STAT 110
Final Exam Practice Questions
Spring 2016

True/False Questions:

1. The t-test is *never* valid if the sample size is small, say less than 30. (TRUE OR FALSE)

2. The results of an observational study indicate that people who use vitamin supplements get fewer colds than people who don't. However, we can't conclude that vitamin supplements prevent colds because this type of study does not allow us to infer causation. (TRUE OR FALSE)

3. A survey was administered to a random sample of college students. Both males and females were surveyed, and one question asked was "How much are you willing to spend on a stereo system (in dollars)?" An analysis was carried out to see if the average price students were willing to spend differs across gender. The 95% confidence interval for the true difference in means is given by $\mathbf{100.86 \leq \mu_{male} - \mu_{female} \leq 386.62}$. Identify whether the following statements about this interval are correct by circling whether the statement is true or false.

   a. We are 95% certain that, on average, college students are willing to spend between $100.86 and $386.62 on a stereo system. (TRUE OR FALSE)
   b. The study provides statistical evidence that males are willing to spend more on a stereo system than females. (TRUE OR FALSE)
   c. The study provides evidence that 95% of all college students spend between $100.86 and $386.62 on a stereo system. (TRUE OR FALSE)
   d. We have evidence that 95% of males are willing to spend more on a stereo system than females. (TRUE OR FALSE)

4. It is possible for the standard deviation to be less than zero. (TRUE OR FALSE)

5. An observation that is close to the mean has a Z-score that is close to zero. (TRUE OR FALSE)

6. An observation that has a Z-score of 1 can be classified as a potential outlier. (TRUE OR FALSE)

7. A study of malignant breast tumors was conducted at the University of Wisconsin-Madison. A sample of malignant tumor cells was examined under an electron microscope, and researchers measured the cell radius of each. They then obtained a 95% confidence interval for the true mean radius of malignant cells, which is given by $17.03 \leq \mu \leq 17.90$. Identify whether the following statements about this interval are correct by circling whether the statement is true or false.

   a. We are 95% certain that the true average radius for malignant breast tumor cells is between 17.03 and 17.90. (TRUE OR FALSE)

   b. We are 95% certain that the true average radius for *all* (including benign) breast tumor cells is between 17.03 and 17.90. (TRUE OR FALSE)

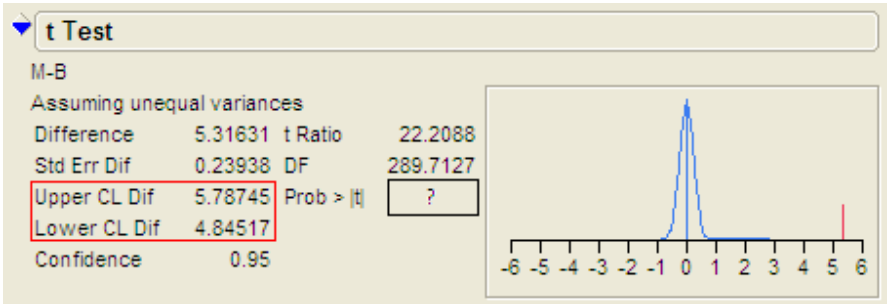
   c. We are 95% certain that the average radius for malignant breast tumor cells *in our sample* is between 17.03 and 17.90. (TRUE OR FALSE)

Multiple Choice Questions:

8. Consider the previous problem. The p-value for testing whether the true mean radius of malignant breast tumor cells is different from 15 is

a. Less than .05, since the 95% confidence interval does not include zero.
b. Less than .05, since the 95% confidence interval does not include 15.
c. Greater than .05, since the 95% confidence interval does not include 15.
d. Greater than .05, since the 95% confidence interval does not include zero.
e. It is impossible to tell.

9. Suppose that the researchers at the University of Wisconsin-Madison also sampled benign breast tumor cells, and an analysis was carried out to compare the average cell radius of benign tumor cells to that of malignant tumor cells. A portion of the output from this analysis is shown below.



