Unit 1 For Live Session Assignment

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MSDS 6371: Statistical Foundations

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Quick Quiz Question 1: Study Design

Question:

Why were poems given to judges in random order in the creativity study?

Analysis:

- Random ordering prevents systematic bias in judging
- Judges may become more lenient or strict over time
- Order effects could confound with treatment effects

Conclusion:

Randomization ensures that any differences in creativity scores can be attributed to the motivation treatment rather than the order of judging.

Quick Quiz Question 2: Statistical Design

Key Concepts:

Random Sampling

- Enables generalization
- Representative of population
- External validity

Random Assignment

- Enables causal inference
- Balances confounding variables
- Internal validity

Quick Quiz Question 3: Study Validity

Case Study: 1930 Milk Supplement Study

Issues Identified:

- Pre-existing group differences
- Evidence of non-random assignment
- Potential selection bias by teachers

Impact on Study Validity:

- Cannot establish causation
- Results are questionable
- Demonstrates the importance of proper randomization

Question 2
What is the difference between a randomized experiment and a random sample? Under what type of study/sample can a causal inference be made?

Answer:

- A random sample is when units are randomly selected from a population to participate in a study. This allows for generalization to the broader population.
- A randomized experiment involves randomly assigning subjects (who may or may not have been randomly sampled) to different treatment groups. This controls for confounding variables.
- Causal inference can only be made from randomized experiments. Random assignment creates groups that are probabilistically similar in all ways except the treatment.

Literary Digest Poll Analysis (1936)

Population of Interest

The desired population was all eligible American voters who would participate in the 1936 presidential election.

Actual Sampled Population

The magazine sampled from a much wealthier subset of Americans:

- Magazine subscribers (likely higher income and education)
- Phone owners (during the Great Depression, phones were luxury items)
- Car owners (automobiles were also indicators of wealth in 1936)

Key Issues

This created significant sampling bias because:

- The sample was not representative of the general voting population
- Wealthier Americans tended to favor Republican candidate Landon
- Poll missed many lower-income voters who supported Roosevelt
- The large sample size (1 in 4 Americans) didn't correct for a biased sampling frame

Fertilizer Study: Scope of Inference Analysis

Scenario A: Discount Offer with Survey

We offer the new fertilizer at a discount to customers who have purchased the old fertilizer. Customers must also complete a survey.

Scope of Inference:

- No random assignment: Cannot establish causation
- Self-selected sample: Cannot generalize to the broader population
- Voluntary response bias from survey returns
- Potential confounding from farmer selection of fertilizer

Scenario B: Random Assignment with Voluntary Reporting

When customers order, we randomly send them the old or new fertilizer. Some farmers report yields.

Scope of Inference:

- Random assignment allows causal inference about the fertilizer effect
- Non-random sample: Cannot generalize beyond study participants
- Potential response bias from voluntary reporting
- Strong internal validity but limited external validity

Statistical Significance

While the p-value (0.0001) shows strong statistical significance, the scope of inference determines how broadly we can apply these findings:

- Scenario A: Association only, limited to respondents
- Scenario B: Causal inference possible, but only for study participants

Impact of Motivation Type on Creativity Scores: Study Results

Key Finding

- Mean Score Difference: 4.1442 points higher in the intrinsic group
- Statistical Significance: p = 0.0058

Based on 10,000 permutations

Study Groups

Intrinsic Motivation (n=24)

- •Inner drive and personal interest
- •Mean score: 20.04

Extrinsic Motivation (n=23)

- •External rewards and incentives
- •Mean score: 15.90

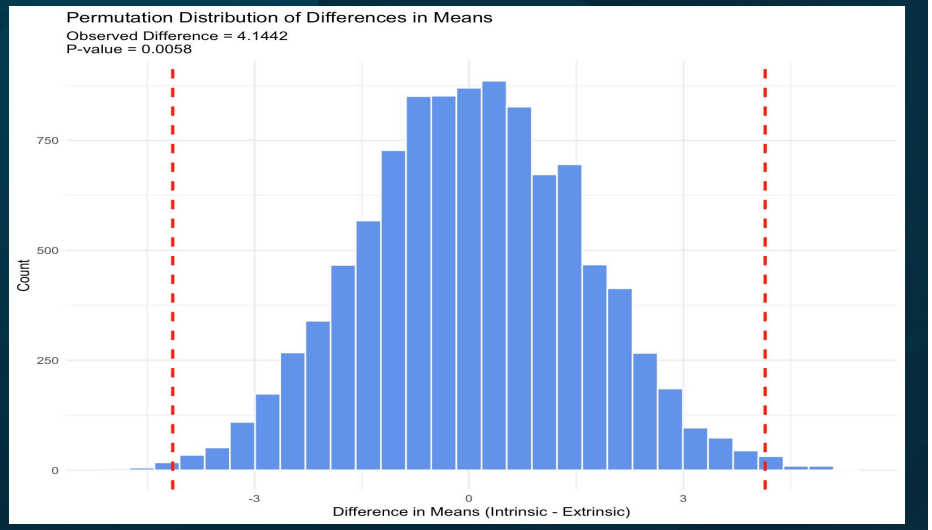
Interpretation

- •Strong evidence for motivation effect
- •Less than 1% chance of random occurrence
- •Consistent, measurable impact

Statistical Analysis

Method: Permutation Test

- •Observed difference: 4.1442
- •P-value: 0.0058 (highly significant)
- •Test conducted at α = 0.05 level



Implications

Key Takeaways:

- •Intrinsic motivation significantly improves creativity
- •The effect size of ~4 points represents a meaningful improvement
- •Results are statistically robust and reliable

Recommendations:

- •Foster environments that promote internal motivation
- •Consider redesigning reward structures
- •Balance extrinsic incentives with intrinsic motivators

Unit 1: Key Takeaways

Research Design Principles

•Random Assignment vs Random Sampling:
- Random assignment enables causal inference
- Random sampling enables population generalization

•Sample Size vs Sampling Method:
- Large sample size doesn't fix biased sampling
- Representative samples matter more than size alone

Statistical Testing

•Permutation Tests:
- Powerful non-parametric alternative to t-tests
- Based on the randomization of group labels
- It is handy when normality is questionable

•P-values:
- Interpret in the context of study design
- Statistical significance ≠ practical significance

Scope of Inference

•Causation requires:
- Random assignment to treatments
- Control of confounding variables

•Generalization requires:
- Random sampling from the target population
- Representative sample characteristics

Questions for Live Session Discussion

Practical Applications

1. What are some real-world examples of the statistical methods we studied in this unit?
2. What are some common challenges to research design concepts?
3. What are the best ways to communicate results from these statistical methods?