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Examination of Proper Randomness of the Number Generated by L. H. C. Tippett

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Abstract

In the construction of Random Numbers Table, L.H.C. Tippett used some mechanical techniques for generating the random numbers. The numbers in the table have been subjected to various statistical test of randomness.

In this paper, the randomness of random numbers generated by L. H. C. Tippett has been tested by applying the Chi-square (χ^2) test for testing the significance of difference between observed frequency of each of the digit in the table and the corresponding theoretical (expected) frequency. The test shows that the random numbers table constructed by Tippett is not random, because the random numbers of the table deviate significantly from proper randomness.

Keywords: Random number generated by L. H. C. Tippett, testing of randomness, chi-square-test.

Introduction

Drawing of random sample has been found to be vital or basic work in every branch of experimental sciences. The most practical, scientific and economical method of selecting a random sample consists of the use of Random Number Table. Some commonly used random number tables are due to Tippett's (1927), Fisher and Yates (1938), Kendall and Babington Smith's (1939) and Rand Corporation (1955)

The random number tables have been subjected to various statistical tests of randomness. These tests have limitation 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 the tables. In the present study, an attempt has been made to test this. The study, here, has been made limited to the testing of proper randomness of the random numbers of the table generated by L.H.C.Tippett.

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 division of the degree of its randomness from proper randomness is insignificant. In order to test the proper randomness of the random numbers table

constructed by L.H.C.Tippett χ^2 - test has been applied.

Materials and methods

Method of Testing of proper Randomness of numbers generated by L.H.C.Tippett (1927):

The random number table constructed by Tippett consists of 10,400 four digit numbers giving in all 41,600 digits selected at random from the British Census report.

To know whether the numbers in random number table constructed by Tippett are proper or not Pearsonian χ^2 (chi-square) test for goodness of fit has been applied. Here the observed frequencies of the ten digits from 0 to 9 are obtained and tested against the theoretical expected frequencies on the basis of the hypothesis that the set of numbers is random according to which each digit has the probability $1/10$ to occur in any position of the series.

Steps in the method

In order to test the proper randomness of the numbers of Tippett's 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 100 trials,200 trials

..... up to 41,600 trials as shown in table. 1.1 to 1.17.

Step2: in the second step, compute the theoretical expected frequencies. This is done by dividing trials ie. first 100, first 200..... and first 41,600 by 10 assuming that the digits 0 to 9 occurs equal number of times.

Step3: In the third step, compute the Pearsonian χ^2 (chi-square) for each of the trials.

Step4: Compare the χ^2 (chi-square) values with the corresponding theoretical values.

Step5: Draw conclusion as per the results obtained in step4

Results and discussion

The results obtained on operating the steps (Nos.1-3) on the random number table constructed by Tippett

1. Examination of proper randomness of the table due to L.H.C Tippett.

Tables: Observed frequency of occurrence of digits along with the respective expected frequency (shown in bracket) and the value of Chi- square (χ^2) statistic from L.H.C Tippett

Table 1.1.

