MAT121 Statistics I Midterm Exam #3

4/17/2025

Name _____ WCUID Number_____
(please print) (please print)

Instructions

1. **Formula Sheet**:
   - You are allowed to bring **one formula sheet** (8.5" x 11", single-sided or double-sided) with **formulas only**.
   - The formula sheet must be handwritten or printed and will be collected at the end of the exam.
2. **Calculators**:
   - (Graphing or scientific) calculators are allowed for this exam.
   - Calculators with internet access, communication capabilities, or stored notes are **not allowed**.
3. **Notebooks and Notes**:
   - **No notebooks, notes, or additional materials** are allowed during the
4. **Exam Versions**:
   - Each student will receive a **different version** of the exam.
   - Ensure you are working on your assigned version only.
5. **Grading for Word Problems**:
   - For word problems, you must provide **detailed steps and justification** for your solution.
   - Correct answers with **no or incorrect justification** will receive **ZERO credit**.
   - Partial credit may be awarded for correct steps even if the final answer is incorrect.
6. **Multiple Choice Problems**:
   - For multiple-choice questions, **manually calculate** your answer and select the option that is **closest to your calculated result**.
   - If your calculated answer does not match any option exactly, choose the **closest value**.
7. **General Rules**:
   - No communication or collaboration with other students is allowed during the exam.
   - All electronic devices (e.g., phones, smartwatches) must be turned off and stored away.

Part I: Multiple-choice Questions [4 points each, total 48 points]: *Please circle the correct answer.*

For each question, only one choice is correct. If your calculated answer does not match any option exactly, choose the **closest value**.

Problem 1. A randomly selected sample of 1,000 college students was asked whether they had ever used the drug Ecstasy. Sixteen percent (16% or 0.16) of the 1,000 students surveyed said they had. Which one of the following statements about the number 0.16 is correct?

A. It is a sample proportion.
B. It is a population proportion.
C. It is a margin of error.
D. It is a randomly chosen number.

Answer A

Problem 2. Null and alternative hypotheses are statements about:

A. population parameters.
B. sample parameters.
C. sample statistics.
D. it depends - sometimes population parameters and sometimes sample statistics.

Answer A

Problem 3. A result is called "statistically significant" whenever

A. The null hypothesis is true.
B. The alternative hypothesis is true.
C. The p-value is less or equal to the significance level.
D. The p-value is larger than the significance level.

Answer C.

Problem 4. It is known that for right-handed people, the dominant (right) hand tends to be stronger. For left-handed people who live in a world designed for right-handed people, the same may not be true. To test this, muscle strength was measured on the right and left hands of a random sample of 15 left-handed men, and the

difference (left-right) was found. The alternative hypothesis is one-sided (left hand stronger). The resulting t-statistic was 1.80. This is an example of:

A. A two-sample t-test.
B. A paired t-test.
C. A pooled t-test.
D. An unpooled t-test.

Answer B

Problem 5. Assuming the conditions are met, based on the t-statistic of 1.80 the appropriate conclusion for this test using $\alpha = .05$ is

A. Df = 14, so p-value < .05, and the null hypothesis can be rejected.
B. Df = 14, so p-value > .05, and the null hypothesis cannot be rejected.
C. Df = 28, so p-value < .05, and the null hypothesis can be rejected.
D. Df = 28, so p-value > .05, and the null hypothesis cannot be rejected.

Answer A or B (denpending how the difference is defined, assign full credit for shoosing either A or B)

Problem 6. A random sample of 25 college males was obtained and each was asked to report their actual height and what they wished as their ideal height. A 95% confidence interval for μd = average difference between their ideal and actual heights was 0.8" to 2.2". Based on this interval, which one of the null hypotheses below (versus a two-sided alternative) can be rejected?

A. H_0: $\mu_d = 0.5$
B. H_0: $\mu_d = 1.0$
C. H_0: $\mu_d = 1.5$
D. H_0: $\mu_d = 2.0$

Answer A

Problem 7. The average time in years to get an undergraduate degree in computer science was compared for men and women. Random samples of 100 male computer science majors and 100 female computer science majors were taken. Choose the appropriate parameter(s) for this situation.

A. One population proportion p.
B. Difference between two population proportions $p_1 - p_2$.
C. One population mean μ_1
D. Difference between two population means $\mu_1 - \mu_2$

Answer D

Problem 8. A large company examines the annual salaries for all of the men and women performing a certain job and finds that the means and standard deviations are \$32,120 and \$3,240, respectively, for the men and \$34,093 and \$3521, respectively, for the women. The best way to determine if there is a difference in mean salaries for the population of men and women performing this job in this company is

A. to compute a 95% confidence interval for the difference.
B. to subtract the two sample means.
C. to test the hypothesis that the population means are the same versus that they are different.
D. to test the hypothesis that the population means are the same versus that the mean for men is higher.

Answer: A and C (assign full credit for choosing either A or C.)

