Biyani's Think Tank

Concept based notes

Simulation and Modeling

(BCA Part-III)

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Preface

I am glad to present this book, especially designed to serve the needs of the students. The book has been written keeping in mind the general weakness in understanding the fundamental concepts of the topics. The book is self-explanatory and adopts the “Teach Yourself” style. It is based on question-answer pattern. The language of book is quite easy and understandable based on scientific approach.

This book covers basic concepts related to the microbial understandings about diversity, structure, economic aspects, bacterial and viral reproduction etc.

Any further improvement in the contents of the book by making corrections, omission and inclusion is keen to be achieved based on suggestions from the readers for which the author shall be obliged.

I acknowledge special thanks to Mr. Rajeev Biyani, *Chairman* & Dr. Sanjay Biyani, *Director* (*Acad.*) Biyani Group of Colleges, who are the backbones and main concept provider and also have been constant source of motivation throughout this Endeavour. They played an active role in coordinating the various stages of this Endeavour and spearheaded the publishing work.

I look forward to receiving valuable suggestions from professors of various educational institutions, other faculty members and students for improvement of the quality of the book. The reader may feel free to send in their comments and suggestions to the under mentioned address.

Author

Syllabus

Defination of System : Types of system-continous and discrete; Modeling process and defination of a model; Compurter work load and preparerating of its models; Verification and validation modeling procedures;l comparing model data with real system.

Simulation Process: Use of simulation discrete and continuous simulation procedures; simulation of a time sharing computer system.

Simulation languages: A brief introduction to important discrete and continuous simulation language; Algorithm development and pseudo code writing for simulation problems. Use of database and A.I. techniques in the area of modeling and simulation.

Chapter 1

Introduction and Motivation

Q.1 What is system?

Ans. The term system is derived from the Greek word system, which means an organized relationship among fins hiring units or component. A system may be defined "as an orderly grouping of interdependent components linked together according to a plan to achieve a specific objective."

The components of a system may be simple or complex, basic or advanced, each component is a part of the total system has to do its share of work for the system to achieve the intruded goal.

Q.2 Explain various characteristics of any system?

Ans. The various characteristics of any system are described follow.

Organization:- Organization imp his starchier & order. It is the arrangement of components that helps to achieve objectives. In the design of a business system for example the hierarchical relationships starting with the president on top & boding donrcnord to the blue-collar warders represents the organization starchier. Such an arrangement partiays a system subsystem relationships defines the oimlthority stretcher specifies the formal flow of communication & formalizes the chain of command.

Interaction:- Interaction refers to the oranner in which each component functions with other components of the system. In an brgemisation, for example, purchasing must interod with production, aolrertising with soles & payroll with personal. The interrelationship between these components enables the perform effectively.

Interdependence: - Interdependence means that parts of the organization or computer system depend on are another. They are coordinated & linked together according to a plan. One subsystem depends on the input of another subsystem for proper functioning that is the output of are subsystem is the required input for another subsystem. This interdependence is crucial is system work.

<u>Integration: -</u>It refers to the holism of the systems. Synthesis follows analysis to achieve the central objective. Integration is concerned with how a system is tied together. It is more them sharing a physical part or location. It means that parts of the system work together within the system even tough each part performs a unique function. Successful integration will typically produce a synergetic effect & greater total import than if each components works separately.

<u>Central objective: -</u> The last characteristic of a system is its control objective. Objectives may be real or stated. Although a stated objective may be the real objective

it is not uncommon for an organization to state one objective & operate to achieve another. The important point is that users must know the central objective of the computer application early in the analysis of a successful design & concession.

Q.3 What is system concept?

Ans. Scholars in various disciplines who are concerned about the tendency toward the fragmentation of knowledge & the increasing complicity of phenomena have sought a unifying approach to knowledge. Ludwig von berlalanffy a biologist developed a general systems theory that applies to any arrangement of elements such as cells, people, societies or even planets. Norbert wiener a mathematician, observed that information & communications provide connecting links for unifying fragments or elements. His system concept of information theory, which shows the parolld between the functioning of human beings & electronic systems, laid the foundation for today's computer system. Herbert A Simon a political scientist related the system concept to the study of organization by uniming an ongoing system a processor of information by making decisions.
System analysis & general for information system were founded in general systems theory, which emphasizes a close look at all parts of a system. Joo often analysis focus on only are component. General system they by is concerned with den doping a systematic theoretical framework upon which to male decisions. It discourages thinking in a vacuum & encourages consideration of all the activities of the organization & its internal environment. Pioneering work in general system theory emphasized that organizations be viewed as total system. The idea of systems has become most practical & necessary in conceptualization the interrelationships & integration of operations, especially when using computers thus, a system is a may of thinking abort

organizations & their problems. It also involves a set of techniques that helps in solving problems.

Q.4 What are the types of systems?

Ans. The various types of systems are given below common classifications of systems are:

1. **Physical or ales tract.**
2. **Continuous or discrete**

1. **<u>Physical or ales tract:-</u>**

Physical systems are tangible entities that may be static or dynamic in operation. For example the physical parts of the computer centre are the offices, desks & chairs that facilitate operation of the computer. They can be seen & coinled; they are static. In contrast a programmed computer is a dynamic system. Data programs output & applications change as the users demands or the priority of the information requested changes.

Abstract systems a conceptual or non physical entities. They may be as straightforward as formulas of relationships among sets of variables or models the abstract conceptualization of physical situations. A model is a representation of a real or a planned system. The use of models makes it easier for the analyst to visualize relationship in the system under study. The objective is to point out the significant dements & the buy interrelationships of a complen system.

2. **<u>Continuous or discrete:-</u>**

Systems such as the aircraft in which the changes are predominantly smooth are called continuous systems. Systems, like the factory in which changes are predominantly discontinuous mill be called discrete systems. Few systems are wholly continuous or discrete the aircraft for example may make discrete adjustments to its trim as altitude changes while in the factory example machining proceeds continuously, even though the start & finish of a job are discrete changes. However in most systems one type of change predominates so that systems can usually be classified as being continuous or discrete.

Q.5 What is Modeling & Simulation?

Ans. Simulation in general is to pretend that one deals with real thing while really working with an imitation. In operations research the imitation is a

computer model of the simulated reality. A flight simulator on a PC is also a computer model of some aspects of the flight: it shows on the screen the controls and what to "pilot"(the youngster who operates it) is supposed to see from the "cockpit"(his armchair).

Q.6 Why to use models?

Ans. To fly a simulator is safer and cheaper than the real airplane. For precisely this reason, models are used in industry commerce and military: it is very costly, dangerous and often impossible to make experiments with real systems. Provided that models are adequate descriptions of reality (they are valid), experimenting with them can save money, suffering and even time.

Q.7 When to use simulations?

Ans. Systems that change with time, such as a gas station where cars come and go (calleddynamic systems) and involve randomness. Nobody can guess at exactly which time the next car should arrive at the station, are good candidates for simulation. Modeling complex dynamic systems theoretically need too many simplifications and the emerging models may not be therefore valid. Simulation does not require that many simplifying assumptions, making it the only tool even in absence of randomness.

Q.8 How to simulate?

Ans. Suppose we are interested in a gas station. We may describe the behavior of this system graphically be plotting the number of cars in the station; the state of the system. Every time a car arrives the graph increases by one unit while a departing car causes the graph to drop one unit. This graph (called sample path), could be obtained from observation of a real station, but could also be artificially constructed. Such artificial construction and the analysis of the resulting sample path (or more sample paths in more complex cases) consist of the simulation.

Chapter 2

System Dynamic

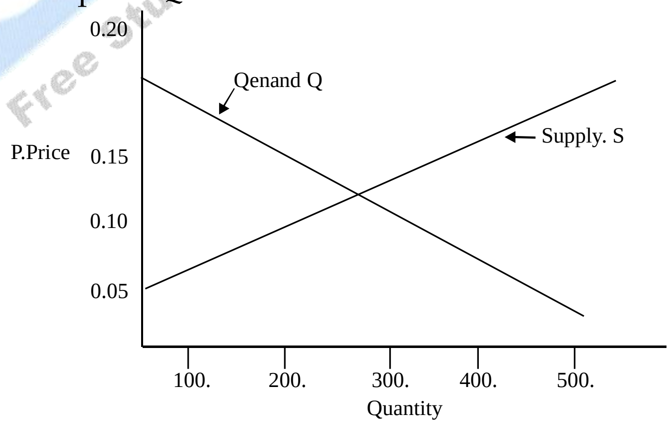
Q1 Explain static mathematical model

Ans. A static model eves the station ships between the system attributes when the system equilibrium. It the point Y equilibrium is changed by attiring any of the attribute values the model enables the new valves for all the attributes to be derived but does not show the way in which they changed to their new values. For example in marketing a commodity these is a balance between the supply and demand for the commodity. Both factors depend upon price: a simple market model will show what is the price at which the balance occurs.

Command for the commochty will be low when the price is high and it will increase as the price drops. The relationship between demand, denoted by Q, and price, denoted by P, might be represented by the strength line marked "Demand" in the following graph. On the other hand, the supply can be expected to increase as the price increases because the supplies see an opportunity for more revenue suppose supply denoted by S, is plotlrd against price and the relationship is the strength time marked "supply" in the fig. it the condition remain stable the price will settle to the point at which the two lines cross, because that is where the supply eznals the demand.

