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Drawing of Random Six-Digit Numbers from a Single Table of Random Three-Digit Numbers

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ABSTRACT: A method has been developed for drawing of random six-digit numbers from a single table of random three-digit numbers as an alternative of the three methods, already developed, of drawing of random six-digit numbers (i) from a single table of random two-digit numbers, (ii) from three independent tables of random three-digit numbers and (iii) from two independent tables of random three-digit numbers respectively. This paper describes the derivation of the method with numerical example in order to show the application of the method.

KEYWORDS: Table of random three-digit numbers, drawing of random six-digit numbers, method of drawing.

I. INTRODUCTION

A lot of tables have already been constructed for random numbers . These tables have been constructed by *Tippett* (1927), *Mahalanobis* (1934), *Kendall* & *Smith* (1938 , 1939), *Fisher* & *Yates* (1938), *Hald* (1952), *Royo* & *Ferrer* (1954), *RAND Corporation* (1955), *Quenouille* (1959), *Moses* & *Oakford* (1963), *Rao*, *Mitra* & *Matthai* (1966), *Snedecor* and *Cochran* (1967), *Rohlf* & *Sokal* (1969), *Manfred* (1971), *Hill* & *Hill* (1977) and others. Among these tables, the following four tables are treated as suitable in drawing of simple random sample (with or without replacement) from a population (*Cochran*, 1940):

(1) Tippett's Random Numbers Table that consists of 10,400 four-digit numbers giving in all 41,600 single digits selected at random from the British Census report (*Tippett*, 1927).

(2) Fisher and Yates Random Numbers Table that comprises 15000 digits arranged in two's (*Fisher* & *Yates*, 1938).

(3) Kendall and Smith's Random Numbers that consists of 100,000 digits grouped into 25,000 sets of random four-digit numbers (*Kendall* & *Smith*, 1938).

(4) Random Numbers Table by Rand Corporation that contains of one million digits consisting of 200,000 random numbers of 5 digits each (*Rand Corporation*, 1955).

The proper randomness of these tables is yet to be tested. In a study made by *Chakrabarty* (2010) on the testing of randomness of the table due to *Fisher* and *Yates* (1938), it has been found that this table, consisting of the 7500 occurrences of the 100 three-digit numbers, is not properly random and deviates significantly from proper randomness. Due to this reason, one table consisting of 6000 random occurrences of the 100 three-digit numbers has been constructed as an alternative/competitor of this table (*Chakrabarty*, 2013*a*). Also, one table containing 5000 random occurrences of the 1000 three-digit numbers has been constructed by *Chakrabarty* (2013*b*) due to the unavailability of such table of three-digit numbers. Two more tables, one containing 20000 occurrences of random three-digit numbers and the other containing 20000 occurrences of random three-digit numbers, have also been constructed by the same author [*Chakrabarty*(2013*a* , 2016*b*)]. Recently, study has been made on testing the proper randomness of the random number tables due to Tippett (*Sarmah* & *Chakrabarty*, 2014), due to Kendall & Smith (*Sarmah* & *Chakrabarty*, 2014*b*), due to *Rand Corporation* (*Sarmah*, *Chakrabarty* & *Barman* (2015*b*). In the studies, each of the tables has been found to be suffered from proper randomness. This leads to think of constructing of table of random four-digit numbers. Moreover, there is or there may be necessity of drawing of random five-digit numbers, random six-digit numbers, random seven-digit numbers etc.. However, due to the increasing difficulties in the construction of tables of these types of random numbers by the method composed by *Chakrabarty* (2013*a*), it had been compelled to think of an alternative

