4. What is the nature of computation of monte carlo method? Find the value of I using monte carlo method.

$$I = \int_2^5 x^3 \, dx$$

=) Monte carlo simulation is a computerized mathematical technique to generate random sample data, based on some known distribution of numerical experiments. the nature of computation of monte carlo method is experimental. It observes the way in which all the variables of model change with time. It test lots of lots of input sample & output is observed.

the given eqn $= \int_2^5 x^3 \, dx$

let, Area of regular shape $= (5-2) \times 140$
$= 420$

for x coordinate
let, $r = $ random numbers between 20 & 50
$x = 0.1 (r)$
r for y coordinate = random number between 0 and 1

computed by hand, computers are extensively ... value of the computer is its more conventional data-processing capability. ... other types of model used for simulation purposes, there is no need for a special programming language to organize the simulation task. ... Econometric models of this nature have been built for the national economies of ... Many large corporations also use models ...

(a) STABLE MARKET

(b) UNSTABLE MARKET

y = height of rectangle $\times r$

$= 140 \times r$

Random Number (r_x)	x 0.1(r)	random number (r_y)	y 140r	x^3	M	N
22	2.2	.57	79.8	10.65	0	1
25	2.5	.18	25.2	15.63	0	2
18	1.8	.00	0.0	5.83	1	3
45	4.5	.90	126.0	91.13	1	4
25	2.5	.05	7.00	15.63	2	5
27	2.7	.77	107.8	19.68	2	6
48	4.8	.66	92.4	110.68	3	7
43	4.3	.10	14.0	79.51	4	8
40	4.0	.76	106.4	64.00	4	9
47	4.7	.42	58.8	103.82	5	10
38	3.8	.78	109.2	54.87	5	11
33	3.3	.88	123.2	35.94	5	12
24	2.4	.03	4.2	13.82	6	13
47	4.7	.09	12.6	103.80	7	14
42	4.2	.77	107.8	74.09	7	15
25	2.5	.61	85.4	15.63	7	16
33	3.3	.27	37.8	35.94	7	17
50	5.0	.60	84.0	125.00	8	18
34	3.4	.29	40.6	39.3	8	19
21	2.1	.40	56.6	9.26	8	20

$M = 8$

$N = 20$

$\therefore$ value of $I = \frac{M}{N} \times A$

$= \frac{8}{20} \times (140 \times 3) = 168.00$

The accuracy of result can be increased by increasing the no of observations.

5. What do you mean by monte carlo method estimate the value of

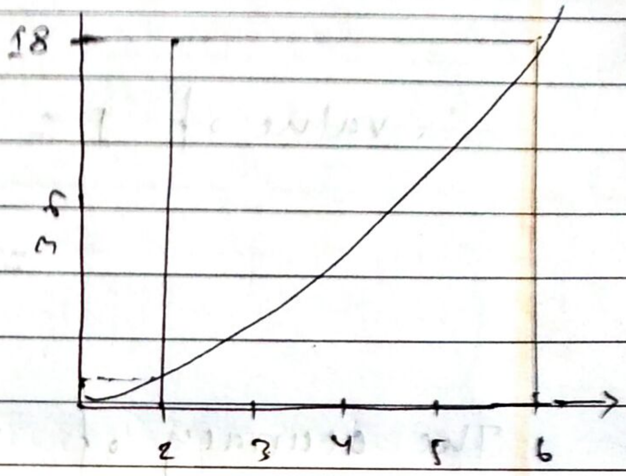
$$\int_2^6 3x \, dx$$ using monte carlo method

Also mention the application of monte carlo method.

=) Monte carlo method is a computerized mathematical technique to generate random sample data, based on some known distribution of numericals experiments.

Although distributed lag models are ... used to run them. However, ... computed by hand, computers are extensively used ... data-processing capability. Unlike ... value of the computer is its more conventional ... other types of model used for simulation purposes, there is no need for a special programming language to organize the simulation task.
Econometric models of this nature have been built for the national economies ... large corporations also use models ...

given eqn = $\int_2^6 3x \, dx$



let

the given function $f(x) = \int_2^6 3x$ plotted on graph
and area of rectangle having length $6-2 = 4$
and height is 18

so

Area of rectangle (A) $= 4 \times 18 = 72$

For generation of random numbers we consider

$r_x = 20 - 60$

$x = 0.1r$

$r_y = 0 - 1$

$y = 18r$

r_x	x	r_y	y	f(n)	In/out	M	N
20	2.0	.57	10.26	6	out	0	1
28	2.8	.00	0	8.4	in	1	2
35	3.5	.9	16.2	10.5	out	1	3
50	5.0	.25	4.5	15	in	2	4
40	4.0	.66	11.88	12	in	3	5
44	4.4	.88	15.84	13.2	out	3	6
25	2.5	.42	7.56	7.5	out	3	7
51	5.1	.56	10.08	15.3	in	4	8
47	4.7	.48	8.64	14.1	in	5	9
42	4.2	.03	0.54	12.6	in	6	10
33	3.3	.09	1.62	9.9	in	7	11
59	3.9	.05	0.9	11.7	in	8	12
29	2.9	.25	4.5	8.7	in	9	13
49	4.9	.30	5.4	14.7	in	10	14
59	5.9	.45	8.1	17.7	in	11	15
24	2.4	.91	16.38	7.2	out	11	16

∴ value of I $= \frac{M}{N} \times A$

$= \cancel{\frac{16}{11} \times 72}$ $\quad \frac{11}{16} \times 72$

$= \cancel{104.72}$ $\quad 49.5$ #

The accuracy of result can be increased by increasing no of observation.

Application of monte carlo is listed below :

→ Monte carlo method used in almost every science, mathematics to economics

→ Monte carlo methods are very important in computational physics, physic chemistry etc.

→ Monte carlo method widely used in statistical physics.

8. Write the consequences of properties of pseudo random numbers. Explain different types of test of random number.

=) Proporties of preduo random numbers are as listed below:

i) The generated numbers may not be uniformly distributed.
ii) The generated numbers may not be continuous.
iii) The mean of the generated numbers may be too high or too low.
iv) variance may be too high or too low.

Types of random numbers have two main proporties
i) uniformity &
ii) is independence

Types of random test of random numbers are explained below:

① Uniformity Test:
The test of uniformity test or frequency test is a basic test that should always be performed to to validate a random number generators. Two test

are available they are;

(i) kolmogorov - ~~simirnov~~ ~~Test~~ smirnov Test
(ii) chi - squared Test

(i) kolmogorov - ~~simrn~~ smirnov Test
It compares the continuous cumulative distribution function (cdf) of the ~~ua~~ uniform distribution with the empirical cdf, of the N sample observations.

(ii) chi - squared Test
The chi-squared test uses the sample statistic

$$X_0^2 = \sum_{i=1}^{n} \frac{(O_i - E_i)^2}{E_i}$$

where

O_i = is observed number in ith class
E_i = Expected a number in ith class
n = no of class
for uniform distribution, E_i is given by

$$E_i = \frac{N}{n}$$

for equally spaced classes, where N is the total no of observation.

It can be shown that the sampling distribution χ_0^2 is approximately the chi-square distribution with n-1 degrees of freedom.

2. Testing for Independence

i) Auto correlation Test:
The correlation between numbers is tested and compare the sample correlation to the expected correlation of zero.

ii) Run test:
tests the run up and down or the run above & below the mean by comparing the actual values to expected values. The statistics for ~~compurisk~~ comparision is the chi-square test.

iii) Poker Test:
Treats the numbers grouped together as a poker hand. Then the hands obtained are compared to what is expected using the chi-square test.

9. Explain kolmogorv - smirnov test and step carried out for the test.

=) It compares the ~~contixuo~~ continuous cumulative distribution function (cdf) of the function distribution with the ~~expr~~ empirical cdf, of the N sample observations. The cdf of an ~~enxprici.~~ empirical distributions is a step function with jumps at each observed value.

Step carried out for kolmogorv - smirnov test are as follows:

Step 1: Rank the data from smallest to largest. let R(i) denote the ith smallest observation so that.

$$R(1) \le R(2) \le \dots \le R(N)$$

Step 2: compute

$$D^+ = \left(\frac{i}{N} - R_i \right) \quad \text{and}$$

$$D^- = R_i - \frac{(i-1)}{N}$$

Step 3: compute

$\max(D+)$ & $\max(D-)$ &

$D = \max(D+, D-)$

Step 4: Determine critical value D_α from the table for the specified significance level α and the given sample size.

Step 5:

a. if $D \le D_\alpha$ uniformly distributed

b. if $D > D_\alpha$ Not uniformly distributed

10. Using the mixed multiplicative congruential method, find the set 15 of random numbers for $a = 13$ and $b = 17$ with the seed value $R_0 = 14$

=) given $a = 13$ $b = 17$

$R_0 = 14$

let $m = \cancel{15/19}$ $\cancel{15}$ 19

we know

$\cancel{r_1}$ $r_{i+1} = (a r_i + b) \bmod m$

~~$r_1 = (13 \times 14 + 17) \bmod 15 = 199 \bmod 15$~~

$r_1 = (13 \times 14 + 17) \bmod 15 = 199 \bmod 15 = 13$ residue $\cancel{11} = 4$

$r_2 = (13 \times 4 + 17) \bmod 15 = 69 \bmod 15 = 4$ residue $9 = 9$

$r_3 = (13 \times 9 + 17) \bmod 15 = 134 \bmod 15 = 8$ residue $14 = 14$

$r_1 = (13 \times 14 + 17) \bmod 19 = 199 \bmod 19 = 10$ residue $9 = 9$

$r_2 = (13 \times 9 + 17) \bmod 19 = 134 \bmod 19 = 7$ residue $1 = 1$

$r_3 = (13 \times 1 + 17) \bmod 19 = 30 \bmod 19 = 1$ residue $11 = 11$

$r_4 = (13 \times 11 + 17) \bmod 19 = 160 \bmod 19 = 8$ residue $8 = 8$

$r_5 = (13 \times 8 + 17) \bmod 19 = 169 \bmod 19 = 18$ residue $17 = 17$

$r_6 = (13 \times 17 + 17) \bmod 19 = 238 \bmod 19 = 12$ residue $10 = 10$

$r_7 = (13 \times 10 + 17) \bmod 19 = 147 \bmod 19 = 7$ residue $14 = 14$

$r_8 = (13 \times 14 + 17) \bmod 19 = 199 \bmod 19 = 10$ residue $9 = 9$

$r_4 = (13 \times 9 + 17) \bmod 19 = 134 \bmod 19 = 1$ residue 1 = 1

$r_5 = (13 \times 8 + 17) \bmod 19 = 121 \bmod 19 = 6$ residue 7 = 7
$r_6 = (13 \times 7 + 17) \bmod 19 = 108 \bmod 19 = 5$ residue 13 = 13
$r_7 = (13 \times 13 + 17) \bmod 19 = 186 \bmod 19 = 9$ residue 15 = 15
$r_8 = (13 \times 15 + 17) \bmod 19 = 212 \bmod 19 = 11$ residue 3 = 3
$r_9 = (13 \times 3 + 17) \bmod 19 = 56 \bmod 19 = 2$ residue 18 = 18
$r_{10} = (13 \times 18 + 17) \bmod 19 = 251 \bmod 19 = 13$ residue 4 = 4
$r_{11} = (13 \times 4 + 17) \bmod 19 = 69 \bmod 19 = 3$ residue 12 = 12
$r_{12} = (13 \times 12 + 17) \bmod 19 = 173 \bmod 19 = 9$ residue 2 = 2
$r_{13} = (13 \times 2 + 17) \bmod 19 = 43 \bmod 19 = 2$ residue 5 = 5
$r_{14} = (13 \times 5 + 17) \bmod 19 = 82 \bmod 19 = 4$ residue 6 = 6
$r_{15} = (13 \times 6 + 17) \bmod 19 = 95 \bmod 19 = 5$ residue 0 = 0

