Learning Objective (Short Explanation)

Is chapter me aap **Statistics aur Probability** ke 3 main topics seekhoge:

1️⃣ **Descriptive Statistics:** Data ko summarize aur analyze karna using **Mean, Median, Mode, Variance, Standard Deviation, aur Correlation**.
✅ Example: Class ke students ke marks ka average aur variation nikalna.

2️⃣ **Inferential Statistics:** Sample data se **poori population ka prediction** karna using **Sampling, Hypothesis Testing, aur Confidence Intervals**.
✅ Example: 1000 logon ke salary data se poori city ki average salary predict karna.

3️⃣ **Probability:** Kisi event ke hone ke **chances** calculate karna using **Probability Rules, Distributions, aur Conditional Probability**.
✅ Example: Toss karne pe Head aane ka chance 50% hai.

📊 **Statistics: Data ko Collect, Analyze aur Interpret karna**

👉 **Kya hota hai?**
Statistics ek technique hai jo **data ko collect, analyze aur interpret** karne me madad karti hai. Matlab, hume agar **bahut saara data diya ho**, toh Statistics ki madad se hum **usko summarize karke patterns ya trends** nikal sakte hain.

👉 **Key Points:**

- **Data Collection:** Pehle hume data ikattha karna hota hai. (Survey, Experiment ya Observation se)
- **Data Analysis:** Fir hum us data ka analysis karte hain taaki samajh sake ki **trend kya hai?**
- **Interpretation:** Finally, hum data ko interpret karke **decision-making** me use karte hain.

👉 **Real-World Example:**
Maan lo ek **company ko apne customers ka feedback analyze karna hai**.

- Wo **1000 customers ka survey karti hai**
- Data ko analyze karke dekhti hai ki **80% log service se khush hain**
- Iska matlab hai ki company ka performance acha hai, aur bas **20% customers ke concerns pe kaam karna padega**

📌 **Conclusion:** Statistics ka kaam **data-driven decisions** lene me help karna hai.

🎲 **Probability: Kisi Event ke Hone ke Chances**

👉 **Kya hota hai?**
Probability ka matlab hai **kisi event ke hone ke chances nikalna**. Ye uncertainty ko quantify karta hai aur predict karta hai ki **kisi random scenario me kya outcome ho sakta hai?**

👉 **Key Points:**

- Probability **0 se 1 ke beech hoti hai**, jisme:
    - **0 ka matlab** - Event kabhi nahi hoga.
    - **1 ka matlab** - Event pakka hoga.
    - **0.5 ka matlab** - Event hone aur na hone ka chance equal hai.

👉 **Real-World Example:**
Maan lo **ek coin toss kar rahe ho**:

- **Head aane ka chance = 50% (0.5 probability)**
- **Tail aane ka chance = 50% (0.5 probability)**

Agar hum **cricket match me predict karna chahein ki ek team jeetegi ya nahi**, toh hum probability ka use karke uska **winning percentage** nikal sakte hain.

📌 **Conclusion:** Probability ka use **random events aur uncertainty ko model karne** ke liye hota hai, jaise **weather forecast, stock market predictions, aur AI models**. 🚀

Descriptive Statistics ka main kaam **data ko summarize aur analyze** karna hota hai taaki hum usme **patterns aur trends** samajh sakein.

1️⃣ Introduction

📌 **Definition:**
Descriptive Statistics ka matlab hai **data ko summarize, organize aur represent** karna taaki hum usko easily samajh sakein.

📌 **Importance:**

- **Data ko simple aur meaningful banata hai**
- **Patterns aur trends identify karne me help karta hai**
- **Decision making easy ho jati hai**

✅ **Example:**
Ek school ke students ke marks ka data agar raw format me ho, toh usko analyze karna mushkil hoga. **Descriptive Statistics ki madad se hum average marks (Mean), beech ka value (Median), aur sabse common marks (Mode) nikal sakte hain.**

2️⃣ Measures of Central Tendency

Yeh **data ke center ya middle value** ko represent karta hai.

📌 **Mean (Average):**
Total values ka sum leke number of values se divide karna.
✅ **Example:** Agar kisi class ke students ke marks hain:

- **40, 50, 60, 70, 80**
- Mean = (40+50+60+70+80) / 5 = **60**

📌 **Median (Middle Value):**
Agar values ko ascending order me rakhein toh **jo value**

beech me hogi, wahi median hoga.

✅ **Example: 10, 20, 30, 40, 50** ka median **30** hoga.

📌 **Mode (Most Frequent Value):**

Jo value **sabse zyada baar repeat hoti hai**, wahi Mode hoti hai.

✅ **Example: 2, 3, 3, 3, 5, 6, 7** ka mode **3** hai kyunki yeh sabse zyada repeat ho raha hai.

3️⃣ Measures of Dispersion

Yeh **data ke spread aur variability** ko batata hai.

📌 **Range:**

Maximum aur Minimum value ka difference.

✅ **Example: Marks: 10, 20, 30, 80, 90**

- Range = **90 - 10 = 80**

📌 **Variance:**

Data values aur mean ke beech **kitna variation hai**, yeh batata hai.

📌 **Standard Deviation:**

Variance ka **square root** hota hai, jo batata hai ki **data mean ke around kitna spread hai**.

✅ **Example:** Agar ek test me students ke marks **50, 55, 60, 65, 70** hain, toh **Standard Deviation low hoga** kyunki sabhi values ek doosre ke paas hain.

Agar marks **10, 20, 30, 80, 90** hain, toh **Standard Deviation high hoga** kyunki values ka spread zyada hai.

4️⃣ Correlation and Covariance

Yeh **do variables ke beech relationship** ko measure karta hai.

📌 **Covariance:**
Agar **do variables ek saath increase ya decrease ho rahe hain**, toh **positive covariance** hoti hai. Agar ek badhta hai aur dusra ghatta hai, toh **negative covariance** hoti hai.

📌 **Correlation Coefficient:**
Yeh **-1 se +1 ke beech hota hai** aur batata hai ki do variables kitne strongly related hain.

