Hypothesis Testing

Learning Objectives

- - Understand hypothesis testing
- - Define null and alternative hypotheses
- - Explain errors and significance level
- - Interpret statistical results

What is Hypothesis Testing?

- A statistical method used to make decisions about a population based on sample data.
- It helps determine whether an observed effect is real or due to chance.

Why Do We Need Hypothesis Testing?

- - To support scientific decisions
- - To test research questions
- - To evaluate medical and biological studies

Basic Concept

- We start with an assumption (null hypothesis)
- Then test evidence against it using data

What is the Null Hypothesis (H_0)?

- - States there is no effect
- - No difference or no association
- - Always includes equality (=, ≥, ≤)

- Example: There is no difference between two treatments

What is the Alternative Hypothesis (H_1 or H_a)?

- - Opposes the null hypothesis
- - Suggests a real effect or difference exists
- - Supported if H_0 is rejected

Types of Alternative Hypotheses

- - Two-tailed: difference exists
- - One-tailed (right): increase
- - One-tailed (left): decrease

Examples of Hypotheses (Medical)

- H_0: Drug A has no effect on blood pressure
- H_1: Drug A reduces blood pressure

Assumption in Hypothesis Testing

- We assume H_0 is true first
- Then check if data provides strong evidence against it

Test Statistic

- A value calculated from sample data
- Examples: z-test, t-test, chi-square
- Used to make decision

Significance Level (a)

- Probability of rejecting a true null hypothesis
- Common value: 0.05
- Represents 5% risk of error

p-value

- Probability of observing the data if H_0 is true
- $p \leq a \rightarrow$ reject H_0
- $p > a \rightarrow$ fail to reject H_0

Decision Rule

- If $p \leq 0.05 \rightarrow$ statistically significant
- If $p > 0.05 \rightarrow$ not statistically significant

Type I Error

- Rejecting H_0 when it is true
- False positive
- Probability = a

Type II Error

- Failing to reject H_0 when it is false
- False negative
- Probability = β

Power of a Test

- Power = $1 - \beta$
- Probability of correctly rejecting false H_0
- High power is desirable

Application in Biology & Medicine

- - Clinical trials
- - Lab experiments
- - Disease association studies

Common Student Mistakes

- - Accepting H_0 instead of 'fail to reject'
- - Confusing p-value with probability of H_0

Summary

- - Hypothesis testing supports decisions
- - H_0 and H_1 are core concepts
- - p-value guides conclusions