Stat 301 Spring 2019 Exam 2 practice problems

These questions are all taken from previous semesters' exams. For the exam you may use a calculator and a 4x6 index card of your own notes (back and front). It is ***strongly advised*** *that you attempt to solve these problems on your own before looking at the solutions. This is the most effective means of testing your own understanding prior to the exam.*

1. A researcher studying hormonal changes in male dogs is investigating the effect of neutering on aggression. Before embarking on a large study, she decides to conduct a small "pilot" study involving n = 7 dogs. Each dog is observed interacting with other dogs for one hour on both the day before the neutering operation, and three weeks after the operation. During each one hour observation period, an observer records how many "aggressive acts" the dog engages in. The results are given in the table below:

	Mean	Standard deviation
# of aggressive acts before	5.1	3.7
# of aggressive acts after	3.1	4.1
Paired differences (before - after)	2.0	3.4

a. The t-critical value for 95% confidence and df = 6 is 2.45. Construct a 95% confidence interval for the mean # of aggressive acts before neutering.

b. Construct a 95% confidence interval for the population mean paired difference in # of "aggressive acts" before neutering vs. after neutering.

c. If we were to conduct a two-tailed hypothesis test at $\alpha = 0.05$ testing against the null hypothesis of "no difference", would we reject or fail to reject H_0? Briefly justify your answer.

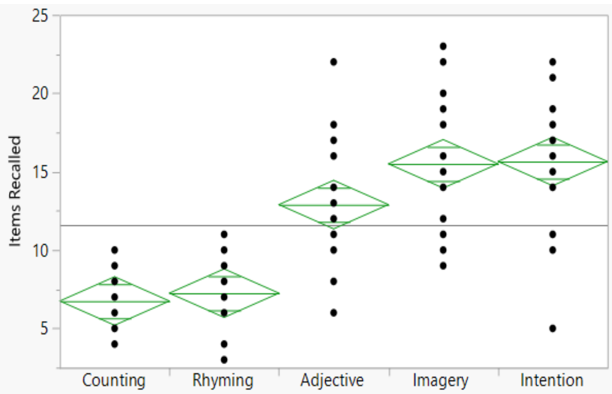
d. Calculate the t-test statistic that tests against $H_0: \mu_d = 0$

e. Calculate the standard deviation of the sampling distribution of $\bar{X}_d$.

2. A memory study was performed in which participants were randomly assigned to one of five groups. Each participant was shown a list of 25 words. The groups were differentiated as follows:

- Subjects in the "Counting" group were asked to count the letters in each word.
- Subjects in the "Rhyming group" were asked to think of words that rhymed with the words on their list.
- Subjects in the "Adjective" group were asked to come up with adjectives to modify their words.
- Subjects in the "Imagery" group were asked to form vivid mental images of their words
- Subjects in the "Intention" group were instructed to memorize each word

After the word tasks and a short waiting period, subjects were asked to write down as many words off their list as they could remember. The goal of the statistical analysis was to investigate whether there were significant differences across groups in average number of words memorized. JMP output of the analysis is below:



Analysis of Variance

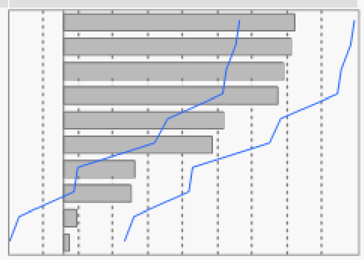
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Recall Condition	4	1514.9400	378.735	31.2095	<.0001*
Error	95	1152.8500	12.135		
C. Total	99	2667.7900			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
Counting	20	6.7500	0.77895	5.204	8.296
Rhyming	20	7.2500	0.77895	5.704	8.796
Adjective	20	12.9000	0.77895	11.354	14.446
Imagery	20	15.5000	0.77895	13.954	17.046
Intention	20	15.6500	0.77895	14.104	17.196

Ordered Differences Report

Level	- Level	Difference	Std Err Dif	Lower CL	Upper CL	p-Value
Intention	Counting	8.900000	1.101602	6.71304	11.08696	<.0001*
Imagery	Counting	8.750000	1.101602	6.56304	10.93696	<.0001*
Intention	Rhyming	8.400000	1.101602	6.21304	10.58696	<.0001*
Imagery	Rhyming	8.250000	1.101602	6.06304	10.43696	<.0001*
Adjective	Counting	6.150000	1.101602	3.96304	8.33696	<.0001*
Adjective	Rhyming	5.650000	1.101602	3.46304	7.83696	<.0001*
Intention	Adjective	2.750000	1.101602	0.56304	4.93696	0.0143*
Imagery	Adjective	2.600000	1.101602	0.41304	4.78696	0.0203*
Rhyming	Counting	0.500000	1.101602	-1.68696	2.68696	0.6509
Intention	Imagery	0.150000	1.101602	-2.03696	2.33696	0.8920



The questions a. through f. on this page and the next page refer to this study.

a. Write out the null and alternative hypotheses for the ANOVA F-test

b. Should the null hypothesis for the ANOVA F-test be rejected? Briefly explain why or why not.

