# IJESRT

## INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY

## Testing of Randomness of the Number Generated by Fisher and Yates

**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 Fisher and Yates has been examined by Chakrabarty in2010 by computing the probability of occurrence of each digit in the table of generated numbers and then applying the theoretical probabilistic concept of randomness.

In this paper, the same has been tested 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.

The test shows that the numbers generated by Fisher and Yates deviate significantly from proper randomness.

**Keywords:** Random number generated by Fisher and Yates, 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 Fisher and Yates (1938), Tippett's (1927), 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 Fisher and Yates 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 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 Fisher and Yates $x^2$- test has been applied.

## Materials and methods

Method of Testing of proper Randomness of numbers generated by Fisher and Yates

The random number table constructed by Fisher and Yates consists of a total of 7500 two digited numbers giving in all 15000 digits.

To know whether the numbers in random number table constructed by Fisher and Yates are proper or not Pearsonian $x^2$ (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 excepted 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 Fisher and Yates 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 15000 trials as shown in table. 1.1 to 1.6

Step2: in the second step, compute the theoretical expected frequencies. This is done by dividing trials ie. first 100, first 200………………. and first 15000 by 10 assuming that the digits 0 to 9 occurs equal number of times.

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

Step4: Compare the $x^2$ (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 Fisher and Yates have been observed. From table 1.6 it is observed that occurrence of digit 0 to 9 are not equal, the digit 6 occurs highest number of times whereas digit 1 occurs lowest number of times.

## Conclusion

From tables 1.1 to 1.6 that is the tables prepared for observed frequency of occurrence of digits along with respective expected frequency (shown in bracket) it is observed that the calculated value of $x^2$

is significant. That is calculated value of $x^2$ have been found to be significant on comparing them with the corresponding theoretical values.

Hence it may be concluded that the table of numbers generated by Fisher and Yates deviates significantly from proper randomness. Therefore the numbers of Fisher and Yates Random Numbers Table cannot be treated as properly random.

1. Examination of proper randomness of the table due to Fisher and Yates

**Tables:**

*Table 1.1. Observed frequency of occurrence of digits along with the respective expected frequency (shown in bracket) and the value of Chi- square ($x^2$) statistic from Fisher and Yates table*