Since the relationship have been assumed linear, the complete market model can be written mathematically as follows.

Q = a-bp S = C+ap S = Q



The last equation states the condition for the market to be cleared; it says supply equals demand and so determines the price to which the market will settle. For the model to correspond to normal market condition in which demand goes down and supply increases as price goes up the coefficients b and d need to be positive numbers.

The eqnilibrivnm market price, infect is given by the following expression

$$P = \frac{a-c}{b+d}$$

More usually the demand will be represented by a curve that slopes downwards and the supply be a curve that slopes upwards, according to following figure

It may not then be possible to express the relationships by equations that can be solved. Some numeric method is then needed to solve the equations. Droving the curves to scale and determining graphically where they intersect is one such method. In practice it is difficult to get precise valves for the coefficients of the nodal observation over an extended period of time however will establish the stops(that is the valve of b and d) in the neighborhood of the equilibrium point, and of covrse actual experience will have established equilibrium prvces under various conditions. The values depend upon economic factors so that observation will usually attempt to correlate the valves with the economy allowing the model to be used as a means of forecasting changes in market conditions for anticipated economic changes.

Q.2 Explain Dynamic Mathematical model.

Ans. A dynamic mathematical model allows the changes of system attributes to be derived as a function of time. The derivation may be made with an analytical solution or with a numerical computation defending upon the complexity of the model the equation that was derived to describe the behavior of a car wheel is an example of a dynamic mathematical model in this case an equation that can be solved analytically. It is customary to white the equation in the form.

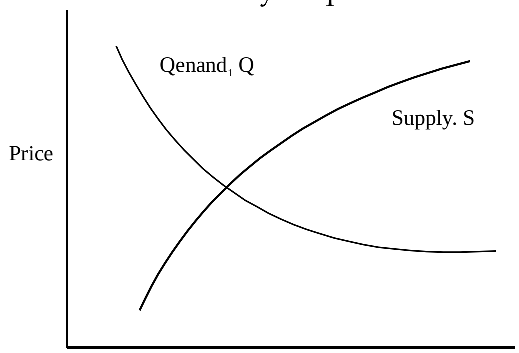
X + 2qwx + wx = wf (f) – (i)

Where

X - displacement

Expressed in the form solution can be given in terms of the variable cut following fig shows how x vales in response to a starchy force applied at time t= o as would occur for instance if a load were suddenly placed on the

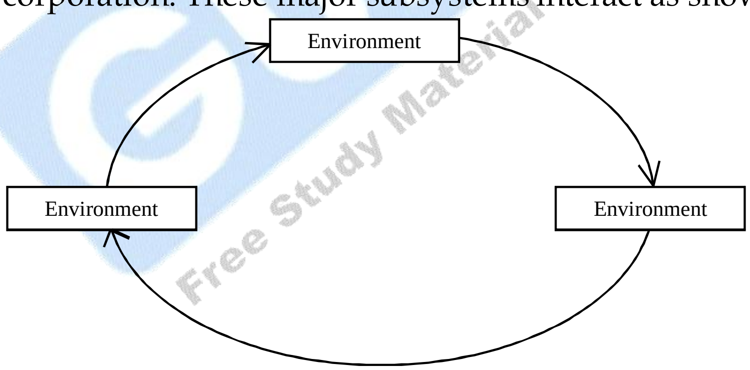
automobile. Solutions are shown for several values of g, and it can be seen that when g is less than 1 the motion is oscillatory.
The factor g is called the damping ratio and when the motion is oscillatory the frequency of oscillation is determined from the formula W = 2πF Where f is the number of cycle per second



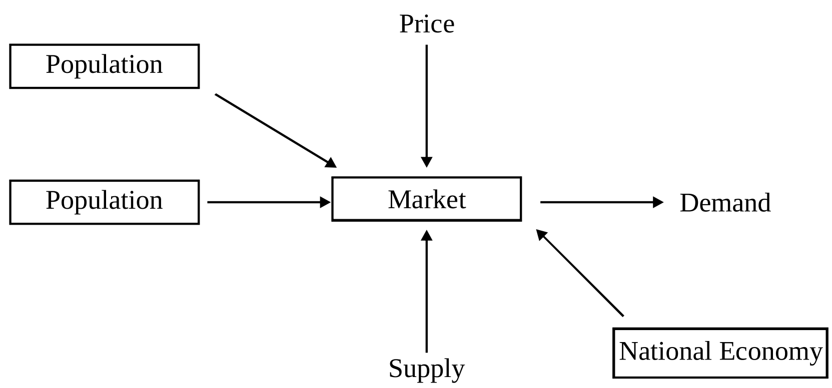
Non-linear marfal - model

Q.3 Explain corporate model

Ans. The main use of corporate model is in helping to understand what conditions will prevail under different sits of assumptions. Industry and it is planning to produce and market some new product. A first level of delovl might consider the complete model as consisting three pacts, each of a different genial natural. Corporate model tales into two major segments: The physical plant which provides the means for production: and the management segment, representing the policy – making aspects of the corporation. These major subsystems interact as shown in following figure



Environment Segment



The Environment segment

The above figure shows how the environment subsystem might be further brofan down. The major element is the market model the set of relationship that determine what the demand for the product will be. Major output of this model is "Demand". Two major inputs are the price and supply of the product. Several other factors can influence the market. The ones chosen here are the national economy the population that purchases the product and competition from other produces. The national economy affects the market by influencing the amount of money available to consumers.

Change in economic conditions would change the coefficients of that model if the national economy is to be included in the present model an output of this subsystem would be the coefficients to be used in the market model.

The obrions influence of population on the market is through knowing how many people are likely to buy the product.

An additional factor could be the distribution of the population if the model is to go as for as considering where the product distribution outlets are to be placed.

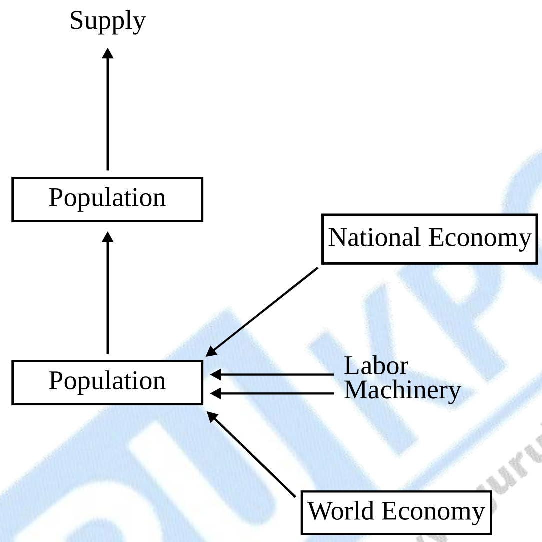
Competition from other producers or from similar products is another factor to be considered. It this is included the competition model is likely to interact with the population model.

Production segment A breakdown of the production sub-system in the

following fig. the main input is the amount of labor and machinery assigned for production.

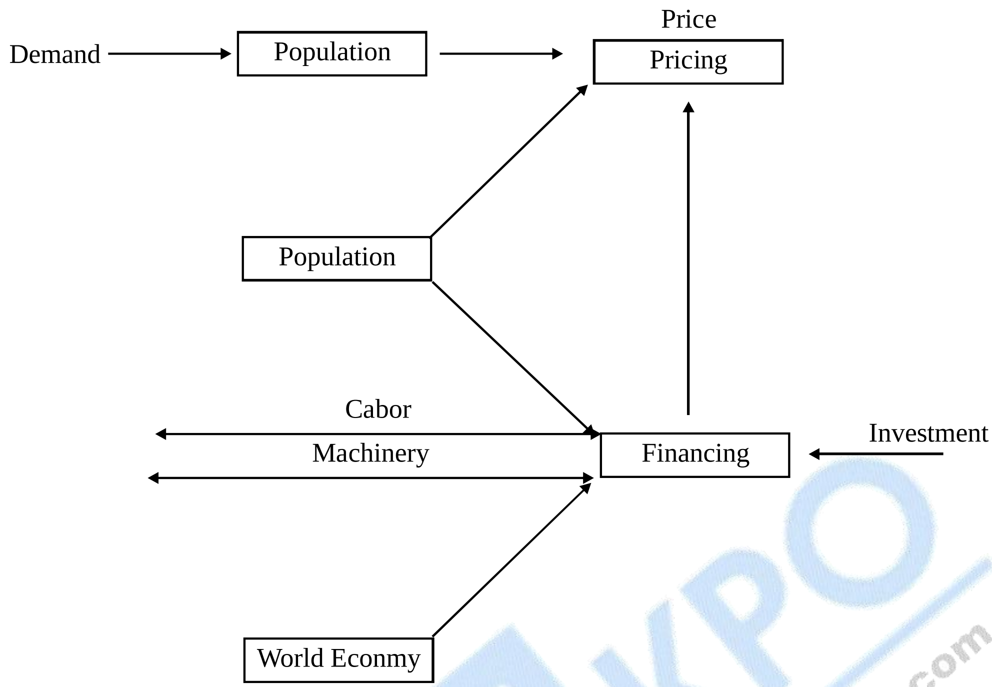
Mans output is the supply of the product. If it is dradeel to look at the market geographically then a distribution subsystem will be needed to investigate how to location of ware houses should be matched to population distribution.

