

Problems Section 4B

(#1-10) Use each of the following ANOVA F-test statistics and the corresponding critical values to fill out the table.

	F-test stat	Sentence to explain F-test statistic.	Critical Value	Does the F-test statistic fall in a tail determined by the critical value? (Yes or No)	Does sample data significantly disagree with H_0 ?
1.	+5.573		+2.886		
2.	+1.192		+3.113		
3.	+0.664		+2.949		
4.	+4.415		+3.125		
5.	+3.718		+4.117		
6.	+0.991		+2.009		
7.	+2.652		+1.875		
8.	+1.585		+3.225		
9.	+2.447		+2.798		
10.	+8.133		+2.891		

(#11-20) Use each of the following P-values and corresponding significance levels to fill out the table.

	P-value Proportion	P-value %	Sentence to explain the P-value	Significance Level %	Significance level Proportion	If H_0 is true, could the sample data occur by random chance or is it unlikely?	Reject H_0 or Fail to reject H_0 ?
11.	0.186			10%			
12.	0.0042			1%			
13.	2.59×10^{-4}			5%			
14.	0.006			1%			
15.	0.353			5%			
16.	0			10%			
17.	0.041			5%			
18.	0.274			10%			
19.	1.04×10^{-8}			1%			
20.	0.067			5%			

21. The F-test statistic compares the variance between the groups to the variance within the groups. Explain how the variance between the groups is calculated and what it tells us. Explain how the variance within the groups is calculated and what it tells us. How can we use the variance between and the variance within to calculate the F-test statistic?

22. If the variance between the groups were significantly larger than the variance within, would the F-test statistic be large or small? Explain why.

23. If the variance between the groups were about the same as the variance within, would the F-test statistic be large or small? Explain why.

24. The ANOVA printout involves the degrees of freedom within the groups, the degrees of freedom between the groups and the total degrees of freedom. How are the different degrees of freedom calculated?



(#25-28) Directions: Use the following Statcato statistics, graphs and ANOVA printout to test the population claims. For each of the following problems answer the following.

- Give the null and alternative hypothesis.
- Check the assumptions for a One-Way ANOVA test.
- Write a sentence to explain the F test statistic.
- Use the F test statistic and Critical Value to determine if the sample data significantly disagrees with the null hypothesis. Explain your answer.
- Use the P-value and Significance Level to answer the following: Could the sample data or more extreme have occurred because of sampling variability or is it unlikely that the sample data occurred because of sampling variability? Explain your answer.
- Should we reject the null hypothesis or fail to reject the null hypothesis? Explain your answer.
- Write a conclusion for the hypothesis test addressing evidence and the claim.
- What is the variance between the groups? What is the variance within the groups? Was the variance between significantly higher than the variance within? Explain how you know.
- Was the categorical and quantitative variables related or not. Explain your answer.

25. A random sample of black bears were weighed at various times of the year. Some of the bears were weighed in the spring, some in the summer and some in the fall. The bears were tagged so that the same bear was not measured more than once. Use a 1% significance level and the following Statcato statistics, graphs and ANOVA printout to test the population claim that the time of year (season) is related to the weight of the bears.

One-way ANOVA: Significance level = 0.01

Selected column variables: C1 Spring Bear Weig... C2 Summer Bear Weig... C3 Fall Bear Weight...

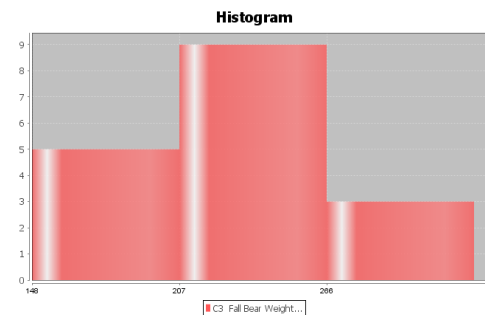
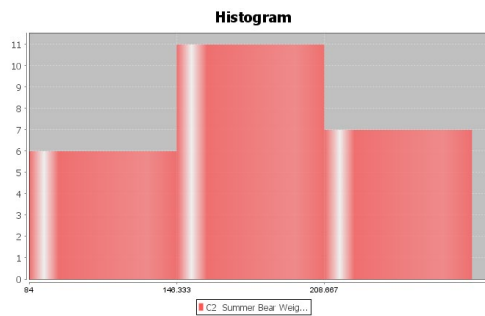
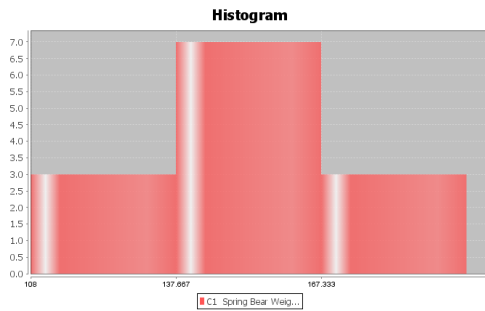
Source of Variation	DOF	SS	MS	Test statistic F	Critical value F	p-Value
Treatment (Between Groups)	2	45539.29263	22769.64632	13.55345	5.0472	0.00002
Error (Within Groups)	51	85679.46663	1679.98954			
Total	53	131218.75926				