| Number of trails (from the first) | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | $x^2$-value |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 100 | 3(10) | 8(10) | 13(10) | 13(10) | 11(10) | 10(10) | 17(10) | 12(10) | 5(10) | 8(10) | 15.4 |
| 200 | 8(20) | 20(20) | 28(20) | 25(20) | 20(20) | 19(20) | 26(20) | 24(20) | 12(20) | 18(20) | 17.7 |
| 300 | 16(30) | 30(30) | 40(30) | 36(30) | 29(30) | 27(30) | 40(30) | 33(30) | 20(30) | 29(30) | 18.386 |
| 400 | 28(40) | 41(40) | 44(40) | 42(40) | 37(40) | 39(40) | 55(40) | 44(40) | 32(40) | 38(40) | 13.1 |
| 500 | 42(50) | 51(50) | 53(50) | 51(50) | 44(50) | 52(50) | 59(50) | 50(56) | 41(50) | 51(50) | 6.28 |
| 600 | 48(60) | 58(60) | 64(60) | 56(60) | 57(60) | 66(62) | 75(60) | 67(60) | 50(60) | 59(60) | 10.008 |
| 700 | 59(70) | 66(70) | 73(70) | 66(70) | 67(70) | 74(70) | 80(70) | 81(70) | 63(70) | 71(70) | 6.55 |
| 800 | 70(80) | 74(80) | 83(80) | 79(80) | 77(80) | 82(80) | 94(80) | 89(80) | 70(80) | 82(80) | 6.75 |
| 900 | 81(90) | 83(90) | 91(90) | 87(90) | 86(90) | 97(90) | 102(90) | 100(90) | 80(90) | 93(90) | 6.189 |
| 1000 | 91(100) | 93(100) | 104(100) | 102(100) | 94(100) | 103(100) | 109(100) | 108(100) | 88(100) | 108(100) | 5.48 |
| 1100 | 101(110) | 100(110) | 115(110) | 117(110) | 105(110) | 110(110) | 116(110) | 125(110) | 93(110) | 118(110) | 7.95 |
| 1200 | 112(120) | 111(120) | 123(120) | 130(120) | 118(120) | 117(120) | 127(120) | 133(120) | 102(120) | 127(120) | 7.076 |
| 1300 | 120(130) | 121(130) | 130(130) | 140(130) | 130(130) | 125(130) | 136(130) | 149(130) | 111(130) | 138(130) | 8.682 |
| 1400 | 136(140) | 136(140) | 141(140) | 148(140) | 135(140) | 137(140) | 148(140) | 158(140) | 116(140) | 145(140) | 7.995 |
| 1500 | 144(150) | 142(150) | 153(150) | 165(150) | 144(150) | 145(150) | 156(150) | 165(150) | 129(150) | 157(150) | 7.644 |
| 1600 | 155(160) | 155(160) | 165(160) | 178(160) | 151(160) | 160(160) | 163(160) | 176(160) | 137(160) | 160(160) | 7.961 |
| 1700 | 170(170) | 161(170) | 176(170) | 189(170) | 165(170) | 170(170) | 172(170) | 187(170) | 146(170) | 164(170) | 8.2808 |
| 1800 | 183(180) | 169(180) | 189(180) | 196(180) | 179(180) | 181(180) | 186(180) | 194(180) | 152(180) | 171(180) | 8.702 |
| 1900 | 193(190) | 177(190) | 201(190) | 208(190) | 186(190) | 191(190) | 196(190) | 202(190) | 163(190) | 183(190) | 7.714 |
| 2000 | 210(200) | 184(200) | 211(200) | 220(200) | 202(200) | 196(200) | 202(200) | 212(200) | 170(200) | 193(200) | 9.97 |
| 2100 | 220(210) | 195(210) | 221(210) | 231(210) | 214(210) | 201(210) | 211(210) | 220(210) | 182(210) | 205(210) | 9.014 |
| 2200 | 231(220) | 204(220) | 230(220) | 220(239) | 225(220) | 211(220) | 216(220) | 233(220) | 194(220) | 217(220) | 8.297 |
| 2300 | 244(230) | 211(230) | 240(230) | 247(230) | 236(230) | 226(230) | 223(230) | 242(230) | 203(230) | 228(230) | 8.994 |
| 2400 | 254(240) | 220(240) | 247(240) | 257(240) | 250(240) | 230(240) | 230(240) | 255(240) | 207(240) | 242(240) | 10.2405 |
| 2500 | 265(250) | 229(250) | 254(250) | 270(250) | 261(250) | 244(250) | 240(250) | 266(250) | 216(250) | 255(250) | 11.104 |