✅ **Example:**

- **Height aur Weight:** Agar kisi ka height zyada hai toh weight bhi zyada ho sakta hai → **Positive Correlation**
- **Temperature aur Jacket Sales:** Temperature badhne se log jackets kam kharidenge → **Negative Correlation**

📌 **Conclusion:**
Descriptive Statistics data ko **summarize aur analyze karne** me help karta hai taaki hum **better decisions** le sakein. 🚀

Descriptive Statistics ka kaam **data ko summarize karna** hota hai taaki bada data set **easy aur samajhne layak format me convert ho sake**. Yeh sirf data ko describe karta hai, **koi prediction ya conclusion nahi nikalta**.

1️⃣ Summarizes Data

👉 Kya matlab hai?

Descriptive Statistics ka use **large data sets ko chhoti aur simple form me present** karne ke liye hota hai. Isse hume **data me patterns aur trends** samajhne me madad milti hai.

✅ Example:

Maan lo ek school me **1000 students ke marks available hain**. Agar hume har ek student ka mark individually dekhna pade, toh analysis difficult ho jayega.

- Descriptive Statistics ki help se hum **Average Marks (Mean), Beech ka Value (Median), aur Most Frequent Marks (Mode)** nikal sakte hain.
- Isse hume ek **overall idea mil jata hai ki students ka performance kaisa hai**.

2️⃣ Measures of Central Tendency

👉 Kya matlab hai?

Yeh **data ka central value ya representative value** batata hai. Iske 3 important measures hote hain:

1. **Mean (Average)** – Sabhi values ka sum lekar total numbers se divide karte hain.
2. **Median (Middle Value)** – Data ko ascending order me rakhkar beech ki value lete hain.

3. **Mode (Most Frequent Value)** – Jo value sabse zyada repeat hoti hai, wahi Mode hoti hai.

✅ **Example:**
Maan lo kisi class ke students ke marks hain: **40, 50, 60, 70, 80**

- **Mean** = (40+50+60+70+80) / 5 = **60**
- **Median** = **60** (middle value)
- **Mode** = **Agar ek value zyada baar repeat hoti, toh wahi mode hoti**

3️⃣ Measures of Dispersion

👉 **Kya matlab hai?**
Yeh **batata hai ki data kitna spread out hai**. Agar values ek dusre ke paas hain toh spread **kam** hoga, aur agar values bahut alag hain toh spread **zyada** hoga.

🟢 **Important Measures:**

- **Range** = Maximum - Minimum value
- **Variance** = Mean se data ka deviation measure karta hai
- **Standard Deviation** = Variance ka square root, jo batata hai ki values mean ke around kitni spread hain

✅ **Example:**
Marks = **10, 20, 30, 80, 90**

- **Range** = 90 - 10 = **80**

- **Standard Deviation high hoga**, kyunki values zyada spread hain

Agar marks **45, 48, 50, 52, 55** hote, toh spread **kam hota** aur standard deviation bhi **kam hota**.

4️⃣ Data Visualization

👉 **Kya matlab hai?**
Data ko **graph aur charts** ke through represent karna taaki analysis easy ho sake.

🟢 **Common Charts:**

- **Histogram** – Data ka distribution dikhata hai
- **Pie Chart** – Percentage representation ke liye
- **Box Plot** – Outliers aur spread analysis ke liye

✅ **Example:**
Agar ek company ke **sales data ko histogram me dikhaya jaye**, toh hume samajh aayega ki **kis month me zyada sales huyi aur kis month me kam**.

5️⃣ No Inference (Sirf Summary, Koi Prediction Nahi)

👉 **Kya matlab hai?**
Descriptive Statistics sirf **data ko summarize karta hai**, lekin **koi future prediction nahi karta**.

✅ **Example:**
Agar ek survey me pata chalta hai ki **80% log ek mobile brand**

ko pasand karte hain, toh yeh sirf **past data ka analysis hai**. Yeh **nahi bata sakta ki future me bhi log yahi brand pasand karenge ya nahi**.

📌 **Conclusion:**
Descriptive Statistics ka kaam **data ko summarize, visualize aur analyze karna** hota hai. Yeh **data ke baare me insights deta hai**, lekin **koi future prediction nahi karta**. 🚀

Measures of Central Tendency ka matlab hota hai **data ka ek central ya representative value** nikalna, jo **poore dataset ka overall trend** represent kare. Iska main purpose **data ko simplify karna** aur ek **single value se entire dataset ko summarize karna** hota hai.

1️⃣Central Tendency Kya Hai?

👉 **Kya matlab hai?**
Central Tendency ek aisa concept hai jo **data ke beech ka value dikhata hai** taaki hume uska **overall trend samajh aaye**. Iska kaam **data ko simplify karna aur ek aisi value dena hai jo poore dataset ka representative ho**.

✅ **Example:**
Maan lo 5 students ke marks diye gaye hain:
👉 **50, 60, 70, 80, 90**

- Agar hume poore dataset ka **ek representative value** chahiye, toh hum **Mean, Median ya Mode** ka use kar sakte hain.

2️⃣ Central Tendency Ki Importance

👉 **Kya matlab hai?**

🔹 **Data ko summarize karta hai** – Ek hi value se poore dataset ka idea mil jata hai

🔹 **Distribution aur general characteristics samajhne me madad karta hai** – Data ka pattern aur uska spread dikhata hai

🔹 **Comparison easy ho jata hai** – Alag-alag datasets ke beech comparison karna simple ho jata hai

✅ **Example:**
Agar kisi **school ki average attendance 85%** hai, toh yeh ek single value me school ki attendance ka overall trend batata hai.

3️⃣ Common Measures of Central Tendency

👉 **Kya matlab hai?**
Central Tendency ke 3 main measures hote hain:

1. **Mean (Average)** – Sabhi values ka sum lekar total numbers se divide karte hain
2. **Median (Middle Value)** – Data ko ascending order me rakhkar beech ki value lete hain
3. **Mode (Most Frequent Value)** – Jo value sabse zyada repeat hoti hai

✅ **Example:**
Agar students ke marks diye gaye hain: **40, 50, 60, 70, 80**

- **Mean** = (40+50+60+70+80) / 5 = **60**
- **Median** = **60** (Middle value)
- **Mode** = **Agar ek value zyada baar repeat hoti, toh wahi mode hoti**

💡 **Example for Mode:**
Agar marks **30, 40, 40, 50, 60** hain, toh **Mode = 40** (kyunki 40 do baar aaya hai)

4️⃣ Real-World Applications of Central Tendency

👉 **Kahan Use Hota Hai?**
Central Tendency ka use kaafi saare fields me hota hai:

🔹 **Economics** – Average income ya GDP nikalne ke liye
🔹 **Healthcare** – Patients ke average blood pressure ya sugar level analyze karne ke liye
🔹 **Education** – Students ke average marks ya performance analyze karne ke liye

✅ **Example:**
Agar ek **company ka average employee salary ₹50,000** hai, toh yeh ek single value me bata raha hai ki **mostly log ₹50,000 ke aaspaas kama rahe hain**.

