**BST 203 Lab 2: Non-Parametric Methods**

**July 26th 2022**

###### Paired Data

* *Sign Test (Not Often Used)*
* Uses the signs (+ or -) of the differences only
* For small *n*, use binomial distribution to calculate p-value for *D*
* *Wilcoxon Signed-Rank Test*
* Nonparametric analogue to the paired t-test
* Incorporates the magnitude of differences via ranks
* For small *n,* use Table A.6 to calculate p-value of *T*
* More powerful than the Sign Test and should be used if given a choice between the two

|  |  |  |
| --- | --- | --- |
| Nonparametric Tests for Paired Data | | |
|  | Sign Test | Wilcoxon Signed-Rank Test |
| H0 | Median difference =0 | Median difference =0 |
| Summary of observed data | *D* = # positive differences | *T* = smaller of the sums of the positive and negative ranks |
| Mean |  |  |
| Standard Deviation |  |  |
| Test Statistic |  |  |
| Distribution of test Statistic (large n) | Standard Normal | Standard Normal |

## Independent Data

* Wilcoxon Rank Sum Test
* Nonparametric equivalent to the two-sample t-test
* Assumes that the distributions of the two populations have the same shape
* If *n* is small, use table A.7 to calculate p-values for *W*

|  |  |
| --- | --- |
| Nonparametric Tests for Independent Data | |
|  | Wilcoxon Rank Sum Test |
| H0 | median1 = median2 |
| Summary of observed data | *W* = smaller of the sums of the ranks in the two samples |
| Mean |  |
| Standard Deviation |  |
| Test Statistic |  |
| Distribution of test Statistic (large n) | Standard Normal |

**Example**

**1.** A crossover trial was conducted to test the ability to perform simple puzzle assembly under varying conditions. Eight total subjects were recruited and subjected to two rounds of puzzle building. In the “normal” round, subjects were allowed to construct the puzzle in peace. In the “stress” round, subjects were told they would receive a mild shock three minutes after the start of the experiment and in 30 second intervals after that. Systolic blood pressure was recorded under each condition. The dataset lab2a.dta on the course website contains each subject’s maximum blood pressure under both conditions (the variable normal contains max SBP under the normal condition and the variable stress contains max SBP under the stress condition).

* What type of data? Are the data *independent* or *dependent*? What parametric and nonparametric tests are available for this type of data?
* Open the data set lab2a. Generate a new variable that is the difference in SBP under each condition.

generate diff = normal – stress

* Create a histogram of the differences. Do they look normally distributed?

hist diff, freq

* What type of statistical test is most appropriate for this data and why?
* What are your null and alternative hypotheses?
* Perform the test with STATA (Drop down menu: *Statistics/Summaries,tables,&tests/Nonparametric tests of hypotheses/Wilcoxon matched-pairs signed-rank test* )

. signrank normal=stress

Wilcoxon signed-rank test

sign | obs sum ranks expected

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positive | 1 4.5 17.5

negative | 6 30.5 17.5

zero | 1 1 1

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all | 8 36 36

unadjusted variance 51.00

adjustment for ties -0.13

adjustment for zeros -0.25

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adjusted variance 50.63

Ho: normal = stress

z = -1.827

Prob > |z| = 0.0677

* What is the value of your test statistic? Using the STATA output, how could you have calculated it by hand? (Note: the mean and variance of the STATA output adjusts for ties)
* What is the p-value of your test?
* Draw a conclusion.

**2.** In an effort to assess to adequacy of the legal blood-alcohol level for operating a vehicle, the state has decided to perform a randomized trial to test the effect of alcohol on reaction time. The study authors believe the legal limit may need to be lowered (though they will not let this guide their analysis of course). Nineteen total subjects were randomized to either the placebo group or the alcohol group with ten subjects in the placebo and 9 in the alcohol. Subjects in the alcohol group consumed two alcoholic beverages while subjects in the placebo group consumed two similar tasting but non-alcoholic beverages. The average reaction time in seconds to a series of simulated driving tests was calculated and can be found for each subject in the dataset lab2b.dta. The variable react contains the reaction time in seconds and the variable group lists the groups.

* What type of data? Are the data *independent* or *dependent*? What parametric and nonparametric tests are available for this type of data?
* Open the data set lab2b.dta which can be found on the course website under the lab data section.
* Create boxplots of the reaction timesfor each group. Do they look normally distributed?

graph box react, over(group)

* What type of statistical test is most appropriate for this data and why?
* What are your null and alternative hypotheses?
* Perform the test with STATA.

. sort group

. ranksum react, by(group)

Two-sample Wilcoxon rank-sum (Mann-Whitney) test

group | obs rank sum expected

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alcohol | 9 122 90

placebo | 10 68 100

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combined | 19 190 190

unadjusted variance 150.00

adjustment for ties 0.00

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adjusted variance 150.00

Ho: react(group==alcohol) = react(group==placebo)

z = 2.613

Prob > |z| = 0.0090

* What is the value of your test statistic? Using the STATA output, how could you have calculated it by hand?
* What is the p-value of your test?
* Draw a conclusion.

**3.** We will perform a Kruskal-Wallis Test on the 2010 world cup dataset (lab1.dta) from Lab 1.

* Open the data set lab1.dta which can be found on the course website under the lab data section.
* What type of statistical test is most appropriate for this data and why?
* What are your null and alternative hypotheses?
* Perform the test with STATA.

. kwallis logpasses, by(position)

Kruskal-Wallis equality-of-populations rank test

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| position | Obs | Rank Sum |

|------------+-----+----------|

| Defender | 134 | 25558.00 |

| Forward | 77 | 9301.50 |

| Midfielder | 139 | 26565.50 |

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chi-squared = 28.854 with 2 d.f.

probability = 0.0001

chi-squared with ties = 28.857 with 2 d.f.

probability = 0.0001

* What is the value of your test statistic provided by STATA ? How does it compare with the one-way ANOVA p-value that you calculated yesterday?
* What is the p-value of your test?
* Draw a conclusion.

**4. (On Your Own)** Suppose that you are interested in examining the effects of the transition from fetal to postnatal circulation among premature infants. For each of the 14 healthy newborns, respiratory rate is measure at two different times – once when the infant is fewer than 15 days old and again when he or she is more than 25 days old.

| Subject | Time 1 | Time 2 |  |
| --- | --- | --- | --- |
| 1 | 62 | 46 |  |
| 2 | 35 | 42 |  |
| 3 | 38 | 40 |  |
| 4 | 80 | 42 |  |
| 5 | 48 | 36 |  |
| 6 | 48 | 46 |  |
| 7 | 64 | 45 |  |
| 8 | 26 | 40 |  |
| 9 | 48 | 42 |  |
| 10 | 27 | 40 |  |
| 11 | 43 | 46 |  |
| 12 | 67 | 31 |  |
| 13 | 52 | 44 |  |
| 14 | 88 | 48 |  |

* Using the sign test, evaluate the null hypothesis that the median difference in respiratory rates for the two times is equal to 0.
* Evaluate the same hypothesis with the Wilcoxon signed-rank test using the fact that the sum of the positive ranks is 78.5 while the sum of the negative ranks is -26.5.
* Do you reach the same conclusion in each case? Why might your conclusions not be the same?

**STATA Tips:** Nonparametric tests

To perform the nonparametric tests, you must open the data or enter it into the Data Editor. All of the tests are contained under the *Statistics/Summaries, tables, & tests/Nonparametric tests of hypotheses* menu. Note that the Mann-Whitney test is another name for the Wilcoxon rank sum test.