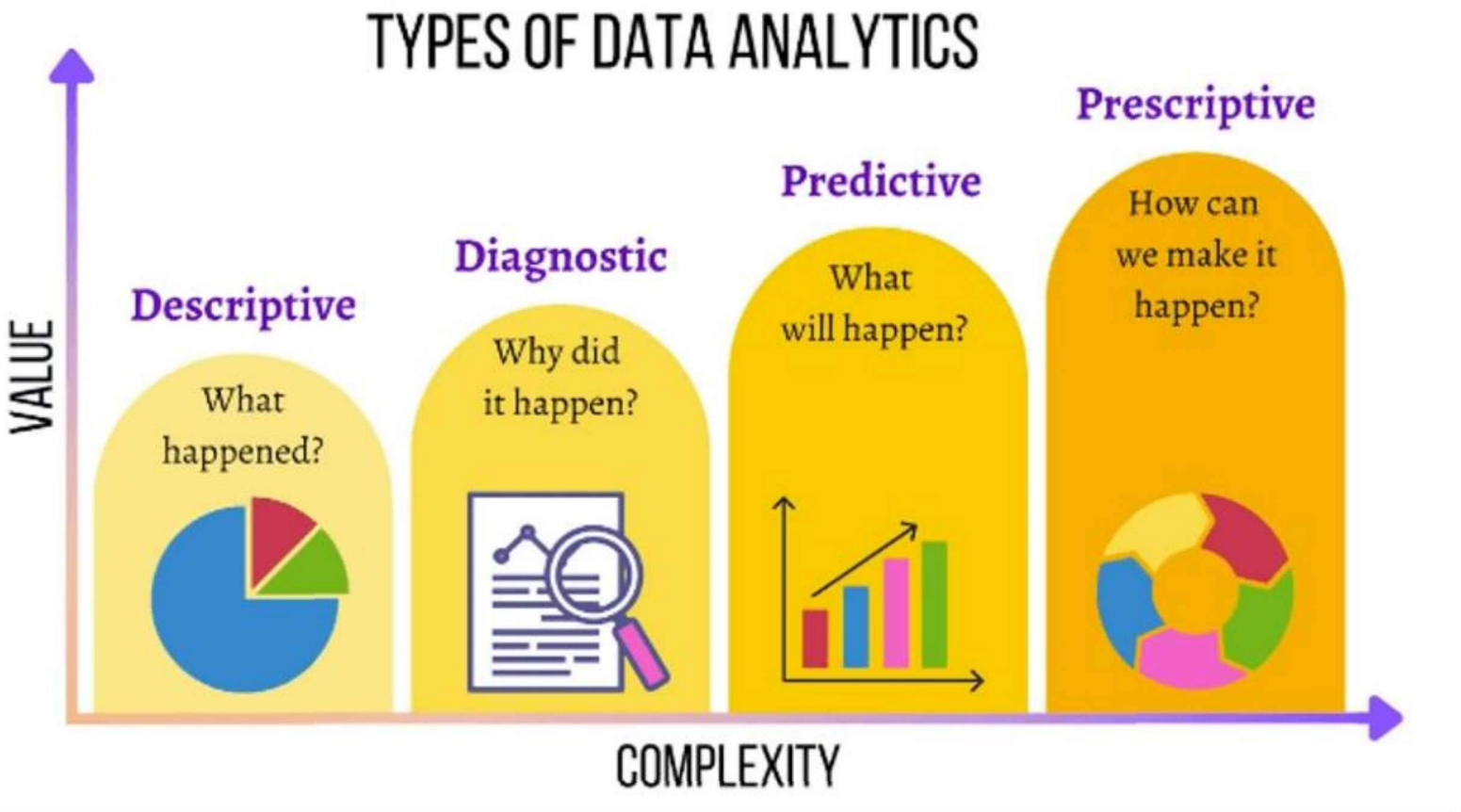
- **Steamlit:** A web-based data analytics platform that allows users to create interactive, web-based dashboards and reports.

- **R Programming:** A leading analytics tool in the industry, widely used for statistics and data modeling. It can easily manipulate data and present it in different ways.

- **Python:** A versatile programming language that can handle various data analyses and integrate with third-party packages for machine learning and data visualization.

## ❖ DIFFERENT TYPES OF DATA ANALYSIS

❖ The four main types of data analysis: Descriptive, Diagnostic, Predictive, and Prescriptive



- **Descriptive Analytics**
- **Descriptive analytics is a simple, surface-level type of analysis that looks at what has happened in the past.**
- The two main techniques used in descriptive analytics are **data aggregation and data mining—so**, the data analyst **first gathers the data and presents** it in a summarized format (that's the aggregation part) and then "**mines" the data to discover patterns**.
- The data is then presented in a way that can be easily understood by a wide audience (not just data experts).
- It's important to note that descriptive analytics doesn't try to explain the historical data or establish cause-and-effect relationships; at this stage, **it's simply a case of determining and describing the "what".**
- Descriptive analytics draws on descriptive statistics, which you can learn about here.
- **Data aggregation is the process of summarizing a large pool of data for high level analysis. At its most basic level, it involves compiling information from a range of prescribed databases and organizing it into a simpler, easy-to-use medium, usually utilizing sum, average, mean, or median references**

## ❖ Diagnostic Analytics

❖ **While descriptive analytics looks at the "what", diagnostic analytics explores the "why".**

❖ When running diagnostic analytics, data analysts will first seek to identify anomalies within the data—that is, anything that cannot be explained by the data in front of them.

❖ **For example:**

❖ If the data shows that there was a sudden drop in sales for the month of March, the data analyst will need to investigate the cause.

❖ To do this, they'll get on what's known as the discovery phase, identifying any additional data sources that might tell them more about why such irregularities happened.

❖ Finally, the data analyst will try to uncover causal relationships—for example, looking at any events that may correlate or correspond with the decrease in sales. At this stage, data analysts may use probability theory, regression analysis, filtering, and time-series data analytics.

## ❖ Predictive Analytics

❖ **Predictive analytics tries to predict what is likely to happen in the future**.

❖ This is where data analysts start to come up with actionable, data-driven insights that the company can use to inform their next steps.

❖ Predictive analytics estimates the likelihood of a future outcome based on historical data and probability theory, and while it can never be completely accurate, it does eliminate much of the guesswork from key business decisions.

❖ Predictive analytics can be used to forecast all sorts of outcomes—from what products will be most popular at a certain time, to how much the company revenue is likely to increase or decrease in a given period.

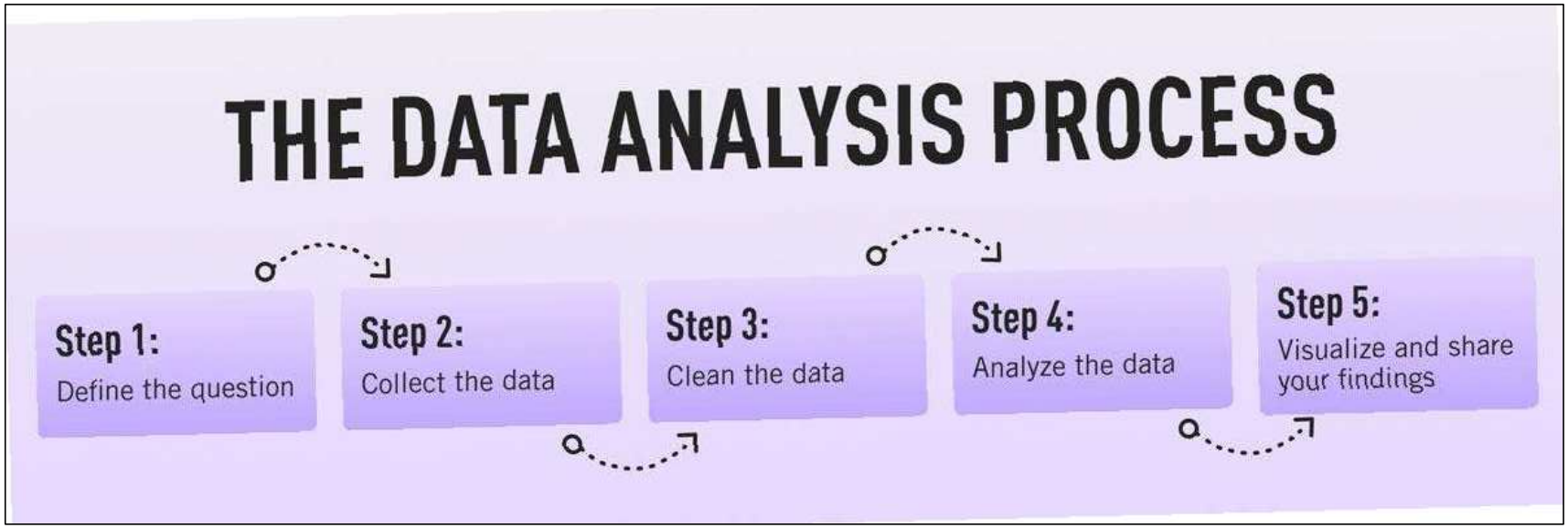
❖ Ultimately, predictive analytics is used to increase the business's chances of "hitting the mark" and taking the most appropriate action.

## ❖ Prescriptive Analytics

- ❖ Prescriptive analytics advises on the actions and decisions that should be taken.
- ❖ In other words, prescriptive analytics shows you how you can take advantage of the outcomes that have been predicted.
- ❖ When conducting prescriptive analysis, data analysts will consider a range of possible scenarios and assess the different actions the company might take.
- ❖ Prescriptive analytics is one of the more complex types of analysis, and may involve working with algorithms, machine learning, and computational modeling procedures.
- ❖ However, the effective use of prescriptive analytics can have a huge impact on the company's decision-making process and, ultimately, on the bottom line.

**Explain the step-by-step process that a data analyst typically follows in their workflow.**

- Like any scientific discipline, data analysis follows a rigorous step-by-step process. Each stage requires different skills and know-how.
- To get meaningful insights, though, it's important to understand the process as a whole. An underlying framework is invaluable for producing results that stand up to scrutiny.



**Step 1: Define the question(s) you want to answer**

- In the first step of process the data analyst is given a problem/business task. The analyst has to understand the task and the stakeholder's expectations for the solution.
- A stakeholder is a person that has invested their money and resources to a project. The analyst must be able to ask **different questions in order to find the right solution to their problem**.
- The analyst has to find the root cause of the problem in order to fully understand the problem.
- The analyst must make sure that he/she doesn't have any distractions while analyzing the problem.
- Communicate effectively with the stakeholders and other colleagues to completely understand what the underlying problem is.
- At this stage, you'll take a clearly defined problem and come up with a relevant question or hypothesis you can test.
- **Questions to ask yourself for the Ask phase are:**
  - What are the problems that are being mentioned by my stakeholders?
  - What are their expectations for the solutions?

**Step 2: Collect the data**

- The second step is to Prepare or Collect the Data. This step includes collecting data and storing it for further analysis.
- The analyst has to collect the data based on the task given from multiple sources. The data has to be collected from various sources, internal or external sources.
- Internal data is the data available in the organization that you work for while external data is the data available in sources other than your organization.
- The data that is collected by an individual from their own resources is called first-party data.
- The data that is collected and sold is called second-party data.
- Data that is collected from outside sources is called third-party data. The common sources from where the data is collected are Interviews, Surveys, Feedback, Questionnaires. The collected data can be stored in a spreadsheet or SQL database.
- Data analysts will usually gather structured data from primary or internal sources, such as CRM software or email marketing tools.

**Step 3: Clean the data**

- The third step is Clean and Process Data. After the data is collected from multiple sources, it is time to clean the data.
- Clean data means data that is free from **misspellings, redundancies**, and **irrelevance**.
- Clean data largely depends on data integrity. There might be duplicate data or the data might not be in a format, therefore the unnecessary data is removed and cleaned.
- There are different functions provided by SQL and Excel to clean the data. **This is one of the most important steps in Data Analysis as clean and formatted data helps in finding trends and solutions**.
- The most important part of the Process phase is to check whether your data is biased or not. Bias is an act of favoring a particular group/community while ignoring the rest. Biasing is a big no-no as it might affect the overall data analysis. The data analyst must make sure to include every group while the data is being collected.
- Your original dataset may contain duplicates, anomalies, or missing data which could distort how the data is interpreted, so these all need to be removed.
- Data cleaning can be a time-consuming task, but it's crucial for obtaining accurate results.
- Ex. Field extraction algorithm, Clustering .

**Step 4: Analyze the data**

- The fourth step is to Analyze. The cleaned data is used for analyzing and identifying trends.
- It also performs calculations and combines data for better results. The tools used for performing calculations are Excel or SQL.
- These tools provide in-built functions to perform calculations or sample code is written in SQL to perform calculations.
- Using Excel, we can create pivot tables and perform calculations while SQL creates temporary tables to perform calculations.
- Programming languages are another way of solving problems. They make it much easier to solve problems by providing packages. The most widely used programming languages for data analysis are R and Python.
- Some common techniques include **regression analysis, cluster analysis, and time-series analysis.**
- **This step in the process also ties in with the four different types of analysis we looked at in (Descriptive, Diagnostic, Predictive, and Prescriptive).**

**Step 5: Interpret and share the results**

- This final step in the process is where data is transformed into valuable business insights.
- Depending on the type of analysis conducted, you'll present your findings in a way that others can understand—in the form of a chart or graph.
- The data now transformed has to be made into a visual (chart, graph).
- The reason for making data visualizations is that there might be people, mostly stakeholders that are non-technical.
- Visualizations are made for a simple understanding of complex data. **Tableau** and **Looker** are the two popular tools used for compelling data visualizations.
- **Tableau** is a simple drag and drop tool that helps in creating compelling visualizations.
- **Looker is a data viz tool** that directly connects to the database and creates visualizations.
- Tableau and Looker are both equally used by data analysts for creating a visualization.
- R and Python have some packages that provide beautiful data visualizations.
- R has a package named **ggplot** which has a variety of data visualizations.
- A presentation is given based on the data findings.

- Sharing the insights with the team members and stakeholders will help in making better decisions.
- It helps in making more informed decisions and it leads to better outcomes.
- Presenting the data involves transforming raw information into a format that is easily comprehensible and meaningful for various stakeholders.
- This process includes the creation of visual representations, such as charts, graphs, and tables, to effectively communicate patterns, trends, and insights collected from the data analysis.
- The goal is to facilitate a clear understanding of complex information, making it accessible to both technical and non-technical audiences.
- Effective data presentation involves thoughtful selection of visualization techniques based on the nature of the data and the specific message planned.
- It goes beyond mere display to storytelling, where the presenter interprets the findings, highlights key points, and guides the audience through the narrative that the data unfolds.
- Whether through reports, presentations, or interactive dashboards, the art of presenting data involves balancing simplicity with depth, ensuring that the audience can easily grip the significance of the information presented and use it for informed decision-making.

## Why Data Analytics Using Python?

- There are many programming languages available, but Python is popularly used by statisticians, engineers, and scientists to perform data analytics.

Here are some of the reasons why Data Analytics using Python has become popular:

- Python is easy to learn and understand and has a simple syntax.
- The programming language is scalable and flexible.
- It has a vast collection of libraries for numerical computation and data manipulation.
- Python provides libraries for graphics and data visualization to build plots.
- It has broad community support to help solve many kinds of queries.

**Python Libraries for Data Analytics**

- One of the main reasons why Data Analytics using Python has become the most preferred and popular mode of data analysis is that it provides a range of libraries.
- **NumPy:** NumPy supports n-dimensional arrays and provides numerical computing tools. It is useful for Linear algebra and Fourier transform.
- **Pandas:** Pandas provides functions to handle missing data, perform mathematical operations, and manipulate the data.
- **Matplotlib:** Matplotlib library is commonly used for plotting data points and creating interactive visualizations of the data.
- **SciPy:** SciPy library is used for scientific computing. It contains modules for optimization, linear algebra, integration, interpolation, special functions, signal and image processing.
- **Scikit-Learn:** Scikit-Learn library has features that allow you to build regression, classification, and clustering models.

# Visual Representation of the Data, Measures of Central Tendency, Dispersion

## Visual Representation of the Data

### What is Data Visualization?

- Data visualization is a field in data analysis that deals with visual representation of data. It graphically plots data and is an effective way to communicate inferences from data.