📌 **Conclusion:**
Measures of Central Tendency **ek dataset ka center ya typical value batate hain**, jo **data ko summarize karne aur samajhne me madad karta hai**. Yeh **real-world problems me decision-making ke liye useful hota hai**, jaise salary comparison, student performance analysis, aur business trends samajhna. 🚀

📊 **Mean – Detailed Explanation (Hinglish)**

Mean ek **sabse common measure of central tendency** hai, kyunki yeh **dataset ki sabhi values ko consider karta hai** aur ek **single representative value** nikalta hai.

1️⃣Mean Kya Hai?

👉 **Kya matlab hai?**
Mean ka matlab hota hai **sabhi values ka sum lekar total numbers se divide karna**. Isko **Arithmetic Average** bhi bolte hain.

✅ **Formula:**

Mean=∑ValuesTotal Number of Values\text{Mean} = \frac{\sum \text{Values}}{\text{Total Number of Values}}Mean=Total Number of Values∑Values

✅ **Example:**
Agar 5 students ke marks diye gaye hain:
👉 **50, 60, 70, 80, 90**
Toh **Mean** = (50 + 60 + 70 + 80 + 90) ÷ 5
👉 **Mean = 70**

2️⃣ Daily Life Examples of Mean

Mean ka use bahut saare real-world situations me hota hai. Jab bhi hum kisi data ka **"average"** nikalte hain, toh hum mean ka use kar rahe hote hain.

✅ **Example 1: School Marks**
Agar ek school me students ke marks ka **average** nikalna ho, toh hum mean ka use karenge.

✅ **Example 2: Salary Calculation**
Agar hume pata karna ho ki **India me software engineers ki average salary kitni hai**, toh hum different salaries ka **Mean** calculate karenge.

✅ **Example 3: Mobile Sales**
Agar ek shop me **har mahine kitne mobile phones bik rahe hain**, iska **average nikalne ke liye Mean ka use hota hai**.

✅ **Example 4: Cricket Batting Average**

Ek cricketer ne **5 matches me ye scores kiye: 40, 50, 60, 30, 70**

Toh uska batting average (Mean Score) = (40+50+60+30+70) ÷ 5 = **50 runs per match**

3️⃣ Why is Mean Important?

👉 **Kya matlab hai?**

🔹 **Ek representative value deta hai jo poore dataset ka trend dikhata hai**

🔹 **Decision making me madad karta hai** (jaise business planning, salary estimation, etc.)

🔹 **Data ka summary provide karta hai taaki hum easily compare kar sakein**

📌 **Conclusion:**

Mean ek **bahut useful statistical measure hai** jo **poore dataset ka ek single representative value nikalta hai**. Yeh **daily life aur business decisions** me important role play karta hai! 🚀

Mean – Formula & Examples (Hinglish)

📌 **Mean Ka Formula:**

Mean ko calculate karne ka **standard formula** yeh hai:

$\bar{x} = \frac{\sum x_i}{n}$ x¯=n∑xi

- **$\bar{x}$ (Mean):** Dataset ka **average value**
- **$\sum x_i$ (Summation of Values):** Sabhi values ka **total sum**
- **nnn (Number of Values):** Dataset me **total values ki sankhya**

🧮 **Example 1: Average Marks of 5 Students**

👉 **Maan lo 5 students ke mathematics exam ke marks diye gaye hain:**

- 45, 50, 55, 60, 70

✅ **Step 1: Sabhi marks ka sum nikalna**

45+50+55+60+70=28045 + 50 + 55 + 60 + 70 = 28045+50+55+60+70=280

✅ **Step 2: Total students ki sankhya n=5n = 5n=5**

✅ **Step 3: Mean ka formula lagana**

$\bar{x} = \frac{280}{5} = 56$ x¯=5280=56

👉 **Toh, in students ka average marks = 56** 🎯

💡 **Mean Kyu Zaroori Hai?**

✅ **Summarization:** Large dataset ko **ek single value me summarize** karne ke liye

✅ **Comparison:** Alag-alag groups ka **comparison** karne ke liye

✅ **Trend Analysis:** Kisi **pattern ya trend** ko samajhne ke liye

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📌 **Conclusion:**

Mean ek **bahut important statistical tool** hai jo **kisi bhi dataset ka representative average nikalta hai**. Yeh **education, finance, sports, business** jaise har field me use hota hai! 🚀

📊 **Example 2: Effect of an Outlier on the Mean (Hinglish)**

📌 **Pehle Wali Situation**

🔹 **5 students ke marks diye gaye hain:**

👉 **45, 50, 55, 60, 70**

✅ **Mean (Average) pehle calculate kiya tha:**

$\bar{x} = \frac{45 + 50 + 55 + 60 + 70}{5} = \frac{280}{5} = 56$

👉 **Toh, pehle average marks = 56**

📌 **Ab Ek Naya Student Add Ho Raha Hai**

👉 **Ek naye student ke marks = 99**

✅ **Naya Mean Calculate Karein:**

$\bar{x} = \frac{45 + 50 + 55 + 60 + 70 + 99}{6}$x¯=645+50+55+60+70+996\bar{x} = \frac{45 + 50 + 55 + 60 + 70 + 99}{6}x¯=645+50+55+60+70+99

✅ **Total Sum:**

$\sum x_i = 45 + 50 + 55 + 60 + 70 + 99 = 379$∑xi=45+50+55+60+70+99=379\sum x_i = 45 + 50 + 55 + 60 + 70 + 99 = 379∑xi=45+50+55+60+70+99=379

✅ **New Mean:**

$\bar{x} = \frac{379}{6} = 63.17$x¯=3796=63.17\bar{x} = \frac{379}{6} = 63.17x¯=6379=63.17

👉 **Ab Average Marks = 63.17** 🔺 (Jo pehle wale 56 se kaafi zyada hai!)

💡 **Key Takeaway: Outliers Mean Ko Affect Karte Hain!**

🔹 **Outlier kya hai?** - Bahut zyada **chhoti ya badi** value jo dataset se alag dikh rahi ho.

