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A Study on Non Parametric Test: A Statistical Tests of Research Methods for Hypothesis Testing In Higher Institution of Learning in Rivers State

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ABSTRACT

This study presents nonparametric tests as a statistical research method for hypotheses testing in higher institutions in Rivers State (Covering University of Port Harcourt, Rivers State University, Ignatius Ajuru University of Education, Port Harcourt Polytechnic, Ken Saro-Wiwa Polytechnic and Rivers State College of Health Science and Technology, Port Harcourt). The aim of the study is to enable researchers or students to acquire and develop skills that are necessary for computation and applications of non-parametric tests in tertiary institutions. The non-parametric test such as signs test, signed-rank test and runs test were examined and illustrated with examples. Pocket calculator was used for the computations and table values calculated from Tables. The null hypotheses (Ho) in examples 2 and 3 were accepted and the null hypotheses in examples 1 and 3 were rejected. It was concluded that the non-parametric tests are powerful statistical tests of hypotheses for research, because of its numerous applications in every field of studies in tertiary institutions.

Keywords: Non-Parametric Tests, Statistical Tests, Research Methods, Hypotheses Testing, Tertiary Institutions

INTRODUCTION

A statistical hypothesis is an assumption about a population parameter. The assumption may or may not be true. Hypothesis testing refers to the formulae procedures (methods) used by statisticians to accept or reject statistical hypothesis Maxwell (2012).

There are two types of statistical hypotheses.

- Null hypothesis: The null hypothesis denoted by Ho is usually the hypothesis that sample observations result purely from chance (probability)
- Alternative Hypothesis: The alternative hypothesis denoted by H_1 or $H_\wedge$ is the hypothesis that neither sample observations are influenced by some nor random course.

Most of the inferential techniques are based on fairly specific assumptions regarding the nature of the underlying population distribution usually is form and some parameter value must be stated. Frequently, we assure a normal distribution, and we estimate or test hypothesis about the parameters.

Most of the test of hypothesis we have studied in our work require that we make certain assumptions about the populations, from which the samples are drawn. Since there are many situations in which necessary assumptions (statements) about the populations cannot be made. Statisticians have developed alternative techniques of analysis which are known as non-parametric or distribution free tests.

Siegal and Castellan (2004) affirmed that non-parametric test is a test where we make no assumptions about the functional form of the underlying population.

Mason, Lind and Marchal (1998) said that the term non-parametric test implies a test for a hypothesis which is not a statement about the parametric value.

Lacobucci (2005); said that non-parametric methods are standard statistical problems whose specific distribution assumptions are replaced by very general assumptions and the analysis is based on some functions of the sample observations whose sampling distribution can be determined without knowledge of the specific distribution function of the underlying hypothesis.

Non parametric methods are widely used for studying population that take on a ranked order. The use of non-parametric methods may be necessary when data have a ranking but no clear numerical interpretation such as when assessing preferences. Coder, and Foreman (2009) expressed that nonparametric statistical methods are mathematical procedures for statistical hypothesis testing which unlike parametric statistics, make no assumption about the probability distributions of the variables being assessed.

Apart from the fact that non-parametric tests may be used under very general conditions, they are often easier to explain and understand than the standard tests which they replace.

Nonparametric or distribution free tests arc so called because the assumptions underlying their use are "fewer and weaker than (hose associated with parametric tests.

According to John and Frank (1977) in many of the non-parametric tests the computational burden is relatively light. For these reasons, they have become quite popular, and extensive literature is devoted to their theory and application. Rao and Richard (2007); said that in many of the non parametric test, the data are changed from measurements or scores to ranks or even to signs.

This study is based on the following nonparametric tests: signs test, sign rank and runs tests. The aim of the study is to enable researchers or students to acquire and develop skills that are necessary for computation and applications of non-parametric tests for research in tertiary institution.

Aim and Objectives

The study is aimed at creating a research enabling environment for the students, which will make them acquire and develop a necessary statistical skills for computation and application of non-parametric test in higher institutions of learning in Rivers State.

Study Area

The study was undertaken is Rivers State. It is a fast growing state in Niger Delta part of Nigeria, with its capital in Port Harcourt. Rivers State lies with the geographical locations and coordinates of about 4^{o} to 5.5^{o}N, and longitude 6.7^{0}E to 7.5^{o}E and Port Harcourt being the capital city is about 4.5^{o}N to 7^{o}E with an estimated population size of 6,689.087 according to the national population census exercise held in 2006. It have a total of twenty three (23) Local Government Area and has a total of eight Higher Institutions namely, University of Port Harcourt Choba, Rivers State University, Port Harcourt, Ignatius Ajuru University of Education Rumuorlumeni, Port Harcourt, Ken Saro Wiwa Polytechnic Bori, Elechi Amadi Polytechnic, Rivers State College of Health Science and Technology, Rivers State School of Nursing and Rivers State School of Midwifrey Port Harcourt

Methodology

The non-parametric test such as sign test, signed rank test were examined and illustrated wih examples, pocket calculator was also used for the computations of the table values calculated from the tables. However, the author embarked on recognizance survey to the institutions mentioned earlier, the purpose of this, was to source for both primary data and secondary data for the research.

