**COM 968-32 : Statistics for Social Research II**

**(Fall 2024, Sub-term A)**

**Assignment No. 1**

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**Assignment #1: Discussion Questions**

Answer the following questions in short answer format and be prepared to discuss them with your classmates in the virtual residency or the discussion forum.

1. What is the purpose of assumptions tests and what do they tell us about a given sample of data?
2. How are histograms and box-whisker plots helpful when evaluating a sample against a normal distribution?
3. How does normality help inform whether we can use parametric (generalizable to the target population) vs nonparametric procedures (applicable only to the sample)?
4. Determine when to use a t-test and Pearson’s r or their nonparametric equivalents to test hypotheses.
5. Navitage to OGS’s Practical Statistics for Social Research (PSSR) tool. Click on “Example Datasets” and load the “Dependent t-Test: Achievement Scores” dataset. Click on “Descriptives” and then on “Assumptions”. What do the histograms and box and whisker plots tell you about the normality of the samples? Now, click on “Tools and Options” and then “Generate Normal Distributions”. Re-run the “Descriptives” and “Assumptions”. How are the normal distributions different from the original samples?

**Introduction**

This study covers some statistical principles and practice of assumption testing, to determine the efficacy in the evaluation and validation of a given sets of data, with empahasis on the trend in the Groups’ dependent and independent variability. The similarity between the histograms and box-whisker plots are explored, to establish why they are helpful when evaluating a sample against a normal distribution. Moreover, there are the t-tests:used to compare the means of two groups (Fiandini et al., 2024; Li et al., 2024; Parekh, 2024) which requires normally distributed data. The other areas of study are the parametric and non-parametric procedures which are used when there is a large or specific sample size or when the sample meets certain assumptions about normality. The nonparametric test are used in specific sample analyzed, not the wider population. Other areas of study are the skewness which measures data asymmetry around the mean; Excess kurtosis which assesses tail heaviness relative to a normal distribution, indicating more or fewer outliers. There is the Kolmogorov-Smirnov statistic tests designed to match a specified distribution, with larger values suggesting greater divergence. The Shapiro-Wilk statistic tests normality is used where significant results imply a non-normal distribution (A’aqoulah et al., 2024; Reichard, 2024) and are crucial. The Levene’s Test and the F-Test for Equal Variances check for homogeneity across groups, which is essential for analyses assuming equal variances. Together, these tests inform the suitability of data for further parametric statistical procedures (Reichard, 2024). These statistical tests are crucial (de Souza et al., 2024; Yagin et al., 2024) in navigating multiple statistical inductive or deductive, descriptive or in quantitaive output findings.

1. What is the purpose of assumptions tests and what do they tell us about a given sample of data?

 Assumptions tests are used to validate whether a given data sample meets the necessary conditions and the assumptions required to accurately apply a specific statistical test (Shatz, I. (2024; Komatsu et al., 2024) essentially telling us if the conclusions drawn from the analysis are reliable and valid; if the assumptions are not met, the results of the statistical test may be inaccurate or misleading.  The tabular tables and charts derived offer a clear view of the data dynamics and how they are distributed in linear or non linear progressions.

The reminder is that assumptions are checked to ensure that the chosen statistical test is appropriate for the data and that the results can be confidently interpreted. Moreover, If assumptions are not met, it may indicate problems with data collection, data distribution, or the chosen statistical method, prompting the need to address these issues or select a different analysis technique.

**2)** How are histograms and box-whisker plots helpful when evaluating a sample against a normal distribution?

Histograms and box-whisker plots are helpful when assessing a sample alongside a normal distribution (Komatsu et al., 2024; Sandfeld, 2023) because a histogram visually shows the overall shape of the data distribution (Magrab, 2022 Geng, et al., 2024; Shatz, 2024) allowing you to see if it is similar to a bell curve (symmetrical and unimodal) characteristic of a normal distribution. By looking at the height of the bars, you observe the density and able to assess the concentration of data points in different ranges.mentioned earlier.

The box-whisker plot highlights prospective skewness by showing the position of the median relative to the quartiles and can also recognize outliers, which could indicate a deviation from normality. You easily detect the skewness if the median line within the box is not centered, it suggests a skewed distribution. Points that fall outside the whiskers are considered potential outliers, which can also indicate non-normality.  The relative lengths of the "box" (interquartile range) on either side of the median can also provide insight into potential skewness. Some argue while visual assessments are helpful, it's important to also use statistical tests like Shapiro-Wilk test to formally evaluate normality, especially when making critical decisions based on the data.