🔹 **Effect:** Ek single **outlier** bhi mean ko **kaafi increase ya decrease** kar sakta hai.

🔹 **Problem:** Agar **data me extreme values hain**, toh **mean misleading ho sakta hai**!

🔹 **Better Alternative: Aise cases me ‘median’ use karna better hota hai**, jo outliers se **zyada impact nahi leta**.

📌 **Conclusion:**

Mean **outliers ke wajah se biased ho sakta hai**, isliye **agar**

data me extreme values hain, toh median ka use karna better hota hai! 🚀

Mean ke Properties (Gun) – Hinglish me Samjhaye

1️⃣ Sum of Deviations Zero

- Agar hum har value me se **mean minus karein** aur sabko **add karein**, toh total **hamesha zero hota hai**.
- Formula: $\sum (x_i - \bar{x}) = 0$
- Matlab **mean dataset ka perfect balancing point hota hai**. ⚖️

2️⃣ Affected by Values Koi bhi value change hone par mean bhi **change ho jata hai**.

- Har ek data point **mean ko influence karta hai**.

3️⃣ Unique and Defined Har dataset ka **sirf ek hi mean hota hai**.

- Mean **hamesha ek clear value deta hai**, jo **pure data ko represent karta hai**.

4️⃣ Sensitive to Outliers

- **Agar data me koi bahut bada ya chhota number aa jaye** (outlier), toh mean **distort ho sakta hai**.
- Is wajah se, kabhi kabhi **median zyada reliable hota hai**.

📌 **(Conclusion):**

Mean ek **useful measure** hai, lekin **agar outliers zyada hain toh median better ho sakta hai**! 🚀

Python ka Use karke Mean Calculate Karna

Python me mean **bahut easily calculate** kiya ja sakta hai.

📌 **Step-by-Step Explanation:**

✅ **statistics library ka use karke mean nikalna**

✅ **mean() function se calculation karna**

Python Code:

python

Copy code

```
import statistics


# Students ke marks ka list
marks = [45, 50, 55, 60, 70]


# Mean calculate karna
mean_marks = statistics.mean(marks)
```

Result print karna

print("Mean Marks:", mean_marks)

Output:

css

Copy code

Mean Marks: 56

📌 **Mean ka Summary:**

✅ **Sabse common central tendency measure hai**
✅ **Formula:** (Sabhi values ka sum) ➗ (Total values)
✅ **Extreme values se effect hota hai (outliers)**
✅ **Weighted mean use hota hai jab kuch values ki importance zyada ho**
✅ **Python ka use karke bada dataset easily handle kiya ja sakta hai** 🚀

Median – Data ka Middle Value

🔹 **Real-Life Examples:**

- Kisi company me **middle salary** kya hai?
- Mumbai me **houses ka middle price** kya hai?
- Students ke **exam score ka beech ka value** kya hai?

👉 **Median hamesha beech ka value hota hai**, jab data **ascending order me** arrange hota hai.

👉 **Mean sabhi values ko consider karta hai**, lekin **Median sirf middle value dekhta hai**.

👉 **Agar dataset me outliers (extreme values) ho**, toh **Median better choice hota hai**! 🚀

Median Kaise Calculate Karein?

👉 **Step 1:** Numbers ko **ascending order me** arrange karein.

👉 **Step 2: Middle number find karein**:

- **Agar values ki count odd hai**, toh **middle value hi median hota hai**.
- **Agar values ki count even hai**, toh **do middle values ka average median hota hai**.

📝 **Example 1: Odd Set of Numbers**

🔹 5 students ki age: **12, 15, 14, 17, 13**

🔹 **Step 1:** Arrange in **ascending order** → **12, 13, 14, 15, 17**

🔹 **Step 2: Middle value = 14**

✅ **Median = 14**

📝 **Example 2: Outlier Ka Effect**

🔹 **House Prices (₹ lakhs): 50, 55, 60, 62, 500**

📊 **Mean Calculation:**

Mean=50+55+60+62+5005=145.4\text{Mean} = \frac{50 + 55 + 60 + 62 + 500}{5} = 145.4Mean=550+55+60+62+500=145.4

✅ **Mean ₹145.4 lakh aaya, jo galat lag raha hai kyunki ₹500 lakh ek extreme outlier hai.**

📊 **Median Calculation:**

- 🔹 **Sorted Data: 50, 55, 60, 62, 500**
- 🔹 **Middle value = 60**

✅ **Median = ₹60 lakh (Jo zyada accurate representation hai!)**

📌 **Key Takeaway:**

👉 **Median outliers se affect nahi hota** aur **actual central value ko accurately represent karta hai!** 🚀

Median ki Properties (Gun) - Hinglish Me Samjhayein

1️⃣ Focus on Middle Values (Mukhya Mulya Par Dhyan)

- 🔹 Median **sirf beech wale value** ko dekhta hai, **bahar ke values ignore karta hai**.

2️⃣ Resistance to Outliers (Extreme Values se Prabhavit Nahi Hota)

- 🔹 **Agar koi value bahut zyada chhoti ya badi ho (outlier), toh median par koi effect nahi hota**.

3️⃣ Usefulness for Skewed Data (Tedi-Medi Data Me Upyogi)

🔹 **Jab data ek taraf jhukta hai (skewed data), toh mean accurate nahi hota**, lekin **median accurate hota hai**.

4️⃣ Existence (Hamesha Maujood Hota Hai)

🔹 **Har dataset ka ek clear aur defined median hota hai**.

✅ **Key Takeaway:** Median **beech ki value ko dhyan me rakhta hai** aur **outliers se effect nahi hota**, isliye **zyada accurate measure hota hai!** 🚀

Python Me Median Kaise Nikalein? (Hinglish Explanation)

Python ka **statistics** module use karke **median** aasani se find kar sakte hain.

📝 **Example - Python Code for Median Calculation**

python

Copy code

```
import statistics


# Student ke scores ka dataset
scores = [12, 15, 14, 17, 13]


# Median find karna
```

```
median_score = statistics.median(scores)


print("Median Score:", median_score)
```

🔹 **Output:**

yaml

Copy code

Median Score: 14

📌 **Summary of Median (Sankshipt Saransh)**

✓ **Middle Value ka Concept:** Ordered data ka **beech wala value** median hota hai.

