Disclaimer: I DO NOT claim or guarantee whether the answer written here is 100% accurate. If you feel something is not accurate or out-of-order, it will be a great help, if you let me know. You know how to find me. ***I Do Not recommend this note for your exam. Its too raw. Use the note provided by Sir.***

Note: Those question which are crossed (i.e. strike-through) refer to the repeated question which has been solved/answered already.

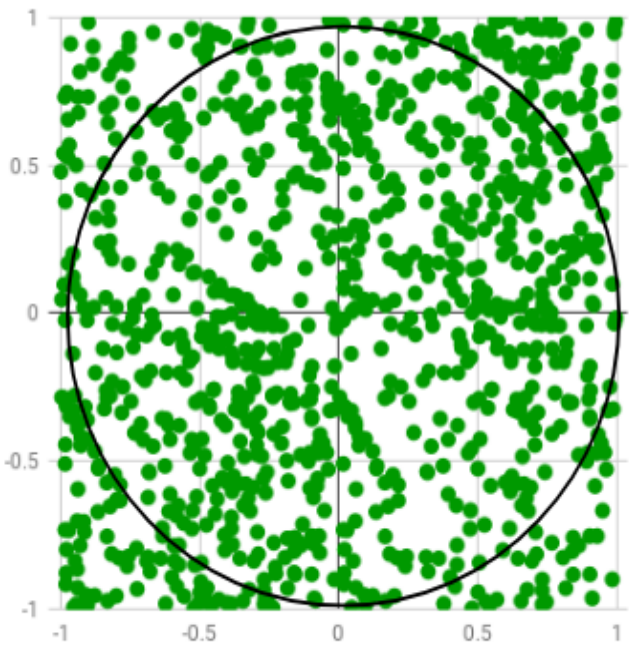
Tips: Don't try to read this pdf using mobile Its pointless and time wasting activity. Use your laptop. Read it in 16:9 full-screen format. **Author: Pranav Bhattarai**

Fall 2019

1 a) Why do we need to simulate a system? Compare Stochastic with Deterministic Simulation System.
1 b) Monte-Carlo method is numerical computation method. Explain how and use it to determine the value of PI.

Monte Carlo methods are a broad class of computational algorithms that rely on repeated random sampling to obtain numerical results. One of the basic examples of getting started with the Monte Carlo algorithm is the estimation of Pi.

The idea is to simulate random (x, y) points in a 2-D plane with domain as a square of side 1 unit. Imagine a circle inside the same domain with same diameter and inscribed into the square. We then calculate the ratio of number points that lied inside the circle and total number of generated points. Refer to the image below:



We know that area of the square is 1 unit sq while that of circle is $\pi*(1/2)^2=\pi/4$. Now for a very large number of generated points,

$$\frac{\text{area of circle}}{\text{area of square}} = \frac{\text{no. of points generated inside the circle}}{\text{total no. of points generated or no. of points generated inside the square}}$$

that is,

$$\pi = 4 * \frac{\text{no. of points generated inside the circle}}{\text{no. of points generated inside the square}}$$

The beauty of this algorithm is that we don't need any graphics or simulation to display the generated points. We simply generate random (x,y) pairs and then check if $x^2+y^2 \leq 1$. If yes, we increment the number of points that appears inside the circle. In randomized and simulation algorithm like Monte Carlo, the more the number of iterations, the more accurate the result is. Thus, the title is should be "Estimating the value of Pi" and not "Determine the value of Pi". Below is the **algorithm** for the method:

1. Initialize circle_points, square_points and interval to 0.
2. Generate random point x.
3. Generate random point y.
4. Calculate d = x*x + y*y.
5. If d <= 1, increment circle_points.
6. Increment square_points.
7. Increment interval.
8. If increment < NO_OF_ITERATIONS, repeat from 2.
9. Calculate pi = 4*(circle_points/square_points).
10. Terminate.

2 a) Explain Predator-Prey model with example.

2 b) Draw block diagram for these equations:

$$dx_1/dt = -k_{12}x_1+k_{21}x_2$$
$$dx_3/dt = k_{23}x_2$$
$$dx_2/dt = k_{12}x_1-(k_{21}+k_{23})x_2$$

3 a) Define CSMP III and explain the types of statement.
3 b) What do you mean by analog computer? Explain its advantage and disadvantage.
4 a) "Call gets lost when link is not available or line is busy" Verify this statement on the basis of various states involved in this simulation.
4 b) What do you mean by uniformity test? Explain the process of uniformity test of random numbers by K-S test method.

OR

Using the linear congruential, find the period of the generator and set of random numbers for a=5, c=1, m=8 & seed x_0=3.
5 a) What are the types of simulation language? Explain the feature of simulation language.
5 b) What is confidence interval? Explain estimation methods and state Central Limit Theorem.
6 a) Differentiate facilities and storage's in details. Draw a block diagram of a simple manufacturing shop model having more than one inspector.

