**Medical Statistic PHL 541**

**(Notes and Examples)**

**How to differentiate between parametric & non-parametric?**

1. Normal distribution
2. Sample size
3. Mean & median
4. Type of data: Ordinal, nominal 🡪 non parametric
5. In case of correlation: linear or non linear

**When to use non parametric?**

Nonparametric tests are widely used when you do not know whether your data follows normal distribution, or you have confirmed that your data do not follow normal distribution.

1. nominal or ordinal data
2. not normal distribution (distribution free)

**What is the advantage of nonparametric?**

1. insensitive to outliers

**Two-sample problems:**

Often in applications we wish to compare two distinct populations with respect to some property. For example, we may want to compare the average salaries of men and women at an equivalent position. Or, we may want to compare the average e®ect of one treatment with that of another. We may want to compare their variances instead of the mean, or we may even want to compare the distributions themselves. Problems such as these are called two-sample problems. In some sense, the two-sample problem is more important than the one-sample problem.

**positively skewed distribution:**

****

**What is better?**

NP tests can be applied to Normal data but parametric tests have greater power IF assumptions met

|  |  |
| --- | --- |
| **Parametric** | **Non Parametric** |
| actual values | ranks |
| Can not be applied to non parametric data | can be applied to parametric data |
| More powerful | Less powerful |
| In symmetric distributions the mean and median are the same  **measure of central tendency**: mean & median | In skewed distributions, median more appropriate  **measure of central tendency**: median |
| Mean nearly equal median | Mean differ largely from median |

|  |  |
| --- | --- |
| **Parametric Tests** | **Non-parametric Tests** |
| **Single sample t-test** | **Wilcoxon-signed rank test** |
| **Paired sample t-test** | **Paired Wilcoxon-signed rank** |
| **2 independent samples t-test** | **Mann-Whitney test(Wilcoxon Rank Sums test!)** |
| **One-way Analysis of Variance** | **Kruskal-Wallis** |
| **Pearson’s correlation** | **Spearman Rank** |
| **Repeated Measures** | **Friedman** |

**Examples on tests non parametric**

1. **The Wilcoxon Signed Rank Test for Paired Comparisons:**
   1. A group of 10 patients with chronic anxiety receive sessions of cognitive therapy. Quality of Life scores are measured before and after therapy.

|  |  |  |
| --- | --- | --- |
| QoL Score | |  |
| Before | **After** | **Diff** |
| 6 | **9** | **3** |
| 5 | **12** | **7** |
| 3 | **9** | **6** |
| 4 | **9** | **5** |
| 2 | **3** | **1** |
| 1 | **1** | **0** |
| 3 | **2** | **-1** |
| 8 | **12** | **4** |
| 6 | **9** | **3** |
| 12 | **10** | **-2** |

* 1. A firm has decided to select one of two express delivery services to provide next-day deliveries to the district offices. To test the delivery times of the two services, the firm sends two reports to a sample of 10 district offices, with one report carried by one service and the other report carried by the second service.

Do the data (delivery times in hours) on the next slide indicate a difference in the two services? ch19 non parametric ppt 🡪 ppt file slide 10-15 , See example on instat,

**District Office Overnight NiteFlite**

Seattle 32 hrs. 25 hrs.

Los Angeles 30 24

Boston 19 15

Cleveland 16 15

New York 15 13

Houston 18 15

Atlanta 14 15

St. Louis 10 8

Milwaukee 7 9

Denver 16 11

**Preliminary Steps of the Test**

* + Compute the differences between the paired observations.
  + Discard any differences of zero.
  + Rank the absolute value of the differences from lowest to highest. Tied differences are assigned the average ranking of their positions.
  + Give the ranks the sign of the original difference in the data.
  + Sum the signed ranks.

. . . next we will determine whether the sum is significantly different from zero.

