

# Overview of Statistics

## Overview of Statistics

### 1. What is Statistics?

- **Definition:** The science of collecting, organizing, summarizing, analyzing, and interpreting data to make informed decisions.
  - **Goal:** Turn raw observations into meaningful information and actionable insights.
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### 2. Branches of Statistics

| Branch                 | Primary Focus                                             | Typical Applications                               |
|------------------------|-----------------------------------------------------------|----------------------------------------------------|
| Descriptive Statistics | Summarizes and visualizes data                            | Reporting sales totals, summarizing survey results |
| Inferential Statistics | Draws conclusions about a larger population from a sample | Clinical trials, opinion polling, quality control  |

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### 3. Types of Data

| Data Type | Scale                                  | Examples                            |
|-----------|----------------------------------------|-------------------------------------|
| Nominal   | Categorical, no order                  | Gender, blood type                  |
| Ordinal   | Categorical, ordered                   | Survey rating (poor?good?excellent) |
| Interval  | Numeric, equal intervals, no true zero | Temperature in °C                   |
| Ratio     | Numeric, equal intervals, true zero    | Height, weight, income              |

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### 4. Descriptive Statistics

#### 4.1 Measures of Central Tendency

- **Mean** – arithmetic average.
- **Median** – middle value when data are ordered.
- **Mode** – most frequent value.

#### 4.2 Measures of Spread (Variability)

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- **Range** –  $\max - \min$ .
- **Interquartile Range (IQR)** –  $Q3 - Q1$ .
- **Variance** – average squared deviation from the mean.
- **Standard Deviation ( $\sigma$  or  $s$ )** – square root of variance; indicates typical deviation.

## 4.3 Shape of Distribution

- **Skewness** – asymmetry (positive  $\rightarrow$  right-skewed, negative  $\rightarrow$  left-skewed).
- **Kurtosis** – “tailedness” (high kurtosis = heavy tails).

## 4.4 Data Visualization

- **Bar chart / Pie chart** – categorical data.
  - **Histogram** – frequency distribution of continuous data.
  - **Boxplot** – median, quartiles, outliers.
  - **Scatter plot** – relationship between two quantitative variables.
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## 5. Probability Foundations

| Concept                              | Description                                                                     |
|--------------------------------------|---------------------------------------------------------------------------------|
| Experiment                           | Procedure producing outcomes.                                                   |
| Sample Space ( $\Omega$ )            | Set of all possible outcomes.                                                   |
| Event                                | Subset of $\Omega$ .                                                            |
| Probability ( $P$ )                  | Numerical measure $0 \leq P(\text{event}) \leq 1$ satisfying Kolmogorov axioms. |
| Conditional Probability ( $P(A B)$ ) |                                                                                 |
| Independence                         | $(P(A \cap B) = P(A)P(B)).$                                                     |

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## 6. Sampling Methods

| Method               | Key Idea                                   | When to Use                                       |
|----------------------|--------------------------------------------|---------------------------------------------------|
| Simple Random Sample | Every unit has equal chance.               | Small, homogeneous populations.                   |
| Stratified Sampling  | Divide into strata, sample proportionally. | Heterogeneous groups where subpopulations matter. |
| Cluster Sampling     |                                            |                                                   |