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By signing your name below, you are agreeing to the following: "I have not and will not collaborate with any other students or other individuals on this exam. The work represented is my own. I recognize that otherwise I will fail the course and be subject to a report of an academic integrity violation, jeopardizing my academic career."

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1. (6 points) A company has offices in two different cities. A computer competency exam is given to the employees at both locations. Assuming the same horizontal and vertical scale for both graphs, which of the following statements are true? Select all that apply.

$\sigma_A < \sigma_B$

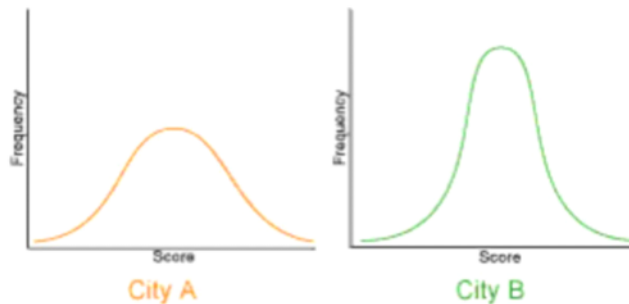
$\sigma_A = \sigma_B$

$\sigma_A > \sigma_B$

$\mu_A < \mu_B$

$\mu_A = \mu_B$

$\mu_A > \mu_B$



2. (6 points) The hypothesis $H_A: \mu > 5$ is tested and a p-value of 0.031 is found. Which of the following statements is **FALSE (select all that apply)**?

 The researcher would reject the null hypothesis at a 10% significance level.

 The probability that the mean is 5 or less is 0.031.

 At a 5% significance level, the observed sample mean is found to be significantly greater than 5.

 At a significance level of 0.05, the two-sided test (with alternative $H_A: \mu \neq 5$) would be rejected.

 The probability of observing a sample mean greater than 5 is 0.031, if the null hypothesis is true.

3. (4 points) Which of the following represents a lower p-value?

 A female athlete has a long jump that is at least 2 standard deviations above the mean.

 A team of 10 female athletes have a mean long jump that is at least 2 standard deviations above the mean.

 These both have the same p-value.

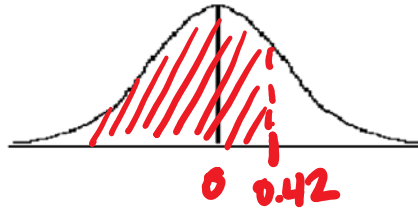
4. (30 points) Suppose the amount spent on rent (in dollars) for NCSU students per month is normally distributed with a mean of \$525 and a population standard deviation of \$60.

a. Find the z-score for an NCSU student whose monthly rent is \$550? (6 pts)

$$z = \frac{550 - 525}{60} = \frac{25}{60}$$

ANS 3a: $z = 0.42$

- b. Assume we wish to find the probability that the student's rent is less than \$550. If the curve below corresponds to the density curve of the test statistic, indicate the value at the center for the test statistic (4 points), indicate the location of the test statistic for this problem (4 points) and shade the area corresponding to the P-value (4 points).



- c. If the lowest 10% of NCSU students corresponds to a z-score of less than or equal to -1.28, find the amount of rent that puts a student in the lowest 10%? (6 pts)

$$-1.28 = \frac{x - 525}{60}$$

$$-1.28 \cdot 60 = x - 525$$

$$\begin{array}{r} -76.8 = x - 525 \\ +525 \quad \quad +525 \\ \hline 448.2 = x \end{array}$$

ANS 3c: \$448.20

- d. If a random sample of 25 NCSU students is collected, calculate the test statistic that corresponds to a mean monthly rent of \$600 for these students. Write a probability statement, both in terms of the variable and in terms of the test statistic, that represents the probability the mean rent is greater than \$600 (6 pts).

$$z = \frac{\bar{x} - \mu}{\sigma/\sqrt{n}} = \frac{600 - 525}{60/\sqrt{25}} = \frac{75}{12} = 6.25$$