✓ **Outliers ka Asar Nahi Hota:** Agar dataset me **koi extreme values ho**, toh **median usse prabhavit nahi hota**.

✓ **Even Number of Values:** Agar dataset me **even values ho**, toh **dono middle values ka average median hota hai**.

✓ **Practical Use Cases: Economics, business, real estate, aur machine learning me median kaafi use hota hai.**

✅ **Conclusion:** Jab **data me bahut extreme values ho**, tab **mean ke bajaye median ka use zyada sahi hota hai!** 🚀

📌 Mode Kya Hota Hai? (Hinglish Explanation)

Mode ek **aisa value hota hai jo dataset me sabse zyada baar repeat hota hai**.

Daily Life Examples:

📱 **Sabse popular mobile brand kaunsa hai?**

👟 **Students ka sabse common shoe size kya hai?**

💻 **Data Science me sabse zyada use hone wali programming language kaunsi hai?**

📌 Mode ka Use

✓ Numerical aur Categorical Dono Data ke liye Useful:

- **Numerical Data:** Sabse zyada baar aane wala number.
- **Categorical Data:** Sabse popular choice, jaise **favourite color, best-selling laptop, etc.**

✓ Mean aur Median se Alag:

- Mean aur median **average aur middle value** pe focus karte hain.
- Mode **sabse zyada baar repeat hone wale value** pe focus karta hai.

✅ **Conclusion:** Jab **humein sabse common value pata karni ho**, tab **mode ka use sabse best hota hai!** 🚀

Mode Kaise Calculate Karein? (Hinglish Explanation)

Mode find karne ke liye ye steps follow karein:

🛠️ Steps to Find Mode:

🔹 **Step 1:** Har value ki frequency (kitni baar repeat ho raha hai) count karein.

🔹 **Step 2:** Jo value(s) **sabse zyada baar repeat ho rahi hai**, wahi **Mode** hai.

📌 Example 1: Simple Dataset ka Mode

Maan lo ek test me students ke marks diye gaye hain:

👉 **45, 50, 55, 50, 60, 50, 70, 75**

✅ Yaha **50 3 baar** repeat ho raha hai.

📌 **Mode = 50** (Sabse zyada baar repeat hone wala value)

📌 Example 2: Bimodal Dataset (2 Modes)

Agar dataset me **2 different values** barabar baar repeat ho rahi ho, toh **Bimodal** kehlata hai.

Maan lo students ki height (cm) di gayi hai:

👉 **150, 160, 165, 150, 170, 175, 165, 180**

✅ **150** aur **165** dono **2 baar** repeat ho rahe hain.

📌 **Modes = 150 & 165 (Bimodal)**

📌 Example 3: Multimodal Dataset (3+ Modes)

Agar **3 ya usse zyada values** equal frequency ke saath repeat ho rahi ho, toh **Multimodal** kehlata hai.

Maan lo ek survey me favourite colours collect kiye gaye hain:
👉 **Red, Blue, Green, Blue, Yellow, Green, Blue, Red, Green, Red**

✅ **Green (3), Blue (3), aur Red (3)** sabse zyada baar aaye hain.
📌 **Modes = Green, Blue & Red (Multimodal)**

✅ **Conclusion:**
Mode **sabse zyada baar repeat hone wala value** hota hai aur agar ek se zyada modes ho, toh **Bimodal ya Multimodal** kehate hain. 🚀

Mode vs Mean vs Median

📌 Python me Mode Kaise Calculate Karein? (Hinglish Explanation)

Python me **statistics** module ka use karke **Mode** nikalna bohot easy hai. Chaliye example dekhte hain:

🛠 Python Code for Mode Calculation

python

Copy code

```
import statistics

numbers = [45, 50, 55, 60, 50, 70, 75]
mode_value = statistics.mode(numbers)

print("Mode:", mode_value)
```

🔹 **Output:**

makefile

Copy code

```
Mode: 50
```

✅ **Yaha 50 sabse zyada baar repeat ho raha hai, isliye Mode = 50 hai.**

📌 Summary of the Mode

✅ **Mode sabse zyada baar repeat hone wala value hota hai.**

✅ Ek dataset me **1, 2, multiple, ya koi mode nahi** ho sakta.

✅ **Categorical data** (jaise most popular brand) ke liye Mode useful hota hai.

✅ **Business, fashion, IT, aur education** me Mode ka use hota hai.

🚀 **Mode ka calculation simple hai aur Python ise aur bhi easy bana deta hai!**

Lab

📌 **Measures of Dispersion (Hinglish Explanation)**

📌 **Measure of Dispersion** ka matlab hota hai **data ka spread** ya **variability** check karna. Yeh batata hai ki data **kitna scattered hai mean ya median ke around**.

🔹 **Kyu Zaroori Hai?**

✅ **Data consistency aur variability** samajhne ke liye use hota hai.
✅ **Risk analysis aur future prediction** me kaam aata hai.
✅ Yeh batata hai ki **data points mean ke pass clustered hain ya bohot dur dur hain**.

📌 **Types of Measures of Dispersion**

1️⃣ **Range** – Maximum aur minimum value ka difference.

2️⃣ **Variance** – Data points mean se kitna deviate kar rahe hain.

3️⃣ **Standard Deviation (SD)** – Variance ka square root, jo data spread batata hai.

4️⃣ **Interquartile Range (IQR)** – Middle 50% data ka spread.

Range (Hinglish Explanation)

📌 **Range** ek **simplest measure of dispersion** hai, jo **data ka spread** check karta hai. Yeh **highest aur lowest values ka difference** batata hai.

🔹 **Range ka Formula**

Range=Maximum Value−Minimum ValueRange = Maximum\ Value - Minimum\
ValueRange=Maximum Value−Minimum Value

🔹 **Example 1: Simple Range Calculation**

Agar ek classroom me **5 students** ki ages di gayi hain:

✅ **Maximum age** = 22

✅ **Minimum age** = 12

👉 **Range = 22 - 12 = 10**

🔹 **Iska Matlab?**

Students ki **ages ka difference 10 years hai**, yaani **data 10 units tak spread hai**.

📌 **Range ki Limitations**

❌ **Outliers** pe sensitive hota hai (Agar ek bohot chhoti ya bohot badi value ho to range bohot badh sakti hai).

❌ **Data distribution ka proper idea nahi deta**, sirf spread batata hai.