*Table 1.2*

| Number of trails (from the first) \ Digits | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | $x^2$-value |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2600 | 269(260) | 236(260) | 268(260) | 283(260) | 270(260) | 258(260) | 254(260) | 273(260) | 228(260) | 261(260) | 9.9448 |
| 2700 | 277(270) | 246(270) | 279(270) | 290(270) | 279(270) | 272(270) | 263(270) | 285(270) | 241(270) | 268(270) | 8.541 |
| 2800 | 287(280) | 259(280) | 287(280) | 297(280) | 289(280) | 281(280) | 278(280) | 294(280) | 251(280) | 277(280) | 6.9996 |
| 2900 | 293(290) | 273(290) | 294(290) | 312(390) | 295(290) | 288(290) | 290(290) | 304(290) | 263(290) | 288(290) | 4.538 |
| 3000 | 308(300) | 283(300) | 306(300) | 328(300) | 301(300) | 297(300) | 295(300) | 310(300) | 275(300) | 300(300) | 6.604 |
| 3100 | 324(310) | 293(310) | 317(310) | 330(310) | 312(310) | 305(310) | 308(310) | 315(310) | 289(310) | 307(310) | 4.647 |
| 3200 | 331(320) | 310(320) | 328(320) | 320(337) | 325(320) | 317(320) | 317(320) | 321(320) | 295(320) | 319(320) | 3.884 |
| 3300 | 341(330) | 314(330) | 338(330) | 349(330) | 332(330) | 329(330) | 332(330) | 328(330) | 307(330) | 330(330) | 4.066 |
| 3400 | 354(340) | 322(340) | 347(340) | 360(340) | 347(340) | 334(340) | 340(340) | 338(340) | 317(340) | 341(340) | 4.6707 |
| 3500 | 362(350) | 331(350) | 359(350) | 371(350) | 353(350) | 344(350) | 347(350) | 353(350) | 332(350) | 348(350) | 4.9755 |
| 3600 | 369(360) | 346(360) | 370(360) | 381(360) | 365(360) | 351(360) | 361(360) | 360(360) | 339(360) | 358(360) | 3.7949 |
| 3700 | 375(370) | 358(370) | 381(370) | 388(370) | 372(370) | 361(370) | 375(370) | 375(370) | 348(370) | 367(370) | 3.358 |
| 3800 | 383(380) | 364(380) | 394(380) | 396(380) | 381(380) | 373(380) | 386(380) | 386(380) | 358(380) | 379(380) | 3.1901 |
| 3900 | 393(390) | 369(390) | 405(390) | 409(390) | 395(390) | 383(390) | 395(390) | 395(390) | 368(390) | 388(390) | 4.2056 |
| 4000 | 405(400) | 379(400) | 419(400) | 420(400) | 404(400) | 390(400) | 401(400) | 406(400) | 376(400) | 400(400) | 4.9175 |
| 4100 | 414(410) | 389(410) | 431(410) | 429(410) | 413(410) | 398(410) | 408(410) | 416(410) | 391(410) | 411(410) | 4.4239 |
| 4200 | 422(420) | 398(420) | 436(420) | 443(420) | 422(420) | 408(420) | 424(420) | 423(420) | 407(420) | 417(420) | 3.8658 |
| 4300 | 430(430) | 405(430) | 447(430) | 456(430) | 434(430) | 419(430) | 432(430) | 430(430) | 417(430) | 432(430) | 4.2776 |
| 4400 | 440(440) | 417(440) | 453(440) | 466(440) | 447(440) | 436(440) | 435(440) | 440(440) | 423(440) | 443(440) | 4.0041 |
| 4500 | 448(450) | 424(450) | 463(450) | 472(450) | 458(450) | 444(450) | 452(450) | 448(450) | 435(450) | 456(450) | 3.7807 |
| 4600 | 457(460) | 436(460) | 473(460) | 483(460) | 464(460) | 458(460) | 461(460) | 457(460) | 445(460) | 466(460) | 7.2959 |
| 4700 | 466(470) | 447(470) | 483(470) | 491(470) | 476(470) | 466(470) | 475(470) | 466(470) | 453(470) | 477(470) | 2.4967 |
| 4800 | 476(480) | 460(480) | 492(480) | 506(480) | 486(480) | 474(480) | 484(480) | 471(480) | 468(480) | 483(480) | 3.245 |
| 4900 | 482(490) | 470(490) | 500(490) | 514(490) | 498(490) | 485(490) | 490(490) | 480(490) | 479(490) | 499(490) | 2.898 |
| 5000 | 498(500) | 480(500) | 508(500) | 524(500) | 509(500) | 493(500) | 502(500) | 490(500) | 486(500) | 510(500) | 2.7952 |