$\therefore$ The sequence of numbers obtained is :

~~4, 9, 14, 9, 1, 11, 8, 7,~~

14, 9, 1, 11, 8, 7, 13, 15, 3, 18, 4, 12, 2, 5, 6, 0

#

11. Test the following sequence of random number for uniformity.

0.59, 0.44, 0.27, 0.83, 0.17, 0.05, 0.73, 0.92, 0.77, 0.35, ~~0.5~~ 0.57

⟹

By using Kolmogorov - Smirnov Test

R_i	.05	.17	.27	.35	.44	.57	.59	.73	.77	.83	.92
i/N	0.09	0.18	.27	.36	.45	.55	.64	.73	.82	.91	1.0
D+	.04	.01	-	.01	.01	-	.05	-	.05	.08	.08
D-	0.05	0.08	.09	.08	.08	.12	.04	.09	~~0.05~~ 0.04	0.01	0.01

Max (D+) = ~~0.8~~ 0.08

Max (D−) = 0.09

Max (D+, D−) = 0.09

critical value = 0.09

lets assume level of significance = 5%

$\alpha = 0.05$

tabulated value for $\alpha = 0.05$ & $N = 11$

is $\mathcal{I} = 0.391$

$\therefore D_{0.05} = 0.391$

$\therefore D < D_\alpha \qquad 0.09 < 0.391$

Since, the given no of uniformly distributed at 5 % level of significance.

#

d, computers ... its more convention... lation purposes, ... task. ... tional econo... modeli

12. Consider the following sequence of random numbers & test the auto correlation for random numbers using ~~singificance~~ level of 95 %.

⇒ 0.12, 0.23, 0.01, 0.31, 0.28, 0.93, 0.89, 0.64, 0.99, 0.33
0.27, 0.35, 0.28, 0.15, 0.93, 0.41, 0.87, 0.69, 0.36,
0.19, 0.58, 0.95, 0.05, 0.68, 0.43, 0.75, 0.60
These 27 random gives 26 pairs

Pairs :
(0.12, 0.23), (0.23, 0.01), (0.01, 0.31), (0.31, 0.28),
(0.28, 0.93), (0.93, 0.89), (0.89, 0.64), (0.64, 0.99),
(0.99, 0.33) (0.33, 0.27), (0.27, 0.35), (0.35, 0.28),
(0.28, 0.15) (0.15, 0.93), (0.93, 0.41), (0.41, 0.87)
(0.87, 0.69), (0.69, 0.36), (0.36, 0.19) (0.19, 0.58),
(0.58, 0.95), (0.95, 0.05), (0.05, 0.68), (0.68, 0.43)
(0.43, 0.75) (0.75, 0.60)

these 26 pairs grouped into 9 classes
the expectation value is 3

class		count	frequency	diff	diff^2
$R_1 \le .33$	& $R_2 \le .33$	* * * * * *	6	3	9
$R_1 \le .67$	& $R_2 \le .33$	* *	2	1	1
$R_1 \le 1.0$	& $R_2 \le .33$	* * *	3	-	-
$R_1 \le .33$	& $R_2 \le .67$	*	1	2	4
$R_1 \le .67$	& $R_2 \le .67$		-	-	-
$R_1 \le 1.0$	& $R_2 \le .67$	* * * * *	5	2	4
$R_1 \le .33$	& $R_2 \le 1.0$	* * *	3		-
$R_1 \le .67$	& $R_2 \le 1.0$	* * * *	4	1	1
$R_1 \le 1.0$	& $R_2 \le 1.0$	* *	2	1	1

$n = 9$ $N = 26$ 20

Expected value $(E_i) = \frac{N}{n}$

$= \frac{26}{9} = 3$

Here $(O_i - E_i)^2 = 20$

By using chi square $(\chi^2) = \sum_{i=1}^{n} \frac{(O_i - E_i)^2}{N} = \frac{20}{3}$

$= 6.67$

degree of freedom $= n-1 = 9-2 = 7$

level of significance $= 0.05$

~~to~~ tabulated value at 5% level of significance ~~7~~ 7 degree of freedom

$= 14.067$

$\therefore$ the value of χ^2 obtained for the given set of random numbers is less than tabulated value so the sequence ~~is~~ not are not serially auto correlated.

#

13. Explain the different steps involved in the verification & validation model.

=) The validation is essential to build the credibility & acceptability of the model. The objectives of validation can be sumarized as:

① To obtain a model that represents the behaviour of the real system so closely that it can be used as a substitute for experimenting on the true system.

(ii) To increase the accuracy of the output - results

In the simulation & Modeling there are three stages or step of the system. they are:

(i) real system
(ii) Conceptual Model
(iii) operational Model or simulation program

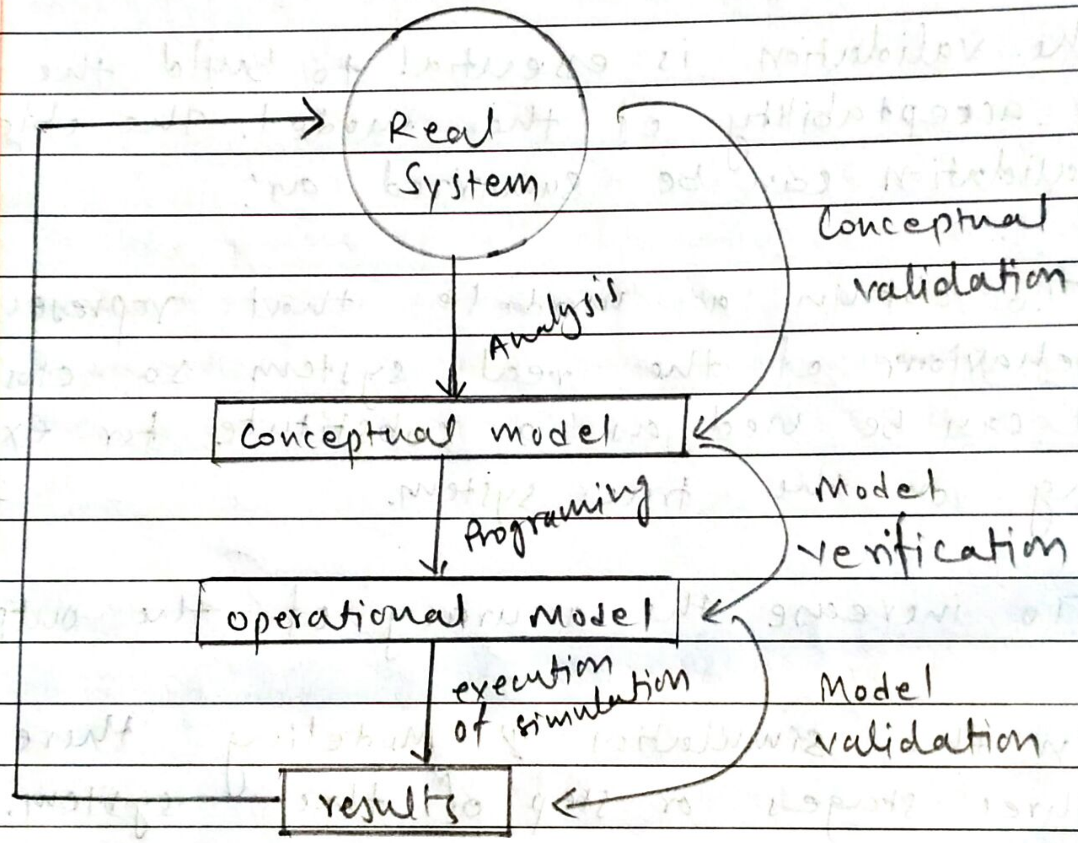


fig: steps of verification & validation Model.

① Real System:
This step in model building consists of studying the real system, its components & their relationships. observing its behaviour and collecting data on it.

(ii) Conceptual Model:
this is second step. It is the construction of a conceptual model of a real system. The variable of interest and the measures of performance are decided. the interrelationship, assumptions to be made and the simplification required are identified. The conceptual validation is the comparision of conceptual model, with the real system.

(iii) Operational Model or simulation programming or Computerized model
third step is the translation of the conceptual model into simulation program or into computer representation ~~model~~ of the model. This simulation program is also called Operational model.

To establish the validity of the model, test runs of the simulation are made and the results are compared with the existing data. Once the validity is established, the model can be implemented.

14. What is run-test? How to test random numbers of randomness using run test explain with example.

=) Run test is a statistical procedure that examines whether a string of data is occurring randomly from a specific distribution. The run test analyzes the occurrence of similar events that are separated by events that are different.

In other words

a runs test is a statistical analysis that helps determine the randomness of data by revealing any variables that might affect data patterns.

Example:

07, 13, 20, 37, 24, 22, 05, 43, 57, 32, 03
19, 27, 34, 47, 50, 55, 59, 04, 35, 25, 18, 11,
26, 33, 41, 52, 02, 37, 17

$P_0 =$ $a = 12.4$ $b = 1.2$ $d =$ $c = -2.4$ 1.2

Re-arrange the given data in ascending order to calculate median

02, 03, 04, 05, 07, 11, 13, 17, 18, 19, 20, 22, 24, 25, 26, 27, 32, 33, 34, 35, 37, 37, 41, 43, 47, 50, 52, 55, 57, 59

$$\text{Median} = \frac{n}{2} = 15^{th} = 26$$

No of observation of lower value = 14 = n_1
It is also called no of observation ~~than~~ less below meadian

No of observation of upper value = 15 = n_2
It is also called no of observation above meadian.

