Signed-Rank and Sign Tests

The background for this (paired) plant growth data is outlined in problem 28 on page 108 of Statistical Sleuth and the data can also be found in the file “ex0428”, but I have included it in the SAS code to hopefully avoid import issues. We are trying to test

Say we have determined that t-tests are not appropriate (look at histogram and Q-Q plot in proc univariate for verification of this) and want to use a non-parametric test. Because we have a paired sample, we should look at tests that are appropriate for 1 sample, since we will be doing a test on the difference. For that reason, a signed-rank test is a good choice (we will also look at the sign test for sake of time, but a signed-rank test is definitely the better option here!).

Below is the code to input the data into SAS and run PROC UNIVARIATE. Notice that when the dataset is created I also create a difference variable. This is not necessary for a paired t-test because SAS will take the difference for you, but it is for a signed-rank or sign test.

**data** plants;

input cross self;

diff=cross-self;

datalines;

23.50 17.38

12.00 20.38

21.00 20.00

22.00 20.00

19.13 18.38

21.50 18.63

22.13 18.63

20.38 15.25

18.25 16.50

21.63 18.00

23.25 16.25

21.00 18.00

22.13 12.75

23.00 15.50

12.00 18.00

;

**run**;

**proc** **univariate** data=plants;

var diff;

histogram;

qqplot;

**run**;

Questions:

1. Now that you’ve seen the histogram and Q-Q plot of the difference, why isn’t a t-test appropriate for this data?
   1. Qq plot does not show evidence of a normal distribution
2. Even though we have 2 groups, a Rank-Sum Test is not appropriate. Why?
   1. No, Because the negative values of the differences are treated are compared for there absolute values and then ranked.
3. What are the p-values for each test (signed-rank and sign)? Since it’s the same data, why aren’t the p-values the same?
   1. Sign = .0074
   2. Signed Rank = .0413
   3. The signed test simply breaks down the data into 1,0,-1 and does not take into consideration the actual values of the data.
4. Write a conclusion for each test (the full sentence, not just “reject” or “fail to reject”). Remember to include the p-value in the statement and don’t forget that this is now a test for a difference of medians.
   1. Using the sign test we received a p-value ,0074 and would reject the null hypothesis that the medians were the most likely the same using a 95% confidence level.
   2. Using the sign test we received a p-value .0413 and would reject the null hypothesis that the medians were the most likely the same using a 95% confidence level.
5. I mentioned above that I would definitely use a signed-rank test instead of a sign test on this data. Why?

Rank-Sum Test

The background for this data is outlined in problem 31 on page 110 of Statistical Sleuth and can be found in the file “ex0431” (though I made a few necessary changes when inputting the data below). We are trying to test

Below is the code to input the data and run a Wilcoxon Rank-Sum Test [Sorry for the length; it was a good example and I couldn’t pass it up!]. I have included a seed in PROC NPAR1WAY so you will be able to compare your answers to the ones in my answer key.

**data** bctherapy;

input survival treatment $;

datalines;

2 Control

6 Control

8 Control

10 Control

12 Control

12 Control

14 Control

14 Control

14 Control

16 Control

16 Control

16 Control

18 Control

18 Control

18 Control

20 Control

22 Control

22 Control

26 Control

34 Control

36 Control

38 Control

40 Control

48 Control

2 Therapy

2 Therapy

4 Therapy

4 Therapy

4 Therapy

6 Therapy

6 Therapy

8 Therapy

10 Therapy

10 Therapy

12 Therapy

14 Therapy

16 Therapy

16 Therapy

16 Therapy

18 Therapy

20 Therapy

22 Therapy

32 Therapy

36 Therapy

46 Therapy

46 Therapy

48 Therapy

48 Therapy

58 Therapy

58 Therapy

66 Therapy

72 Therapy

72 Therapy

82 Therapy

122 Therapy

123 Therapy

123 Therapy

123 Therapy

;

**run**;

**proc** **npar1way** wilcoxon data=bctherapy;

var survival;

class treatment;

exact wilcoxon / mc seed=**596261001**;

**run**;

Questions:

1. (You’ll need some context to answer these questions, so be sure to read the information that goes with the data. It’s Exercise 31 of Chapter 4 on page 110.)
   1. This sample is large enough to likely overcome issues with non-normality, but I can’t use a t-test, not even with a transformation. Why?
      1. The two sides are not drawn from a random population this is a single population in which all people what the same disease. A real test would if you had cancer or did not have cancer.
   2. Why did I change the last 3 numbers from 122 to 123 before running the Wilcoxon Rank-Sum Test? (Hint: they did not need to be 123 specifically, only a number larger than 122.)
      1. This is due to the fact that we are working with censored data, which means you do not know the real value and are effectively creating a ceiling.
2. Why do we use the option “/ mc” in “exact”?
   1. We use the MC in order to limit the number of random permutations
3. Write a conclusion for the test (be sure to include the p-value) based on the Monte Carlo estimates for the exact test. Remember that it is now a test for the difference of medians.
   1. Using the monte Carlo test we received a p-value .1297 and would fail to reject the null hypothesis that the medians were the most likely the same using a 99% confidence level.
4. For both tests, I mentioned that they are now (once we switch to these non-parametric methods) a test for the medians, not the means. Why do you think that is?
   1. This is due to the fact that in a permutation test you assume that the medians are the same, this in turn allows you to switch the values of the data sets in order to test the medians.