6 b) What is SIMSCRIPT? Explain SIMSCRIPT program orientation?

7. Write short on any two:

a) ~~Pseudo Random Number~~

b) ~~Utilization and occupancy~~

c) Estimation Methods

Fall 2018

1 a) What is system simulation? Explain types of model.

Systems simulation is a set of techniques that use computers to imitate the operations of various real-world tasks or processes through simulation.

The types of model are:

i>Static Physical Model: is a scaled down model of a system which does not change with time. Best example of this is scale models. An architect before constructing a building makes a scaled down model of the building, which reflects all it rooms, outer design and other important features. This is an example of static physical model.

ii>Dynamic Physical Model: Dynamic physical models are ones which change with time or which are function of time. In wind tunnel, small aircraft models (static models) are kept and air is blown over them with different velocities and pressure profiles are measured with the help of transducers embedded in the model. Here wind velocity changes with time and is an example of dynamic physical model.

iii>Static Mathematical Model: If mathematical model does not involve time i.e., system does not change with time, it is called a static mathematical model of the system. A static model gives the relationship between the system attributes when the system is in equilibrium. (If the point of equilibrium is change by altering any of the values, the model enable the new values for all the attributes to be derived but doesn't show the way in which they are changed to their new values.)

iv>Dynamic Mathematical Model: This model allows the changes of system attributes to be derived as a function of time. The derivation may be as a function of time. The derivation may with an analytical solution or with numerical computation depending upon the complexity of model. The equation to describe the behavior of a car wheel is an e.g. of this model.

1 b) What do you mean by Monte Carlo method? Estimate the value of $\int_2^5 x^3\,dx$ using Monte Carlo Method.

A particular numerical computation method, called the Monte Carlo method, consist of experimental sampling with random numbers. For example, the integral of a single variable over a given range corresponds to finding the area under the graph representing the function. Monte Carlo simulation can be used to tackle a range of problems in virtually every field such as finance, engineering, supply chain, and science. Monte Carlo simulation is also referred to as multiple probability simulation.

2 a) Use a cobweb model to investigate a market in which the supply and demand are:

$D = 17.91/p^{1/2} - 4.66$

$9s = 5.0(p_{-1} - 1)$

Assume the market is always cleared.

2 b) Why do we need Digital-Analog Simulators? Write the function of CSMP III Statements: DELT, FINTIM, PRDEL, OUTDEL.

Ans: To avoid the disadvantages of analog computers, many digital computer programming languages have been written to produce digital-analog simulators. They allow a continuous model to be programmed on a digital computer in essentially the same way as it is solved on an analog computer.

CSMP III, or Continuous System Modeling Program III is an early scientific computer software designed for modeling and solving differential equations numerically. This enables real-world systems to be simulated and tested with a computer. The function of given CSMP III statements are:

DELT: Integration interval
FINTIM: Finish time
PRDEL: Interval at which to print results
OUTDEL: Interval at which to print-plot

3 a) What is lost call? How can we maintain the calls from being lost? Simulate the telephone system for such calls.

Ans: A lost calls are those calls when a call get lost because the called party is either engaged or when there is no link available to connect.

We can maintain the calls from being lost by delaying calls until they can be connected. To do this, we need to keep the records of the delayed calls. For that, it is necessary to build another list like the calls-in-progress list.

Recomputing the simulation, the system moves through the first two states exactly as before.

<<< See note for this, because it contain figures >>>

3 b) Explain measuring Utilization and occupancy of some entity in discrete system simulation process. What is the key difference between utilization and Occupancy?

Like occupancy, Utilization is calculated as a percentage. However, it differs from occupancy as utilization instead represents the amount of time that advisers spend logged-in, handling and expecting contacts, while present in the contact center.

Utilization answers the question: for what percentage of the time that I pay my advisers are they logged in and assisting or available to assist with a customer activity?

Utilization (%) = (Total Logged-in Time / Total Shift Time) ×100

Utilization is important as input to overhead cost or shrinkage calculations, as it considers 'non-customer-related activities' that still get paid for, but that take the adviser away from servicing a customer.

Occupancy is calculated as a percentage and represents the amount of time that advisers spend on call-related activity while they are logged in and expected to be taking calls. "Call-related activity" includes talk time, hold time and wrap time. It is often referred to as "productive time".

Occupancy answers the question: for what percentage of the time that my advisers are logged in live are they actually busy with a customer activity, or are they available to do more?"

It is typical for a contact center's occupancy to lie between 80 and 85%, and if your occupancy rate is at this level, it is likely that your Resource Planning team are doing a good job. However, if occupancy is consistently higher than 85%, you are risking adviser burnout.

