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Random Number Generator and Dealing a Hand of Cards to study Probability Distribution

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Abstract

Simulation is the process of designing a model of such real systems and conducting experiments with the model for the purpose of either understanding the behavior of the system or of evaluating various strategies for operation of the system. Simulation as an analytic tool is useful only when done on a computer. This is because the practical problems that require simulation are complex and need a very large number of simple, repetitive calculations. Random numbers are not used in the simulation of all types of systems, but they are required for the simulation of Stochastic Systems. These system may be natural or manmade. e.g. the statistical distribution of the number of hearts received in a deal of 13 cards from a deck of 52 cards with a specified suit (hearts), collision of particles in a nuclear reactor, nuclear radioactivity etc. In such stochastic systems, at least one of the variable is given by a probability function. To simulate such random variables, we require a source of randomness

Key Words: **Generator, Mid Square, Probability, Random number**

INTRODUCTION

Nature has an abundance of random phenomena. Among the most familiar are: Complex physical phenomena, Radiation transport in earth's atmosphere, nuclear and high energy physics- radioactivity, diffusion and percolation. Despite the randomness involved these phenomena follow well defined laws, which look very startling when seen superficially. However, computer simulation of these processes has been an interesting field and has helped us to gain an in –depth understanding. In some instances these simulations have resulted in simpler approaches to understand many outstanding and insurmountable problems.

Random numbers are widely used in the simulation of various system in the field of science and engineering, etc. The term system means a group of units which operate in some inter-related manner. Random numbers are not used in the simulation of all types of systems, but they are required for the simulation of Stochastic Systems. The system where chance plays some role and there is unpredictability in their behavior are known as Stochastic Systems. These system may be natural or manmade. e. g. the statistical distribution of the number of hearts received in a deal of 13 cards from a deck of 52 cards with a specified suit (hearts), collision of particles in a nuclear reactor, nuclear radioactivity etc. In such stochastic systems, at least one of the variable is given by a probability function. To simulate such random variables, we require a source of randomness. Stochastic simulation mimics or replicates behavior of system by exploiting randomness to obtain statistical sample of possible outcomes. Because of randomness involved, simulation methods are also known as Monte Carlo methods. Such methods are useful for studying non-deterministic (stochastic) processes.

Simulation is the process of designing a model of such real systems and conducting experiments with the model for the purpose of either understanding the behavior of the system or of evaluating various strategies for operation of the system. Simulation as an analytic tool is useful only when done on a computer. This is because the practical problems that require simulation are complex and need a very large number of simple, repetitive calculations.

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RANDOM NUMBERS

Random numbers are samples from a uniformly distributed random variable between some specified interval and they have equal probability of occurrence in the same manner as all six faces of an unbiased dice have equal chances of occurrence

Randomness

In order to make some sense about random physical processes, it is important to comprehend the meaning of randomness. In a particular process it needs to be interpreted according to the contexts. For example in radioactivity, the randomness lies in the process of decay of the nucleus.

Statistics

Another important feature of the randomness is the statistical independence involved in the occurrence of an event. Once we have an intuitive understanding of the randomness, the next task is to understand the phenomenon involved. To do this we introduce the concept of probability. The probability for an event to occur always lies between zero and unity. We use this concept intuitively in a day –to-day conversation when one talks of tossing a coin, or in dealing with a 13 cards from a deck of 52 cards (say hearts), one is talking about the probability of occurrence of an event. These considerations laid the foundation of all the phenomenon based on the statistical processes in science and can be used to simulate a natural random process on the computer. By taking above concept into consideration in dealing a hand of cards, a statistical distribution, where a set of 1000 observations (of the number of observations in each bin) in a deal of 13 cards from a deck of 52 cards with a specified suit (hearts) the relative probability f(h) of a deal giving h hearts is as follow:

$$f(h)= n(h)/N = (39!)^2\ (13!)^2\ /\ (52!)[(13-h)!]^2\ (26+h)!\ (h!)$$

Where h! (h factorial) means 1x2x3…….h. The product of all the integers from 1 through h. The variable h is discrete (that is, just the numbers 1, 2, 3 …13) rather than continuous. The above relation is also based on one important assumption that any particular selection of 13 cards is as likely to occur as any other selection.