- Using data visualization, we can get a visual summary of our data. With pictures, maps and graphs, the human mind has an easier time processing and understanding any given data.
- Data visualization plays a significant role in the representation of both small and large data sets, but it is especially useful when we have large data sets, in which it is impossible to see all of our data, let alone process and understand it manually.

- Python provides various libraries that come with different features for visualizing data. All these libraries come with different features and can support various types of graphs.
  - **Matplotlib**
  - **Seaborn**
  - **Bokeh**
  - **Plotly**
- We will discuss these libraries one by one and will plot some most commonly used graphs

**Data Set Used**

```
import pandas as pd
# reading the database
data = pd.read_csv("tips.csv")
# printing the top 10 rows
display(data.head(10))
```

**Matplotlib**

❖ Matplotlib is an easy-to-use, low-level data visualization library that is built on NumPy arrays.

❖ It consists of various plots like scatter plot, line plot, histogram, etc. Matplotlib provides a lot of flexibility.

- To install this type the below command in the terminal.
- pip install matplotlib
- After installing Matplotlib, let's see the most commonly used plots using this library.

**1. Scatter Plot**

❖ Scatter plots are used to observe relationships between variables and uses dots to represent the relationship between them. The scatter() method in the matplotlib library is used to draw a scatter plot.

Example:

- import pandas as pd
- import matplotlib.pyplot as plt

**reading the database**

- data = pd.read_csv("tips.csv")

**Scatter plot with day against tip**

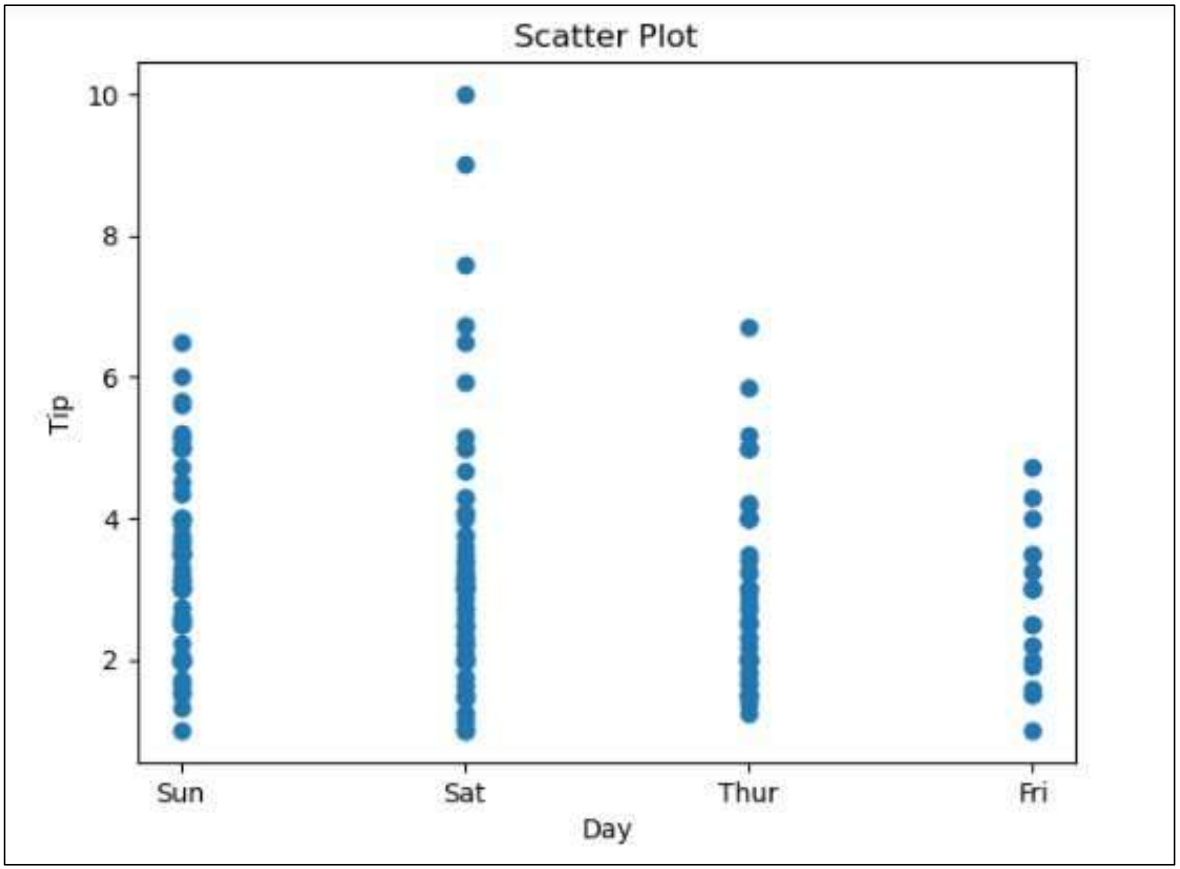
- plt.scatter(data['day'], data['tip'])

**Adding Title to the Plot**

- plt.title("Scatter Plot")

**Setting the X and Y labels**

- plt.xlabel('Day')
- plt.ylabel('Tip')
- plt.show()



- This graph can be more meaningful if we can add colors and also change the size of the points.
- We can do this by using the c and s parameter respectively of the scatter function.
- We can also show the color bar using the **colorbar()** method.

- import pandas as pd
- import matplotlib.pyplot as plt

**# reading the database**

- data = pd.read_csv("tips.csv")

**# Scatter plot with day against tip**

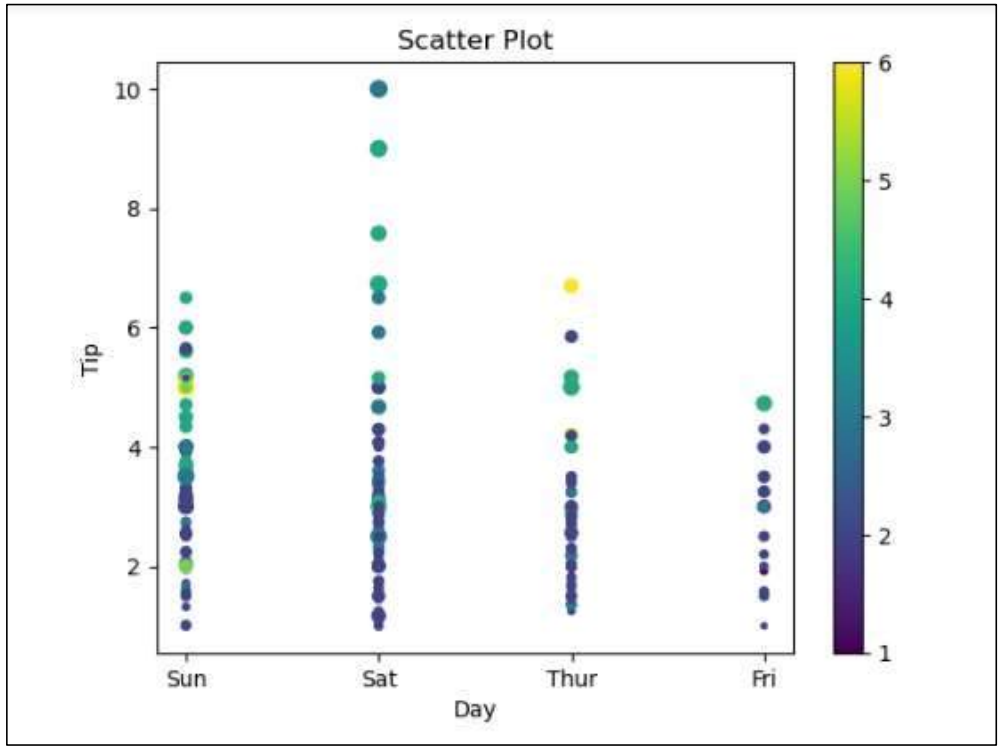
- plt.scatter(data['day'], data['tip'], c=data['size'],
- s=data['total_bill'])

**Adding Title to the Plot**

- plt.title("Scatter Plot")

**Setting the X and Y labels**

- plt.xlabel('Day')
- plt.ylabel('Tip')
- plt.colorbar()
- plt.show()



## 2. Line Chart

❖ Line Chart is used to represent a relationship between two data X and Y on a different axis. It is plotted using the plot() function. Let's see the below example.

**Example:**

- import pandas as pd
- import matplotlib.pyplot as plt

**# reading the database**

- data = pd.read_csv("tips.csv")

**# Scatter plot with day against tip**

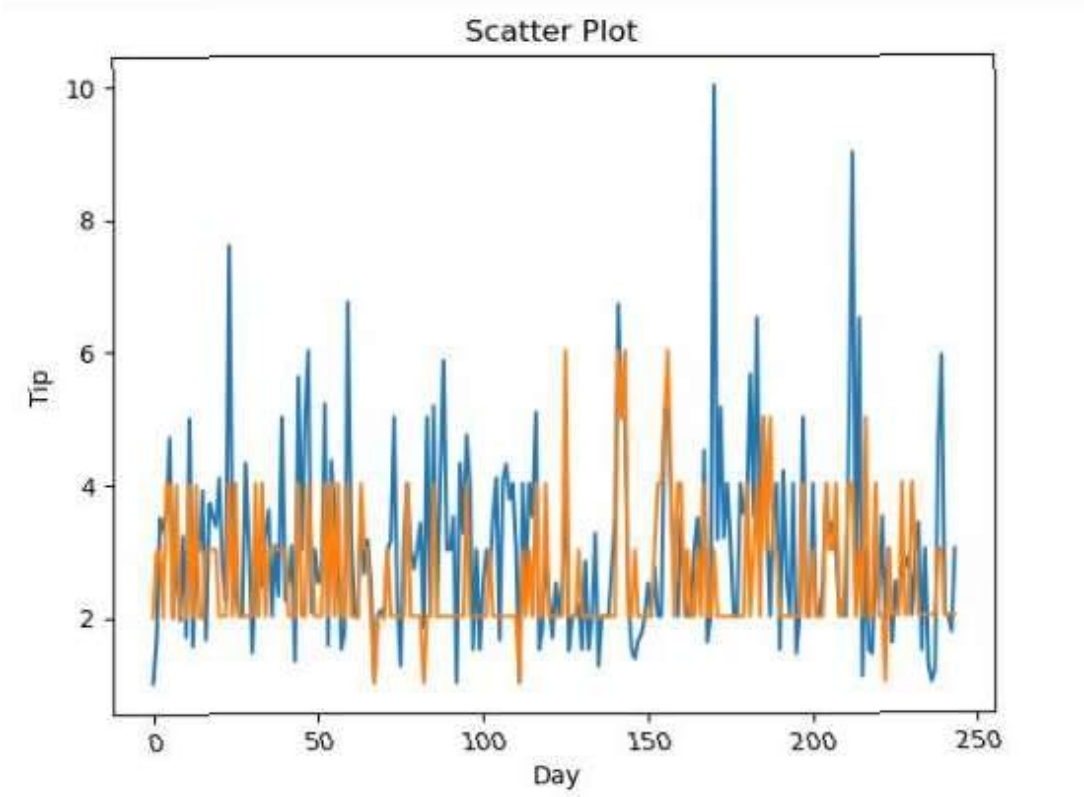
- plt.plot(data['tip'])
- plt.plot(data['size'])

**# Adding Title to the Plot**

- plt.title("Scatter Plot")

**# Setting the X and Y labels**

- plt.xlabel('Day')
- plt.ylabel('Tip')
- plt.show()



### 3. Bar Chart

❖ A bar plot or bar chart is a graph that represents the category of data with rectangular bars with lengths and heights that is proportional to the values which they represent. It can be created using the bar() method.

**Example:**

- import pandas as pd
- import matplotlib.pyplot as plt

**# reading the database**

- data = pd.read_csv("tips.csv")

**# Bar chart with day against tip**

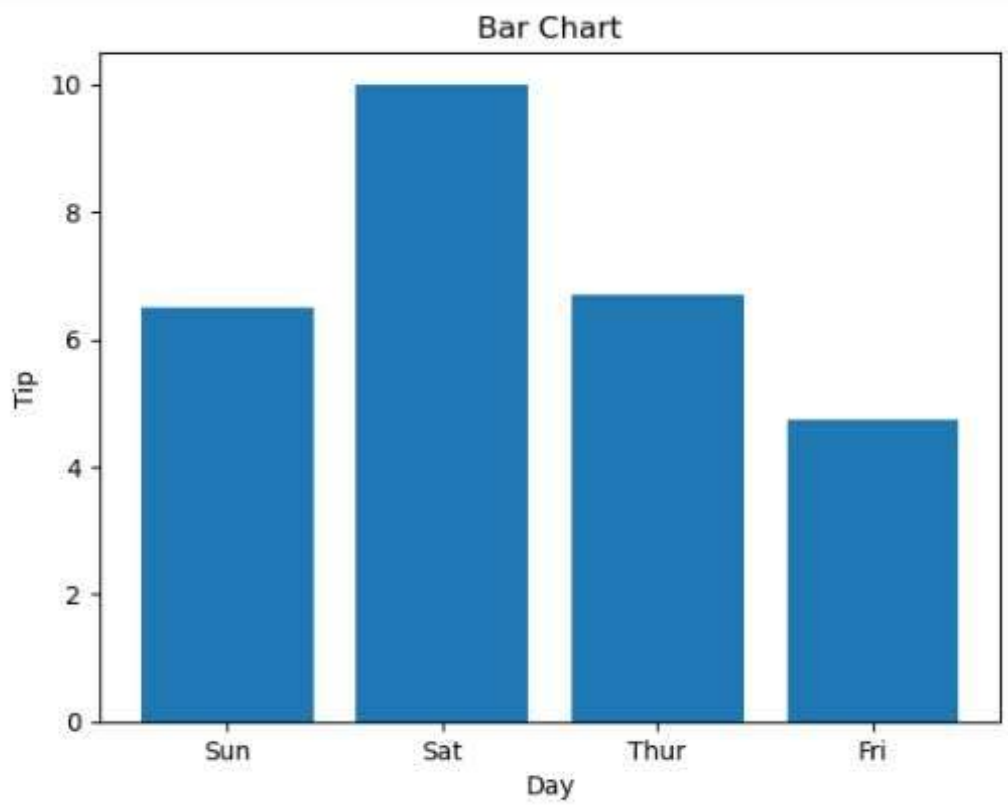
- plt.bar(data['day'], data['tip'])
- plt.title("Bar Chart")

**# Setting the X and Y labels**

- plt.xlabel('Day')
- plt.ylabel('Tip')

**# Adding the legends**

- plt.show()



## 4. Histogram

- A histogram is basically used to represent data in the form of some groups. It is a type of bar plot where the X-axis represents the bin ranges while the Y-axis gives information about frequency. The hist() function is used to compute and create a histogram.
- In histogram, if we pass categorical data then it will automatically compute the frequency of that data i.e. how often each value occurred.

**Example:**

- import pandas as pd
- import matplotlib.pyplot as plt

**# reading the database**

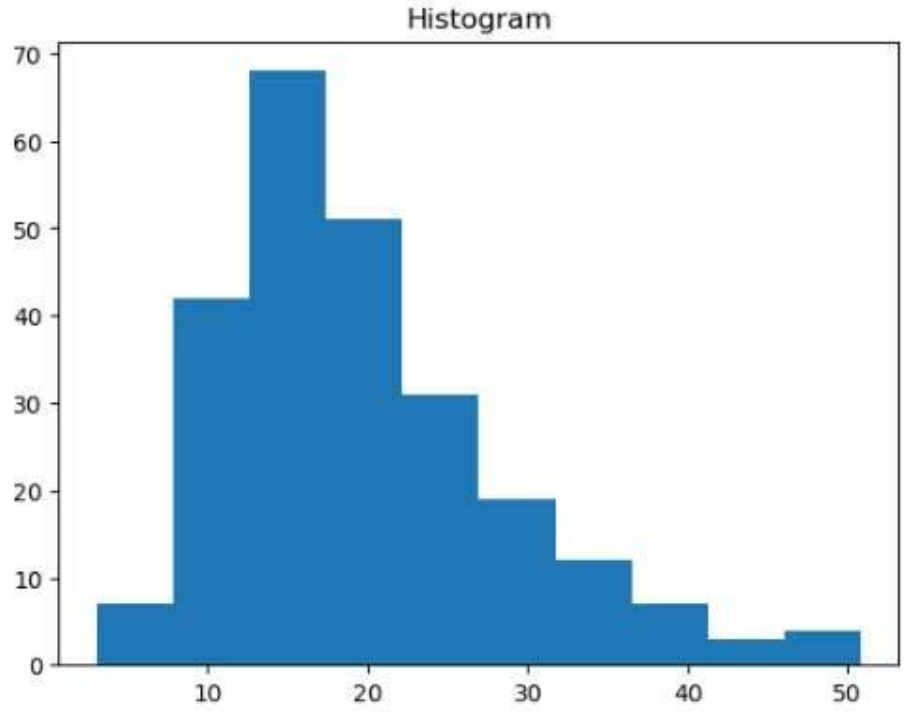
- data = pd.read_csv("tips.csv")

**# histogram of total_bills**

- plt.hist(data['total_bill'])
- plt.title("Histogram")

**# Adding the legends**

- plt.show()



## Seaborn

- Seaborn is a high-level interface built on top of the Matplotlib. It provides beautiful design styles and color palettes to make more attractive graphs.
- To install seaborn type the below command in the terminal.

  pip install seaborn
- Seaborn is built on the top of Matplotlib, therefore it can be used with the Matplotlib as well.
- Using both Matplotlib and Seaborn together is a very simple process. We just have to invoke the Seaborn Plotting function as normal, and then we can use Matplotlib's customization function.
- **Note:** Seaborn comes loaded with dataset such as tips, iris, etc. but for the sake of this tutorial we will use Pandas for loading these datasets.

