Week 3 Quiz
Graded Quiz • 30 min

English Due May 19, 11:59 PM IST

1. Which of the following is **false** about bootstrapping? 1 / 1 point

- (●) A bootstrap confidence interval constructed based on a biased sample will still yield an unbiased estimate for the population parameter of interest.
- ( ) The endpoints of a 95% bootstrap confidence interval are the cutoff values for the top and bottom 2.5% of the bootstrap distribution.
- ( ) Bootstrap distributions are constructed by sampling with replacement from the original sample, while sampling distributions are constructed by sampling with replacement from the population.
- ( ) Bootstrap distributions that are extremely skewed or have isolated clumps of values may yield unreliable confidence intervals.

Correct
This question refers to the following learning objective(s):

Construct bootstrap confidence intervals using one of the following methods:

- Percentile method: XX% confidence level is the middle XX% of the bootstrap distribution.
- Standard error method: If the standard error of the bootstrap distribution is known, and the distribution is nearly normal, the bootstrap interval can also be calculated as $\bar{x}_{boot} \pm z^* SE_{boot}$.

Recognize that when the bootstrap distribution is extremely skewed and sparse, the bootstrap confidence interval may not be appropriate.

If the original sample is biased then the bootstrap distribution will yield a **biased** estimated for the population of interest, bootstrapping is not a remedy for bad data collection.

2. Which of the following is **false** regarding paired data? 0 / 1 point

- ( ) In a paired analysis we first subtract the paired observations from each other, and then do inference on the differences.
- (●) Two data sets of different sizes cannot be analyzed as paired data.

2. Suppose we wanted to compare the rates of return for two stocks: the technology company Intel and the U.S. airline Southwest Airlines. To compare the rates of return, we take a random sample of 50 days of Intel's stock returns and another random sample of 50 days for Southwest's stock returns (not necessarily the same days). These data should not be treated as paired. Why would these data not be considered paired data? 1 / 1 point

- ( ) When random sampling is involved, data can't be treated as paired.
- ( ) The data can't be considered paired data because the two companies are in different industries.
- ( ) 50 observations is not enough to be able to consider the data as paired.
- (●) The data can't be considered paired data because the days for which we have Intel data may be different from the days for which we have Southwest Airlines data.

Correct
This question refers to the following learning objective(s):

- Define observations as paired if each observation in one dataset has a special correspondence or connection with exactly one observation in the other data set.
- Carry out inference for paired data by first subtracting the paired observations from each other, and then treating the set of differences as a new numerical variable on which to do inference (such as a confidence interval or hypothesis test for the average difference).

In this case, the data would be considered paired if the 50 days of returns were the same 50 days for both Intel and Southwest Airlines. Without that special correspondence the data can't be treated as paired.

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2. Which of the following is **false** regarding paired data? 0 / 1 point

- In a paired analysis we first subtract the paired observations from each other, and then do inference on the differences.
- (●) Two data sets of different sizes cannot be analyzed as paired data.
- Each observation in one data set is subtracted from the average of the other data set's observations.
- Each observation in one data set has a natural correspondence with exactly one observation from the other data set.

Incorrect
This question refers to the following learning objective(s):

- Define observations as paired if each observation in one dataset has a special correspondence or connection with exactly one observation in the other data set.
- Carry out inference for paired data by first subtracting the paired observations from each other, and then treating the set of differences as a new numerical variable on which to do inference (such as a confidence interval or hypothesis test for the average difference).

True, in order to do a paired analysis the sample sizes must be equal for the two groups.

3. The distribution of duration of unemployment for all 18-24 year-old Americans is nearly normal with mean 12.7 weeks and standard deviation 0.3 weeks. Suppose we randomly sample 20 people from this population, ask them about the duration of their unemployment (in number of weeks), and record the sample mean. We repeat this 5,000 times, and build a a distribution of sample means. What is the name of this distribution? 1 / 1 point

- sample distribution
- bootstrap distribution
- randomization distribution
- population distribution
- (●) sampling distribution