**District Office Differ. |Diff.| Rank Sign. Rank**

Seattle 7 10 +10

Los Angeles 6 9 +9

Boston 4 7 +7

Cleveland 1 1.5 +1.5

New York 2 4 +4

Houston 3 6 +6

Atlanta -1 1.5 -1.5

St. Louis 2 4 +4

Milwaukee -2 4 -4

Denver 5 8 +8

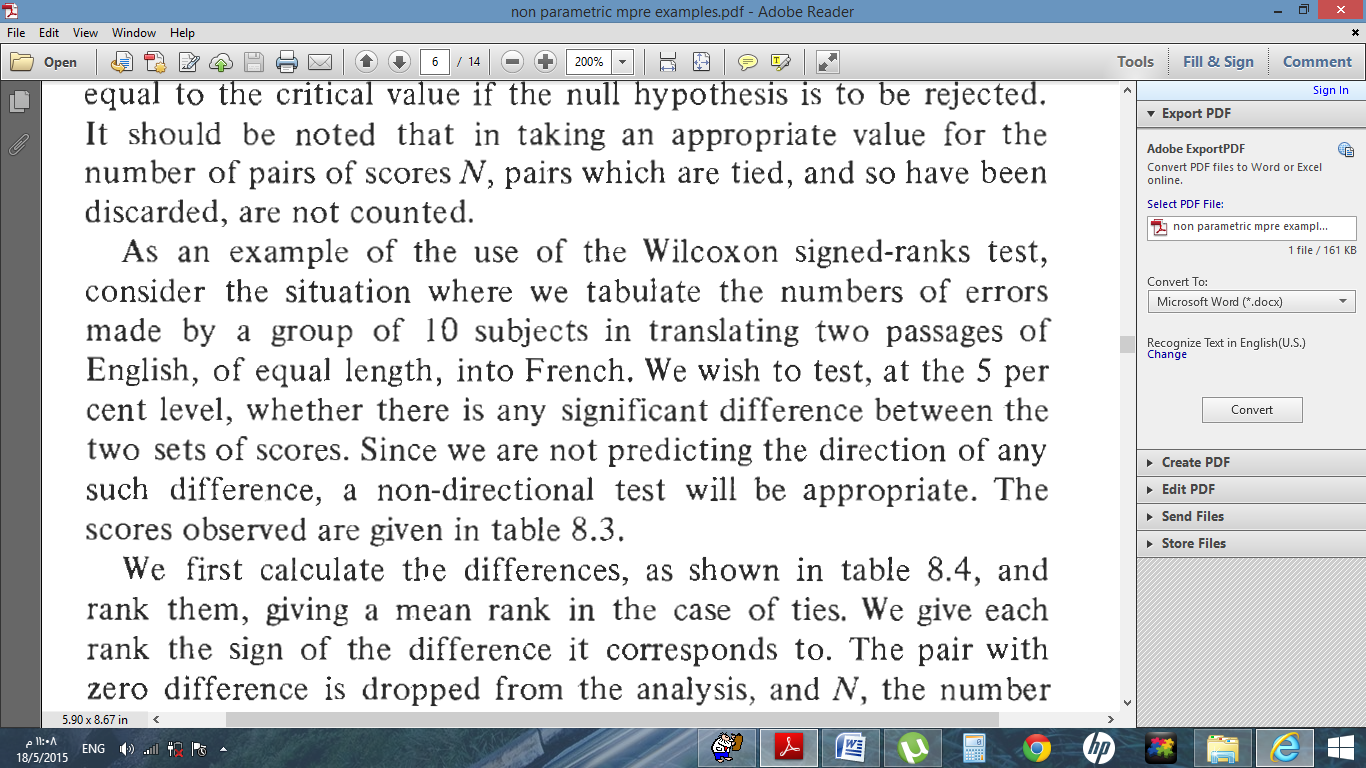
+44

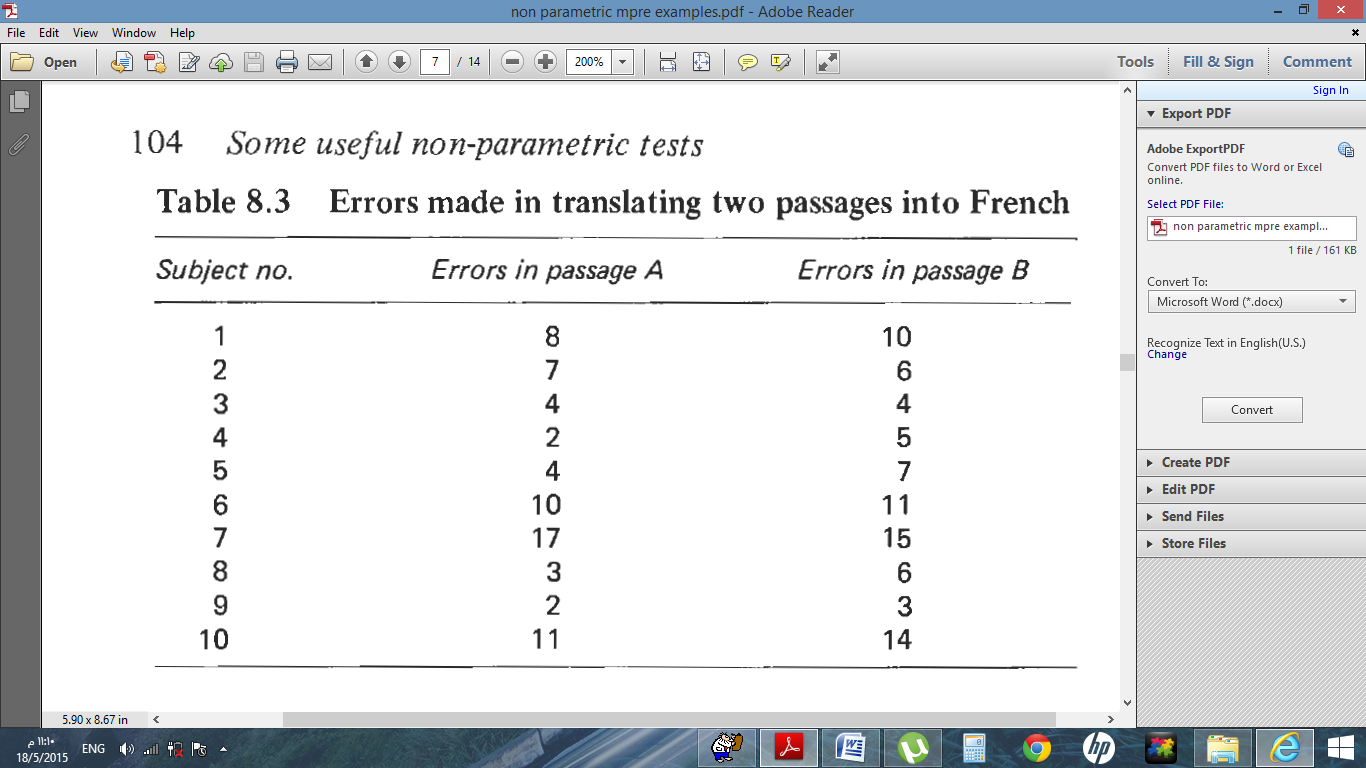
**Answer from ppt:**

Reject *H*0. There is sufficient evidence in the sample to conclude that a difference exists in the delivery times provided by the two services. Recommend using the NiteFlite service.

**Answer from instat:**

considered significant





1. **Mann-Whitney test Ξ Wilcoxon Rank Sum**

* The only requirement is that the measurement scale for the data is at least **ordinal**.
* Take into account 🡪Sums of the ranks. Kruskal-Wallis Test gd
  1. The following data shows the number of alcohol units per week collected in a survey: Non-parametric\_methods\_0 ok 🡪 slide 28

Men (n=13): 0,0,1,5,10,30,45,5,5,1,0,0,0

Women (n=14): 0,0,0,0,1,5,4,1,0,0,3,20,0,0

Is the amount greater in men compared to women?

* 1. Manufacturer labels indicate the annual energy cost associated with operating home appliances such as freezers.

The energy costs for a sample of 10 Westin freezers and a sample of 10 Brand-X Freezers are shown on the next slide. Do the data indicate, using a = .05, that a difference exists in the annual energy costs associated with the two brands of freezers? ch19 non parametric ppt 🡪 ppt file slide 18-15,

**Westin Freezers Brand-X Freezers**

$55.10 $56.10

54.50 54.70

53.20 54.40

53.00 55.40

55.50 54.10

54.90 56.00

55.80 55.50

54.00 55.00

54.20 54.30

55.20 57.00

* + Hypotheses

*H*0: Annual energy costs for Westin freezers and Brand-X freezers are the same.

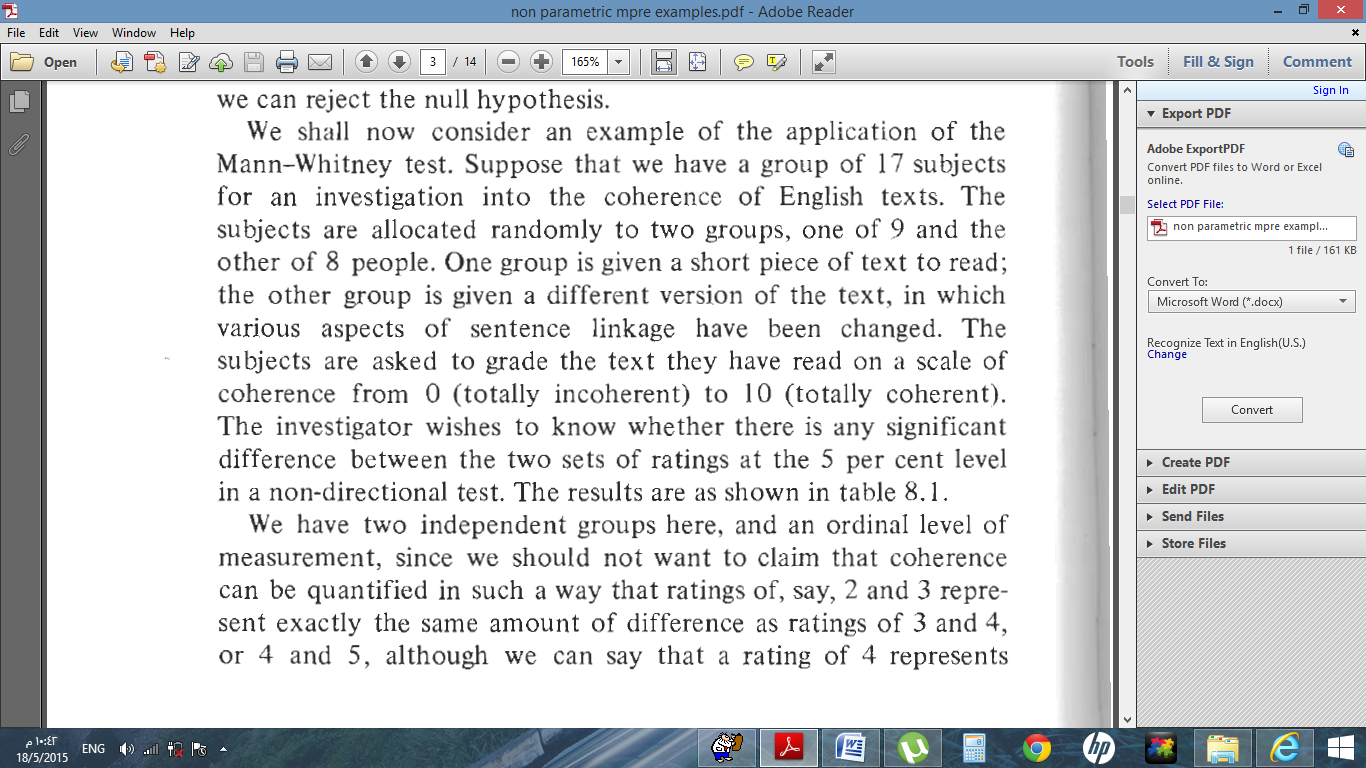
*H*a: Annual energy costs differ for the two brands of freezers.