Production will be inflnrvced by economic factors which might be divided into two categories. Wages effect production, through labor supply and they are an important item in any national economy model. If a national economy model is to be included therefore if will interact with the production model. The would economy might also be important if the cost of imported raw materials has to be considered or if any of the production facilities are located overseas of course if the product is sold overseas the would economy model will also interact with the market model.



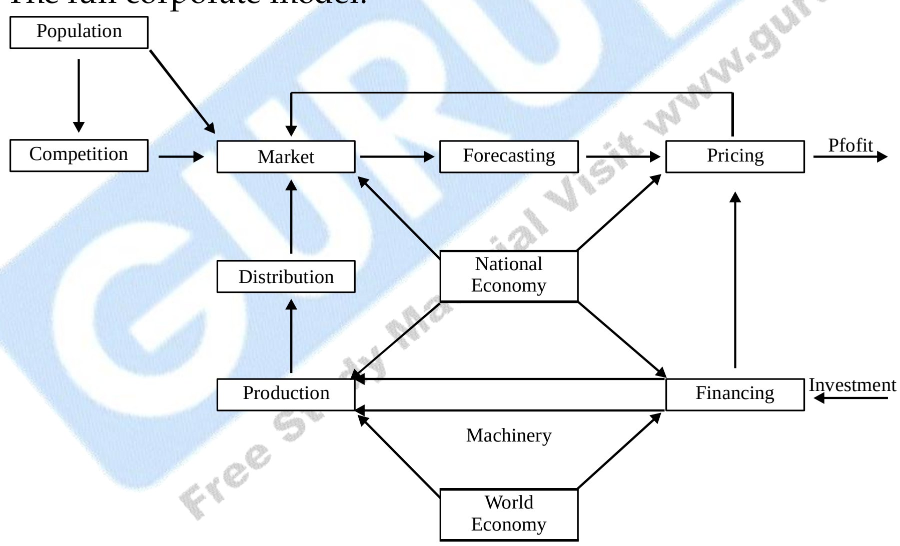
Management segment

The management subsystem, further broken down according to following figure. The main inputs are the demand for the product and capital investment to be made in the business. The main outputs all the price to be set and the profit to be expected. A pricing model sets the price and a financial model decides low the investment capital is to be divided between labor and machinery. Another activity of the management is to predict the future demand for the product. A forecasting model may be needed to refract the way the predictions are made. Both the national and the world economy conditions could influence the financial model through their effects on the money market.



The Management Segment

The full corporate model.



The full corporate Model

The full corporate model Putting together the expansion of the there segments of first fig gives the full model of above figure.

Exponential growth models :-

Growth implies a rate of change are the mathematical models describing growth involve differential equation.

For example, the growth of a capital fund that is earning compound interest. It the growth rate coefficient is K, then the rate at which the fund growth is k times the current size of the fund. Expressed mathematically where x is the current size of the fund.

X = Kx — (i)

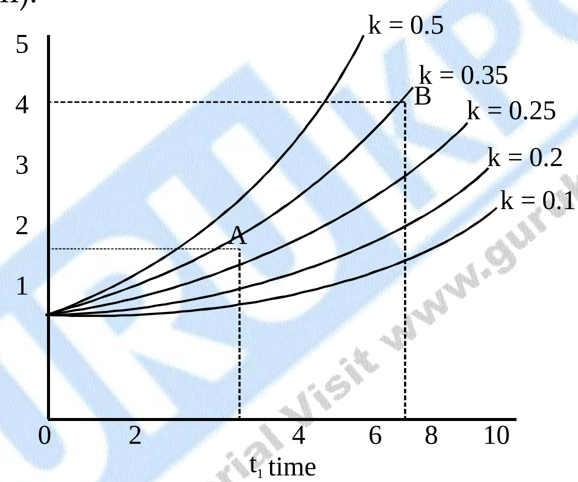
$x = x_o$ at t = 0 = Kx

log x = Kt + $logix_o$

log () = Kt

$x = x_o\ e^{kt}$ — (ii)

Equation first is a first-adve. Differential equation whose solution is the exponential function. The solution in terms of the mathematical constant e, is the equation (ii).



Above figure plats x for various valves of k and an initial value of 1. It can be seen that the fund grows indefinitely whatever valve of k is used and it grown farter with greater valves of k looking at the curve for k-0.2 and picking the pint x=2 the corresponding slope at the point a has a certain valve later at the point B where x has become twice as great as at A.

Since the slope is measured as the first order differential coefficient this fact is simply the reflection of the can defining exponential growth the growth rate is directly proportional to the current level.

Another way of describing the exponential function is to rony that the logarithm of the variable increases linearly with time to lest whether any particular set of data represents exponential growth the logarithms of the data should be plotted against time. If the data then appear to fall on a straight line, the growth is exponential and the slope of the straight line will be greater for larger growth rate coefficients.

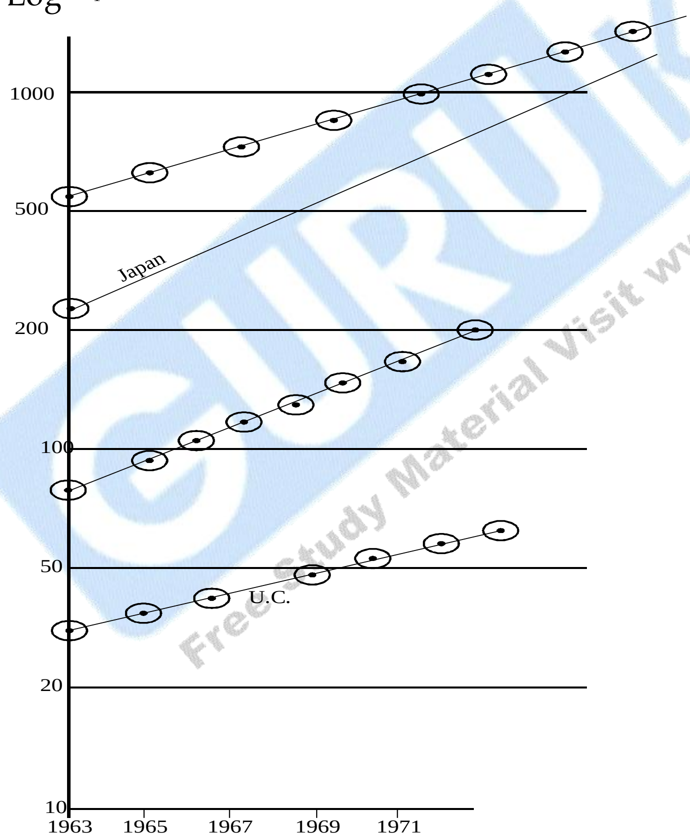
Alternatively the data can plotted on semi - logarithmic graph paper where the horizontal ones are placed at logarithmic intervals. Plotting state on such paper is equivalent to taking the logarithm of the data and then plotting on normal liner graph paper.

The following fig shows the gross national product figures for several countries plotted against year on semi-logarithmic paper. The points fall reasonable well on strength lines, indicating exponential growth rates.

The growth rate coefficient can be estimated by packing two points of the straight line that best gets the data and taking the (mafral) logarithm of the ratio of the values.

It the points are x. and t, and x2 at t2 t > t1 the result is In From which it is possible to derive K. In terms of the more familiar logarithms to base 10, the corresponding result is

$$\text{Log } \frac{x_2}{x_1} = 0.434(t_2 - t_1)K$$



Growth of Dress National Products

Sometimes the coefficient K is expressed in the form 1/T so that The solution for the exponential growth model then takes the form The constant T is said to be a time constant since it provides a measure of how rapidly the variable x groves. For example when t equals T, the variable exactly e times its initial valve xo. It T is small ray 2, x reaches this level after two times units. It T is large, say 20, x only reaches that level after 20 times units. The inverse relationship between K, the growth rate coefficient and T, the time constant, means that a large coefficient is associated with a small time constant and therefore a more rapid rate of increasing.

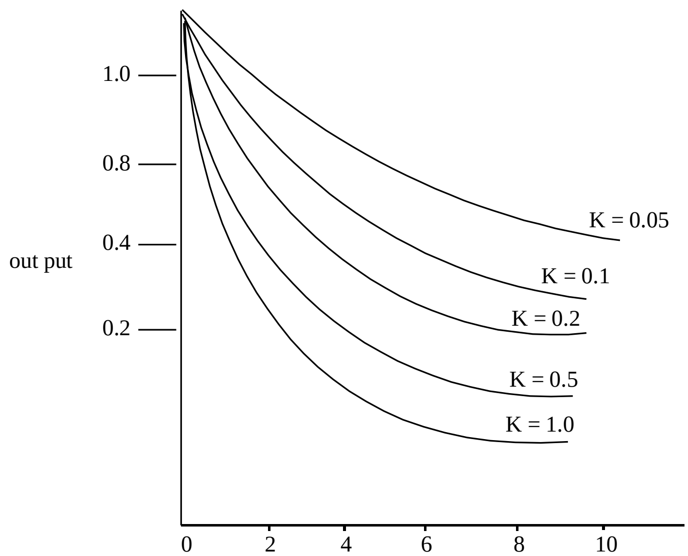
Q.4 Explain exponential decay model?

