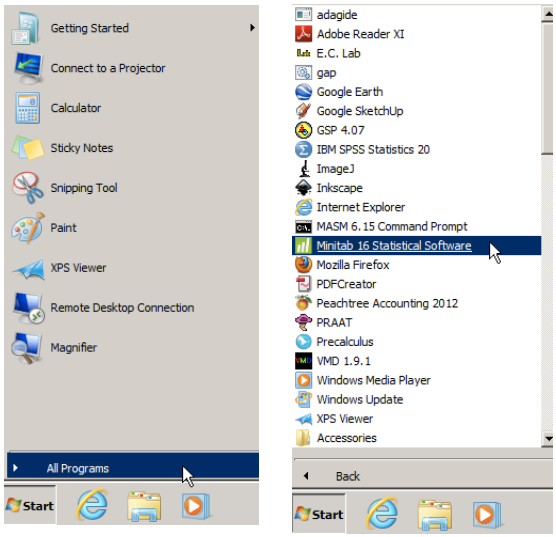
ED632G: Research/Applied Educational Psychology

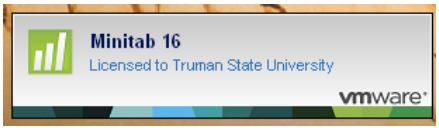
This tutorial is designed to help ED632G students have a better understanding on how to run a general "pre-test vs. posttest" or "improvement over semesters" type of statistical study. The test we will be using for this particular data is a **paired-t test**. This example will be run in **Minitab**.

(All campus computers have Minitab 16. If not, you need to contact ITS. If you are off campus and don't have access to it, contact ITS (or check their website) and ask about the virtual desktop. Information about the virtual desktop can also be found at https://secure.truman.edu/its-s/viewclient/.)

To open Minitab, select **All Programs** from your **Start** menu. Then select **Minitab 16**.

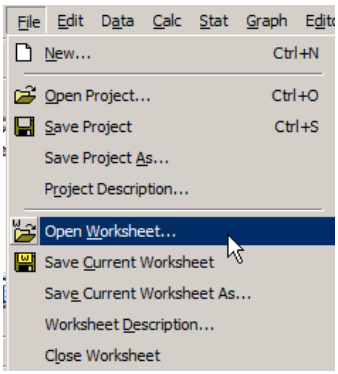


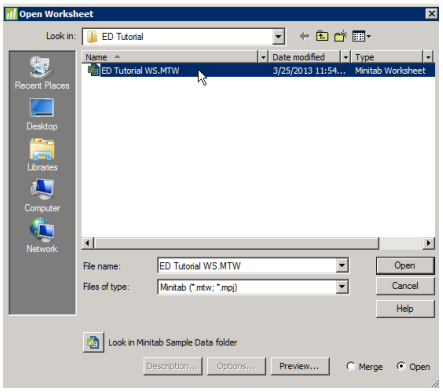
If you have done this correctly, this image should show up in the bottom right hand corner of your screen.



This example will compare the average of students' first semester test scores to an average of their second semester test scores.

Once Minitab is opened, you may input your data into the cells. Excel data may be copied into or opened through Minitab (select **File**, then **Open worksheet**).





After selecting your file, click **open**. If your file is unable to open, check how you have formatted your data and variables. You may need to **copy & paste** your data from Excel or type them in yourself.

Below is the sample data set that we will be using this example. It lists the test scores for 14 students in both their first and second semesters, their average test grades for each semester, and the difference between the test averages of the semesters (the second minus the first).

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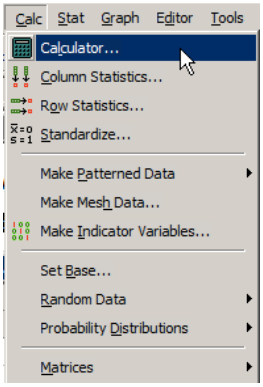
↓	C1-T	C2	C3
	Student	Test Avg_Sem 1	Test Avg_Sem 2
1	Student 1	0.840	0.876
2	Student 2	0.828	0.902
3	Student 3	0.616	0.742
4	Student 4	0.750	0.882
5	Student 5	0.800	0.846
6	Student 6	0.822	0.884
7	Student 7	0.478	0.514
8	Student 8	0.622	0.780
9	Student 9	0.654	0.922
10	Student 10	0.670	0.732
11	Student 11	0.880	0.918
12	Student 12	0.860	0.906
13	Student 13	0.832	0.880
14	Student 14	0.394	0.712