c. What does the value 12.135 from the ANOVA table quantify, conceptually?

d. Write down in detail how JMP computed the value 1514.94.85 in the ANOVA table. Your answer should make it clear exactly what someone would have to enter into a calculator in order to obtain 1514.94. (**3 points**)

e. Which group means are significantly different from the "Adjective" group mean if we perform a Bonferroni multiple comparison correction? Briefly justify your answer, and show your work. (**3 points**)

f. The research hypothesis was that participants in the "Counting" and "Rhyming" groups remember fewer words, on average, than the people in the "Adjective", "Imagery", and "Intention groups. Is there good statistical evidence to support this hypothesis? Briefly explain your answer. (**2 points**)

3. What undesirable outcome does the Bonferroni correction attempt to "correct"?

4.

5. A study was done in which female Beagles who had given birth to stillborn pups were compared to female Beagles who had not given birth to stillborn pups. One question of interest was whether Beagles who had stillborn pups tended to be older than those who hadn't. Here is JMP output obtained using "Fit Y by X", where the response variable is age and the factor (i.e. group) variable is whether the Beagle gave birth to any stillborn pups:

Means and Std Deviations

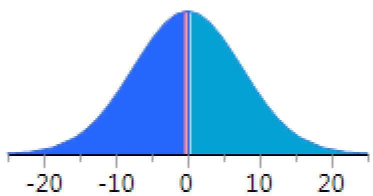
Level	Number	Mean	Std Dev	Std Err Mean	Lower 95%	Upper 95%
No	978	200.404	113.697	3.6356	193.27	207.54
Yes	366	199.972	125.668	6.5688	187.05	212.89

t Test

Yes-No

Assuming unequal variances

Difference	-0.432	t Ratio	-0.05757
Std Err Dif	7.508	DF	601.7783
Upper CL Dif	14.312	Prob > |t|	0.9541
Lower CL Dif	-15.177	Prob > t	0.5229
Confidence	0.95	Prob < t	0.4771



a. What is the value of the 95% confidence interval for $\mu_{Yes} - \mu_{No}$?

b. What is the value of the test statistic that tests $H_0: \mu_{Yes} - \mu_{No} = 0$?

c. What is the two-sided p-value that tests $H_0: \mu_{Yes} - \mu_{No} = 0$?

d. Is the mean age of Beagles who did have stillborn pups significantly different from the mean age of Beagles who did not have stillborn pups? Briefly justify your answer.

6.

7.

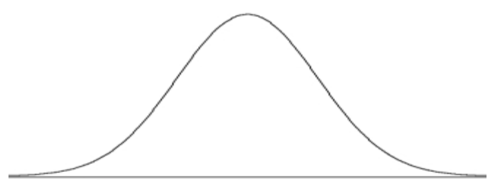
8.

9. Suppose we collect data on two groups that we want to compare to each other. We compute the sample means for both groups and find that the sample means are not equal to each other. What purpose does conducting a hypothesis test serve? Why not just announce that the means are different and leave it at that?

10. Suppose we conduct a hypothesis test with the following null and alternative pair:

H_0: $\mu_1 - \mu_2 = 0$
H_A: $\mu_1 - \mu_2 < 0$

a. After collecting our data and running our analysis, we compute a p-value of 0.45. On the curve below, shade the region that represents this p-value:



b. Make up a plausible value for the test statistic that produced the p-value of 0.45

c. Make up a plausible 95% confidence interval for $\mu_1 - \mu_2$.

d. Does the result of this test suggest that $\mu_1 = \mu_2$? Explain why or why not.

11. The test statistics that we have computed follow known sampling distributions (either t or F). Why are these referred to as "sampling distributions", rather than just "distributions"?

12. Suppose we do a t-test for $H_0: \mu_1 - \mu_2 = 0$, and we compute t = 1.3 and two-sided p-value = 0.204. For each of the scenarios below, state whether the p-value would get bigger, get smaller, or stay the same. (**1 point each**)

a. $\bar{x}_1 - \bar{x}_2$ gets smaller

b. Standard error of $\bar{x}_1 - \bar{x}_2$ gets smaller

c. T-test statistic gets smaller

d. p-value is calculated as right sided rather than two sided

13. The box on the right contains test statistics. Each test statistic corresponds to one of the p-values on the left. Each p-value is two-sided. For each p-value, write down its corresponding test statistic. (**1 point each**)

a. $p = 0.075$	$t =$
b. $p = 0.0013$	$t =$
c. $p = 0.15$	$t =$
d. $p = 0.00003$	$t =$
e. $p = 0.49$	$t =$

test statistic
$t = 1.45$
$t = -1.80$
$t = -4.40$
$t = 3.30$
$t = 0.70$

14. In class we learned that a hypothesis test for a difference in means can be performed by checking to see whether or not zero is contained within the 95% CI for the difference in means. Explain the reasoning behind this method: why does zero being inside or outside the confidence interval tell us if we should reject or fail to reject the null hypothesis?

15. Suppose we compute p-value = 0.14. Would it be correct to say that there's a 14% chance that the null hypothesis is true? Why or why not?