Exam 4 - STAT 303 Session 201

Summer 2009

Name:

UIN:

Signature:

1. Do not open this test until told to do so.
2. Turn in your exam with your answers circled when you are done with the exam. You should not take the exam with you.
3. This is a closed book examination. You may use fix both-sided sheet of formulas that you have brought with you. You should have no other printed or written material with you on the exam. Do not print out the handout as your cheating paper. (I will look everybody's cheating paper.)
4. You have 90 minutes to work on this exam. There are 11 multiple choice questions each worth 5 points and 4 work out questions.
5. You may use a calculator but not a phone during the exam.
6. If you are unsure of what a question is asking for, do not hesitate to ask the instructor or course assistant for clarification.
7. Do not sit directly next to another student.
8. Good Luck!!!

1. A researcher is interested in the tensile strength of a synthetic fiber used to make cloth for men's shirts. It is suspected that the strength is affected by the percentage of cotton in the fiber. *Five levels* of cotton percentage are considered, and five observations are taken at each level. The 25(N) experiments are run in random order. The results are as follows.

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	(a)	475.76	(d)	(f)	<.0001
Error	(b)	161.20	(e)		
Total	24	(c)			

Fill up (a) - (g) in ANOVA Table. Write down whole procedure for calculating (a) - (f). Also, find the R^2.(15 points)

- $DF_{MODEL} = 5 - 1 = 4$ (1 point)
- $DF_{ERROR} = 25 - 5 = 20$ (1 point)
- $SS_{TOTAL} = SS_{MODEL} + SS_{ERROR} = 475.76 + 161.20 = 636.96$ (1 point)
- $MS_{MODEL} = SS_{MODEL}/DF_{MODEL} = 475.76/4 = 118.94$ (3 points)
- $MS_{ERROR} = SS_{ERROR}/DF_{ERROR} = 161.20/20 = 8.06$ (3 points)
- $F - STAT = MS_{MODEL}/MS_{ERROR} = 118.94/8.96 = 14.76$ (3 points)

$R^2 = SS_{MODEL}/SS_{TOTAL} = 475.76/636.96 = 0.7469$ (74.69%) (3 points)

2. Which is an appropriate conclusion for Question 1? (TWO ANSWER)

   (a) **P-value in the ANOVA is quite small. Therefore, we reject the null and conclude that the tensile strength is affected by the percentage of cotton in the fiber.**

   (b) P-value in the ANOVA is quite large. Therefore, we fail to reject the null and conclude that the tensile strength is not affected by the percentage of cotton in the fiber.

   (c) P-value in the ANOVA is quite small. Therefore, we fail to reject the null and conclude that the tensile strength is not affected by the percentage of cotton in the fiber.

   (d) P-value in the ANOVA is quite large. Therefore, we reject the null and conclude that the tensile strength is affected by the percentage of cotton in the fiber.

   (e) **Checking assumption for ANOVA is the first step. Before analyzing ANOVA, we need to check the assumption.**

3. A civil engineer wishes to compare the strength properties of three different types of beams. Type A is made of steel, while types B and C are made of two different and more expensive alloys. The

engineer measures the strength of a beam by applying 3000 pounds at the center, and then measuring the deflection. The data follows normal distribution but each group does not have equal variance. Test result are given as follows:

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	627.083	313.541	12.45	0.0003
Error	21	528.750	25.178		
Total	23	1155.833			

Which is an appropriate conclusion?

(a) P-value in the ANOVA is quite small. Therefore, we reject the null and conclude that there exists a difference in strength properties for three types of beams.

(b) P-value in the ANOVA is quite large. Therefore, we do not reject the null and conclude that there is not a difference in strength properties for three types of beams.

(c) **Since an equal variance assumption is violated, we have to be careful in using ANOVA. It is recommendable to try another approach such as transformation of data.**

(d) Since a normality assumption is violated, we have to be careful in using ANOVA. It is recommendable to try another approach such as transformation of data.

4. The data below show Olympic triple jump distances for men in meters for the years 1896 to 1992 (there were no Olympic games in 1916, 1940, 1944).

year	Distance	year	Distance	year	Distance
1896	13.71	1932	15.72	1968	17.39
1900	14.47	1936	16.00	1972	17.35
1908	14.92	1948	15.40	1976	17.29
1912	14.64	1952	16.22	1980	17.35
1920	14.50	1956	16.35	1984	17.25
1924	15.53	1960	16.81	1988	17.61
1928	15.21	1964	16.85	1992	18.17

Using the data, an a researcher tried to fit a simple linear regression between year and jump distance (response variable) as follows;

Parameter	Estimate	Std. Err.	DF	T-Stat	P-Value
Intercept	-62.312	4.664	19	-13.36	<0.0001
Slope	0.040	0.002	19	16.82	<0.0001

What is your conclusion on the research hypothesis that there is not a linear relationship between them?