The run above & below median are marked as

-07 -13 -20 +37 -24 -22 -05 +43 +57 +32
-03 -19 +27 +34 +47 +50 +55 +59 -04 +35
-25 -18 -11 +26 +33 +41 +52 -02 +37
-17

the sequence of + & - are

−	−	−	+	−	−	−	+	+	+
−	−	+	+	+	+	+	+	−	+
−	−	−	+	+	+	+	−	+	−

Total Runs $(R) = 13$

count ~~Calculate~~ same sequence ~~-+ or~~ - - or ++ .

~~Now Hypoth~~

Now ~~Hyp~~ Hypothesis setting :

H_0 : the sequence was produce in random manner.

H_1 : the sequence was not produce in random manner.

Test statistics :

$$z = \frac{R - \bar{R}}{S_R}$$

where

$$\bar{R} = \frac{2n_1 n_2}{n_1+n_2} + 1$$

$$= \frac{2 \times 14 \times 15}{14+15} + 1$$

$$= 15.48$$

$$S_R^2 = \frac{2n_1 n_2 (2n_1 n_2 - n_1 - n_2)}{(n_1+n_2)^2 (n_1+n_2-1)}$$

$$= \frac{2 \times 14 \times 15 (2 \times 14 \times 15 - 14 - 15)}{(14+15)^2 (14+15-1)}$$

$$= 6.97$$

$$S_R = \sqrt{6.97} = 2.64$$

Now

$$Z = \frac{R - \bar{R}}{S_R} = \frac{13 - 15.48}{2.64} = -0.94$$

$$|Z| = 0.94$$

Now level of significance (α) = 0.05
(assumed)

tabulated value = 1.96

critical region :

$z_{cal} < z_{tab}$

$0.94 < 1.96$ Ho is accepted

Conclusion:
Ho is accepted so the sequence was produce in random manner.

15. What is analog computer? Explain its components in details. Draw a block diagram using analog method for solving the following model.

$$Mx'' + Dx' + kx = kF(t)$$

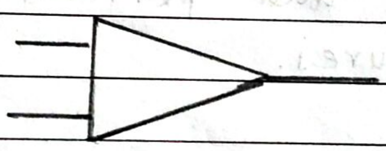
=> An analog computer is a computer which is used to process analog data. Analog computers are store data in a continuous form of physical quantities and perform calculations with the help of measures.

In simulation analog computer are generally used to solve continuous model but sometimes are also used to solve static models. some device whose behaviour is equivalent to a mathematical operation such as addition or integration is combined together in a manner specified by a mathematical model of a system to allow the system to be simulated. That combination is used in the simulation of a continuous system is ~~reffere~~ refered as an analog computer.

Components of Analog Computer are explained below:

(i) Adder / summer / amplifier:

It used to add several input voltage each representing the variable of the model to produce a voltage each representing a sum of the input voltage.



(ii) Scaler:

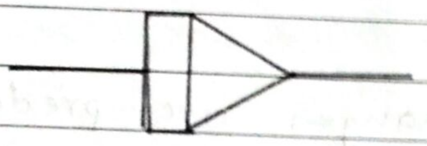
It is used to increase or decrease value.

k = rate of scaling

if input = 1 & $k = 1$ the output will be 2.

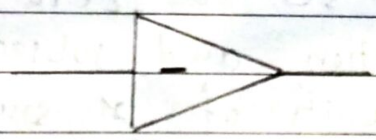
iii) Integrator:

It used to integration.



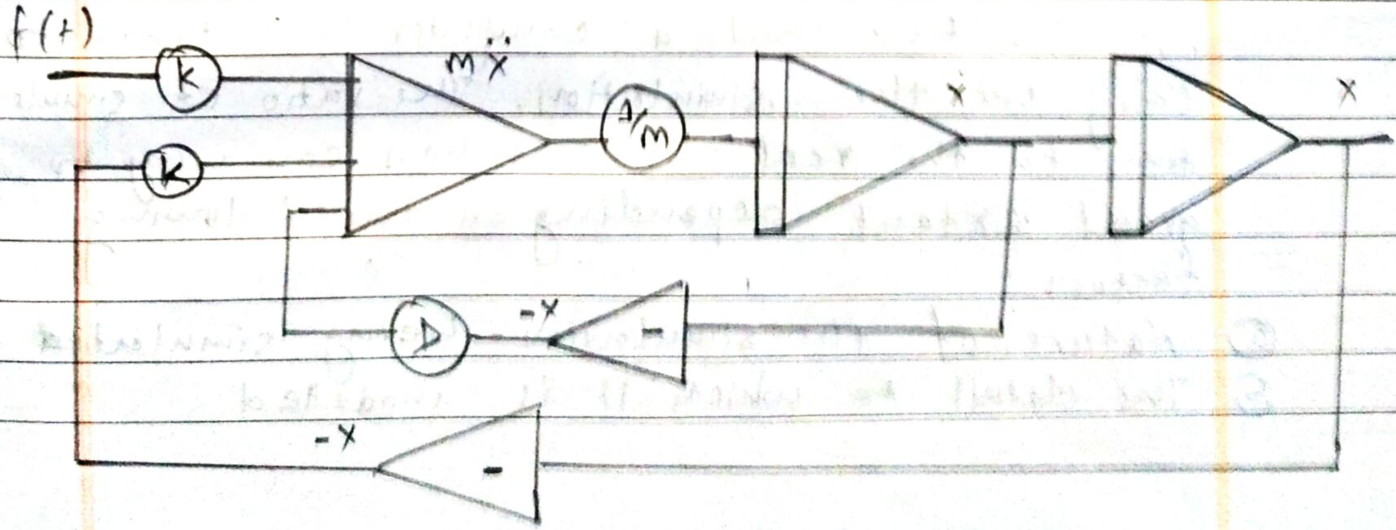
iv) Invertor:

It is designed to cause the output to reverse the sign of input. or It is used to change the value or voltage ~~the~~ +ve to -ve or -ve to +ve.



given $M\ddot{x} + D\dot{x} + kx = kf(t)$

or $Mx'' = k\,f(t) - Dx' - kx$



16. Explain the representation of time in discrete system simulation. Describe event oriented simulation.

=) The system which changes are predominantly discontinuous is called discrete system. Ex - Bank - the no of ~~so~~ customer's changes only when a customer arrives.

~~II~~ Representation of Time

It refers to a number that records the passage of time. It is usually set to zero at the begining of a simulation and subsequently indicates how many units of ~~x~~ simulated time have pass since the beginning of time simulation.

Simulation Time:

It refers to the indicated time, not clock time, not the time that a computer has taken to carry out the simulation. The ratio of simulated time to the real-time taken can vary to a great extent depending on the following factors:

ⓐ Nature of the simulation being simulated

ⓑ The detail to which it is modelled

There are two basic method exist for updating clock time. they are

i) ~~time~~ Event oriented

ii) Interval Oriented

Interval oriented : It is normally uses by continuous system simulation.

Event oriented : It is normally uses by discrete system simulation. the clock is advanced to the time at which next event is due to occur.

17. Explain the SIMSCRIPT execution cycle in detail with diagram.

⇒ SIMSCRIPT is a very widely used language for simulating the discrete system. The language can be considered as more than just a simulation language sa since it can be applied to general programming problems.

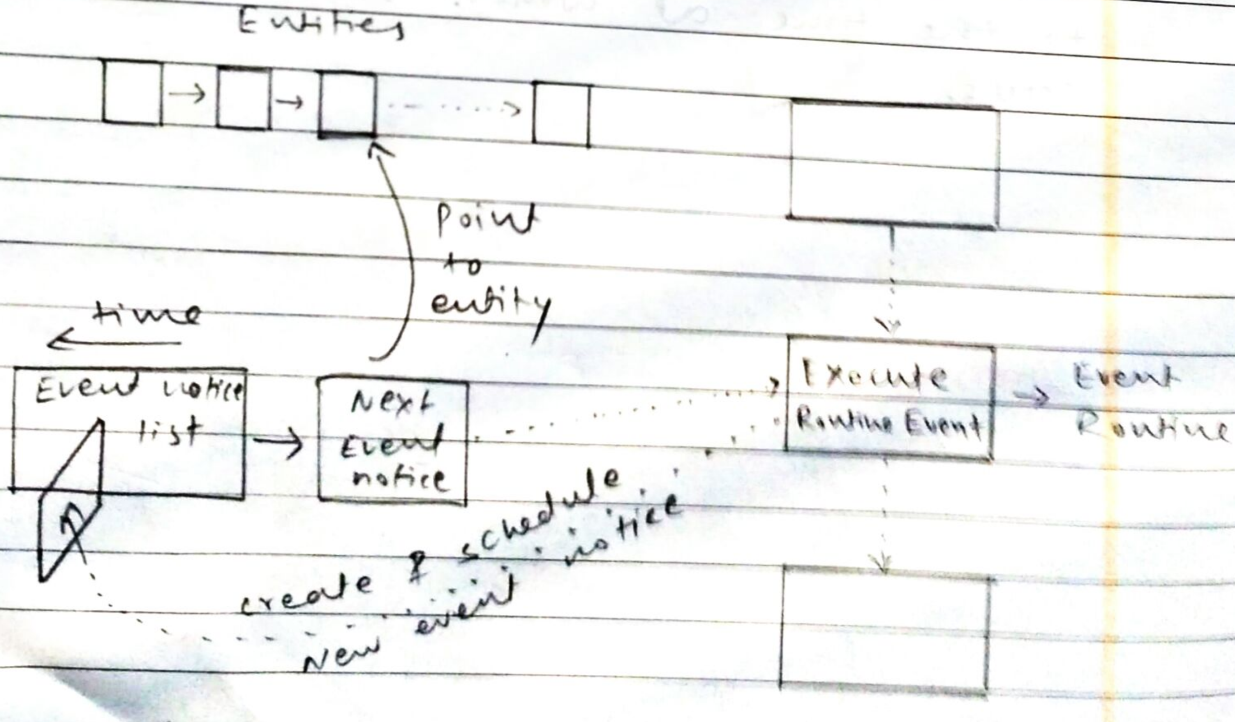


fig: execution cycle of SIMSCRIPT

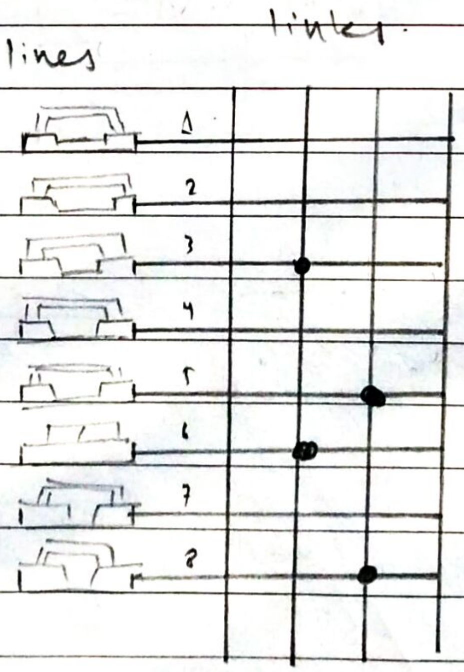
SIMSCRIPT execution process illustrated in above figure. The event notices are filled in ~~chro~~ chronological order. when all events that can be exeuted at a particular time: have been processed. the clock is updated to the time of the next event notice. and control is passed ~~by~~ to the event routine identified by the notice. Eeach event notice records the time the event is due to occur and the event routine that is to execute the event. If the event executed by a routine results in another event, either at the current clock time or in the future. the routine must create a new event notice and file it with the other notices.