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approach of drawing of these types of random numbers. As the first attempt on this approach, one method was developed for drawing of random five-digit numbers from the tables of random three-digit numbers and of random three-digit numbers (*Chakrabarty*, 2016*c*). Later on, in a study, one method was derived for drawing of random six-digit numbers from the two independent tables of random three-digit numbers (*Chakrabarty*, 2016*d*). In another study, one method has been developed for drawing of random six-digit numbers from three independent tables of random three-digit numbers (*Chakrabarty*, 2016*e*). In these two methods of drawing of random six-digit numbers, two or more tables are required. In the first method of these two, two tables are required while in the second method of these two, three tables are required. This leads to the necessity of some method of drawing random six-digit numbers from a single table of random numbers. In a study (*Chakrabarty*, 2016*f*) method has been developed for drawing of random six-digit numbers from a single table of random three-digit numbers. In this study one method has been developed for drawing of random six-digit numbers from a single table of random three-digit numbers. This method of drawing of random six-digit numbers can be used as an alternative of the three methods, already developed, of drawing of random six-digit numbers (i) from a single table of random two-digit numbers, (ii) from three independent tables of random three-digit numbers and (iii) from two independent tables of random three-digit numbers. This paper describes the derivation of the method with numerical example in order to show the application of the method.

II. DRAWING OF RANDOM THREE-DIGIT NUMBERS

The table of random Three-digit numbers constructed by Chakrabarty (2013*a* , 2016*a*) carries the following features:

Features of the Table of Random Three-Digit Numbers:

(1) In the table, each of the 1000 three-digit numbers occurs n times out of $1000n$ consecutive occurrences ($n = 1 , 2 ,$ …….) if we start counting from the observation at the $(1000k + 1)^{th}$ position ($k = 0 , 1 , 2 ,$ …….).

(2) In the table, the frequency of occurrence of each of the 1000 three-digit numbers out of $100n$ consecutive trials ($n = 1 , 2 ,$ …….) may be one more or less than n if we start counting from any position.

(3) The table can be treated as random as per the logic behind the two definitions of probability namely definition in theoretically ideal situation and definition in practically ideal situation (Chakrabarty, 2011).

(4) The table is random with respect to the occurrences of the numbers row-wise but not column-wise. Thus while drawing random numbers from the table, one requires moving row-wise either to the right or to the left starting from any position in the table. The starting position and the direction of movement are to be selected at random by suitable randomized trials in order to keep their randomness intact.

Method of Drawing of Random Three-Digit Numbers from the Table:

Each of the two tables, constructed here, can be used in drawing of random three-digit numbers

(1) which are distinct

and (2) which are not necessarily distinct.

A. Drawing of Distinct Random Three-Digit Numbers

Suppose that we want to draw n random three-digit numbers from the table such that the drawn numbers are distinct. Since distinct three-digit numbers are to be drawn, one can draw a maximum of 1000 such numbers since the total number of such numbers is 1000.

Feature no (2), mentioned in section III, implies that if n three-digit numbers occurred consecutively from the $(100k + 1)^{th}$ position ($k = 0 , 1 , 2 ,$ …….) in the table are drawn subject to the feature no (4) then the drawn n numbers will be distinct and random.

Also feature no (3), mentioned in section III, implies that if n three-digit numbers occurred consecutively in the table are drawn starting from any position then the drawn n numbers may not be distinct. Some of them may occur twice. Thus in order to draw distinct numbers, it is required to exclude the next occurrence of the same number and to draw the next consecutive number occurred in the table following feature no (4) mentioned in section III.

Thus the drawing of random three-digit numbers consists of the two basic tasks namely

(a) selection of the starting position at random

and (*b*) selection of the direction (right or left) of movement at random.

Accordingly, in order to obtain the n random three-digit numbers one is to proceed with the following steps:

1. Select the position, from where to start, at random. Since the table contains 10000 random occurrences of the 100 two-digit numbers, accordingly there are 10000 positions of the numbers namely

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0000 , 0001 , 0002 , …… , 9999.

In selecting the starting position, one thus can apply some usual manual randomization technique of drawing one number from among the10000 numbers

0000 , 0001 , 0002 , …… , 9999

in the case of the table of random three-digit numbers due to Chakrabarty (2013 *b*)

and from among the 20000 numbers

00000 , 00001 , 00002 , …… , 19999

in the case of the table of random three-digit numbers due to Chakrabarty (2016 *b*).