But remember, there is no recommended best-practice benchmark for occupancy, and targets should be set with a goal of continuous improvement in mind, balancing financial/budget requirements with employee needs.

Here are the two equations that most contact centers use to calculate occupancy.

Occupancy (%) = (Total Contact Handling / Time Total Logged Time) ×100

However, these formulas are often presented using the following terminology, although they all equate to the same thing.

Occupancy (%) = (Traffic Intensity (Erlangs) / Raw Advisers) ×100

Occupancy is especially important in schedule design, as it assists with measuring schedule optimization, so as not to have advisers sitting and waiting for calls too often.

4 a) Explain differential linear and partial differential linear equations in details.

Linear differential equation is a differential equation that is defined by a linear polynomial in the unknown function and its derivatives, that is an equation of the form

$a_0(x)y + a_1(x)y' + a_2(x)y'' + \ldots + a_n(x)y^n$

where $a_0(x)$, …, $a_n(x)$ and b(x) are arbitrary differential functions that do not need to be linear, and are the successive derivatives of an unknown function y of the variable x.

This is an ordinary differential equation (ODE). A linear differential equation may also be a linear partial differential equation (PDE), if the unknown function depends on several variables, and the derivatives that appear in the equation are partial derivatives.

A linear differential equation or a system of linear equations such that the associated homogeneous equations have constant coefficients may be solved by quadrature (mathematics), which means that the solutions may be expressed in terms of integrals. This is also true for a linear equation of order one, with non-constant coefficients. An equation of order two or higher with non-constant coefficients cannot, in general, be solved by quadrature. For order two, Kovacic's algorithm allows deciding whether there are solutions in terms of integrals, and computing them if any.

The solutions of linear differential equations with polynomial coefficients are called holonomic functions. This class of functions is stable under sums, products, differentiation, integration, and contains many usual functions and special functions such as exponential function, logarithm, sine, cosine, inverse trigonometric functions, error function, Bessel functions and hyper-geometric functions. Their representation by the defining differential equation and initial conditions allows making algorithmic (on these functions) most operations of calculus, such as computation of anti-derivatives, limits, asymptotic expansion, and numerical evaluation to any precision, with a certified error bound.

4 b) Write the consequences of properties of random numbers. Explain the runs Test of random numbers with an example.

Properties of random numbers are:

i) A sequence of random numbers, R_1, R_2, R_3 … must have two important properties:

- Uniformity, i.e. they are equally probable every where
- Independence, i.e. the current value of a random variable has no relation with the previous values.

ii) Each random number R_i is an independent sample drawn from a continuous uniform distribution between zero and one.

iii) Some consequences of the uniformity and independence properties:

- If the interval (0,1) is divided into *n* sub-intervals of equal length, the expected number of observations in each interval is N/*n* where *N* is the total number of observations. Note that *N* has to be sufficiently large to show this trend.
- The probability of observing a value in a particular interval is independent of the previous values drawn.

5 a) Give GPSS block diagram and write program of the following problem:

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

5 b) Workers come to a supply store at the rate of one every 5±2 minutes. Their requisitions are processed by one of two clerks who take 8±4 minutes for each requisition. The requisition are then passed to single storekeeper who fills them one at a time taking 4±3 minutes for each request. Write GPSS block diagram and code to simulation above program for 1000 requisitions to filled.

6 a) What is confidence interval? Explain Estimation methods and state Central Limit Theorem.

The confidence interval is the range of possible values for the parameter based on a set of data (e.g. the simulation results). It helps the user decide whether or not enough simulations have been run. *If the confidence interval is too large for the particular application then it indicates that not enough simulations have been run. The size of the confidence interval will decrease as the number of simulations increases.*

6 b) Why gathering of statistics is necessary? Explain utilization and occupancy.

7) <u>Write short notes</u>:

a) <u>Discrete probability function Vs Probability density function</u>:

//This is the stupidest question ever asked. It doesn't make any sense.

Discrete Probability function	Probability Density Function
A discrete probability function is a function that can take a discrete number of values (not necessarily finite). This is most often the non-negative integers or some subset of the non-negative integers	

b) <u>Real time simulation</u>: refers to a computer model of a physical system that can execute at the same rate as actual "wall clock" time. In other words, the computer model runs at the same rate as the actual physical system. For example, if a tank takes 10 minutes to fill in the real-world, the simulation would take 10 minutes as well.