Ans. Another model closely related to the exponential growth model is a model in which a variable decays from some initial valve x0, at a rate proportional to the current valve. The model can in fact be interpreted as a negative growth model.

The equation for the model is x = - Kx X = x_0 at t = 0 The solution is x = x_0e^{-kt} The response is shown is fig following figure for various values of K. is with the exponential growth model the constant K is sometimes expressed in the form 1/T.

The characteristics of the model is that the level x is divided by a constant factor for a given interval of time. In the interval of T times units the level is divided by e. since e is approximately 2.72. the level is reduced by a factor of 0.37. Each successive interval of T reduces the level by the some factor. Again there is nothing significant about the valve e_1 but comparing valves of T for different models measures the relative times they will take to decay by a given fraction.

Example of exponential decay model is the manner is which radioactive material decays.



Q. 5 What is Discrete System Simulation?

Ans. Discrete-System Simulation:

Our discrete-system simulator (DSS) is used by INTRACOM, the largest Greek telecom company. We shall expand DSS (in connection with the DSP library) to allow for the specification, simulation and performance testing of distributed protocols for almost any form of environment, including networks with mobile units. The visualization facility of DSS will be enhanced so the user can see the protocol execution in very large networks in a meaningful way through, e.g., a hierarchical description and graph-drawing techniques. INTRACOM, and also INTRASOFT (the largest Greek software company), are interested in the new DSS and DSP library for (1) simulating and testing distributed banking applications and (2) designing hardware for fast networks (routers and switches).

The new DSS tool aims to provide:

- An abstract, clean and semantically correct high level model of any ATM network and of the on-line calls for connections.
- A library of Call Admission Control algorithms in a form that allows them to he easily used by non-experts or to be used and tested by algorithms and networks designers.
- The capability for the user Industry to design new Call Control protocols and/ or test such designs.

The ATM technology is considered as the state of the art network technology that is expected to play an important role in the future networks. The ATM networks are fast packet switching networks achieving their speed by avoiding flow control and error checking at the intermediate nodes in a transmission. ATM operates in a connected mode, but a connection can only be set up and serviced if sufficient resources are available in order to preserve the quality of service to the previous accepted connections. This function is controlled by the call Admission Control algorithms running in the ATM switches.

DSS provides an abstract model for the description of any ATM network which is independent of details of the underlying technology. It simulates the basic functionality of an ATM network which IS that in each time unit cells are produced from traffic generators or forwarded from the switches to their destination.

Under the scope of DSS an ATM network topology consists of links, ATM switches, terminals (workstation) and call/traffic generators (network applications). The critical characteristics of the topology such as the size of the buffers of the ATM switch, the bandwidth of the links, the virtual paths and virtual circuits over the links and the traffic parameters can be defined by the user to approach the behavior of the today's and the future network components. Each ATM switch is modeled as a communicating Finite State Machine. A receipt of a CAC cell combined with its current state activates an action routine of the CAC algorithm. Emphasis is given in the abstract modeling of traffic generation. Adversarial traffic leads the on-line algorithms to their worst case competitive ratio of performance (measured against ideal off-line algorithms that know the future). The DSS cannot simulate worst-case adversaries but can approximatetheir behavior by exploiting certain distribution of call request of high Kolmogorov complexity. The DSS can of course use externally (pragmatic) generate call sequences.

Q.6 What is modal Validation and Verification?

Ans. Verification and Validation

Verification & Validation is process of checking that a product, service, or system meets specifications and that it fulfils its intended purpose. These are critical components of a quality management system.

Verification:- It is a quality process that is used to evaluate whether or not a product, service, or system complies with a regulation, specification, or conditions imposed at the start of a development phase. Verification can be in development scale-up or production. This is often an internal process.

Validation:- It is the process of establishing documented evidence that provides a high degree of assurance that a product. Service, or system accomplishes its intended requirements. This often involves acceptance and suitability with external customers.

It is sometimes said that validation can be expressed by the query 'Are you building the right thing?' and verification by 'Are you building the thing right?' 'Building the right thing' refers back to the user's needs, while 'building it right' checks that the documented development process was followed. In some contexts, it is required to have written requirements for both as well as formal procedures or procedures or protocols for determining compliance.

Q.7 What are the Categories & aspects of validation?

Ans. Validation work can generally be categorized by the following functions:

- **Prospective validation –** the missions conducted before new items are released to make sure the characteristics of the interests which are functional properly and which meet the safety standards.
- **Retrospective validation –** a process for items that are already in use and distribution or production. The validation is performed against the written specifications or predetermined expectations, based upon their historical data/evidences that are documented/recorded. If any critical data is missing, then the work can not be processed or can only be completed partially. The tasks are considered necessary if
  - Prospective validation is missing, inadequate or flawed.

    The change of legislative regulations or standard affects the compliance of the items being released to the public or market.
  - Reviving of out-of-use items

    Some of the examples could be validating of the ancient scriptures that contain controversies, clinical decision rules, data systems etc.
- **Full scale validation**
- **Partial validation-** often used for research and pilot studies if time is constrained. The most important and significant effects are tested. From analytical chemistry perspective, those effects are selectivity, accuracy, repeatability, linearity and its range.
- **Re-validation/ Locational or Periodical validation –** carried out, for the item of interest that is dismissed, repaired, integrated/coupled, relocated, or after a specified time laps. Examples of this category could be relicencing/renewing driver's license, recertifying an analytical balance that has been expired or relocated, and even revalidating professionals.
- **Concurrent validation –** Conducted during a routine processing of services, manufacturing or engineering etc. Example of these could be duplicated

sample analysis, single sample analysis with multiple ended online system suitability testing.

The most tested attributes in the validation tasks may include

- Selectivity/specificity
- Accuracy
- Precision/Repeatability
- Curve fitting

Q.8 What is system Dynamics?

Ans. System Dynamics is a methodology for studying and managing complex feed back system, such as our finds in business an other social system infect if has been used to address practically every sort of feedback system. While the word "system" has been applied to all sort of situations. Fed back is the differentiating descriptor here feedback refers to the situation of x affecting y and y in true affecting x perhaps through a chain of causes and effects.
One can not study the link x and y and independently the link between y and x and predict how the system will behave only the study of the whole system as a fed back system will lead to correct results.

Q.9 What are the steps of system Olympics methodology?

Ans. Following are the steps of system dynamics methodology.

1) Identifies a problem.
2) Develops a dynamics hypothesis. Explaining the cause of the problem.
3) Builds a computer simulation model of the system at the sort of the problem.
4) Tests the model to be certain that it reproduces the behavior seen in the real world.
5) Devices and tests in the model alternative policies that alleviate the problem.
6) Implements this solution.

Q10 Role of casual loop diagrams in system dynamics?

Ans. 1) Casual loop Diagram are useful tools.

2) CL'sq help to discuss a situation. Different view points can be clarified and checked more easily.

3) The some situation can be modeled in different ways.

4) CL dk's allow a reflection of model assumptions.

5) Small differences in model might have regions consequences.

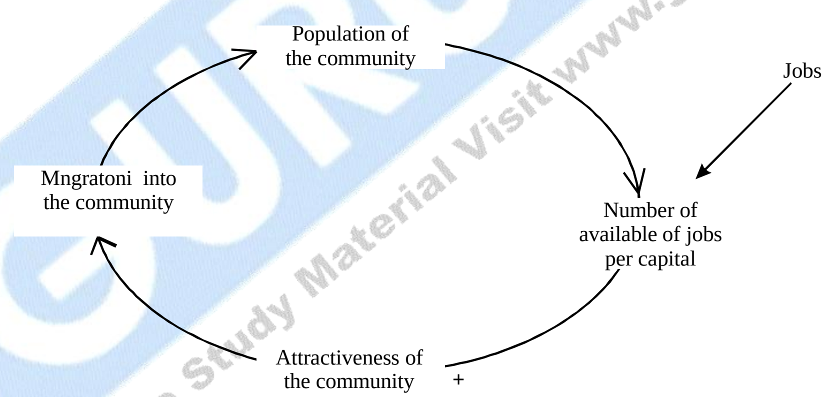
Q.11 What are positive and negative feed back loops?

Ans. Positive and negative feed back loops are the building blocks of system dynamics. While a complete specification of the feed back structure of a system requires specifying levels (states) and rates, the essential components and interactions in a system can be communicated quickly and concisely in a casual loop diagram.

Definition of positive and negative links.

The following fig use shows a possible set of casual relationship. The arrives indicate the casual direction of influences. The sign adjacent to the arrows indicate the polarity.

A plus (+) sign impulse that a change in the variable at the and of the arrow in the same direction. Similarly a minus (-) sign implies that a change in the variable at the and of the arrow will cause a change in the variable at the top of the arrow in the opposite direction.



A typical casual-loop (influence) diagram used to define & negative casual links (influences) The arrow from "attractiveness" to "migration" is cited as an example of a positive influence. "An un crease in the attractiveness of the community in creases migration into the community.

The arrow grow "population" to "Jobs avertable" per eapita" is given as an example of a negative influence.

"An increase in the community's population will cause a decrease in one no. of avertable jobs per capitr".