Correct

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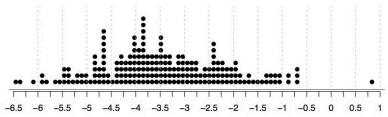
4. Researchers studying IQ scores of mothers and fathers of ``gifted" children collected data from 36 gifted children and their parents. First, differences in IQ scores of the father and the mother were calculated for each child (calculated as father's IQ score - mother's IQ score). The dot plot below shows the bootstrap distribution of means of **200 bootstrap samples** taken from this original sample of differences in IQ scores. The mean of the bootstrap distribution is approximately -3.48 points and the bootstrap standard error is 1.3 points. Assume the usual conditions for constructing a bootstrap confidence interval are satisfied. Which of the following statements is **false**? 0 / 1 point



- Since 0 is apparently an unusual value for the statistic, then at the 5% significance level we would fail to reject a null hypothesis of that claims that the fathers' and mothers' average IQs are equal.
- (●) It's likely that in the original sample, most mothers had higher IQ scores than the fathers.
- A 95% bootstrap confidence interval for the difference in IQ scores is approximately (-6, -0.9).
- A 90% bootstrap confidence interval for the difference in IQ scores would is approximately (-5.6, -1.3).

Incorrect
This question refers to the following learning objective(s):

- Recognize that a good interpretation of a confidence interval for the difference between two parameters includes a comparative statement (mentioning which group has the larger parameter).
- Recognize that a confidence interval for the difference between two parameters that doesn't include 0 is in agreement with a hypothesis test where the null hypothesis that sets the two parameters equal to each other is rejected.

Most sampled differences are negative, and they're calculated as father's IQ score - mother's IQ score, therefore father's IQ score < mother's IQ score.

4. A study examining the relationship between weight of school children (4th to 6th graders) found a 95% confidence interval for the difference between the average number of school days missed by overweight and normal weight children ($\mu_{overweight} - \mu_{normal}$) to be 1.3 to 2.8 days. Which of the following is **true** based on this confidence interval?

0 / 1 point

- ○ At 5% significance level, the data do not provide convincing evidence of a difference between the average number of missed days by overweight and normal weight children.
- ◉ We are 95% confident that overweight children on average miss 1.3 to 2.8 days fewer than children with normal weight.
- ○ At 10% significance level, the data do not provide convincing evidence of a difference between the average number of missed days by overweight and normal weight children.
- ○ We are 95% confident that overweight children on average miss 1.3 to 2.8 days more than children with normal weight.

Incorrect

This question refers to the following learning objective(s):

- Recognize that a good interpretation of a confidence interval for the difference between two parameters includes a comparative statement (mentioning which group has the larger parameter).
- Recognize that a confidence interval for the difference between two parameters that doesn't include 0 is in agreement with a hypothesis test where the null hypothesis that sets the two parameters equal to each other is rejected.

Note the order in which the subtraction is being done.

5. An insurance company wants to estimate (using a confidence interval) its average claim amount using data from 20 randomly selected claims. Which of the following is **false**?

1 / 1 point

- ○ If the distribution of the sampled claim amounts is not extremely skewed, a T interval is appropriate.
- ○ The critical t-score, $t^\star$, has 19 degrees of freedom.
- ○ The confidence interval can also be calculated using bootstrapping.
- ◉ A confidence interval based on this sample is not accurate since the sample size is small.

Correct

Low sample size alone does not necessarily preclude an accurate confidence interval; the T interval may be used if conditions are met.

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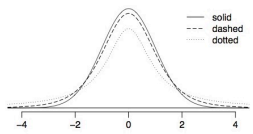
Most sampled differences are negative, and they're calculated as father's IQ score - mother's IQ score, therefore father's IQ score < mother's IQ score.

5. When doing inference on a single mean, which of the following is the **correct** justification for using the t-distribution rather than the normal distribution? **1 / 1 point**

- (●) Because the standard error estimate may not be accurate.
- ( ) Because the t-distribution is not symmetric.
- ( ) All of the above.
- ( ) None of the above.

Correct
With a small sample size our estimate of the standard error as $\frac{s}{\sqrt{n}}$ is not reliable, since the sample standard deviation, s, may not be a reliable estimate for the population standard deviation σ when the sample size is low. We make up for this by using the t instead of the normal distribution.