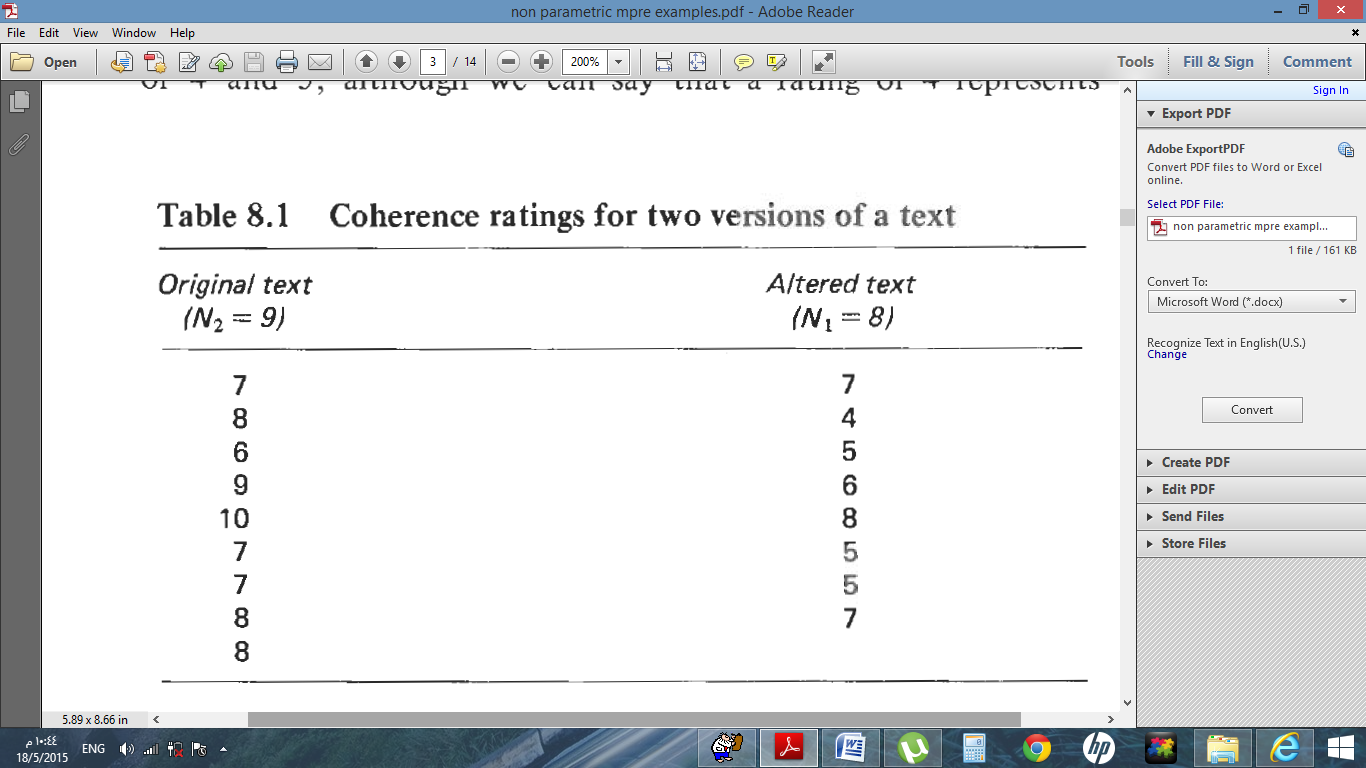
**Answer from ppt:**

Do not reject H0. There is insufficient evidence in the sample data to conclude that there is a difference in the annual energy cost associated with the two brands of freezers.

**Answer from instat:**

Considered not significant





1. **Kruskal-Wallis:**

* If independent samples. Non-parametric\_methods\_0 ok
* The Kruskal-Wallis test can be used with **ordinal** data as well as with **interval** or **ratio** data. ch19 non parametric ppt
* The test does not identify where this [stochastic[http://cdncache-a.akamaihd.net/items/it/img/arrow-10x10.png](http://en.wikipedia.org/wiki/Kruskal%E2%80%93Wallis_one-way_analysis_of_variance)](http://en.wikipedia.org/wiki/Kruskal%E2%80%93Wallis_one-way_analysis_of_variance) dominance occurs or for how many pairs of groups stochastic dominance obtains. Dunn's test would help analyze the specific sample pairs for stochastic dominance. <http://en.wikipedia.org/wiki/Kruskal%E2%80%93Wallis_one-way_analysis_of_variance>
* **Post test (Dunn's test), which:**

1. properly employs the same rankings as the Kruskal-Wallis test, and
2. properly employs the pooled variance implied by the null hypothesis of the Kruskal-Wallis test in order to determine which of the sample pairs are significantly different <http://en.wikipedia.org/wiki/Kruskal%E2%80%93Wallis_one-way_analysis_of_variance>

* A large amount of computing resources is required to compute exact probabilities for the Kruskal-Wallis test. Existing software only provides exact probabilities for sample sizes less than about 30 participants. These software programs rely on asymptotic approximation for larger sample sizes. Exact probability values for larger sample sizes are available. Spurrier (2003) published exact probability tables for samples as large as 45 participants. Meyer and Seaman (2006) produced exact probability distributions for samples as large as 105 participants. <http://en.wikipedia.org/wiki/Kruskal%E2%80%93Wallis_one-way_analysis_of_variance>
* Kruskal-Wallis much the same as Mann-Whitney 🡪 **But** , the Kruskal-Wallis we take account not only of sums of the ranks, but also of the averages of ranks. Kruskal-Wallis Test gd
* Kruskal-Wallis take into account 🡪 sums of the ranks + averages of ranks. Kruskal-Wallis Test gd
* And now for the denouement. When each of the **k** samples includes at least 5 observations (that is, when na, nb, nc, etc., are all equal to or greater than 5), the sampling distribution of **H** is a very close approximation of the chi-square distribution for **df**=**k**—1. It is actually a fairly close approximation even when one or more of the samples includes as few as 3 observations. Kruskal-Wallis Test gd
  1. To assess the effects of expectation on the perception of aesthetic quality, an investigator randomly sorts 24 amateur wine aficionados into three groups, A, B, and C. Subjects are each asked to rate the overall quality of each of three wines on a 10-point scale, with "1" standing at the bottom of the scale and "10" at the top. the three wines are the same for all subjects. The only difference is in the texture of the interview, which is designed to induce a relatively high expectation of quality in the members of group A; a relatively low expectation in the members of group C; and a merely neutral state, tending in neither the one direction nor the other, for the members of group B.

|  |  |  |
| --- | --- | --- |
| Group | | |
|  | A | B | C |
|  | 6.4   6.8   7.2   8.3   8.4   9.1   9.4   9.7 | 2.5   3.7   4.9   5.4   5.9   8.1   8.2 | 1.3   4.1   4.9   5.2   5.5   8.2 |
| mean | 8.2 | 5.5 | 4.9 |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Raw Measures | | |  | Ranked Measures | | |
|  | A | B | C | A | B | C |
|  | 6.4   6.8   7.2   8.3   8.4   9.1   9.4   9.7 | 2.5   3.7   4.9   5.4   5.9   8.1   8.2 | 1.3   4.1   4.9   5.2   5.5   8.2 | 11 12 13 17 18 19 20 21 | 2 3 5.5 8 10 14 15.5 | 1 4 5.5 7 9 15.5 | A, B, C Combined |
|  | sum of ranks | | | | 131 | 58 | 42 | 231 |
| average of ranks | | | | 16.4 | 8.3 | 7.0 | 11 |

**Answer from ppt:**

Observed aggregate difference among the three samples is significant a bit beyond the .01 level

**Answer from instat:**

Considered very significant. Variation among column medians is significantly greater than expected by chance.