**The box and whisker plot examples:**

**The Assumption** is: 7 students get the following scores in 2 subjects:

 Figure 2.1

| **Student** | **Ann** | **Jacob** | **Susan** | **Rose** | **Tom** | **Peter** | **Kate** |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Scores in Maths | 35 | 45 | 56 | 66 | 71 | 78 | 91 |
| Scores in Physics | 30 | 45 | 68 | 70 | 78 | 83 | 85 |

A quick summary of the values for Box and Whisker chart are: Figure 2.2

|  **Maths** | **Physics** |
| --- | --- |
| Median= 66 | Median= 70 |
|  |  |
| Lower quartile= 42 | Lower quartile= 45 |
|  |  |
| Upper quartile= 78 | Upper quartile= 83 |
|  |  |
| Minimum value= 35 | Minimum value= 30 |
|  |  |
| Maximum value= 91 | Maximum value= 85 |

|  |
| --- |
| **Test Scores of 7 Students in 2 Subjects** |
| 100 |  |  91 |  85 | Third Quartile (Physics) |
| 80 |  |  |  | Third Quartile (Maths) |
| 60 |  |  |  |  |
| 40 |  |  |  | First Quartile Physics |
| 20 |  |  35 |  30 | First Quartile (Maths) |
|  |  | Maths  | Physics |  |

 Figure 2.3

 Figure 2.4



Figure 2.5



**Key**

* **Figures 2.1 to 2.3: are Box & Whisker Charts.** They are culled from: Source: Box and whisker plots / https://www.fusioncharts.com/resources/chart-primers/box-and-whisker-chart.
* The Box and Whisker charts are simple and can be analysed and illustrated visually or digitally.
* **Figures 2.4 and 2.5** are culled from Quartile: Definition, Finding, and Using- Statistics By Jim Frost.

The simple method for finding quartiles is to list the values in the dataset in numeric order. Then find the three values that split your data into quarters, as shown above and below. That is, Quartile, Q1 is 20, Q2 is 29 ,and Q3 is 39 shown below.

Quartiles are three values that split your dataset into quarters. These values are the following:

* Q1 First quartile: 25% of the data are below this value.
* Q2: Second quartile / Median: This value splits the data in half.
* Q3 Third quartile: 25% of the data are above this value (Frost, 2024).

3) How does normality help inform whether we can use parametric (generalizable to the target population) vs nonparametric procedures (applicable only to the sample)?

Parametric procedures are used when there is a large sample size or when the sample meets certain assumptions about normality. Normality helps determine whether to use parametric or nonparametric statistical procedures by indicating whether the data is likely drawn from a population with a normal distribution, which is a key assumption for using parametric tests. However, if the data is not normally distributed, then nonparametric tests, which make no such assumption, should be used instead, meaning the results will only be generalizable to the specific sample analyzed, not the wider population.

The Assumption is Parametric tests assume the data is normally distributed (or follows a known distribution) and can be used to make inferences about the population parameters like

mean and standard deviation. They allow for generalization to the wider population if the normality assumption holds true.

Nonparametric tests do not require the assumption of normality, making them suitable for data with unknown distributions or skewed data (Rani, 2024; Okoye & Hosseini, 2024) but the results are typically only applicable to the sample studied. To assess these tests, you examine the histograms, or Q-Q plots to see if the data appears roughly symetricaal and bell-shaped. Performing normality tests Shapiro-Wilk test will require one to statistically assess the likelihood of the data being normally distributed.

 **4)** Determine when to use a t-test and Pearson’s r or their nonparametric equivalents to test hypotheses.

A t-test is used to compare the means of two groups and the data is normally distributed, while using Pearson's- r when you want to assess the linear relationship between two continuous variables that are also normally distributed. For example, if the data does not meet these normality assumptions, it is advised to use the nonparametric equivalents like the Mann-Whitney U test (for comparing groups) or Spearman's rank correlation (for assessing relationships) instead.  The two seem to show some similarities in when utilized.

The T-test is used to compare the means of two groups, and requires normally distributed data. The Nonparametric alternative is Mann-Whitney U test.

The Pearson's r is used to measure the strength of a linear relationship between two continuous variables, and requires both variables to be normally distributed.

Moreover, the non parametric tests are used when the data is not normally distributed (Staňková & Střelec, 2024) when the data is ordinal (ranked), or a small sample size (mentioned earlier). These areas of studies were complemented by Statistical Procedures, the Parametric (Pearson’s correlation), and the Non-Parametric (Spearman’s Rank, and Kendall Tau-b procedures).

