Introduction to statistics:

Statistics is the branch of mathematics that deals with the collection, analysis, interpretation, and presentation of data.

It provides methods for making decisions and predictions based on data.

DATA:

A data is a fact/piece of information that can be stored ,measured and re-accessed.

A data is used to bring insights to increase a company's revenue by collecting ,organizing and analysing.

	1. Collecting Data	**2. Organizing Data**	**3. Analyzing Data**
Techniques:	**Surveys & Questionnaires** – Google Forms, Typeform, Qualtrics **Web Scraping** – Python (BeautifulSoup, Scrapy) **IoT & Sensors** – Collecting real-time data from devices **APIs & Databases** – Google Analytics, SQL databases **Manual Data Entry** – Excel, Google Sheets	**Data Cleaning** – Handling missing values, removing duplicates **Data Structuring** – Converting raw data into tables, CSVs, or databases **Data Storage** – Using databases, spreadsheets, or cloud storage	**Descriptive Statistics** – Mean, Median, Mode, Standard Deviation **Inferential Statistics** – Hypothesis testing, Regression analysis **Machine Learning** – Predictive analytics, clustering, classification
Tool	**Google Forms, SurveyMonkey'** -Online surveys & feedback collection **Scrapy, BeautifulSoup -** Web scraping for data **SQL, PostgreSQL, MySQL-** Database management **IoT Sensors, Raspberry Pi** -Real-time data collection	**Microsoft Excel, Google Sheets** -Sorting, filtering, structuring data **SQL, NoSQL Databases** -Storing and managing structured data **Python (Pandas, NumPy)** -Data manipulation and preprocessing **Power BI, Tableau-** Data visualization & organization	**Python (Pandas, NumPy, SciPy, Scikit-learn)** - Statistical & predictive analysis **R (ggplot2, dplyr, tidyr)** -Statistical modeling & visualization **Excel (Pivot Tables, Data Analysis ToolPak)** -Basic statistical analysis **Tableau, Power BI** - Data visualization & reporting

Example:

Real-World Case Study:

Analyzing Customer Satisfaction for an E-Commerce Business

Objective

An **e-commerce company** wants to analyze **customer satisfaction** based on their shopping experience.

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1. Collecting Data

□ **Primary Data (Direct Collection):**

- **Customer Surveys** – After each purchase, customers fill out a survey rating their experience (1 to 5 stars).
- **Website Analytics** – Tracking how long users stay on the website and their interactions.
- **Customer Support Logs** – Recording complaints, issues, and feedback.

□ **Secondary Data (Existing Data Sources):**

- **Sales Records** – Checking customer purchase history.
- **Competitor Analysis** – Using industry reports to compare with competitors.
- **Social Media Reviews** – Analyzing customer comments and ratings on social platforms.

Tools Used for Data Collection:

Method	Tool
Surveys	Google Forms, Typeform
Web Analytics	Google Analytics
Customer Support Logs	Zendesk, Freshdesk
Sales Data	SQL Databases, Excel
Social Media Data	Web Scraping (Python, BeautifulSoup)

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2. Organizing Data

Once the data is collected, it needs to be cleaned and structured for analysis.

1. **Remove Duplicates** – If a customer filled the survey multiple times, only one entry is kept.
2. **Handle Missing Data** – If some customers skipped questions, missing values are handled using statistical methods.
3. **Categorization** –
   - Grouping customers by age, location, and shopping habits.
   - Sorting satisfaction ratings (1–5 stars).
4. **Visualizing Data** –
   - **Tables** – Showing average rating per month.
   - **Bar Charts** – Number of customers per satisfaction level.
   - **Pie Charts** – Percentage of satisfied vs. unsatisfied customers.