6. How does the shape of the t-distribution change as the sample size increases? **1 / 1 point**



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- ( ) It becomes skewed
- ( ) It becomes flatter
- ( ) It becomes wider
- (●) It becomes more normal looking

Correct
This question refers to the following learning objective(s):

- Describe how the t-distribution is different from the normal distribution, and what ``heavy tail" means in this context.
- Note that the t-distribution has a single parameter, degrees of freedom, and as the degrees of freedom increases this distribution approaches the normal distribution.

As the degrees of freedom increases the t-distribution starts approaching the normal distribution.

7. Air quality measurements were collected in a random sample of 25 country capitals in 2013, and then again in the same cities in 2014. We would like to use these data to compare average air quality between the two years. Which of the following tests is the **most** appropriate? **0 / 1 point**

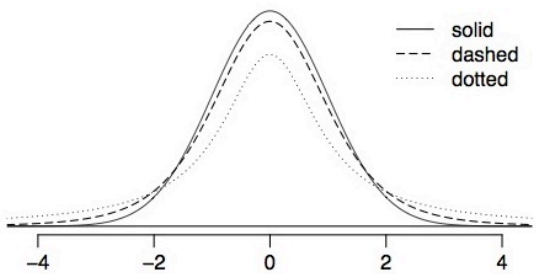
- (●) independent samples t-test with two-sided alternative hypothesis
- ( ) independent samples t-test with one-sided alternative hypothesis
- ( ) paired t-test with one-sided alternative hypothesis
- ( ) paired t-test with two-sided alternative hypothesis

Incorrect
We're looking for a difference between the two years' averages, and the data are collected in the same cities in both years.

8. We are testing the following hypotheses: **0 / 1 point**

6. How does the shape of the t-distribution change as the sample size increases?

1 /



- ○ It becomes flatter
- ◉ It becomes more normal looking
- ○ It becomes skewed
- ○ It becomes wider

Correct

This question refers to the following learning objective(s):

- Describe how the t-distribution is different from the normal distribution, and what ``heavy tail" means in this context.
- Note that the t-distribution has a single parameter, degrees of freedom, and as the degrees of freedom increases this distribution approaches the normal distribution.

As the degrees of freedom increases the t-distribution starts approaching the normal distribution.

7. My friend, Tom, believes that his supermarket's prices are lower than mine, and sets an alternative hypothesis test reflecting this. We construct a list of 10 identical items and purchase them at our respective stores. Tom wants to know if these data support his hypothesis. Which of the following is the **correct** description of Tom's situation?

- ○ Tom has a one-sided alternative hypothesis and should do a paired t-test.
- ○ Tom has a two-sided alternative hypothesis and should do an independent samples t-test.
- ◉ Tom has a one-sided alternative hypothesis and should do an independent samples t-test.
- ○ Tom has a two-sided alternative hypothesis and should do a paired t-test.

⊗ **Incorrect**
Each observation in one data set has a special correspondence to exactly one observation in the other data set.

8. We are testing the following hypotheses:

H_0 : μ = 0.5

H_A : μ $\neq$ 0.5

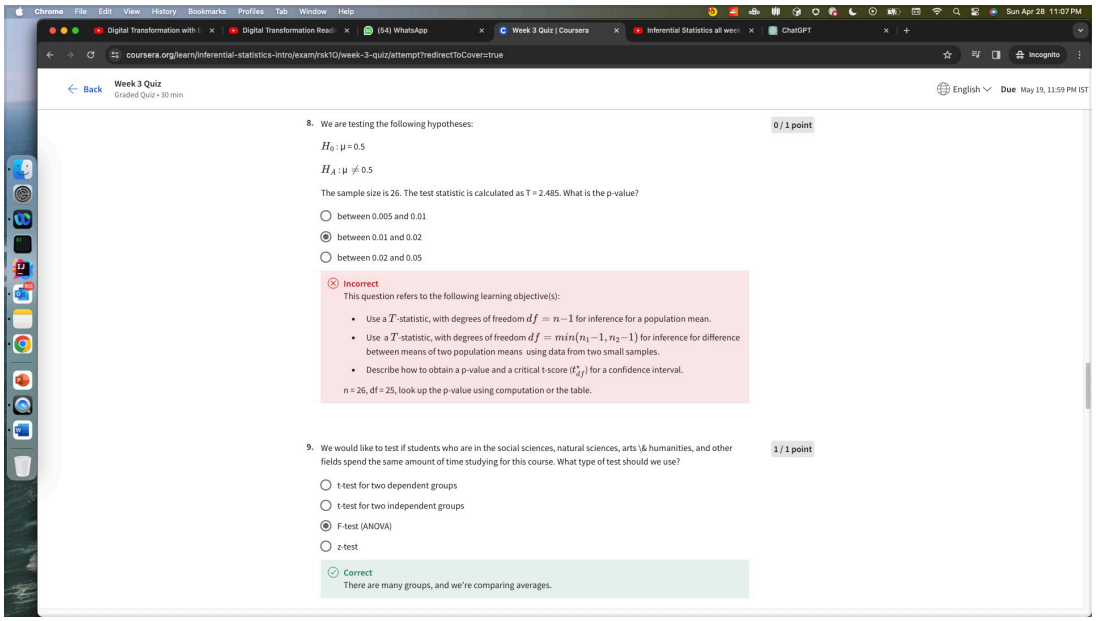
The sample size is 26. The test statistic is calculated as T = 2.485. What is the p-value?