*Table 1.3*

| Number of trails (from the first) \ Digits | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | $x^2$-value |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 5100 | 505(510) | 487(510) | 522(510) | 535(510) | 516(510) | 502(510) | 515(510) | 504(510) | 496(510) | 518(510) | 3.589 |
| 5200 | 510(520) | 495(520) | 531(520) | 546(520) | 527(520) | 514(520) | 524(520) | 512(520) | 511(520) | 530(520) | 5.777 |
| 5300 | 520(530) | 503(530) | 545(530) | 551(530) | 538(530) | 524(530) | 542(530) | 522(530) | 519(530) | 536(530) | 3.6998 |
| 5400 | 528(540) | 524(540) | 554(540) | 561(540) | 546(540) | 531(540) | 554(540) | 532(540) | 529(540) | 551(540) | 3.8445 |
| 5500 | 540(550) | 524(550) | 564(550) | 569(550) | 551(550) | 537(550) | 564(550) | 542(550) | 545(550) | 564(550) | 3.6058 |
| 5600 | 548(560) | 530(560) | 577(560) | 586(560) | 557(560) | 547(560) | 574(560) | 553(560) | 551(560) | 577(560) | 5.0036 |
| 5700 | 560(570) | 536(570) | 588(570) | 600(570) | 564(570) | 553(570) | 586(570) | 567(570) | 558(570) | 588(570) | 5.7851 |
| 5800 | 569(580) | 545(580) | 595(580) | 610(580) | 576(580) | 561(580) | 594(580) | 581(580) | 565(580) | 604(580) | 6.3243 |
| 5900 | 576(590) | 557(590) | 605(590) | 622(590) | 584(590) | 569(590) | 599(590) | 597(590) | 574(590) | 617(590) | 7.0341 |
| 6000 | 583(600) | 569(600) | 617(600) | 630(600) | 600(600) | 576(600) | 606(600) | 606(600) | 586(600) | 627(600) | 6.688 |
| 6100 | 595(610) | 574(610) | 628(610) | 640(610) | 608(610) | 588(610) | 613(610) | 620(610) | 594(610) | 640(610) | 7.3731 |
| 6200 | 605(620) | 585(620) | 639(620) | 646(620) | 618(620) | 600(620) | 625(620) | 633(620) | 601(620) | 648(620) | 7.4613 |
| 6300 | 619(630) | 590(630) | 648(630) | 661(630) | 626(630) | 608(630) | 633(630) | 647(630) | 614(630) | 654(630) | 7.3573 |
| 6400 | 633(640) | 600(640) | 657(640) | 667(640) | 636(640) | 618(640) | 645(640) | 660(640) | 619(640) | 665(640) | 7.279 |
| 6500 | 642(650) | 610(650) | 668(650) | 674(650) | 648(650) | 628(650) | 655(650) | 669(650) | 632(650) | 674(650) | 6.636 |
| 6600 | 651(660) | 620(660) | 678(660) | 683(660) | 655(660) | 639(660) | 667(660) | 676(660) | 646(660) | 685(660) | 6.2479 |
| 6700 | 662(670) | 633(670) | 685(670) | 692(670) | 668(670) | 646(670) | 673(670) | 686(670) | 658(670) | 697(670) | 5.7576 |
| 6800 | 672(680) | 649(680) | 690(680) | 705(680) | 680(680) | 659(680) | 681(680) | 693(680) | 666(680) | 705(680) | 3.5674 |
| 6900 | 680(690) | 659(690) | 697(690) | 722(690) | 691(690) | 668(690) | 689(690) | 707(690) | 673(690) | 714(690) | 5.406 |
| 7000 | 690(700) | 672(700) | 705(700) | 729(700) | 698(700) | 685(700) | 698(700) | 716(700) | 684(700) | 725(700) | 3.4275 |
| 7100 | 700(710) | 679(710) | 719(710) | 736(710) | 709(710) | 692(710) | 708(710) | 728(710) | 691(710) | 738(710) | 5.084 |
| 7200 | 710(720) | 694(720) | 732(720) | 747(720) | 715(720) | 701(720) | 717(720) | 734(720) | 698(720) | 752(720) | 5.203 |
| 7300 | 721(730) | 700(730) | 741(730) | 759(730) | 724(730) | 711(730) | 730(730) | 744(730) | 711(730) | 759(730) | 3.047 |
| 7400 | 737(740) | 710(740) | 749(740) | 767(740) | 733(740) | 723(740) | 740(740) | 754(740) | 716(740) | 771(740) | 5.1216 |
| 7500 | 745(750) | 721(750) | 761(750) | 785(750) | 743(750) | 735(750) | 748(750) | 762(750) | 719(750) | 781(750) | 6.071 |