* 1. Does physical exercise alleviate depression? We find some depressed people and check that they are all equivalently depressed to begin with. Then we allocate each person randomly to one of three groups: no exercise; 20 minutes of jogging per day; or 60 minutes of jogging per day. At the end of a month, we ask each participant to rate how depressed they now feel, on a Likert scale that runs from 1 ("totally miserable") through to 100 (ecstatically happy").

|  |  |  |
| --- | --- | --- |
| (No exercise) | Jogging for  20 minutes | Jogging for  60 minutes) |
| 23 | 22 | 59 |
| 26 | 27 | 66 |
| 51 | 39 | 38 |
| 49 | 29 | 49 |
| 58 | 46 | 56 |
| 37 | 48 | 60 |
| 29 | 49 | 56 |
| 44 | 65 | 62 |

**Answer (from ppt???):**

Because data are examples of ordinal data 🡪 we cannot use parametric test, so we will use non parametric test 🡪 and since we have 3 groups we will use Kruskal-Wallis test

**Answer from instat:**

We get that the test is significant

1. **Friedman:**

* If related samples. Non-parametric\_methods\_0 ok
  1. illustrate the Friedman test with a rating-scale example that is close to my amateur violinist's heart. The venerable auction house of Snootly & Snobs will soon be putting three fine 17th-and 18th-century violins, A, B, and C, up for bidding. A certain musical arts foundation, wishing to determine which of these instruments to add to its collection, arranges to have them played by each of 10 concert violinists. The players are blindfolded, so that they cannot tell which violin is which; and each plays the violins in a randomly determined sequence (BCA, ACB, etc.).

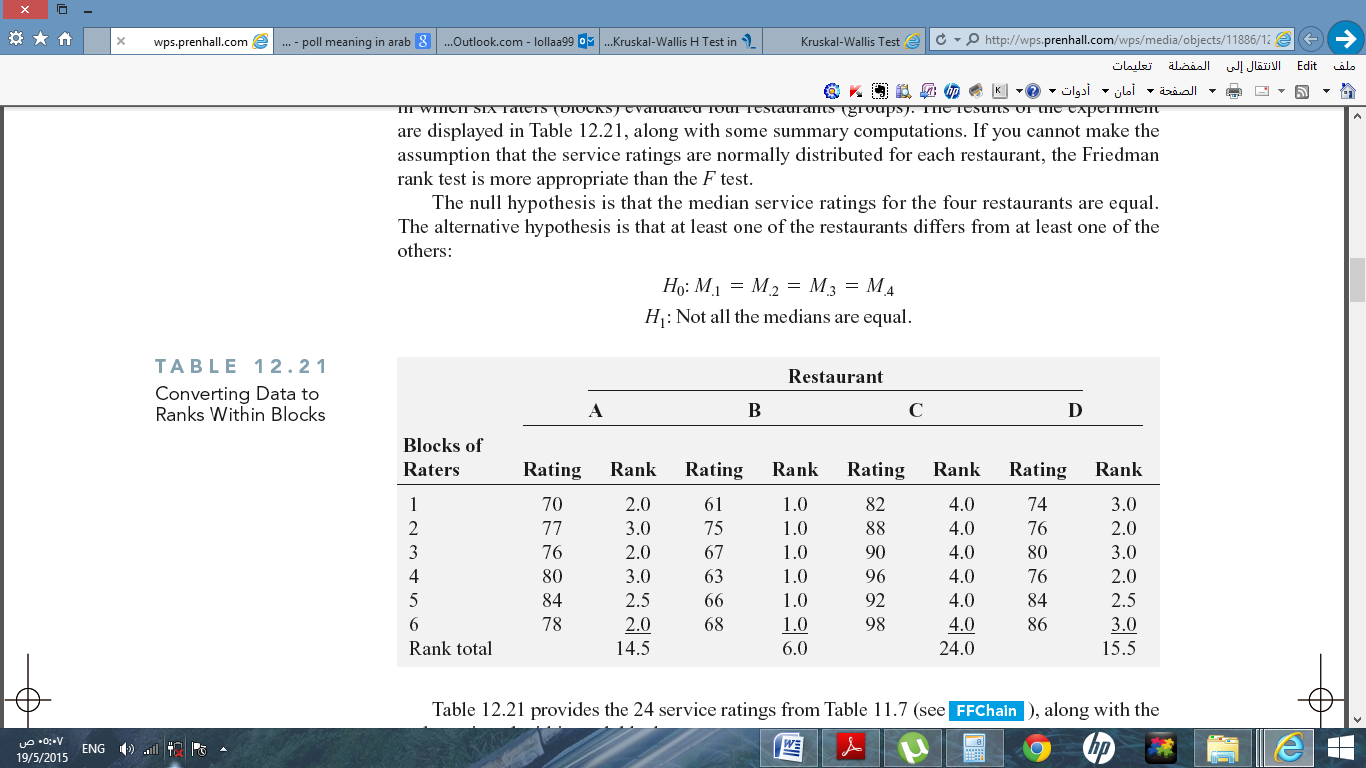
They are not informed that the instruments are classic masterworks; all they know is that they are playing three different violins. After each violin is played, the player rates the instrument on a 10-point scale of overall excellence (1=lowest, 10=highest). The players are told that they can also give fractional ratings, such as 6.2 or 4.5, if they wish. The results are shown in the adjacent table. For the sake of consistency, the n=10 players are listed as "subjects." <http://vassarstats.net/textbook/ch15a.html>

|  |  |  |
| --- | --- | --- |
| Violin | | |
| subjects | A | B | C |
| 1   2   3   4   5   6   7   8   9   10 | 9.0 9.5 5.0 7.5 9.5 7.5 8.0 7.0 8.5 6.0 | 7.0 6.5 7.0 7.5 5.0 8.0 6.0 6.5 7.0 7.0 | 6.0 8.0 4.0 6.0 7.0 6.5 6.0 4.0 6.5 3.0 |

* 1. In a poll 10 subjects rated 4 different paintings on a scale from 0 (don’t like it at all) to 5 (like it very much). The following table shows the data and ranks for all tubjects and paintings: <https://secure.brightstat.com/index.php?p=c&d=1&c=2&i=9>

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Paintings | | | | | | | |
|  | 1 | Rank | 2 | Rank | 3 | Rank | 4 | Rank |
| 1 | 0 | 1 | 5 | 4 | 1 | 2 | 4 | 3 |
| 2 | 3 | 2 | 4 | 3 | 2 | 1 | 5 | 4 |
| 3 | 1 | 1 | 4 | 3.5 | 3 | 2 | 4 | 3.5 |
| 4 | 4 | 4 | 2 | 1.5 | 2 | 1.5 | 3 | 3 |
| 5 | 2 | 1.5 | 2 | 1.5 | 4 | 4 | 3 | 3 |
| 6 | 0 | 1 | 3 | 2 | 5 | 3.5 | 5 | 3.5 |
| 7 | 3 | 2.5 | 1 | 1 | 3 | 2.5 | 4 | 4 |
| 8 | 5 | 3.5 | 3 | 2 | 1 | 1 | 5 | 3.5 |
| 9 | 1 | 1 | 5 | 4 | 2 | 2 | 4 | 3 |
| 10 | 2 | 2 | 4 | 4 | 0 | 1 | 3 | 3 |