- ○ between 0.005 and 0.01
- ○ between 0.02 and 0.05
- ◉ between 0.01 and 0.02

⊗ **Incorrect**
This question refers to the following learning objective(s):

- Use a T-statistic, with degrees of freedom $df = n-1$ for inference for a population mean.
- Use a T-statistic, with degrees of freedom $df = min(n_1-1, n_2-1)$ for inference for difference between means of two population means using data from two small samples.
- Describe how to obtain a p-value and a critical t-score ($t^{\star}_{df}$) for a confidence interval.

n = 26, df = 25, look up the p-value using computation or the table.



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- between 0.005 and 0.01
- between 0.01 and 0.02
- between 0.02 and 0.05

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This question refers to the following learning objective(s):

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- Use a T-statistic, with degrees of freedom $df = min(n_1-1, n_2-1)$ for inference for difference between means of two population means using data from two small samples.
- Describe how to obtain a p-value and a critical t-score (t^*_{df}) for a confidence interval.

n = 26, df = 25, look up the p-value using computation or the table.

9. We would like to test if students who are in the social sciences, natural sciences, arts \& humanities, and other fields spend the same amount of time studying for this course. What type of test should we use? 1 / 1 point

- F-test (ANOVA)
- t-test for two independent groups
- z-test
- t-test for two dependent groups

Correct
There are many groups, and we're comparing averages.

9. We would like to test if students who are in the social sciences, natural sciences, arts \& humanities, and other fields spend the same amount of time studying for this course. What type of test should we use? 1 / 1 point

- F-test (ANOVA)
- t-test for two independent groups
- z-test
- t-test for two dependent groups

Correct
There are many groups, and we're comparing averages.

10. Which of the following is **not** a condition required for comparing means across multiple groups using ANOVA? 1 / 1 point

- There should be at least 10 successes and 10 failures.
- The data within each group should be nearly normal.
- The variability across the groups should be about equal.
- The observations should be independent within and across groups.

Correct
This question refers to the following learning objective(s):

List the conditions necessary for performing ANOVA

- the observations should be independent within and across groups
- the data within each group are nearly normal
- the variability across the groups is about equal

and use graphical diagnostics to check if these conditions are met.

Success-failure condition is relevant for categorical variables.