Problem 9. Which of the following is not a correct way to state a null hypothesis?

A. H_0: $\hat{\mu}_1 - \hat{\mu}_2 = 0$
B. H_0: $\mu_d = 10$
C. H_0: $\mu_1 - \mu_2 = 0$
D. H_0: $p = .5$

Answer A

Problem 10. Marketing research shows that 60 tissues is the average number of tissues a person uses during a cold. The company that makes Kleenex brand tissues thinks that fewer of the tissues are needed. What are their null and alternative hypotheses for justifying the company's belief?

A. Ho: $\mu = 60$ vs Ha: $\mu > 60$
B. Ho: $\mu = 60$ vs Ha: $\mu < 60$
C. Ho: $\bar{x} = 60$ vs Ha: $\bar{x} < 60$
D. Ho: $\mu < 60$ vs Ha:$= 60$

Answer B

Problem 11. In testing the hypotheses Ho: $\mu = 50$ vs Ha: $\mu \neq 50$, the following information is known: $n = 64$, $\bar{x} = 53.5$ and $\sigma = 10$. The standardized test statistic is:

A. $t = 2.8$
B. $t = -2.8$
C. $z = 2.8$
D. $z = -2.8$

Problem 12. If an economist wishes to determine whether there is evidence that the average family income in a community exceeds $32,000,
A. either a one-tail or two-tail test could be used with equivalent results.
B. a one-tail test should be utilized.
C. a two-tail test should be utilized.
D. none of these choices.

Answer B

Problem 13. Researchers have claimed that the average number of headaches per student during a semester of Statistics is 11. Statistics students believe the average is higher. In a sample of n = 16 students, the mean is 12 headaches with a deviation of 2.4. Which of the following represents the null and alternative hypotheses necessary to test the students' beliefs?
A. $H_0: \mu = 11$ vs. $H_a: \mu \neq 11$
B. $H_0: \mu = 11$ vs. $H_a: \mu < 11$
C. $H_0: \mu < 11$ vs. $H_a: \mu = 11$
D. $H_0: \mu = 11$ vs. $H_a: \mu > 11$

Answer: D

Part II World problems [Total 48 points]: *Show your detailed work to earn full credit. Partial credits will be assigned for correct details. Correct answers without appropriate justification will not earn any credit.*

Problem 1.

The owner of a local nightclub has recently surveyed a random sample of n = 225 customers of the club. She would now like to determine whether or not the mean age of her customers is over 35. If so, she plans to alter the entertainment to appeal to an older crowd. If not, no entertainment changes will be made. Suppose she found that the sample mean was 35.5 years, and the population standard deviation was 5 years. Use the p-value method and follow the 6-step procedure to justify the owner's belief about her customer's age.

Solution: This normal test is based on the Central Limit Theorem CLT. Since the sample size is larger than 30, the test result is reliable.

Given sample information: $n = 225$, $\bar{x} = 35.5$, $s = 5$.

Step 1: Identify the claim of the population mean (μ_0).
The given information indicates that the claim is: μ_0 is greater than 35.

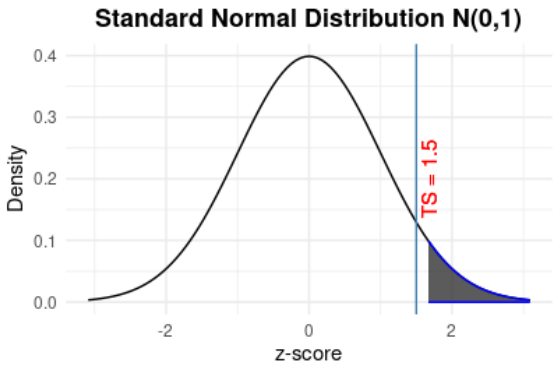
Step 2: Set up the null and alternative hypotheses.
Based on the claim, the null and alternative hypotheses are given by $H_0 : \mu = 35$ and $H_1 : \mu > 35$.

Step 3: Evaluate the test statistic.
The test statistic is defined to be: $TS = \dfrac{\bar{x} - \mu_0}{s/\sqrt{n}} = \dfrac{35.5 - 35}{5/\sqrt{225}} = 1.5$

Step 4: Find the critical value and calculate the p-value.
Based on the significance level, we found the critical value$s$ to be : $z_\alpha = z_{0.05} = 1.645$
The p-value is can be found as p-value $\approx 0.0669999999999999$.

Step 5: Make a statistical decision on H_0.
At the 5% significance level, we do not reject the null hypothesis. $(p\text{-value} = 0.067)$.

Step 6: Draw conclusion [justify the claim in step 1].
At the 5% significance level, we reject the alternative hypothesis .



Note: The claim is not greater than 35 (i.e., less than or equal to), the null and alternative are still the same

Problem 2.