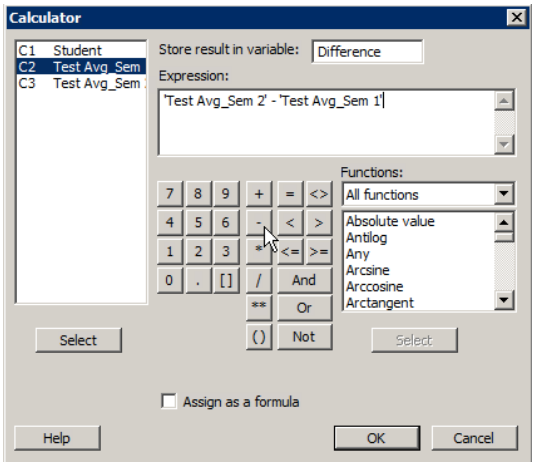
Analyzing data

In this example we will create our hypothesis tests, run a paired-t test, and interpret our data according to our test results.

Checking for normality

We want to know if we have a normally distributed sample in order to run our statistics. In order to do this, we will need to graph a probability plot. We will be graphing the how much students have improved over the semesters. To do this, we must calculate the difference between their second and first semester of average test scores.





Select **Calc** in the top left menu bar to open the **Calculator**. Next, type in "Difference" as your new variable to store your data. Then input your expression subtracting the average score of second semester minus the first. Hit **OK** when finished.

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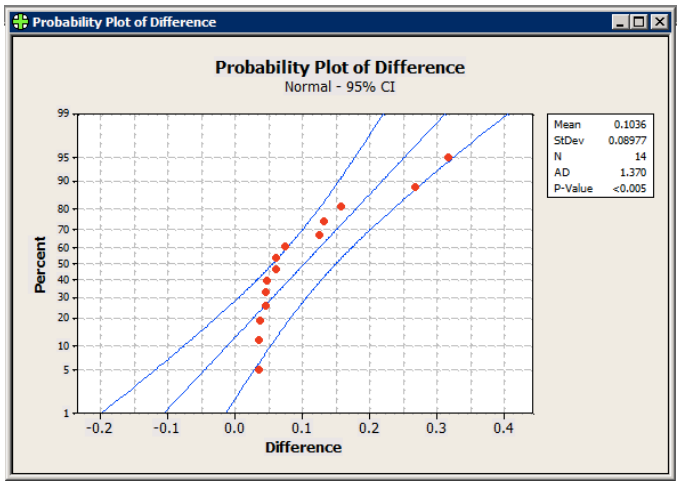
↓	C1-T	C2	C3	C4
	Student	Test Avg_Sem 1	Test Avg_Sem 2	Difference
1	Student 1	0.840	0.876	0.036
2	Student 2	0.828	0.902	0.074
3	Student 3	0.616	0.742	0.126
4	Student 4	0.750	0.882	0.132
5	Student 5	0.800	0.846	0.046
6	Student 6	0.822	0.884	0.062
7	Student 7	0.478	0.514	0.036
8	Student 8	0.622	0.780	0.158
9	Student 9	0.654	0.922	0.268
10	Student 10	0.670	0.732	0.062
11	Student 11	0.880	0.918	0.038
12	Student 12	0.860	0.906	0.046
13	Student 13	0.832	0.880	0.048
14	Student 14	0.394	0.712	0.318

Your newest variable should be stored in the next column of your worksheet.

Graphing

Select **Graph** in the top right left hand corner, then **Probability Plot.** Select the single option then choose/type in 'difference' to graph.

Generally, you want your data points to follow the straight blue line in the center and fall between the two curved outer blue lines.



