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Section F (Optional)

Non-Parametric Analogue to the Two Sample t-test

Alternative to the Two Sample T-Test

- Nonparametric test for comparing two groups

- "Non-parametric" refers to a class of tests that do not assume anything about distribution of the data

- Nonparametric test for comparing two groups
  - Mann-Whitney Rank Sum Test (Wilcoxon Rank Sum Test)
  - Also called Mann-Whitney-Wilcoxon (a mouthful)

- Tries to answer the following question:
  - Are the two population distributions different?

Advantages

- Does not assume populations being compared are normally distributed
  - The two-sample t-test requires that assumption with very small samples sizes
- Uses only ranks
- Not sensitive to outliers

Disadvantage of the Nonparametric Test

- Nonparametric methods are often less sensitive (powerful) for finding true differences because they throw away information (they use only ranks)
- Need full data set, not just summary statistics
- Results do not include any confidence intervals quantifying range of possibility for true difference between populations

Example: Health Education Study

- Evaluate an intervention to educate high school students about health and lifestyle over a two-month period
- 10 students randomized to “intervention” or “control” group
- x = post test score – pre-test score is outcome to compare between the intervention and control groups

Example: Health Education Study

- x = post- pretest score for both groups

Intervention (I)	5	0	7	2	19
Control (C)	6	-5	-6	1	4

  - Only five individuals in each sample!!!
  - We want to compare the control and intervention groups to assess whether the “improvement” (post–pre) in scores are different, taking random sampling error into account

Example: Health Education Study

- With such a small sample size, we need to be sure score improvements are normally distributed if we want to use t-test (BIG assumption)

- Possible approach:
  - Mann-Whitney-Wilcoxon non-parametric test!

Example: Health Education Study

- First step—rank the pooled data (ignore groupings)

	-6	-5	0	1	2	4	5	5	7	19
– Rank	1	2	3	4	5	6	7	8	9	10

Example: Health Education Study

- Second step—“reattach” group status

	-6	-5	0	1	2	4	5	5	7	19
– Rank	1	2	3	4	5	6	7	8	9	10
– Group	C	C	I	C	I	C	I	C	I	I

Example: Health Education Study

- Find the average rank in each of the two groups

- Intervention group average rank

$$\frac{3+5+6+9+10}{5} = 6.8$$

- Control group average rank

$$\frac{1+2+4+6+8}{5} = 4.2$$

Example: Health Education Study

- Statisticians have developed formulas and tables to determine the probability of observing such an extreme discrepancy in ranks (6.8 vs. 4.2) by chance alone
  - This is the p-value

- In the health education study, the p-value was .17
  - The interpretation is that the Mann-Whitney test did not show any significant difference in test score “improvement” between the intervention and control group (p = .17)

Notes

- The two-sample t-test would give a different answer ($p = .14$)
- Different statistical procedures can give different p-values
- If the largest observation, 19, was changed, the p-value based on the Mann-Whitney test would not change but the two-sample t-test would change

Notes

- The t-test or the nonparametric test?
  - Statisticians will not always agree, but there are some guidelines
  - Use non-parametric test if sample size is small and you have no reason to believe data is “well behaved” (normally distributed)
  - Only “ranks” available

Using Stata to Perform Mann-Whitney-Wilcoxon

- Data, as entered

```
. list diff int_cntrl

     +-----------------+
     | diff   int_cn~l |
     |-----------------|
  1. |    4          0 |
  2. |    1          0 |
  3. |   -6          0 |
  4. |   -5          0 |
  5. |    6          0 |
     |-----------------|
  6. |   19          1 |
  7. |    2          1 |
  8. |    7          1 |
  9. |    0          1 |
 10. |    5          1 |
     +-----------------+
```

Using Stata to Perform Mann-Whitney-Wilcoxon

- "ranksum" command
  - Syntax:
    - ranksum *varname*, by(*group_var*)

```
. ranksum diff, by( int_cntrl)

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

   int_cntrl |      obs    rank sum    expected
-------------+---------------------------------
           0 |        5          21        27.5
           1 |        5          34        27.5
-------------+---------------------------------
    combined |       10          55          55

unadjusted variance       22.92
adjustment for ties        0.00
                     ----------
adjusted variance         22.92

Ho: diff(int_cn~l==0) = diff(int_cn~l==1)
             z =  -1.358
    Prob > |z| =   0.1745
```

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```

Using Stata to Perform t-test

- "*ttest*" command without "*i*" on end when data already in Stata
  - Syntax:
    - ttest *varname*, by(*group_var*)

```
. ttest diff, by( int_cntrl)

Two-sample t test with equal variances
------------------------------------------------------------------------------
   Group |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
       0 |       5           0    2.387467    5.338539   -6.628672    6.628672
       1 |       5         6.6    3.325658    7.436397   -2.633506    15.83351
---------+--------------------------------------------------------------------
combined |      10         3.3    2.221361     7.02456   -1.725068    8.325068
---------+--------------------------------------------------------------------
    diff |                -6.6    4.093898               -16.04055    2.840545
------------------------------------------------------------------------------
    diff = mean(0) - mean(1)                                      t =  -1.6122
Ho: diff = 0                                     degrees of freedom =        8

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.0728         Pr(|T| > |t|) = 0.1456          Pr(T > t) = 0.9272
```

Summary: Educational Intervention Example

- **Statistical methods**
  - 10 high school students were randomized to either receive a two-month health and lifestyle education program (or no program)
  - Each student was administered a test regarding health and lifestyle issues prior to randomization (and after the two-month period)

Summary: Educational Intervention Example

- **Statistical methods**
  - Differences in the two test scores (after-before) were computed for each student
  - Mean and median test score changes were computed for each of the two study groups
  - A Mann-Whitney rank sum test was used to determine if there was a statistically significant difference in test score change between the intervention and control groups at the end of the two-month study period

Summary: Educational Intervention Example

- **Result**
  - Participants randomized to the educational intervention scored a median five points higher on the test given at the end of the two-month study period, as compared to the test administered prior to the intervention
  - Participants randomized to receive no educational intervention scored a median one point higher on the test given at the end of the two-month study period
  - The difference in test score improvements between the intervention and control groups was not statistically significant ($p = .17$)