One method of drawing of such number is as follows:

Take a set of 10 identical small balls marking them by the 10 digits

0 , 1 , 2 , 3 , 4 , 5 , 6 , 7 , 8 , 9

respectively and put them inside a opaque container C_1 .

Similarly, take another set of 4 identical small balls marking them by

L , R , M_1 & M_2

respectively and put them inside a different opaque container C_2 .

Now, draw one ball at random from the container C_1 containing the 10 balls and note down digit appeared on it.

Let the digit drawn be d_1.

Next, draw another ball at random from the container C_1 containing the same 10 balls and note down digit appeared on it.

Let the digit drawn at this stage be d_2.

Then, draw one ball at random from the container C_2 putting 2 balls marked with L & R inside it.

If the drawn ball is R, put the digit d_2 at the right position of d_1 and if the drawn ball is L, put the digit d_2 at the left position of d_1.

Thus if the ball R appears, the selected two-digit number will be d_1d_2 and if the ball L appears, the selected two-digit number will be d_2d_1.

Let the selected two-digit number be d_2d_1.

Next, draw another ball at random from the container C_1 containing all the 10 balls and note down digit appeared on it.

Let the digit drawn here be d_3.

Then, draw one ball at random from the container C_2 putting 3 balls marked with

L , M_1 & M_2

inside it and put the digit d_3 at the

left position of d_2d_1 if the drawn ball is L ,

middle position of d_2d_1 if the drawn ball is M_1

& right position of d_2d_1 if the drawn ball is .

Thus the selected three-digit number will be $d_3d_2d_1$ or $d_2d_3d_1$ or $d_2d_1d_3$ in accordance with the selected ball is L or M_1 or R .

Let the selected three-digit number be $d_2d_3d_1$.

Finally, draw another ball at random from the container C_1 containing all the 10 balls and note down digit appeared on it. Let the digit drawn here be d_4.

Then, draw one ball at random from the container C_2 putting 4 balls marked with

L , M_1 , M_2 & R

inside it and put the digit d_4 at the

left position of $d_2d_3d_1$ if the drawn ball is L ,

1st middle position (from left) of $d_2d_3d_1$ if the drawn ball is M_1 ,

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2nd middle position (from left) of $d_2d_3d_1$ if the drawn ball is M_2

& right position of $d_2d_3d_1$ if the drawn ball is .

Thus the selected four-digit number will be $d_4d_3d_2d_1$ or $d_2d_4d_3d_1$ or $d_2d_1d_4d_3$ or $d_2d_1d_3d_4$ in accordance with the selected ball is L or M_1 or M_2 or R .

The position of the four-digit number selected here will be the required starting position f**or the table of random three-digit numbers due to Chakrabarty (2013 *a*)**

. Let the i^{th} (i is any of the four numbers $d_4d_3d_2d_1$, $d_2d_4d_3d_1$, $d_2d_1d_4d_3$, $d_2d_1d_3d_4$) position be selected in the earlier step.

In this step, draw the number that occurs at the i^{th} position in the table.

For the table of random three-digit numbers due to Chakrabarty (2013 *b*), one digit from the two digits 0 & 1 is to be selected by conducting a Bernoulli trial and is to be placed at the left position of the selected number as selected above. The number so obtained is the selected number of the starting position.

2. Let the i^{th} position be selected in the earlier step. Draw the number that occurs at the i^{th} position in the table.
3. Chose whether to move towards left or towards right. The choice can be made at random by a binary trial e.g. by tossing of an unbiased coin or by drawing a number from the container C_2 putting two identical balls, marked with L and R respectively, inside it.
4. If it is chosen to move towards right, draw the numbers occurred at the positions

$$i\ ,\ i+1\ ,\ i+2\ ,\ \ldots\ldots\ldots\ldots\ ,\ i+n-1$$

in the table to obtain the n random three-digit numbers.