18. What is lost call? Explain the simulation of telephone system & how show how lost calls & delayed called handled in details.

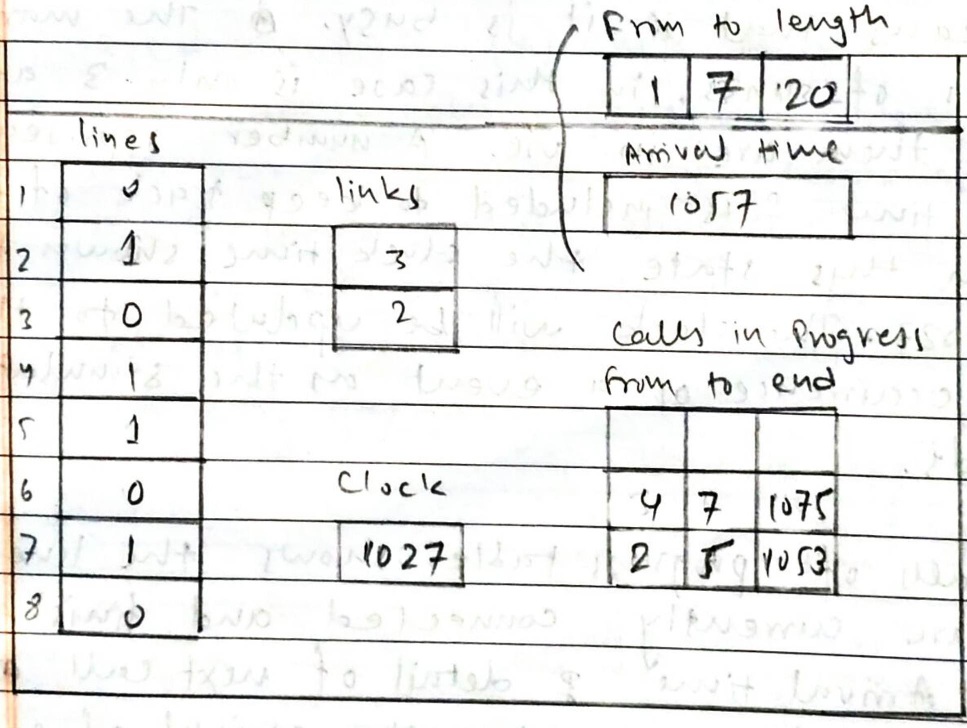
⇒ Any call that can not be connected at the time it arrives is immediately abandoned is called lost calls. A call may be lost due to following reasons:

i) if the called party is engaged (busy)
ii) if no link is available (a blocked call).

Simulation of Telephone system:



The system has several telephones (there only 8 are shown) connected to a switchboard by line. The switchboard has several lines provided to the condition that only one connection at a time can be made ~~a~~ to each line.



call counters

Processed	Completed	Blocked	Busy
131	98	5	28

~~safe~~ state 1

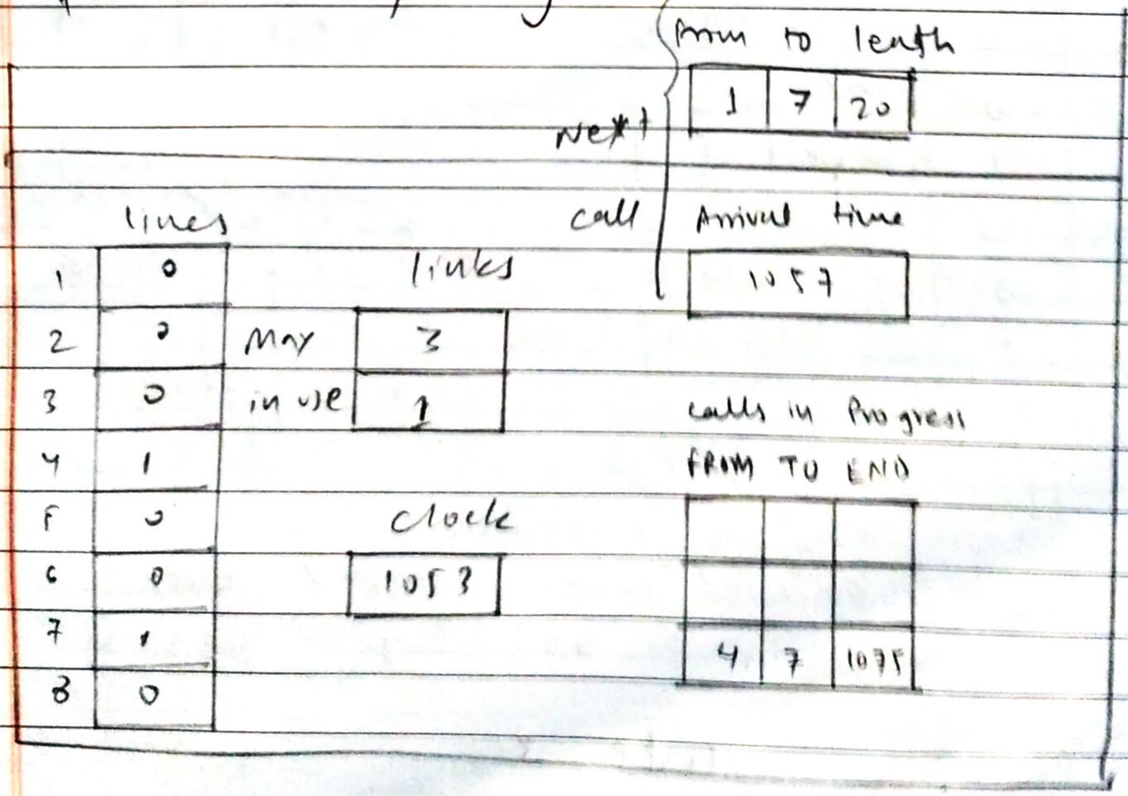
In current state of system shown in above above fig that line 2 is connected to line 5 and line 4 is connected to line 7. One way of representing the state of the line. A zero in the table means the line is free while 1 means that it is busy. The maximum numbers of links, in this case is only 3 and 2 of them are in use. A number representing clock time is included to keep track of events. In this state the clock time shown to be 1027. The clock will be updated to the next occurrence of a event as the simulation proceeds.

The calls of progress table shows the lines that are currently connected and finished time. Arrival time & detail of next call are also shown to generate the arrival of calls.

the In fig the state of the system at time 1027. there are two activities causing events. new calls can arrive and existing call can finish. There are 3 future events the call between line 2 and 5 is due to finish at time 1053, the call between line 4 to and 7 is due to finish at time 1075 and a new call is due to arrive at time 1057. The next calls when it arrives will come from line 1 to and attempt to go line 7. It is due to last 20 seconds.

Delayed calls (*) check in next page

suppose the telephone system is modified so that calls that can not be connected are not lost. Inseted, they wait ~~exa~~ until they can be connected. It can happen to message in a switching system that has store-and-forward capability.



call counter

Processed	completed	Blocked	Busy
132	99	5	28

state - 2

In this sate 2 the system time at time 1053, call between 2 and 5 is finished.

Next call

3	6	98

arrival time

1063

lines

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

links

max	3
in use	1

clock

1057

call in progress

from	To	end
4	7	1075

call counter

Processed	completed	Blocked	Busy
133	99	3	29

state 3

In this state 3 the system.
In state 2 we can see next call arrival time is 1057. the clock is updated to 1057 in state 3. call is arrival so we need to tests: first to see if a link is available or not and then to see if the party is busy or not.

at this state 3 the called party line 7 is busy so the call is lost. the both proceed call and busy increased by 1 at call counter. and next call arrival time is 1063 between 3 and 6 for 98 seconds.

Delayed call:

(*) check in previous page

lines

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

links

max	3
inuse	1

clock

1057

Next call

from	to	length
3	6	98

Arrival time

1063

Delayed calls →

1	7	20

Call in progress

4	7	1075

call counters

Processed	completed	Blocked	Busy
132	99	5	25

state - 4

this state of system ~~time~~ at time

the state of the system at time 1057 this sate shows call delayed also. this delayed counters shows how many calls were delayed by encountering busy or blocked condition.
Now when the call is compled, It is necessary to check the delayed calls list to see if a waiting call can be ~~converted~~ connected. In state 4 lines 7 is busy up to 1075 so 1 to 7 delayed call showing. It processed after only clock time at 1075.

Q. Explain event & integral oriented time advance mechanism with suitable example of each.

=) Discrete event simulation concerns the modeling of a system as it envolves over time by a representation in which the state variables change instantaneously at separate points in time. These points in time are the one which an event occurs, where an event is defined as an instantaneous ocurrace that may change the state of a system.

Because of the dynamic nature of discrete-event simulation model, we must keep of the current value of simulation time as the simulation proceeds and we also need a mechanism to advance simulation time from one variable to another, we call the variable in simulation model that gives that current value of simulation time the simulation clock or simulation time.

Simulation time means the integral clock time and not the time a computer was taken to carryout the simulation. There are two principle approaches for advancing the simulation clock are

(i) Next ~~time~~ event time advance / event oriented
(ii) fixed increment time advance / interval oriented.

(i) Next event time advance:
Next event time advances mechanism estimates the time of futuristic events that are going to be happen on the basis of a list of events (~~interms~~ of in terms of arrival ~~time~~ state or deputure state). Under this approach, the mechanism is ~~sta~~ started along with locating the simulation clock at zero.

(ii) Fixed increment time advance:
Under this approach simulation clock advances a specified unit of time for representing ~~exe~~ exact increment. While upgradation ~~in the~~ in the future further process in simulation clock. It examines the event list to identify the possible occurrence of any event in past period of time.

Q10. How can you use replication of run in an analysis of simulation output? Explain.

=) The precision of results of a ~~dyn~~ dynamic stochastic can be increased by repeating the experiment with different random numbers strings.

For each replication of a small sample size, the sample mean is determined.

Repeating the experiment with different random number for the sample size gives a set of an independent determination of sample mean. even though the distribution of the sample mean depends upon the degree of autocorrelation, this independent determination of sample mean can be used to estimate the variance of the distribution.

suppose,

→ Experiment is repeated p-times with independent random numbers.