11. Based on the ANOVA output below, what is the value of the F-statistic? Choose the closest answer.

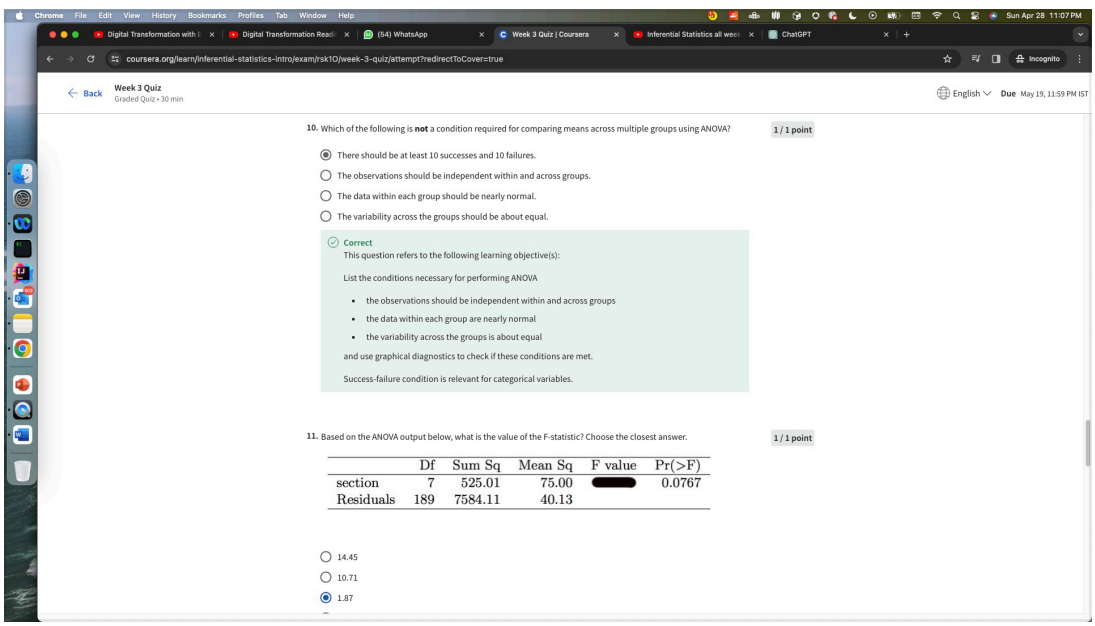
	Df	Sum Sq	Mean Sq	F value	Pr(>F)
section	7	525.01	75.00	[redacted]	0.0767
Residuals	189	7584.11	40.13		

- ○ 27.00
- ○ 10.71
- ◉ 1.87
- ○ 14.45
- ○ 0.54

Correct

This question refers to the following learning objective(s): Recognize that the test statistic for ANOVA, the F statistic, is calculated as the ratio of the mean square between groups (MSG, variability between groups) and mean square error (MSE, variability within errors). Also recognize that the F statistic has a right skewed distribution with two different measures of degrees of freedom: one for the numerator ($df_G = k - 1$, where k is the number of groups), and one for the denominator ($df_E = n - k$, where n is the total sample size).

The F statistic is calculated as the ratio of the mean square between groups (MSG, variability between groups) and mean square error (MSE, variability within errors): 75/40.13=1.87



12. A study compared five different methods for teaching descriptive statistics. The five methods were traditional lecture and discussion, programmed textbook instruction, programmed text with lectures, computer instruction, and computer instruction with lectures. 45 students were randomly assigned, 9 to each method. After completing the course, students took a 1-hour exam. We are interested in finding out if the average test scores are different for the different teaching methods. Which of the following is the appropriate set of hypotheses?

- ○ $H_0 : s_{between} = s_{within}$

  $H_A : s_{between} \neq s_{within}$
- ◉ $H_0 : \mu_{between} = \mu_{within}$

  $H_A : \mu_{between} \neq \mu_{within}$
- ○ $H_0 : \mu_{between} \neq \mu_{within}$

  $H_A : \sigma_{between} \neq \sigma_{within}$
- ○ $H_0 : \mu_1 = \mu_2 = \mu_3 = \mu_4 = \mu_5$

  $H_A : \mu_1 \neq \mu_1 \neq \mu_2 \neq \mu_3 \neq \mu_4 \neq \mu_5$
- ○ $H_0 : \mu_1 = \mu_2 = \mu_3 = \mu_4 = \mu_5$