Descriptive Statistics

Variable	Mean	Standard Deviation
C1 Spring Bear Weights in Pounds	151.385	22.463
C2 Summer Bear Weights in Pounds	182.125	48.017
C3 Fall Bear Weights in Pounds	228.118	40.769

Variable	N total
C1 Spring Bear Weights in Pounds	13
C2 Summer Bear Weights in Pounds	24
C3 Fall Bear Weights in Pounds	17





26. A census of Math 075 pre-stat students was taken in the fall 2015 semester. The students were separated into three sleep groups: low amount of sleep, moderate amount of sleep, high amount of sleep. They were also asked how many total units they have completed at the college. Though the data was not random, you can assume it was representative of Math 075 students at COC. Use a 10% significance level and the following Statcato statistics, graphs and ANOVA printout to test the claim that sleep is not related the total number of units completed.

One-way ANOVA: Significance level = 0.1

Selected column variables: C5 COC Units - Low ... C6 COC Units - Medi... C7 COC Units - High...

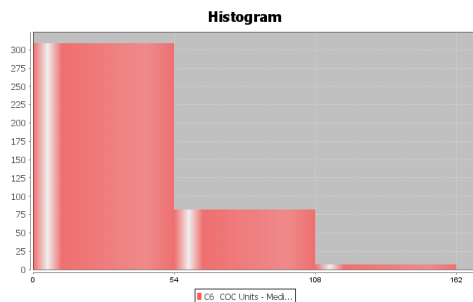
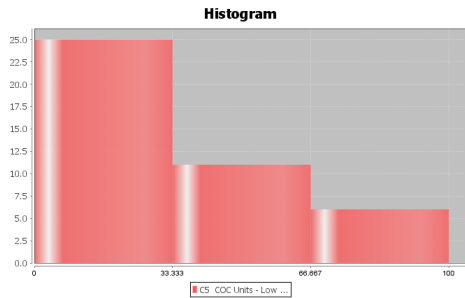
Source of Variation	DOF	SS	MS	Test statistic F	Critical value F	p-Value
Treatment (Between Groups)	2	2822.35625	1411.17813	1.83387	2.3133	0.16087
Error (Within Groups)	497	382446.38503	769.50983			
Total	499	385268.74128				

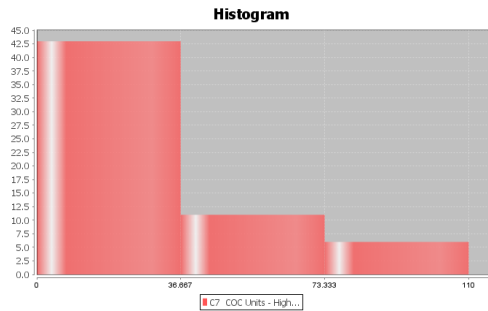


Descriptive Statistics

Variable	Mean	Standard Deviation
C5 COC Units - Low Sleep Group	32.952	28.586
C6 COC Units - Medium Sleep Group	32.990	27.585
C7 COC Units - High Sleep Group	25.675	28.178

Variable	N total
C5 COC Units - Low Sleep Group	42
C6 COC Units - Medium Sleep Group	398
C7 COC Units - High Sleep Group	60





27. A census of Math 075 pre-stat students was taken in the fall 2015 semester. The students were separated into four political parties: democratic, republican, independent party, and other political party. They were also asked number of alcoholic beverages they consume per week. Though the data was not random, you can assume it was representative of Math 075 students at COC. Use a 5% significance level and the following Statcato statistics, graphs and ANOVA printout to test the claim that political party is not related to the number of alcoholic beverages.

One-way ANOVA: Significance level = 0.05

Selected column variables: C9 # Drinks per Wee... C10 # Drinks per Wee... C11 # Drinks per Wee... C12 # Drinks per Wee...

