

Introduction to Statistics: Exam Review Sheet

Undergraduate Introductory Statistics · Course-Concept Review · 566-word excerpt

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Concept map

Descriptive statistics summarize the sample you observed. Inferential statistics use a sample to estimate or test claims about a population while accounting for sampling uncertainty. A parameter describes a population; a statistic describes a sample. Standard deviation describes variation among observations. Standard error describes how much a statistic such as the sample mean would vary across repeated samples.

Confidence intervals estimate plausible values for a population parameter. Hypothesis tests evaluate how compatible the observed data are with a null model. These procedures answer related but different questions: an interval emphasizes estimation and precision, while a test emphasizes evidence against a specified null hypothesis.

Formula and interpretation sheet

One-sample mean confidence interval when the population standard deviation is unknown: sample mean $\pm t^* \times (\text{sample standard deviation} / \text{square root of } n)$. The critical value t^* depends on the chosen confidence level and degrees of freedom. A larger sample reduces standard error because the denominator grows with the square root of n .

A p-value is the probability, assuming the null hypothesis and model are correct, of observing a result at least as incompatible with the null as the result obtained. It is not the probability that the null hypothesis is true. Statistical significance does not automatically imply a large or important effect.

Cohen's d expresses a mean difference in standard-deviation units. Effect size addresses magnitude; a confidence interval addresses precision; a p-value addresses compatibility with the null model. Strong interpretation considers all three where appropriate.

Worked example

A sample of 25 students has a mean score of 72 and a sample standard deviation of 10. For a 95% confidence interval with 24 degrees of freedom, use $t^* \approx 2.064$. Standard error = $10 / \sqrt{25} = 2$. Margin of error = $2.064 \times 2 = 4.128$. The interval is approximately 72 ± 4.128 , or 67.9 to 76.1.

Interpretation: using this method, the estimated population mean lies between approximately 67.9 and 76.1. Do not say that 95% of individual students score inside this interval. The interval estimates a population mean, not the spread of individual observations.

Retrieval-practice questions

1. Explain the difference between standard deviation and standard error without using a formula.
2. What happens to standard error when sample size increases?
3. Why does a confidence interval become wider when the confidence level increases?
4. State the null and alternative hypotheses for a one-sample mean test.
5. Explain why $p = .03$ does not mean there is a 3% chance that the null hypothesis is true.
6. Give an example of a statistically significant result with little practical importance.

Answer checkpoints: standard deviation concerns observations; standard error concerns a statistic across repeated samples. Larger n generally reduces standard error. Higher confidence requires a larger critical value. A p -value is calculated under the null model and does not assign a posterior probability to that model.

Common errors and two-session review plan

Common errors: confusing population parameters with sample statistics; reporting a p -value as the probability the null is true; interpreting a confidence interval as a range containing 95% of individuals; choosing a test before identifying variable type and design; and reporting significance without direction, magnitude, or uncertainty.

Session one: rebuild the concept map from memory, solve the worked interval without looking, and explain every symbol aloud. Session two: complete mixed practice that forces a choice among description, estimation, and testing; then correct errors by naming the misconception, not merely copying the answer. Finish with a one-page formula sheet that includes conditions and interpretations beside each formula.