* 1. To illustrate the Friedman rank test, return to the fast-food chain study from Section 11.2, in which six raters (blocks) evaluated four restaurants (groups). The results of the experiment are displayed in Table 12.21, along with some summary computations. If you cannot make the assumption that the service ratings are normally distributed for each restaurant, the Friedmanrank test is more appropriate than the F test. http://wps.prenhall.com/wps/media/objects/11886/12171343/OnlineTopics/bbs12e\_onlinetopic\_ch12-9.pdf



* 1. Example: The hypothesis tested is that prices should decrease with distance from the key area of gentrification surrounding the Contemporary Art Museum. The line followed is Transect 2 in the map below, with continuous sampling of the price of a 50cl bottle water at every convenience store. http://geographyfieldwork.com/SpearmansRank.htm

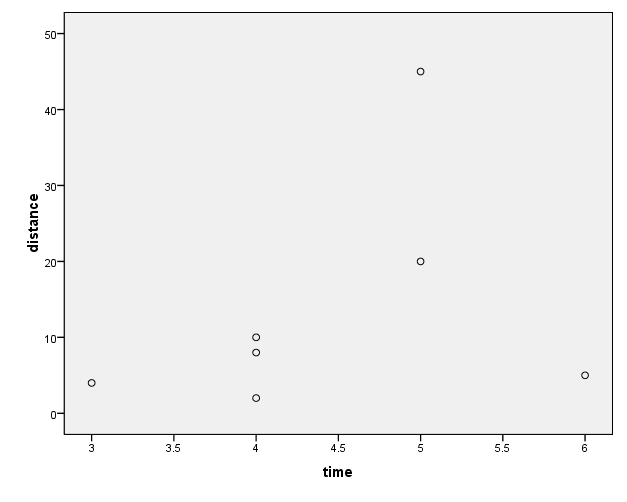
1. **Spearman Rank Correlation**:

* The only test that rank each group alone.
* The Spearman rank-correlation coefficient, rs , is a measure of association between two variables when only **ordinal** data are available. ch19 non parametric ppt 🡪 ppt file slide 26,
* Values of *rs* can range from –1.0 to +1.0, where:

1. values near 1.0 indicate a strong positive association between the rankings, and
2. values near -1.0 indicate a strong negative association between the rankings.
   1. A researcher wishes to assess whether the distance to general practice influences the time of diagnosis of colorectal cancer. The null hypothesis would be that distance is not associated with time to diagnosis. Data collected for 7 patients

**Distance from GP and time to diagnosis**

|  |  |
| --- | --- |
| Distance (km) | Time to diagnosis (weeks) |
| 5 | **6** |
| 2 | **4** |
| 4 | **3** |
| 8 | **4** |
| 20 | **5** |
| 45 | **5** |
| 10 | **4** |



* 1. Connor Investors provides a portfolio management service for its clients. Two of Connor’s analysts rated ten investments from high (6) to low (1) risk as shown below. Use rank correlation, with a = .10, to comment on the agreement of the two analysts’ ratings.

**Investment A B C D E F** G H I J

**Analyst #1** 1 4 9 8 6 3 5 7 2 10

**Analyst #2** 1 5 6 2 9 7 3 10 4 8

**Analyst #1 Analyst #2**

**Investment**  **Rating** **Rating**  **Differ. (Differ.)2**

A 1 1 0 0

B 4 5 -1 1

C 9 6 3 9

D 8 2 6 36

E 6 9 -3 9

F 3 7 -4 16

G 5 3 2 4

H 7 10 -3 9

I 2 4 -2 4

J 10 8 2 4

Sum = 92

**Answer from ppt:**

Do no reject H0. There is not a significant rank correlation. The two analysts are not showing agreement in their rating of the risk associated with the different investments.

**Answer from instat:**

considered not significant.

* 1. **The data:** The variables for this analysis are **fishnum** (number of fish displayed) and **fishgood** (rating of fish quality on a 1-10 scale).

32,6 41,5 31,3 38,3 21,7 13,9 17,9 22,8 24,6 11,9 17,7 20,8

Research Hypothesis: Knowing that store owners are often over-worked, the researcher hypothesized that stores with fewer fish would have healthier fish (thus predicting a negative or inverse relationship between these variables in this population). <http://psych.unl.edu/psycrs/handcomp/hcspear.PDF>

**Answer from ppt:**

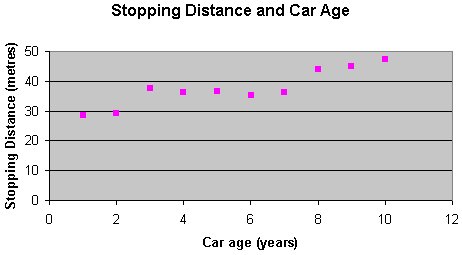
This result supports the research hypothesis that those stores with fewer fish tended to have healthier fish, whereas those stores with more fish would tend to have fish with lower health quality.

* 1. Researchers at the European Centre for Road Safety Testing are trying to find out how the age of cars affects their braking capability. They test a group of ten cars of differing ages and find out the minimum stopping distances that the cars can achieve. The results are set out in the table below:

**Table 1: Car ages and stopping distances**

|  |  |  |
| --- | --- | --- |
| **Car** | **Age (months)** | **Minimum Stopping at 40 kph (metres)** |
| A | 9 | 28.4 |
| B | 15 | 29.3 |
| C | 24 | 37.6 |
| D | 30 | 36.2 |
| E | 38 | 36.5 |
| F | 46 | 35.3 |
| G | 53 | 36.2 |
| H | 60 | 44.1 |
| I | 64 | 44.8 |
| J | 76 | 47.2 |

These figures form the basis for the scatter diagram, below, which shows a reasonably strong positive correlation - the older the car, the longer the stopping distance.



|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Car** | **Age (months)** | **Minimum Stopping at 40 kph (metres)** | **Age rank** | **Stopping rank** |
| A | 9 | 28.4 | 1 | 1 |
| B | 15 | 29.3 | 2 | 2 |
| C | 24 | 37.6 | 3 | 7 |
| D | 30 | 36.2 | 4 | 4.5 |
| E | 38 | 36.5 | 5 | 6 |
| F | 46 | 35.3 | 6 | 3 |
| G | 53 | 36.2 | 7 | 4.5 |
| H | 60 | 44.1 | 8 | 8 |
| I | 64 | 44.8 | 9 | 9 |
| J | 76 | 47.2 | 10 | 10 |

**Answer from ppt:**

So in the above case, there is evidence of strong positive correlation between stopping distance and age of car; in other words, the older the car, the longer the distance we could expect it to take to stop.

* 1. Let's say that we want to track the progress of a group of new employees of a large service organization. We think we can judge the effectiveness of our induction and initial training scheme by analysing employee competence in weeks one, four and at the end of the six months.

Let's say that Human Resource managers in their organization have been urging the company to commit more resources to induction and basic training. The company now wishes to know which of the two assessments - the new employee's skills on entry or after week four - provides a better guide to the employee's performance after six months. Although there is a small sample here, let's assume that it is accurate.

**Answer from ppt:**

The correlation between the Entry Mark and the Final Mark is 0.23; the correlation between the four week test and the Final Mark is 0.28. Thus, both of the tests have a positive correlation to the Final (6 month) Test; the entry test has a slightly weaker positive correlation with the Final Mark, than the Four Week Test. However, both figures are so low, that the correlation is minimal. The skills measured by the Entry test account for about 5 per cent of the skills measured by the Six Month Mark.

|  |  |  |  |
| --- | --- | --- | --- |
| **Name** | **Skills on entry % score** | **Skills at week 4 % score** | **Skills at 6 mths % score** |
| ab | 75 | 75 | 75 |
| bc | 72 | 69 | 76 |
| cd | 82 | 76 | 83 |
| de | 78 | 77 | 65 |
| ef | 86 | 79 | 85 |
| fg | 76 | 65 | 79 |
| gh | 86 | 82 | 65 |
| hi | 89 | 78 | 75 |
| ij | 83 | 70 | 80 |
| jk | 65 | 71 | 70 |

1. **Chi-Squared (Χ2):**

* If the assumptions are not satisfied

If E < 5 in any one cell, we use Fisher's exact test to obtain a P-value that does not rely on the approximation to the Chi- squared distribution.This is best left to a computer program as the calculations are tedious to perform by hand. MedicalStatisticsAtAGlance2000Petrie

* **If the estimated data in any given cell is below 5** 🡪 use fisher instead <http://www.ling.upenn.edu/~clight/chisquared.htm>
* Hypotheses: <http://stattrek.com/chi-square-test/goodness-of-fit.aspx?Tutorial=AP>

H0: The data are consistent with a specified distribution.   
Ha: The data are not consistent with a specified distribution.