→ x_{ij} = ith ~~obs~~ observation of jth ~~item~~ run

→ Then estimates for sample mean

$$\bar{X}_n(n) = \frac{1}{n}\sum_{i=1}^{n} X_{ij}$$

→ then estimate for variance for j^{th} run $S^2_j(n)$ is given by

$$S^2_j(x) = \frac{1}{n-1}\sum_{i=x}^{n}\left(X_{ij} - \bar{X}_n(n)\right)^2$$

Now, combining the results of p independent measurements gives the following estimate for the mean waiting time $\bar{X}$ and variance S^2:

$$\bar{X} = \frac{1}{p}\sum_{i=1}^{p} \bar{X}_i(n)$$

$$S^2 = \frac{1}{p}\sum_{j=1}^{p} S^2_j(n)$$

Here the value of $\bar{X}$ is an estimate for mean waiting time and the value of S^2 can be used to establish the confidence of intervals.

~~2~~. H.W

Q1. What are the desirable features of ~~software~~ simulation software? Differentiate facilities & stores in details.

=) Desirable features of simulation software are as follows:

i) Modeling flexibility
ii) Ease of modeling
iii) fast execution ~~method~~ speed
iv) compatibility to various computer systems
v) statistical capabilities
vi) Capability of Animations
vii) Report presentation capabilities

Difference between facilities & stores

Facilities	Stores
① An item of equipment that can handle only one transaction at a time is called a facility.	① An item of equipment that can handle large no of transaction at a time is called a store.

Facilities	Stores
(ii) It used in single channel queueing system.	(ii) It is used in multi channel queueing system.
(iii) Block Types HOLD, SEIZE & RELEASE are concerned with the use of facilities.	(iii) ~~STO~~ Block Types STORE, ENTER, LEAVE are concerned with the use of stores.
(iv) Example: In a library the book issue counter.	(iv) Example: 5 cashiers in a supermarket working equally fast.

22. "Replication of run will refine simulation output"
Explain the statement with necessary example.

=) Output analysis is the modeling stages concerned with designing replications, computing statistics from them and presenting them in textual or graphical format. It focuses on the analysis of simulation output (output statistics).

It provides the main value added for the simulation enterprise by trying to understand system behaviour and generate predictions for it.

A good design of simulation replications allows the analyst to obtain the most statistical information from simulation runs for the least computational cost. In particular we seek to minimize the no of replications and their length and still obtain reliable statistics.

23. Explain the types of simulation on the basis of output. Define & explain estimation method used in analysis of simulation output.

=> There are two types of simulation with regard to output analysis they are:

(i) Terminating simulation
(ii) Non-terminating simulation.

(i) Terminating simulation:
Terminating simulation is one that runs for some duration ~~of~~ of time T_E, where E is a specified event (or set of event) that stops the simulation simulation ~~sta~~ starts at time 0 under specified initial conditions and stop at the stopping time T_E.
The different runs use independent random numbers and same initilization rule. The Event E often occurs at a point when the system is cleaned out. Initial condition for a terminating ~~system~~ simulation generally affect the desired measure of performance, these

Conditions should be representative of those actual system.

Example:
Bank has working hours 9 to 5, the object is to measure the quality of customer service in this specified 8 hours. here the initial Condition is no of ~~Ø~~ customers at time $E(t) = 0$

(ii) Non - Terminating simulation:
~~D.I~~ It is a system that runs continuously or at least a very long period of time. It ~~sta~~ starts at simulation time 0 under initial condition defined by the analyst and run for some analyst defined period of time T_E.
A steady - state simulation is a simulation whose objectives is to study long-run behavior of a non- terminating system.
Example: ~~Lete~~ Telephone systems.

Estimation Methods:
It Estimate the range ~~of~~ for the random variables so that the desired output can be achieved. Infinite population crew a stationery probability distribution with a finite mean μ and finite variance σ^2. ~~sample~~ The population distribution is not affected by sample variable and time. If further the value of one sample is not affected in any way by the value of any other sample. the random variables are mutually independent. Random variable that meets all these condition said to be IID (Independent Identically distributed) ua usually abbreviated to IID under board condition that can be expected to hold for simulation data, the central limit theorem can be applied to I.I.D. data. The ~~CLT~~ theorem states that the sum of n i.i.d. variables, drawn from a population that has a mean of μ and a variance of σ^2 is approximately distributed as a normal variable with the mean of $n\mu$ and a variance of $n\sigma^2$. we can apply estimation method to that variable taken from infinite population.

27. What are various techniques of elemination of initial bias?

=) The length of transit period, where the system behaviour changes with time, depends upon the initial conditions. After a sufficient length of simulation run, the system behaviour attains stedy state. In stedy state, the values of the systems responses though fluctuate about the expected value, but the expected value don't change with time. The effect of transients on the simulation results can be avoided in a number of ways. some commonly used method are given below:

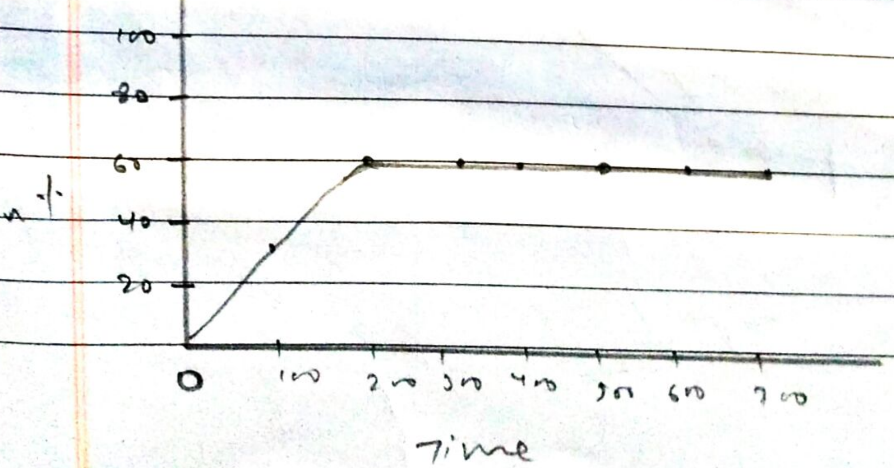
(a) The starting condition of the system be selected as close to the stedy ~~as~~ state as possible.

(b) Allow warming up period:
In this method

In this ~~sp~~ method ~~collect~~ if the real system exists, data on system is collected and is used to decide the initial condition. If there is no real system exist some ~~varie~~ variants of existing system are to be studied. then any information ~~avai~~ available from identical or ~~near~~ near identical real systems can be used to approximate the starting condition.

In totally imaginary system, the experience of the ~~at~~ analyst or ~~consul~~ consultations with experts should be used to work out some starting condition.

(3) Allow warming up period:
In this method: ~~the~~ the observations for some part for the simulation run in the start are ignored.
Example:



In the above fig: the system may be considered as stopped ~~still the~~ untill last 200 time unit. system parameter are initilized while maintaining the state of the system. and run is started after 200 time unit.

(c) Make the simulation run significiently long
It is another method, that may be employed for reducing is effect of initial bias, is to make the simulation run significiently long, so the initial bias is diluted and ~~become~~ becomes negligible. however this is computationally inefficient and uneconomical.

25. What is simulation language? What is difference between simulation language and general purpose language. Write down the merits of simulation language.

=) ~~simulation~~ language ~~is~~ a ~~pro~~.

A programming language that is ~~spe~~ specialized to the implementation of simulation programs. or ~~It~~ A ~~sim~~ simulation language is used to describe the operation of a simulation on a computer. There are two major types. ~~of~~ ~~sim~~.

~~simulation~~ simulation language ~~s~~ were developed to ~~asset~~ assist in the design of simulation models through their "world view" to expedite computer ~~la~~ programming through their special purpose, high-level statements and to encourage proper model analysis.

Difference between General Purpose language and simulation language.

General purpose language	simulation language
It is a programming language that is designed to be used for creating ~~sofu~~ software in the widest variety of applications.	It is a special purpose language structured to meet the programming requirements of the simulation models of a specific class of situations.
For developing model huge amount of coding, debugging and analysis of result need to be carried out.	It provides a ~~saving~~ ~~in~~ ~~coding~~ built in features thus increases the speed of model development.
It is less expensive.	It is expensive than general purpose language
This language are more flexible.	~~This~~ language ~~are~~ no or very less flexibility is available in simulation language.

This language are availabe on any platform.	Few simulation languages are special hardware and memory configuration.
Example: C, FORTAN, BASIC etc.	Example SIMSCRIPT, ~~GPSS~~, SIMAN, GPSS / PC, SLX etc.

Merits of simulation language are as below:

1. Since most of features of built in so simulation language take comparatively less programming time & effort

2. The simulation model coded in simulation languages can easily be changed and modified.

3. The error detection and analysis done automatically in simulation language.

4. The simulation models developed in simulation languages, especially in ~~sp~~ the specific application packages called simulators are very easy to use.

26. What are different types of simulation tools. Explain.

=> Many simulation tools have been developed to reduce the time & effort required to construct a simulation model. From a the viewpoint of the user. These tool can be classified into four types they are as to be explained below:

i) Libraries
① libraries as the name indicates, is a collection of a large number of routines for the commonly occuring features like the generation of streams of random numbers, generation of variables from various statistical distribution, queue discipline, analysis of results and validation of model etc. most of library routines are written for general purpose languages like C, c++ & java.

ii) Simulation language:
In case of a simulation language, most of the features, built as routines in libraries are in built as block and provides natural framework for simulation modeling. A large no of simulation languages and a still larger no of simulators are available

for constructing ~~simulator~~ simulation modes for varied applications.

iii) GUI - Based System:
The Graphical User Interface (GUI) is a type of user interface which allows people to interact with a computer through icons, visual indicators, along with text, lables, which represent the information & action to the users. The GUI Based simulation as the name suggests makes use of graphical icons, where an icon represents an instruction or a group of instruction that are often together. The simulation constructions involves dragging the icons from the displayed icon library, placing them in ~~order~~ proper order & connecting them as a network & filling in details about the input parameter.

iv) Wizards:
A wizards is a user interface where the user ~~led~~ led through a sequence of dialogs and is forced to perform the task in a specific sequence. Wizard are programs that solicit information from the user at each step & after the user is through predefined sequence, the intended task

is accomplished. Example ATM ~~mach~~ at Bank.

27. Why gathering of statistics ~~is~~ in necessary in simulation? What are 6 commonly needed statistics? Explain how measurement of utilization and occupancy is done.

=) Gathering of statistics is necessary because in order to ~~test~~ test out a hypothesis or statistical method. Whenever a new ~~sta~~ ~~statis~~ ~~stati~~ statistical method is developed or used, there are assumptions that need to be tested and confirmed. Statisticians use simulated data to test them out.