5. If it is chosen to move towards left, draw the numbers occurred at the positions

$$i\ ,\ i-1\ ,\ i-2\ ,\ \ldots\ldots\ldots\ldots\ ,\ i-n+1$$

in the table to obtain the n random three-digit numbers.

6. It may occur that some number or numbers among those drawn may be occurred twice. In that situation, retain only one occurrence of them and draw additional numbers appeared at the consecutive positions in the table as per requirement.

Suppose, k additional numbers are required to be drawn.

Then draw the numbers occurred at the positions

$$i+n\ ,\ i+n+1\ ,\ ,\ i+n+2\ ,\ \ldots\ldots\ldots\ldots\ ,\ i+n+k-1$$

if it is chosen to move towards right

and draw the numbers occurred at the positions

$$i-n\ ,\ i-n-1\ ,\ ,\ i-n-2\ ,\ \ldots\ldots\ldots\ldots\ ,\ i-n-k+1$$

if it is chosen to move towards left.

Note 2.1: Drawing of distinct random numbers corresponds to the drawing of simple random sample without replacement.

B. Drawing of Random Three-Digit Numbers (Not Necessarily Distinct)

The features (1) and (2), mentioned in section III, imply that if three-digit numbers are picked up at a gap of g positions ($1001 \leq g \leq 1999$), the picked up numbers will not necessarily be distinct.

Thus in order to to draw n random three-digit numbers which need not necessarily be distinct, one is to proceed with the following steps:

1. Select one position from where to start at random by the similar method as in the case of drawing of distinct random three-digit numbers mentioned above. Let the i^{th} position be selected.
2. Draw the number that occurs at the i^{th} position in the table.
3. Chose the length of jump that is to be 1001 or more and 1999 or less at random. It can be chosen by some usual manual randomization technique of drawing one number from among the numbers

$$1001\ ,\ 1002\ ,\ 1003\ ,\ \ldots\ldots\ldots\ldots\ ,\ 1999.$$

Let the selected length of jump be l.

The random selection of the length of the jump can be done by similar method as done in the selection of the starting position.

4. Chose whether to jump towards left or towards right. The choice can be made by the same method as in the earlier case.
5. If it is chosen to jump towards right, draw the numbers occurred at the positions

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$$i\ ,\ i+l\ ,\ i+2l\ ,\ \ldots\ldots\ldots\ldots\ ,\ i+(n-1)\,l$$

in the table to obtain the required *n* random thre-digit numbers.

6. If it is chosen to move towards left, draw the numbers occurred at the positions

$$i\ ,\ i-l\ ,\ i-2l\ ,\ \ldots\ldots\ldots\ldots\ ,\ i-(n-1)\,l$$

in the table to obtain the required *n* random three-digit numbers.

Note 2.2: Drawing of random numbers, not necessarily, distinct corresponds to the drawing of simple random sample with replacement.

III. DRAWING OF RANDOM SIX-DIGIT NUMBERS

Let $d_1d_2d_3$ be a random three-digit number drawn from a table of random three-digit numbers.

The possible values that $d_1d_2d_3$ assumes are the 1000 three-digit numbers

000 , 001 , 002 , …… , 998 , 999

and the probability that $d_1d_2d_3$ assumes any of them is equal which is 0.001.

Similarly, if $d_4d_5d_6$ *is another three-digit number drawn independently from the same table then* the possible values that $d_4d_5d_6$ assumes are also the 1000 three-digit numbers

000 , 001 , 002 , …… , 908 , 999

and the probability that that $d_4d_5d_6$ assumes any of them is equal which is 0.001.

Now if the two three-digit numbers namely

$$d_1d_2d_3 \ \&\ d_4d_5d_6$$

are combined together to form the six-digit number $d_1d_2d_3d_4d_5d_6$

then the possible values that $d_1d_2d_3d_4d_5d_6$ will assume are the 100000 six-digit numbers

000000 , 000001 , 000002 , …… , 999999

and the probability that $d_1d_2d_3d_4d_5d_6$ assumes any one of them is equal which is 0.000001

(since the two numbers $d_1d_2d_3$ & $d_4d_5d_6$ have been drawn independently).