Example of Organized Data (Table Format)

Month	Avg. Satisfaction (1-5)	No. of Complaints	Avg. Delivery Time (days)
Jan	4.2	50	3.1
Feb	4.5	40	2.8
Mar	4.1	60	3.4
Apr	3.8	90	4.2

Tools Used for Data Organization:

Method	Tool
Data Cleaning & Sorting	Excel, Python (Pandas)
Categorization	SQL, Python (NumPy)
Visualization	Tableau, Power BI, Matplotlib

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3. Analyzing Data

company applies **statistical techniques** to extract insights.

□ **Descriptive Analysis:**

- **Mean Satisfaction Score** → The company finds that the average rating is **4.1 out of 5**.
- **Complaint Rate** → More complaints were received in April, which aligns with an increase in delivery times.

□ **Inferential Analysis:**

- **Regression Analysis** → Shows that **faster deliveries** lead to **higher customer satisfaction**.
- **Hypothesis Testing** → Tests whether **offering discounts** significantly increases repeat purchases.

□ **Predictive Analysis (Machine Learning):**

- A **classification model** predicts whether a customer is likely to return based on their shopping history and satisfaction score.

Analysis Findings:

□ **Customers who received deliveries in 3 days or less rated the service 4.5+ on average.**
□ **Customers who had a complaint were 60% less likely to shop again.**
□ **Offering a 10% discount increased repeat purchases by 15%.**

Tools Used for Data Analysis:

Method	Tool
Descriptive Statistics	Excel, Python (Pandas, NumPy)
Inferential Statistics	SPSS, Python (Statsmodels, SciPy)
Machine Learning	Scikit-learn, TensorFlow

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4. Business Decision & Outcome

□ **Problem Identified:** Customers were dissatisfied with **longer delivery times** in April, leading to more complaints.
□ **Solution Implemented:** The company **partnered with a faster delivery service** and introduced **free shipping for orders above $50**.
□ **Result:**
□ **Customer satisfaction increased from 3.8 to 4.5 in the following months.**
□ **Complaints dropped by 30%.**
□ **Sales improved by 20% due to better customer retention.**

Types of Statistics

1. Descriptive Statistics	2. Inferential Statistics
Deals with **summarizing and presenting data** in a meaningful way. Orgainzing and summarizing the complete data/population.(ex:average delay of flights/train, Height/weight of students in class) □ **Measures of Central Tendency** – Find the "center" of the data. • **Mean (Average)** – Sum of values divided by total count. • **Median** – Middle value in an ordered dataset. • **Mode** – Most frequently occurring value. □ **Measures of Dispersion (Spread of Data)** • **Range** – Difference between the highest and lowest value. • **Variance** – How far data points are spread from the mean. • **Standard Deviation (SD)** – Measures data variability. □ **Measures of Shape & Symmetry** • **Skewness** – Measures if data is asymmetrical. • **Kurtosis** – Measures whether data has heavy or light tails.	**draws conclusions** about a population based on a **sample**. Using data,has been measured to form conclusion about population(ex- no of trees in forest) (height/weight of people in india) Why? Population is large ,because of time and resource constraints. Within given sample , data can be concluded something about population □ **Probability Distributions** – Used to predict outcomes. • Normal Distribution • Binomial Distribution • Poisson Distribution • Pmf • Pdf • Cdf • Ctl • Statisticaltest • **Normal Distribution (Bell Curve)** – Many natural datasets follow this pattern. • **Binomial & Poisson Distributions** – Used in probability-based events. □ **Hypothesis Testing** – Determines if a result is significant.