*Table 1.4*

| Number of trails (from the first) \ Digits | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | sk value |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 7600 | 755(760) | 735(760) | 771(760) | 794(760) | 753(760) | 742(760) | 759(760) | 771(760) | 730(760) | 790(760) | 5.544 |
| 7700 | 762(770) | 745(770) | 780(770) | 804(770) | 764(770) | 755(770) | 776(770) | 781(770) | 739(770) | 794(770) | 4.8017 |
| 7800 | 773(780) | 755(780) | 791(780) | 814(780) | 772(780) | 758(780) | 790(780) | 795(780) | 750(780) | 802(780) | 6.1348 |
| 7900 | 783(790) | 766(790) | 799(790) | 823(790) | 788(790) | 765(790) | 801(790) | 803(790) | 758(790) | 814(790) | 5.2715 |
| 8000 | 793(800) | 776(800) | 802(800) | 832(800) | 797(800) | 772(800) | 811(800) | 818(800) | 772(800) | 827(800) | 5.504 |
| 8100 | 803(810) | 786(810) | 816(810) | 839(810) | 806(810) | 783(810) | 817(810) | 829(810) | 785(810) | 836(810) | 4.8868 |
| 8200 | 809(820) | 794(820) | 826(820) | 850(820) | 817(820) | 799(820) | 825(820) | 837(820) | 796(820) | 847(820) | 4.6364 |
| 8300 | 819(830) | 806(830) | 838(830) | 850(830) | 824(830) | 811(830) | 834(830) | 846(830) | 807(830) | 856(830) | 4.1867 |
| 8400 | 830(840) | 818(840) | 845(840) | 869(840) | 832(840) | 823(840) | 840(840) | 855(840) | 823(840) | 865(840) | 3.5018 |
| 8500 | 842(850) | 828(850) | 855(850) | 872(850) | 843(850) | 832(850) | 858(850) | 860(850) | 833(850) | 877(850) | 3.072 |
| 8600 | 856(860) | 834(860) | 859(860) | 884(860) | 850(860) | 846(860) | 872(860) | 866(860) | 845(860) | 888(860) | 3.2025 |
| 8700 | 863(870) | 839(870) | 870(870) | 893(870) | 862(870) | 856(870) | 886(870) | 884(870) | 851(870) | 896(870) | 3.7743 |
| 8800 | 869(880) | 851(880) | 876(880) | 905(880) | 872(880) | 865(880) | 895(880) | 894(880) | 863(880) | 910(880) | 4.5071 |
| 8900 | 884(890) | 865(890) | 883(890) | 919(890) | 880(890) | 871(890) | 905(890) | 904(890) | 872(890) | 917(890) | 3.9144 |
| 9000 | 894(900) | 872(900) | 892(900) | 931(900) | 884(900) | 882(900) | 917(900) | 917(900) | 886(900) | 925(900) | 4.248 |
| 9100 | 906(910) | 883(910) | 898(910) | 942(910) | 897(910) | 892(910) | 925(910) | 931(910) | 893(910) | 933(910) | 4.2746 |
| 9200 | 913(920) | 890(920) | 906(920) | 950(920) | 916(920) | 900(920) | 938(920) | 942(920) | 903(920) | 941(920) | 4.4044 |
| 9300 | 923(930) | 896(930) | 915(930) | 964(930) | 927(930) | 905(930) | 950(930) | 956(930) | 910(930) | 954(930) | 5.6684 |
| 9400 | 931(940) | 904(940) | 923(940) | 974(940) | 936(940) | 919(940) | 962(940) | 965(940) | 920(940) | 966(940) | 5.813 |
| 9500 | 940(950) | 918(950) | 932(950) | 982(950) | 945(950) | 926(950) | 974(950) | 979(950) | 929(950) | 975(950) | 5.8473 |
| 9600 | 947(960) | 927(960) | 944(960) | 990(960) | 956(960) | 937(960) | 986(960) | 989(960) | 937(960) | 987(960) | 5.9722 |
| 9700 | 956(970) | 944(970) | 954(970) | 999(970) | 966(970) | 944(970) | 997(970) | 999(970) | 946(970) | 995(970) | 4.8202 |
| 9800 | 962(980) | 955(980) | 959(980) | 1007(980) | 977(980) | 955(980) | 1004(980) | 1014(980) | 960(980) | 1007(980) | 5.7298 |
| 9900 | 973(990) | 964(990) | 968(990) | 1013(990) | 994(990) | 965(990) | 1011(990) | 1022(990) | 974(990) | 1016(990) | 5.0662 |
| 10000 | 985(1000) | 974(1000) | 977(1000) | 1026(1000) | 999(1000) | 978(1000) | 1022(1000) | 1033(1000) | 978(1000) | 1028(1000) | 5.432 |

