Mathematical Notes on Statistical Tests and Analysis

Jamuna S Murthy
Assistant Professor
Department of CSE

Academic Year - 2025-26

1 T-Test

One-sample T-test:

$$t = \frac{\bar{x} - \mu}{s/\sqrt{n}}$$

Independent Two-sample T-test:

$$t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}}$$

Degrees of Freedom (approx.):

$$df \approx \frac{\left(\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}\right)^2}{\frac{\left(\frac{s_1^2}{n_1}\right)^2}{n_1 - 1} + \frac{\left(\frac{s_2^2}{n_2}\right)^2}{n_2 - 1}}$$

2 Paired T-Test

$$t = \frac{\bar{d}}{s_d/\sqrt{n}}$$

Degrees of Freedom: $df = n - 1$

3 Correlation (Pearson's)

$$r = \frac{\sum (x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum (x_i - \bar{x})^2 \sum (y_i - \bar{y})^2}}$$

Range: $-1 \leq r \leq 1$

4 Chi-Square Test

$$\chi^2 = \sum \frac{(O_{ij} - E_{ij})^2}{E_{ij}}$$

Degrees of Freedom:

$$df = (r-1)(c-1)$$

5 Analysis of Variance (ANOVA)

One-Way ANOVA:

$$F = \frac{\text{Between-group variability (MSB)}}{\text{Within-group variability (MSW)}} = \frac{\frac{\sum n_i(\bar{x}_i - \bar{x})^2}{k-1}}{\frac{\sum (x_{ij} - \bar{x}_i)^2}{N-k}}$$

Degrees of Freedom:

- Numerator $df = k - 1$
- Denominator $df = N - k$

6 Correlation vs ANOVA

- **Correlation:** Relationship between two continuous variables.
- **ANOVA:** Difference among multiple group means.

Practice Questions

T-test

- A pharmaceutical company claims their drug reduces blood pressure significantly. How would you test this claim statistically?
- Group A scores: (10,12,15,11), Group B scores: (9,8,11,13). Are they significantly different?

Paired T-test

- Assess the effectiveness of a new teaching method by comparing pre and post-test results.
- Evaluate weight changes after following a diet for two months.

Correlation

- Analyze if study hours correlate with exam scores.
- Relationship between physical activity and BMI.

Chi-Square

- Test if gender influences smartphone brand preference.
- Analyze if voting behavior depends on age groups.

ANOVA

- Compare effectiveness across three training methods.
- Evaluate yield differences for four fertilizer types.