Commonly needed statistics are:

① Counts: giving the no of entities of a particular type or the no of times some event occured.

(b) Summary Measures; such as extreme values, mean values & standard deviations.

(c) Utilization; defined as the fraction (or percentage) of time some entity is engagged.

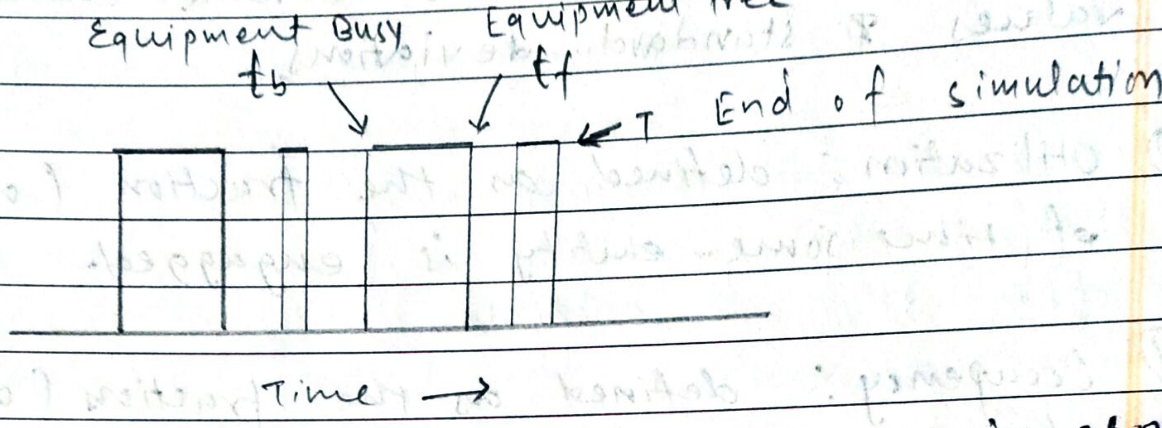
(d) Occupency: defined as the fractions (or percentage) of a group of entities in use on the average.

(e) Distributions: of important variables such as queue lengths or waiting times.

(f) Transit Time: defined as the time taken for an entity to move from one part of the system to some other part.

Measuring Utilization & Occupency:

A common requirement of a simulation is measuring the load on some entity, such as an item of equipment. The simplest measure is to determine what fraction will be used to describe this statistic.



Time history of equipment usages shown in above fig. To measure the utilization, it is necessary to keep a record of the time t_b at which the item last became busy. when the equipment becomes free at time t_f, the interval $t_f - t_b$ is derived & and added to a counter. At ~~utilization~~ the end of simulation run, the utilization U is derived by dividing the accumulated total by the total time, so that if the entity is used N times:

$$U = \frac{1}{T} \sum_{r=1}^{N} (t_f - t_b)$$

A ~~direc~~ discrete simulation program, updating time as event occur will measure the intervals $t_f - t_b$ directly but continious simulation program updating time is small integrals need build up the count by counting the no of intervals in which the item is busy.

For group of entities:

$$A = \frac{1}{T} \sum_{r=1}^{N} n_r (t_{r+1} - t_r)$$

If there is an upper limit on the number of entities, then the ~~ocyapayey~~ occupancy indicates the average number in use as a ration to the maximum number.

If M is the maximum no of entities, and the quantity n_r is the number busy in the interval t_r to t_{r+1} the average occupancy, assuming the number n changes N times is:

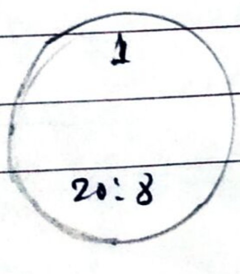
$$\frac{1}{TM} \sum_{r=1}^{N} n_r (t_{r+1} - t_r)$$

28. What is GPSS ? Draw the blocks used in GPSS and describe any eight of it with example.

⇒ The General purpose simulation system (GPSS) is a process-oriented language designed for discrete event modeling. The GPSS language has in-built mechanism to collect statistics, analyze them, produced tabulated outputs and execute a no of ~~w~~ mundane task the GPSS user can devote more times and attention to the important issues involved in the modeling.

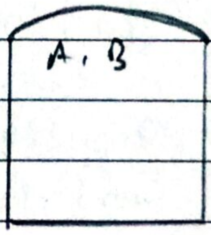
The development of a simulation model in GPSS is a block by block construction. A set of standard block is the form of a block diagram that represents the flow of entities through the various paths of the system. Each ~~blo~~ block represents a step in the action of the system and links, joining the blocks, represent the sequence of events that can occur.

① ORIGINATE: this block types is concerned with the creation of transactions. the transactions are continuously generated according to the given block time

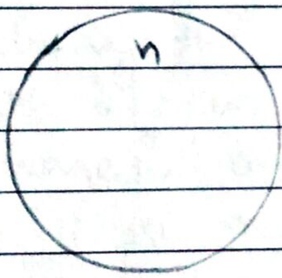


(mean ± spread)

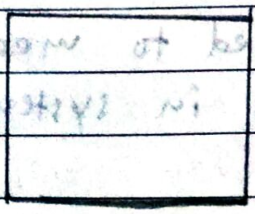
② GENERATE : The generator block is also for creation of transactions. and as long as they can enter the system.



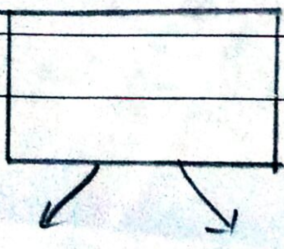
③ TERMINATE : this block is concerned with the removal of transaction from the simulation.



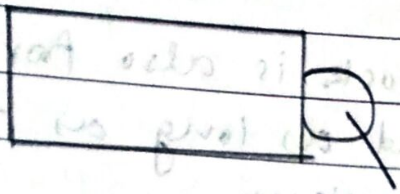
④ ADVAnce : this block concerned with flow of transactions.



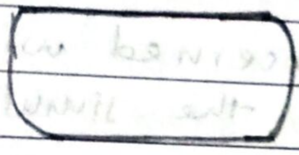
⑤ BRANCH : This block concerned with the flow of transaction:



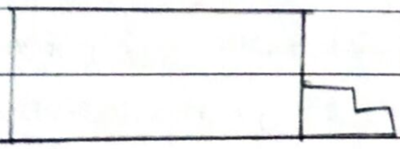
6. QUEUE : this block is placed at a position, where congestion in flow of transaction is expected.



7. MARK :



8. TABULATE



MARA & TABULATE Block are used to measure the time spent by a transaction in system. It also gather the information.

29. What are the merits of GPSS? Explain GPSS statements: SIMULATE, START, END

Merits of GPSS are as follows:

i) GPSS is written in machine language and is very fast from the execution point of view The simulation which may requires hours of CPU time in FORTAN, can be executed in minute in GPSS.

2. A GPSS being block based is very fast in developing the models. A model which may require month of writting programs in other programming languages, can be written in days in GPSS, once it is rightly understood.

3. The Programs written in GPSS can be easily ~~modifid~~ modified.

4. GPSS in much more friendly as compared to the general purpose language.
5. It is widely available.
6. GPSS allows animations in its models.
7. It is a multi-vendor language & is being continually updated.

Every GPSS program will have these statement SIMULATE, START and END. ~~staten~~

SIMULATE: this ~~sta~~ statement is generally the first statement of the program, but it is not necessary to be always first. the general form of SIMULATE statement is

SIMULATE n

the operand n is optional. It is used to limit the running time of the program.

~~Sim~~

SIMULATE 5

means that program ~~ca~~ can run upto a maximum of 5 minutes.

START: GPSS program must have ~~so~~ a START statement.

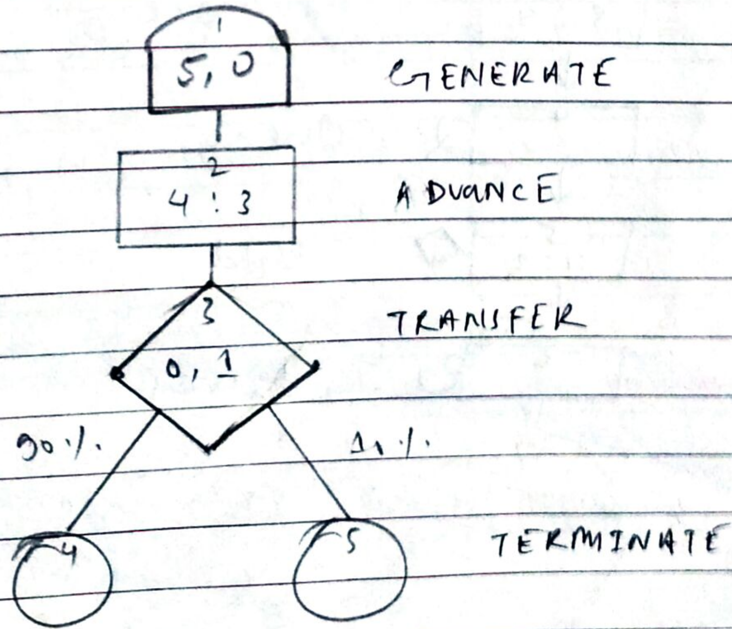
START n

where n is must be a non-zero integer, which gives maximum no of runs. It is like a counter.

END: this statement is always the last statement in a program.

80. Discuss Brefly about GPSS. Give the GPSS Block diagram for the following program:

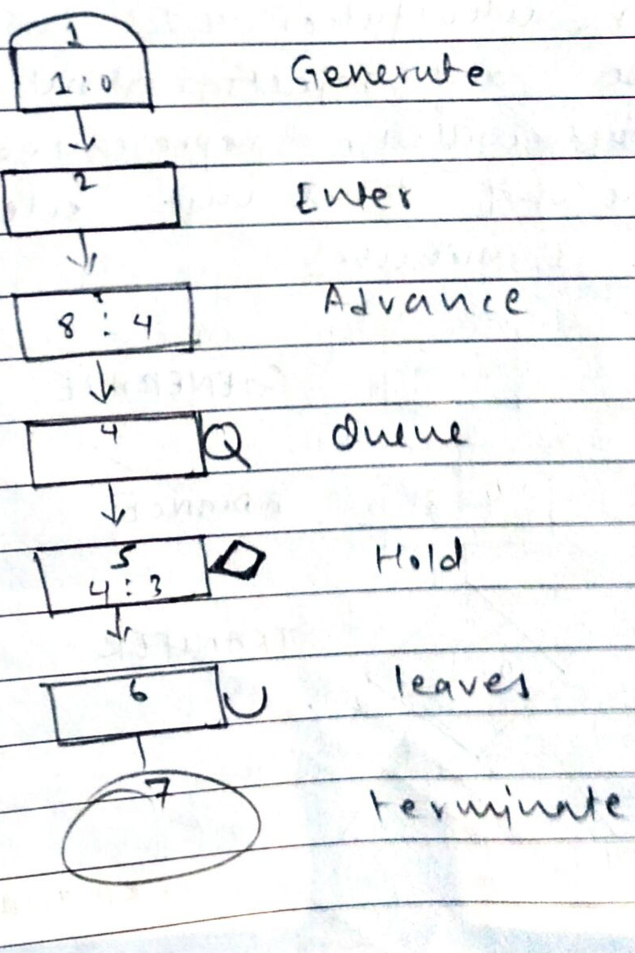
A machine tool in a manufacturing shop is turning out parts at the rate of one every 5 minutes, As they finished, the parts go on to an inspector, who takes 4 ± 3 minutes to examine each one and rejects about 10% of parts. Each part will be represented by one transaction and the ~~unit~~ time unit selected for the problem will be 1 minute.