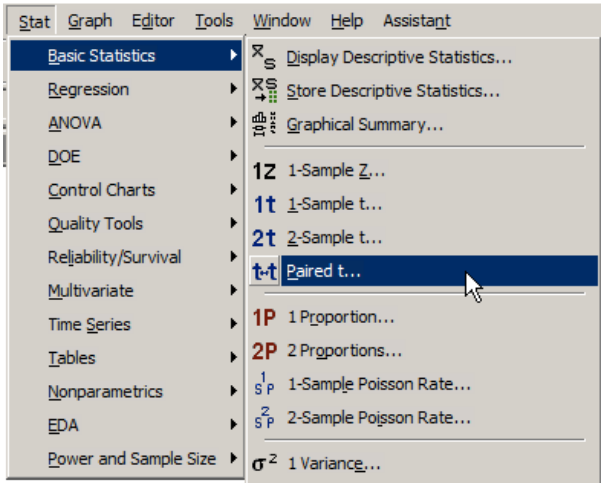
Hypothesis Testing

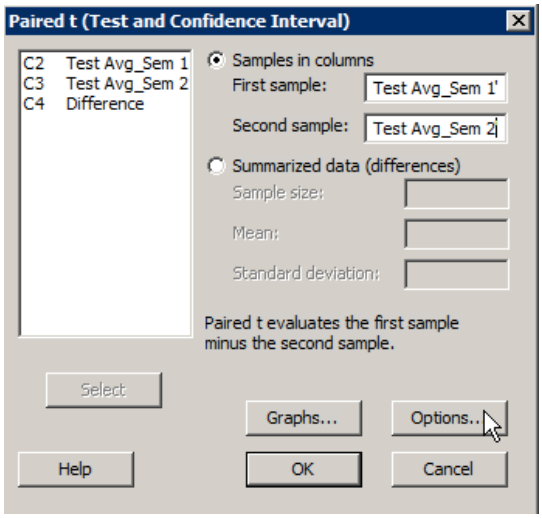
A **one tailed hypothesis test** is conducted the researcher believes that the students' first semester average test scores are lower than the students' second semester average test scores.

$$H_o: \mu_{\text{Test Avg\_Sem 1}} = \mu_{\text{Test Avg\_Sem 2}} \qquad H_A: \mu_{\text{Test Avg\_Sem 1}} < \mu_{\text{Test Avg\_Sem 2}}$$

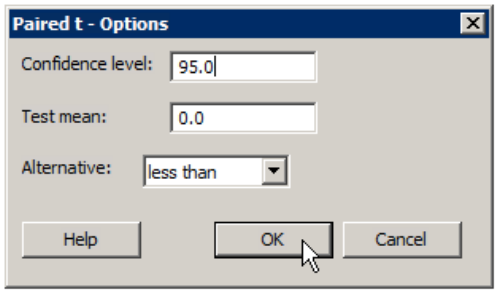
Now we will compare the matched pair/2 dependent samples (**Paired t-test**). If the test subjects are matched and paired by certain traits when assigned to the treatment groups, we no longer have independent samples. Each measurement in a treatment group can be reasonably paired with a measurement in the other treatment group, which is decided before the experiment was run. The data will be placed into 2 columns with each row corresponding to a "paired" data set. For this example each of the individual student's first semester average test score is in a same row with his or her second semester average test score. To test if there is a significant difference between the two semesters we run the **paired-t test** in Minitab.

To run a paired-t test, select **Stat** from the menu in the top left corner, then find **Basis Statistics**. Under basic statistics should be the option **Paired t…** Choose this and input your two samples. The order of your samples should match your hypothesis tests.





In order to run a one sided test, you must choose **options** then whether you want to test if your first average is greater than, less than, or not equal to your second average (this is dependent upon your hypothesis tests).



Results

Here is the output for the **paired-t test**:

Paired T-Test and CI: Test Avg_Sem 1, Test Avg_Sem 2

```
Paired T for Test Avg_Sem 1 - Test Avg_Sem 2

                 N     Mean   StDev  SE Mean
Test Avg_Sem 1  14   0.7176  0.1503   0.0402
Test Avg_Sem 2  14   0.8211  0.1144   0.0306
Difference      14  -0.1036  0.0898   0.0240


95% upper bound for mean difference: -0.0611
T-Test of mean difference = 0 (vs < 0): T-Value = -4.32 P-Value = 0.000
```

Here is the **interpretation** of/**conclusion** for these results:

We can see that the p-value for the test is well below our cutoff of 0.05 (alpha level) and so we would reject the null hypothesis and conclude there is significant evidence that the average of students' first semester test scores was less than the average of their second semester test scores. There is statistical evidence to say that students' average second semester scores were greater than their average first semester scores.