The definitions given in this reference in terms of changes of variables all entirely consistent with the examples given. However if the positive definition had been applied to another positive influence in the loop fig. (1), an inconsistency world have appeared. Consider the link from migration to population. The definition claims that a charge in migration will produce a change in population in the some direction, yet a decrease in migration will not produce a decrease in population in less migration become negative, drawing people of the city. As long as migration is positive it will always increase the population of the community, whether migration itself is increasing or decreasing.

Furthermore, it is not even always true that an increase in migration produces an increase in population in the previous fig.

Suppose available jobs per capita is low that the community is not attractive and people are migrating out of the city. In such a case true negative migrating is always decrease the population of the community, whether migration it self is increasing or decreasing.

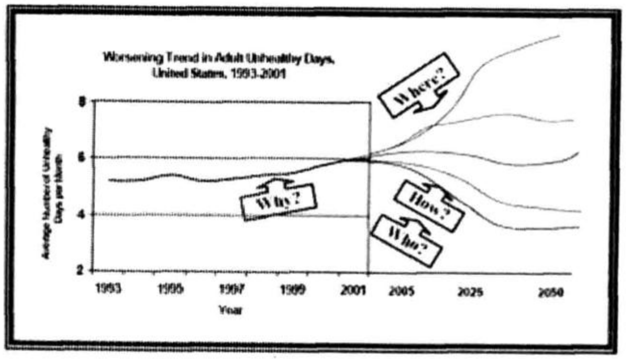
Thus it can not be said with any certainty that a change in migration in the figure will produce a change in population in same direction. Past of the problem here is that migration can be interpreted to represent a net rate, but the real difficulty is much more ubiquitous. The traditional definition of positive and negative links in casual loop fail for at least one link in most casual loop diagrams system dynamics might draw. In the simple positive loop involving population & births per year the link from births to population fails the traditional definition: a decrease in birth per year will not result in a decrease in population, since birth can only increase a population.

Q.12 What are the steps in SD Modeling?

Ans SD modeling supports a pragmatic, navigational view by pursuing four general line of inquiry.

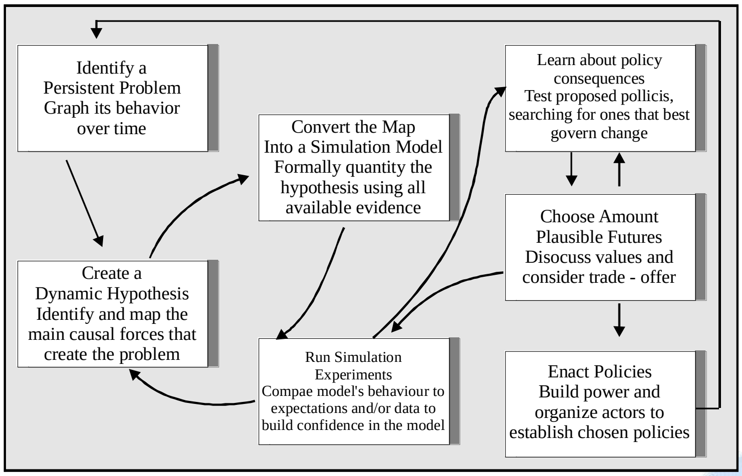
- Why are certain aspects of the system changing?
- Where is the system headed if no new action is taken?
- How else can the system behave, if different decisions are made?
- Who has the power to move the system in a safer, healthier direction?

System Dynamics Modeling Addresses Navigational Questions



To answer these questions, SD modeling proceeds iteratively through the following general steps

- Identify a persistent problem that exists, in part, because of dynamic complexity. The emphasis on dynamic complexity does not refer to problems that have many parts)ie., combinatorial complexity), but rather to problems that involve mutually reinforcing factor (e.g., behavioral feedback), accumulations over time, significant delays between actions and effects, or non-linear patterns of change(e.g., better-before- worse or vice versa);
- Develop a preliminary dynamic hypothesis (causal map) by identifying which causal forces are at work and how they relate to one another;
- convert the hypothesis into formal computer model. This is done by riting a system of differential equations, calibrating them based on available data, and noting any areas of uncertainty, which then become the focus for sensitivity analysis. In other words, uncertainty or lack of previously collected data is not a fatal flaw for SD modeling, as it can be for statistical techniques such as regression modeling or structural equation modeling.
- Use the computer model to conduct controlled simulation studies, with the goal of learning how the system behaves and how to govern its evolution over time;
- Choose among the set of plausible futures those that best reflect stakeholder values and that strike an acceptable balance among inevitable trade-offs.
- Keep repeating the process, creating better hypotheses, models, policy insights, and more effective action with each iteration. Iterative Steps in System Dynamics Modeling



Q.13 What is table function?

Ans. A table function is a function defined in the table form.You may need table function to define a complex non-linear relationship which cannot be described as a composition of standard function or to bring experimental data defined as a table function to a continuous mode.

The function works in the following way the are defines a function by giving a number of (argument valves) pairs i.e. number of base points on XY chart. A call of function with some valve passed as a function argument will return a valve of the function.

To define a table function

1. Chaises the table functions dement for the model page of the palette view.
2. Click in the graphical editor where you want to place the table function icon.
3. Go to the general page of the properties view and specify the function properties.
4. Specify the name of the function in the name edit box.
5. Define data for a table function in the table data table. Each “argument value” pair is specified I an individual low of the label. To define pair of valves go to the last row of the “Table data” table and enter the argument valve in the argument cell and the function valve in the function cell. To remove some pair of valves select the corresponding row of the table and click.
6. Specify how the table function should be interpolated using the interpolation drop-down list.

7. Specify how the table function should behave when its argument is out of large using the out of range drop-down list.

Chapter 3

Discrete System Simulation and Model Validation

Q.1 What are basic simulation terminology?

Ans.

1. **System -** A system is an organized group of entities such as people, equipment, methods and parts, which work together toward a specific objective. A simulation model characterizes a system by mathematically describing the responses that can result from the interaction of entities.

2. **System state-** A system state is a collection of variables stochastic (can change randomly) and deterministic (not influenced by probability) which contain all the information necessary to describe a system at any point of time.

3. **Static model-** A static model is one which is not influenced by time. There is no simulation dock involved. The static of the model does not change with respect to time. A simulation model that simulates the roll of a die in an example of static model. The output of the model is not affected by time.

4. **Dynamic model-** A dynamic model is representation, which is influenced by time. The static of the model evolves over simulated seconds, hours, days and months. Manufacturing and many service systems are generally modeled using a dynamic approach.

5. **Warm-up-period-** A warm up period is the amount of time that the model needs to run to remove the initialization bias before statistical data collection begins. The linger of the period is dependent upon the type of model being used. Warm up periods for steady state simulation can sound through experimentation with moving averages and other techniques.

6. Model Run- A model run mvolves operating a simulation for a specifically period of time with a unique set of random valves. The simulation run length is the amount of time simulated during the model runs.

7. Independent model replication -An independent model Replication entails operating the same model for the same period of time with one or more random seed valves. Multiple model replications are essential when analyzing results.

Q. 2 Write manufacturing Terminology?

Ans. **1.Pull system-** In a pull system everything is focused on the next stage of production and what is needed there (customer order driver). That what is needed in the next stage of production is produced.

The explanation of the name pull system is: - Row materials and parts are pulled from the back of the factory towards the front where they become finished goods. So in a full system the idel of producing are the same rate as customers are using the products is being realized.

2. Push system-

In a push system the emphasis lies on using information about customers, suppliers and production to manage material flow The name push system result from the say the system ways:- Materials and parts are made and after that they are send to the place where they are needed next (which is another stage in production or inventory), thus) the system is pushing material though production.

Q.3 What are pro model terminology?

Ans. 1.Entities - Entities are items processed through the system. They may represent parts, people, and paperwork or almost anything that require system resources. Each entity may have different graphic icons to represent it in different sates of processing or at various points in the system.

2. Locations- Locations are fixed points through which entities move. These points may be anywhere that an entity is processed. They can also be queuing areas, storage locations or conveyors. Capacity, defined as the nesebers of entities that can be at a location at one time.

3. **Processing -** Processing logic defines the operation performed and onward routing for each entity type at each location in the system.

Processing is defined for each type of quantity at each location where it either undergoes some action or simply awaits access to a subsequent location.

4. Arrivals - Arrivals are introduction of entities into the system. An arrivals location is specified as is a quantity or batch size for each entity type.

Resources- Resources are an individual person, piece of equipment or transporter that is required to perform some action, but is not a location as described above. In many cases a resource will be shared among several location and must move along a pre-determined path network.

Shifts - Shifts are schedules that may be assigned to resources and locations. Hours of work are defined graphically and any breaks I the shift can also be specified.

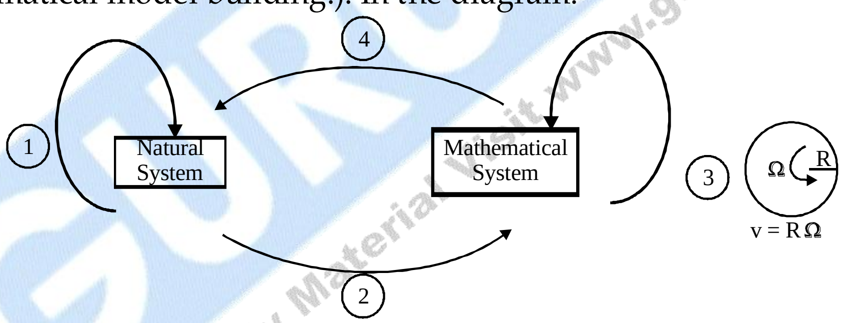
<u>Attributes-</u> Attribute is very similar to the variables but is unique to specific location or entity.
Attributes are used to capture information as an entity travels through the model.