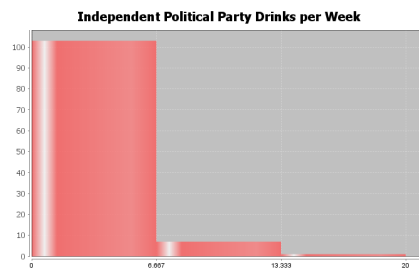
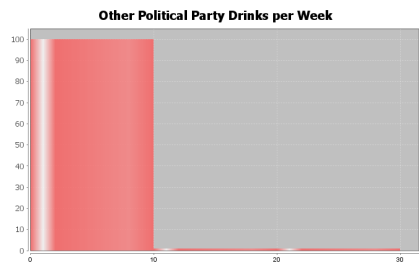
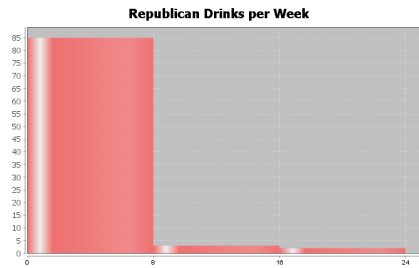
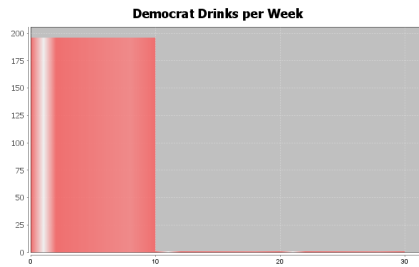
Source of Variation	DOF	SS	MS	Test statistic F	Critical value F	p-Value
Treatment (Between Groups)	3	25.44137	8.48046	0.89597	2.6228	0.44306
Error (Within Groups)	497	4704.16342	9.46512			
Total	500	4729.60479				

Descriptive Statistics

Variable	Mean	Standard Deviation
C9 # Drinks per Week - Democrats	0.914	2.566
C10 # Drinks per Week - Independent Political Party	1.342	2.943
C11 # Drinks per Week - Other Political Party	1.373	3.447
C12 # Drinks per Week - Republicans	1.411	3.753

Variable	N total
C9 # Drinks per Week - Democrats	198
C10 # Drinks per Week - Independent Political Party	111
C11 # Drinks per Week - Other Political Party	102
C12 # Drinks per Week - Republicans	90





28. A census of Math 075 pre-stat students was taken in the fall 2015 semester. The students were asked what their favorite social media is: Facebook, Instagram, Snapchat, or Twitter. They were also asked number minutes per day spent on social media. Though the data was not random, you can assume it was representative of Math 075 students at COC. Use a 5% significance level and the following Statcato statistics, graphs and ANOVA printout to test the claim that the type of social media is related to the number of minutes per day spent on social media.

One-way ANOVA: Significance level = 0.05

Selected column variables: C14 Facebook - Social... C15 Instagram - Social... C16 Snapchat - Social... C17 Twitter - Social...

Source of Variation	DOF	SS	MS	Test statistic F	Critical value F	p-Value
Treatment (Between Groups)	3	169375.54058	56458.51353	8.20214	2.6354	0.00003
Error (Within Groups)	293	2016833.12272	6883.38950			
Total	296	2186208.66330				

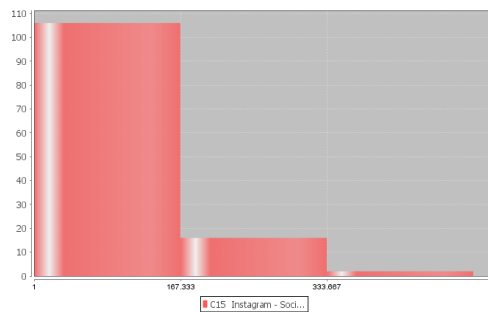
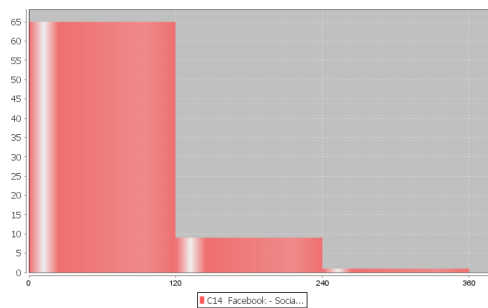


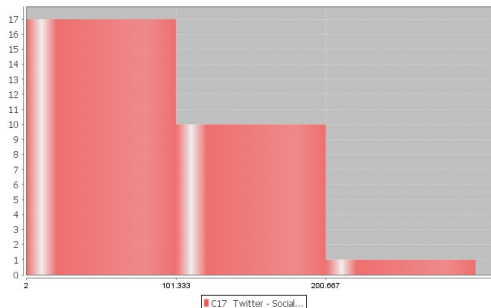
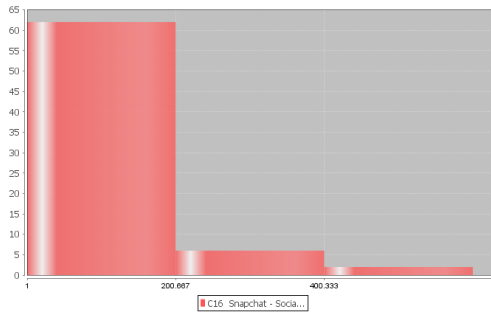
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Descriptive Statistics