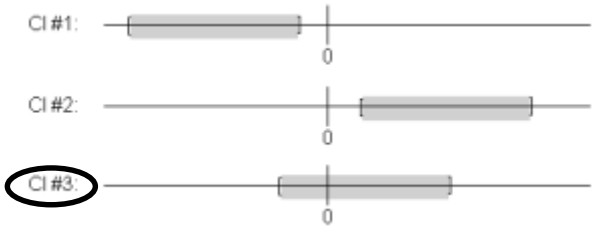
Note that the 95% confidence interval for the difference in means is given by $\mathbf{4.85 \le \mu_{malignant} - \mu_{benign} \le 5.79}$. Also, the two-tailed p-value for testing for a difference in means is not shown in the output. This p-value is

a. Greater than .05, since the 95% confidence interval does not include zero.
b. Less than .05, since the 95% confidence interval does not include zero.
c. It is impossible to tell.

10. A psychology experiment was conducted in which two samples of female students participated. One sample consisted of 11 students known to suffer from bulimia; the other sample consisted of 14 students with normal eating habits. Each student completed a questionnaire from which a "fear of negative evaluation" (FNE) score was produced (the higher the score, the greater the fear of negative evaluation). The assumptions for the two sample t-test were met, and the test for whether the bulimics had a higher FNE score resulted in a p-value of .0443. Which of the following statements is CORRECT?

a. Without a doubt, bulimics have a higher fear of negative evaluation (FNE) score than do students with normal eating habits.
b. There is evidence that having bulimia causes one's fear of negative evaluation (FNE) score to increase.
c. There is evidence that bulimics tend to have a higher FNE score; however, we cannot say that having bulimia causes the FNE score to increase.
d. The sample sizes are too small to draw a valid conclusion.

11. Suppose that from the bulimia study mentioned in the previous problem, we observed from our sample that the average FNE score for bulimics in the study was 17.8 while the average FNE score for those with normal eating habits was 14. The p-value for testing whether the mean FNE score was different for bulimics versus students with normal eating habits was .0886. Identify (by circling the label) which of the following 95% confidence intervals is most likely correct for $\mu_{\text{bulimic}} - \mu_{\text{normal eating habits}}$.



12. An industrial plant claims to discharge no more than 1000 gallons of wastewater per hour, on average, into a neighboring lake. An environmental action group decides to monitor the plant, and they are trying to find evidence that this limit is being exceeded. A random sample of 10 hours is selected over a period of a week. Suppose that the data are normally distributed, and the test gives a p-value of .0324. Which of the following is the most correctly written conclusion?

a. We have evidence that the limit is exceeded.
b. We have evidence that the limit is NOT exceeded.
c. Without a doubt, more than 1000 gallons of wastewater per hour is discharged, on average.
d. The sample size is too small to draw a valid conclusion.

Questions 13-15 concern the following scenario. Suppose that a teacher carried out an experiment to compare two teaching methods (traditional vs. experimental). The teacher wanted to show that standardized test scores were higher for those students in the experimental classroom.

13. What is the null hypothesis that would be used to test this result?

a. The traditional teaching method is more effective.
b. The experimental teaching method is more effective.
c. The traditional and experimental methods are equally effective.

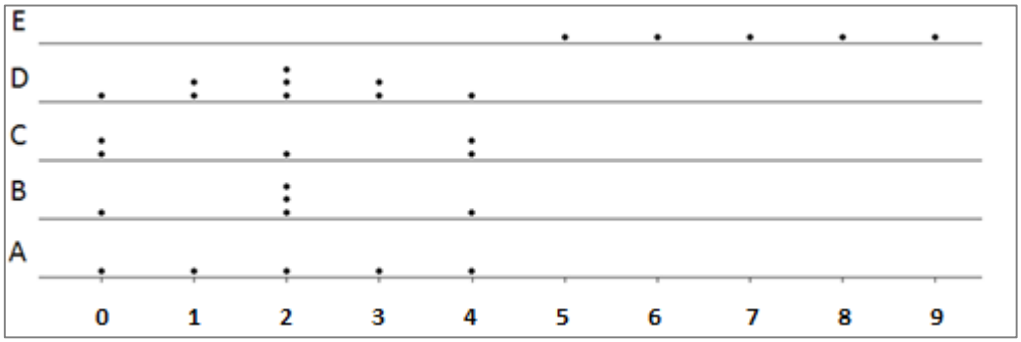
14. Suppose the teacher obtained a p-value of .02 from this study. Which of the following conclusions is most correct?