(a) P-value is quite large so that we do not reject the null. Hence we conclude that there is not a linear relationship between year and jump distance.

(b) P-value is quite large so that we reject the null. Hence we conclude that there is a linear relationship between year and jump distance.

(c) **P-value is quite small so that we reject the null. Hence we conclude that there is a linear relationship between year and jump distance.**

(d) P-value is quite small so that we reject the null. Hence we conclude that there is not a linear relationship between year and jump distance.

5. Select the FALSE statement about alternative hypothesis for several analysis.

(a) The alternative hypothesis for χ^2-square is that there is a relationship that means the variables are not independent.

(b) The alternative hypothesis for ANOVA is that at least one of the means is different from the others.

(c) **The alternative hypothesis for regression analysis is that the coefficient of intercept is not zero.**

(d) The alternative hypothesis for two sample t-test (two-sided) is that the the population mean for group 1 is different from the population mean for group 2.

6. Which one is the FALSE statement?

(a) The chi-square statistic is equal to the square of the z statistic and $\chi^2(1)$ critical values are equal to the squares of the corresponding $N(0,1)$ critical values.

(b) If you add $\chi^2(1)$ n times, it will be $\chi^2(n)$.

(c) The advantage of the z test is that we can test either one-sided or two-sided alternatives.

(d) **For tables larger than 2 $\times$ 2, we will use the χ^2-test whenever the all of the expected cell counts are greater or equal to 5.**

(e) For 2 $\times$ 2 tables, we require that all four expected cell counts be 5 or more.

7. Suppose we have four groups for comparing means. Select the FALSE statement about the assumption of ANOVA?

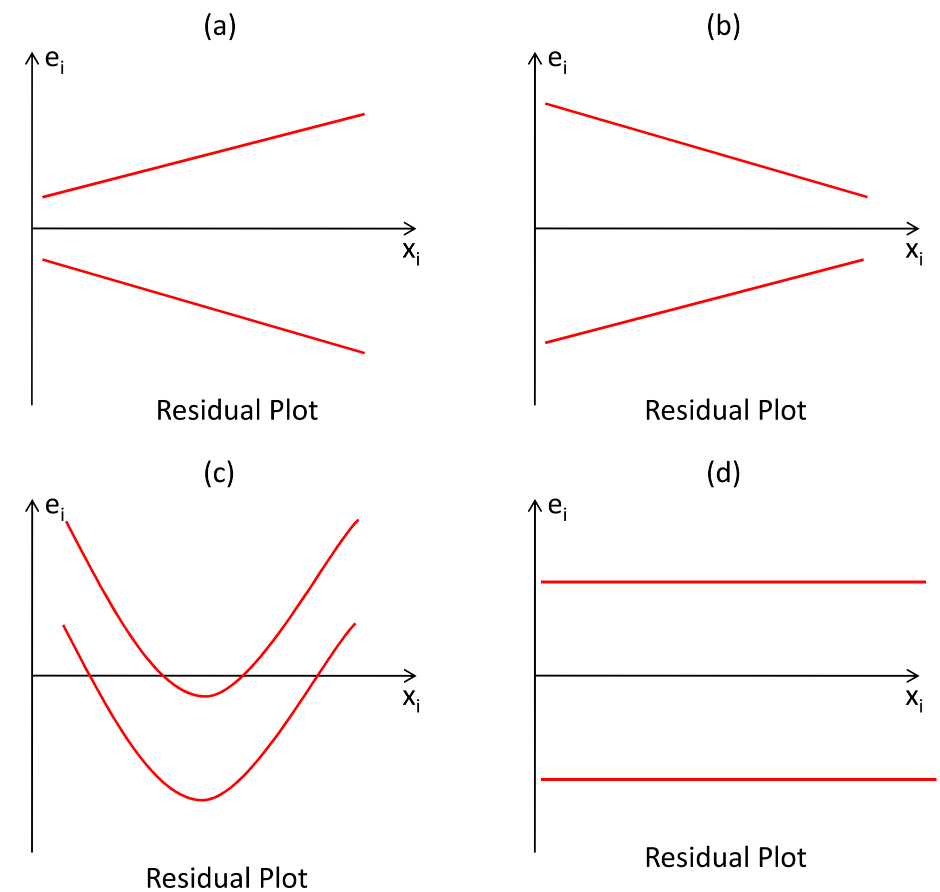
(a) Each of the four population or group distributions is normal.