Variable	Mean	Standard Deviation
C14 Facebook - Social Media Minutes per day	43.867	58.103
C15 Instagram - Social Media Minutes per day	83.206	82.817
C16 Snapchat - Social Media Minutes per day	110.914	109.552
C17 Twitter - Social Media Minutes per day	90.964	59.408

Variable	N total
C14 Facebook - Social Media Minutes per day	75
C15 Instagram - Social Media Minutes per day	124
C16 Snapchat - Social Media Minutes per day	70
C17 Twitter - Social Media Minutes per day	28





(#29-33) Directions: Go to www.lock5stat.com and click on the StatKey button. Under the “More advanced randomization tests” menu click on “ANOVA for Difference in Means”. For each of the following problems, use a randomized simulation to answer the following. Assume the data met the assumptions for an ANOVA hypothesis test. For each problem, answer the following questions.

- Give the null and alternative hypothesis.
- The F -test statistic is given under “Original Sample”. Write a sentence to explain the F test statistic.
- Simulate the null hypothesis and put the significance level in the right tail to calculate the critical value. What was the critical value? (Answers will vary.)
- Use the F test statistic and Critical Value to determine if the sample data significantly disagrees with the null hypothesis. Explain your answer.
- Put in the test statistic into the right tail to calculate the P -value. What was the P -value? (Answers will vary.)
- Use the P -value and Significance Level to answer the following: Could the sample data or more extreme have occurred because of sampling variability or is it unlikely that the sample data occurred because of sampling variability? Explain your answer.
- Should we reject the null hypothesis or fail to reject the null hypothesis? Explain your answer.
- Write a conclusion for the hypothesis test addressing evidence and the claim.
- What is the variance between the groups? What is the variance within the groups? Was the variance between significantly higher than the variance within? Explain how you know.
- Was the categorical and quantitative variables related or not. Explain your answer.

29. Use the random car data and a 1% significance level to test the claim that the country a car is from is related to its gas mileage. Go to www.matt-teachout.org and open the random car data. Copy and paste the country and the miles per gallon columns next to each other in a new excel spreadsheet. The country should be on the left and the miles per gallon should be on the right. Then copy both columns together. Go to www.lock5stat.com and click on the StatKey button. Under the “More advanced randomization tests” menu click on “ANOVA for Difference in Means”. Click on the “Edit Data” button and paste the country and mpg columns into StatKey. Click on “Generate 1000 Samples” a few times and then “Right-Tail”. Put in the original sample F -test statistic in the bottom box to estimate the P -value. Complete the questions above.



30. Under the “ANOVA for Difference in Means” menu in StatKey, click on the button at the top left of the page and click on “Sandwich Ants”. We are studying the number of ants that are drawn to different kinds of food. In this data, we are looking at the mean average number of ants that come to three different types of sandwiches left out to spoil. Use a 5% significance level to test the claim that the number of ants is not related to the type of sandwich.

31. Use the random car data and a 10% significance level to test the claim that the country a car is from is not related to its horsepower. Go to www.matt-teachout.org and open the random car data. Copy and paste the country and the horsepower columns next to each other in a new excel spreadsheet. The country should be on the left and the horsepower should be on the right. Then copy both columns together. Go to www.lock5stat.com and click on the StatKey button. Under the “More advanced randomization tests” menu click on “ANOVA for Difference in Means”. Click on the “Edit Data” button and paste the country and horsepower columns into StatKey. Click on “Generate 1000 Samples” a few times and then “Right-Tail”. Put in the original sample F-test statistic in the bottom box to estimate the P-value. Complete the questions above.

32. Under the “ANOVA for Difference in Means” menu in StatKey, click on the pulse rate and award data. This data looks at the average pulse rates of those people that have won Olympic, Academy and Nobel awards. Use a 1% significance level to test the claim that the population mean average pulse rate is related to the type of award the person won.

33. Under the “ANOVA for Difference in Means” menu in StatKey, click on the Homes for Sale (price by state) data. This data looks at the average selling price of homes in four different states. Use a 10% significance level to test the claim that the population mean average home price is related to the state the home is sold in.