In a real time simulation, the simulation is performed in a discrete time with constant step also known as *fixed step simulation* as time moves forward in equal duration of time, other techniques having variable step are used for high frequency transients but are unsuitable for real time simulation. In a real time simulation the time required to solve the internal <u>state equations</u> and functions representing the system must be less than the fixed step. If calculation time exceeds the time of the fixed step, an over run is said to have occurred. In simple words, real-time simulation must produce the internal variables and output within the same length of time as its physical counterpart would.

c) <u>Distributed lag model</u>: is defined as a type of model that have the property of changing only at fixed interval of time and based on current values of variables on other current values of variables and values that occurred in previous intervals. This model consists of linear algebraic equations that represent continuous system but data are available at fixed points in time. Any variable that can be expressed in the form of its current value and one or more previous value is called lagging variable. And hence this model is given the name distributed lag model.

Advantages of distributed lag model

- Simple to understand and can be computed by hand, computers are extensively used to run them.
- There is no need for special programming language to organize simulation task.

<u>Spring 2018</u>

1 a) "Before system simulation, it is necessary to predict how a system performs its activities", Explain this with the principals of system modeling.

The principal of system modeling are: // book answer

i. Block Building:
   The description of system should be organized in the series of blocks to simplify the specification of interaction within the system. Each block represents a part of system that depends upon a few, preferably one, input variables and results in a few output variables. The system as a whole can then be described in terms of the interconnections between the blocks. Correspondingly, the system can be represented in terms of the interconnection between the blocks.

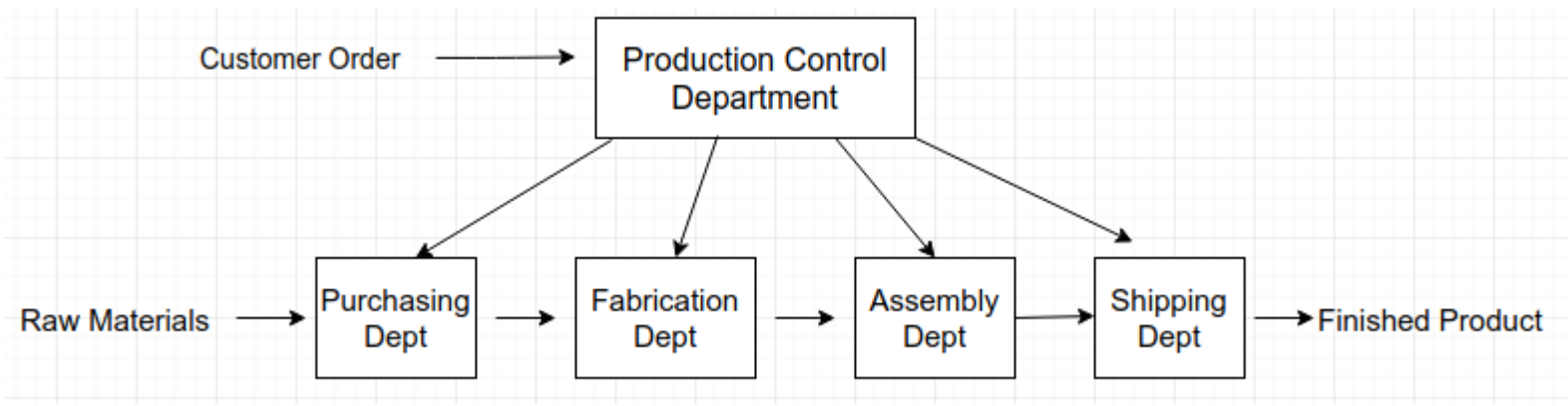


Fig: Factory System

The description of a factory given in above figure is a typical example of block diagram. Each department of the factory has been treated as a separate block, with the inputs and outputs being the work passed from department to department. The fact that the departments might occupy the same floor space and might use the same personnel or the same machines has been ignored.

ii. Relevance
> The model should only include those aspect of the system that are relevant to the study objective. As an example, if the factory system study aims to compare the effects of different operating rules on efficiency, it isn't relevant to consider the hiring of employee as an activity. While irrelevant information in the model may not do any harm, it should be excluded because it increases the complexity of the model and causes more work in solving the model.

iii. Accuracy
> The accuracy of the information gathered for the model should be considered. In the aircraft system, for example, the accuracy with which the movement of the aircraft is described depends upon the representation of the air-frame. It may suffice to regard the air-frame as a rigid body and derive a very simple relationship between control surface movement and aircraft heading, or it may be necessary to recognize the flexibility of the air-frame and make allowance for vibrations in the structure. An engineer responsible for estimating the fuel consumption may be satisfied with the simple representation. Another engineer, responsible for considering the comfort of the passengers, needs to consider vibrations and will want the detailed description of the air-frame.

iv. Aggregation
> A further factor to be considered is the extent to which the number of individual entities can be grouped together into larger entities. The general manager of the factory may be satisfied with the description that has been given. The production control manager, however, will want to consider the shops of the departments as individual entities.