<u>Arrays -</u> Array is a matrix of valves that may be referenced as a time saving feature is model construction.

<u>Variables -</u> The model binlder as a counter a logic switch or for any one or more additional purposes can define variables. Variables are global to the model.

Q4. What is Modeling Process?

Ans. The Modeling Process The diagram below is a schematic representation of the entire model building process. (It is itself a mathematical model of mathematical model building!). In the diagram:



1. Represents the **natural law** which actually governs the behavior of the natural system. This may be some complex combination of chemistry, biology, physics, politics, economics, etc. In general, the natural law may be quite unknowable to us.

2. Represents **formalization**, or the building of the mathematical mode. This is where the modeler must make the difficult decisions about which parts of the natural system to model closely and which parts to ignore, and then how to assemble those pieces. Deciding how to represent a natural system in mathematical terms is often the most.

   difficult part of the modeling process.

3. Represents **mathematical deduction**, where we work within the model using computations, graphing, algebra, etc. to solve a purely mathematical problem. At this stage, we are removed from the messier aspects of physical reality, working instead with mathematical representations of the essential features of the modeled system.
4. Represents **interpretation** of the deductions made within the model. If the model is a good one, then the results of the mathematical calculation should say something about the actual behavior of the natural system. If the model's predications do not match reality, then it may be necessary to refine the model and cycle through the process again.

Example: Airline Crash Investigations

Whenever a plane crashes, the Federal Aviation Administration (FAA) is responsible for carrying out an investigation to determine its cause. This usually involves building a mathematical mode. On a computer, of the airplane and the conditions under which it crashed. In terms of the modeling process outlined above:

Natural law represents the actual conditions and causes for the crash. These might be complex combinations of many different factors, such as weather, mechanical failure, or pilot error.

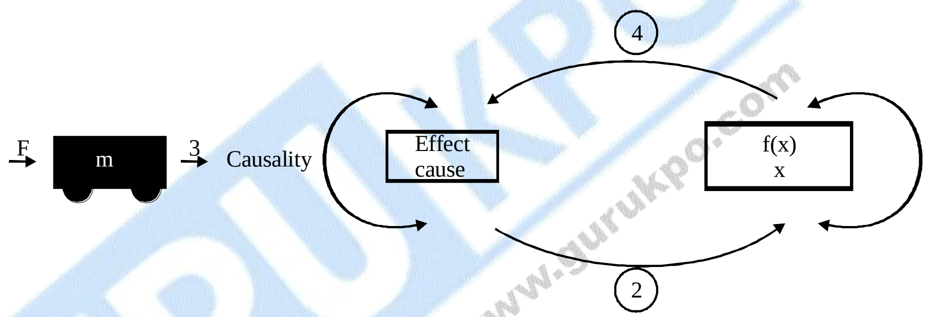
Formalization represents the choices which the computer programmers must make concerning the essential features of the aircraft and the external conditions. What mathematical objects (equations, graphs, etc.) simply and accurately describe different possible weather conditions? How should complex engine behaviors and unpredictable pilot actions be represented? Ideally, each important factor must be accounted for in the model, and so must all of their essential interactions. **Mathematical deduction** is the investigation of possible crash scenarios within the model. Once all of the various cause and effect relationships, and their various interactions, have been expressed in mathematical terms in a computer program, the program can be run-that is the mathematical computations can be carried out by the machine-under a variety of different initial conditions.

Countless model airplanes may be "crashed" in a search for a match with the known facts.

Interpretation is the part of the process that the FAA might report at a news conference. For example, if no scenario involving various pilot errors o run usual weather conditions results in a model crash at all like the actual one, then the FAA may claim that these possibilities have been ruled out, and direct their efforts to an investigation of engine failure. If, on the other hand, a model simulation of the aircraft's encounter with a windy downburst produces a close match of what was observed, then the case may be closed.

Functions as Models

1. A function can serve as a simple kind of mathematical model, or a simple piece of a larger model. Remember that a function is just a rule, f, that expresses the dependency of one variable quantity, y, on another variable quantity, x. we can think of the rule(given in our model as a graph, a formula, or a table of values) as a representation of some natural **cause and effect** relationship-if x, then y- between the two variable quantities. Schematically:



represented in the form of models. The scientific method is basically one of creating, verifying, and modifying models of the world. The goal of the scientific method is to simplify and explain the complexity and confusion of the world. The applied scientist and technologist then use the models of science to predict and control the world.

This book is about a particular set of models, called statistics, which social and behavioral scientists have found extremely useful. In fact, most of what social scientists know about the world rests on the foundations of statistical models. It is important, therefore, that social science understand both the reasoning behind the models, and their application in the world.

DEFINITION OF A MODEL

A model is a representation containing the essential structure of some object or event in the real world.

The representation may take two major forms:

1. Physical, as in a model airplane or architect's model of a buildingor

2. symbolic, as in a natural language, a computer program, or a set of mathematical equations.
In either form, certain characteristics are present by the nature of the definition of a model.

Q.5 What are the Characteristics of model?

Ans.

1. Models are necessarily incomplete.

Because it is a representation, no model includes every aspect of the real world. If it did, it would no longer be a model. In order to create a model, a scientist must first make some assumptions about the essential structure and relationships of objects and/or events in the real world. These assumptions are about what is necessary or important to explain the phenomena.
For example, a behavioral scientist might wish to model the time it takes a rat to run a maze. In creating the model the scientist might include such factors as how hungry the rat was how often the rat had previously run the maze, and the activity level of the rat during the previous day. The model-builder would also have to decide how these factors interacted when constructing the model. The scientist does not assume that only factors included in the model affect the behavior. Other factors might be the time-of-day, the experimenter who ran the rat, and the intelligence of the rat.

The scientist might assume that these are not part of the "essential structure" of the time it takes a rat to run a maze. All the factors that are not included in the model will contribute to error in the predictions of the model.

2. The model may be changed or manipulated with relative ease.

To be useful it must be easier to manipulate the model than the real world. The scientist or technician changes the model and observes the result, rather than doing a similar operation in the real world. He or she does this because it is simpler, more convenient, and/or the results might be catastrophic.

A race car designer, for example, might build a small of a new design and test the model in a wind tunnel. Depending upon the results, the designer can then modify the model and retest the design. This process is much easier than building a complete car for every new design. The usefulness of this technique, however, depends on whether the essential structure of the wind resistance of the design was captured by the wind tunnel model.

Changing symbolic models is generally much easier than changing physical models. All that is required is rewriting the model using different symbols. Determining the effects of such models is not always so easily accomplished.

In fact, much of the discipline of mathematics is concerned with the effects of symbolic manipulation.

If the race car designer was able to capture th essential structure of the wind resistance of the design with a mathematical model or computer program, he or she would not have to build a physical model every time a new design was to be taste. All that would be required would be the substitution of different numbers or symbols into the mathematical model or computer program. As before, to be useful the model must capture the essential structure of the wind resistance.

The values, which may be changed in a model to create different models, are called parameters. In physical coddles, parameters are physical things. In the race car example, the designer might vary the length, degree of curvature, or weight distribution of the model. In symbolic models parameters are represented by symbols. For example, in mathematical models parameters are most often represented by variables. Changes in the numbers assigned to the variables change the model.

Q.6 Compare Modal Data with the real System.

Ans. The scientific method is a procedure for the construction and verification of models. After a problem is formulated, the process consists of four stages.

1. **<u>Simplification/Idealization.</u>** As mentioned previously, a model contains the essential structure of objects or events. The first stage identifies the relevant features of the real world.

2. **<u>Representation/Measurement.</u>**

   The symbols in a formal language are given meaning as objects, events or relationships in the real world. This is the process used in translating "word problems" to algebraic expressions in high school algebra. This process is called representation of the world. In statistics, the symbols of algebra (numbers) are given meaning in a process called measurement.

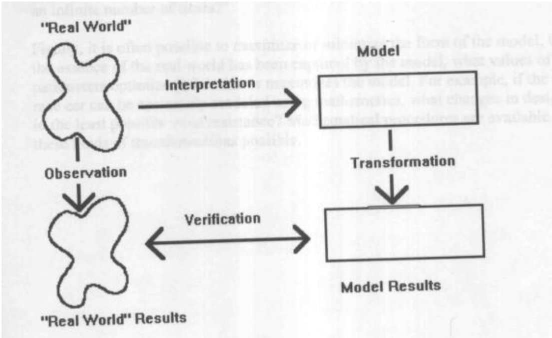
3. **<u>Manipulation/Transformation.</u>**

   Sentences in the language are transformed into other statements in the language. In this manner implications of the model are derived.