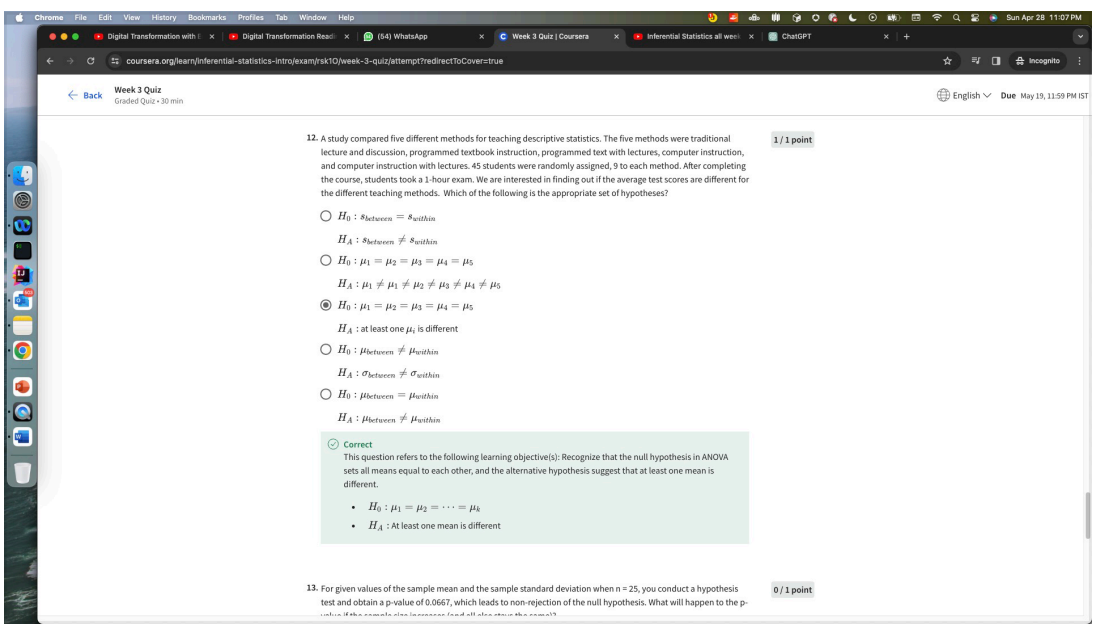
  H_A : at least one μ_i is different

⊗ **Incorrect**

This question refers to the following learning objective(s): Recognize that the null hypothesis in ANOVA sets all means equal to each other, and the alternative hypothesis suggest that at least one mean is different.

- $H_0 : \mu_1 = \mu_2 = \cdots = \mu_k$
- H_A : At least one mean is different

There is no such thing as $\mu_{between}$ and μ_{within}, it is true that in ANOVA we compare the variability between and within groups, but the hypotheses are about the group means.



13. Researchers studying people's sense of smell devised a measure of smelling ability. A higher score on this scale means the subject can smell better. A random sample of 36 people (18 male and 18 female) were involved in the study. The average score for the males was 10 with a standard deviation of 3.4 and the average score for the females was 11 with a standard deviation of 2.7. Which of the following is the correct standard error for the test evaluating whether the males and females have differing smelling abilities, on average? Choose the closest answer.

- ○ 3.504
- ○ 0.801
- ○ 1.047
- ◉ 1.023
- ○ 0.724

Correct

This question refers to the following learning objective(s):

- Use a t-statistic, with degrees of freedom $df = n-1$ for inference for a population mean:

$$\text{CI: } \bar{x} \pm t^{\star}_{df} SE \qquad \text{HT: } T_{df} = \frac{\bar{x} - \mu}{SE}$$

where $SE = \frac{s}{\sqrt{n}}$.

- Use a t-statistic, with degrees of freedom $df = n_{diff}-1$ for inference for the difference in two paired (dependent) means:

$$\text{CI: } \bar{x}_{diff} \pm t^{\star}_{df} SE \qquad \text{HT: } T_{df} = \frac{\bar{x}_{diff} - \mu_{diff}}{SE}$$

where $SE = \frac{s}{\sqrt{n}}$. Note that μ_{diff} is often 0, since often $H_0 : \mu_{diff} = 0$

$SE = \sqrt{\frac{3.4^2}{18} + \frac{2.7^2}{18}}$

4. A study compared five different methods for teaching descriptive statistics. The five methods were traditional lecture and discussion, programmed textbook instruction, programmed text with lectures computer instruction, and computer instruction with lectures. 45 students were randomly assigned, 9 to each method. After completing the course, students took a 1-hour exam. We are interested in finding out if the average test scores are different for the different teaching methods.