In some studies, it may be necessary to construct artificial entities through the process of aggregation. For example, an economic or social study will usually treat a population as a number of social classes and conduct a study as though each social class were a distinct entity.

Similar considerations of aggregation should be given to the representation activities. For example, in studying a missile defense system, it may not be necessary to include the details of computing a missile trajectory for each firing. It may be sufficient to represent the outcome of many firings by a probability function.

1 b) What is the name of computation of Monte Carlo method? Find the value I using the Monte Carlo method: $I = \int_{2}^{5} 2x dx$

Solution:

Standard value $= 2\int_{2}^{5} x dx = 2\left[x^2/2\right]_{2}^{5} = 2\,[25/2 - 4/2] = 21$

By Monte Carlo Method,

b=5
a=2

To find c, for maximum value of f(x) or y:

$f'(x) = 0$
$d/dx\ (2x) = 0$

… (to be continued)

2 a) Discuss about continuous system simulation language (CSSL). Explain different component of analog methods.

2 b) Explain Representation of Time in Discrete system simulation. Describe Significant event simulation.

3 a) What is lost call? How can we maintain the calls from being lost? Simulate the telephone system for such calls (Delayed calls).

3 b) Enlist the 6 common statistics use to generate the simulated output and explain how you measure them.

// Answer need to be conformed //
Six commonly required statistics which are usually included in the output of a simulation are as follows:

i. Counts- giving the number of entities of a particular type or the number of times some event occurred.
ii. Summary measures- such as extreme values, mean values, and standard deviations.
iii. Utilization- defined as the fraction (or percentage) of time some entity is engaged.
iv. Occupancy- defined as the fraction (or percentage) of a group of entities in use on the average.
v. Distributions- of important variables, such as queue lengths or waiting times.
vi. Transit times- defined as the time taken for an entity to move from one part of the system to some other part.

4 a) How initial bias can be removed? Explain about replication of run in analysis of simulation output.

4 b) Explain different statements in CSMP III. Describe the Execution cycle for the simscript program with necessary diagrams.

5 a) "A random variable is drawn from an infinite population that has a stationary probability distribution with a finite mean and finite variance", elaborate this by using central limit theorem for estimation.

5 b) Workers come to a supply store at a rate of one every 5 $^{+}_{-}$2 minutes. Their requisition are processed by one of two clerks who takes 8-+4 minutes for each requisition. The requisition are then passed to a single storekeeper who fills them one at a time, taking 4+-3 minutes for each request. Draw the GPSS block diagram to simulate the queue of workers and measure the distribution of time taken for 1000 requisitions to be filled.

OR

Explain SIMSCRIPT program execution cycle with necessary diagrams.

6 a) What is GPSS? Explain any eight GPSS block diagram symbols with their example.
GPSS
6 b) What are advantages of simulation language over the general purpose programming language for simulation study? Explain about temporary and permanent entities in simscript.

7. Write short notes on:
a) Types of Models

b) Measuring utilization and occupancy //book answer

A common requirement of simulation is measuring the load on some entity, such as an item of equipment. The simplest measure is to determine what fraction of time the item was engaged during the simulation run. The term *utilization* will be used to describe this statistic.

For Utilization statistics, timing information must be kept for each individual entity. Occupancy statistics only require keeping a count of a class of entities, and recording the last time the count changed, just two numbers. If the number of active entities is large, it can cost a great deal more space and time to record utilization than occupancies.

c) ~~Hybrid simulation~~

Fall 2017

1 a) Define simulation and explain the importance of simulation contrasting its application.
1 b) What is Monte Carlo Method and why it is used? Explain steps for the calculation and give a suitable example of Monte Carlo method.
Monte Carlo Simulation (named after a famous casino town1 in Europe) refers to the type of simulation in which a static, approximate, and stochastic model is used for a deterministic system.
Steps of calculation of Monte Carlo method are:
i) Define a function and select random numbers.
ii) Test the function against the random number.
iii) The good accuracy can be achieved by increasing the number of random samples.
iv)

2 a) Draw the Cobweb model of a market economy for the following condition:
$D = 12.4 - 1.2\ P$
$S = 1.0 + 0.9\ P_{-1}$
$P_0 = 1.0$

Ans: Given:
$D = 12.4 - 1.2P$
$S = 1.0 + 0.9P_{-1}$
$P_0 = 1.0$

Now, in equilibrium condition: Demand (D) = Supply (S)
$\therefore \quad 12.4 - 1.2P = 1.0 + 0.9P_{-1}$
$12.4 - 1 = 0.9P_{-1} + 1.2P$
$11.4 = 0.9P_{-1} + 1.2\ P$
... (to be continued)

OR

Explain Event and Interval Oriented Time Advance Mechanism with suitable example of each.