4. **<u>Verification.</u>**

   Selected implications derived in the previous stage are compared with experiments or observations in the real world. Because of the idealization and simplification of the model-building process, no models can ever be in perfect agreement with the real world. In all cases, the important question is not whether the model is true, but whether the model was adequate for the purpose at hand. Model-building in science is a continuing process. New and moiré powerful models replace less powerful models, with "truth" being a closer approximation to the real world.

These four stages and their relation ship to one another are illustrated below.



ADEQUACY AND GOODNESS OF MODELS

In general, the greater the number of simplifying assumptions made about the essential structure of the real world, the simpler the model. The goal of the scientist is to create simple models that have a great deal of explanatory power. Such models are called parsimonious models. In most cases, however, simple yet powerful models are not available to the social scientist. A trade-off occurs between the power of the model and the number of simplifying assumptions made about the world. A social or behavioral scientist must decide at what point the gain in the explanatory power of the model no longer warrants the additional complexity of the model.

MATHEMATICAL MODELS

The power of the mathematical model is derived from a number of sources. First, the language has been used extensively in the past and many models exist as examples. Some very general models exist which may describe ea large number of real world situations. In statistics, for example, the normal curve and the general linear model often serve the social scientist in many different situations. Second, many transformations are available in the language of mathematics.

Third, mathematics permits thoughts which are not easily expressed in other languages. For example, "what if I could travel approaching the speed of light?" or "What if I could flip this coin an infinite number of times?" in statistics these "what if" questions often take the form of questions like "What would happen if took an infinite number of infinitely precise measurements?" or "What would happen if I repeated this experiment an infinite number of times?"

Finally, it is often possible to maximize or minimize the form of the model. Given that the essence of the real world has been captured by the model, for example, if the design of a race car can be accurately modeled using mathematics, what changes in design will result in the least possible wind resistance? Mathematical procedures are available which make these kinds of transformations possible.

Q.7 Write a note an Discrete simulation languages.

Ans. A number of programming languages have been produced to simpligy the taste of writing discrete system simulation programs.

Essentially these programs embody a language with which to describe the system and a programming system that will establish a system image and exente a simulation algorithm. Each language is bard upon a set of concepts used for describing the system. The term world view has come to be used to describe this aspect of simulation programs. The user of program must learn the world view of the particular language he is using and be able to describe the system in those terms. Give such a description. The simulation programming system is able to establish a data structure that form the system image. It will also comate and sometimes supply routines to represent the activities poutiness supply routines to represent the activities poutiness are supplied to carry out such functions as scanning events, updating the clock gathering statistics and maintaining events in the time and priority sequence. These are heeded to effect the simulation algorithm. Most programs also provide a report generation. There is however a great variety in both the world varies of the languages and the degree to which the programming system return the user of programming details.

It is not feasible to discuss all the simulation language that are available instead the discussion will be limited to two languages. GPSS and SIMSCRIPT.

The reasons for choosing these two specific languages are that they are among the most widely used languages, and they illustrate the divergence in design consideration

GPSS has been written specifically fore users with little or no programming experience while SMSCRIPT, along with many other simulation languages, requires programming skill to the level where the user is able to program in FORTRAN or ALGOL.

The simplification of GPSS result in some loss of flexibility so that while SIMSCRIPT requires more programming skills it is capable to representing more complex data structures and can execute more complex decision rules. Both GPSS and SIMSCRIPT appear to be general enough to be equally applicable to a wide variety of system. The differences are summed up by saying that the greater programming flexibility of SIMSCRIPT means that in more complex models SIMSCRIPT is able to produce a more compact model that requires less storage space and generally sill be executed more rapidly.

Q.8 What is Model? Explain all the types of Models.

Sol. A model is the body of information about a system gathered for the purpose of studying the system. Since the purpose of the study will determine the nature of the information that is gathered, there is no unique model of a system. Different models of the same system will be produced by different analysts interested in different aspect of the system or by the same analyst as his undertaking of the system changes.

Types of Models: Models used in system studies have been classified in many ways as follows:

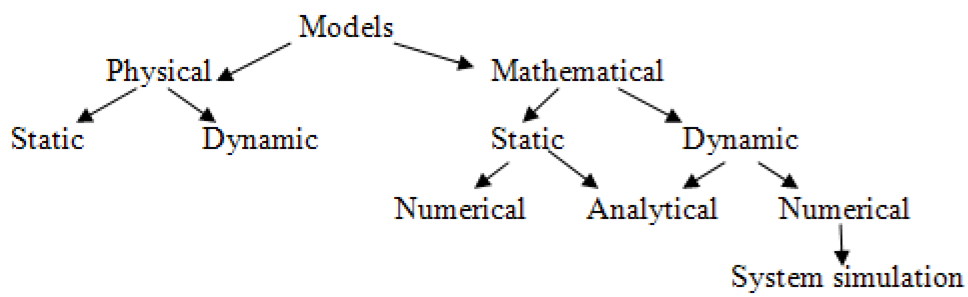


Fig. : Types of Model

The classifications that will be used here are illustrated as:

1. Physical and Mathematical model.
2. Static and Dynamic Model.
3. Analytical and Numerical Model.

(1) Physical and Mathematical Model:

First of all, models are separated into physical models or mathematical models. Physical models are based on some analogy between such systems as mechanical and electrical or electrical and hydraulic. In a physical model of a system, the system attributes are represented by such measurements as a voltage or the position of a shaft. The system activities are reflected in the physical laws that derive the model like voltage, ampere, torque, length, width, height etc.

Mathematical models, on the other hand uses symbolic notation and mathematical equations to represent a system. The system attributes are represented by variables and the activities are represented by mathematical functions that inter-relate the variables.

(2) Static and Dynamic Model :

Static models can only show the values that system attributes taken when the system is in balance and does not change with environment.

Dynamic models, on the other hand, follow the changes over time that result from the system activities and changes when there is change in environment.

(3) **Analytical and Numerical Model** :

In case of mathematical models, a third distinction is the technique by which the model is "solved', that is, actual values are assigned to system attributes. A distinction is made between analytical and numerical methods.

Applying analytical techniques means using the deductive reasoning of mathematical theory to solve a model in practice, only certain forms of equations can be solved. Using analytical technique, therefore, is a matter of finding the model that can be solved and best fits the system being studied.

For example, linear differential equations can be solved. Knowing this, an engineer who restricts the description of a system so that form will derive a model that can be solved analytically.

Numerical models involve applying computational procedures to solve equations. Any assignment of numerical values that uses mathematical tables involves numerical method, since tables are derived numerically.

Static Physical Model: A static physical model is used as a means of solving equations with particular boundary conditions. In static physical models the measurements that are taken to represent attributes of the system being studied under one set of equilibrium conditions. In this case, the measurements do not translate directly into system attribute values. Well known laws of similitude are used to convert measurements on the scale model to the values that would occur in the real system. For example, A model of a DNA molecule.

Dynamic Physical Model: Dynamic physical model depends upon an similarity between the system being studied and some other system of a different nature, the analogy usually depends upon an underlying similarity in the forces governing the behavior of the systems.

X is the distance moved.

M is the mass.

K is the stiffness of the string.

D is the damping factor of the shock absorber

The mechanical system and the electrical system are analogy of each other, and the performance of either can be studied with the other. In practice, it is simpler to modify the electrical system than to change the mechanical system, so it is more likely that the electrical system will have been built to study the mechanical system.

Static Mathematical Models: A static model gives the relationship between the system attributes when the system is in equilibrium. The point of equilibrium is changed by altering any of the attribute values; the model enables the new values for all the attributes to be derived but does not show the way in which they changed to their new values. For example, in marketing a commodity there is a balance between the supply and demand for the commodity. Both factors depend upon price: a simple market model will show what the price at which the balance occurs is S = Q. The relationship between demand, denoted by Q, and price, denoted by P, might be represented by the straight line marked "Demand" in the following figure:

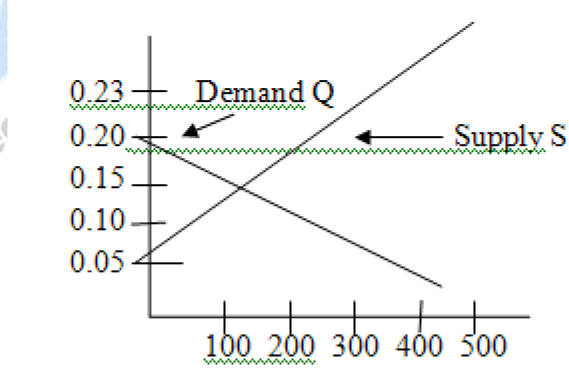


Fig.: Linear market model

Dynamic Mathematical Model: A dynamic mathematical model allows the changes of system attributes to be derived as a function of time. The

derivation may be made with an analytical solution or with a numerical computation, depending upon the complexity of the model.
The equation that was derived to describe the behavior of a car wheel is an example of a dynamic mathematical model.

Q9 What is time Management? What is Methods of Time Management?

Ans **Time management** is the act or process of planning and exercising conscious control over the amount of time spent on specific activities, especially to increase effectiveness, efficiency or productivity. Time management may be aided by a range of skills, tools, and techniques used to manage time when accomplishing specific tasks, projects and goals complying with a due date. This set encompasses a wide scope of activities, and these include planning, allocating, setting goals, delegation, analysis of time spent, monitoring, organizing, scheduling, and prioritizing. Initially, time management referred to just business or work activities, but eventually the term broadened to include personal activities as well. A time management system is a designed combination of processes, tools, techniques, and methods. Usually time management is a necessity in any project development as it determines the project completion time and scope.

