

Welcome to **instats**

The Session Will Begin Shortly

START

Statistics in R with Tidyverse

Session 10: One- and Two-Sample Hypothesis Tests

Framework for Hypothesis Tests

- Hypothesis testing: make inferences about population based on a sample
- Null hypothesis (H_0): assumed true, no effect or difference
- Alternative hypothesis (H_A): claim against H_0 , need evidence to reject H_0

Comparing Hypothesis Tests to Criminal Trials

- **Null Hypothesis:** Similar to presumption of innocence ("innocent until proven guilty")
- **Alternative Hypothesis:** Similar to the prosecutor's claim ("guilty")
- Decision:
 - **Reject H_0 :** Sufficient evidence to reject innocence (guilty verdict)
 - **Fail to reject H_0 :** Not enough evidence to reject innocence (not guilty, but not necessarily innocent)
- **Type I Error:** Wrongly convicting an innocent person (rejecting H_0 when it is true)
- **Type II Error:** Letting a guilty person go free (failing to reject H_0 when H_A is true)
- Significance level (α) = "beyond a reasonable doubt"

One-Sample Hypothesis Test

- Example: Test claim about population mean, μ
- Null hypothesis: $\mu = 3.6$ grams (average almond weight)
- Alternative hypothesis: $\mu < 3.6$ grams
- Goal: determine likelihood of observing a sample mean as extreme as observed

Types of Hypothesis Tests

- **Two-sided test:** evidence against H_0 comes from both directions (greater or less)
- **One-sided test:** evidence against H_0 comes from one direction only
- Examples:
 - left-sided test ($H_A: \mu < 3.6$)
 - right-sided test ($H_A: \mu > 3.6$)
 - two-sided test ($H_A: \mu \neq 3.6$)

Steps in Hypothesis Testing

1. Define H_0 and H_A (null and alternative hypotheses)
2. Choose significance level α (e.g., 0.05)
3. Calculate test statistic (e.g., t statistic for one-sample tests)
4. Compare p -value calculated from test statistic to α
5. Make decision and interpret results in the context of the problem

Theory-Based Hypothesis Test Example

- Calculate sample mean and standard deviation
- Test statistic formula: $t = \frac{\bar{x} - \mu}{s/\sqrt{n}}$
- Calculate p -value for significance

Simulation-Based Hypothesis Testing

- Use permutation tests to simulate null hypothesis scenario
- Shuffle data to simulate "no effect" world
- Calculate test statistic for each shuffle to form null distribution

P -Value and Statistical Significance/Discernibility

- **P -value**: probability of observing a test statistic as extreme as the observed one, assuming H_0 is true
- If $p\text{-value} < \alpha$, reject H_0 (evidence against H_0 is strong)
- Example: $p\text{-value} = 0.03$, $\alpha = 0.05 \rightarrow$ reject H_0

Connection Between Hypothesis Testing and Confidence Intervals

- If the null value is outside the confidence interval, reject H_0
- Example: 95% CI does not contain 3.6 \rightarrow reject H_0

Demo & Exercises

Q & A

STOP