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STATISTICAL TEST IN TWO INDEPENDENT VARIABLES

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ABSTRACT

In statistics, the Mann–Whitney U test is a nonparametric test of the null hypothesis that two samples come from the same population against an alternative hypothesis, especially that a particular population tends to have larger values than the other. It can be applied on unknown distributions contrary to t-test which has to be applied only on normal distributions, and it is nearly as efficient as the t-test on normal distributions.

KEYWORD: ***Nonparametric statistical technique, t-test, Mann-Whitney U test***

INTRODUCTION

Mann-Whitney U test is a non-parametric statistical technique. It is used to analyze differences between the medians of two data sets. It can be used in place of a t-test for independent samples in cases where the values within the sample do not follow the normal or t-distribution but also when the distribution of values is unknown. In order for the Mann-Whitney U test to be applied, values need to be measurable on an ordinary scale and comparable in size. The fact that all values are compared makes it distinct from the t-test, which compares the sample means. The Mann-Whitney U is also used to test the null hypothesis, subject to both samples coming from the same basic set or having the same median value. The test involves the calculation of a statistic, usually called *U*, whose distribution under the null hypothesis is known. In the case of small samples, the distribution is tabulated, but for sample sizes above ~ 20 approximations using the normal distribution is fairly good. Some books tabulate statistics equivalent to *U*, such as the sum of ranks in one of the samples, rather than *U* itself. The *U* test is included in most modern statistical packages. It is also easily calculated by hand, especially for small samples. There are two ways of doing this.

Method one:

For comparing two small sets of observations, a direct method is quick, and gives insight into the meaning of the *U* statistic, which corresponds to the number of wins out of all pairwise contests (see the tortoise and hare example under Examples below). For each observation in one set, count the number of times this first value wins over any observations in the other set (the other value loses if this first is larger). Count 0.5 for any ties. The sum of wins and ties is *U* for the first set. *U* for the other set is the converse.

Method two:

For larger samples:

1. Assign numeric ranks to all the observations, beginning with 1 for the smallest value. Where there are groups of tied values, assign a rank equal to the midpoint of unadjusted rankings. Now, add up the ranks for the observations which came from sample 1. The sum of ranks in sample 2 is now determinate, since the sum of all the ranks equals $N(N + 1)/2$ where N is the total number of observations.
2. U is then given by,

$$U_1 = R_1 - \frac{n_1(n_1+1)}{2}$$

Where n_1 is the sample size for sample 1, and R_1 is the sum of the ranks in sample 1.

Note that it doesn't matter which of the two samples is considered sample 1. An equally valid formula for U is

$$U_2 = R_2 - \frac{n_2(n_2+1)}{2}$$

The smaller value of U_1 and U_2 is the one used when consulting significance tables. The sum of the two values is given by

$$U_1 + U_2 = R_1 - \frac{n_1(n_1+1)}{2} + R_2 - \frac{n_2(n_2+1)}{2}.$$

Knowing that $R_1 + R_2 = N(N + 1)/2$ and $N = n_1 + n_2$, and doing some algebra, we find that the sum is

$$U_1 + U_2 = n_1 n_2.$$

Mann-Whitney U test is the alternative test to the independent sample t-test. It is a non-parametric test that is used to compare two population means that come from the same population, it is also used to test whether two population means are equal or not. It is used for equal sample sizes, and is used to test the median of two populations. Usually the Mann-Whitney U test is used when the data is ordinal. Wilcox on rank sum, Kendall's and Mann-Whitney U test are similar tests and in the case of ties, it is equivalent to the chi-square test.

ASSUMPTIONS:

Mann-Whitney U test is a non-parametric test, hence it does not assume any assumptions related to the distribution. There are, however, some assumptions that are assumed:

1. The sample drawn from the population is random.
2. Independence within the samples and mutual independence is assumed.
3. Ordinal measurement scale is assumed.

CALCULATION:

$$U = n_1 n_2 + \frac{n_2(n_2+1)}{2} - \sum_{i=n_1+1}^{n_2} R_i$$

Where:
U=Mann-Whitney U test
N_1 = sample size one
N2= Sample size two
R_i = Rank of the sample size
are not normally distributed. Whereas a *t* test is a test of population means, the Mann-Whitney test is commonly regarded as a test of population medians. This is not strictly true, and treating it as such can lead to inadequate analysis of data.