Signs Tests

The sign test is one of the simpliest nonparametric tests. This test uses plus sign (+) and minus (-) rather than quantitative data. The test makes assumption about the form of the distribution of difference and does n assume that all subjects are from the same distribution. It is often used as alternative to the one-sample t-test, where we test the null hypothesis

$\eta = \eta_o$ against some alternative.

In the sign test, we replace each sample value exceeding with a plus and replace each sample value less than ii,, with a minus sign, then the probability of getting a value equal to ii,, is zero; in cases where we do get a value equals to mean (η_o), we simply discard it and then test the equivalent null hypothesis that the number of plus signs is a random variable having a binomial distribution with parameters n (number of plus signs and minus signs) and P = ½. Our two tailed alternative $\eta < \eta_o$ and $\eta > \eta_o$ become P > ½ and P < ½ respectively. When n is small, we refer to a table of binominal probabilities directly, and when n is large, one can use the normal approximation with p = ½ respectively. When n is small, we refer to a table of binominal probabilities directly, and when n is large, one can use the normal approximation with P = ½.

Example 1.

The following arc measurements of the weights of students in the Department of Mathematics and Statistics at Rivers Slate College of Arts and Science, Port Harcourt.

63	65	60	89	61	71	58	51
69	62	63	72	65	06	72	

Use the sign test to test the null hypothesis that the mean weight of the students $\eta = 60$ against the alternative $\eta > 60$ at the $\alpha = 0.05$ significance level.

Solution

Since we already have our hypotheses, we replace each value exceeding 60 with a plus sign and each value less than 60 with a minus sign: (after having removed the value equal to 60) so n = 14 and x = 12 using a table of binomial probabilities, we find that for n = 14 and p = ½ the probability of 12 or more successes is 0.006 + 0.00 1 0.007, and since this is less than x = 0.05, we reject the null hypothesis that = 60, and conclude that $\eta \neq 60$

The Wilcoxon Signed - Rank Tests.

The sign, test only concerns itself with whether or not a value is above or below the mean η_o, but it does not consider how far above or below that value is. The signed-ranke test however consider both the sign as well as the [magnitude of the differences between pairs. When this is done a more 'powerful test is obtained. We again assume that the population is symmetric and continuous. In this test, we first calculate each of the differences between the supposed mean η_o and every data entry collected (entries equal to η_o are again discarded). Then we rank the absolute values of the differences in the 'following way: the smallest difference in absolute value is ranked 1, the next , smallest is ranked 2, and so forth until all are ranked. If two or more entries share the same absolute value, we assign them the mean of the ranks that they would have occupied (for instance, if three entries have the same absolute value and would have taken ranks 2,3, and 4, then we assign each the rank $\frac{2+3+4}{3} = 3.$

This allows us to find the following three test statistics:

T = $\sum$ (ranks assigned to positive differences)

T = $\sum$ (ranks assigned to native differences)

T = min(T^+, ,T^-)

We then use each of these test statistics depending on our alternative hypothesis, as seen below

Alternative Hypothesis	**Reject Null Hypothesis if**
$\eta \neq \eta_o$	$T \leq T\alpha$
$\eta > \eta_o$	$T^- \leq T_2\alpha$
$\eta < \eta_o$	$T^+ \leq T_2\alpha$

Here α is the significance level, and T $T\alpha$ or $T_2\alpha$ can be found in a table of critical values for the signed-rank test (for a given n, our sample size).

Example 2.

The marks obtained by 15 students of the department Mathematics and Statistics in calculus during the first semester examination at Rivers State College of Arts and Science, Port Harcourt arc shown below: 75, 70, 83, 45, 80, 30, 68, 62,, 85, 69, 82, 4, 73, 65 and 60. Use the signed rank test with α = .05 to test whether the mean mark of the student is 68.

Solution.

We begin by stating our hypotheses:

H_0 : μ = 68

H_1 : μ $\neq$ 68.

Our critical region will be $T \leq T_{0.05}$

There is only one value equal to the mean so we remove it and we are left with n = 14. using our statistics table, we see that $T_{.05}$ = 21 when n = 14, so our critical region will be $T \leq 21$. So subtracting 68 from each entry and ranking the absolute value of the difference, we get the following

Marks	**Difference**	**Absolute value**	**Rank**
75	7	7	6
70	2	2	2
83	15	15	10
45	-23	23	12
80	12	12	8
30	-38	38	14
62	-6	6	5
85	17	17	11
69	1	1	1
82	14	14	9
40	-28	28	1.3
73	5	5	4
65	-3	3	3
60	-8	8	7

Source: Maxwell (2012)

T^- = 12 + 14 + 5 + 13 + 3 + 7 = 54

T^+ = 6 + 2 + 10 + 8 + 11 + 1 + 9 + 4 = 51

So T = 51. Since 51 > 21, we accept the null hypothesis that p μ = 68.