31. Write down some merits of GPSS? Draw the block diagram for the following program.

Worker come to supply store at the rate of one every time. Their requisition are processed by ~~the~~ one of the two clerk who takes 8 ± 4 minutes for each requisition are then ~~tt~~ passed single store keeper who face than one at time taking ~~30~~ 4 ± 3 minutes for each request.

=>



32. What is simulation language? Difference between simulation language & simulators.

=) Difference between simulation language & simulators.

Simulation language	Simulators
It is a special purpose language structured to meet the programming requirements of the simulation models of a specific class of situations	It is a computer software, that allows simulating a specific class of systems with little programming.
It saves less time and effort.	It saves more time & effort.
required programming skills.	It doesnot required programing skills.
platform independent.	platform dependent.

...nsidered

markets. eg ...

33. Explain following simulation language in detail.
SIMSCRIPT, SLAM & SIMAN.

SIMSCRIPT :

SIMSCRIPT was developed by Harry Markowtz and others Rand Corporation in 1962. The SIMSCRIPT can though be employed in both the process-oriented and event oriented simulations.

SIMSCRIPT is a general purpose programming language and has the programming features of the general purpose computer like : FORTAN, C, ALGOL. SIMSCRIPT has powerful control statement and capabilities for programming discrete event models, continus models and combined discrete-event continus models. SIMSCRIPT has animation and graphic capabilities in enhanced verision. It can't be run on all classes of computers.

SLAM :

SLAM (Simulation language for Alternative modeling) was developed by Dennis Pegden and Alan Pritskar in 1979. which can be employed to construct the model. first construct the flow diagram using nodes, branches then ~~translate~~ translate into executable models. by writting the equivalent set of SLAM statements. A variety of forms of this language are available like without animation, with animation etc.

SIMAN :

SImulation ANalysis was developed by Dennis Pegden in 1982. It was the first important simulation language designed for microcomputers. It is provided with special features like work-stations, conveyours, transporters, automated guided vechicle etc. It gained a very quickly popularity it is also employed for developing process oriented, event oriented and combinations of the two models.

34. Explain different types of validation techniques with example.

=) There are three validation techniques:

(i) Face validity
(ii) Validation of assumption
(iii) output data validation

(i) Face validity:
A model that, on the surface, appears to be reasonable to the people who are knowledgeable about the system under study, is said to have high face validity. The face validity of a simulation model is thus obtained by the extensive involvement of people who have sound knowledge about the real system, and of the end users.
For example: in modeling a manufacturing system, information should be collectio collected from all such resources as machine operators, maintenance staff, supervisors, engineers, managers and vendors etc.

(13) Validation of Assumption:
During the model construction many simplification have to be carried out and many assumption have to be made to maintain the neatness of the model and to meet the objectives of study. To ensure that the behaviour of the model is representative of the behaviour of the real system, the assumption have to be as close to reality as possible. The output of a simulation model depends to a great extent on the assumption made. ~~For example, the assumption~~

(14) Output data Validation:
In each simulation model, there are some specific responses which are of interest to the modeler and the model is built to predict these responses with reasonable accuracy over a range of input conditions. When the value of the selected inputs match the inputs to the real system, then the outputs of the model should also match the ouputs of the real ~~system~~ system.

35. Write short note on followings:

① Queuing system:
Queuing system are simplified mathematical model to explain congestion and ~~a~~ delays of waiting in line. Queuing theory examines every component of waiting line to be served, including the arrival process, service process, no of servers, number of system place etc.

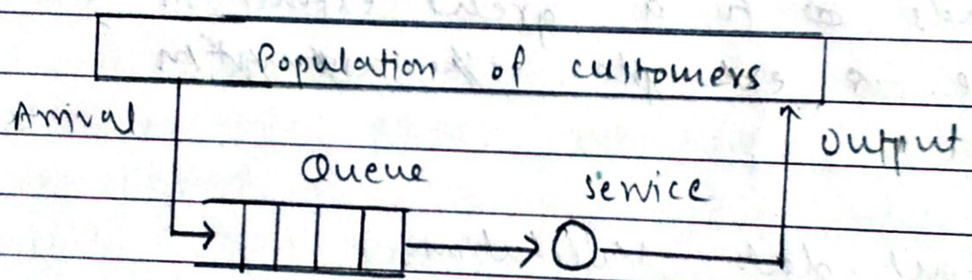


Fig: Queue system

Queue system occurs any time 'customer' demand service from some facility usually usually both the arrival of the customer and service times are assumed to be random. If all of the servers are busy when new customer arrives these will generally wait in line for the next aviable server.

2. Real time simulation:

Real time simulation refers to a computer model of a physical system that can execute at the same rate as the actual "wall clock" time. In other words, the computer model runs at the same rate as the actual physical system. For example if a ~~tak~~ tank takes 10 minutes to fill in the real-word, the simulation would take 10 minutes as well.

Realtime simulation occurs commonly in computer gaming, but also is important in the industrial market for operator training and off-line controller tuning. Computer languages like LabView, VisSim allow quick creation of such real time simulations.

3. Distributed lag Model
If the regression model includes not only the current but also the lagged (past) values of the explanatory variables (the x's) it is called a distributed lag model. If the model includes one or more lagged values. It is called an autoregressive model. This is known as a dynamic model.

In other words distributed lag model is defined as a type of model that have a property of changing only at fixed interval of time and based on current values of variables on other current values of variable and values that occured in previous intervals.

In economic studies, some economic data are collected over uniform time intervals such as a month or year. This model consists of linear algebric equations that represent continious system but data are available at fixed points in time.

4. Cob Web Model:

Cobweb theory is used to explain fluctuations and instability in price and quantity within certain markets. eg agricultural markets.

Cobweb theory is the idea that price fluctuations can lead to fluctuations in supply which cause a cycle of rising and falling prices.

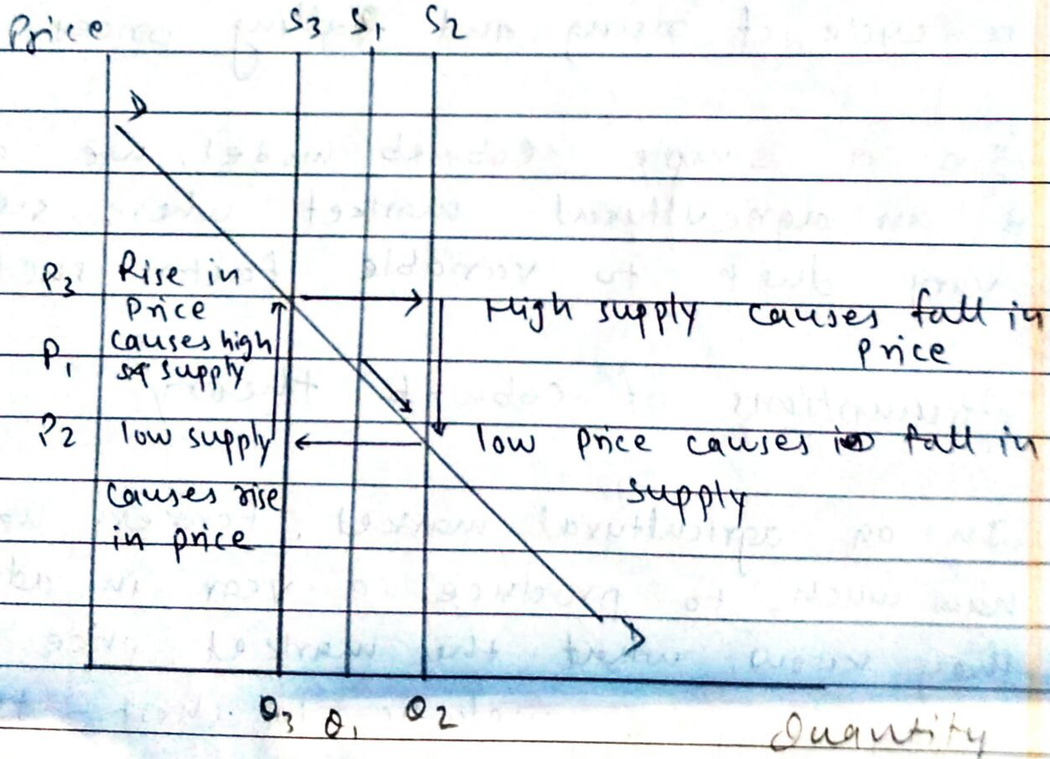
In a simple cobweb model, we assume there is an agricultural market where supply can vary due to variable factors such as weathers.

Assumptions of cobweb theory:

- In an agricultural market, farmers have to decide how much to produce a year in advance - before they know what the market price will be. (supply is price inelastic in short - term).
- A key determinant of supply will be ~~price~~ the price from previous year.

A low price will mean some farmers go out of business. Also, a low price will discourage farmers from growing the crop in the next year.

- Demand for agricultural good is ~~to~~ usually price inelastic (a fall in price only causes a smaller % increase in demand)



1. If there is a very good harvest, then supply will be ~~go~~ greater than expected and this will cause a fall in price.

2. However, this fall in price may cause some farmers to go out of business. Next year farmer may be put off by the low price and produce something else. The consequence is that if we have one year of low prices, next year farmers reduce the supply.