| Digits | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | χ^2 -value |
|--------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|-----------------|
| 100 | 10(10) | 10(10) | 14(10) | 7(10) | 9(10) | 12(10) | 11(10) | 9(10) | 9(10) | 9(10) | 3.4 |
| 200 | 24(20) | 22(20) | 26(20) | 14(20) | 24(20) | 16(20) | 15(20) | 18(20) | 19(20) | 22(20) | 7.9 |
| 300 | 29(30) | 36(30) | 37(30) | 25(30) | 38(30) | 24(30) | 27(30) | 26(30) | 26(30) | 31(30) | 8.1923 |
| 400 | 35(40) | 48(40) | 50(40) | 35(40) | 49(40) | 36(40) | 33(40) | 36(40) | 33(40) | 45(40) | 11.25 |
| 500 | 45(50) | 60(50) | 63(50) | 45(50) | 59(50) | 45(50) | 39(50) | 42(50) | 43(50) | 59(50) | 14.8 |
| 600 | 51(60) | 71(60) | 76(60) | 52(60) | 69(60) | 57(62) | 45(60) | 59(60) | 53(60) | 67(60) | 15.6017 |
| 700 | 62(70) | 75(70) | 83(70) | 65(70) | 74(70) | 68(70) | 61(70) | 73(70) | 59(70) | 80(70) | 8.7705 |
| 800 | 81(80) | 87(80) | 94(80) | 72(80) | 78(80) | 80(80) | 73(80) | 82(80) | 64(80) | 89(80) | 5.8 |
| 900 | 93(90) | 94(90) | 108(90) | 83(90) | 84(90) | 92(90) | 84(90) | 95(90) | 70(90) | 97(90) | 10.5318 |
| 1000 | 101(100) | 104(100) | 120(100) | 89(100) | 96(100) | 99(100) | 98(100) | 107(100) | 82(100) | 104(100) | 6.42 |
| 1100 | 115(110) | 123(110) | 130(110) | 98(110) | 104(110) | 105(110) | 109(110) | 114(110) | 92(110) | 110(110) | 11.398 |
| 1200 | 131(120) | 141(120) | 136(120) | 106(120) | 113(120) | 115(120) | 119(120) | 122(120) | 98(120) | 119(120) | 13.1479 |
| 1300 | 141(130) | 152(130) | 141(130) | 119(130) | 122(130) | 125(130) | 130(130) | 129(130) | 108(130) | 133(130) | 10.9994 |
| 1400 | 151(140) | 165(140) | 152(140) | 133(140) | 133(140) | 129(140) | 138(140) | 140(140) | 117(140) | 142(140) | 10.0284 |
| 1500 | 155(150) | 173(150) | 161(150) | 138(150) | 148(150) | 143(150) | 152(150) | 153(150) | 126(150) | 151(150) | 9.9269 |
| 1600 | 166(160) | 185(160) | 167(160) | 148(160) | 161(160) | 155(160) | 160(160) | 161(160) | 137(160) | 160(160) | 8.8126 |
| 1700 | 175(170) | 194(170) | 176(170) | 157(170) | 169(170) | 169(170) | 179(170) | 170(170) | 143(170) | 168(170) | 9.5345 |
| 1800 | 183(180) | 206(180) | 183(180) | 174(180) | 176(180) | 176(180) | 191(180) | 179(180) | 151(180) | 181(180) | 9.389 |
| 1900 | 194(190) | 216(190) | 197(190) | 182(190) | 194(190) | 182(190) | 194(190) | 291(190) | 160(190) | 190(190) | 9.4842 |
| 2000 | 201(200) | 225(200) | 210(200) | 194(200) | 202(200) | 194(200) | 203(200) | 202(200) | 170(200) | 199(200) | 8.4 |
| 2100 | 208(210) | 233(210) | 219(210) | 206(210) | 212(210) | 206(210) | 212(210) | 208(210) | 182(210) | 214(210) | 6.9248 |
| 2200 | 217(220) | 240(220) | 224(239) | 215(220) | 224(220) | 220(220) | 217(220) | 222(220) | 198(220) | 223(220) | 4.5816 |
| 2300 | 227(230) | 252(230) | 239(230) | 223(230) | 235(230) | 225(230) | 224(230) | 233(230) | 211(230) | 231(230) | 4.3787 |
| 2400 | 238(240) | 258(240) | 249(240) | 238(240) | 240(240) | 235(240) | 239(240) | 243(240) | 217(240) | 243(240) | 4.0041 |
| 2500 | 247(250) | 265(250) | 259(250) | 245(250) | 257(250) | 245(250) | 250(250) | 253(250) | 227(250) | 252(250) | 3.664 |

Table 1.5

Table with 12 columns: Digits, 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, x^2-value. It contains numerical data for digits 10100 through 12500.

Table 1.6

Table with 12 columns: Digits, 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, x^2-value. It contains numerical data for digits 12600 through 15000.

Table 1.7

Table with 12 columns: Digits, 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, x^2-value. It contains numerical data for digits 15100 through 17500.

Table 1.8

Table with 11 columns: Digits, 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, value. It lists digit combinations from 17600 to 20000 and their corresponding values.

Table 1.9

Table with 11 columns: Digits, 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, value. It lists digit combinations from 20100 to 22500 and their corresponding values.

Table 1.10

Table with 11 columns: Digits, 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, value. It lists digit combinations from 22600 to 25000 and their corresponding values.