□ **Graphical Representation of Data** • **Bar Charts, Histograms, Pie Charts** – Used for categorical data. • **Box Plots, Scatter Plots** – Used for numerical data.	• **Null Hypothesis (H_0)** – No difference or effect. • **Alternative Hypothesis (H_1)** – There is a significant effect. • **p-value** – If $p < 0.05$, reject H_0. □ **Confidence Intervals** – Gives a range of values where a population parameter is likely to be. □ **Regression Analysis** – Identifies relationships between variables. **Linear Regression** – Predicts continuous outcomes. **Logistic Regression** – Predicts categorical outcomes.
Scope- Entire dataset Graphs used - Bar charts, Histograms,	**Scope-** Uses a sample to infer about population Graphs used- Confidence Intervals, Probability Distributions
Example : □ **Dataset:** Exam scores → 65, 75, 80, 85, 90 □ **Mean =** (65+75+80+85+90) ÷ 5 = 79 □ **Median =** 80 (Middle value) □ **Range =** 90 - 65 = 25 □ **Visualization:** A histogram of the scores shows the distribution.	**Example :** □ A company surveys **500 customers** to estimate satisfaction for **all customers**. □ **Hypothesis:** "Discounts increase repeat purchases." □ **p-value < 0.05**, so the effect is significant. □ **Regression:** More discounts → Higher retention.
Method - ------- Tools Used Central Tendency ----Excel, Python (NumPy, Pandas) Dispersion Measures -----R, SPSS, Python (SciPy) Graphs & Charts ----Tableau, Power BI, Matplotlib	Method ---Tools Used Probability Distributions-- Python (SciPy, Statsmodels) Hypothesis Testing--- SPSS, R, Python (t-tests, ANOVA) Regression Analysis ---Excel, Python (Scikit-learn)

Conclusion:

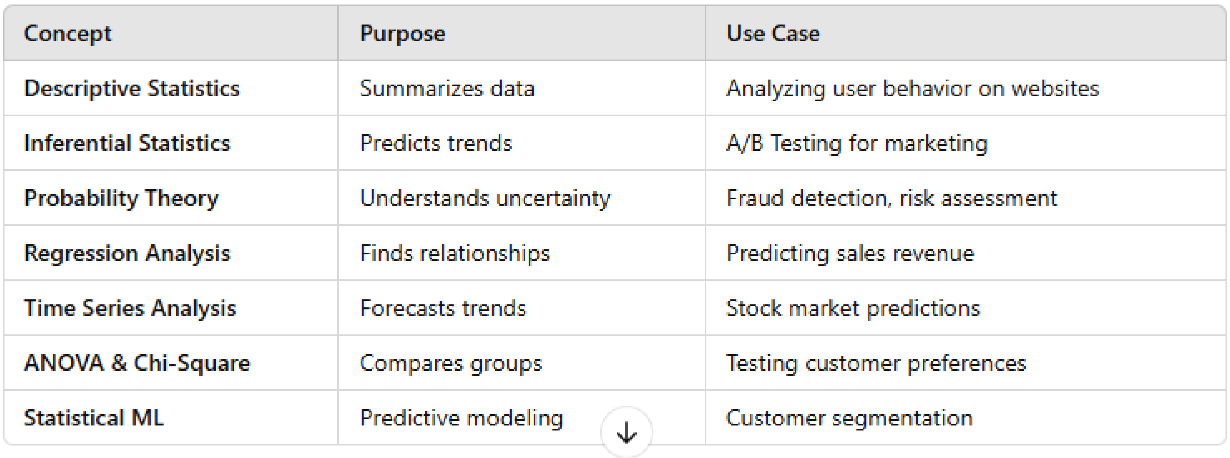
□ **Descriptive Statistics** helps summarize **what happened** in the data.
□ **Inferential Statistics** helps predict **what will happen** in the larger population.

Why is Statistics Important in Data Science & Analytics?

Statistics is the **foundation** of Data Science (DS) and Analytics because it helps in **data collection, processing, analysis, and interpretation** to make informed decisions.

It ensures that data-driven insights are reliable and accurate.

Few applications of statistics in data science/data analytics.



Concept	Purpose	Use Case
Descriptive Statistics	Summarizes data	Analyzing user behavior on websites
Inferential Statistics	Predicts trends	A/B Testing for marketing
Probability Theory	Understands uncertainty	Fraud detection, risk assessment
Regression Analysis	Finds relationships	Predicting sales revenue
Time Series Analysis	Forecasts trends	Stock market predictions
ANOVA & Chi-Square	Compares groups	Testing customer preferences
Statistical ML	Predictive modeling	Customer segmentation