* The variables you consider must be mutually exclusive; participation in one category should not entail or allow participation in another. In other words, the data from all of your cells should add up to the total count, and no item should be counted twice. <http://www.ling.upenn.edu/~clight/chisquared.htm>
* **Degrees of Freedom :** 2x2 grid, the degrees of independence are therefore (2-1)\*(2-1), or **1** <http://www.ling.upenn.edu/~clight/chisquared.htm>
  1. Acme Toy Company prints baseball cards. The company claims that 30% of the cards are rookies, 60% veterans, and 10% are All-Stars. The cards are sold in packages of 100. Suppose a randomly-selected package of cards has 50 rookies, 45 veterans, and 5 All-Stars. Is this consistent with Acme's claim? Use a 0.05 level of significance.
* Null hypothesis: The proportion of rookies, veterans, and All-Stars is 30%, 60% and 10%, respectively.
* Alternative hypothesis: At least one of the proportions in the null hypothesis is false.

**Answer from ppt:**

**Interpret results**. Since the P-value (0.0001) is less than the significance level (0.05), we cannot accept the null hypothesis.

**Note:** If you use this approach on an exam, you may also want to mention why this approach is appropriate. Specifically, the approach is appropriate because the sampling method was simple random sampling, the population was more than 10 times larger than the sample, the variable under study was categorical, and each level of the categorical variable had an expected frequency count of at least 5.

|  |  |  |  |
| --- | --- | --- | --- |
|  | normal | hyper | Total |
| Placebo | 14 (18.57) | 36 (31.4) | 50 (raw total) |
| Losartan | 25 (20.4) | 30 (34.57) | 55 (raw total) |
| Total | 39 (column total) | 66 (column total) | 105 (grand total) |

Expected= (raw total) x (column total)/ (grand total)

= 50 x 39 /105 = 18.57

X2 =

= = 20.25 🡪 20.25 + …….

* 1. For example, if you want to test whether attending class influences how students perform on an exam, using test scores (from 0-100) as data would not be appropriate for a Chi-square test. However, arranging students into the categories "Pass" and "Fail" would. Additionally, the data in a Chi-square grid should not be in the form of percentages, or anything other than frequency (count) data. Thus, by dividing a class of 54 into groups according to whether they attended class and whether they passed the exam, you might construct a data set like this: <http://www.ling.upenn.edu/~clight/chisquared.htm>

|  |  |  |  |
| --- | --- | --- | --- |
|  | Pass | Fail | Total |
| Attended | 25  (18.94) | 6  (12.05) | 31 |
| Skipped | 8  (14.05) | 15  (8.94) | 23 |
| Total | 33 | 21 | 54 |

6.4.

|  |  |  |  |
| --- | --- | --- | --- |
|  | Democrat | Republican | Total |
| Male | 20 | 30 | 50 |
| Female | 30 | 20 | 50 |
| Total | 50 | 50 | 100 |

* 1. For example, suppose that a cross between two pea plants [yields[http://cdncache-a.akamaihd.net/items/it/img/arrow-10x10.png](http://www2.lv.psu.edu/jxm57/irp/chisquar.html)](http://www2.lv.psu.edu/jxm57/irp/chisquar.html) a population of 880 plants, 639 with green seeds and 241 with yellow seeds. You are asked to propose the genotypes of the parents. Your hypothesis is that the allele for green is dominant to the allele for yellow and that the parent plants were both heterozygous for this trait. If your hypothesis is true, then the predicted ratio of offspring from this cross would be 3:1 (based on Mendel's laws) as predicted from the results of the Punnett square
  2. Suppose you conducted a drug trial on a group of animals and you hypothesized that the animals receiving the drug would show increased heart rates compared to those that did not receive the drug. You conduct the study and collect the following data:

|  |  |  |  |
| --- | --- | --- | --- |
|  | Heart Rate  Increased | No Heart Rate  Increase | Total |
| Treated | 36 | 14 | 50 |
| Not treated | 30 | 25 | 55 |
| Total | 66 | 39 | 105 |

>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>

**Transformation**

1. **why use transformation:**

To change from non-parametric diagram to parametric (ex. non linear to linear), after that if still not normal, use non-parametric test. MedicalStatisticsAtAGlance2000Petrie

1. **How do we transform:**

* Log 🡪 skew to the right (+ skew), **logarithmic transformation, *z*** = **logy**
* y2 🡪 skew to the left (- skew), **The square transformation,** *z* **=y2**
* 🡪 **The reciprocal transformation,** *z* = **l/y** , used when we have dilution
* 🡪 skew to the right (+ skew), 🡪 skew to the left (- skew) ?????????
* *z* = **In *P/*1- P The logit (logistic) transformation** MedicalStatisticsAtAGlance2000Petrie

Note: most common 🡪 log 🡪(non linear)

🡪(Dilution)

**>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>**

**Chi-Squared (Χ2)**

* If the assumptions are not satisfied

If E < 5 in any one cell, we use **Fisher's exact test** to obtain a P-value that does not rely on the approximation to the Chi- squared distribution.This is best left to a computer program as the calculations are tedious to perform by hand.

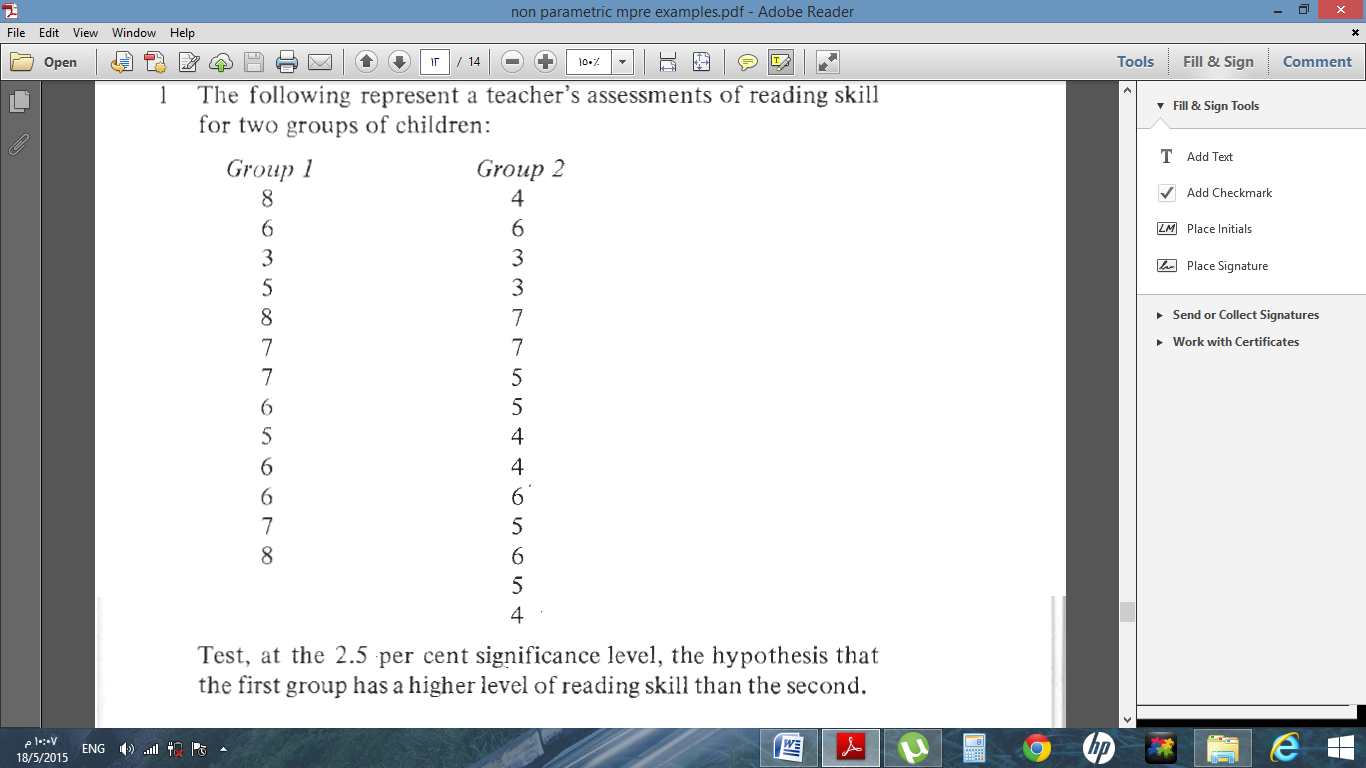
* Hypotheses:

H0: The data are consistent with a specified distribution.   
Ha: The data are not consistent with a specified distribution.

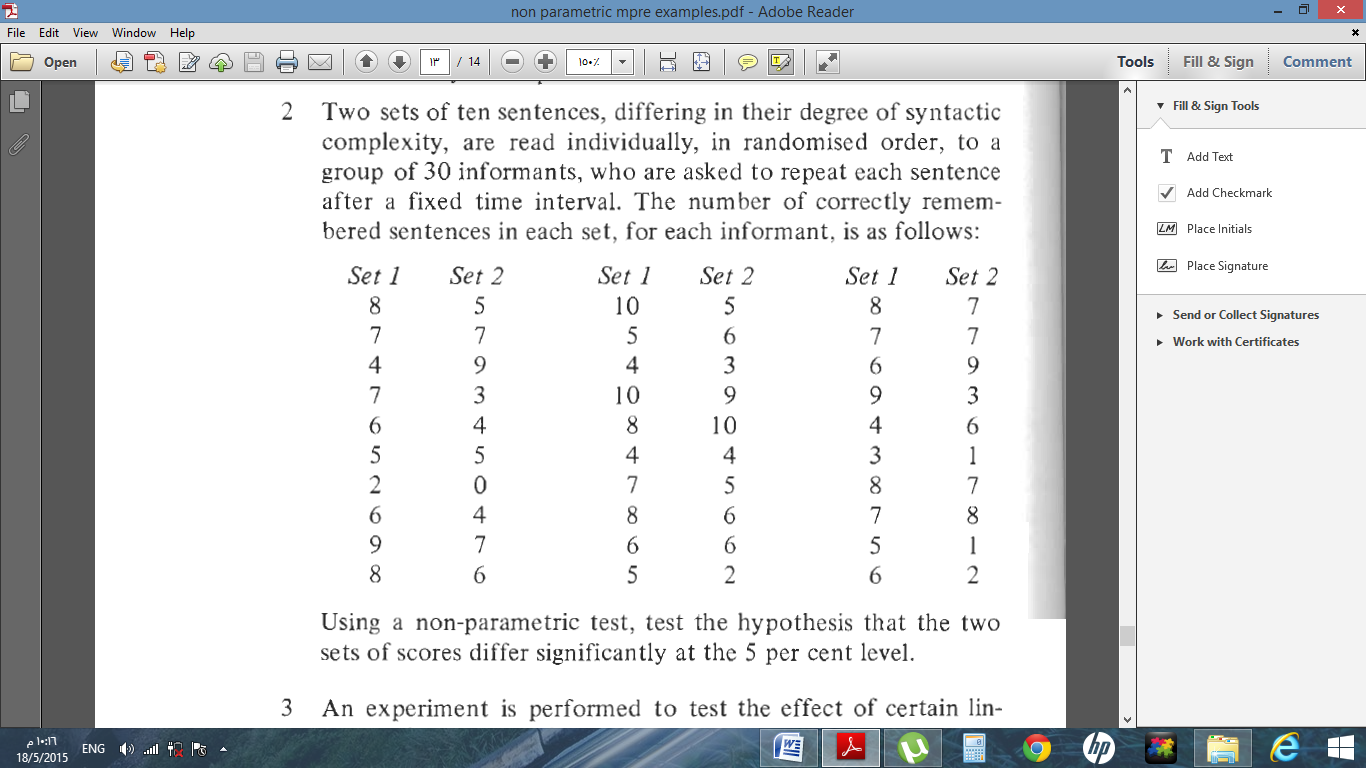
**>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>**