Thus the six-digit number $d_1d_2d_3d_4d_5d_6$ is a random one.

Similarly, the other six-digit number

$$d_4d_5d_6d_1d_2d_3$$

is also a random one.

If one of these two six-digit numbers is selected by performing a random binomial trial, the selected number will be a random six-digit number.

If the process is repeated once, one more random six-digit number can be obtained.

By further repetitions, one can obtain more random six-digit numbers.

Therefore in order to draw *n* random six-digit numbers from a single table of random three-digit numbers, it is required to draw two independent sets, each of *n* random three-digit numbers, from the table.

It is to be noted that any successive three digits of different six-digit numbers can be same. Conversely, with the same successive three digits there can be different six-digit numbers. Therefore, the random three-digit numbers in each of the two independent sets of random three-digit numbers, drawn in order to form random six-digit numbers, need not be distinct.

It is further to be noted that the random selection of which set's three-digit numbers will be placed at the left position, which set's three-digit number will be placed at the right position while combining them in the formation of random six-digit number can be made afresh for each random six-digit number to be drawn or can be made once, before drawing the three-digit numbers for the two sets, to be applied in the construction of all random six-digit numbers to be selected.

Thus, in order to draw *n* random six-digit numbers one can apply the following two methods:

First method of drawing

In order to draw *n* random six-digit numbers, in this method, one can proceed with the following steps:

(1) Make a choice at random which set's three-digit numbers will be placed at the left position, which set's three-digit number will be placed at the right position while combining them in the formation of random six-digit numbers. This can be done by a random binomial trial.

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(2) Draw the 1st set of *n* random three-digit number from the table by the method discussed in Section II *b*.
(3) Draw the 2nd set of *n* random three-digit number from the table by the same method independently from the 1st set.
(4) Combine the random three-digit numbers of the 1st set with the corresponding random three-digit numbers of the 2nd set by the choice of the positions obtained in step (1) to obtain the *n* random six-digit numbers.

Second method of drawing

In order to draw *n* random six-digit numbers, in this method, one can proceed with the following steps:

(1) Draw two random three-digit numbers independently from the table of random three-digit numbers by the same method as discussed in Section II *b*.
(2) Make a choice at random which set's three-digit numbers will be placed at the left position, which set's three-digit number will be placed at the right position while combining them in the formation of random six-digit numbers. This can be done by a random binomial trial.
(3) Combine the two three-digit numbers, obtained in step (1), as per the selected choice of the positions to obtain one random six-digit number.
(4) Perform the above three steps more $(n-1)$ times to obtain more $(n-1)$ random six-digit numbers.
(5) The random six-digit numbers obtained in step (3) & Step (4) are the required *n* random six-digit numbers.

IV. NUMERICAL EXAMPLE

Example (4.1): Let it be wanted to draw 20 random six-digit numbers from the table of random three-digit numbers constructed by *Chakrabarty* (2016*a*).

First method of drawing

Let a trial namely the throwing of an unbiased coin be performed to make a choice which set's three-digit number will be placed at the left position and which set's three-digit number will be placed at the right position while combining them in the formation of random six-digit number.

Suppose, the selected choice is as follows:

Three-digit number belonging to the **1st Set** will be placed at the **Left** position,
& Three-digit number belonging to the **2nd Set** will be placed at the **Right** position.

Now let us draw the 1st set of 20 random three-digit numbers from the table by the method as described in Section II *b*.

Let the numbers drawn be

647 , 487 , 559 , 083 , 937 , 090 , 590 , 287 , 542 , 360 , 551 , 094 , 970 , 274 , 426 , 137 , 646 , 559 , 278 , 774 .