A bottling company produces bottles designed to hold 12 ounces of liquid. Periodically, the company receives complaints that their bottles do not contain enough liquid. To test this claim at a significance level of 0.05, the company randomly samples 16 bottles and finds that the average amount of liquid is 11.9 ounces, with a standard deviation of 0.4 ounces. Assume that the actual volumes of the bottles are normally distributed.

Solution: This t test is based on the assumption that the population is normal and the population variance is unknown.

Given sample information: $n = 16$, $\bar{x} = 11.9$, $s = 0.4$.

Step 1: Identify the claim of the population mean (μ_0).
The given information indicates that the claim is: μ_0 is less than 12.

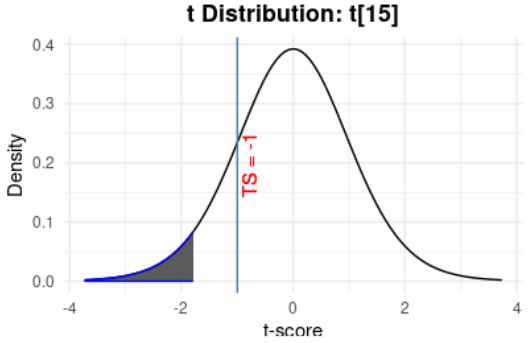
Step 2: Set up the null and alternative hypotheses.
Based on the claim, the null and alternative hypotheses are given by $H_0 : \mu = 12$ and $H_1 : \mu < 12$.

Step 3: Evaluate the test statistic.
The test statistic is defined to be: $TS = \dfrac{\bar{x} - \mu_0}{s/\sqrt{n}} = \dfrac{11.9 - 12}{0.4/\sqrt{16}} = -1.$

Step 4: Find the critical value and calculate the p-value.
Based on the significance level, we found the critical value$s$ to be :$-t_{\alpha,df} = -t_{0.05,15}$. = -1.753.
The p-value is can be found as p-value $\approx$ 0.167.

Step 5: Make a statistical decision on H_0.
At the 5% significance level, we do not reject the null hypothesis that the true mean is 12 (p-value = 0.167).

Step 6: Draw conclusion [justify the claim in step 1].
At the 5% significance level, we reject the alternative hypothesis .



Problem 3

To compare the customer satisfaction levels of two competing cable television companies, 164 customers of Company A and 200 customers of Company B were randomly selected and were asked to rate their cable companies on a five-point scale, with 1 being least satisfied and 5 most satisfied. The survey results are summarized in the following table:

Company A	Company B
$n_1 = 164$	$n_1 = 200$
$\bar{X} = 3.5$	$\bar{Y} = 3.3$
$s_1^2 = 0.25$	$s_1^2 = 0.30$

Test whether the data provides sufficient evidence to conclude that Company A has a higher mean satisfaction rating than does Company B.

Step 1: Identify the claim of the population mean $(\mu_1 - \mu_2)$.
The given information indicates that the claim is: $\mu_1 - \mu_2$ is greater than 0.

Step 2: Set up the null and alternative hypotheses.
Based on the claim, the null and alternative hypotheses are given by $H_0 : \mu_1 - \mu_2 = 0$ and $H_1 : \mu_1 - \mu_2 > 0$.

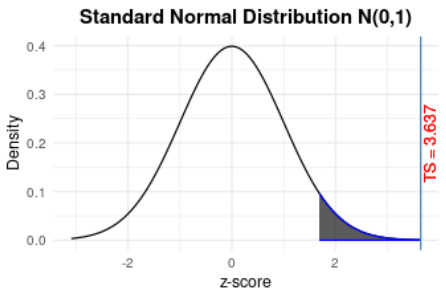
Step 3: Evaluate the test statistic.
The test statistic is defined to be:

$$TS = \frac{(\bar{x}_1 - \bar{x}_2) - (\mu_1 - \mu_2)}{\sqrt{s_1^2/n_1 + s_2^2/n_2}} = \frac{(3.5 - 3.3) - 0}{\sqrt{0.25/164 + 0.3/200}} = 3.637.$$

Step 4: Find the critical value and calculate the p-value.
Based on the significance level, we found the critical value$s$ to be : $z_\alpha = z_{0.05}. = 1.645$.
The p-value is can be found as p-value ≈ 0.

Step 5: Make a statistical decision on H_0.
At the 5% significance level, we reject the null hypothesis. (p-value< 0.001).

Step 6: Draw conclusion [justify the claim in step 1].
At the 5% significance level, we conclude the alternative hypothesis. The claim is addressed using relationship between the alternative hypothesis and the claim.



Midterm #03 Summary

1. Five Number Summary :

The five-number summary is use used to describe the shape of the distribution of a given numerical data. It consists of five numbers: minimum data value, first quartile, median, the third quartile, and the maximum data value.

The five-number summary of this given data set is:

stats	value
Min.	23.00
1st Qu.	63.00
Median	82.00
3rd Qu.	95.00
Max.	100.00

2. Boxplot :

The boxplot is a geometric representation of the five-number summary. The boxplot of the given data set is given below.