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Examination of Proper Randomness of the Numbers generated by L.H.C. Tippett (1927)

B.K. Sarmah*, D. Chakrabarty,
**Department of Statistics, Bholanath College, Dhubri, Assam, India.*
Department of Statistics, Handique Girls' College, Assam, India

Abstract: *Proper randomness of the numbers generated by L.H.C Tippett has been examined.*
By B.K. Sarmah and D. Chakrabarty in Dec.. 2014, IJESRT Vol-3, issue 12, by applying the Chi-square test for testing the significance of difference between observed frequency of each of the digit in the table and the corresponding theoretical (expected) frequency.
In this paper, the randomness of the digits have been tested by applying t-test for amount of deviation of the observed number of occurrences and the theoretical(expected) number of occurrences of the respective digits and hence the numbers.
The test shows that the numbers generated by L.H.C Tippett deviated significantly in most the observations from proper randomness.
Keywords: *Random number generated by L.H.C Tippett, students t-test, testing of randomness.*

I. Introduction

Drawing of random sample has been found to be vital or basic necessity in most of the researches and investigations especially of applied sciences. The convenient practical method of selecting a random sample consists of the use of Table of Random Numbers. Existing tables of random numbers, used commonly, are the ones due to Fisher and Yates (Constructed in 1938), L.H.C. Tippett (Constructed in 1927), Kendall and Babington Smith (Constructed in 1939) and Rand Corporation (constructed in 1955)

The random number tables have been subjected to various statistical tests of randomness. These tests have limitations to decide on proper randomness of the numbers occurring in the corresponding tables. As a Consequence it is not guaranteed that the numbers in each of these tables are properly random. This leads to think of testing the proper randomness of the numbers in this tables. In the present study, an attempt has been made to test this. The study, here, has been made on the testing of randomness of the table of numbers constructed by L.H.C Tippett only.

By the existing statistical methods, it is only possible to know whether the randomness of the numbers of a table is proper. It is only possible to know whether the deviation of the degree of its randomness is significant.

In order to test the proper randomness of the random numbers table constructed by Tippett t-test has been applied.

II. Materials and Methods:

Tippetts random number table consists of a total of 41600 digits arranged in 10,400 four digited numbers

To know whether the number in random numbers table of Tippetts are proper or not student's t-test for amount of deviation is applied.

Let 'd' be the variable denoting the measure of the deviation (amount of deviation) of the observed number of occurrences of the respective digit.

Suppose, di(i=0,1….9) are independent observed values of the deviation variables.

If the table of number is random then di=0, for all i, in the ideal situation . However, due to chance error, di may assume non zero value.

Thus the values of di's are due to chance error but not due to any assignable error if the table is random.

The chance variables are i.i.d. N.(o,σ) variables.

Thus testing of randomness is equivalent to testing of the hypothesis H_o

That $E(d_i) = 0$, for all i,

Let us consider the statistic t for testing H_o

i.e. $$t = \frac{\overline{d} - E(\overline{d})}{S.E.(\overline{d})} \sim t_{n-1}$$

where,

$$\overline{d} = \frac{1}{n} \sum_{i=1}^{n} d_i$$

We have,

$$E(\overline{d}) = \frac{1}{n} \sum E(d_i) = 0$$

When H_o is true

Also,

$$var\ (\overline{d}) = \frac{\sigma^2}{n},\ \sigma^2 \text{ is unknown}$$

However unbiased estimate of σ^2 is

$$s^2 = \frac{1}{n-1}\sum(d_i - \overline{d}_)^2$$

$$= \frac{1}{n-1}[\Sigma\ {d_i}^2 - \frac{(\Sigma d_i)^2}{n}]$$

Which implies unbiased estimate of

$$var\ (\overline{d}) = \frac{s^2}{n}$$

$$and\ S.D.(\overline{d}) = \frac{s}{\sqrt{n}}$$

Therefore statistic t for testing H_o becomes

$t = \frac{\overline{d}}{s/\sqrt{n}}$ when H_o is true and this t follows student's t distribution with (n-1) d.f.

III. Steps in the Method:

In order to test the proper randomness of the numbers of L.H.C Tippett table one is required to proceed with the following steps:

Step1: In the first step, observe the occurrences of the digits 0 to 9 for first 2000 trails, second 2000 trials …….. … up to 20th 2000 trails and lastly for 1600 trails as shown in the table.

Step2: In the second step, compute the theoretical expected frequencies. This is done by dividing trails i.e. 1st 2000 …… and 20th 2000 and last 1600 trails by 10 assuming that the digit 0 to 9 occurs equal number of times.

Step 3: In the third step, compute the amount of deviation of observed occurrences of digits and expected occurrences of digits.

Step 4: In the fourth step, compute the value of student's t for each of the trails.

Step 5: Compare the t value with corresponding theoretical values.

Step 6: Draw conclusion as per the result obtained in step 5.

IV. Results and discussion:

The results obtained on operating the steps (Nos. 1 to 5) on the random numbers table constructed by L.H.C Tippett have been observed. It is observed from the table that occurrences of digit 0 to 9 are not equal.

V. Conclusion:

From the table prepared for observed frequency of occurrence of digits along with respective expected frequency (shown in bracket) it is observed that the calculated value of t is significant in most of the cases except 1st 2000, 10th 2000, 17th 2000 and 1600th trails. That is calculated value of 't' have been found to be significant on comparing them with the corresponding theoretical values for most of the caes (trails).

