

# Testing of Proper Randomness of Numbers Generated by Fisher and Yates :: Run Test

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**ABSTRACT:** To decide whether the number generated by Fisher and Yates are properly random or not one may apply nonparametric tests for randomness. Various types of nonparametric tests are ordinary run test Wald – wolfowitz Run test, sign test, Mann-whitney – Wilcoxon U-test, Mann-Kendall test. Here, We shall apply ordinary run test by taking the median of the number to test the proper randomness of the numbers of Fisher and Yates random members table. It is observed that Fisher and Yates random numbers table may be regarded random with respect to run test.

**KEYWORDS :** Fisher and Yates random number table testing of randomness, non parametric test, run test.

## I. INTRODUCTION

A run is defined as a series of increasing values or a series of decreasing values. The number of increasing or decreasing values is the length of the run. In a random number data set, the probability that a particular number is larger or smaller than the median value follows a binomial distribution, which forms a basis of the run test.

Drawing of random sample has been drawing of random has been found necessary in most of the investigations. The most practical method of selecting a random sample consists of the use of random numbers table. Commonly used random numbers tables are Fisher and Yates, LHC Tippett, Kendall and Babington Smith and Rand corporation. These tables have been subjected to various statistical tests of randomness. Proper randomness of Fisher and Yates Random Numbers table has been examined by D. Chakraborty in 2010 by comparing the probability of occurrence of each digit in the table and then applying the theoretical probabilistic concept of randomness. The same has been tested by B.K. Sarmah and D. Chakraborty (November, 2014 IJESRT) by applying Chi-square test for testing the significance of difference between observed frequency of each of the digit in the table and corresponding theoretical ( expected ) frequency. The randomness of the digits of Fisher and Yates are also tested by applying t-test for amount of deviation of the observed number of occurrence and theoretical ( expected) number of occurrence of the respective digits. Both the test shows that the numbers generated by Fisher and Yates are not property random.

In this study an attempt has been made to test the proper randomness of number of Fisher and Yates table by applying run test.

In statistical literature “proper randomness” refers to a process that can produce independently and identically distributed (iid) samples (number) having equal probability of occurrences.

## II. MATERIALS AND METHOD

Fisher and Yates random number table consists of a total of 15000 digits comprising of 7500 two digitd random numbers, viz 00,01,02.....99

In order to test the randomness of the occurrence of the numbers we note that if the occurrence is random then the theoretical median of the observations will be 49.5.

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Let us consider a sequence of runs from the table by writing A if the observation is above median and B if the observation is below the median.

Let us consider the following hypothesis

$H_0$  : The occurrences of numbers in the table is in random manner.

$H_1$  : The occurrences of the numbers in the table is not in random manner.

Under the null hypothesis  $H_0$ , the test statistic is given by.

$$Z = \frac{U - E(U)}{\sqrt{V(U)}} \sim N(0,1)$$

Where,

U = Number of observed runs

$$E(U) = \frac{n+2}{2}$$

$$V(U) = \frac{n}{4} \left( \frac{n-2}{n-1} \right)$$

n = Number of observations considered.

We may accept  $H_0$ , iff  $|Z| < 1.96$  (5% level of significance)

### III. STEPS IN THE METHOD

In order to test the proper randomness of the numbers of Fisher and Yates table one is required to proceed with the following steps:

Step -1: In the first step runs of A and B are observed for first 500 numbers second 500 numbers ..... up to 15<sup>th</sup> 500 numbers as shown in the table.

Step -2: In the second step count the total number of runs for first 500, second 500..... upto 15<sup>th</sup> 500 numbers.

Step -3: In this step the values of Z are calculated by applying the formula

$$Z = \frac{U - E(U)}{\sqrt{V(U)}} \sim N(0,1)$$

Step - 4: compare the calculated value of  $|Z|$  with 1.96 ( at 5% Level of significance).

Step-5: Draw conclusion as per the result obtained in step 4.

### IV. CONCLUSION

From the table prepared for pattern of runs, number of runs and value of  $|Z|$ , it is observed that values of  $|Z|$  calculated for first 500..... to last 15<sup>th</sup> 500 numbers are found to be insignificant comparing them with standard value of Z (1.96 at 5% level of significance)

Hence as far as the run test is concerned, Fisher and Yates random number table may be considered as random.