Random Number Generators

In principle, a random number is simply a particular value taken on by a random variable. Random numbers are of two types: truly random and pseudo random numbers. A sequence of truly random number is unpredictable and therefore cannot be reproduced. Such a sequence can only be generated by an actual physical process. We can generate a random number by randomly interrupting any uniform process. (For example, if the sequence of digits selected is 8,5,4,6,1 then the value of uniform (0,1) random variable is (0.85461).Using these physical processes, tables of the values of uniform (0,1) random variables ,known as random number tables, have been extensively published. However, digital computers do not generate random numbers in the way. In practice, they are pseudo random numbers instead of truly randomness. The numbers, which appear to be random and are generated by using some fast and deterministic methods are known as pseudorandom numbers.

Several arithmetic methods of generating pseudorandom numbers have been suggested, studied and used on computers for many years. These methods are generally based on some recurrence relation. Each new number is generated from the previous one by applying some simple operation based on recurrence relation. Most commonly used generators are:

i. Mid Square generator
ii. Mixed multiplicative congruential generator
iii. Transformation method
iv. Rejection method etc.

The method employed to generate random numbers is "Mid Square generator".

ALGORITHM

The algorithm for random number generator (Mid Square Generator**)** and dealing a hand of Cards to find out relative probability distribution, a set of 1000

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observations (of the number of observations in each bin) in a deal of 13 cards from a deck of 52 cards with a specified suit (hearts) is as follows:

Main Program

Step1: Define types of variables
Step2: Give dimension to bins n
Step3: Assign the values to the bins a (n), seed.
Step4: Start a loop over t in 1000 steps.
Step5: Assign zero values to variable 1, showing frequency
of cards
Step6: Start a loop over j in 13 steps
Step7: Call the subroutine to generate random numbers
Step8: Check if the number of cards lies between 1 and 13
Step 9: Increment I by one if the previous condition is
satisfied.
Step 10: Loop started at step 6 ends
Step 11: The integer content of the i[th] bin is incremented
by one.
Step 12: Loop started at 4 ends
Step 13: Write the value of bin numbers and contents of
each bin
Step 14: End the program

Subroutine

Step1: Define subroutine variables (subroutine card (sd, cd))
Step2: Define types of variables (Integer cd)
Step3: Assign the values to the variable.(x=sd*sd)
Step4: Assign the values to the variable (x=int(x/100)
Step5: Assign the values to the variable (sd)
Step6: Assign the values to the variable (cd)
Step 7: Return the function
Step 8: End the subroutine

PROGRAMME

The FORTRAN program for random number generator (Mid Square Generator) and dealing a hand of Cards to find out relative probability distribution, a set of 1000 observations (of the number of observations in each bin**)** in a deal of 13 cards from a deck of 52 cards with a specified suit (hearts) is as follows:

C*********Random number generator (Mid Square Generator) and dealing a hand of Cards to find out relative probability distribution**************

```
          integer c
          dimension a(13)
          do 5 n=1,13
          a(n)=0
5         continue
          Seed=3761
          Do 20 t=1, 1000
          i=0
          do 10 j=1,13
          call card (seed , c)
          if (c.le.13)then
          i=i+1
          endif
10        continue
          a(i)=a(i)+1
20        continue
C %%%%%%%%%%%%%
          Do 30 k=1,13
          Write(*,*) k,a(k)
30        continue
          Stop
End
C %%%%%%%%%%%%%
          Subroutine card(sd,cd)
          Integer cd
          X=sd*sd
          X=int(x/1000)
          Sd=x-int(x/1000)*1000
          X=sd/1000
          Cd=x*52
          Return
          End
```

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DATA TABLE:

Table 1: Frequency Distribution of Hearts in different trails.

