

# Statistics and Data Analysis

## Unit 03 – Lecture 02 Notes

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### Topic

Null vs alternative; one-sample and two-sample t-tests; p-values and interpretation.

### Learning Outcomes

- Define null and alternative hypotheses clearly
- Compute a one-sample t statistic (given summary)
- Explain p-value and significance level alpha
- Distinguish one-tailed vs two-tailed tests
- State key assumptions behind the t-test

### Detailed Notes

These notes are designed to be read alongside the slides. They expand each slide bullet into plain-language explanations, small worked examples, and common pitfalls. When a formula appears, emphasize (1) what each symbol means, (2) the assumptions needed to use it, and (3) how to interpret the final number in the problem context.

### t-test Basics

- $H_0/H_1$  setup
- Test statistic measures how far the sample is from  $H_0$
- Assumptions: independence, outliers, normality/CLT

### p-values

- p-value = probability of data (or more extreme) assuming  $H_0$
- Small p-value  $\rightarrow$  evidence against  $H_0$
- p-value is not effect size

## Exercises (with Solutions)

### Exercise 1: Write hypotheses

Claim: mean score is 60. Write  $H_0$  and  $H_1$  for a two-sided test.

#### Solution

- $H_0: \mu = 60$
- $H_1: \mu \neq 60$

### Exercise 2: Compute t

Given  $n=25$ ,  $\bar{x}=53$ ,  $s=10$ , test  $H_0: \mu=50$ . Compute t.

#### Solution

- $SE = 10/\sqrt{25} = 2$
- $t = (53-50)/2 = 1.5$
- $df = 24$

### Exercise 3: Tail choice

You want to show a new method increases mean score. One-tailed or two-tailed?

#### Solution

- One-tailed (right):  $H_1: \mu > \mu_0$

## Exit Question

Why can a very small p-value still be unimportant in practice?

## Demo (Python)

Run from the lecture folder:

```
python demo/demo.py
```

Output files:

- `images/demo.png`
- `data/results.txt`

## References

- Montgomery, D. C., & Runger, G. C. *Applied Statistics and Probability for Engineers*, Wiley.
- Devore, J. L. *Probability and Statistics for Engineering and the Sciences*, Cengage.
- McKinney, W. *Python for Data Analysis*, O'Reilly.