**# importing packages**

- import seaborn as sns
- import matplotlib.pyplot as plt
- import pandas as pd

**# reading the database**

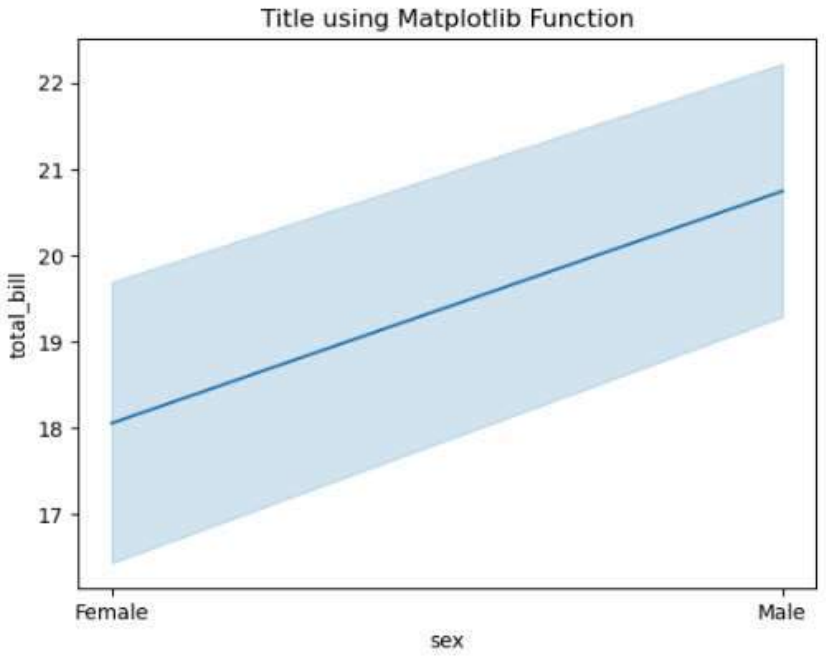
- data = pd.read_csv("tips.csv")

**# draw lineplot**

- sns.lineplot(x="sex", y="total_bill", data=data)

**# setting the title using Matplotlib**

- plt.title('Title using Matplotlib Function')
- plt.show()



## 1. Scatter Plot

❖ Scatter plot is plotted using the scatterplot() method. This is similar to Matplotlib, but additional argument data is required.

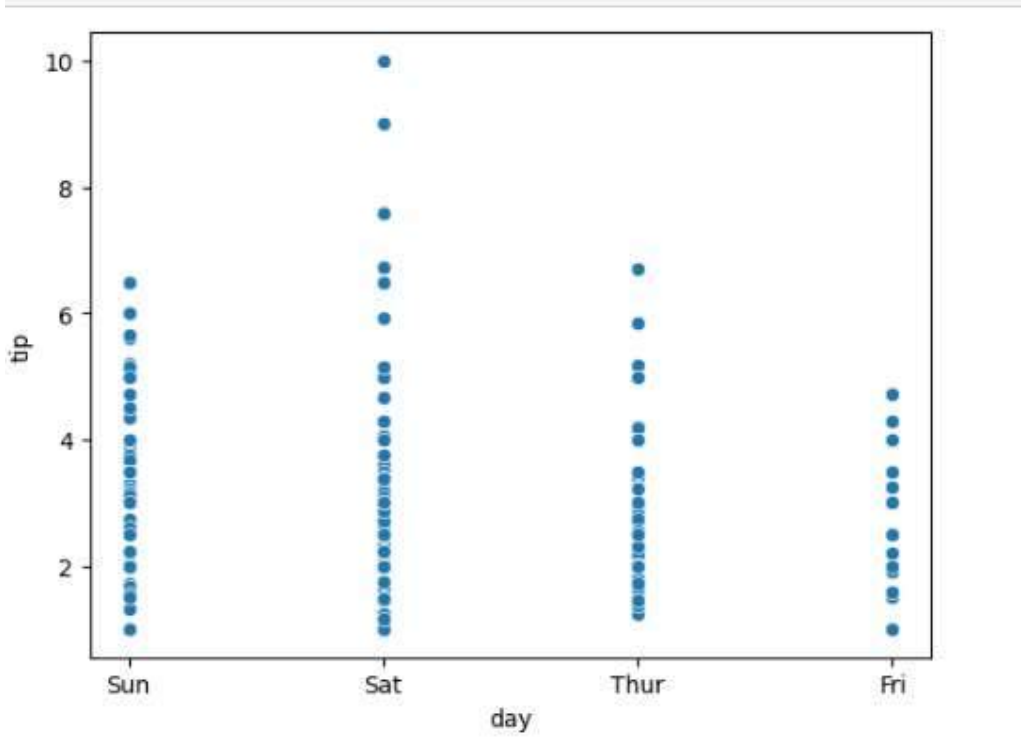
**Example:**

**# importing packages**

- import seaborn as sns
- import matplotlib.pyplot as plt
- import pandas as pd

**# reading the database**

- data = pd.read_csv("tips.csv")
- sns.scatterplot(x='day', y='tip', data=data,)
- plt.show()



❖ To find that while using Matplotlib it will a lot difficult if you want to color each point of this plot according to the sex.

❖ But in scatter plot it can be done with the help of hue argument.

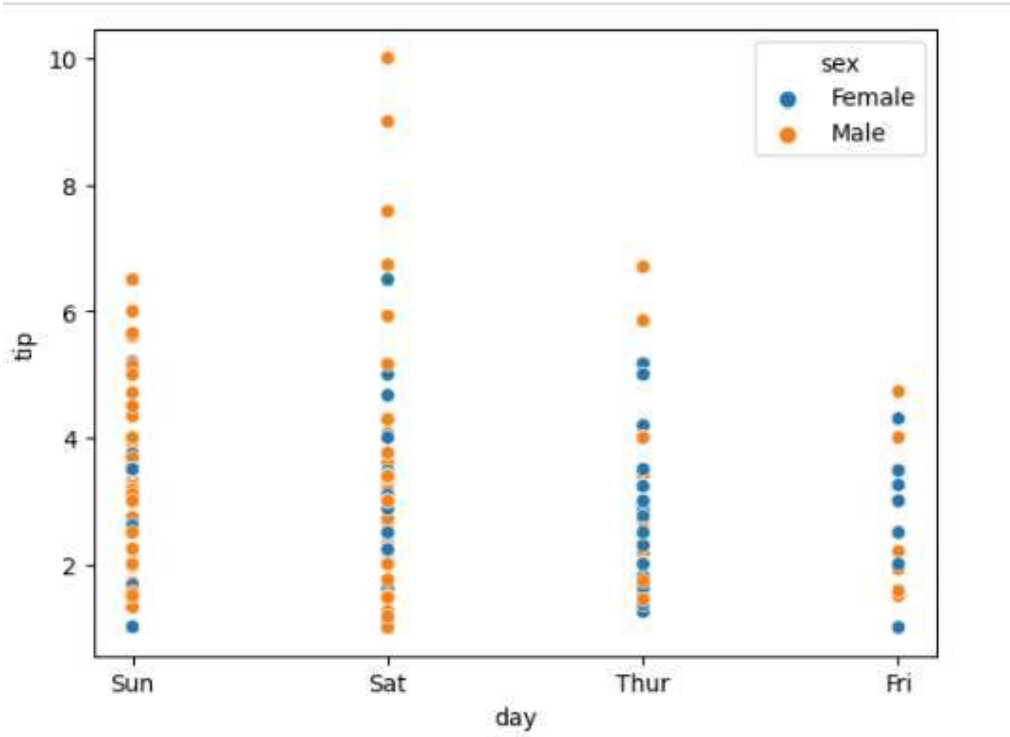
**Example:**

**# importing packages**

- import seaborn as sns
- import matplotlib.pyplot as plt
- import pandas as pd

**# reading the database**

- data = pd.read_csv("tips.csv")
- sns.scatterplot(x='day', y='tip', data=data,
- hue='sex')
- plt.show()



## 2. Line Plot

❖ Line Plot in Seaborn plotted using the lineplot() method. In this, we can pass only the data argument also.

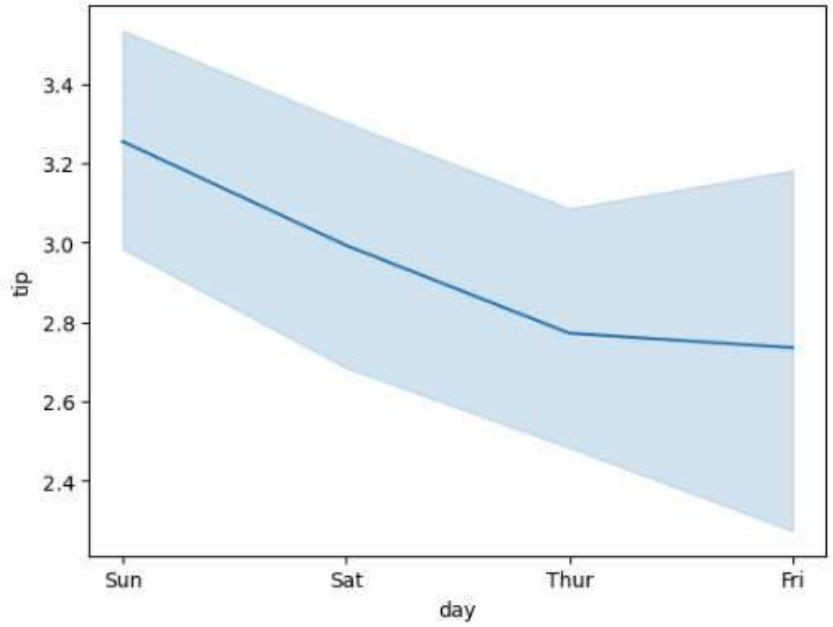
Example:

**# importing packages**

- import seaborn as sns
- import matplotlib.pyplot as plt
- import pandas as pd

**# reading the database**

- data = pd.read_csv("tips.csv")
- sns.lineplot(x='day', y='tip', data=data)
- plt.show()



**# importing packages**

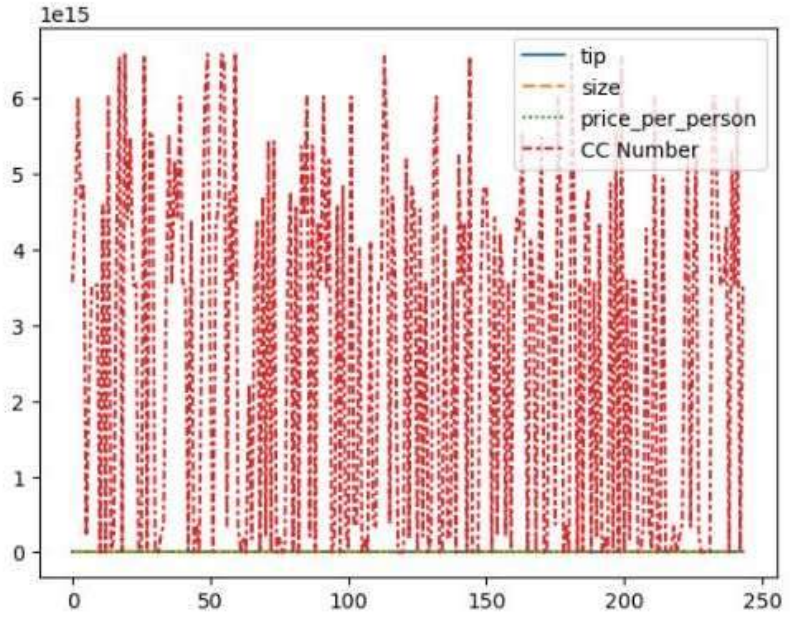
- import seaborn as sns
- import matplotlib.pyplot as plt
- import pandas as pd

**# reading the database**

- data = pd.read_csv("tips.csv")

**# using only data attribute**

- sns.lineplot(data=data.drop(['total_bill'], axis=1))
- plt.show()



### 3. Bar Plot

❖ Bar Plot in Seaborn can be created using the barplot() method.

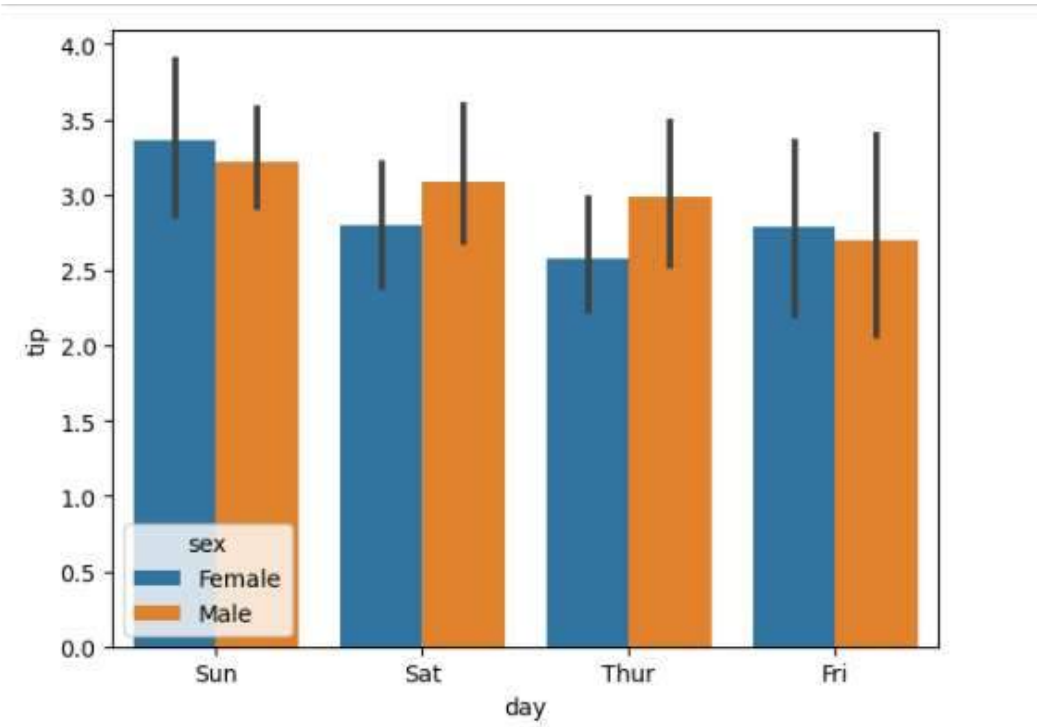
**Example:**

**# importing packages**

- import seaborn as sns
- import matplotlib.pyplot as plt
- import pandas as pd

**# reading the database**

- data = pd.read_csv("tips.csv")
- sns.barplot(x='day',y='tip', data=data,
- hue='sex')
- plt.show()



## 4. Histogram

- ❖ The histogram in Seaborn can be plotted using the histplot() function.
- ❖ After going through all these plots you must have noticed that customizing plots using Seaborn is a lot more easier than using Matplotlib. And it is also built over matplotlib then we can also use matplotlib functions while using Seaborn.