(b) Each samples from four population or group is a random sample.

(c) Each samples from four population or group is selected independently of one another.

(d) **Each of the four population or group distribution can have different variances.**

8. The following four figures are a graphical representation of residual plots. X-axis implies the x values and Y-axis implies the residuals. Residuals are distributed between the upper red line and the lower red line. Which residual plot is an appropriate one for regression analysis? Answer: (d)



9. Select the FALSE statement in Regression analysis.

(a) When the sample size of regression analysis increase, the confidence band of regression line will decrease.

(b) **The MS_{TOTAL} in ANOVA table can be calculated by the sum of $MS_{Group} + MSE$.**

(c) Mean Square Error (MSE) is the estimates of true population variance.

(d) As the R^2 increase, the Mean Square Error (MSE) decrease.

(e) As the R^2 decrease, the correlation of explanatory variable and response variable will be weaker.

10. Select the FALSE statement.

(a) When the two variables are independent, the χ^2 test statistic is small. (χ^2 test)

(b) As the two categorical variables being tested become more related, the p-value gets smaller. (χ^2 test)

(c) The F-test statistic is exactly 0 if the sample means are all equal. (ANOVA)

(d) The F-test statistic increases as the means spread apart. (ANOVA)

(e) **There is no FALSE statement above.**

11. Consider the following pair of data sets. Which of the following is true? Check ALL that apply.

Data set A

Sample	Mean	Standard Deviation	Sample Size
1	2.5	0.7906	5
2	3.5	0.7906	5
3	2.5	0.7906	5

Data set B

Sample	Mean	Standard Deviation	Sample Size
1	2.5	1.904	5
2	3.5	1.904	5
3	2.5	1.904	5

(a) The value of the test statistic F will be larger for data set A because there is more spread between the means in data set A.

(b) **The value of the test statistic F will be larger for data set A because the standard deviation is smaller in data set A.**

(c) The value of the test statistic F will be larger for data set B because there is more spread between the means in data set B.

(d) The value of the test statistic F will be larger for data set B because the standard deviation is larger in data set B.

(e) **The ANOVA p-value will be smaller for data set A.**

(f) The ANOVA p-value will be smaller for data set B.

12. The study attempted to examine the relationship between exposure to R-Rated movies and smoking habits among adolescents. Smoking in R-rated movies is higher than any other movie-rating category. Therefore, the objective of this study was to determine if an association existed between parental restrictions on movies and adolescent cigarette use.

	Smoking	Non-smoking	Total
Complete Restriction	14	701	715
Partial Restriction	288	2114	2402
No Restriction	499	928	1427
Total	801	3743	4544

The result of χ^2 analysis is following.

Test-Stat	DF	p-Value
469.003	2	.000

What is your conclusion on the research hypothesis?

(a) **We reject the null hypothesis. Therefore, we conclude that the smoking and exposure to R-Rate movies are not independent.**

(b) We reject the null hypothesis. Therefore, we conclude that the smoking and exposure to R-Rate movies are independent.

(c) We fail to reject the null hypothesis. Therefore, we conclude that the smoking and exposure to R-Rate movies are not independent.

(d) We fail to reject the null hypothesis. Therefore, we conclude that the smoking and exposure to R-Rate movies are independent.

(e) We cannot claim our conclusion because we need more information.

13. Shortly after September 11th 2001, a researcher wanted to determine if the proportion of females that favored war with Iraq was significantly different from the proportion of males that favored war with Iraq. In a sample of 60 females, 26 favored war with Iraq. In a sample of 53 males, 34 favored war with Iraq. ($z_{.05} = 1.645$, $z_{.025} = 1.96$, $z_{.01} = 2.326$, and $z_{.005} = 2.5758$.) (10 points)

(a) Construct a hypothesis test using 0.01 level of significance. (6 points)

H_0: $p_1 = p_2$ vs. H_1: $p_1 \neq p_2$. (1.5 points)

$$\hat{p} = \frac{26+34}{60+53} = 0.531$$

$$z = \frac{26/60 - 34/53}{\sqrt{0.531(1-0.531)\left(\frac{1}{60}+\frac{1}{53}\right)}} = -2.21$$