Next, let us draw the 2nd set of 20 random three-digit numbers from the table by the same method but independently of the 1st set.

Let the numbers drawn, in this case, be

090 , 296 ,139 , 984 , 522 , 072 , 808 , 466 , 422 , 279 , 998 , 402 , 892 , 286 , 500 , 182 , 336 , 811 , 503 , 354 .

Now, let us combine the corresponding numbers drawn from the two tables as per the selected choice of combination.

Thus, the selected 20 random six-digit numbers are

647090 , 487296 , 559139 , 083984 , 937522 , 090072 , 590808 , 287466 , 542422 , 360279 , 551998 , 094402 ,
970892 , 274286 , 426500 , 137182 , 646336 , 559811 , 278503 , 774354 .

Second method of drawing

First, let us draw two random three-digit numbers independently to include in the two sets namely the 1st Set, & the 2nd Set respectively by the method described in Section II *b*.

Let the two numbers drawn be

647 , 090 .

Next, let a random binomial trial namely namely tossing of an unbiased coin be performed to choice which set's three-digit number will be placed at the left position and which set's three-digit numbers will be placed at the right position while combining them in the formation of random six-digit numbers.

Suppose, the selected choice is as follows:

Three-digit number belonging to the 1st Set will be placed at the Left position,
& Three-digit number belonging to the 2nd Set will be placed at the Right position.

Thus, the 1st selected six-digit random number is 647090 .

In order to obtain the remaining 19 random six-digit numbers, the two steps are to be repeated 19 times.

Let the outcomes of all the 20 trials be as shown in **Table-4-1**.

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Table-4-1

Serial No of Trial	Three-digit Number obtained in 1st Set	Three-digit Number obtained in 2nd Set	Outcome of the Random Trial: Position of Three-digit Number belonging to		Selected Random Six-Digit Number
			1st Set	2nd Set	
1	647	090	Right	Left	090647
2	487	296	Left	Right	487296
3	559	139	Left	Right	559139
4	083	984	Right	Left	984083
5	937	522	Left	Right	937522
6	090	072	Right	Left	072090
7	590	808	Right	Left	808590
8	287	466	Right	Left	466287
9	542	422	Left	Right	542422
10	360	279	Left	Right	360279
11	551	998	Right	Left	998551
12	094	402	Left	Right	094402
13	970	892	Right	Left	892970
14	274	286	Right	Left	286274
15	426	500	Left	Right	426500
16	137	182	Right	Left	182137
17	646	336	Right	Right	646336
18	559	811	Left	Right	559811
19	278	503	Left	Right	278503
20	774	354	Right	Left	354774

Thus, the selected 20 random six-digit numbers to are
090647 , 487296 , 559139 , 984083 , 937522 , 072090 , 808590 , 466287 , 542422 , 360279 , 998551 , 094402 , 892970 , 286274 , 426500 , 182137, 646336 , 559811 , 278503 , 354774.

V. CONCLUSION

The method of drawing of random six-digit numbers, developed here, is an alternative way of drawing of random six-digit numbers in the absence of table of random six-digit numbers.

The existing methods of drawing of random six-digit numbers from three independent tables of random three-digit numbers and from two independent tables of random three-digit numbers respectively are also two alternative way of drawing of random six-digit numbers in the absence of table of random six-digit numbers.

In the method of drawing of random six-digit numbers from three independent tables of random three-digit numbers, three tables are to be used. Similarly, in the method of drawing of random six-digit numbers from two independent tables of random three-digit numbers, two tables are to be used. In the method of drawing of random six-digit numbers developed here, only single table of random three-digit numbers is quite enough.

It is to be noted that among the two methods of drawing of random six-digit numbers, explained in Section III, the first one is simpler than the second one.

It seems that it can be possible to draw random nine-digit numbers from a single table of random three-digit numbers. Thus one problem for researcher, at this stage, is to search for whether there exists some method of drawing of random nine-digit numbers from a single table of random three-digit numbers and to discover the method if such method exits.

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