

# Statistics and Data Analysis

## Unit 03 – Lecture 03: Hypothesis Testing (t-test): Paired Test and Effect Size

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<https://github.com/tali7c/Statistics-and-Data-Analysis>

# Quick Links

Overview

Paired Design

Effect Size

Exercises

Demo

Summary

# Agenda

- 1 Overview
- 2 Paired Design
- 3 Effect Size
- 4 Exercises
- 5 Demo
- 6 Summary

# Learning Outcomes

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- Differentiate paired vs independent designs
- Compute within-pair differences  $d_i$
- Run a paired t-test (conceptually)
- Explain effect size and why we report it
- Interpret results in context (not only p-value)



# Paired Design: Key Points

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- Analyze differences  $d_i = \text{after} - \text{before}$
- Pairing reduces noise from individual differences

# Paired Design: Key Formula

$$t = \frac{\bar{d}}{s_d/\sqrt{n}}, \quad \text{df} = n - 1$$

# Effect Size: Key Points

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- p-value answers: evidence?
- Effect size answers: how big?
- Large n can make tiny effects significant

# Effect Size: Key Formula

$$d = \frac{\bar{x}_1 - \bar{x}_2}{s_{\text{pooled}}}$$



## Exercise 1: Compute differences

Before/After: (10,12), (12,12), (11,14), (9,10). Compute  $d_i$  and  $\bar{d}$ .

# Solution 1

- $d_i$ : 2,0,3,1
- $\bar{d} = 1.5$

## Exercise 2: CI idea

If the 95% CI for mean difference excludes 0, what does it suggest?

## Solution 2

- Evidence of a change (difference likely non-zero).
- Check magnitude and context.

## Exercise 3: Interpret d

If Cohen's  $d=0.3$ , what does it suggest (rule of thumb)?

## Solution 3

- Small effect (context dependent).
- Still may matter if cheap/safe to adopt.

# Mini Demo (Python)

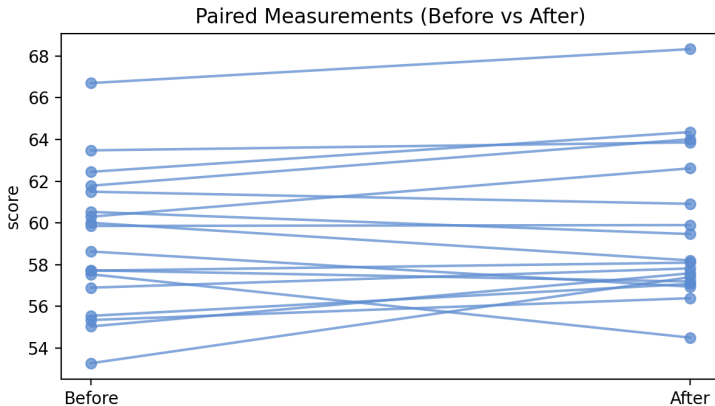
Run from the lecture folder:

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

Outputs:

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

# Demo Output (Example)





# Summary

- Key definitions and the main formula.

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- How to interpret results in context.

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- Key definitions and the main formula.
- How to interpret results in context.
- How the demo connects to the theory.

# Exit Question

Why can paired designs be more powerful than independent designs?