1. Descriptive Statistics

Descriptive statistics summarise and describe the main characteristics of a dataset.

Key Measures and Real-World Examples

a. Measures of Central Tendency

1. Mean (Average)
   Formula:
   Mean = $\Sigma X / n$
   Example:
   Monthly sales (in units) for a store: [120, 150, 180, 200, 250]
   Calculation:
   Mean = (120 + 150 + 180 + 200 + 250) / 5 = 180
   Interpretation: The store sells an average of 180 units per month.
2. Median
   Example:
   Sales data: [120, 150, 180, 200, 250]
   Sorted order: [120, 150, 180, 200, 250]
   The middle value is 180.
3. Mode
   The most frequent value in the dataset.
   Example:
   Customer satisfaction ratings: [4, 4, 5, 3, 4, 3, 5, 4]
   Mode = 4 (most frequent).

b. Measures of Dispersion

1. Range
   Formula:
   Range = Maximum Value - Minimum Value
   Example:
   Sales data: [120, 150, 180, 200, 250]
   Range = 250 - 120 = 130
2. Variance and Standard Deviation
   Variance Formula:
   Variance (σ^2) = $\Sigma(X_i - \bar{X})^2 / n$
   Standard Deviation Formula:
   Standard Deviation (σ) = $\sqrt{\text{Variance}}$
   Example:
   Daily temperatures: [30, 32, 34, 36, 38]
   - Mean = 34
   - Variance = $[(30 - 34)^2 + (32 - 34)^2 + (34 - 34)^2 + (36 - 34)^2 + (38 - 34)^2] / 5 = 8$
   - Standard Deviation = $\sqrt{8} = 2.83$

2. Inferential Statistics

Inferential statistics help draw conclusions about a population based on sample data.

Key Concepts and Real-World Examples

a. Hypothesis Testing

- Null Hypothesis (H_0): There is no difference/effect.
- Alternative Hypothesis (H_a): There is a difference/effect.

Example:
Does a new marketing strategy increase sales?

- Sales before strategy: [200, 210, 215, 220, 230]
- Sales after strategy: [250, 260, 270, 280, 300]

Interpretation: If $p < 0.05$, the difference is statistically significant.

b. Confidence Intervals (CI)
Formula:
$CI = \bar{X} \pm Z \times (\sigma / \sqrt{n})$

Example:

- Sample mean = 180, Std Dev = 15, n = 25, Z = 1.96
- $CI = 180 \pm 1.96 \times (15 / \sqrt{25})$
- CI = (174.12, 185.88)

3. Probability

Probability quantifies the likelihood of events.

Key Concepts and Real-World Examples

a. Simple Probability

Example:
A bag contains 5 red, 3 blue, and 2 green balls.

- Total balls = 5 + 3 + 2 = 10
- Probability (P) = Favourable Outcomes / Total Outcomes
- P(Blue) = 3 / 10 = 0.3

b. Conditional Probability
Formula:
$P(A \mid B) = P(A \cap B) / P(B)$

Example:
A factory produces 60% A-grade items and 40% B-grade items. If 5% of A-grade and 10% of B-grade items are defective, what is the probability that a defective item is A-grade?

We are given:

- $P(A) = 0.60$ (probability that an item is A-grade)
- $P(B) = 0.40$ (probability that an item is B-grade)
- $P(D \mid A) = 0.05$ (probability that an A-grade item is defective)
- $P(D \mid B) = 0.10$ (probability that a B-grade item is defective)

We want to find $P(A \mid D)$, the probability that a defective item is A-grade.

Bayes' Theorem:

Bayes' Theorem states:

$P(A \mid D) = (P(D \mid A) * P(A)) / P(D)$

Where:

- $P(A \mid D)$ is the probability that the item is A-grade given that it is defective.
- $P(D \mid A)$ is the probability that an A-grade item is defective.
- $P(A)$ is the probability that an item is A-grade.
- $P(D)$ is the total probability that an item is defective.

To calculate $P(D)$ (the total probability of a defective item), we use the law of total probability:

$P(D) = P(D \mid A) * P(A) + P(D \mid B) * P(B)$

Step 1: Calculate P(D)

P(D) = (0.05 * 0.60) + (0.10 * 0.40) P(D) = 0.03 + 0.04 P(D) = 0.07

Step 2: Apply Bayes' Theorem

Now, we can calculate P(A | D):

P(A | D) = (0.05 * 0.60) / 0.07 P(A | D) = 0.03 / 0.07 P(A | D) ≈ 0.4286

Conclusion:

The probability that a defective item is A-grade is approximately 0.4286 or 42.86%.

c. Bayes' Theorem
Formula:
P(A | B) = [P(B | A) × P(A)] / P(B)

4. Frequency Distribution

Frequency distribution shows how often each value occurs.

Example: Exam scores: [70, 80, 90, 70, 80, 90, 90, 100, 70]

Score	Frequency
70	3
80	2
90	3
100	1

Example Graphs : Example_Graphs.ipynb