2 b) Define CSMP III and explain the types of statements.
CSMP III, or Continuous System Modelling Program III is an early scientific computer software designed for modelling and solving differential equations numerically. This enables real-world systems to be simulated and tested with a computer.

The types of statements are:

i) Structural Statements, which define the model. They consist of FORTRAN-like programming language statements, and functional blocks of program code (procedures) designed for repeat operations that frequently occur in a model definition.
Structural statements can make use of the operations of addition, subtraction, multiplication, division, and exponentiation, using the same notation and syntax rules as are used in FORTRAN.

ii) Data Statements, which assign numerical values to various changing parameters, constants, and initial conditions.

iii) Control Statements, which specify options in assembly and execution of the program, and the choice of output of the results of the calculations performed.

3 a) What is Feedback system? Explain parasite-host model with suitable example of each.
3 b) Define Discrete event simulation. Explain simulation of a telephone system.
Discrete event simulation (DES) is the process of codifying the behavior of a complex system as an ordered sequence of well-defined events. In this context, an event comprises a specific change in the system's state at a specific point in time.

To model a telephone system we consider the following entities: Telephone Lines, Links (through which call can be established), Phone Calls. Temporary entities are those that are created and destroyed during the simulation whereas permanent entities remain during the run. Usually entities declared as permanent are stored collectively rather than in individually identifiable records. Unlike temporary entities, permanent entities are not destroyed individually; they are destroyed collectively. In this respect telephone lines and links should be permanent entities because they are usually permanent and can be handled collectively. But individual phone call created for a short period of time and after that they should be destroyed. So we can consider phone call as temporary entity.

4 a) What is Bootstrapping and why it used? Explain the Generation of Arrival Patterns in discrete system simulation.

4 b) Explain Kolmogorov-Smirnov test and steps carried out for the test.

Or

Using the multiplicative congruential method, find the period of the generator and set of random numbers for a=13, m=2^6 and X_0=1 and 2.

5 a) Discuss briefly about GPSS. Draw the blocks used in GPSS and also write about any five basic commands.
GPSS (General Purpose Simulations System) language was developed principally by the IBM Corporation published in 1961. The system which is to be simulated in GPSS is described by a block diagram in which the blocks represent the activities, and lines joining the blocks indicate the sequence in which the activities can be executed. Where there is a choice of activities, more than one line leaves a block and the condition for the choice is stated the block.
Features of GPSS

1. Restricted to simple queuing problem.
2. Poor computational facilities.
3. Inflexible input and output.
4. No language extension possible.
5. Easy to learn and use.
6. Good debugging facilities.
7. Machine efficiency is often poor.
8. Interpretative system.

Any five basic commands for GPSS are:

1.
2.
3.
4.
5.

5 b) Explain the SIMSCRIPT execution life cycle.
SIMSCRIPT is an event-statement oriented discrete language. A completely new version SIMSCRIPT II was released by the RAND Corporation in 1968.

About SIMSCRIPT

1. User should know programming in PROTRAN or ALGOL for learning SIMSCRIPT.
2. It is capable of representing more complex data- structures and can execute more complex design rule.
3. It is able to produce a more compact model that requires less storage space and generally will be executed more rapidly.
4. SIMSCRIPT program can be implemented on several different manufactures‘ computer system and can be applied in general programming problems.

SIMSCRIPT System Concepts

(1) The system to be simulated is considered to consist of entities having attributes that interest with activities.
(2) Interaction causes events that change the state of the system.
(3) It may have temporary or permanent entities and attributes.
(i) Temporary entities are created and destroyed during the execution of simulation.
(ii) Permanent entities remain during the execution. Its attributes are stored as arrays.
(4) The user can define sets and facilities and are provided for entering and removing entities into and from sets.
(5) Activities are considered as extending over time with their beginning and their end being marked as events occurring instantaneously.
(6) Each type of event is describing by an event-routine and is given a name.
(7) Each event routine are needed to execute the changes that result when an external event become due for execution, part of the automatic initialization procedure of SIMSCRIPT is to prepare the first exogenous event from each data set.
(8) An endogenous event is caused by a scheduling statement in some event routing while an exogenous event requires the reading of data supplied by user.
(9) An event marking the beginning of an activity will usually schedule the event that marks the end of the activity.

Features of SIMSCRIPT

(1) Machine-independent general-purpose simulation language.
(2) Algorithmic capabilities comparable to those of ALGOL or PL/1.
(3) Simulation concepts are relatively few and very general.
(4) Data collection facilities are excellent.
(5) Input-output facilities are good.
(6) Security (error detection) is poor.
(7) Flexibility for experimental design is good.
(8) Machine efficiency is high.
(9) Harder to learn than GPSS.