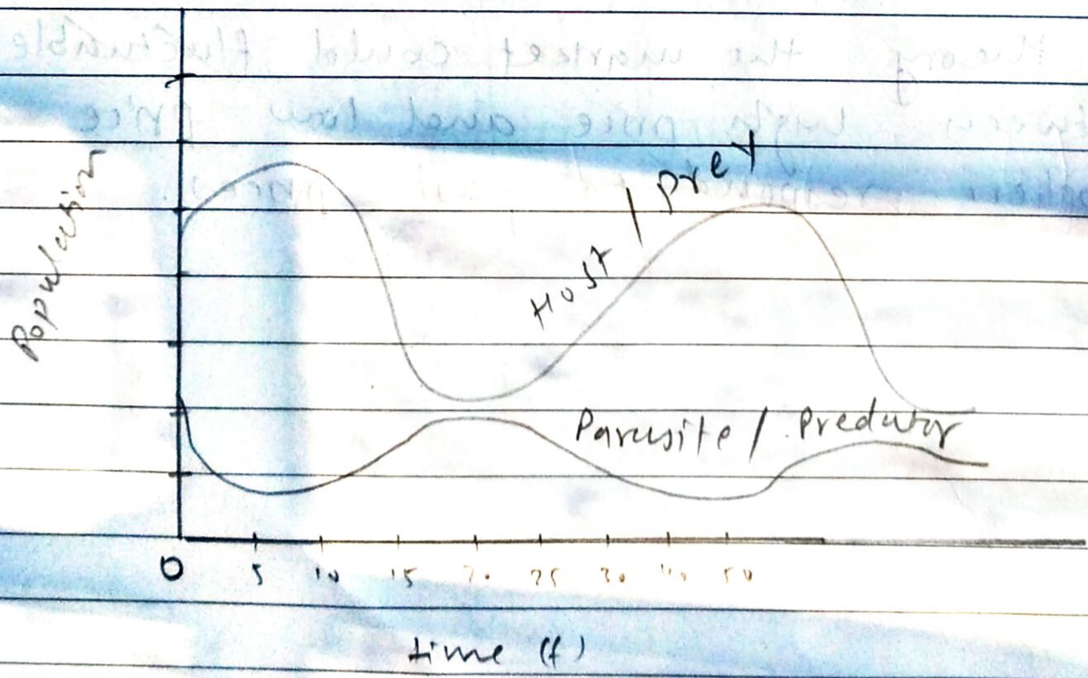
3. If supply is reduced, then this will cause the price to rise.

4. If farmers see high prices (and high profits), then next year they inclined to increase supply because the product is more profitable.

In theory the market could ~~fluctuable~~ fluctuate between high price and low price as suppliers respond to past prices.

5. Predator - ~~Pray~~ Prey Model

It is also called parasite - host model. An environment consist of two population i.e. predator and prey. It is also a mathematical model. The prey is passive but the predator depends on the prey for their source of food. A predator is an organism that eats another organism. some example of The prey is the organism which the predator ~~ets~~ eats. some example of ~~pread~~ predator ~~or~~ and ~~pray~~ as prey are lions and zebra, ~~fo~~ and fox and rabbit and cat and mouse.



Model assumes a set of fixed positive constants

a = growth ~~of~~ rate of prey

b = rate at which predators destroy prey

c = rate at which predators increase by consuming Prey

r = death rate of Predators

The following condition will be hold for model

let

$x(t)$ = Prey pobulation at the time t

$y(t)$ = Predator population

$\dot{x} = ax$ (absense of predator prey wil grow ~~expon~~ exponentially $a > 0$)

~~Dea~~ Death rate of the prey due to interaction is proportional to $x(t)\, y(t)$ with a positive ~~constant~~ propertionality constant so

$\cancel{\dot{x}(t) = ax(t) - b\,x(t)}$

$$\dot{x}(t) = ax(t) - bx(t) \cdot y(t) \quad \text{— (I)}$$

without prey, ~~pred~~ predators will die exponentiall according to $\dot{y}(t) = -ry(t)$ for $r > 0$

the birth strongly depends on both population size so we finally find for a certain $c > 0$

$$\dot{y}(t) = -ry(t) + cx(t)y(t) \quad \text{— (II)}$$

These - (I) & (II) equation lead to following system differential equations:

$$\dot{x}(t) = \cancel{a x(t) - \quad}$$

$$\dot{x}(t) = a x(t) - b x(t) y(t)$$
$$\dot{y}(t) = -r y(t) + c x(t) y(t)$$

From the given pop^n
$x(t) \cdot y(t)$
we compute for $(e^{at}, 0), (0, e^{-at})$

~~From~~ From the system we find the sol^n

$$\dot{x}\left(\frac{r}{x} - c\right) + \dot{y}\left(\frac{a}{y} - b\right) = 0$$

6. Properties of random numbers!

=) Random number is a number generate by a process whose outcome is unpredictable and which can not subsequently reliably ~~pne~~ reproduce. Random numbers are the basic building block for all simulation algorithms.

Properties of random numbers are!

(i) Uniformity
(ii) Independence

the consequence of uniformity and independence properties are !

1. If the interval [0,1] is divided into n classes or subinterval of equal length, then the expected number of observation in each intervals is N/n where N is the total no of observations.
2. The probability of observing a value in a particular interval is independent of previous values drawn.

7. Pseudo Random Numbers:
Pseudo means false but here pseudo implies that the random numbers are generated by using some known arithmetic operations. since the arithmetic operation is known and the sequence of random numbers can be repeatedly obtained, the numbers can not be called truely random. However the pseudo random numbers generated by many computer routines very closely fulfil the requirement of the desired randomness.

If the method of random number generation i.e the random number generator is defective the generated pseudo-random number may have the following departures ~~to~~ from ideal randomness:

① The generated random numbers may not be uniformly distributed.

② The generated random numbers may not be continuous.

3. The variance may be too high or too low.

7. Hybrid simulation

Hybrid simulation is a system which is develo that combines analog and digital computer for simulation. Hybrid simulation depends upon ~~A~~ the application. One computer may be simulating the system being studied while the other is ~~pro~~ providing a simulation of the environment in which the system is to operate. It is also possible that the system being simulated in an interconnection of continuous and discrete subsystem, which can be best be modeled by an analog & digital computer being linked together.

Hybrid simulation is a methodology that combines multiple modalities of modeling / simulation Complex scenarios are decomposed into ~~so~~ simpler ones each on being simulated through strategy. All these building blocks are then synchronized & ~~d~~ coordinated.

verification and validation of model

The development of a simulation model is incomplete without its verification and validation. The validation is essential to build the credibility and acceptability of the model. The main objectives of validation canbe summarized as:

① To obtain a model that represents the behaviour of the real system so closely that it it can be used as a subtitute for experiment on the true system.

(ii) ~~to~~ To increase the accuracy of the output results, so that these are within some prescribed limits.

The verification and validation is not a seprate stage in the process of development of a simulation model rather an integral part of it and is carried out throughout the process of model development. This requires a close interaction between the model developing team, people who are knowledgeable about the system, and end users of the simulation model.

9. Feedback system

Feedback system have a closed loop structure that brings results from past action of the systems back to control future action. so feedback system infac influenced by their own past behaviour. Extending the blind control example, a feedback system would be a system that not only opens the blinds when the sun rises but also adjusts the blinds during the day to ensure the room is not subjected to direct sunlight.

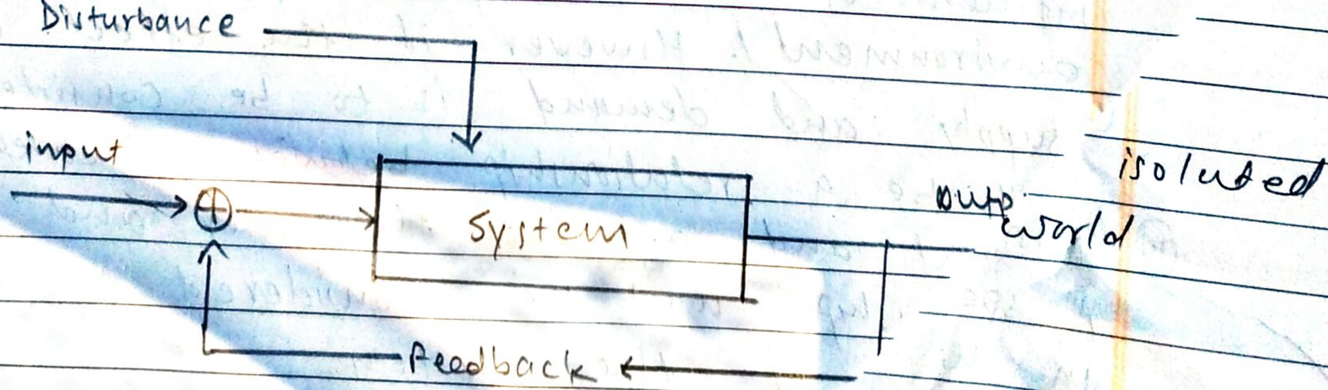


fig: Fedback System

10. System Enviornment
Everything that remains outside of the system under consideration is called system. Environment. The system is often affected by change occuring outside ~~en~~ environment. Some system activity may also produce changes the don't react on the system (but react outside the system). such ~~etc~~ changes occuring outside the system is said to occur in the system environment.

When we are going to model the system, we must decide the boundary ~~between~~ between system and the environment. This decision depends on the purpose of the system study. In the case of the factory system, factors controlling the arrival of the order may be considered to be the influence of the factory (ie part of the environment). However if the effect of the supply and demand is to be considered, there will be a relationship between between factory output and arrival of the order and ~~its~~ this relationship must be considered as the activity of the system.

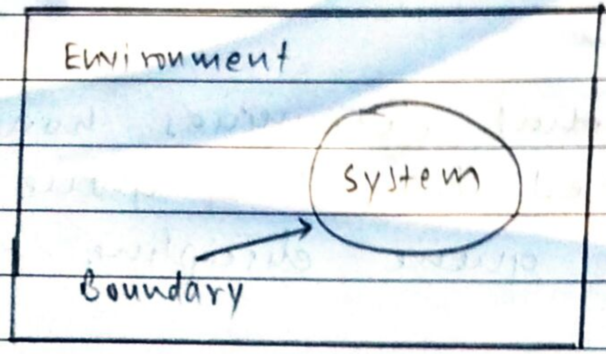


fig: system Environment

system Types:

(i) closed system : no interaction between system and environment.

(ii) open system: Activity in the environment that affects the system.

(iii) Isolated system: The system which is isolated from the external world (environment).

11. Queue Discipline:
Queue Discipline that determines how the customers are selected from the queue for service. There are various queue discipline they are;

(i) First in first out:
It is also called the first come first serve. according to ~~that~~ this rule. services is offered on the basis of arrival time of customer, the customer who ~~co~~ came first will get the service first.

(ii) Last in first out:
In some situations the last arrival is served first as in big ~~co~~. go-downs the item coming last are taken out first, in ~~crowed~~. crowded trains or elevators passengers getting in last came first out.

(iii) Priority:
A special no is assigned to each customer in the waiting line. It is called priority. Than according to the number the ~~custo~~ customer is choosen for the service.

(IV) Random :

The service discipline is said to be random when all waiting customer have equal chance of getting selected for service. The selection follows purely ~~choice~~ random choice.

(V) Shortest Processing Time First :

It means that the customer will shortest service time will be choosen 1st for the ~~servic~~ service.