Table 1.14

Table with 11 columns: Digits, 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, x^2-value. Rows range from 32600 to 35000.

Table 1.15

Table with 11 columns: Digits, 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, x^2-value. Rows range from 35100 to 37500.

Table 1.16

Table with 11 columns: Digits, 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, x^2-value. Rows range from 37600 to 40000.

Table 1.17

| Digits | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | χ^2 -value |
|--------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| 40100 | 4110(4010) | 3962(4010) | 4041(4010) | 4055(4010) | 4041(4010) | 3967(4010) | 3909(4010) | 3943(4010) | 4017(4010) | 4055(4010) | 8.6943 |
| 40200 | 4125(4020) | 3972(4020) | 4050(4020) | 4064(4020) | 4046(4020) | 3974(4020) | 3918(4020) | 3959(4020) | 4032(4020) | 4060(4020) | 8.6632 |
| 40300 | 4138(4030) | 3978(4030) | 4066(4030) | 4073(4030) | 4048(4030) | 3986(4030) | 3927(4030) | 3970(4030) | 4041(4030) | 4073(4030) | 8.921 |
| 40400 | 4148(4040) | 3987(4040) | 4076(4040) | 4086(4040) | 4060(4040) | 3995(4040) | 3938(4040) | 3978(4040) | 4050(4040) | 4082(4040) | 9.0153 |
| 40500 | 4155(4050) | 3995(4050) | 4097(4050) | 4099(4050) | 4069(4050) | 4003(4050) | 3950(4050) | 3986(4050) | 4057(4050) | 4089(4050) | 9.1000 |
| 40600 | 4164(4060) | 4000(4060) | 4105(4060) | 4112(4060) | 4079(4060) | 4010(4060) | 3967(4060) | 3993(4060) | 4071(4060) | 4099(4060) | 8.8044 |
| 40700 | 4178(4070) | 4007(4070) | 4113(4070) | 4121(4070) | 4087(4070) | 4019(4070) | 3978(4070) | 4002(4070) | 4083(4070) | 4112(4070) | 9.3351 |
| 40800 | 4184(4080) | 4012(4080) | 4120(4080) | 4133(4080) | 4097(4080) | 4029(4080) | 3992(4080) | 4012(4080) | 4096(4080) | 4125(4080) | 9.1598 |
| 40900 | 4198(4090) | 4019(4090) | 4132(4090) | 4144(4090) | 4108(4090) | 4042(4090) | 4001(4090) | 4018(4090) | 4105(4090) | 4133(4090) | 9.5824 |
| 41000 | 4208(4100) | 4031(4100) | 4141(4100) | 4160(4100) | 4116(4100) | 4056(4100) | 4011(4100) | 4030(4100) | 4109(4100) | 4138(4100) | 9.3375 |
| 41100 | 4220(4110) | 4037(4110) | 4155(4110) | 4169(4110) | 4129(4110) | 4066(4110) | 4019(4110) | 4044(4110) | 4116(4110) | 4145(4110) | 9.5207 |
| 41200 | 4230(4120) | 4045(4120) | 4170(4120) | 4180(4120) | 4137(4120) | 4082(4120) | 4024(4120) | 4052(4120) | 4125(4120) | 4165(4120) | 9.866 |
| 41300 | 4239(4130) | 4051(4130) | 4183(4130) | 4189(4130) | 4246(4130) | 4092(4130) | 4033(4130) | 4064(4130) | 4136(4130) | 4167(4130) | 9.9955 |
| 41400 | 4251(4140) | 4064(4140) | 4191(4140) | 4194(4140) | 4157(4140) | 4103(4140) | 4041(4140) | 4071(4140) | 4151(4140) | 4177(4140) | 9.9817 |
| 41500 | 4265(4150) | 4075(4150) | 4201(4150) | 4204(4150) | 4161(4150) | 4112(4150) | 4051(4150) | 4082(4150) | 4157(4150) | 4192(4150) | 10.1614 |
| 41600 | 4274(4160) | 4085(4160) | 4209(4160) | 4213(4160) | 4175(4160) | 4121(4160) | 4062(4160) | 4086(4160) | 4169(4160) | 4206(4160) | 10.3015 |

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