Organization of a SIMSCRIPT Program: Event routines are closed routines and some means must be provided for transferring control between them.
The transfer is affected by the use of event notices which are created when it is determined that an event is scheduled. If the event is to involve one of the temporary entities, of which these maybe many copies, the event notice will usually identify which one is involved.

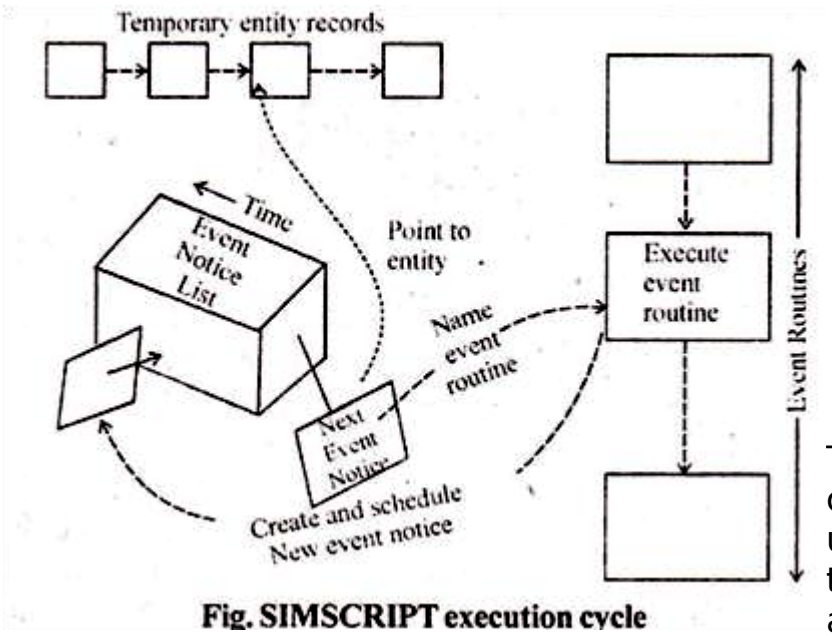
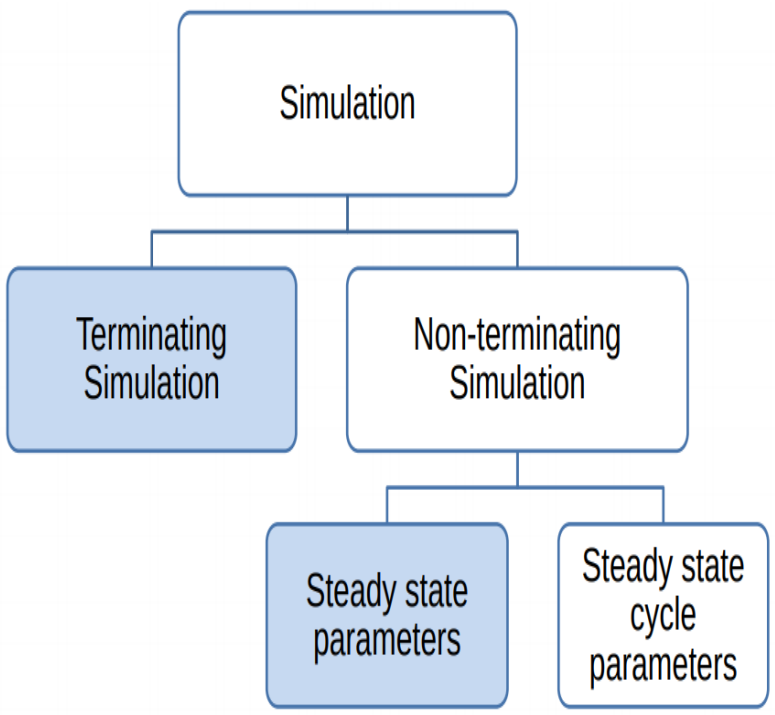


Fig. SIMSCRIPT execution cycle

The event notices are filled in chronological order. When all events that can be executed at a particular time have been processed, the clock is updated to the time to the next event notice and control is passed to the event routine identified by the notice. These actions are automatic and do not need to be programmed.

6 a) Explain the types of simulation on the basis of output. Define and explain estimation methods used in analysis of simulation output.

There are two types of simulation on the basis of output:



Terminating simulation and Non-termination simulation:

i) A terminating simulation is one that runs for some duration of time T_E, where E is a specified event or set of events which stops the simulation. Such simulation 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 initialization rule.
- The event E often occurs at a point when the system is cleaned out.
- Initial condition for a terminating simulation generally affect the desired measure of performance, these conditions should be representative of those actual system.

ii) Non-Terminating Simulation is a system that runs continuously, or at least for a very long period of time. It starts at simulation time 0
under initial conditions defined by the analyst and runs for some analyst defined period of time T_E.

A steady-state simulation is a simulation whose objective is to study long-run behavior of a non-terminating system.

