

Hypothesis testing is a structured approach to making inferences about population parameters based on sample data, helping to determine whether observed patterns are statistically significant or likely due to random chance.

Hypothesis testing is used to determine whether there is enough evidence in a sample of data to infer that a certain condition holds true for the entire population. The process involves the following key steps:

1. Formulate Hypotheses:

- Null Hypothesis (H_0): A statement that there is no effect or no difference, and it serves as the default assumption to be tested.

- Alternative Hypothesis (H_1 or H_a): A statement that contradicts the null hypothesis, suggesting that there is an effect or a difference.

2. Select a Significance Level (α): This is the probability of rejecting the null hypothesis when it is actually true. Common choices are 0.05, 0.01 or 0.10

3. Choose the Appropriate Test: Depending on the data and the hypotheses, select a statistical test.

4. Calculate the Test Statistic: Using the sample data, calculate the test statistic, which measures how far the sample data deviates from the null hypothesis.

5. Determine the P-Value: The p-value is the probability of observing a test statistic as extreme as, or more extreme than, the value observed under the null hypothesis.

6. Compare the P-Value to the Significance Level:

- If the p-value is less than or equal to the significance level ($p \leq \alpha$), reject the null hypothesis in favor of the alternative hypothesis.

- If the p-value is greater than the significance level ($p > \alpha$), fail to reject the null hypothesis.

7. Draw a Conclusion: Based on the comparison, conclude whether there is sufficient evidence to support the alternative hypothesis or not.

EXAMPLES involving hypothesis testing for the mean in healthcare:

1. Average Blood Pressure:

- Question: Is the average systolic blood pressure of patients in a new treatment program lower than 120?
- Null Hypothesis (H_0): The average blood pressure of patients in the new treatment program is equal to 120.
- Alternative Hypothesis (H_1): The average blood pressure of patients in the new treatment program is lower than 120.

2. Effectiveness of a New Drug:

- Question: Does a new drug reduce the average cholesterol level in patients more than the existing drug, 45 mg/dL?
- Null Hypothesis (H_0): The average cholesterol level reduction is the same for both the new drug and the existing drug.
- Alternative Hypothesis (H_1): The average cholesterol level reduction is greater than 45 mg/dL

3. Hospital Stay Duration:

- Question: Has the average length of hospital stay decreased by 3 days after implementing a new patient care protocol?
- Null Hypothesis (H_0): The average length of hospital stay after implementing the new protocol is the same as before.
- Alternative Hypothesis (H_1): The average length of hospital stay after implementing the new protocol decreases by 3 days or more.

EXAMPLES involving hypothesis testing for the mean in business and economics:

1. Product Sales:

- Question: Has the average sales revenue of a new product line increased by 20% after a marketing campaign?
- Null Hypothesis (H_0): The average sales revenue of the new product line is the same before and after the marketing campaign.
- Alternative Hypothesis (H_1): The average sales revenue of the new product line is higher after the marketing campaign by at least 20%.

2. Market Prices:

- Question: Do the average prices of homes in a new real estate development differ from the average prices in the surrounding area?
- Null Hypothesis (H_0): The average prices of homes in the new development are the same as the average prices in the surrounding area.
- Alternative Hypothesis (H_1): The average prices of homes in the new development differ from the average prices in the surrounding area.