(1.5 points for Test Statistics) Since p-Value $= 2P(Z > |-2.21|) = 0.0269$ (1.5 points), we fail to reject H_0. Then, we can conclude the proportion of females that favored war with Iraq was significantly different from the proportion of males that favored war with Iraq. (1.5 points)

(b) Construct a 99% confidence interval for the difference between the proportion of females that favor the war and the proportion of males that favor the war? (4 points)

$$\hat{p}_1 - \hat{p}_2 \pm Z_{.005}\sqrt{\frac{p_1(1-p_1)}{n_1} + \frac{p_2(1-p_2)}{n_2}} = (-0.445, 0.0283)$$

14. A hospital wishes to justify the benefits of nutrition programs for pregnant women using birth weight data from newborns. The hospital hopes to show that the mean birth weight for newborns from mothers who complete the program is different from the birth weight for newborns from mothers who do not complete the program. A group of 24 pregnant women were randomly divided into two groups; the first group received the nutrition program and the second group did not receive the program. The sample mean and the standard deviation of group 1 are 2600 and 100 and the sample mean and the standard deviation of group 2 are 2500 and 80. (10 points)

(a) Construct 95% and 99% confidence intervals for $\mu_1 - \mu_2$ *with assumption of pooled variance.* (6 points)

Pooled Variance (2 points)

$$S_p^2 = \frac{(n_1-1)S_1^2 + (n_2-1)S_2^2}{n_1+n_2-2} = \frac{(12-1)100^2 + (12-1)80^2}{12+12-2} = 8200$$

95% Confidence Interval (2 points)

$$\bar{X}_1 - \bar{X}_2 \pm t_{.025,22} S_p\sqrt{\frac{1}{n_1} + \frac{1}{n_2}} = 2600 - 2500 \pm 2.074 \cdot 90.553\sqrt{\frac{1}{12} + \frac{1}{12}} = (23.332, 176.668)$$

99% Confidence Interval (2 points)

$$\bar{X}_1 - \bar{X}_2 \pm t_{.005,22} S_p\sqrt{\frac{1}{n_1} + \frac{1}{n_2}} = 2600 - 2500 \pm 2.819 \cdot 90.553\sqrt{\frac{1}{12} + \frac{1}{12}} = (-4.205, 204.205)$$

(b) Conduct the appropriate hypothesis test at the 0.05 and 0.01 level of significance using the confidence interval calculated in (a). Also, state the decision would depend on whether we use a 95% or 99% confidence interval.(4 points)

For 95% confidence interval, we reject the null hypothesis. (1 point)

For 99% confidence interval, we fail to reject the null hypothesis. (1 point)

By confidence level, the decision will be different (2 points)

15. A consumer advocacy group feels that Walmart provides a less safe shopping environment than Target. To try to prove their point, they randomly selected 11 Walmart stores and found the annual number of crime reports filed for these stores. Each of these Walmart stores was then paired with a Target store within a 10 mile radius, and the annual crime reports for the associated Target stores were

also recorded. The sample mean of Walmart is 831.05 and those of Target are 808.05. The standard deviation of difference is 45.06. Test to to see if the mean number of crime incidents at Walmart stores is significantly larger than the mean number of crime incidents at Target stores. The level of significance is 0.05. (6 points)

H_0: $\mu_1 = \mu_2$ vs H_1: $\mu_1 > \mu_2$ (1.5 points)
Test Statistics (1.5 points)

$$t = \frac{(\bar{X}_1 - \bar{X}_2) - (\mu_1 - \mu_2)}{s_{diff}/\sqrt{n}} = \frac{831.05 - 808.05}{45.06/\sqrt{11}} = 1.693$$

with df = 10. Then, p-Value = $P(T > 1.693)$ is between 0.05 and 0.10. (1.5 points) Therefore, we fail to reject H_0 and the mean number of crime incidents at Walmart is not significantly larger than the mean number of crime incidents at Target (1.5 points)

16. If we are very certain that the true standard deviation of the number of defects per screen is below 1, what sample size would be required so that the width of the 99% confidence interval for the mean number of defects per screen is at most 0.20? Make sure you enter a whole number below. ($z_{.05} = 1.645$, $z_{.025} = 1.96$, $z_{.01} = 2.326$, and $z_{.005} = 2.5758$.) (4 points)

The margin of error $m = 0.20/2 = 0.10$. (1 points) Then, the sample size is

$$n = \left[\frac{Z_{\alpha/2}\sigma}{m}\right]^2 = \left[\frac{2.5758 \times 1}{0.1}\right]^2 = 663.47 \approx 664$$

At least 664 samples is needed.