No. of Hearts	Frequency Distribution for different trials				
	100 Trials	**1000 Trials**	**10000 Trials**	**100000 Trials**	**1000000 Trials**
1	0	0	0	0	0
2	1	1	1	1	1
3	747	7497	74997	749997	7499997
4	250	2500	25000	250000	2500000
5	1	1	1	1	1
6	1	1	1	1	1
7	0	0	0	0	0
8	0	0	0	0	0
9	0	0	0	0	0
10	0	0	0	0	0
11	0	0	0	0	0
12	0	0	0	0	0
13	0	0	0	0	0

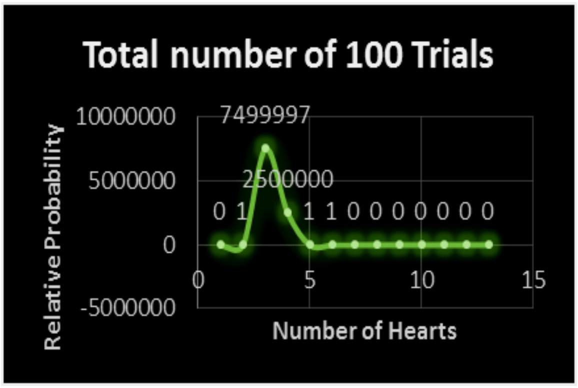

Figure1: Total number of 100 trials

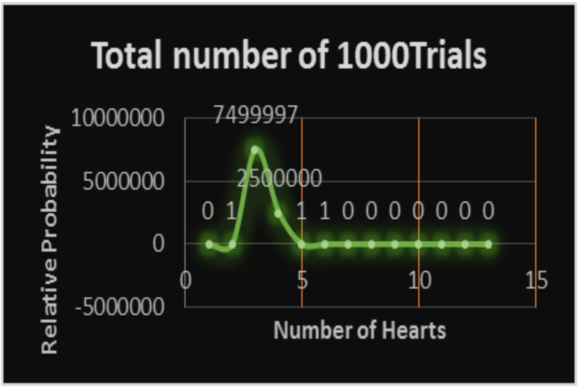

Figure 2: Total number of 1000 trials

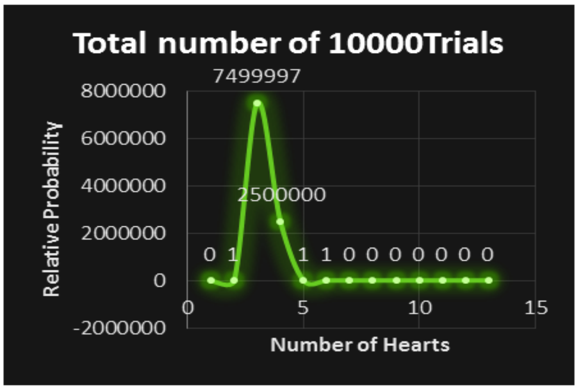

Figure 3: Total number of 10000 trials

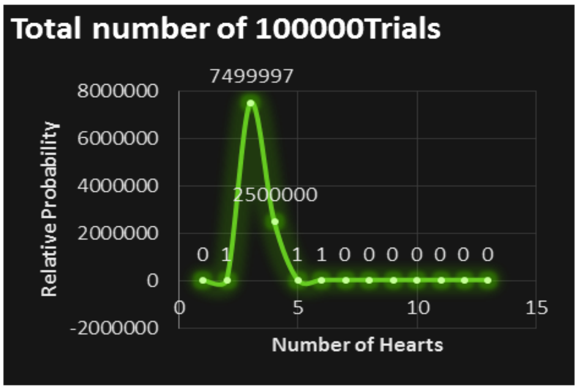

Figure 4: Total number of 100000 trials

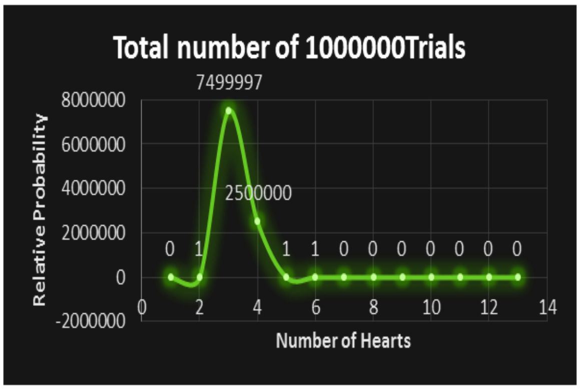

Figure 5: Total number of 1000000 trials

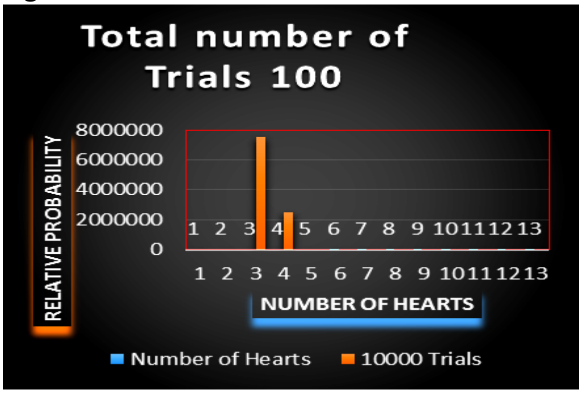

Figure 6: Total number of trials 100

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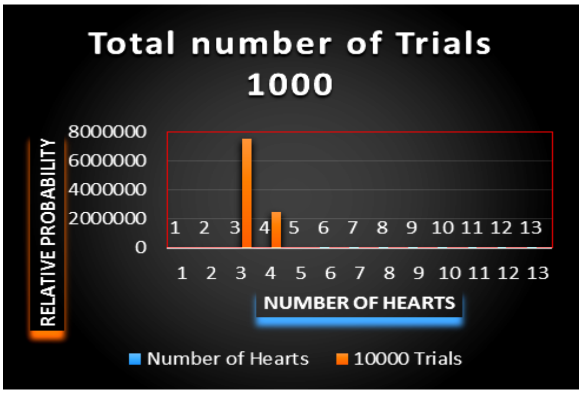

Figure 7: Total number of trials 1000

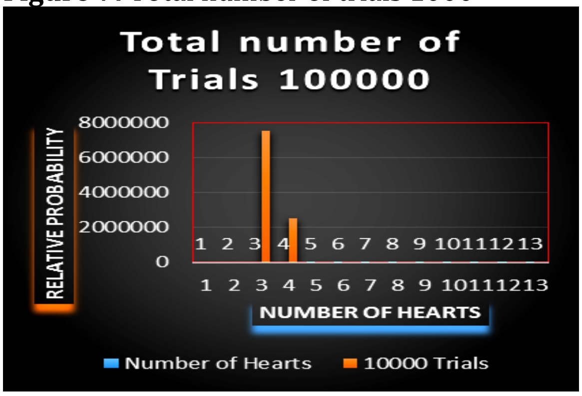

Figure 8: Total number of trials 100000

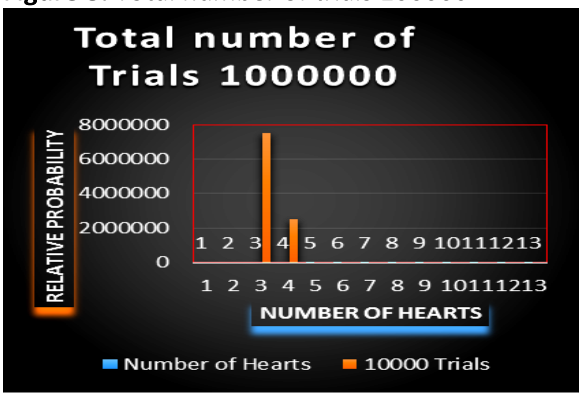

Figure 9: Total number of trials 1000000

RESULT & CONCLUSION

The statistical distributions as observed is as shown in the histograms and in distribution curves from I to IX. All these trends give the frequency or probability to observed values of a variables with in a particular range. Calculating mean or average values is 3.25. Thus the most probable number is 3 (three).

The knowledge of such distribution can help in formulating a theory in cases in which the underlying theory is unknown. For example, precise data on the wavelength distribution of thermal radiation (such as that emitted by glowing objects) led to the development of the quantum theory of radiation in the early 1900s by Planck and Einstein.

Such distribution can help in formulating a theory in cases in which methods are useful for studying non-deterministic (stochastic) processes, deterministic systems that are too complicated to model analytically ,deterministic problems whose high dimensionality makes standard discretization infeasible (e.g., Monte Carlo integration).

CONFLICT OF INTEREST: None

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