a. There is no evidence that the experimental approach is more effective since the p-value is less than .05.
b. There is evidence that the approaches are equally effective since the p-value is less than .05.
c. There is evidence that the experimental approach is more effective because the p-value is less than .05.

15. Which of the following interpretations of the p-value is correct? Recall that the p-value is .02, or 2%.

a. There is a 98% chance that the experimental method is more effective than the traditional method.
b. There is a 2% chance that the traditional method is more effective than the experimental method.
c. There is a 2% chance of obtaining a result as extreme as was actually found in the study, assuming the two teaching methods are equally effective.

For Questions 16 -18, consider the following data sets. Note that you should NOT need to use formulas to answer these questions.



16. Circle the most correct answer below.

a. The range of data set E is the largest since it consists of the highest values.
b. The range of all data sets is the same.
c. The range of data set C is largest since it has two values at its minimum and two values at its maximum.
d. None of the above is a correct statement.

17. Circle the most correct answer below.

a. The standard deviations of data sets B and D are the same.
b. The standard deviations of data sets B and C are the same.
c. The standard deviations of data sets A and E are the same.
d. None of the above is a correct statement.

18. Circle the most correct answer below.

a. Data set B has a larger standard deviation that Data Set A.
b. Data set B has a larger standard deviation than Data Set C.
c. Data set A has a larger standard deviation than Data Set C.
d. None of the above is a correct statement.

19. Suppose the average score on an exam is 78 with a standard deviation of 5. If the professor realizes that a question was unfair and decides to give every student three points back (i.e., each score is increased by 3 points), what are the new mean and standard deviation?

a. mean = 78, standard deviation = 5
b. mean = 78, standard deviation = 8
c. mean = 81, standard deviation = 5
d. mean = 81, standard deviation = 8

Short Answer Questions:

20. Recall the study which was conducted to identify potential risk factors for low birth weight. A random sample of new mothers was taken, and the birth weight of their child was recorded. Several categorical variables were measured for mother (for example, we examined smoking status in class); here, we will focus on whether or not the mother was hypertensive during pregnancy. There were 13 hypertensive mothers (high) and 173 non-hypertensive mothers (normal) in the study.

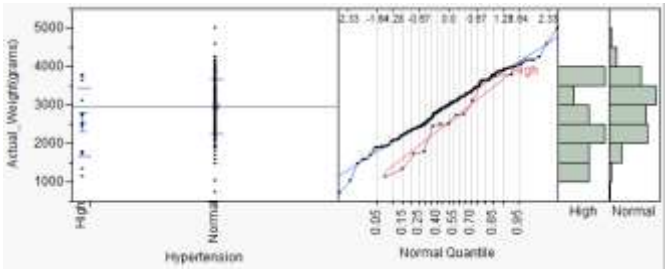
a. Is there evidence that the average birth weight is smaller for those mothers who are hypertensive during pregnancy? Carry out a formal hypothesis test to answer this research question. Note that Hypertension=High for mothers who were hypertensive.

Check the assumptions behind the test.

1. Are the two groups independent? Why or why not?

   Yes - The observations in the two groups aren't paired in any natural way.

2. Are both sample sizes sufficiently large? If not, is it reasonable to assume that both populations are normally distributed? Justify your answer.



Even though the number of subjects in the "High" group is small, the data are approximately normally distributed. So, the two-sample t-test is valid.

Convert the research question into H_0 and H_a.

