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LESSON 14 - HYPOTHESIS TESTING; INDEPENDENT SAMPLES

In this lesson we will see how to perform a hypothesis test for the difference of two means. We will use Problem 24 on page 459 as an example. Open Minitab, clear the area below the date/time stamp, then type in your name, Lesson 14, Example, and define the variables as usual. We will let X_1 = Science test score of a student when traditional lab sessions are used and X_2 = Science test score of a student when interactive simulation software is used. Enter the data from Traditional Lab into C1 and label it X_1 , then enter the data for Interactive Simulation Software into C2 and label it X_2 . Display the two data sets.

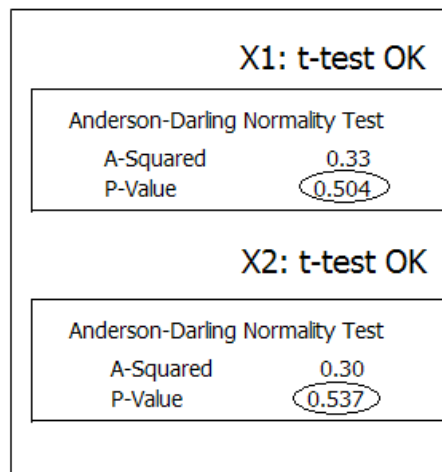
The first task is to make sure that the t-test will be valid in this case. Since the data is given as stem-and-leaf plots, it is quite clear that the two sets seem to come from approximately normal distributions, but we will use the Anderson-Darling normality test introduced in Lesson 13 to make sure. Click Stat > Basic Statistics > Graphical Summary and select both C1 and C2 into the "Variables:" box then click "OK". Two graphical summaries will be created. Make each of them all black and white; then add your name, an appropriate subtitle, and an ellipse to each as discussed in Lesson 13. The critical portion of each is shown in the figure to the right. (But when you do a similar problem for Assignment 14 you will print the complete summaries.) We see that it is indeed valid to use the t-test in this case.

To conduct the t-test click on Stat > Basic Statistics > 2-Sample t. Now click on the "Samples in different columns" button, select X_1 into "First:" and X_2 into "Second:", then check "Assume equal variances" and click on "Options" to make sure that "Alternative:" is set to "less than". Finally, we click "OK" and "OK". We will use the P-Value method, but since we are told to use a 5% level of significance, we can type our decision and conclusion. The results, after clearing out superfluous "stuff", are shown at the top of the next page.

There is one important result in that output that should call our attention. The degrees of freedom is 39. It is computed by $d.f. = n_1 + n_2 - 2 = 22 + 19 - 2 = 39$ when the population variances are equal.

Minitab uses a much more complicated formula to compute the degrees of freedom than the simple rule in our text. To see the rule used by Minitab click on Help > Methods and formulas. Click on 2-sample t. Click on Test statistics on the right. Then you will see the formula Minitab uses to compute the degrees of freedom. The Minitab method makes the test a little more sensitive, but the book's way is certainly easier. Recommendation: If you are doing one of these problems by hand, do it the books way, but if you are using Minitab, take advantage of their more sophisticated approach.

Notice that the dialog box for the two sample t-test also makes it possible to do the test with summary data as we saw in lessons 11, 12, and 13. It works the same as in those previous



cases except that you now have to enter the means, standard deviations, and sample sizes for both samples. We will not work another example.

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Lesson 14
Example

X1 = Science test score of a student when traditional lab sessions are used
X2 = Science test score of a student when interactive simulation software is used

Data Display

Row	X1	X2
1	64	70
2	70	74
3	71	75
4	72	75
5	73	77
6	76	77
7	76	78
8	77	80
9	78	80
10	78	83
11	79	84
12	79	87
13	80	88
14	80	88
15	81	89
16	81	89
17	81	91
18	85	93
19	88	99
20	89	
21	90	
22	92	

Two-Sample T-Test and CI: X1, X2

Two-sample T for X1 vs X2

	N	Mean	StDev	SE Mean
X1	22	79.09	6.90	1.5
X2	19	83.00	7.64	1.8

Difference = μ (X1) - μ (X2)
Estimate for difference: -3.91
95% upper bound for difference: -0.08
T-Test of difference = 0 (vs <): T-Value = -1.72 P-Value = 0.047 DF = 39
Both use Pooled StDev = 7.2533

Decision: Since P-Value = 0.047 < 0.05, we would reject H0.
Conclusion: There is enough evidence to support the claim the mean science test score is lower for students taught using the lab method than it is for students taught using the interactive simulation software.

Also notice that Minitab has no "2-Sample z" test. We know from our text that the formula for the test statistic for a 2 sample z and a 2 sample t are the same, it is only the table we use to find the critical value that changes. We also know that for large samples, that is $n > 30$, the normal distribution table and the t distribution table are virtually the same. Thus, if we are faced with a two sample mean problem with both samples large, this 2-Sample t procedure from Minitab would give us the same result as using the 2 sample z procedure described in our text.

MINITAB ASSIGNMENT 14

See instructions on page 8.

1. Do problem 23 on page 459 It is required to do Anderson-Darling normality test to make sure t-test is appropriate. Write your answers for the question in the session window.

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