**Exercises**

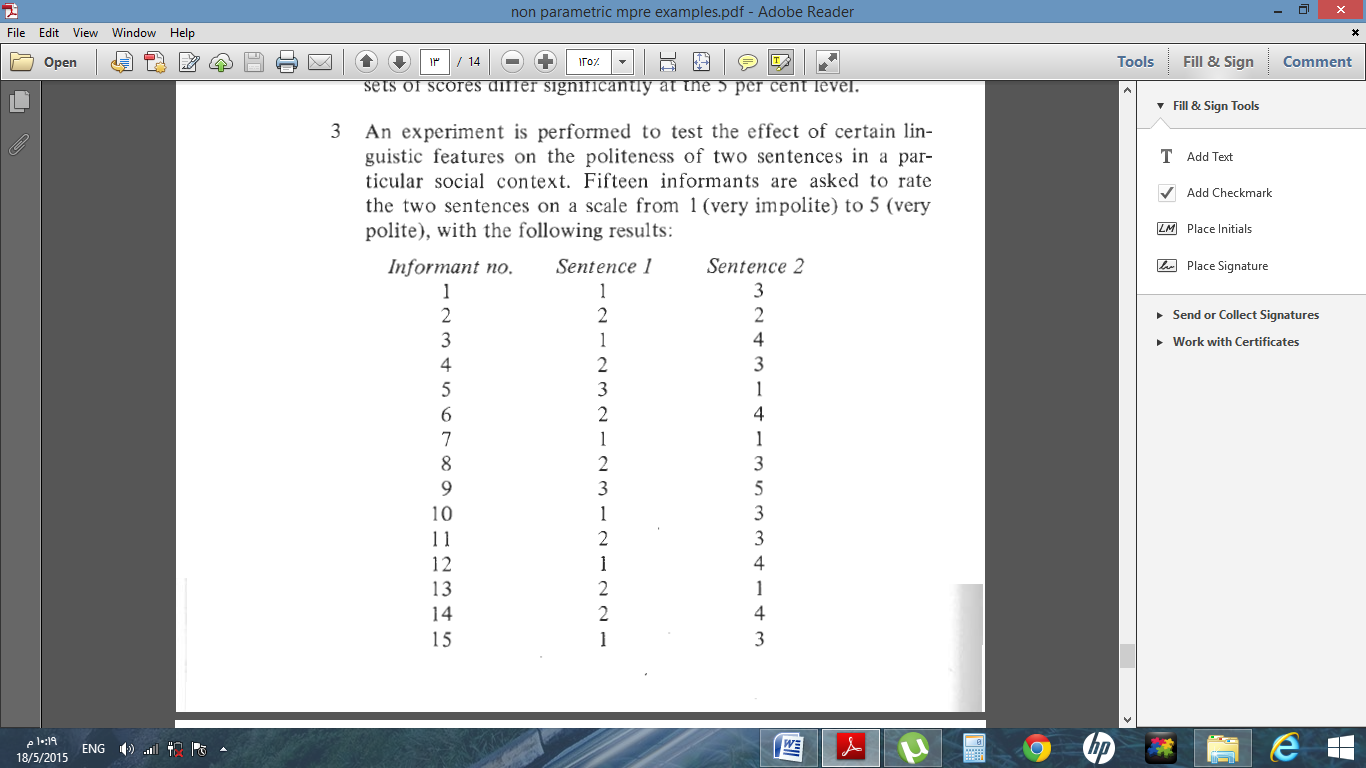
**Pdf: non parametric mpre examples**

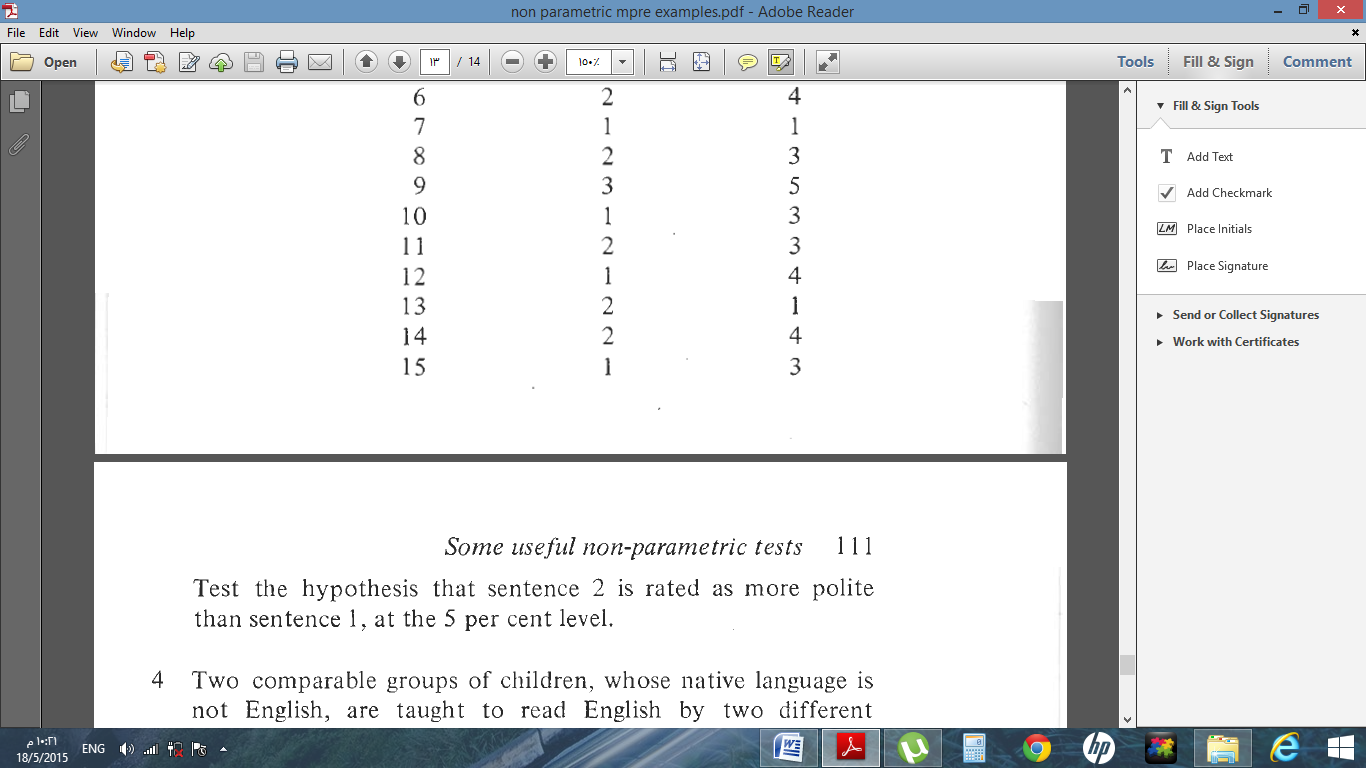
****

Answer: Mann-whitney, instat 🡪 significant.

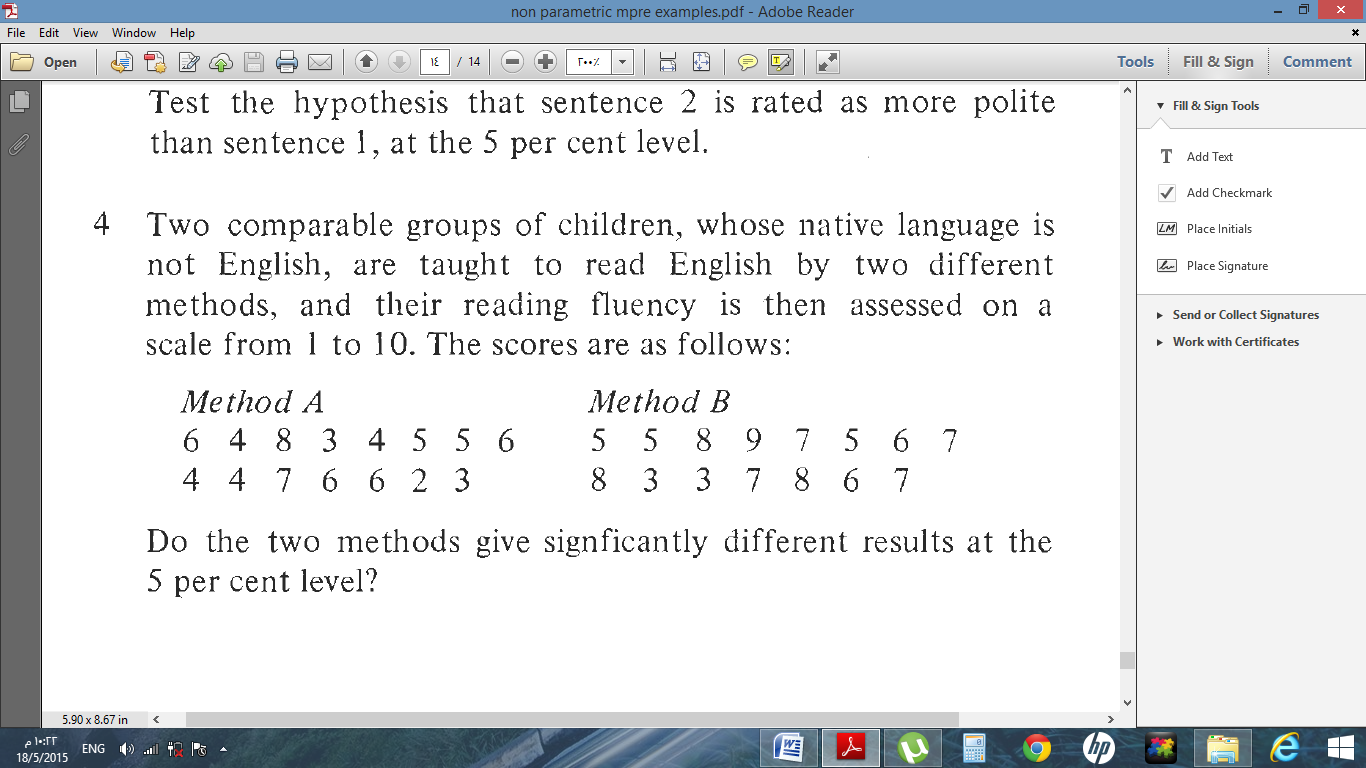


Answer: Wilcoxon signed





Answer: Wilcoxon signed



Answer: Mann-whitney

***Good luck,***

***Alaa Felimban***