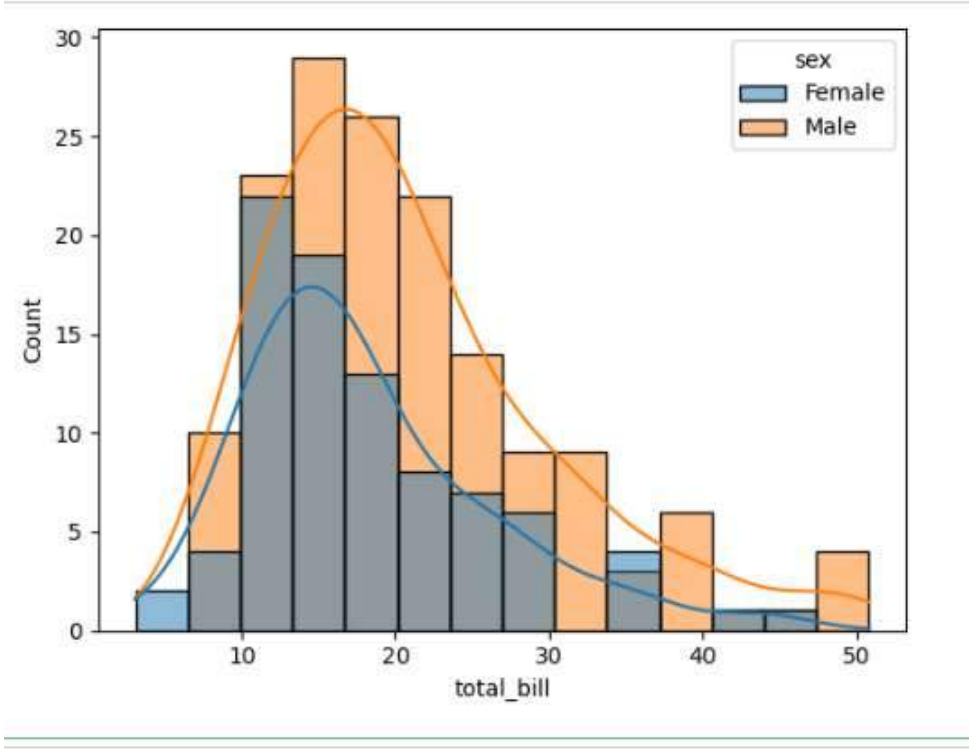
Example:

**# importing packages**

- import seaborn as sns
- import matplotlib.pyplot as plt
- import pandas as pd

**# reading the database**

- data = pd.read_csv("tips.csv")
- sns.histplot(x='total_bill', data=data,
  kde=True, hue='sex')
- plt.show()



## Bokeh

- Let's move on to the third library of our list. Bokeh is mainly famous for its interactive charts visualization.
- Bokeh renders its plots using HTML and JavaScript that uses modern web browsers for presenting elegant, concise construction of novel graphics with high-level interactivity.
- To install this type the below command in the terminal.

```
pip install bokeh
```

### 1. Scatter Plot

- Scatter Plot in Bokeh can be plotted using the scatter() method of the plotting module. Here pass the x and y coordinates respectively.

Example:

**# importing the modules**

- from bokeh.plotting import figure, output_file, show
- from bokeh.palettes import magma
- import pandas as pd

**# instantiating the figure object**

- graph = figure(title = "Bokeh Scatter Graph")

**# reading the database**

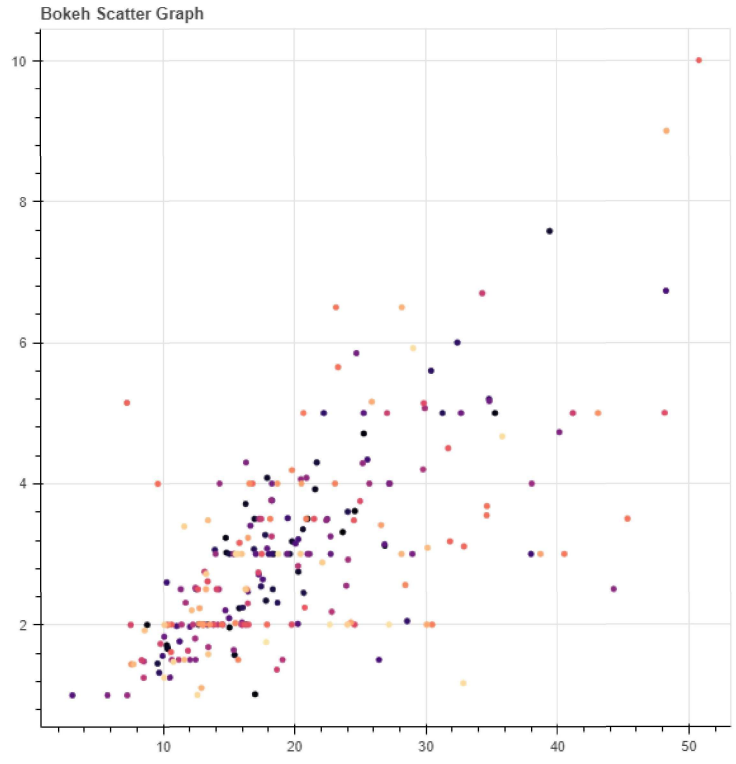
- data = pd.read_csv("tips.csv")
- color = magma(256)

**# plotting the graph**

- graph.scatter(data['total_bill'], data['tip'], color=color)

**# displaying the model**

- show(graph)



## 2. Line Chart

A line plot can be created using the line() method of the plotting module.

Example:

**# importing the modules**

- from bokeh.plotting import figure, output_file, show
- import pandas as pd

**# instantiating the figure object**

- graph = figure(title = "Bokeh Bar Chart")

**# reading the database**

- data = pd.read_csv("tips.csv")

**# Count of each unique value of tip column**

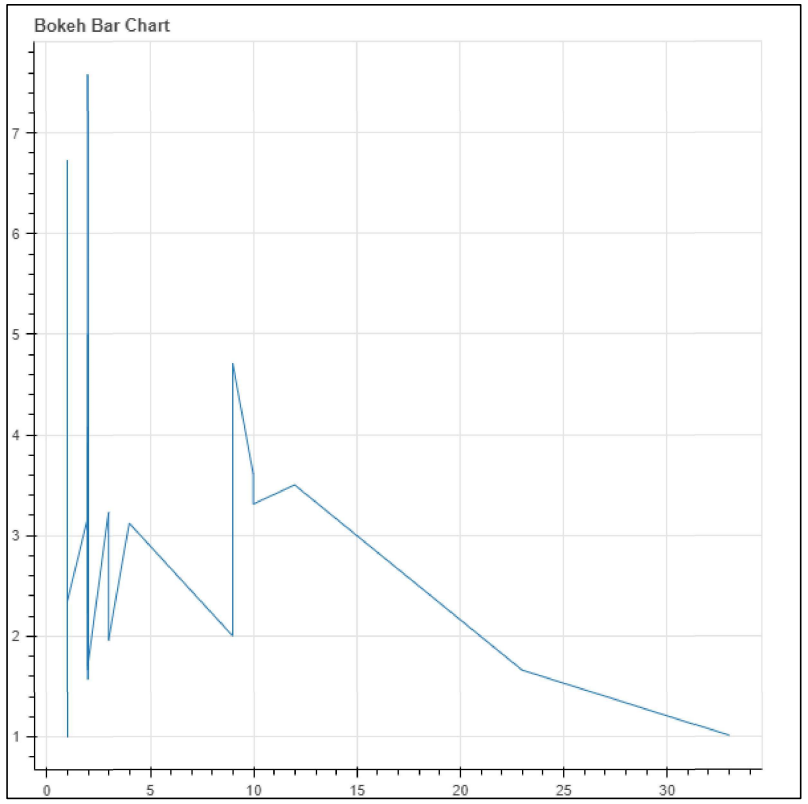
- df = data['tip'].value_counts()

**# plotting the graph**

- graph.line(df, data['tip'])

**# displaying the model**

- show(graph)



## 3. Bar Chart

❖ Bar Chart can be of two types horizontal bars and vertical bars. Each can be created using the hbar() and vbar() functions of the plotting interface respectively.

**Example:**

**# importing the modules**

- from bokeh.plotting import figure, output_file, show
- import pandas as pd

**# instantiating the figure object**

- graph = figure(title = "Bokeh Bar Chart")

**# reading the database**

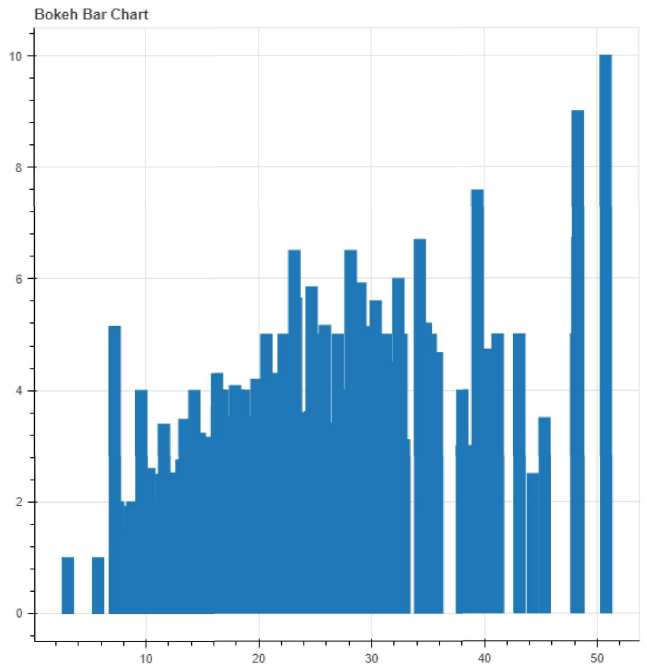
- data = pd.read_csv("C:\\Exp\\tips.csv")

**# plotting the graph**

- graph.vbar(data['total_bill'], top=data['tip'])

**# displaying the model**

- show(graph)



**Interactive Data Visualization**

- One of the key features of Bokeh is to add interaction to the plots. Let's see various interactions that can be added.

**Interactive Legends**

- click_policy property makes the legend interactive. There are two types of interactivity –
- **Hiding:** Hides the Glyphs.
- **Muting:** Hiding the glyph makes it vanish completely, on the other hand, muting the glyph just de-emphasizes the glyph based on the parameters.

Example:

**# importing the modules**

- from bokeh.plotting import figure, output_file, show
- import pandas as pd

**# instantiating the figure object**

- graph = figure(title = "Bokeh Bar Chart")

**# reading the database**

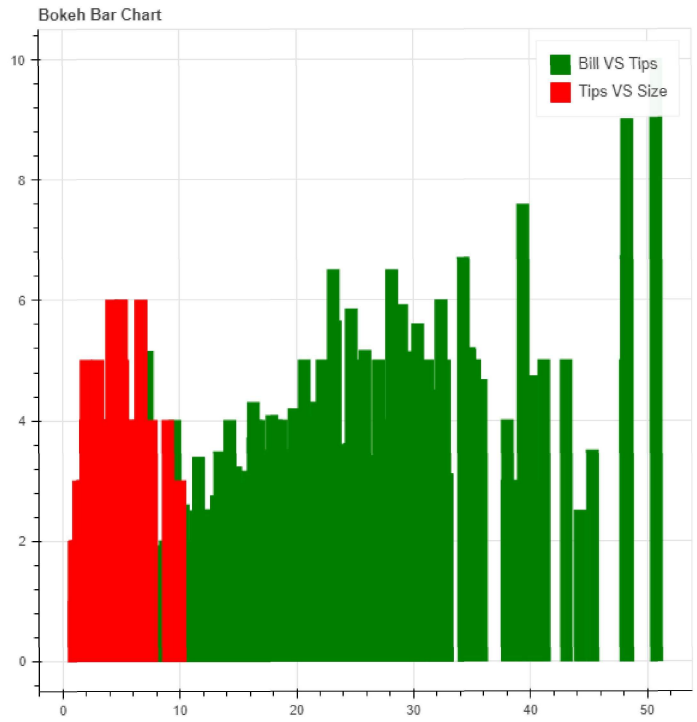
- data = pd.read_csv("tips.csv")

**# plotting the graph**

- graph.vbar(data['total_bill'], top=data['tip'],
  legend_label = "Bill VS Tips", color='green')
- graph.vbar(data['tip'], top=data['size'],
  legend_label = "Tips VS Size", color='red')
- graph.legend.click_policy = "hide"

**# displaying the model**

- show(graph)



**Adding Widgets**

- Bokeh provides GUI features similar to HTML forms like buttons, sliders, checkboxes, etc. These provide an interactive interface to the plot that allows changing the parameters of the plot, modifying plot data, etc.
- Let's see how to use and add some commonly used widgets.
- **Buttons:** This widget adds a simple button widget to the plot. We have to pass a custom JavaScript function to the CustomJS() method of the models class.
- **CheckboxGroup:** Adds a standard check box to the plot. Similarly to buttons we have to pass the custom JavaScript function to the CustomJS() method of the models class.
- **RadioGroup:** Adds a simple radio button and accepts a custom JavaScript function.
- **Note:** All these buttons will be opened on a new tab.

**Example:**

```
from bokeh.io import show
from bokeh.models import Button, CheckboxGroup, RadioGroup, CustomJS
button = Button(label="GFG")
button.js_on_click(CustomJS(
        code="console.log('button: click!', this.toString())"))
# Labels for checkbox and radio buttons
L = ["First", "Second", "Third"]
# the active parameter sets checks the selected value by default
checkbox_group = CheckboxGroup(labels=L, active=[0, 2])
checkbox_group.js_on_click(CustomJS(code="""
        console.log('checkbox_group: active=' + this.active, this.toString())"""))
# the active parameter sets checks the selected value by default
radio_group = RadioGroup(labels=L, active=1)
radio_group.js_on_click(CustomJS(code="""
        console.log('radio_group: active=' + this.active, this.toString())"""))
show(button)
show(checkbox_group)
show(radio_group)
```

**Sliders:**

❖ Adds a slider to the plot. It also needs a custom JavaScript function.

**Example:**

- from bokeh.io import show
- from bokeh.models import CustomJS, Slider
- slider = Slider(start=1, end=20, value=1, step=2, title="Slider")
- slider.js_on_change("value", CustomJS(code="""console.log('slider: value=' + this.value, this.toString())""")) 
- show(slider)

**Plotly**

- This is the last library of our list and you might be wondering why plotly. Here's why –
- Plotly has hover tool capabilities that allow us to detect any outliers or anomalies in numerous data points.
- It allows more customization.
- It makes the graph visually more attractive.
- To install it type the below command in the terminal.

```
pip install plotly
```

**1. Scatter Plot**

- Scatter plot in Plotly can be created using the scatter() method of plotly.express. Like Seaborn, an extra data argument is also required here.