H_0: $\mu_{normal} = \mu_{high}$

H_a : $\mu_{normal} > \mu_{high}$

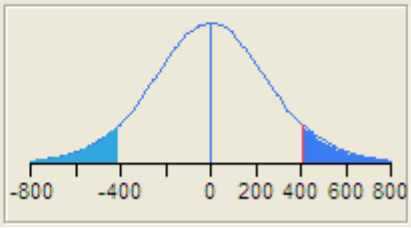
Determine the p-value and make a decision regarding H_0.

t Test

Normal-High

Assuming unequal variances

Difference	412.28	t Ratio	1.649423
Std Err Dif	249.95	DF	13.21029
Upper CL Dif	951.39	Prob > |t|	0.1226
Lower CL Dif	-126.84	Prob > t	0.0613
Confidence	0.95	Prob < t	0.9387



p-value: **.0613**

Write a conclusion in terms of the original research question.

Technically, the study does not provide enough evidence to support the research question because the p-value is not below .05. However, because the p-value is close to falling below .05, you may argue that the study provides marginal evidence that the average birth weight is smaller for those mothers who are hypertensive during pregnancy than for those with normal blood pressure.

b. Give a 95% confidence interval for $\mu_{Normal} - \mu_{High}$. You can use the appropriate JMP output.

Lower endpoint = **-126.84**

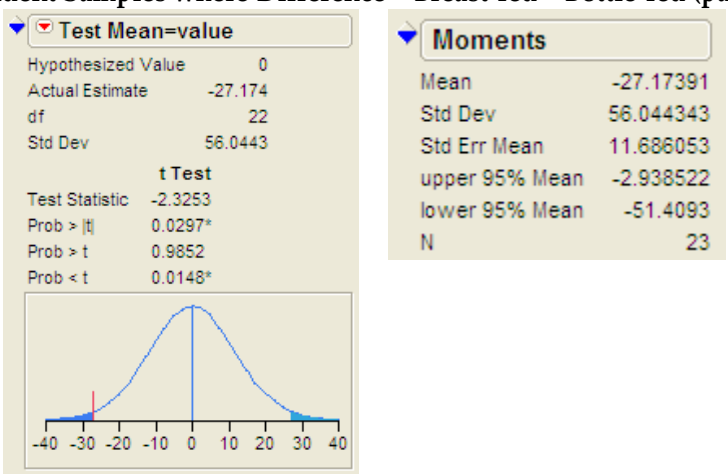
Upper endpoint = **951.39**

c. Interpret the confidence interval from part b in the context of the problem.

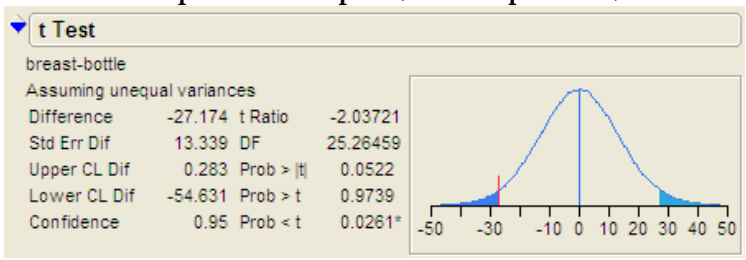
We are 95% certain that the true difference in mean birth weight between the "high" and "normal" groups lies between -126.84 and 951.39. Since this interval includes zero, it is plausible that the difference could be zero (which means there is no evidence the means differ between groups).

21. A common symptom of otitus media (ear infection) in young children is the prolonged presence of fluid in the middle ear, known as a middle-ear effusion. The presence of fluid may result in temporary hearing loss and interfere with normal learning skills in the first two years of life. One hypothesis is that babies who are breast-fed for at least 1 month build up some immunity against the effects of the disease and have less prolonged effusion than do bottle-fed babies. A small study of 24 pairs of babies is set up, where the babies are matched on a one-to-one basis according to age, sex, socioeconomic status, and type of medications taken. One member of the matched pair is a breast-fed baby, and other member is a bottle-fed baby. The outcome variable is the duration of middle-ear effusion after the first episode of otitus media. The data were analyzed in JMP in two different ways:

Dependent Samples where Difference = Breast-fed – Bottle-fed (paired t-test)



Independent Samples (two-sample t-test)



a. Which of these analyses is appropriate for these data—Dependent (paired t-test) or Independent Samples (two-sample t-test)? Explain your reasoning.