*Table 1.5*

| Number of trails (from the first) \ Digits | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | sl-value |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 10100 | 1000(1010) | 980(1010) | 985(1010) | 1035(1010) | 1010(1010) | 993(1010) | 1031(1010) | 1039(1010) | 990(1010) | 1037(1010) | 4.992 |
| 10200 | 1016(1020) | 992(1020) | 992(1020) | 1045(1020) | 1017(1020) | 1000(1020) | 1040(1020) | 1049(1020) | 1002(1020) | 1047(1020) | 4.8175 |
| 10300 | 1026(1030) | 1008(1030) | 1001(1030) | 1060(1030) | 1021(1030) | 1010(1030) | 1045(1030) | 1058(1030) | 1015(1030) | 1056(1030) | 4.4821 |
| 10400 | 1037(1040) | 1019(1040) | 1012(1040) | 1064(1040) | 1038(1040) | 1018(1040) | 1054(1040) | 1068(1040) | 1026(1040) | 1064(1040) | 3.8945 |
| 10500 | 1046(1050) | 1028(1050) | 1023(1050) | 1080(1050) | 1045(1050) | 1027(1050) | 1065(1050) | 1050(1050) | 1040(1050) | 1073(1050) | 3.872 |
| 10600 | 1056(1060) | 1033(1060) | 1037(1060) | 1091(1060) | 1048(1060) | 1041(1060) | 1082(1060) | 1083(1060) | 1049(1060) | 1080(1060) | 4.0281 |
| 10700 | 1064(1070) | 1041(1070) | 1048(1070) | 1099(1070) | 1060(1070) | 1047(1070) | 1095(1070) | 1092(1070) | 1055(1070) | 1099(1070) | 4.677 |
| 10800 | 1075(1080) | 1051(1080) | 1060(1080) | 1104(1080) | 1070(1080) | 1056(1080) | 1109(1080) | 1097(1080) | 1065(1080) | 1113(1080) | 4.594 |
| 10900 | 1083(1090) | 1059(1090) | 1073(1090) | 1118(1090) | 1080(1090) | 1066(1090) | 1116(1090) | 1105(1090) | 1081(1090) | 1119(1090) | 4.203 |
| 11000 | 1098(1100) | 1069(1100) | 1079(1100) | 1126(1100) | 1091(1100) | 1078(1100) | 1126(1100) | 1114(1100) | 1091(1100) | 1128(1100) | 3.9865 |
| 11100 | 1108(1110) | 1077(1110) | 1087(1110) | 1138(1110) | 1101(1110) | 1090(1110) | 1136(1110) | 1131(1110) | 1096(1110) | 1136(1110) | 4.3925 |
| 11200 | 1117(1120) | 1089(1120) | 1095(1120) | 1149(1120) | 1110(1120) | 1100(1120) | 1148(1120) | 1145(1120) | 1103(1120) | 1144(1120) | 4.651 |
| 11300 | 1131(1130) | 1098(1130) | 1102(1130) | 1157(1130) | 1116(1130) | 1106(1130) | 1159(1130) | 1158(1130) | 1118(1130) | 1155(1130) | 4.5079 |
| 11400 | 1135(1140) | 1113(1140) | 1114(1140) | 1164(1140) | 1132(1140) | 1119(1140) | 1165(1140) | 1165(1140) | 1127(1140) | 1166(1140) | 4.0389 |
| 11500 | 1144(1150) | 1120(1150) | 1124(1150) | 1171(1150) | 1142(1150) | 1152(1150) | 1179(1150) | 1175(1150) | 1141(1150) | 1172(1150) | 3.8884 |
| 11600 | 1151(1160) | 1130(1160) | 1136(1160) | 1184(1160) | 1150(1160) | 1141(1160) | 1187(1160) | 1187(1160) | 1147(1160) | 1187(1160) | 4.2668 |
| 11700 | 1161(1170) | 1145(1170) | 1141(1170) | 1201(1170) | 1153(1170) | 1146(1170) | 1199(1170) | 1197(1170) | 1158(1170) | 1199(1170) | 5.293 |
| 11800 | 1175(1180) | 1150(1180) | 1148(1180) | 1216(1180) | 1159(1180) | 1155(1180) | 1210(1180) | 1207(1180) | 1168(1180) | 1212(1180) | 6.614 |
| 11900 | 1186(1190) | 1156(1190) | 1161(1190) | 1224(1190) | 1173(1190) | 1165(1190) | 1223(1190) | 1212(1190) | 1178(1190) | 1222(1190) | 5.7344 |
| 12000 | 1200(1200) | 1169(1200) | 1171(1200) | 1235(1200) | 1183(1200) | 1170(1200) | 1228(1200) | 1226(1200) | 1187(1200) | 1231(1200) | 5.671 |
| 12100 | 1213(1210) | 1178(1210) | 1182(1210) | 1241(1210) | 1194(1210) | 1184(1210) | 1236(1210) | 1238(1210) | 1191(1210) | 1243(1210) | 5.4714 |
| 12200 | 1220(1220) | 1185(1220) | 1196(1220) | 1257(1220) | 1204(1220) | 1194(1220) | 1246(1220) | 1244(1220) | 1195(1220) | 1259(1220) | 6.1468 |
| 12300 | 1232(1230) | 1196(1230) | 1201(1230) | 1265(1230) | 1211(1230) | 1205(1230) | 1267(1230) | 1251(1230) | 1206(1230) | 1266(1230) | 5.469 |
| 12400 | 1238(1240) | 1200(1240) | 1210(1240) | 1280(1240) | 1216(1240) | 1219(1240) | 1282(1240) | 1262(1240) | 1213(1240) | 1280(1240) | 7.8212 |
| 12500 | 1245(1250) | 1210(1250) | 1219(1250) | 1292(1250) | 1224(1250) | 1225(1250) | 1297(1250) | 1275(1250) | 1227(1250) | 1286(1250) | 8.2478 |

