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Topics to study for Exam 3

Chapter 13: Confidence intervals for proportions

- Know the difference between a population and a sample
- Know what $\hat{p}$ and p represent
- Knowing how to identify a "success"
- Independence Assumption or as a practical approximation
    - Randomization
    - 10% condition
    - Success/Failure condition
- Be able to use the 68-95-99.7 rule to find the approximate probability of a specific $\hat{p}$ (or less) from a normally distributed sampling distribution of $\hat{p}$.
- Meaning of confidence
- Conditions to check for a confidence interval
    - Randomization
    - 10% condition
    - Success/Failure condition
- Understanding the Margin of Error
- How standard error is related to the standard deviation for proportions
- How to calculate the standard error for proportions
- Critical values
    - Being able to read the output from this on-line calculator https://adamspannbauer.github.io/stats-applets/#/normal
- Being able to calculate a confidence interval with the aid of the formula sheet
- Trade-off between certainty and precision in confidence intervals
- Interpreting Data Analysis output

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Chapter 14: Confidence Intervals for Means

- Know the difference between a population and a sample
- Know what $\bar{y}$ and μ represent
- Have a general understanding of the Central Limit Theorem
- Know assumptions for CLT when the parameters (μ and σ) are known
    - Independence condition or as a practical approximation
        - Randomization condition
        - 10% condition
    - Large enough sample condition
- Know the difference between two distributions
    - Real-world distribution of the sample that one might see in a histogram
    - Math-world distribution of a sample statistic such as the sample mean
- Given the mean and standard deviation of a population, be able to calculate the mean and standard deviation of the sampling distribution of $\bar{y}$ (given the sample size n)
- Know assumptions for CLT when the parameters (μ and σ) are unknown
    - Randomization
    - 10% condition
    - Nearly normal condition
- Understand the reason for using the t-Distribution
- Understand the characteristics of the t-Distribution
    - Similarities/differences to the Normal Distribution
    - Understand degrees of freedom as an additional parameter to manage
    - How to calculate degrees of freedom for a confidence interval of a single mean
- Understanding the Margin of Error of a confidence interval
- Calculation of standard error of the sample mean
    - Relationship to standard deviation
- Finding the critical value for a t-distribution by using the distribution calculator https://adamspannbauer.github.io/stats-applets/#/studentt
- Calculation of confidence intervals using the formula sheet
- Understanding Data Analysis output

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Chapter 15: Testing Hypotheses

- Hypotheses
  - Null hypothesis
    - Understand the null always has the sign of equality (=)
  - Alternative hypotheses
    - Understand reasoning behind the three possible alternatives (≠, >, <)
    - One sided and two-sided
  - Ability to set the correct null and alternative hypotheses
    - Based on the parameter (p or μ)
    - From a word problem
- Interpretation of a p-value in general
- How the p-value is used to decide about the null hypothesis
  - When to Reject
  - When to Fail to Reject
- Reasoning of hypothesis testing
  - Conditions to check for a proportion (one-sample z-test)
    - Randomization
    - 10% condition
    - Success/Failure condition
  - Conditions to check for a mean (one-sample t-test)
    - Randomization
    - 10% condition
    - Nearly Normal condition
- Test statistics calculation and interpretation
  - Mechanics of calculation using the formula sheet
- Finding p-value of test statistic and the alternative hypothesis
  - Using an online calculator to find a p-value
  - Using Data Analysis output to find a p-value
  - How to decide about the null hypothesis based on p-value
- Relationship of hypothesis tests with confidence intervals
  - Both are built on same formulas/conditions
  - A (1-α)100% confidence interval can be interpreted as the set of all null hypothesized values that one would not reject in a two-side test with an alpha level of α
- Knowing the threshold for the null hypothesis is called the Alpha level (Level of significance)
- Understand what is to be reported for a hypothesis test
  - Decision about the null hypothesis:
    - reject the null hypothesis
    - fail to reject the null hypothesis.
  - Alpha level (level of significance).
  - P-value
  - Conclusion of the hypothesis test

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Chapter 16: More about Tests and Intervals

- Interpretation of a p-value in general
  - Interpretation of large and small p-values
  - A sufficiently small p-value could mean
  - (1) that the null hypothesis is true and data was observed that is very improbable under this hypothesis or (2) that the null hypothesis is false
  - We choose to believe (2) and reject the null hypothesis
- Alpha levels
  - Knowing when something is statistically significant
- Practical vs. statistical significance
- Errors of a hypothesis test
  - Type I error
    - α = alpha = probability of making a Type I error
  - Type II error
    - β = beta = probability of making a Type II error
- The severity of a type of error is based on context of the problem
- The three things that determine what β is:
  - Effect size (or, just "how false" is the null hypothesis?)
  - Chosen alpha level (α)
  - Sample size (n)
- Trade-offs between alpha and beta
  - Decreasing the probability of both errors can be done only by increasing the sample size
- Power
  - 1-β
  - Probability of correctly rejecting a false null hypothesis

Chapter 17: Comparing Means for Independent Samples

- Understand the parameter of a difference of two means (μ1- μ 2)
- Conditions to check when comparing means
  - Check for both groups
    - Randomization
    - 10% condition
    - Nearly normal condition
  - Check between the groups
    - The groups must have been selected independently of each other
- Standard error for the difference of sample means
  - Relationship to standard deviation
- Degrees of freedom calculation
  - How to calculate degrees of freedom for two means using http://volweb.utk.edu/~ccwiek/TwoSampleDoF.html
  - Find the degrees of freedom from Data Analysis output
- Confidence Intervals

    - Finding the critical value for a t-distribution by using the distribution calculator https://adamspannbauer.github.io/stats-applets/#/studentt
    - Calculations using the formula sheet
    - Finding the Upper and Lower limits on output
    - Interpretation of the confidence interval
- t-test for the difference of two means
- Setting up null and alternative hypotheses from a word problem
- Test statistics calculation and interpretation
    - Mechanics of calculation using the formula sheet
- Interpreting a hypothesis test using output
- Conclusion of a hypothesis test of the difference of two means

Chapter 19: Comparing Counts

- Chi-Square (χ^2) test of independence
- Hypotheses for Chi-square test
    - Null
    - Alternative
    - Setting them up from a word problem
- Conditions to check
    - The data are counts from categorical data
    - Randomization
    - 10% condition
    - Expected cell counts must all be at least 5
- Calculations
    - Row, column and grand totals
    - Expected cell counts
    - Cell Chi-square
    - Chi-square test statistic
        - What it means when this is large
    - Row percentages (calculate from data)
- If the null hypothesis is rejected, being able to explain the nature of the association from the visualization and/or the Row percentages
- p-value interpretation
- Conclusion of a Chi-Square (χ^2) test of independence
- Being able to read the output from the following online calculator: https://adamspannbauer.github.io/stats-applets/#/chisquare
- Chi-square and causation
- Interpreting Data Analysis output

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Tools and Techniques

- Be able to select the correct tool (from ALL the tools covered in the course) to address a particular problem or situation.
- You won't be expected to actually demonstrate proficiency with the tools if they were from Exam 1 or Exam 2, just know which tool is the right one for the job!
- Expect a few multiple-choice questions on this topic.