- import plotly.express as px
- import pandas as pd

**# reading the database**

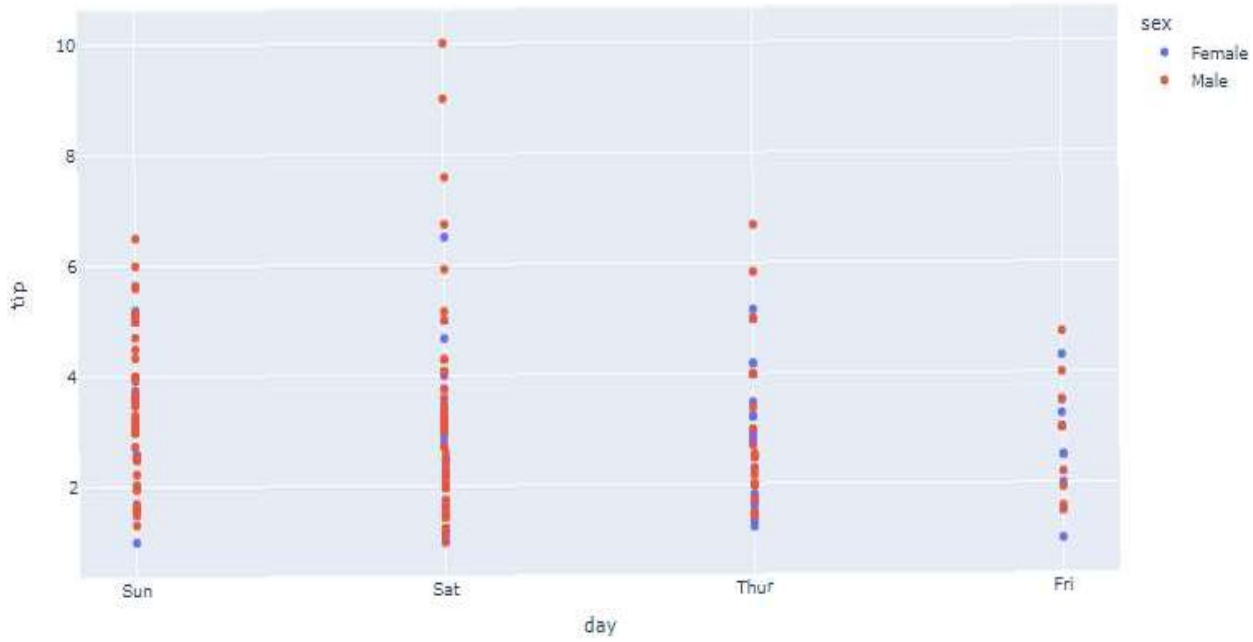
- data = pd.read_csv("tips.csv")

**# plotting the scatter chart**

- fig = px.scatter(data, x="day", y="tip", color='sex')

**# showing the plot**

- fig.show()



## 2. Line Chart

❖ Line plot in Plotly is much accessible and illustrious annexation to plotly which manage a variety of types of data and assemble easy-to-style statistic. With px.line each data position is represented as a vertex

Example:

- import plotly.express as px
- import pandas as pd

**# reading the database**

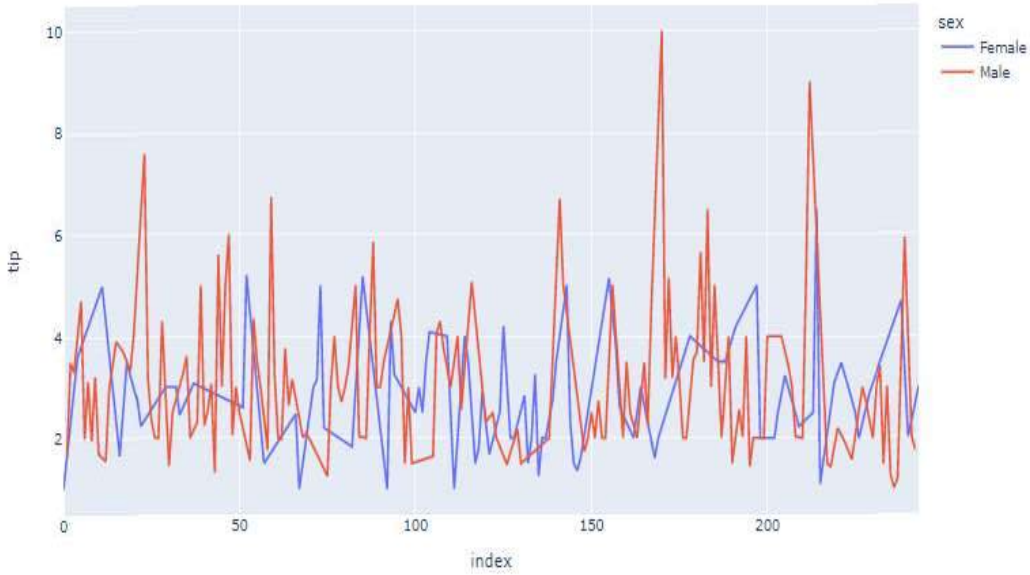
- data = pd.read_csv("C:\\Exp\\tips.csv")

**# plotting the scatter chart**

- fig = px.line(data, y='tip', color='sex')

**# showing the plot**

- fig.show()



### 3. Bar Chart

❖ Bar Chart in Plotly can be created using the bar() method of plotly.express class.

**Example:**

- import plotly.express as px
- import pandas as pd

**# reading the database**

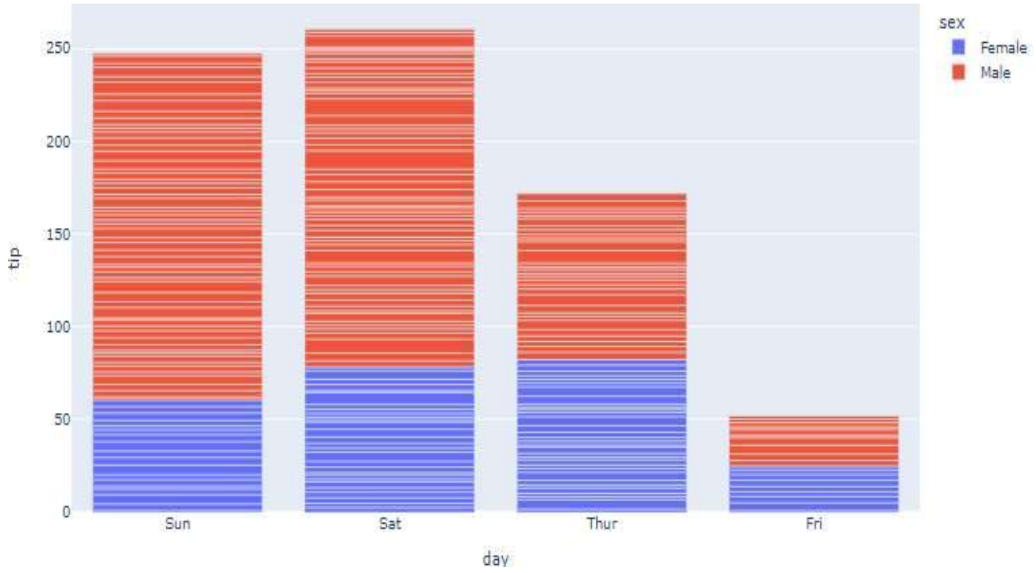
- data = pd.read_csv("tips.csv")

**# plotting the scatter chart**

- fig = px.bar(data, x='day', y='tip', color='sex')

**# showing the plot**

- fig.show()



## 4. Histogram

❖ In plotly, histograms can be created using the histogram() function of the plotly.express class.

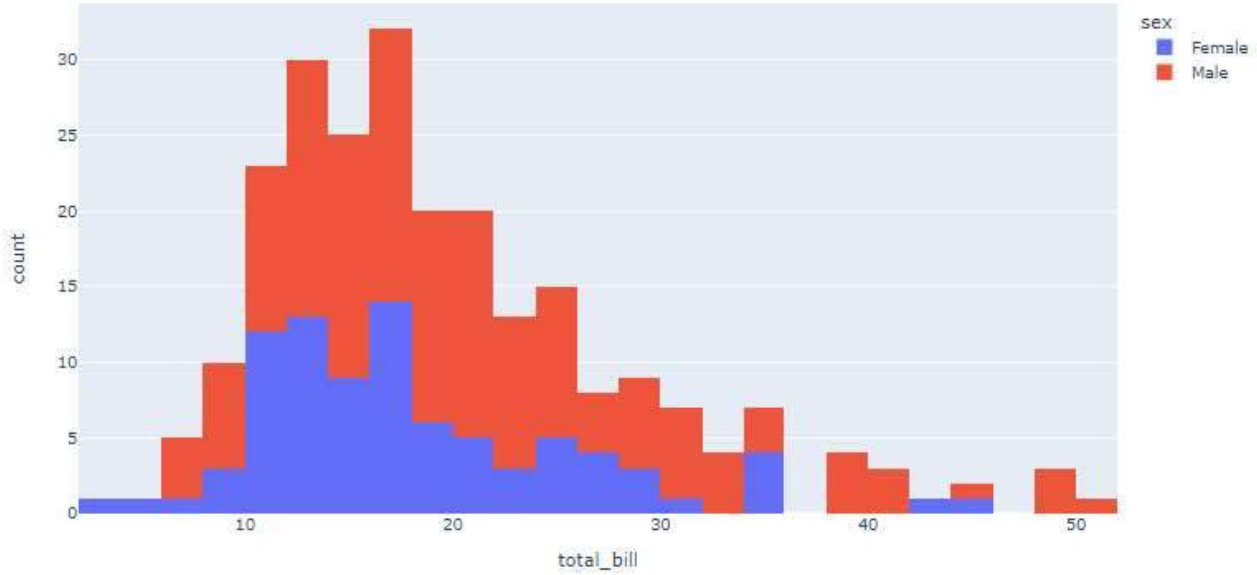
Example:

```
import plotly.express as px
import pandas as pd

# reading the database
data = pd.read_csv("tips.csv")

# plotting the scatter chart
fig = px.histogram(data, x='total_bill', color='sex')

# showing the plot
fig.show()
```



## Measures of Central Tendency

- Measures of central tendency are statistical measures that describe the center or average of a set of data values. They provide a single value that represents the central or typical value in a dataset. The three main measures of central tendency are:

**Mean:**

- The mean, often referred to as the average, is calculated by **adding up all the values** in a dataset and then **dividing by the number of values**.
- Formula:

$$m = \frac{\text{sum of the terms}}{\text{number of terms}}$$

$m$ = mean

**Median:**

- The median is the middle value in a dataset when it is ordered from least to greatest. If there is an even number of values, the median is the average of the two middle values.
- To find the median, the data must be sorted first.
- For an odd number of values: Median = Middle value
- For an even number of values: Median =Sum of two middle values / 2

**Mode:**

- The mode is the value that appears most frequently in a dataset.
- A dataset may have no mode (if all values occur with the same frequency), one mode (unimodal), or multiple modes (multimodal).

## Dispersion

- Dispersion measures in statistics quantify the extent to which data values spread out or deviate from the central tendency. They provide insights into the variability, or spread, within a dataset. Common measures of dispersion include:

**Range:**

- The range is the simplest measure of dispersion and is calculated as the difference between the maximum and minimum values in a dataset.
- **Formula: Range = Maximum value − Minimum value**

**Variance:**

- Variance measures the average squared deviation of each data point from the mean of the dataset.

$$\sigma^2 = \frac{\Sigma (x - \mu)^2}{N}$$ Population Variance

$$s^2 = \frac{\Sigma (x - \bar{x})^2}{n - 1}$$ Sample Variance

**Standard Deviation:**

- The standard deviation is the square root of the variance. It provides a more interpretable measure of dispersion in the same units as the original data.
- Formula for population standard deviation:

$$\mathrm{SD} = \sqrt{\mathrm{Var}}$$

- Formula for sample standard deviation

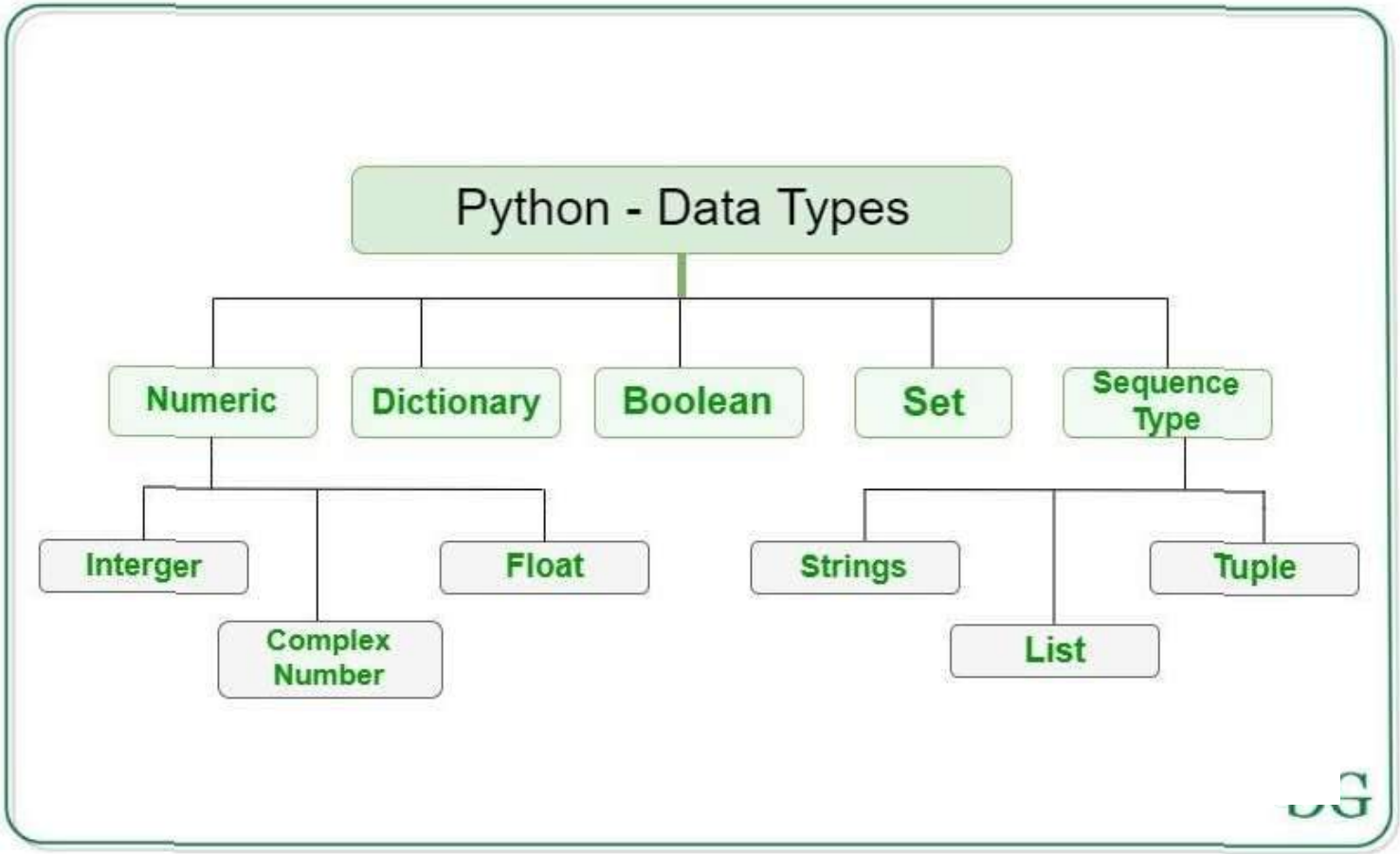
$$\mathrm{SD} = \sqrt{\mathrm{Var}}$$

**Interquartile Range (IQR):**

- The IQR is a measure of statistical dispersion, or in simple terms, it represents the range within which the middle 50% of the data values lie.
- It is the difference between the third quartile (Q3) and the first quartile (Q1).
- Formula: IQR=Q3−Q1

## Different types of data and data structures use cases? Using Python

- Data types are the classification or categorization of data items. It represents the kind of value that tells what operations can be performed on a particular data. Since everything is an object in Python programming, data types are actually classes and variables are instance (object) of these classes.
- Following are the standard or built-in data type of Python:
  1. Numeric
  2. Sequence Type
  3. Boolean
  4. Set
  5. Dictionary


Python - Data Types
Numeric
Dictionary
Boolean
Set
Sequence Type
Interger
Complex Number
Float
Strings
List
Tuple

**Numeric**

- In Python, numeric data type represent the data which has numeric value. Numeric value can be integer, floating number or even complex numbers. These values are defined as int, float and complex class in Python.
- Integers – This value is represented by **int** class. It contains positive or negative whole numbers (without fraction or decimal). In Python there is no limit to how long an integer value can be.
- Float – This value is represented by **float** class. It is a real number with floating point representation. It is specified by a decimal point. Optionally, the character e or E followed by a positive or negative integer may be appended to specify scientific notation.
- Complex Numbers – Complex number is represented by complex class. It is specified as (real part) + (imaginary part)j. For example – 2+3j

**Note – type() function is used to determine the type of data type.**

## Sequence Type

- In Python, sequence is the ordered collection of similar or different data types. Sequences allows to store multiple values in an organized and efficient fashion. There are several sequence types in Python –

  String

  List

  Tuple

## 1) String

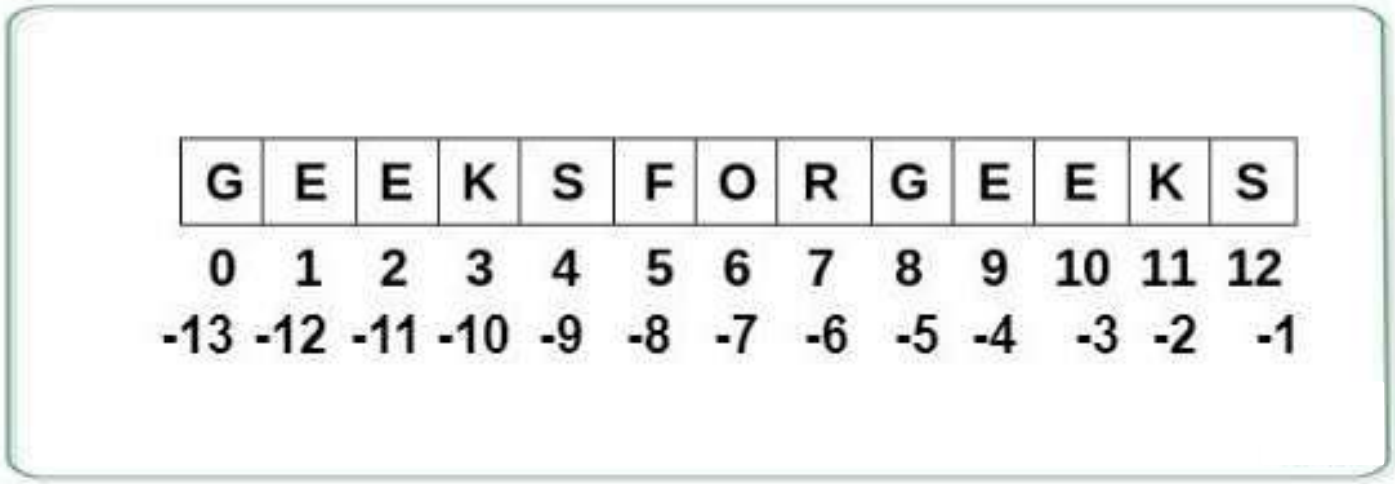
- In Python, Strings are arrays of bytes representing Unicode characters. A string is a collection of one or more characters put in a single quote, double-quote or triple quote.
- In python there is no character data type, a character is a string of length one. It is represented by **str** class.

