Hypothesis Testing

1. Introduction

- Hypothesis testing is a **statistical method** used to make inferences or conclusions about a population/dataset based on sample data.
- It helps determine whether a **claim (hypothesis)** about a datasetis **true or false**
- For example, if a company claims that their **new battery lasts 10% longer** than the previous model, hypothesis testing can be used to verify this claim using sample data.

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2. Key Concepts in Hypothesis Testing

(i) Null Hypothesis (H_0)

- The default assumption that there is **no effect** or **no difference , or no relationship** in the data.

(ii) Alternative Hypothesis (H_1 or Ha)

- The statement that contradicts the null hypothesis, indicating significant effect, difference, or relationship.

(iii) Significance Level (α)

- The probability of rejecting the null hypothesis when it is actually true.
- Common values: **0.05 (5%) or 0.01 (1%)**.

(iv) p-Value

- Probability of obtaining extreme results if H_0 is true.
- If **p-value < α**, we **reject H_0** (evidence favors H_1).

(v) Test Statistic

- A numerical value calculated from the sample data : **Z-score, t-score, Chi-square value**.

3.Steps in Hypothesis Testing

1. State the Hypotheses

- **Null Hypothesis (H_0):** Assumes **no effect, no difference, or no relationship**.
- **Alternative Hypothesis (H_1 or H_a):** Assumes a **significant effect, difference, or relationship**.

2 Choose a Significance Level (α)

- Common values: **0.05 (5%)** or **0.01 (1%)**.
- **α = 0.05** means a **5% chance** of incorrectly rejecting **H_0**.

3 Select the Statistical Test

- **t-test, Z-test, Chi-square test, ANOVA**, etc.

4 Compute the Test Statistic & p-Value

- The **test statistic** measures the difference between groups.
- The **p-value** helps in decision-making:
  - **If p < α**, reject **H_0** (significant difference).
  - **If p > α**, fail to reject **H_0** (no significant difference).

5 Make a Conclusion

- If H_0 is rejected → Evidence supports H_1.
- If H_0 is not rejected → Not enough evidence to support H_1.

Types of Hypothesis Testing

1. Based on Direction of Test

- **One-Tailed Test** – Tests for an effect in **one specific direction** (e.g., only increase or only decrease).

- **Two-Tailed Test** – Tests for an effect in **both directions** (e.g., any increase or decrease).

2. Based on Data Distribution

- **Parametric Tests** – Assume data follows a **normal distribution** (e.g., **t-Test, Z-Test, ANOVA**).
- **Non-Parametric Tests** – Used when data **does not follow normal distribution** (e.g., **Chi-Square Test, Mann-Whitney U Test**).

3. Based on Number of Groups Compared

- **t-Test** – Compares **two groups** (e.g., before vs. after).
- **ANOVA (Analysis of Variance)** – Compares **three or more groups**.
- **Chi-Square Test** – Used for **categorical data** analysis.
- **Z-Test** – Used when **sample size (n) > 30** and population variance is known.