After it focuses on the estimation of steady-state system parameters. The estimation techniques include the replication/deletion approach,the regenerative method, the batch means method, and the standardized time series method. Second, it reviews recent statistical procedures to find the best system among a set of competing alternatives.

6 b) Why estimation of initial bias is used in Simulation output? Explain.

Estimation of initial bias (bias means unevenness or imbalance) is used in simulation output to know what errors are causing the changes in given output. Initialization bias problem can lead to errors, particularly in steady-state output analysis.

How should the simulation be initialized? Suppose that a machine shop closes at a certain time each day, even if there are jobs waiting to be served. You have to be careful to start each day with a demand that depends on the number of jobs remaining from the previous day.

Initialization bias can lead to point estimators for steady-state parameters having high mean squared error. Since initialization bias raises important concerns, how do we detect and deal with it? In the end, the estimate can still has few % bias to the true expected value. The question becomes, how much bias is acceptable?

If initialization bias is detected, one may want to do something about it. Two simple methods for dealing with bias:

(a) Truncate the output by allowing the simulation to “warm up” before data are retained for analysis. Experimenter hopes that the remaining data are representative of the steady-state system. Output truncation is probably the most popular method for dealing with initialization bias; and all of the major simulation languages have built-in truncation functions.

(b) Make a very long run to overwhelm the initialization effects. This method of bias control is conceptually simple to carry out and may yield point estimators having lower mean squared errors than the analogous estimators from truncated data . However, a problem with this approach is that it can be wasteful with observations; for some systems, an excessive run length might be required before the initialization effects are rendered negligible.

7) Write Short on:

a) Verification and Validation of model: Verification is the process of determining whether the simulated computer program works as intended or not. It ensure that product is being build according to specified requirement and design. It ask question like “Are we building the model right?”. It is carried out by QA (Question & Answer) teams to check whether the implementation of the model is as per specification document or not. It is carried out before the validation. Reviews, meetings and inspections are involved in this process. Verification process explains whether the outputs are according to inputs or not.

Validation is the process of determining whether the conceptual model is an actual representation of actual system being analyzed. It ask question like,” Are we building right model?”. It is process of evaluating model at the end of the development process to determine whether model meets the expected requirements. Validation is carried out just after the verification. Black box testing, White box testing, etc are involved in this process. Validation process describe whether the model is accepted or not.

The verification and validation model is also called V-model.

b) Pseudo Random numbers: A pseudo random numbers are the unique random numbers generated by *pseudo-random number generator* (PRNG) which is a computer program written for, and used in, probability and statistics applications when large quantities of random digits are needed. Most of these programs produce endless strings of single-digit numbers, usually in base 10, known as the decimal system. When large samples of pseudo-random numbers are taken, each of the 10 digits in the set {0,1,2,3,4,5,6,7,8,9} occurs with equal frequency, even though they are not evenly distributed in the sequence.

c) Hybrid ~~Computers~~ Simulation: //Note: Hybrid Computer is not in our course. Hybrid Simulation is. Printing mistake

Hybrid simulation is a testing method for examining the seismic response of structures using a hybrid model comprised of both physical and numerical substructures. Because of the unique feature of the method to combine physical testing with numerical simulations, it provides an opportunity to investigate the seismic response of structures in an efficient and economically feasible manner. It is this feature of the method which made it gain widespread use in recent years. This paper presents the theory of the method including an overview of the previous research related to various aspects of the method, an overview of two hybrid simulation applications, and the future directions for transforming the method to its next generation.

2015 Spring

1 a) Define system modeling? What are the various types of system models? Explain each of them.

1 b) What is Monte Carlo method? Briefly describe its historical background. Find the value of π (pie) using Monte Carlo method.

2 a) Explain the steps of Simulation study.

2 b) What are the various component of Analog Computer? Draw the analog computer for the following function:

$$a\ddot{x} + bx - c\theta = F(t)$$

$$e\ddot{\theta} + f\theta - gx = G(t)$$

3 a) Explain telephone system simulation with busy call.

3 b) Define Linear & Non-Linear differential equation. Explain CSMP III statement with example.

4 a) Discuss the major task performed in simulation of programming.

4 b) Why random numbers are useful? Test the following random numbers for their uniformity: 0.44 0.81 0.14 0.05 0.93

5 a) Define GPSS. Explain different types of block along with their characteristics.

5 b) Explain the organization of SIMSCRIPT program with necessary diagram.

6 a) What is estimation method? Discuss the various methods of elimination of internal bias of simulation output.

6 b) How replication of run can be used in simulation output?

7) Write short notes on any two:

a) Feedback

b) Queuing System

c) Cobweb models

2013 3a) Draw the analog computer for following function:

$ax^{\cdot\cdot} + bx - c$