Dependent (paired) – the subjects are paired according to variables selected by the researchers

b. Use the correct JMP output to find the 95% confidence interval for $\mu_{\text{breast-fed}} - \mu_{\text{bottle-fed}}$.

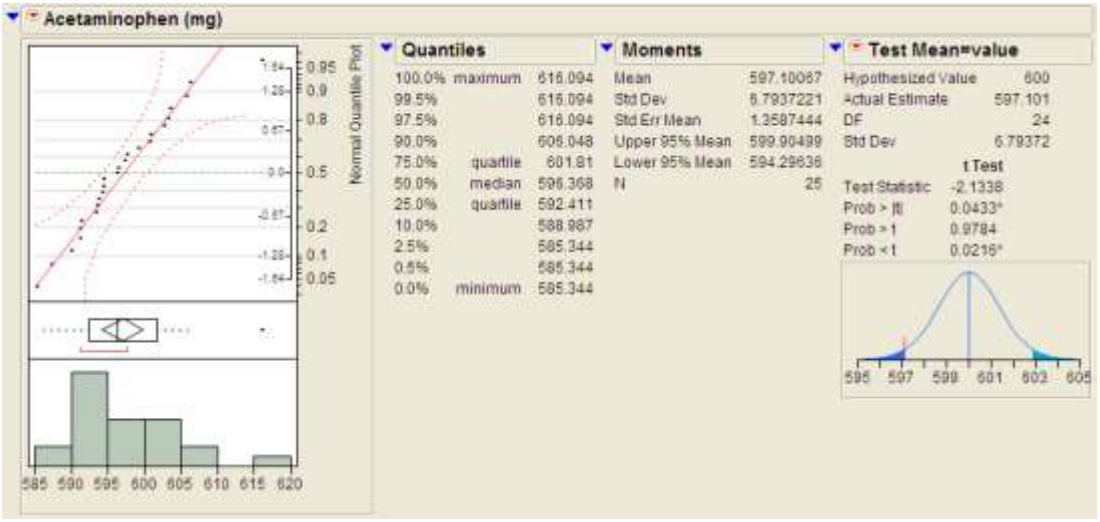
Lower endpoint = **-51.4**

Upper endpoint = **-2.9**

c. Do we have enough evidence to conclude that there is a difference in the duration of middle-ear effusion for the breast-fed versus the bottle-fed babies? Explain.

Yes. The confidence interval does not include zero, which provides evidence for a difference between the two groups. You could also state that the two groups differ because p-value = .0297.

22. Acetaminophen is an active ingredient found in many over-the-counter and prescription medicines, such as pain relievers and cold medications. It is safe and effective when used correctly, but taking too much can lead to liver damage. A researcher hypothesizes the mean amount of acetaminophen in a particular brand of cold tablets is greater than the 600 mg claimed by the manufacturer. A random sample of 25 tablets was taken, and the data were analyzed in JMP as follows.



Research question: Is the mean amount of acetaminophen greater than 600 mg?

a. Explain why the t-test can be used for these data to test a claim about the population mean (i.e., check the assumptions behind the t-test).

Even though the sample size is fairly small, the distribution is approximately normally distributed. So, the t-test is valid.

b. Set up the null and alternative hypotheses to test the research question of interest.

H_o: **$\mu = 600$**
H_a: **$\mu > 600$**

c. Find the p-value for testing the research question of interest. **p-value = .9784**

d. Write a conclusion in the context of the problem. **The study does not provide evidence that the mean is greater than 600 mg. In fact, the study provides evidence that the mean is *less* than 600 mg.**