## Creating String

- Strings in Python can be created using single quotes or double quotes or even triple quotes.

## Accessing elements of String

- In Python, individual characters of a String can be accessed by using the method of Indexing. Indexing allows negative address references to access characters from the back of the String, e.g. -1 refers to the last character, -2 refers to the second last character and so on.



**2) List**

- Lists are just like the arrays, declared in other languages which is a ordered collection of data. It is very flexible as the items in a list do not need to be of the same type.

Creating List

- Lists in Python can be created by just placing the sequence inside the square brackets[].

**Accessing elements of List**

- In order to access the list items refer to the index number. Use the index operator [ ] to access an item in a list. In Python, negative sequence indexes represent positions from the end of the array.
- Instead of having to compute the offset as in List[len(List)-3], it is enough to just write List[-3]. Negative indexing means beginning from the end, -1 refers to the last item, -2 refers to the second-last item, etc.

**3) Tuple**

- Just like list, tuple is also an ordered collection of Python objects. The only difference between tuple and list is that tuples are immutable i.e. tuples cannot be modified after it is created. It is represented by tuple class.

**Creating Tuple**

- In Python, tuples are created by placing a sequence of values separated by 'comma' with or without the use of parentheses for grouping of the data sequence. Tuples can contain any number of elements and of any datatype (like strings, integers, list, etc.).

Note: Tuples can also be created with a single element, but it is a bit tricky. Having one element in the parentheses is not sufficient, there must be a trailing 'comma' to make it a tuple.

**Note – Creation of Python tuple without the use of parentheses is known as Tuple Packing.**

**Accessing elements of Tuple**

- In order to access the tuple items refer to the index number. Use the index operator [ ] to access an item in a tuple. The index must be an integer. Nested tuples are accessed using nested indexing.

**Boolean**

- Data type with one of the two built-in values, True or False. Boolean objects that are equal to True are truthy (true), and those equal to False are falsy (false). But non-Boolean objects can be evaluated in Boolean context as well and determined to be true or false. It is denoted by the class bool.

Note – True and False with capital 'T' and 'F' are valid booleans otherwise python will throw an error.

**Set**

- In Python, Set is an unordered collection of data type that is iterable, mutable and has no duplicate elements. The order of elements in a set is undefined though it may consist of various elements.

**Creating Sets**

- Sets can be created by using the built-in set() function with an iterable object or a sequence by placing the sequence inside curly braces, separated by 'comma'. Type of elements in a set need not be the same, various mixed-up data type values can also be passed to the set.

**Accessing elements of Sets**

- Set items cannot be accessed by referring to an index, since sets are unordered the items has no index. But you can loop through the set items using a for loop, or ask if a specified value is present in a set, by using the in keyword.

**Dictionary**

- Dictionary in Python is an unordered collection of data values, used to store data values like a map, which unlike other Data Types that hold only single value as an element, Dictionary holds key:value pair. Key-value is provided in the dictionary to make it more optimized. Each key-value pair in a Dictionary is separated by a colon :, whereas each key is separated by a 'comma'.

**Creating Dictionary**

- In Python, a Dictionary can be created by placing a sequence of elements within curly {} braces, separated by 'comma'. Values in a dictionary can be of any datatype and can be duplicated, whereas keys can't be repeated and must be immutable. Dictionary can also be created by the built-in function dict(). An empty dictionary can be created by just placing it to curly braces{}.

Note – Dictionary keys are case sensitive, same name but different cases of Key will be treated distinctly.

## Provide an explanation of Jupyter Notebook

- Jupyter Notebook is an open-source, interactive web application that allows you to create and share documents containing live code, equations, visualizations, and narrative text. It is widely used in data science, machine learning, research, and education.
- The name "Jupyter" is a combination of the three core programming languages it supports: Julia, Python, and R.

**Support for Multiple Languages:**

- Jupyter Notebook supports various programming languages, not just the three in its name. This includes languages like Scala, Bash, and others, making it a versatile tool for different tasks.

**Interactive Computing:**

- It allows you to execute code in a step-by-step manner, making it easy to experiment, test, and debug code snippets.

**Rich Output:**

- Besides code execution, Jupyter can display rich output such as HTML, images, videos, and interactive widgets directly in the notebook. This makes it a powerful tool for data visualization and exploration.

**Markdown Support:**

- Jupyter Notebooks support Markdown cells, enabling the inclusion of formatted text, headings, lists, and even LaTeX equations.
- This makes it easy to create well-documented and organized documents.

**Integrated Data Visualization:**

- It seamlessly integrates with popular Python libraries like Matplotlib, Seaborn, and Plotly, allowing you to create interactive and static visualizations within the notebook.

**Ease of Sharing:**

- Notebooks can be easily shared with others by exporting them in various formats, such as HTML, PDF, or slides. This facilitates collaboration and communication of data analyses and research findings.

**Kernel Architecture:**

- Jupyter uses a modular architecture with kernels. Each kernel is responsible for executing code in a specific language. For example, there are kernels for Python, R, Julia, etc.

**Support for Data Science Libraries:**

- Jupyter is commonly used in conjunction with data science libraries like NumPy, Pandas, SciPy, and scikit-learn. This integration makes it a popular environment for data analysis and machine learning.

**Using Jupyter Notebook:**

**Installation:**

- Jupyter can be installed using the Python package manager, pip. You can install it with the command: pip install jupyter.

**Launching Jupyter Notebook:**

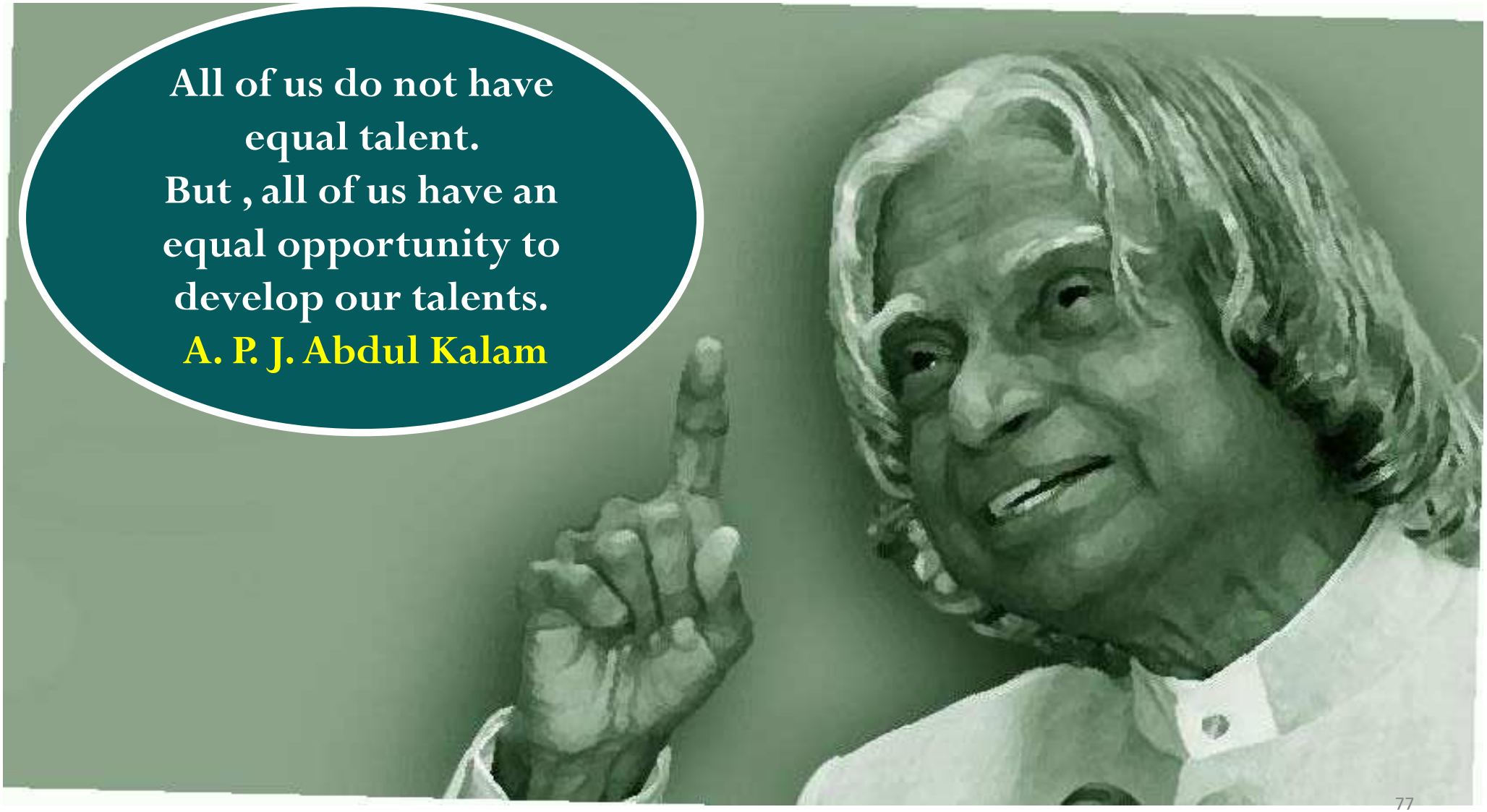
- After installation, you can start Jupyter by running the command jupyter notebook in your terminal. This will open a new tab in your web browser with the Jupyter dashboard.

**Creating and Running Cells:**

- In a Jupyter Notebook, code is written and executed in cells. You can create a new cell by clicking the "+" button on the toolbar and choose the cell type (code or Markdown). To execute a cell, use Shift+Enter.

**Saving and Exporting:**

- Notebooks can be saved using the "Save" option in the toolbar. They can also be exported to different formats through the "File" menu.


All of us do not have
equal talent.
But , all of us have an
equal opportunity to
develop our talents.
A. P. J. Abdul Kalam


Thank
You!

## UNIT-II

**Introduction to Probability:** Classical Probability, Relative Frequency, Sample Space, Events, Types of Probability, conditional Probability, Bayesian Rule, Relative frequency method, Random Variable, Distribution Function, Density Function

**Sampling and Sampling Distribution**: Random vs Non Random Sampling, Simple random sampling, cluster sampling, concept of sampling distributions, Student's t-test, Chi-square and F-distributions. Central limit theorem and its application, confidence intervals

### Reference Books:


1. McKinney, W. (2012). Python for data analysis: Data wrangling with Pandas, NumPy, and IPython. " O'Reilly Media, Inc.".
2. Swaroop, C. H. (2003). A Byte of Python. Python Tutorial.
3. Ken Black, sixth Editing. Business Statistics for Contemporary Decision Making. “John Wiley & Sons, Inc”.
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## Probability:

- Probability is a branch of mathematics that deals with the likelihood or chance of different outcomes occurring in a particular event.
- It provides a framework for quantifying uncertainty and randomness in various situations. There are different approaches to understanding and calculating probability, and **three fundamental concepts are classical probability, relative frequency, and sample space.**
- Probability is simply how likely something is to happen. Whenever we're unsure about the outcome of an event, we can talk about the probabilities of certain outcomes—how likely they are. The analysis of events governed by probability is called statistics.
- **A strong likelihood or chance of something. The relative possibility an event will occur ...the ratio of the number of actual occurrences to the total number of possible occurrences.**

**Three Types of Probability**

❖ **1. Classical Probability :**

❖ Classical probability is based on the assumption of equally likely outcomes in an experiment. When all possible outcomes of an experiment are equally likely, classical probability can be calculated by dividing the number of favorable outcomes by the total number of possible outcomes. The classical probability (P(A)) of an event A is given by:

$$P(A) = \frac{\text{Number of Favorable Outcomes for Event A}}{\text{Total Number of Possible Outcomes}}$$

❖ **For example, when rolling a fair six-sided die, the probability of getting a 4 is 1/6 because there is only one favorable outcome (rolling a 4) out of the six possible outcomes (rolling a 1, 2, 3, 4, 5, or 6).**

**2. Relative Frequency:**

- Relative frequency probability is based on the observed outcomes of an experiment. Instead of assuming equal likelihood, it calculates probability by looking at the proportion of times an event occurs in a large number of trials. The relative frequency (P(A)) of an event A is given by

$$P(A) = \frac{\text{Number of Times Event A Occurs}}{\text{Total Number of Trials}}$$

- **For example, if you toss a coin 100 times and it comes up heads 60 times, the relative frequency of getting heads is 60/100 or 0.6.**

**2. Sample Space:**

- The sample space of an experiment is the set of all possible outcomes. It is denoted by S and is fundamental to understanding probability. The sample space includes every possible result, and events are subsets of the sample space.
- For example, when rolling a six-sided die, the sample space (S) is {1, 2, 3, 4, 5, 6}. Events, such as getting an even number or rolling a 3, are subsets of this sample space.
- **Events:**
- An event is a subset of the sample space, representing a collection of outcomes.
- Events can be simple (a single outcome) or compound (multiple outcomes).
- The occurrence of an event is an observable result of the experiment.
- Events are often denoted by capital letters (e.g., A, B).

## Terms Related to Probability

### Experiment:

- An experiment is a type of action with unknown outcomes. There are a few positive outcomes and a few negative consequences in every experiment.
- Scientists will make thousands of unsuccessful attempts before they could make a successful attempt to make any invention.

### Random Experiment:

- A random experiment is one in which the set of possible outcomes is known. Still, the specific outcome in a given experiment cannot be predicted before the experiment is carried out.
- Example: Rolling a die, tossing a coin

**Trial:**

- Trials are the various tries made during an experiment. In other words, a trial is any particular outcome of a random experiment.
- Example: Tossing a coin
- **Event:**
- A trial with a clearly defined outcome is an event. For example, getting a tail when tossing a coin is termed an event.
- **Random Event:**
- A random event cannot be easily foreseen. The chance value for such situations is extremely low. The appearance of a rainbow in the rain is a completely random occurrence.
- **Outcome:**
- The outcome of an event is a collection of all possible outcomes.
- Example: There are two different results when a sportsperson hits a ball towards the goal post. He has a chance to score or miss the goal.

## Types of Probability.

- Probability can be categorized into various types, each with its own approach to defining and calculating the likelihood of events. The three main types of probability are Classical Probability, Empirical (or Relative Frequency) Probability, and Subjective Probability.