The Runs Tests

The final type of test we explore is based on the theory of runs, where a run is a succession of identical letters (or other kinds of symbols). It could refer to consecutive heads in flips of a fair coin, for instance when written on paper, this run would be . . . . H, H, H, H, H , ..., this is a run of 5 heads). This test is used for determining randomness.

The total number of runs gives an indication of whether the Sam pie is random or not.

Testing method (for small samples)

Let n_1 = member of elements of one kinds (eg head)

n_2 = members of elements of the other kind (tails)

N = $n_1 + n_2$ of runs when n_1 or $n_2 \leq 20$, a table is given tbr determining whether Ho (randomness) should be accepted or not at α = 0.05 significance level.

Example 3

In a practical examination of the Department of Mathematics and Statistics at Rivers State College of Arts and Science, Port Harcourt, a student tossed a fair coin 20 times and the following results were obtained as:

H H H H T T H H RH H T T T H H T T T T.

Test at α = .05 significance level whether these coin produces a random sequence of heads and tails.

Solution

Stating the hypotheses:

H_o: The coin produces a random sequence.

H_1: The coin did not produce random sequence

Since α = .05, n_1 = 11 and n_2 = 9, we use our table to find $r^1_{0.025}$ and $r_{0.025}$.

Which are 6 and 11 respectively, so we reject Ho, the null hypothesis if r $\leq$ 6 or r $\geq$ 11. By inspection pf the data, r = 6, which lies within our critical region. Therefore we reject the null hypothesis and conclude that the coin did not produce random sequence of heads and tails.

Large Samples

For either n or n_2 > 20, for such samples a good approximate to the sampling distribution of the total number of runs is the normal distribution with mean

$$\mu = \frac{2n^1 n^2}{n^1+n^2} + 1 \qquad (1)$$

Standard deviation

$$6. \quad = \quad \sqrt{\frac{2n^1 n^2 (n^1 n^2 - n^1 - n^2)}{(n_1 + n_2)(n_1 + n_2 - 1)}} \qquad (2)$$

And standard normal distribution

$$Z \quad = \quad \frac{r - \mu}{6} = 6$$

Z is normally distributed over mean o and standard deviation 1.

Here, the standard normal table is used.

Examples 4

The following is an arrangement of men, M, and Women, W, lined up to purchased tickets for a football march 2011 at Port Harcourt.

M	W	M	W	M	M	M	W	M	W
M	W	W	M	M	M	M	W	W	M
M	M	W	M	M	M	W	W	W	M
M	M	W	M	W	M	M	M	M	W
M	W	W	W	M	M	M	M	W	W

Test for randomness at α = 0.05 significance level.

Solution

We first state our hypotheses:

H_o: Arrangement is random

H_1: Arrangement is not random. We construct our critical region using the normal distribution, which tell us to reject the null hypothesis.

If Z $\leq$ - 1. 96 or Z $\geq$ 1.96. Since n_1 (men) = 30, n_2 (women) = 20 and r = 26, we get

$$\mu = \frac{2(30)(20)}{30+20} + \frac{1200}{50} + 1 = 25$$

And

$$6. \quad = \sqrt{\frac{2(30)(20)(2)(30)20-30-20}{(30+20)^2(30+20-1)}} = \sqrt{\frac{1200(1150)}{2500(49)}} = 3.36$$

Therefore we have

$$Z = \frac{26-25}{3.36} + \frac{1}{3.36} = 0.298$$

$$= 0.30$$

Since 0.30 is within the accept region, we accept the null hypothesis and conclude that the arrangement is random.

CONCLUSION AND RECOMMENDATION

The aim of the study is to acquire and develop skills that are necessary for computations and application of non-parametric tests for research in tertiary institutions.

Nonparametric test is a test where we make no assumptions about the functional form of the underlying population. For both the signs test and signed — rank test, we only need that the underlying population is continuous and sysmetric. For the runs test, we need only assume that they are two possible outcomes and the date is ordered.

The test statistics for the signs test will simply be the number of observed plus sign when n is small. If n is large, we may use the normal approximation to the binomial distribution. For the signed-rank test, we have three test statistics, each of these correspond to the different possible alternative hypotheses. The test statistic for the runs test, we have two different test statistics. The non-parametric tests are powerful statistical tests of hypotheses for research projects, because of its numerous applications in every field of studies.

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