Hence it may be concluded that the table of numbers constructed by L.H.C Tippett deviates significantly from proper randomness.

Therefore L.H.C Tippett Random Numbers Table Cannot be treated as properly random.

VI. Table

Observed frequency of occurrence of digits along with the respective expected frequency (Shown in bracket), amount of deviation (di) and the values of students 't' statistic from L.H.C Tippett.

Digits	0	1	2	3	4	5	6	7	8	9	t-value
1st 2000	1 201 (200)	20 225 (200)	10 210 (200)	6 194 (200)	2 202 (200)	6 194 (200)	3 203 (200)	2 202 (200)	30 170 (200)	1 199 (200)	2.65 *
2ND 2000	8 208 (200)	8 208 (200)	4 196 (200)	2 198 (200)	16 184 (200)	33 167 (200)	10 190 (200)	6 206 (200)	27 227 (200)	16 216 (200)	3.56
3rd 2000	5 205(200)	19 219 (200)	11 211 (200)	4 204(200)	12 212 (200)	6 194 (200)	11 211 (200)	27 173 (200)	5 195 (200)	24 176 (200)	4.15
4th 2000	4 204 (200)	3 197 (200)	17 217 (200)	0 200 (200)	8 192 (200)	4 196 (200)	6 206(200)	14 186 (200)	4 204 (200)	2 198 (200)	3.57
5th 2000	2 198 (200)	13 213 (200)	1 199 (200)	9 191 (200)	17 183 (200)	22 222 (200)	12 188 (200)	11 211 (200)	1 201 (200)	6 194 (200)	3.99
6TH 2000	25 175 (200)	26 174 (200)	7 193 (200)	5 205 (200)	3 203 (200)	25 225 (200)	10 210 (200)	10 210 (200)	4 204 (200)	1 201 (200)	4.14
7TH 2000	1 201 (200)	7 207 (200)	2 198 (200)	19 219 (200)	9 191 (200)	23 187 (200)	8 192 (200)	13 213 (200)	6 194 (200)	2 198 (200)	3.99
`8TH 2000	26 226 (200)	17 183 (200)	4 196 (200)	12 188 (200)	12 212 (200)	15 185 (200)	1 201 (200)	2 198 (200)	10 210 (200)	1 201 (200)	4.14
9TH 2000	13 187 (200)	6 194 (200)	6 206 (200)	11 211 (200)	4 204 (200)	3 197 (200)	10 210 (200)	18 182 (200)	17 217 (200)	8 192 (200)	5.37
10TH 2000	9 209 (200)	1 201 (200)	8 208 (200)	24 224 (200)	2 202 (200)	12 212 (200)	6 194 (200)	3 197 (200)	26 174 (200)	21 179 (200)	3.31 *
11TH 2000	11 211 (200)	4 196 (200)	10 210 (200)	1 199 (200)	9 209 (200)	7 193 (200)	11 211 (200)	18 182 (200)	23 177 (200)	12 212 (200)	4.42
12th 2000	10 190 (200)	2 198 (200)	20 180 (200)	5 195 (200)	29 229 (200)	19 219 (200)	18 182 (200)	14 186 (200)	18 218 (200)	3 203 (200)	5.43
13TH 2000	3 203 (200)	5 195 (200)	6 206 (200)	11 211 (200)	10 190 (200)	1 201 (200)	22 178 (200)	12 188 (200)	2 198 (200)	30 230 (200)	3.64
14TH 2000	22 222(200)	4 196 (200)	5 205 (200)	15 215 (200)	8 205 (200)	25 175 (200)	7 207 (200)	8 192 (200)	4 204 (200)	21 179 (200)	7.48
15 TH 2000	14 186 (200)	23 187 (200)	15 215 (200)	9 209 (200)	7 207 (200)	7 207 (200)	22 178 (200)	9 209 (200)	11 189 (200)	13 213 (200)	7.48
16th 2000	3 203 (200)	17 183 (200)	3 203 (200)	5 205 (200)	5 205 (200)	8 208 (200)	2 202 (200)	8 192 (200)	6 206 (200)	7 193 (200)	4.19
17th 2000	12 212 (200)	38 162 (200)	3 197 (200)	13 213 (200)	25 225 (200)	2 198 (200)	21 179 (200)	3 197 (200)	4 204 (200)	13 213 (200)	2.83 *
18th 2000	27 227 (200)	7 207 (200)	11 211 (200)	0 200(200)	15 185 (200)	9 191 (200)	5 205 (200)	29 171 (200)	14 186 (200)	17 217 (200)	4.04
19th 2000	20 220 (200)	12 212 (200)	19 181 (200)	23 177 (200)	12 212 (200)	24 176 (200)	2 202 (200)	5 205 (200)	28 228 (200)	13 187 (200)	5.44
20th 2000	11 211 (200)	0 200 (200)	1 199 (200)	13 187 (200)	6 194 (200)	11 189 (200)	11 189 (200)	6 206 (200)	23 223 (200)	2 202 (200)	3.93
Last 1600	15 175 (160)	24 136 (160)	15 175 (160)	0 160 (160)	13 147 (160)	8 168 (160)	2 162 (160)	2 158 (160)	1 159 (160)	0 160 (160)	2.83 *

*Indicates the values which are less than theoretical values of $t_{0.01,8} = 3.36$

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