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**Table : Observed runs, number of runs and the value of Z statistic from Fisher and Yates.**

Random Numbers considered	Pattern of Runs	No. of runs U	$E(U) = \frac{n+2}{2}$	$V(U) = \frac{n}{4} \left( \frac{n-2}{n-1} \right)$	IZI
1 <sup>st</sup> 500	BBBAAAABAABAABAB....	244	251	124.75	0.63
2 <sup>nd</sup> 500	BAAAABABBBBAAAABB..	246	251	124.75	0.45
3 <sup>rd</sup> 500	ABBBABBAAAAABBAA....	245	251	124.75	0.54
4 <sup>th</sup> 500	ABBAABABABAB.....	254	251	124.75	0.27
5 <sup>th</sup> 500	AB BBABAABBAAA.....	244	251	124.75	0.63
6 <sup>th</sup> 500	BBAAAABABBBBA.....	242	251	124.75	0.81
7 <sup>th</sup> 500	ABBAAABBABBABB.....	250	251	124.75	0.09
8 <sup>th</sup> 500	ABBBBBAAAABBB.....	254	251	124.75	0.27
9 <sup>th</sup> 500	AAABBABBAAAABBB.....	253	251	224.75	0.18
10 <sup>th</sup> 500	BBBBBBABBBBAA.....	261	251	124.45	0.90
11 <sup>th</sup> 500	BAAABBAABBBBAB.....	233	251	124.75	1.61
12 <sup>th</sup> 500	BBAABAABBABBB.....	254	251	124.75	0.27
13 <sup>th</sup> 500	AABABBABBBAAB.....	244	251	124.75	0.63
14 <sup>th</sup> 500	AABABABABBBBA.....	255	261	124.75	0.36
15 <sup>th</sup> 500	AAABBAABBBBAAAABBB.....	246	251	124.75	0.45

### REFERENCES

- Cochran, W.G. (1940): "Sample survey", Cambridge University press.
- Chakrabarty, D. (2004): "A theoretical definition of probability based on common sense", Bulletin of pure and applied sciences, 23 E-2, 343-349.
- Chakrabarty, D. (2005): "Probability; Link between classical definition and Empirical definition", J. Ass. Sc. Soc., 45,13-18.
- Chakrabarty, D. (2006): "Non equally likely outcomes: The classical definition of probability", Bulletin of pure and applied sciences, 25, E-2, 471-481.
- Chakrabarty, D. (2007): "Empirical definition of probability : Special case of its Theoretical definations". Int. J. Agricult. Stats. Sci., 3(1), 261-267.
- Chakrabarty, D. (2008): "Bernolli's definition of probability: Special case of its Chakrabarty definition", Int. J. . Agricult. Stats. Sci., 4(1), 23-267.
- Cochran (1940): "A survey of Experimental design", Mimeo, U.S.D.A.
- Fisher, R. A. (1938): Statistical table for biological, agricultural and medical research, 6<sup>th</sup> edition (1982), Longman group limited, England, 37-38 & 134-139.
- Kendall, M.G. and B. B. Simith (1938): Randomness and Random sampling numbers, Jour. Roy Sat. Soc., 103, 147-166.
- Rand Corporation (1955): A million random digits free press, Glenoe, III.
- Snedecor, G.W. and W. G. Cochran (1967): "Statistical methods, Iowa state university press, Ames, Iowa, 6<sup>th</sup> edition.
- Tippet (1927). "Random number tables" tracts of computer, No.-15, Cambridge University press.
- Von Mises R. (1939): "Probability, Statistics and Truth" Macmillian.
- Sarmah, B.K and Chakrabarty, D (2014): " Testing of Randomness of Number generated by Fisher and Yates"(Chi-Square test), IJESRT, 3(11), 632-636.
- Sarmah, B.K and Chakrabarty, D (2014): " Examination of Proper Randomness of the Number Generated by L.H.C Tippet, (Chi-Square test)JESRT, 3(12), 661-668.
- Sarmah, B.K and Chakrabarty, D (2015): Examination of Proper Randomness of the Number Generated by Kendall and Babington Smith (Chi-square test). IJESRT 4(2) Febuary/15, 260-282.
- B.K. Sarmah\*, D. Chakrabarty, N. Barman (2015): Examination of Proper Randomness of the Number Generated by Rand Corporation (1955) (Chi-square test), IJESM 5(1): January- March, 2015, 97-119.
- Sarmah, B.K and Chakrabarty, D (2015): Testing of proper Randomness of the numbers generated by Fisher and Yates (Applying t-test) ABJMI Vol-7 issue -I, Jan- June 2015, P 87-90.
- Sarmah, B.K. and Chakrabarty D. (2015): Examination of proper Randomness of the numbers generated by L.H.C. Tippet (1927)(t-test) IOSR Journal of Mathematics, Vol-11, Issue-3 May-June,2015 PP.35-37 .
- Brajendra Kanta Sarmah and Dhritikesh Chakrabarty: Examination of proper randomness of the numbers Generated by Roud Corporation, 1955 (t-test) IJIRSET, Vol-4, Issue-10, Oct,2015