**1. Classical Probability:**

- This type of probability is based on a priori knowledge and assumes that all outcomes in the sample space are equally likely.
- It is most applicable to situations where each outcome is equally likely, such as flipping a fair coin or rolling a fair die.
- The classical probability of an event A is calculated as the ratio of the number of favorable outcomes to the total number of possible outcomes.

$$P(A) = \frac{\text{Number of Favorable Outcomes for Event A}}{\text{Total Number of Possible Outcomes}}$$

**2. Empirical (Relative Frequency) Probability:**

- ❖ Empirical probability is based on observed frequencies from past events or experiments.
- ❖ It involves conducting experiments or observations and calculating the ratio of the number of times an event occurs to the total number of trials.
- ❖ As the number of trials increases, the relative frequency converges to the actual probability of the event.

$$P(A) = \frac{\text{Number of Times Event A Occurs}}{\text{Total Number of Trials}}$$

**3. Subjective Probability:**

- ❖ Subjective probability is based on an individual's personal judgment or belief about the likelihood of an event occurring.
- ❖ It is subjective in nature and may vary from person to person, depending on their knowledge, experience, and perception.
- ❖ Subjective probabilities are often used in decision-making and situations where objective data is unusual.
- ❖ There is no specific formula for subjective probability; individuals assign probabilities based on their perception, experience, or other subjective factors.

## Conditional Probability:

- Conditional probability is one of the types of probability in probability theory, where the probability of one event is dependent on the other event already happened.
- As this type of event is very common in real life, conditional probability is often used to determine the probability of such cases.
- It is denoted by P(A|B), where A and B are events, and it reads as "the probability of A given B.“
- The formula for conditional probability is defined as:
  - $P(A|B)=P(A \cap B) / P(B)$
- P(A|B) is the probability of event A happening, given that event B has already happened.
- P(A∩B) is the probability of both events A and B happening.
- P(B) is the probability of event B happening

**Key points about conditional probability:**

**Interpretation:**

- Conditional probability represents the updated probability of an event A occurring based on the knowledge that event B has already occurred.
- It provides a refined probability estimate, taking into account the additional information provided by event B.

**Calculation:**

- The formula $P(A|B) = P(B)P(A \cap B)$ calculates the conditional probability by dividing the probability of both events A and B occurring by the probability of event B.

**Independent Events:**

- If events A and B are independent, then $P(A|B)=P(A)$, meaning that the occurrence of event B does not affect the probability of event A.

**Dependent Events:**

- If events A and B are dependent, the conditional probability , $P(A|B)$ may differ from the unconditional probability P(A).
- **Multiplication Rule:**
- The multiplication rule for probability is related to conditional probability and states that $P(A \cap B)=P(B) \times P(A|B)$.

## Bayesian Rule

- Bayesian Rule, also known as Bayes' Theorem or Bayes' Rule, is a fundamental concept in probability theory.
- It provides a way to update the probability of a hypothesis based on new evidence or information. In data analytics, Bayes' Theorem is often used for statistical inference, machine learning, and decision-making.
- The formula for Bayes' Theorem is expressed as follows:

$$P(A|B) = \frac{P(B|A) \times P(A)}{P(B)}$$

Where:

- P(A|B) is the probability of hypothesis A given the evidence B (posterior probability).
- P(B|A) is the probability of evidence B given the hypothesis A (likelihood).
- P(A) is the prior probability of hypothesis A (prior probability).
- P(B) is the probability of evidence B occurring (normalizing constant).

**Bayes' Theorem has numerous applications in various fields. Here are a few examples:**

**Medical Diagnosis:**

- Scenario: Suppose you have a rare medical condition (A) that affects only 1% of the population. There is a diagnostic test (B) for this condition, but it is not perfect and produces false positives.
- Application: Bayes' Theorem can be used to calculate the probability that you have the condition given a positive test result, taking into account the test's sensitivity and specificity.

**Spam Filtering:**

- Scenario: You receive an email, and your email system uses a spam filter. The filter looks at certain characteristics of emails (features) to determine whether an email is spam (A) or not.
- Application: Bayes' Theorem can be applied to update the probability of an email being spam based on observed features, improving the accuracy of the spam filter over time.

**Quality Control:**

- Scenario: A factory produces items, and there is a quality control test (B) to check whether an item is defective (A) or not.
- Application: Bayes' Theorem can help in updating the probability of an item being defective given a failed quality control test, incorporating information about the overall defect rate and the test's accuracy.

**Legal Decision Making:**

- Scenario: In a court trial, evidence (B) is presented, and the goal is to determine the guilt or innocence of the accused (A).
- Application: Bayes' Theorem can be used to update the probability of guilt or innocence based on the presented evidence, considering the likelihood of the evidence under both scenarios.

**Customer Relationship Management (CRM):**

- Scenario: A company wants to predict the likelihood of a customer (A) making a purchase based on their previous behavior and interactions (B).
- Application: Bayes' Theorem is used to update the probability of a customer making a purchase given recent interactions, helping tailor marketing strategies.

**Weather Forecasting:**

- Scenario: Meteorologists use historical weather data (A) and current observations to predict future weather conditions (B).
- Application: Bayes' Theorem can help in adjusting the probability of certain weather events based on new observations, providing more accurate and updated weather forecasts.

**Machine Learning:**

- Scenario: In a machine learning classification problem, you want to predict whether an image contains a specific object (A) based on features extracted from the image (B).
- Application: Bayes' Theorem is used in Bayesian classifiers to update the probability of an image containing the object given observed features.

**Traffic Flow Prediction:**

- Scenario: Transportation planners want to predict the probability of traffic congestion (A) based on historical traffic data and current conditions (B).
- Application: Bayes' Theorem helps in updating the probability of traffic congestion given recent observations, improving traffic management strategies.

## Relative frequency method:

- The relative frequency method is a statistical approach used in data analytics to analyze and summarize data based on the observed frequencies or proportions of different outcomes.
- It involves calculating the relative frequency of each event, which is the proportion of times that event occurs relative to the total number of observations.
- This method is particularly useful for exploring and describing the distribution of categorical or discrete data.
- Here are the key steps involved in the relative frequency method:

**Collect Data:**

- Gather the relevant data, typically categorical or discrete, where observations fall into distinct categories or classes.

**Count Frequencies:**

- Count the number of occurrences of each category in the dataset. This creates a frequency distribution, showing how often each category appears.

**Calculate Relative Frequencies:**

- Calculate the relative frequency for each category by dividing the frequency of that category by the total number of observations. Mathematically, it can be expressed as:

$$\text{Relative Frequency of Category} = \frac{\text{Frequency of Category}}{\text{Total Number of Observations}}$$

**Express as Percentages:**

- Optionally, the relative frequencies can be expressed as percentages by multiplying them by 100.
- This helps in providing a more intuitive understanding of the distribution.

**Visualize the Distribution:**

- Represent the relative frequencies graphically using charts or graphs such as bar charts, pie charts, or histograms.
- Visualization aids in better understanding the patterns and trends in the data.

❖ Let's consider a simple example where you have collected data on the favorite colors of 100 people:

Blue: 30 people

Red: 20 people

Green: 15 people

Yellow: 10 people

Other: 25 people

**Calculations:**

$$\text{Relative Frequency of Blue} = \frac{30}{100} = 0.30$$

$$\text{Relative Frequency of Red} = \frac{20}{100} = 0.20$$

$$\text{Relative Frequency of Green} = \frac{15}{100} = 0.15$$

$$\text{Relative Frequency of Yellow} = \frac{10}{100} = 0.10$$

$$\text{Relative Frequency of Other} = \frac{25}{100} = 0.25$$

## Random Variable

- A random variable is a mathematical concept used in probability theory and statistics to describe numerical outcomes that result from a random experiment, process, or phenomenon. In simpler terms, it is a variable whose values are determined by chance. Random variables are a key component in the study of probability and are used to model uncertain situations.
- There are two main types of random variables:

**Discrete Random Variable:**

- A discrete random variable is one that takes on a countable number of distinct values. These values are often isolated points on the number line.
- Examples of discrete random variables include the number of heads obtained when flipping a coin, the number of cars passing through a toll booth in an hour, or the number of emails received in a day.
- The probability distribution of a discrete random variable is often described using a probability mass function (PMF), which gives the probability of each possible value of the random variable.

**Continuous Random Variable:**

- A continuous random variable is one that can take on any value within a specified range or interval.
- Continuous random variables are associated with continuous phenomena and have an infinite number of possible values.
- Examples include the height of a person, the temperature in a room, or the time it takes for a computer to process a task.
- The probability distribution of a continuous random variable is described using a probability density function (PDF).
- Unlike the PMF for discrete random variables, the PDF does not directly give probabilities for specific values but instead provides the probability density over intervals.

## The Distribution Function

- In the theoretical discussion on Random Variables and Probability, we note that the probability distribution induced by a random variable X is determined uniquely by a consistent assignment of mass to semi-infinite intervals of the form $(-\infty,t]$ for each real t.
- This suggests that a natural description is provided by the following.
- **Definition**
- The distribution function FX for random variable X is given by

$$F_X(t) P(X \leq t) = P(X \in (-\infty, t]) \; \forall t \in R$$

- In terms of the mass distribution on the line, this is the probability mass at or to the left of the point t. As a consequence

## Density Function

- A density function, also known as a probability density function (PDF), is a function that describes the likelihood of a random variable appearing as a certain value.
- The function's value at any given sample in the sample space can be interpreted as the relative likelihood that the value of the random variable would be equal to that sample

**Sample Definition**

- How frequently do researchers hunt for the appropriate survey participants for a market research study or an already conducted survey in the field?
- The sample or respondents for this study may be chosen from a group of **known or unknowing consumers or customers.**
- Often times, even though you are aware of the typical respondent profile, you cannot complete your research project without the respondents.
- In these circumstances, researchers and research teams get in touch with specialized organizations to use their respondent panel or purchase respondents from them to finish research studies and surveys.
- They could be respondents from the general population who meet the demographic requirements or those who meet certain criteria.
- The success of research investigations depends on these responders. The many sample types, sampling techniques, and representative instances are covered in length in this page. Additionally, it describes how to compute the size, provides information about an online sample, and highlights the benefits of employing them.

**What is a Sample?**

- A sample is a summarized set of information that a **researcher selects or picks from a broader population using a predetermined technique of selection**. These components are referred to as **observations, sampling units, or sample points.**
- Developing a sample is a productive way to carry out research. The entire population must frequently be studied, which is difficult, expensive, and time consuming.
- As a result, studying the sample offers information the researcher can use to understand the complete population.
- For instance, a cell phone manufacturer might want to interview students at American universities about certain features.
- If the researcher wants to find features that students utilize, features they would want to see, and the price they are prepared to pay, an extensive research study must be carried out.
- It is crucial to complete this step in order to comprehend the features that need to be developed, those that need to be upgraded, the device's price, and the go-to-market plan.

- There were 24.7 million students enrolled in American universities in 2016-17 alone.
- It is impossible to investigate all of these pupils; the time and money required to do so would render the study meaningless and the new technology unnecessary.
- A sufficient sample of students for study can be obtained by selecting universities based on their geographic location and then selecting a subset of their students.
- The population for market research is typically rather large. The entire population cannot be counted, in all likelihood.
- Typically, the sample represents a sizeable portion of this population.
- Surveys, polls, and questionnaires are then used by researchers to gather data from these samples, and this data analysis is extrapolated to the larger community.

**Types of Samples: selection methodologies with examples**

- A sampling method is the procedure used to get a sample.
- While this technique generates the quantitative and qualitative data that can be collected as part of a research study, sampling plays a crucial role in the research design.
- Probability sampling and non-probability sampling are two separate approaches to sampling techniques.

**Examples of probability sampling techniques**

- The process of obtaining a sample through probability sampling involves choosing the objects from a population according to probability theory.
- Everyone in the population is included in this technique, and everyone has an equal chance of getting chosen. Hence, there is absolutely no bias in this kind of sample. The research can then involve every member of the population.
- The selection criteria are chosen at the beginning of the market research study and are a crucial part of the investigation.
- **Four different types of samples can be used in probability sampling. They are:**


1
Simple Random Sampling
2
Cluster Sampling
3
Systematic Sampling
4
Stratified Random Sampling

## 1. Simple random sampling

- This method of sample selection is the easiest to understand. Each participant has an equal chance of taking part in the study using this strategy. Each member of this sample population has an equal chance of being chosen at random to become an object.
- For instance, if a university dean wanted to gather input from students about how they felt about the professors and their level of education, this sample could include all 1000 students at the university. To create this sample, 100 students can be chosen at random from any class.

## 2. Cluster sampling

- A sample technique called cluster sampling divides the respondent population into equal clusters. Based on defining demographic factors like age, location, gender, etc., clusters are found and included in a sample. This makes it incredibly simple for a survey developer to draw useful conclusions from the responses.
- For instance, if the FDA (Food and Drug Administration) wishes to gather information on negative drug side effects, it can divide the US mainland into distinct clusters, such as states. Respondents in these clusters are subsequently given research surveys. Using this method of sample generation, comprehensive data collection and easily actionable information are provided.

### 3. Systematic sampling

- By using systematic sampling, a population is sampled by randomly selecting respondents at equal intervals. Picking a beginning point and then choosing responders at a predetermined sample interval is the method for choosing the sample.
- As an diagram, when choosing 1,000 volunteers for the Olympics from a list of 10,000 applicants, each applicant is assigned a count between 1 and 10,000. Then a sample of 1,000 volunteers can be obtained by counting backwards from 1 and selecting each respondent with a 10-second interval.

### 4. Stratified random sampling

- In the research design phase, stratified random sampling is a technique for segmenting the respondent population into discrete but pre-defined parameters. The responders in this method don't overlap; rather, they speak for the entire population as a whole.
- For instance, a researcher examining persons from various socioeconomic backgrounds can identify respondents based on their yearly earnings. Afterward, some of the objects from these samples can be employed for the research study. This creates smaller groups of persons or samples.

**Non-probability sampling methodologies with examples**

- The researcher's judgment is used to choose a sample in the non-probability sampling technique.
- This kind of sample is primarily determined by the researcher's or mathematician's capacity to access it.
- When conducting preliminary research, this kind of sampling is employed since the main goal is to generate a hypothesis regarding the research issue.
- Here, each participant does not have an equal probability of being in the sample population, and the sample is only made aware of these parameters after it has been chosen.
- Non-probability sampling can be divided into **four different kinds of samples**. They are:


1
Convenience Sampling
2
Purposive Sampling
3
Snowball Sampling
4
Quota Sampling

## 1. Convenience sampling

- In plain English, convenience sampling refers to the ease with which a researcher can contact a respondent.
- The method used to create this sample is not scientific.
- The selection of the sample components is done only on the basis of proximity, not representativeness, and the researchers have almost no control over it.
- When there are time and financial constraints on gathering feedback, this non-probability sampling method is used.
- As an Example, consider researchers who are conducting a mall-intercept study to determine the likelihood that people will use a **perfume** produced by a perfume business.
- Based on their closeness to the survey desk and desire to engage in the study, the sample respondents in this sampling technique are selected.

**2. Judgmental/purposive sampling**

- The judgmental or purposive sampling approach is a way of selecting a sample based only on the researcher's judgment and understanding of the target audience, the nature of the study, and other relevant factors. Only those individuals who meet the research criteria and end goals are chosen using this sample technique, while the rest are excluded. If the research question is "Would you like to do your Masters?" and the only acceptable response is "Yes," then everyone else is not included in the study. As an illustration, if the research question is "What University do you prefer as a student for Masters?"

**3. Snowball sampling**

- A non-probability sampling method where the samples have uncommon characteristics is known as snowball sampling or chain-referral sampling. This sampling method uses recommendations from current participants to find the sample populations needed for a study. For instance, when asked for feedback on a touchy subject like AIDS, respondents are reticent to provide details. In this situation, the researcher can enlist individuals who have expertise or understanding of such individuals and ask them to gather information on behalf of the researcher.

**4. Quota sampling**

- With quota sampling, the researcher is free to choose the sample they want to use based on their stratification. This method's main characteristic is that two persons cannot coexist in two different environments.
- For instance, a shoe producer could want to comprehend how millennial view the brand in relation to other factors like comfort, cost, etc. For this study, it solely chooses female millennial because the goal is to gather opinions on women's shoes.