Variance (Hinglish Explanation)

📌 **Variance** ek **important measure of dispersion** hai jo **data ke spread** ko represent karta hai. Yeh batata hai ki **data points mean se kitne dur ya paas hai**.

🔹 **Range useful hoti hai, par variance data distribution ka aur accurate analysis provide karta hai**.

🔹 **Variance ka Formula**

σ^2 = \frac{\sum (x_i - $\bar{x}$)^2}{N}

✅ **Jahaan:**

- σ^2 = Variance

- x_i = Har ek data value
- $\bar{x}$ = Mean (Average)
- **N** = Total number of values

🔹 **Variance Kaise Calculate Karein? (Step-by-Step)**

🔸 **Step 1:** Mean ($\bar{x}$) find karein.

🔸 **Step 2:** Har ek data point ka **mean se difference nikaalein** ($x_i - \bar{x}$).

🔸 **Step 3:** In differences ka **square karein** taaki negative values avoid ho sakein.

🔸 **Step 4:** In squared values ka **sum karein**.

🔸 **Step 5:** Final result ko **number of values (N) se divide karein**.

🔹 **Example: Variance Calculation**

Agar ek dataset diya gaya hai:
5, 7, 9, 12, 15

Step 1: Mean Calculate karein:

$\bar{x}$ = \frac{(5+7+9+12+15)}{5} = \frac{48}{5} = 9.6

Step 2: Mean se difference nikaalein:

Data (x_i)	**($x_i - \bar{x}$)**	**($x_i - \bar{x}$)²**
5	(5 - 9.6) = -4.6	21.16
7	(7 - 9.6) = -2.6	6.76

Data (x_i)	($x_i - \bar{x}$)	($x_i - \bar{x}$)²
9	(9 - 9.6) = -0.6	0.36
12	(12 - 9.6) = 2.4	5.76
15	(15 - 9.6) = 5.4	29.16

Step 3: Squared differences ka sum:

21.16+6.76+0.36+5.76+29.16=63.221.16 + 6.76 + 0.36 + 5.76 + 29.16 = 63.221.16+6.76+0.36+5.76+29.16=63.2

Step 4: Total values (N) se divide karein:

σ2=63.25=12.64σ^2 = \frac{63.2}{5} = 12.64σ2=563.2=12.64

✅ **Variance = 12.64**

📌 **Variance ke Key Points**

✅ **Higher Variance → Data zyada spread hai**
✅ **Lower Variance → Data mean ke aas paas concentrated hai**
✅ **Variance ka square root le kar Standard Deviation nikaalte hain** (jo zyada readable hota hai)

👉 **Agla topic chahiye? Standard Deviation ya aur examples?** 😀

📌 **Example 1: Variance Calculation (Simple Example in Hinglish)**

Agar humare paas **marks dataset** diya gaya hai:
10, 20, 30, 40, 50

🔹 **Step 1: Calculate the Mean**

$\bar{x}$ = \frac{10 + 20 + 30 + 40 + 50}{5} = \frac{150}{5} = 30

🔹 **Step 2: Find the Squared Differences**

Har ek data point ka mean se difference aur uska square calculate karein:

Marks (x_i)	(x_i - $\bar{x}$)	(x_i - $\bar{x}$)²
10	(10 - 30) = -20	400
20	(20 - 30) = -10	100
30	(30 - 30) = 0	0
40	(40 - 30) = 10	100
50	(50 - 30) = 20	400

🔹 **Step 3: Calculate Variance**

σ2=(400+100+0+100+400)5σ^2 = \frac{(400 + 100 + 0 + 100 + 400)}{5}σ2=5(400+100+0+100+400) σ2=10005=200σ^2 = \frac{1000}{5} = 200σ2=51000=200

✅ **Variance = 200**

📌 **Key Takeaways**

✔ **Agar variance high hai (200), toh iska matlab marks zyada spread hain.**

✔ **Agar variance low hota, toh iska matlab marks ek common range ke andar hote.**

✔ **Variance ka square root le kar Standard Deviation nikalte hain jo data spread ko aur clearly represent karta hai.**

Variance Calculation Using Python

Python mein variance calculate karna bahut easy hai using **NumPy** library.

🔹 **Code Example**

python

Copy code

```
import numpy as np


# Marks dataset
marks = [10, 20, 30, 40, 50]


# Variance Calculation
variance_value = np.var(marks)
```

Output

print("Variance of Marks:", variance_value)

🔹 **Output**

css

Copy code

Variance of Marks: 200.0

📌 **Explanation**

✔ **np.var() function** variance calculate karne ke liye use hoti hai.

✔ **List ke values mean se kitni deviated hain, uska square ka average nikalta hai.**

✔ **Variance high hone ka matlab data widely spread hai, aur low hone ka matlab data clustered hai.**

📌 **Standard Deviation (SD) Calculation**

Standard Deviation ek important measure of dispersion hai jo data ke spread ka idea deta hai.
Agar **Standard Deviation zyada hai**, to iska matlab data **widely spread** hai, aur agar **kam hai**, to data **clustered** hai.

🔹 Formula for Standard Deviation

σ=σ2\mathbf{\sigma = \sqrt{\sigma^2} }σ=σ2

Where:
✓ **σ (Standard Deviation)** = Variance ka square root
✓ **σ² (Variance)** = Variance

📌 Example Calculation

Agar hamare paas dataset **10, 20, 30, 40, 50** hai,
Toh **Variance = 200** (pichle example se).

Standard Deviation Calculation:

σ=200≈14.14\sigma = \sqrt{200} \approx 14.14σ=200≈14.14

📌 Python Code for Standard Deviation

Python mein **numpy** library ka std() function use karke SD nikal sakte hain.

🔹 Code Example

python

Copy code

```
import numpy as np


# Marks dataset
marks = [10, 20, 30, 40, 50]
```

Standard Deviation Calculation

std_value = np.std(marks)

Output

print("Standard Deviation of Marks:", std_value)

🔹 **Output**

css

Copy code

Standard Deviation of Marks: 14.14

📌 **Summary**

✓ Standard Deviation variance ka square root hota hai.

✓ Agar SD zyada hai, toh values zyada scattered hain.

✓ Python mein np.std() function se SD easily calculate hota hai.

Lab

📌 Covariance in Statistics

Covariance **do variables ke beech ka relationship** batata hai, ki agar ek variable change ho raha hai to dusra **kaise behave karega**.

