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## Business Analytics | 5th Edition

### Chapter 19, Problem 1C

#### Problem

Nancy Krentz, the owner and manager of a property appraisal service based in York, Pennsylvania, is concerned that her four appraisers (Allen, Felan, Maloy, and Nelson) are producing appraisals of comparable properties that are generally not equivalent. She wants to conduct an investigation to determine whether her concerns are valid. Nancy directs her administrative assistant, Katie Shaffer, to identify 40 similar properties in the York area for use in the study. Given the sample of comparable properties, Nancy then arbitrarily divides the 40 properties into four subsets of ten. Next, she randomly assigns each subset to one of the four appraisers for assessment. The appraisals of the given 40 properties are listed in the file C19\_01.xlsx. Given Nancy's limited background in statistical analysis, she has asked for your expert assistance in evaluating the data that her assistant has compiled. She recalls that at one point in her business studies she learned a systematic method, called analysis of variance, for comparing the averages of related groups of quantitative data. However, she cannot recall the assumptions that must be met to apply this methodology, nor the procedures for implementing the appropriate method and correctly interpreting the results. Nancy has prepared the following list of questions that she would like for you to help her answer:

- What requirements must be met to apply analysis of variance? Is it appropriate to use analysis of variance in this case?
- Assuming that it is appropriate to apply a form of analysis of variance here, how can she use the appropriate method to analyze the data?
- Does the statistical analysis confirm her suspicion that there are individual differences among the four appraisers? If so, which of the four appraisers are typically generating evaluations that are larger or smaller than those of the others?
- Has the statistical test been formulated in the best manner? In particular, was it appropriate for Nancy to divide the 40 selected properties into four subsets of ten and then assign each subset to one of the appraisers? If not, how could the design of the study be modified to discover the most useful information in evaluating the appraisal staff at Krentz? Be as specific as possible.
- In light of the results of this data analysis, what steps, if any, should Nancy take to improve the situation in her organization?

#### Step-by-step solution

##### Step 1/13

Consider the data given below for appraisals of the given 40 properties with appraisers:

	A	B
1	Appraiser	Appraisal amount
2	Allen	\$34,900
3	Allen	\$36,394
4	Allen	\$35,863
5	Allen	\$37,512
6	Allen	\$36,946
7	Allen	\$36,263
8	Allen	\$36,041
9	Allen	\$35,305
10	Allen	\$34,864
11	Allen	\$36,283
12	Felan	\$31,839
13	Felan	\$35,521
14	Felan	\$35,315
15	Felan	\$33,365
16	Felan	\$34,990
17	Felan	\$34,947
18	Felan	\$34,239
19	Felan	\$35,814
20	Felan	\$32,896
21	Felan	\$34,475
22	Maloy	\$34,705
23	Maloy	\$37,529

##### Step 2/13

The requirements to be met for applying ANOVA are stated below:

- Each sample is an independent random sample.
- The distribution of the response variable follows a normal distribution.
- The population variances are equal across responses for the group level.

So, calculate the standard deviation of amount of appraisals for each appraiser.

Calculate the standard deviation as shown below:

	E5							
	C	D	E	F	G	H	I	
3								
4		Allen						
5		Standard deviation =	848.2505					
6								

##### Step 3/13

Hence, standard deviation for A's appraisal amount is 848.2505.

Applying similar formula to rest appraisers, the values are given below:

The standard deviation for F's appraisal amount is 1274.894.

The standard deviation for M's appraisal amount is 1087.916.

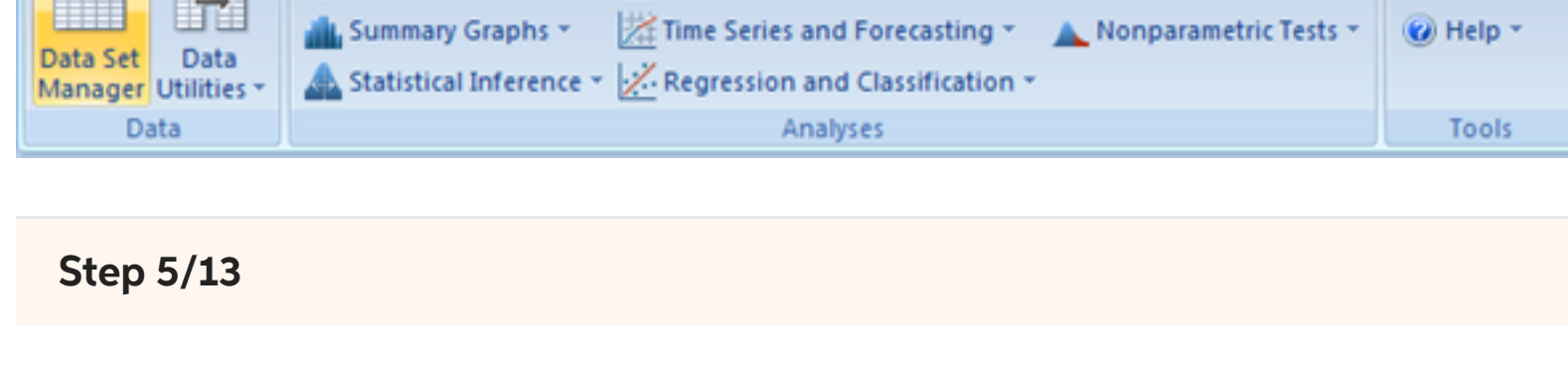
The standard deviation for N's appraisal amount is 1240.961.