SUMMARY POINTS

- The Mann-Whitney test is used as an alternative to a *t* test when the data are not normally distributed
- The test can detect differences in shape and spread as well as just differences in medians
- Differences in population medians are often accompanied by equally important differences in shape
- Researchers should describe the clinically important features of data and not just quote a P value

The Mann-Whitney U test is, in exceptional circumstances, more powerful than the t-test. Indeed, it is more powerful in the detection of a difference on the extent of the possible differences between populations' averages than the t-test when a small manpower is associated with a small variance [8].On the other hand, when the sample size is similar or when the smallest manpower has the greatest variance, the t-test is more powerful on all the extent of the possible differences

ADMINISTRATION, ANALYSIS AND REPORTING

Statistics Solutions consists of a team of professional methodologists and statisticians that can assist the student or professional researcher in administering the survey instrument, collecting the data, conducting the analyses and explaining the results. Like any statistical test, the Mann-Whitney U has forces and weaknesses. In terms of forces, like any non-parametric test, the Mann-Whitney U does not depend on assumptions on the distribution (i.e. one does not need to postulate the data distribution of the target population). One can also use it when the conditions of normality neither are met nor realisable by transformations. Moreover, one can use it when his sample is small and the data are semi-quantitative or at least ordinal. In short, few constraints apply to this test. The Mann-Whitney U test is also one of the most powerful non-parametric tests (Landers, 1981), where the statistical power corresponds to the probability of rejecting a false null hypothesis. This test has thus good probabilities of providing statistically significant results when the alternative hypothesis applies to the measured reality. Even if it is used on average-size samples (between 10 and 20 observations) or

with data that satisfy the constraints of the t-test, the Mann-Whitney has approximately 95% of the Student's t-test statistical power [5]. By comparison with the t-test, the Mann-Whitney U is less at risk to give a wrongfully significant result when there is presence of one or two extreme values in the sample under investigation. Despite this, the Mann and Whitney test has its limits. With the Monte Carlo methods, methods that calculate a numerical value by using random or probabilistic processes, it was shown that the t-test is most of the time more powerful than the U-test. Indeed, this fact remains whatever the amplitude of the differences between the averages of the populations under investigation and even if the distributions of these populations do not meet the criteria of normality [8,9]. On the other hand, very little statistical power is lost if the Mann-Whitney U test is used instead of the t-test and this, under statistically controlled conditions. In addition, the Mann-Whitney U test is, in exceptional circumstances, more powerful than the t-test. Indeed, it is more powerful in the detection of a difference on the extent of the possible differences between populations' averages than the t-test when a small manpower is associated with a small variance [8,9]. On the other hand, when the sample size is similar or when the smallest manpower has the greatest variance, the t-test is more powerful on all the extent of the possible differences. This paper describes the use of the Mann-Whitney U test, as an alternative to the t-test. Unlike the t-test which compares the mean values of two groups, the Mann-Whitney U test compares their medians. This statistical technique examines the differences between two independent groups on a continuous scale. It is therefore considered a specific statistical technique that is significantly different from other nonparametric tests, primarily from the Wilcoxon rank test and Friedman test. The work is intended for all who are deeply engaged in empirical research, especially using the nonparametric tests.

In the studies of professional development of teachers of primary schools the most commonly used criterion variables were gender (male, female), education (college, university), occupation (class teacher, subject teacher) and school environment (urban, rural). Research issues which may be asked in the professional development of teachers comprise: do male and female teachers with college and university education, class and subject teachers and teachers employed in primary schools in urban and rural areas differ in the level of understanding of the importance and need of their professional development for education in primary school. Answers to these questions can be reached effectively using the Mann Whitney U test. In order to understand better the Mann-Whitney U Test statistical technique, it is presented on the example of practical application within the statistical program SPSS, followed by discussion and analysis of research results.

A similar feature is even more evident in data from a study of pain in blood glucose testing. A visual analogue scale was used to record pain at the thumb or ear. The authors report "The median pain score was 8.5 mm in the thumb group, the difference in median pain score is small. Although this is true, the box plots in the paper show that the spread of scores in the thumb group is much greater than for the ear group. In particular, at least three out of 30 people in the thumb group report a score that is at least twice the highest value in the ear group. Overall, values seem much higher in the thumb group. This is important because patients are likely to be more concerned with the worst pain they might experience than the median value.

CONCLUSION

Mann-Whitney U test is used for every field, but in frequently used in psychology, medical/nursing and business. For example, in psychology, it is used to compare attitude or behavior, etc. In medicine, it is used to know the effect of two medicines and whether they are equal or not. It is also used to know whether or not a particular medicine cures the ailment or not. In business, it can be used to know the preferences of different people and it can be used to see if that changes depending on location. The Mann-Whitney test is sometimes used for comparing the efficacy of two treatments in clinical trials. It is often presented as an alternative to a *t* test when the data is given.

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