*Table 1.6*

| Number of trails (from the first) \ Digits | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | $\chi^2$-value |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 12600 | 1249(1260) | 1219(1260) | 1232(1260) | 1304(1260) | 1236(1260) | 1236(1260) | 1312(1260) | 1278(1260) | 1236(1260) | 1298(1260) | 8.509 |
| 12700 | 1261(1270) | 1230(1270) | 1239(1270) | 1316(1270) | 1248(1270) | 1244(1270) | 1324(1270) | 1288(1270) | 1243(1270) | 1307(1270) | 8.8626 |
| 12800 | 1277(1280) | 1239(1280) | 1248(1280) | 1321(1280) | 1257(1280) | 1250(1280) | 1338(1280) | 1300(1280) | 1254(1280) | 1316(1280) | 8.3969 |
| 12900 | 1292(1290) | 1249(1290) | 1258(1290) | 1327(1290) | 1267(1290) | 1258(1290) | 1348(1290) | 1313(1290) | 1262(1290) | 1326(1290) | 8.9979 |
| 13000 | 1301(1300) | 1258(1300) | 1264(1300) | 1335(1300) | 1283(1300) | 1271(1300) | 1359(1300) | 1331(1300) | 1264(1300) | 1334(1300) | 9.469 |
| 13100 | 1308(1310) | 1270(1310) | 1277(1310) | 1347(1310) | 1295(1310) | 1280(1310) | 1367(1310) | 1334(1310) | 1275(1310) | 1347(1310) | 8.8581 |
| 13200 | 1316(1320) | 1280(1320) | 1285(1320) | 1365(1320) | 1302(1320) | 1285(1320) | 1380(1320) | 1542(1320) | 1289(1320) | 1356(1320) | 9.664 |
| 13300 | 1324(1330) | 1288(1330) | 1298(1330) | 1374(1330) | 1309(1330) | 1295(1330) | 1391(1330) | 1347(1330) | 1302(1330) | 1372(1330) | 9.766 |
| 13400 | 1330(1340) | 1295(1340) | 1308(1340) | 1390(1340) | 1318(1340) | 1304(1340) | 1403(1340) | 1353(1340) | 1319(1340) | 1380(1340) | 8.4756 |
| 13500 | 1336(1350) | 1308(1350) | 1321(1350) | 1342(1350) | 1331(1350) | 1313(1350) | 1411(1350) | 1364(1350) | 1329(1350) | 1385(1350) | 9.497 |
| 13600 | 1350(1360) | 1315(1360) | 1337(1360) | 1411(1360) | 1346(1360) | 1320(1360) | 1423(1360) | 1371(1360) | 1335(1360) | 1392(1360) | 6.5339 |
| 13700 | 1362(1370) | 1329(1370) | 1345(1370) | 1420(1370) | 1357(1370) | 1330(1370) | 1436(1370) | 1380(1370) | 1341(1370) | 1400(1370) | 9.3647 |
| 13800 | 1373(1380) | 1339(1380) | 1359(1380) | 1426(1380) | 1370(1380) | 1342(1380) | 1445(1380) | 1388(1380) | 1347(1380) | 1411(1380) | 8.817 |
| 13900 | 1382(1390) | 1347(1390) | 1372(1390) | 1436(1390) | 1380(1390) | 1354(1390) | 1452(1390) | 1397(1390) | 1357(1390) | 1423(1390) | 8.5059 |
| 14000 | 1394(1400) | 1355(1400) | 1380(1400) | 1444(1400) | 1393(1400) | 1367(1400) | 1462(1400) | 1405(1400) | 1367(1400) | 1433(1400) | 8.2736 |
| 14100 | 1405(1410) | 1362(1410) | 1388(1410) | 1455(1410) | 1406(1410) | 1373(1410) | 1473(1410) | 1411(1410) | 1383(1410) | 1444(1410) | 8.566 |
| 14200 | 1413(1420) | 1368(1420) | 1399(1420) | 1464(1420) | 1412(1420) | 1379(1420) | 1492(1420) | 1421(1420) | 1399(1420) | 1452(1420) | 9.5832 |
| 14300 | 1425(1430) | 1376(1430) | 1402(1430) | 1478(1430) | 1427(1430) | 1385(1430) | 1499(1430) | 1430(1430) | 1413(1430) | 1465(1430) | 10.449 |
| 14400 | 1434(1440) | 1381(1440) | 1412(1440) | 1490(1440) | 1441(1440) | 1394(1440) | 1510(1440) | 1441(1440) | 1424(1440) | 1473(1440) | 10.526 |
| 14500 | 1439(1450) | 1396(1450) | 1421(1450) | 1503(1450) | 1453(1450) | 1404(1450) | 1517(1450) | 1451(1450) | 1432(1450) | 1484(1450) | 10.192 |
| 14600 | 1450(1460) | 1409(1460) | 1430(1460) | 1516(1460) | 1461(1460) | 1414(1460) | 1526(1460) | 1455(1460) | 1446(1460) | 1493(1460) | 9.941 |
| 14700 | 1465(1470) | 1414(1470) | 1438(1470) | 1528(1470) | 1470(1470) | 1424(1470) | 1533(1470) | 1471(1470) | 1457(1470) | 1502(1470) | 9.987 |
| 14800 | 1475(1480) | 1428(1480) | 1443(1480) | 1536(1480) | 1476(1480) | 1436(1480) | 1542(1480) | 1483(1480) | 1471(1480) | 1510(1480) | 9.725 |
| 14900 | 1488(1490) | 1438(1490) | 1451(1490) | 1547(1490) | 1487(1490) | 1446(1490) | 1552(1490) | 1493(1490) | 1479(1490) | 1519(1490) | 8.614 |
| 15000 | 1498(1550) | 1449(1550) | 1465(1550) | 1558(1550) | 1498(1550) | 1458(1550) | 1562(1550) | 1498(1550) | 1488(1550) | 1526(1550) | 26.118 |