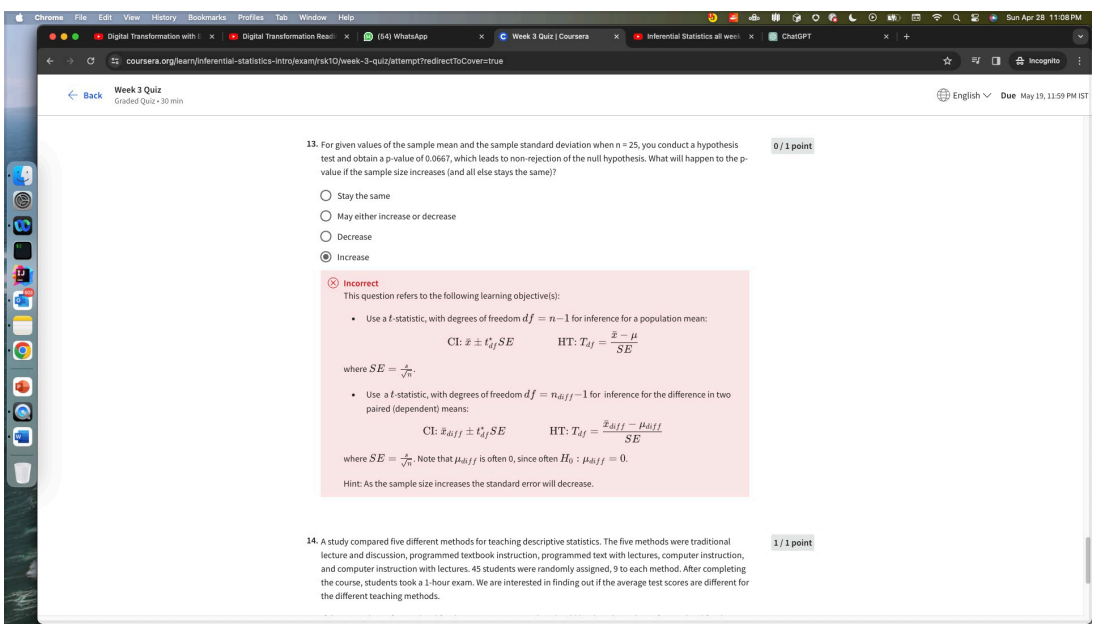
How many pairwise tests would we need to do in order to compare all pairs of means to each other?

- ○ 20
- ○ 3
- ○ 5
- ◉ 10
- ○ 4

Correct

This question refers to the following learning objective(s): Describe why conducting many t-tests for differences between each pair of means leads to an increased Type 1 Error rate, and we use a corrected significance level (Bonferroni correction, $\alpha^\star = \alpha/K$, where K is the number of comparisons being considered) to combat inflating this error rate.

- Note that $K = \frac{k(k-1)}{2}$, where k is the number of groups.



CI: $\bar{x}_{diff} \pm t^*_{df} SE$ HT: $T_{df} = \frac{\bar{x}_{diff} - \mu_{diff}}{SE}$

where $SE = \frac{s}{\sqrt{n}}$. Note that μ_{diff} is often 0, since often $H_0 : \mu_{diff} = 0$.

Hint: As the sample size increases the standard error will decrease.

14. A study compared five different methods for teaching descriptive statistics. The five methods were traditional lecture and discussion, programmed textbook instruction, programmed text with lectures, computer instruction, and computer instruction with lectures. 45 students were randomly assigned, 9 to each method. After completing the course, students took a 1-hour exam. We are interested in finding out if the average test scores are different for the different teaching methods.

1 / 1 point

If the original significance level for the ANOVA was 0.05, what should be the adjusted significance level for the pairwise tests to compare all pairs of means to each other?

- ○ 0.5
- ◉ 0.005
- ○ 0.05
- ○ 0.25
- ○ 0.01

Correct

This question refers to the following learning objective(s): Describe why conducting many t-tests for differences between each pair of means leads to an increased Type 1 Error rate, and we use a corrected significance level (Bonferroni correction, $\alpha^* = \alpha / K$, where K is the number of comparisons being considered) to combat inflating this error rate.

- Note that $K = \frac{k(k-1)}{2}$, where k is the number of groups.

$K = \frac{5x4}{2}$, $\alpha^* = 0.05/10 = 0.005$