🔹 Types of Covariance

1. 📈 **Positive Covariance**
    - Dono variables **saath-saath badhte** ya **kam hote** hain.
    - Example: **Study Time** 📖 **& Exam Scores** 📊 (Jitna zyada study, utna achha score)
2. 📉 **Negative Covariance**
    - Ek variable badhta hai, dusra **kam hota hai**.
    - Example: **Speed** 🚗 **& Travel Time** ⏳ (Jitni zyada speed, utna kam time)
3. ➖ **Zero Covariance**
    - Dono variables ke beech **koi relation nahi hota**.
    - Example: **Shoe Size** 👟 **& IQ Level** 🧠 (Ek dusre se koi lena-dena nahi)

📌 Covariance Formula

$$Cov(X,Y) = \frac{\sum (X_i - \bar{X}) (Y_i - \bar{Y})}{N}$$

Where:

✓ **X,YX, YX,Y** → Do variables

✓ **Xi,YiX_i, Y_iXi,Yi** → Individual values

✓ **X‾,Y‾\bar{X}, \bar{Y}X‾,Y‾** → Mean of X and Y

✓ **NNN** → Number of values

📌 Covariance Calculation Using Python

Python mein **numpy** ya **statistics** library ka use karke covariance easily find kar sakte hain.

🔹 Example: Covariance of Study Time & Exam Scores

python

Copy code

```
import numpy as np


# Study Hours & Exam Scores
study_time = [1, 2, 3, 4, 5]
exam_scores = [50, 55, 65, 70, 80]


# Covariance Calculation
cov_matrix = np.cov(study_time, exam_scores, bias=True)
covariance = cov_matrix[0, 1]  # Extract covariance value


# Output
```

print("Covariance:", covariance)

🔹 **Output**

makefile

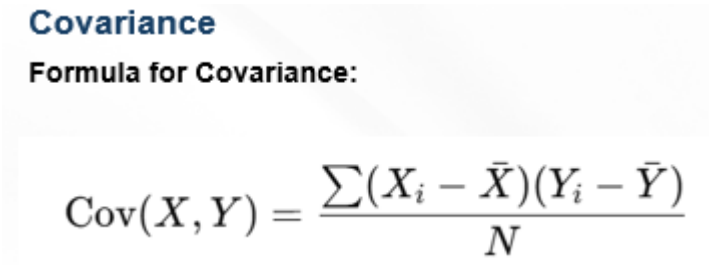
Copy code

Covariance: 12.5

📌 **Summary**

✓ Covariance relationship batata hai ki do variables ek saath kaise change karte hain.
✓ Positive covariance → Dono variables ek saath badhte ya ghatte hain.
✓ Negative covariance → Ek badhta hai, dusra ghatta hai.
✓ Zero covariance → Koi relation nahi hai.
✓ Python mein np.cov() function se covariance easily calculate hota hai.

Covariance ka **use business analysis mein hota hai**, jaise ki **advertising spend** aur **sales revenue** ke beech relation



samajhne ke liye.

Where:

X_i, Y_i = Data values for two variables

$\bar{X}, \bar{Y}$ = Means of the two datasets

N = Number of data points

📌 Step 1: Calculate the Mean of X and Y

👉 X̄ (Advertising Spend ka Mean):

$$\bar{X} = \frac{10 + 20 + 30 + 40 + 50}{5} = 30$$

👉 Ȳ (Sales Revenue ka Mean):

$$\bar{Y} = \frac{15 + 25 + 35 + 50 + 65}{5} = 38$$

📌 Step 2: Compute the Covariance

Covariance ka formula:

$$\text{Cov}(X,Y) = \frac{(X_1 - \bar{X})(Y_1 - \bar{Y}) + (X_2 - \bar{X})(Y_2 - \bar{Y}) + (X_3 - \bar{X})(Y_3 - \bar{Y}) + (X_4 - \bar{X})(Y_4 - \bar{Y}) + (X_5 - \bar{X})(Y_5 - \bar{Y})}{N}$$

$$\text{Cov}(X,Y) = \frac{(10-30)(15-38) + (20-30)(25-38) + (30-30)(35-38) + (40-30)(50-38) + (50-30)(65-38)}{5}$$

$$= \frac{(-20)(-23) + (-10)(-13) + (0)(-3) + (10)(12) + (20)(27)}{5}$$

$$= \frac{460 + 130 + 0 + 120 + 540}{5}$$

$$= \frac{125}{5} = 250$$

📌 Interpretation

✔ **Covariance = 250**, jo **positive hai**, iska matlab **higher advertising spend ke saath sales revenue bhi badhta hai.**

Correlation Overview

👉 **Correlation** ek **statistical measure** hai jo **do variables ke beech relation ka direction aur strength** batata hai.

📌 **Correlation Ki Range**

$-1 \leq r \leq 1$

1️⃣ **Positive Correlation (r > 0)** – Jab **dono variables ek saath badhte hain**.
2️⃣ **Negative Correlation (r < 0)** – Jab **ek variable badhta hai aur dusra girta hai**.
3️⃣ **Zero Correlation (r = 0)** – Jab **koi relation nahi hota**.

📌 **Formula for Correlation (Pearson's Correlation Coefficient)**

$$r = \frac{\text{Cov}(X,Y)}{\sigma_X \cdot \sigma_Y}$$

📍 **Where:**
✓ **Cov(X, Y)** = **Covariance** of X and Y
✓ **σX, σY** = **Standard Deviations** of X and Y
✓ **$\bar{X}$, $\bar{Y}$** = **Means** of X and Y

✅ **Ye formula covariance ko scale karta hai** by dividing with the product of standard deviations, taaki **different datasets ke relationships compare kiye ja sakein**.