**5)**  Navitage to OGS’s Practical Statistics for Social Research (PSSR) tool. Click on “Example Datasets” and load the “Dependent t-Test: Achievement Scores” dataset. Click on “Descriptives” and then on “Assumptions”. What do the histograms and box and whisker plots tell you about the normality of the samples? Now, click on “Tools and Options” and then “Generate Normal Distributions”. Re-run the “Descriptives” and “Assumptions”. How are the normal distributions different from the original samples?

What the histograms and box and whisker plots tell about the normality of the samples:

* They show two Groups 1 and 2 with continous variables, with the mean values of zero distributions.
* The Pearson’s r-coeficients are NAN, not of values. They show the direction of a linear relationship between two continuous variables.
* The p-value is NAN, not of values. It serves as an alternative to rejection points to provide the smallest level of significance at which the null hypothesis may be rejected. A smaller p-value means stronger evidence in favor of the alternative hypothesis.
* There is a mix of Ho, non statistical significance and Ha statistical significant hypothesis.
* **In Step 3: The Run Statistical Procedures** **show:**

In the Ho hypothesis: No statistically significant relationship exists between Group 1 and Group 2.

In the Ha hypothesis: A statistically significant relationship exists between Group 1 and Group 2.

1. Quasi-Experimental / Causal-Comparative Designs, namely:
2. the Parametric (Pearson’s correlation).
3. And the Non-Parametric (Spearman’s Rank, and Kendall Tau-b).
4. Summary of Descriptive Assumption Tests: See details below:

Assumptions Tests in statistics evaluate whether data characteristics meet the conditions required for specific statistical tests.

Skewness measures data asymmetry around the mean; values far from zero suggest significant skew. Excess kurtosis assesses tail heaviness relative to a normal distribution, indicating more or fewer outliers.

The Kolmogorov-Smirnov statistic tests if a sample matches a specified distribution, with larger values suggesting greater divergence.

The Shapiro-Wilk statistic tests normality, where significant results imply a non-normal distribution.

Levene’s Test and the F-Test for Equal Variances check for homogeneity across groups, which is essential for analyses assuming equal variances. Together, these tests inform the suitability of data for further parametric statistical procedures:

1. **In Step Four the Review Results and output show:** two Groups 1 and 2 of variables, : the Pearson’s Correlation Coefficient of (r) as NAN, and the P-value, as an NAN (Not a number), it shows the Ho: Null values, and Ha: Alternative value relationships in Table # 8:

**Step Four: Review Results:**

**Output**

**Pearson’s Correlation Coefficient** is a parametric procedure to measure the strength and direction of a linear relationship between two continuous variables. It assumes both variables are normally distributed. Interpretation is based on the correlation coefficient, ranging from -1 to +1, indicating negative or positive linear relationships.

**Results of Statistical Procedure**

**Table 8**

|  |  |
| --- | --- |
| **Measure** | **Value** |
| Group 1 (Group 1) Mean | 0.0000 |
| Group 2 (Group 2) Mean | 0.0000 |
| Pearson's Correlation Coefficient (r) | NaN |
| p-value | NaN |

**Hypotheses**

Ho: No statistically significant relationship exists between Group 1 and Group 2.

Ha: A statistically significant relationship exists between Group 1 and Group 2.

**Findings**

The r-value of NaN indicates a large positive effect between Group 1 and Group 2.

The probability that the relationship between Group 1 and Group 2 was statistically significant at

a 95% confidence level (p = NaN). The null hypothesis could not be rejected.

**Scatterplot**

|  |  |
| --- | --- |
| Y000 |   |
| X |  0 |

**The Scatter plot** shows “0” values on the X and Y axis.

**Attribution**

Statistical procedures were conducted using [PSSR (Practical Statistics for Social Research)](https://stats.ogs.edu/), statistical analysis software developed by Joshua D. Reichard for [Omega Graduate School](https://ogs.edu/) based on the [jStat](https://jstat.github.io/) library.

**Reference**

Reichard, J. (2024). *Practical Statistics for Social Research (PSSR)*. Omega Graduate School. <https://stats.ogs.edu/>.

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 **Conclusion**

 Given the crucial relevance of groups’ dependent and independent variable data in descriptive, inductive and the quantitative deductive experiments (Komatsu et al, 2024) the assumption and the t-test, the parametric and non-parametric statistics have become indispensable in relative statistical research studies. This study shows that the use of histograms and box-whisker plots are mostly embraced in comparative statitical experiments in academia, marketing, income distribution, employment demographics because they are simpler to comprehend, to assess and evaluate by organizations, customers and corporate clientele. Moreover, they are helpful when assessing a sample alongside a normal distribution because a histogram visually shows the overall shape of the data distribution allowing you to see if it is similar to a bell curve, symmetrical and unimodal characteristic of a normal distribution.

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