**Understanding T-values and P-values**

- Every T-value contains a P-value to work with it.
- A **P-value** is referred to as the **probability that the outcomes from the sample data** happened coincidentally. **A p-value, or probability value, is a number describing how likely it is that your data would have occurred under the null hypothesis of your statistical test.**
- P-values have values starting **from 0% to 100**%. They are generally written as a decimal.
- For instance, a P-value of 10% is 0.1.
- It is good to have low P-values. Lower P-values indicate that the data **did not happen coincidentally**.
- For instance, a P-value of 0.1 indicates that there is only a 1% probability that the experiment's outcomes occurred coincidentally.
- Generally, in many cases, a P-value of 5%, that is 0.05, is accepted to mean the data is said to be valid.

**A p-value is a statistical measurement used to validate a hypothesis against observed data. A p-value measures the probability of obtaining the observed results, assuming that the null hypothesis is true. The lower the p-value, the greater the statistical significance of the observed difference**

## CHI-SQUARE TEST

- A chi-square test is a statistical test that is used to compare observed and expected results.
- A chi-square test is a statistical hypothesis test that examines whether two categorical variables are independent in influencing the test statistic.
- It's used to compare observed results with expected results to determine if a difference is due to chance or a relationship between the variables.
- **The goal of this test is to identify whether a disparity between actual and predicted data is due to chance or to a link between the variables under consideration**.
- As a result, the chi-square test is an ideal choice for aiding in our understanding and interpretation of the connection between our two categorical variables.
- A chi-square test or comparable nonparametric test is required to test a hypothesis regarding the distribution of a categorical variable.
- Categorical variables, which indicate categories such as animals or countries, can be nominal or ordinal. They cannot have a normal distribution since they can only have a few particular values.

- It is used to calculate the difference between two categorical variables, which are:
  - As a result of chance
  - Because of the relationship
- Formula For Chi-Square Test

$$x_c^2 = \frac{\Sigma (O_i - E_i)^2}{E_i}$$

Where

c = Degrees of freedom

O = Observed Value

E = Expected Value

- The degrees of freedom in a statistical calculation represent the number of variables that can vary in a calculation. The degrees of freedom can be calculated to ensure that chi-square tests are statistically valid. These tests are frequently used to compare observed data with data that would be expected to be obtained if a particular hypothesis were true.
- The Observed values are those you gather yourselves.
- The expected values are the frequencies expected, based on the null hypothesis.

## Categorical Variables

- Categorical variables belong to a subset of variables that can be divided into discrete categories. Names or labels are the most common categories. These variables are also known as qualitative variables because they depict the variable's quality or characteristics.
- Categorical variables can be divided into two categories:
- **Nominal Variable:** A nominal variable's categories have no natural ordering. Example: Gender, Blood groups
- **Ordinal Variable:** A variable that allows the categories to be sorted is ordinal variables. Customer satisfaction (Excellent, Very Good, Good, Average, Bad, and so on) is an example.

**Use of Chi-Square Test:**

- Chi-square is a statistical test that examines the differences between categorical variables from a random sample in order to determine whether the expected and observed results are well-fitting.
- Here are some of the uses of the Chi-Squared test:
- The Chi-squared test can be used to see if your data follows a well-known theoretical probability distribution like the Normal or Poisson distribution.
- The Chi-squared test allows you to assess your trained regression model's goodness of fit on the training, validation, and test data sets.
- **Karl Pearson introduced this test in 1900 for categorical data analysis and distribution. This test is also known as 'Pearson's Chi-Squared Test'.**
- Chi-Squared Tests are most commonly used in hypothesis testing. A hypothesis is an assumption that any given condition might be true, which can be tested afterwards.
- The Chi-Square test estimates the size of inconsistency between the expected results and the actual results when the size of the sample and the number of variables in the relationship is mentioned.

- These tests use degrees of freedom to determine if a particular null hypothesis can be rejected based on the total number of observations made in the experiments. Larger the sample size, more reliable is the result.
- There are two main types of Chi-Square tests namely –
  - Independence
  - Goodness-of-Fit

**Independence**

- The Chi-Square Test of Independence is a derivable ( also known as inferential ) statistical test which examines whether the two sets of variables are likely to be related with each other or not.
- This test is used when we have counts of values for two nominal or categorical variables and is considered as non-parametric test.
- A relatively large sample size and independence of observations are the required criteria for conducting this test.

**For Example-**

- In a movie theatre, suppose we made a list of movie genres.
- Let us consider this as the first variable. The second variable is whether or not the people who came to watch those genres of movies have bought snacks at the theatre.
- Here the null hypothesis is that the genre of the film and whether people bought snacks or not are unreliable.
- If this is true, the movie genres don't impact snack sales.

**Goodness-Of-Fit**

- In statistical hypothesis testing, the Chi-Square Goodness-of-Fit test determines whether a variable is likely to come from a given distribution or not.
- We must have a set of data values and the idea of the distribution of this data.
- We can use this test when we have value counts for categorical variables.
- This test demonstrates a way of deciding if the data values have a " good enough" fit for our idea or if it is a representative sample data of the entire population.

For Example-

- Suppose we have bags of balls with five different colours in each bag. The given condition is that the bag should contain an equal number of balls of each colour. The idea we would like to test here is that the proportions of the five colours of balls in each bag must be exact.

## Write a Python Program to implement Chi-Square Test

```
import numpy as np
from scipy.stats import chi2_contingency
# Define your contingency table (replace with your data)
observed_data = np.array([
    [10, 20, 30],
    [15, 25, 40] ])
# Calculate the Chi-square statistic, p-value, degrees of freedom, and expected table
chi2_statistic, p_value, degrees_of_freedom, expected_data = chi2_contingency(observed_data)
# Print the results
print("Chi-Square Statistic:", chi2_statistic)
print("P-value:", p_value)
print("Degrees of Freedom:", degrees_of_freedom)
print("Expected Table:\n", expected_data)
# Interpretation
if p_value < 0.05:
    print("Reject null hypothesis: There is a statistically significant relationship between the variables.")
else:
    print("Fail to reject null hypothesis: There is no evidence of a statistically significant relationship.")
```

## Output

```
Chi-Square Statistic: 0.1296296296296296
P-value: 0.9372410104578182
Degrees of Freedom: 2
Expected Table:
 [[10.71428571 19.28571429 30.        ]
 [14.28571429 25.71428571 40.        ]]
Fail to reject null hypothesis: There is no evidence of a statistically significant relationship.
```

Explanation:

1. **Import libraries:** We import numpy for numerical operations and chi2_contingency from scipy.stats for chi-square test calculations.
2. **Define observed data:** Replace observed_data with your actual contingency table containing observed counts for each category combination.
3. **Calculate Chi-square test:** chi2_contingency function takes the observed data as input and returns the chi-square statistic, p-value, degrees of freedom, and expected table.
4. **Print results:** The program prints the calculated values and interprets the results based on the p-value.
    1. If p-value < 0.05 (common significance level), we reject the null hypothesis and conclude that there is a statistically significant relationship between the variables.
    2. Otherwise, we fail to reject the null hypothesis and say there's no evidence of a significant relationship.

## Student's t-Test

- In the area of statistics, a student's t-test is mentioned as a method of testing the theory about the mean of a small sample drawn from a normally distributed population where the standard deviation of the given population is unknown.
- We can define the Student t-test as a method that tells you how significant the differences can be between different groups. **A Student t-test is defined as a statistic and this is used to compare the means of two different populations.**
- It is a method that is often used in hypothesis testing to find out whether a process or whether a given treatment actually has any effect on the population of interest, or whether or not two populations are different from each other.
- You wish to know whether the mean petal length of iris flowers differs according to their distinct species.
- You find two different species of iris flowers growing in a garden and they measure 25 petals of each species.
- You can test the difference between these two groups with the help of the Student t-test.

- The null hypothesis (H0) is one that tells the true difference between these groups.
- The alternate hypothesis (Ha) is one that tells the true difference is different from zero.

**Student t Test Introduction**

- In the year 1908, an Englishman named **William Sealy Gosset** developed the t-test as well as t distribution.
- **William** worked at the Guinness brewery in Dublin and found which existing statistical techniques using large samples were not useful for the small sample sizes which he encountered in his work).
- The **t distribution** belonging under a family of curves in which the number of degrees of freedom specifies a particular curve.
- As the sample size (and the degrees of freedom) increases, the t distribution approaches the bell shape of the standard normal distribution. In common, for tests involving the mean of a sample of size greater than 30, then the normal distribution is applied.

**Types of Student t-Test**

- When choosing a Student t-test, two things need to be kept in mind: whether the groups being compared are coming from a single population or two different populations, There are different types of t-tests, but the two most common ones are.
  1. **Independent Samples T-Test**
  2. **Paired Samples T-Test**
- The **independent samples t-test**, also known as the unpaired t-test, is a statistical test that determines if there is a significant difference between the means of two unrelated groups
- The Independent Samples t Test compares the means of two independent groups in order to determine whether there is statistical evidence that the associated population means are significantly different. The Independent Samples t Test is a parametric test. This test is also known as: Independent t Test.
- A **paired samples t-test**, also known as a dependent samples t-test, compares the means of two measurements taken from the same individual, object, or related units
- The Paired-Samples T Test procedure compares the means of two variables for a single group. The procedure computes the differences between values of the two variables for each case and tests whether the average differs from 0. The procedure also automates the t-test effect size computation

**Student t-Test Formula**

- We have already discussed the t-test definition. The formula for the two-sample t-test (a.k.a. the Student's t-test) is shown below.

$$\text{Student t Test Formula, } t = \frac{\overline{x_1} - \overline{x_2}}{\sqrt{\left(s^2\left(\frac{1}{n_1} + \frac{1}{n_2}\right)\right)}}$$

- In the formula given above, t is equal to the t-value, x1 and x2 are the means of the two groups being compared, $s^2$is the pooled standard error of the two groups, and n1 and n2 are the numbers of observations in each of the groups.
- A larger t-value denotes the difference between group means is greater than the pooled standard error, indicating a more significant difference between the groups.
- You can compare your calculated t-value against the values in a critical value chart to determine whether your t-value is greater than what would be expected by chance. If so, you can reject the null hypothesis and you can conclude which two groups are in fact different.

**1. Independent Samples T-Test:**

- This test is used when comparing the means of two independent groups. For example, comparing the average scores of two different groups of participants in an experiment or comparing the means of two different treatment groups.
- The formula for the t-statistic in the independent samples t-test is:

$$t = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}}$$

- Where X1 and X2 are the sample means s1 and s2 are the sample standard deviations, and n1 and n2 are the sample sizes.

**Paired Samples T-Test:**

- This test is used when comparing the means of two related groups. For example, comparing the scores of the same group of participants before and after a treatment.
- The formula for the t-statistic in the paired samples t-test is:

$$t = \frac{\bar{d}}{\frac{s_d}{\sqrt{n}}}$$

- where d is the mean of the differences between paired observations, s d is the standard deviation of the differences, and n is the number of pairs.

## Example Program: Paired t-Test Program for Dependent Samples

1. **Import the stats module from scipy:**

```
from scipy import stats
```

❖ This imports the necessary statistical functions from the scipy library.

2. **Define the paired_t_test function**

```
def paired_t_test(before, after):
    # Perform paired t-test
    t_statistic, p_value = stats.ttest_rel(before, after)

    return t_statistic, p_value
```

❖ This function takes two lists (before and after) as input, representing paired measurements before and after a treatment.

❖ It then uses stats.ttest_rel to perform a paired t-test and returns the t-statistic and p-value.

**3. Example usage:**

```
before_treatment = [28, 30, 32, 34, 36]
after_treatment = [25, 29, 31, 33, 35]
```

❖ These lists represent the measurements taken before and after a treatment.

**4. Perform the paired t-test:**

```
t_statistic, p_value = paired_t_test(before_treatment, after_treatment)
```

❖ This line calls the paired_t_test function with the provided lists and stores the results in t_statistic and p_value.

**5. Print the results:**

```
print("t-statistic:", t_statistic)
print("p-value:", p_value)
```

❖ These lines print the calculated t-statistic and p-value.

6. Interpret the result:

**alpha = 0.05**

**if p_value < alpha:**

**print("Reject the null hypothesis. There is a significant difference before and after treatment.")**

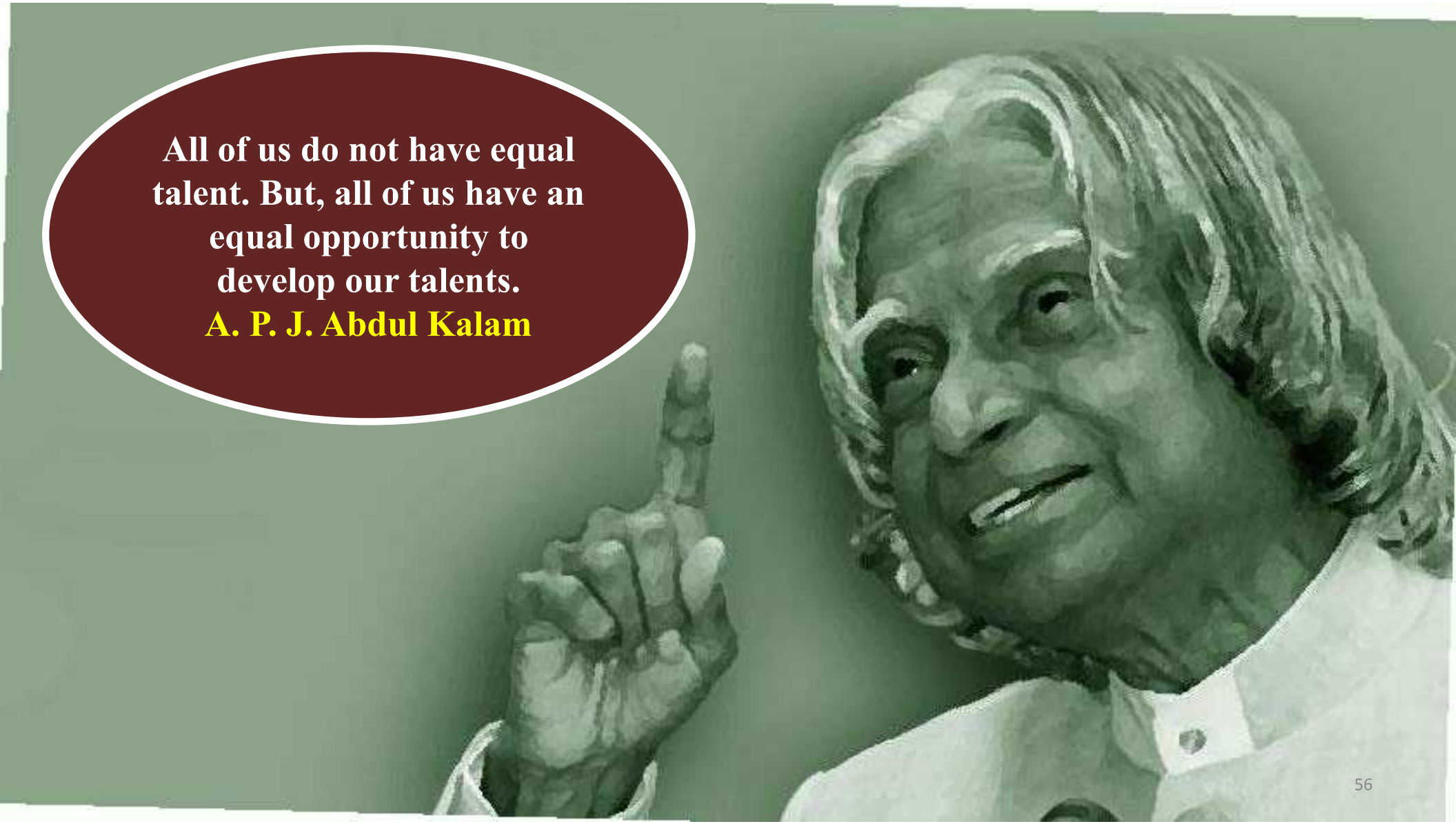
**else:**

**print("Fail to reject the null hypothesis. There is no significant difference before and after treatment.")**

❖ These lines interpret the result by comparing the p-value to a significance level (alpha). If the p-value is less than alpha, the null hypothesis is rejected, indicating a significant difference between before and after treatment. Otherwise, the null hypothesis is not rejected. Adjust the alpha level based on the desired significance threshold.

OUTPUT

```
t-statistic: 0.5741692517632145
p-value: 0.5816333668955778
Fail to reject the null hypothesis. There is no significant difference between the groups.
```


All of us do not have equal talent. But, all of us have an equal opportunity to develop our talents.
A. P. J. Abdul Kalam


Thank
You!