📌 Example: Correlation Calculation

📍 Given Data:

- Advertising Spend (X): 10, 20, 30, 40, 50
- Sales Revenue (Y): 15, 25, 35, 50, 65

📌 Example: Correlation Calculation

📍 Given Data:

- Advertising Spend (X): 10, 20, 30, 40, 50
- Sales Revenue (Y): 15, 25, 35, 50, 65

📌 Step 2: Compute the Correlation Coefficient (r)

📍 Calculate the Numerator:

$$\sum(X_i - \bar{X})(Y_i - \bar{Y}) = (-20)(-23) + (-10)(-13) + (0)(-3) + (10)(12) + (20)(27)$$

$$= 460 + 130 + 0 + 120 + 540 = 1250$$

📍 **Calculate the Denominator:**

$$\sqrt{\sum(X_i - \bar{X})^2} = \sqrt{(-20)^2 + (-10)^2 + (0)^2 + (10)^2 + (20)^2}$$

$$= \sqrt{400 + 100 + 0 + 100 + 400} = \sqrt{1000} \approx 31.62$$

$$\sqrt{\sum(Y_i - \bar{Y})^2} = \sqrt{(-23)^2 + (-13)^2 + (-3)^2 + (12)^2 + (27)^2}$$

$$= \sqrt{529 + 169 + 9 + 144 + 729} = \sqrt{1580} \approx 39.75$$

📍 **Calculate the Correlation (r):**

$$r = \frac{1250}{(31.62 \times 39.75)}$$

$$= \frac{1250}{1256.79} \approx 0.995$$

📌 **Conclusion**

✅ Correlation = 0.995

📊 Since 0.995 is very close to 1, it indicates a strong positive correlation between advertising spend and sales revenue.

Python Code to Calculate Correlation

Python makes it easy to compute correlation using NumPy and Pandas.

Python code:

python

Copy code

```
import numpy as np
```

```
x = [10, 20, 30, 40, 50]  # Advertising spend
y = [15, 25, 35, 50, 65]  # Sales Revenue

# Compute correlation matrix
correlation_matrix = np.corrcoef(x, y)  # This will create a 2×2 correlation matrix

# Extract the correlation coefficient
correlation_value = correlation_matrix[0, 1]  # Correlation is located at [0,1] in the matrix

print("Correlation Coefficient:", correlation_value)
```

🛠 **Output:**

```
mathematica
Copy code
Correlation Coefficient: 0.995
```

✅ This code correctly calculates the correlation coefficient between advertising spend and sales revenue.

Lab

Descriptive Statistics vs. Inferential Statistics

Feature	Descriptive Statistics	Inferential Statistics
Definition	Summarizes and describes data.	Makes predictions or generalizations about a population using sample data.
Purpose	Provides insights into data distribution, central tendency, and variability.	Helps infer conclusions about a larger population.
Techniques Used	Mean, median, mode, standard deviation, variance, frequency distribution, graphs, etc.	Hypothesis testing, confidence intervals, regression analysis, etc.
Scope	Focuses only on the given dataset.	Extends conclusions beyond the observed dataset.
Example	"The average age of students in a class is 20 years."	"Based on a survey of 100 students, the average age

Feature	Descriptive Statistics	Inferential Statistics
		of all university students is estimated to be 21 years."

Key Difference

- **Descriptive Statistics** → Summarizes **what the data shows**.
- **Inferential Statistics** → **Makes predictions** based on data samples.

Inferential Statistics

🔹 **Definition:** Inferential statistics allows us to **make predictions or draw conclusions** about a population based on a sample.

🔹 **Purpose:** It helps in **generalizing findings** from a sample to a larger population.

Key Concepts

📌 **Population:** The **entire group** we want to study or draw conclusions about.

📌 **Sample:** A **smaller subset** selected from the population for analysis.

📌 **Why Use Samples?**

✓ Collecting data from an entire population is often **impractical** or **impossible** due to time and cost constraints.

📌 **Statistical Inference:**

✅ Uses sample data to **estimate population parameters**, such as:

- **Mean (Average)**
- **Proportions**
- **Trends and Patterns**

📌 **Key Goal:**

🎯 To **draw conclusions** that can be applied to the whole population **based on sample data**.

Inferential Statistics (अनुमानात्मक Statistics)

🔹 **Definition:** Inferential statistics हमें **sample (chhoti dataset)** ke basis par **poori population** ke baare me conclusion nikalne ki technique hai.

🔹 **Purpose:** Ye help karta hai **sample ke findings ko generalize** karke **poori population** pe apply karne me.

Key Concepts (Main Cheezein)

📌 **Population:** Wo **poora group** jisko hum study karna chahte hain.

📌 **Sample:** Population ka **chhota part**, jo analysis ke liye liya jata hai.

📌 **Samples kyu zaroori hain?**

✓ Pura data collect karna **impossible ya costly** ho sakta hai, isliye sample ka use hota hai.

📌 **Statistical Inference:**

✅ Sample data ka use karke **Population parameters** ka estimation kiya jata hai, jaise:

- **Mean (average nikalna)**
- **Proportions (kitna % kis category me hai)**
- **Trends aur Patterns (kya pattern follow ho raha hai)**

📌 **Key Goal:**

🎯 Sample data ko analyze karke **poori population ke liye valid conclusions nikalna**.

Sampling ka matlab hai **poori population me se chhota set (sample) choose karna** taaki uska analysis karke **poori population ke baare me conclusion nikal sakein**.

Isme **random selection** hota hai, yani har member ko **equal chance** milta hai sample me aane ka.

- **(a) Simple Random Sampling (SRS)**
  - **Random tarike se** sample select hota hai.
  - Jaise ek **list me se randomly naam pick karna**.
  - **Example:** Lottery system, computer-generated random numbers.
- **(b) Stratified Sampling**
  - Population ko **groups (strata) me divide** karke har group me se **random sample** liya jata hai.
  - **Example:** Ek school me students ko **class-wise** divide karke har class me se **randomly kuch students** lena.
- **(c) Systematic Sampling**
  - **Fixed interval pe selection hota hai**.
  - **Example:** Agar 100 logon ka survey karna ho, toh **har 10th person** ko select karna.
- **(d) Cluster Sampling**
  - **Puri population ko groups (clusters) me divide karna** aur **random clusters select karna**.
  - **Example:** Ek country ko **cities me divide karke kuch cities ko randomly select karna** aur sirf unhi pe study karna.

Lab

Summary (Ek Nazar Me Pura Chapter)

✅ **Descriptive Statistics**: Data ko summarize aur analyze karne ka tareeka hai, jisme **mean, median, standard deviation** jaise measures use hote hain.

✅ **Inferential Statistics**: Sample data ke basis par **poori population ke baare me prediction** karne ka method hai. Isme **hypothesis testing aur confidence intervals** jaise techniques use hoti hain.

✅ **Correlation & Covariance**: **Variables ke beech relation** measure karne ke liye use hote hain, taaki **data patterns** samjhe ja sakein.