ANS 3d: $z = 6.25$
Test statistic

ANS 3d: $P(\bar{x} > 600)$
Probability statement for variable

ANS 3d: $P(z > 6.25)$
Probability statement for test statistic

5. (24 points) In the US, what is the mean number of eggs a hen lays in a year? Data were collected over a year from 500 hens living in farms across the US. The mean number of eggs laid by hens in the sample was 254, with a population standard deviation of 15.
- a. If we want a 92% confidence interval, which of the following is the most appropriate value to choose as the critical value? (6 pts)

- 0.96
- 2.33
- 0.92
- 1.75

Using table below, critical value must be between 1.645 and 1.96

- b. Ignore the values given above and calculate the 95% confidence interval in the space below. Show all work and write your final interval in the box provided. (18 pts)

$$\bar{x} \pm z_{\alpha/2} \sigma / \sqrt{n}$$

$$254 \pm 1.96 \cdot \frac{15}{\sqrt{500}}$$

$$254 \pm 1.315$$

Common Critical Values

Confidence Level	Critical Value
0.90	1.645
0.95	1.96
0.99	2.575

Final Interval:

$$(252.685, 255.315)$$

6. (4 points) The proportion of smartphone users on NC State campus that use Android devices is not known. A survey is taken and a confidence interval is calculated and is found to be (0.22, 0.38).

This interval is too large to make meaningful conclusions and we want to be a little more specific. If we wished to decrease the width of the interval, what should we do? (Check all that apply.)

- Increase the percent confidence
- Decrease the percent confidence
- Increase the sample size
- Decrease the sample size
- Increase the null hypothesis
- Decrease the null hypothesis

7. (4 points) True or False: if the P-value is small, it means that the observed data is very unlikely to have occurred under H_0 , so we are less confident in rejecting the null hypothesis.

- True
- False

8. (18 points) Wolf-Fi is looking to hire some NC State grads, but they wish to know if unpaid time off is a benefit that would be valued by new hires. The long-term proportion of employees that have used unpaid time off is 0.18. It is suspected that new hires would prefer to use this benefit less than the current workforce. A survey is taken of 200 NC State grads and 28 said they would like this benefit.
- a. What are the correct null and alternative hypotheses to test the claim? (6 pts)

- | | | | |
|----------------------------------|-----------------------|----------------------------------|-------------------|
| <input type="radio"/> | $H_0: \mu = 0.18$ | <input checked="" type="radio"/> | $H_a: p < 0.18$ |
| <input checked="" type="radio"/> | $H_0: p = 0.18$ | <input type="radio"/> | $H_a: p = 0.14$ |
| <input type="radio"/> | $H_0: \hat{p} = 0.18$ | <input type="radio"/> | $H_a: \mu < 0.18$ |
| <input type="radio"/> | $H_0: \bar{x} = 0.18$ | <input type="radio"/> | $H_a: \mu = 0.14$ |

- b. Calculate the test statistic appropriate for this test. Show all work. (6 pts)

$$\hat{p} = \frac{28}{200} = 0.14$$

$$Z = -1.472$$

$$Z = \frac{\hat{p} - p}{\sqrt{\frac{pq}{n}}} = \frac{0.14 - 0.18}{\sqrt{\frac{0.18 \cdot 0.82}{200}}}$$

ANS 5b: $Z = -1.472$

- c. Assume the correct p-value is 0.0705, which statement is correct at a 5% significance level? (6 pts)
- Reject H_0 : We have sufficient evidence to conclude that the proportion that prefer unpaid time off is less than 0.18.
 - Reject H_0 : We have sufficient evidence to conclude that the proportion that prefer unpaid time off is not equal to 0.18.
 - Reject H_0 : We have sufficient evidence to conclude that the proportion that prefer unpaid time off is at least 0.18.
 - Fail to reject H_0 : We do not have sufficient evidence to conclude that the proportion that prefer unpaid time off is at least 0.18.
 - Fail to reject H_0 : We have sufficient evidence to conclude that the proportion that prefer unpaid time off is less than 0.18.
 - Fail to reject H_0 : We do not have sufficient evidence to conclude that the proportion that prefer unpaid time off is less than 0.18.
9. (4 points) The sampling distribution of the mean is defined as the:
- Mean of sample data that has been collected from a simple random sample
 - Mean of sample data that follows a normal distribution
 - Distribution of the sample means of all possible samples of a certain size
 - Distribution of data that has been collected from a simple random sample