## References

[1] Cochran, W.G. (1940): "Sample survey", Cambridge University press.

[2] Chakrabarty, D. (2004): "A theoretical definition of probability based on common sense", Bulletin of pure and applied sciences, 23 E-2, 343-349.

[3] Chakrabarty, D. (2005): "Probability;Link between classical definition and Empirical definition", J. Ass. Sc. Soc., 45,13-18.

[4] Chakrabarty, D. (2006): "Non equally likely outcomes: The classical definition of probability", Bulletin of pure and applied sciences, 25, E-2, 471-481.

[5] Chakrabarty, D. (2007): "Empirical definition of probability : Special case of its Theoretical definations". Int. J. Agricult. Stats. Sci., 3(1), 261-267.

[6] Chakrabarty, D. (2008): "Bernolli's definition of probability: Special case of its Chakrabarty definition", Int. J. . Agricult. Stats. Sci., 4(1), 23-267.

[7] Cochran (1940): "A survey of Experimental design", Mimeo, U.S.D.A.

[8] Fisher, R. A. (1938): Statistical table for biological, agricultural and medical research, 6th edition (1982), Longman group limilted, England, 37-38 & 134-139.

[9] Kendall, M.G. and B. B. Simith (1938): Randomness and Random sampling numbers, Jour. Roy Sat. Soc., 103, 147-166.

[10] Rand Corporation (1955): A million random digits free press, Glenoe, III.

[11] Snedecor, G.W. and W. G. Cochran (1967): "Statistical methods, Lowa state university press, Ames, Lowa, 6th edition.

[12] Tippet (1927). "Random number tables" tracts of computer, No.-15, Cambridge University press.

[13] Von Mises R. (1939): "Probability, Statistics and Truth" Macmillian.