Since, the standard deviations (hence variance) are not equal and have a large amount of difference between them hence it is not appropriate to apply ANOVA in this case.

##### Step 4/13

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- Now, in order to perform ANOVA, follow the steps given below:

**Step 1:** Select the whole data. And click on Data set manager in the StatTools menu as shown in the screen shot below:

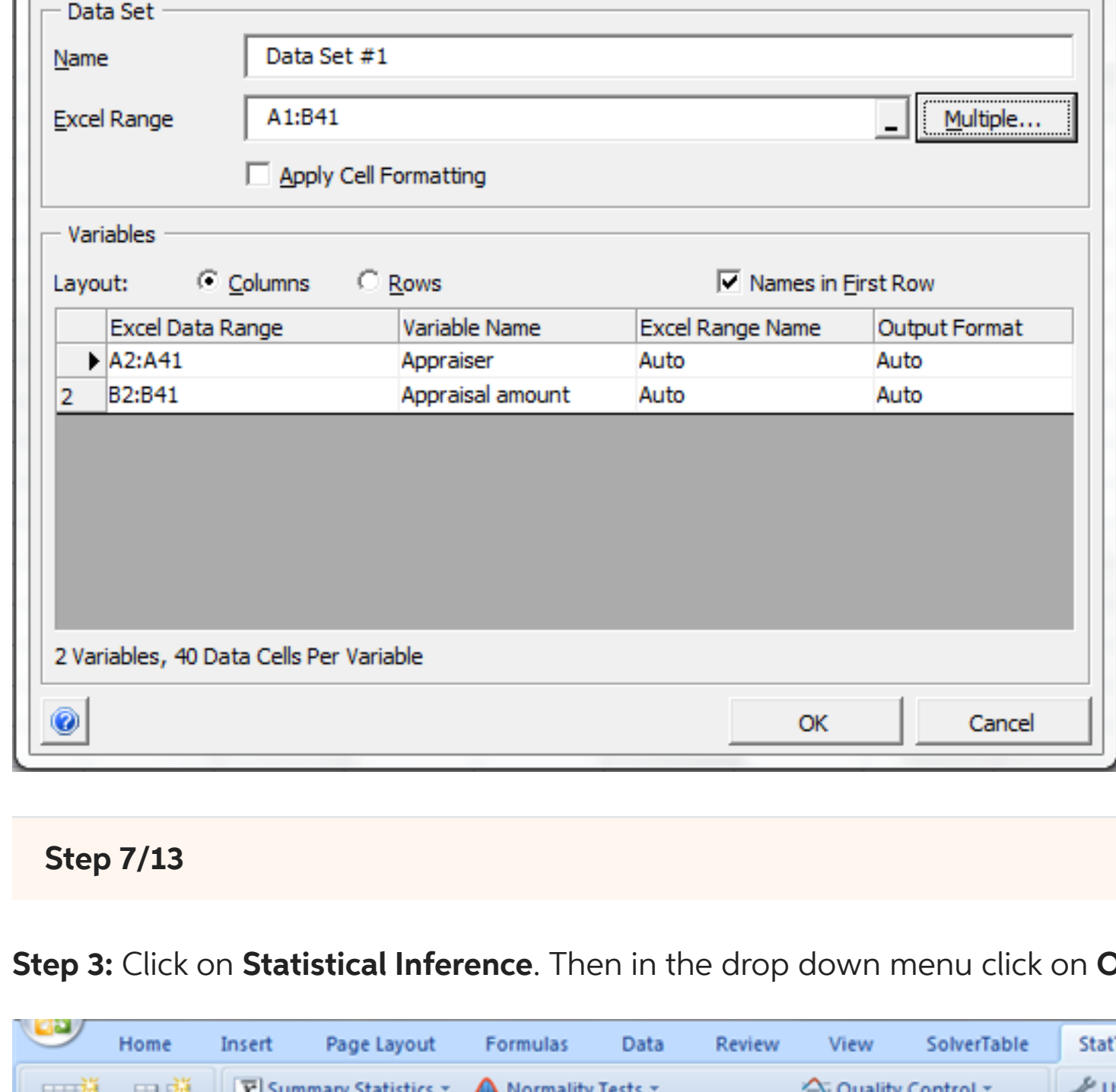


##### Step 5/13

**Step 2:** A dialogue box will open, as shown below. Click Ok and the data set get formed for the use in StatTools.

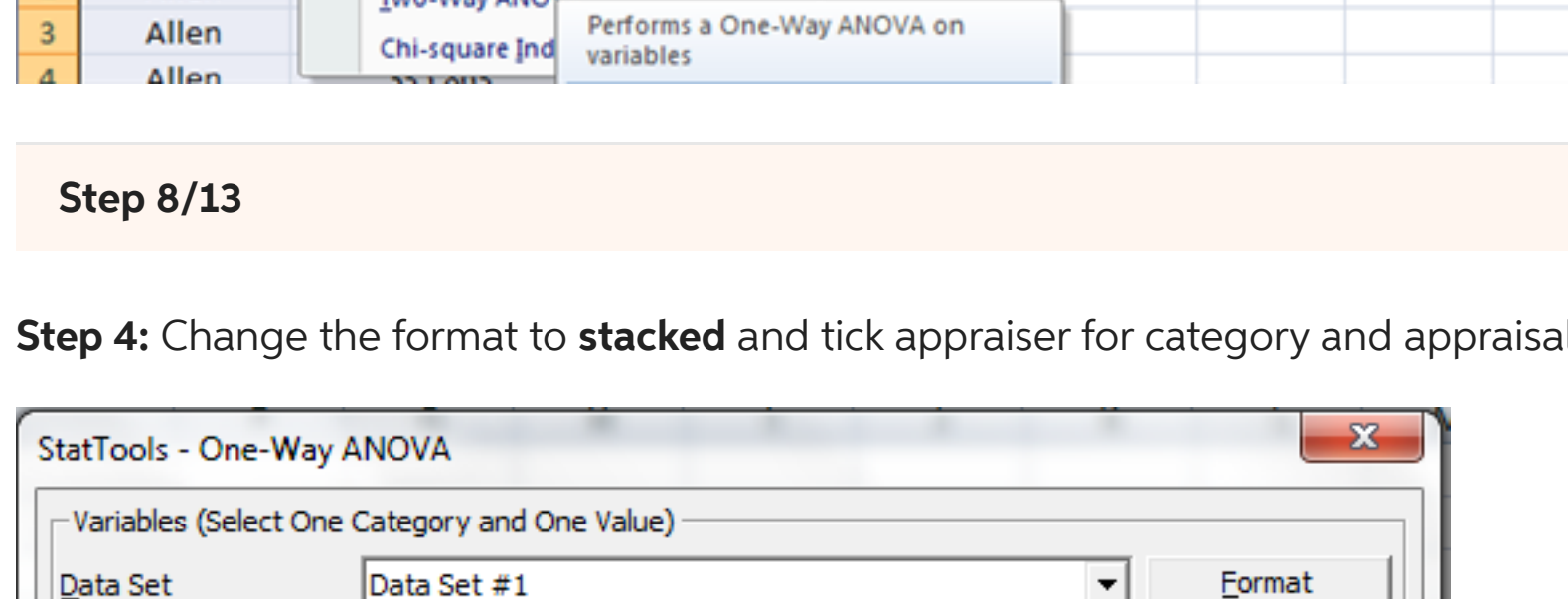
The screenshot is shown below:

##### Step 6/13



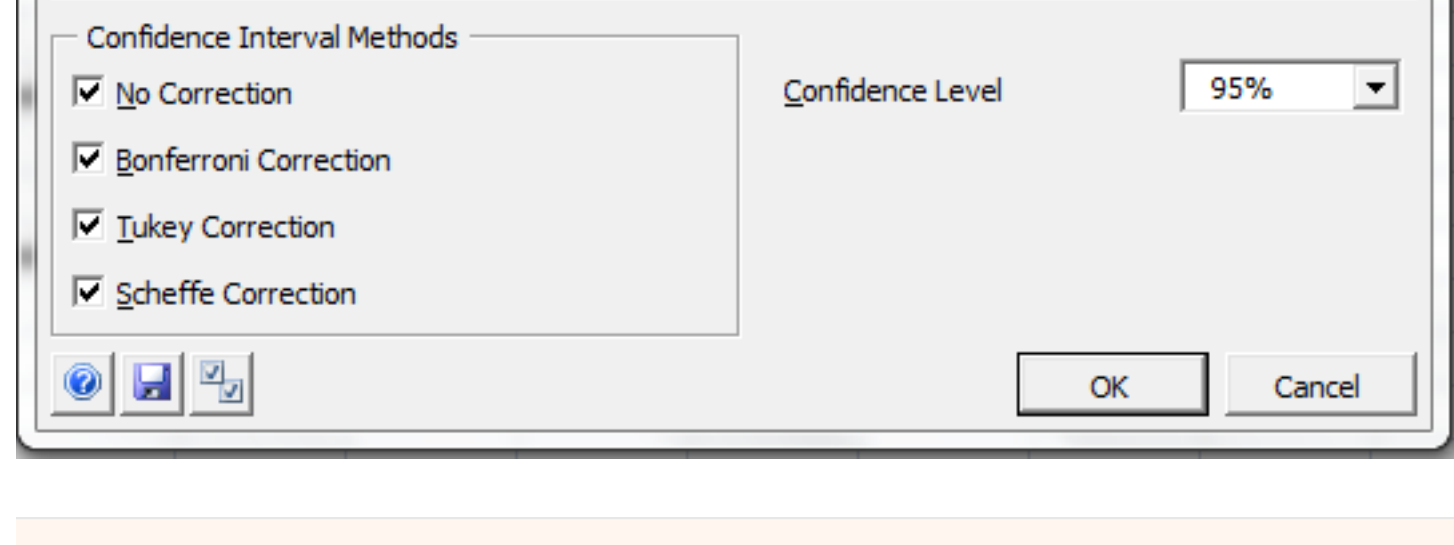
##### Step 7/13

**Step 3:** Click on **Statistical Inference**. Then in the drop down menu click on **One-way ANOVA** as shown in the screen shot below:



##### Step 8/13

**Step 4:** Change the format to **stacked** and tick appraiser for category and appraisal amount for value as seen in the screen shot below:



##### Step 9/13

**Step 5:** Click **Ok** in the above dialogue box.

The ANOVA table is shown below:

ANOVA Summary					
Total Sample Size	40				
Grand Mean		Rs. 34975.88			
Pooled Std Dev		Rs. 1125.66			
Pooled Variance		Rs. 1271107.22			
Number of Samples	4				
Confidence Level	95.00%				
ANOVA Sample Stats					
Sample Size	Data Set #1	Data Set #2	Data Set #3	Data Set #4	
Sample Mean	\$36037.10	\$34340.10	\$36220.30	\$33306.00	
Sample Std Dev	\$348.35	\$1274.89	\$1087.92	\$1340.96	
Sample Variance	71528.99	162535.43	118360.68	159993.78	
Pooled Weight	0.2500	0.2500	0.2500	0.2500	
Overall ANOVA Table					
	Sum of Squares	Degrees of Freedom	Mean Squares	F-Ratio	p-Value
Between Variation	Rs. 5674544.48	3	Rs. 1555281.49	Rs. 13.44	< 0.0001
Within Variation	Rs. 4541505.90	36	Rs. 1267107.22		
Total Variation	Rs. 10429706.38	39			

##### Step 10/13

Thus, by looking at the  $p$ -value obtained above in the output summary of One-Way ANOVA test, it can be said that there is evidence to reject the Null Hypothesis because on comparing this value with 0.05, it is found that  $p$ -value = < 0.0001 which is very less than 0.05.

This is the condition for accepting the Alternative Hypothesis.

So, Null Hypothesis can be rejected at 5 % significance levels and can be concluded that the mean appraisals among the 4 appraisers are not equal.

##### Step 11/13

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- Yes. There are differences among the four appraisals as shown below:

Confidence Interval Tests	Difference of Means
Appraisal amount (Allen)-Appraisal amount (Felan)	Rs. 1697.00
Appraisal amount (Allen)-Appraisal amount (Maloy)	-Rs. 183.20
Appraisal amount (Allen)-Appraisal amount (Nelson)	Rs. 2731.10
Appraisal amount (Felan)-Appraisal amount (Maloy)	-Rs. 1880.20
Appraisal amount (Felan)-Appraisal amount (Nelson)	Rs. 1034.10
Appraisal amount (Maloy)-Appraisal amount (Nelson)	Rs. 2914.30

From the above output, it can conclude that there are significant differences between the means of the 4 appraisers.

Whereas, there is maximum difference between the appraisal amounts of M and N, and the minimum difference between the appraisal amounts of A and M.

##### Step 12/13

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- The test has not been formulated in the best manner as the data does not obey the assumptions of ANOVA. The data has not been divided properly and adequately.

In order to modify the design of the study, the division of subsets from the 40 properties should also be done in random order.

Each subset should have values that are randomly allotted from the whole data rather than allotting the first 10 properties to one and so on.

##### Step 13/13

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- In order to get similar appraisals for all the appraisers, there should be training programs for the weaker one who are not able to get high appraisal amounts on the comparable land.

More methods to enhance their ability should be introduced and looked in the matter of how they interact and convince the others.

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8CQ	8P	9CQ	9P	10CQ
10P	11P	12P	13P	14P
15P	16P	17P	18P	19P
20P	21P	22P	23P	24P
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