Methods of Time Management

• **Weekly Planner**

- Method that provides a visual display of your optimal studying times each week.
- The planner is used to fill-in your schedule for the week.
- You schedule your fixed weekly commitments, your commitments for the particular week, and your social activities.
- Most importantly, you schedule study/HW time (being specific about when and what you will study).
- An accompanying assignment planner can help you keep track of specific upcoming assignments so that you know what assignments to do during your available study time.
- Template of the weekly planner and assignment planner is located at: http://www.lehigh.edu/~inacsup/cas/studyskills.html

- **Academic Yearly Planner**
  - Method to keep track of homework assignments, due dates, and upcoming exams.
  - As soon as you get the syllabus for each class, record major academic events throughout the semester such as test dates and paper due dates.
  - Record each week's homework and reading assignments.
  - You can also schedule non-academic events such as athletic practices, vacations, and social activities.

- **Monthly Calendar**
  - Similar to the academic yearly planner, this method enables you to keep track of homework assignments, due dates, and upcoming exams.
  - However, this method provides a broader perspective by allowing you to see the approaching events and commitments of the month on one page.
  - Especially helpful to those students who have difficulties remembering long-term assignments until they are just around the corner.

- **To Do Lists**
  - Method to keep track of what needs to be done during a particular day.
  - Write your to-do list the night before or first thing in the morning.
  - Review your to-do list and decide on the priority of each task (ex. ABC rating scale).
  - Always start by doing your most urgent tasks first.
  - Once you complete a task, cross it off your list and enjoy your accomplishment.
  - Carry over any tasks that remain incomplete to the next day's to-do list and prioritize.
  - Additionally, these methods can be used in combination to provide you even more assistance with time management.
  - There may be other methods of time management that will prove most effective for you. The goal is to find a method that allows you to organize your life and finish everything that needs to be done in a timely and efficient manner.

- **If you need any assistance with time management, please feel free to make an appointment with the study skills consultant in the Center for Academic Success**

Object Generation

Our vision is to simplify software development with object oriented methods and tools.

Some keys to success in software projects are good communication, systematic testing, reduced complexity and iterative development. We use object oriented methods to achieve these goals.

Development Tools

Tool support is necessary to use object oriented design throughout development and not just as a paper exercise that is forgotten once the coding starts.

We are developing an Eclipse plugin called HiberObjects. This plugin makes it easy to design classes and unit tests for Hibernate and JPA. HiberObjects is free and open source.

There is a commercial extension HiberObjects Import DB Pro to reverse engineer existing databases into HiberObjects.

We have another product DB Importer to reverse engineer existing databases and generate JPA code without UML.

Consulting

Object Generation AB is located in Uppsala, Sweden. We provide consulting services in Scandinavia within object oriented methods and Java development. Our specialties are UML, Eclipse plugins, Hibernate, GWT and Groovy/Grails.

Q10 What is Event?explain Event synchronization component.

Ans In computer science, an **event** (also called **event semaphore**) is a type of synchronization mechanism that is used to indicate to waiting processes when a particular condition has become true.

An event is an abstract data type with a boolean state and the following operations:

- **wait** - when executed, causes the executing process to suspend until the event's state is set to true. If the state is already set to true has no effect.
- **set** - sets the event's state to true, release all waiting processes.
- **clear** - sets the event's state to false.

Different implementations of events may provide different subsets of these possible operations; for example, the implementation provided by Microsoft Windows provides the operations **wait** (WaitForObject and related functions), **set** (SetEvent), and **clear** (ResetEvent). An option that may be specified during creation of the event object changes the behaviour of SetEvent so that only a single process is released and the state is automatically returned to false after that process is released.

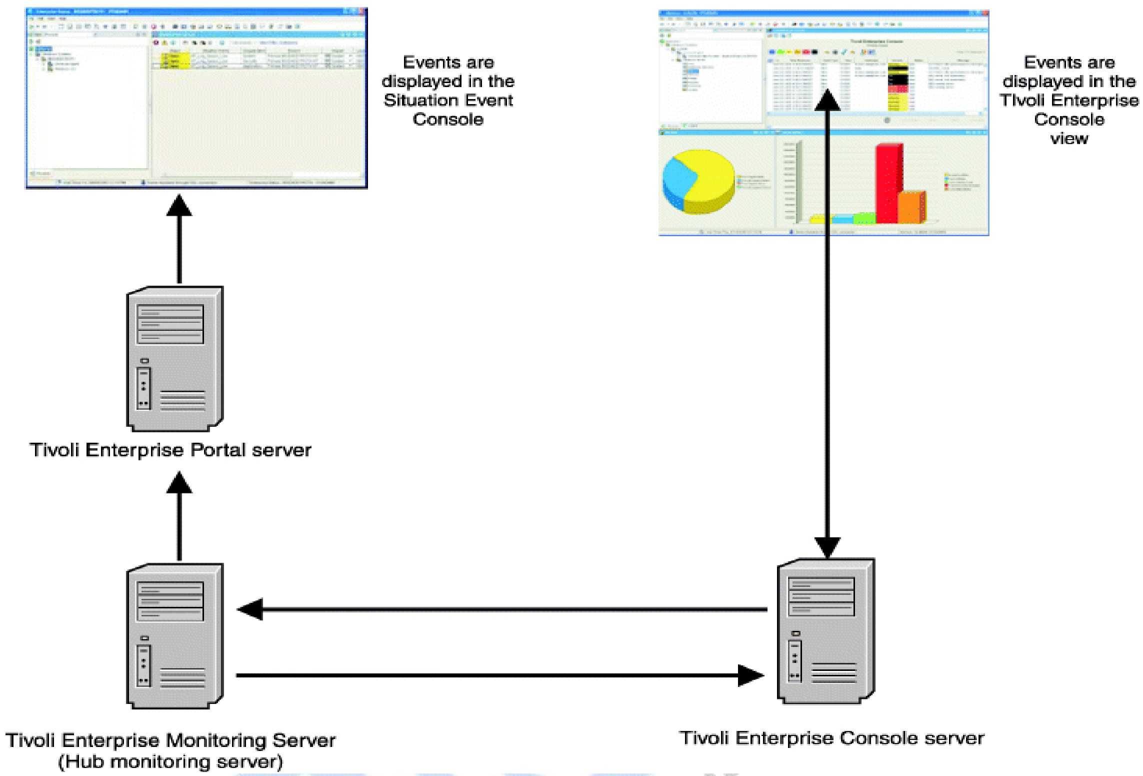
Events are similar in principle to the *condition variables* used in monitors, although the precise mechanism of use is somewhat different.

Event synchronization component

The event synchronization component, the Event Integration Facility or EIF, sends updates to situation events that are forwarded to a Tivoli Enterprise Console event server or a Netcool/OMNIbus Object Server back to the monitoring server. Figure shows the flow of situation events from the monitoring server to the event server as EIF events and the flow of updates to the situation events back to the monitoring server. The Situation Event Console, the Common Event Console, and the Tivoli Enterprise Console event views are synchronized with the updated status of the events.

If you are monitoring event data from a supported event management system in the Tivoli Enterprise Console event view or the Common Event Console view, you can filter out forwarded events.

Figure . Event synchronization overview



For information about the various configurations of monitoring servers and event servers that you can have in your environment, see Integrating event management systems.

Q11 What is Queue management? Describe the types?

Ans- A queue management system is used to control queues. Queues of people form in various situations and locations in a queue area. The process of queue formation and propagation is defined as queuing theory. Queues exist in two main forms:

Types of queue

Structured queues

Here people form a queue in a fixed, predictable position, such as at supermarket checkouts, some other retail locations such as banks, airport security and so on.

Very often, queue management systems are set up to manage ticket ranking for a service (with or without a numbered ticket) with identification and thus enable a serene and stress-free waiting (without to wait in a queue, one behind the other.

Extending the different possibilities, planned reception by appointment and remotely rank allocation on Smartphone or through SMS can also be included.

Unstructured queues

Where people form a queue in unpredictable and varying locations and directions. This is often the case in some forms of retail, taxi queues, ATMSs and at periods of high demand in many situations.

Nevertheless organizational systems exist to manage these cases: rank allocation for a service / need / salesperson, pagers or 2D or RFID badges or simply by reading the customer card. Although many have tried to implement a way of structuring these queues, no one has successfully implemented a management system that works. In fact Doctor P.H. Martin from Stanford once quoted that "Queue management is a hopeless endeavour. One cannot calculate the structure of man."

Queue measurement and management techniques
Various queue measurement and management techniques exist:

Physical barrier
They aimed at guiding queue formation and organising it in the most efficient way.

Signage and signalling systems
These aim to provide information to people queuing to aid efficient queue formation and flow, as well as setting service expectations.

Automatic queue measurement systems
These use a variety of measurement technologies which predict and measure queue lengths and waiting times and provide management information to help service levels and resource deployment.

Q12 What is LIST PROCESSING IN SIMULATION?explain it.

Ans Most simulations involve *lists*

Queues, event list, others

A list is composed of *records*

Record: Usually corresponds to an object in the list

By convention, a record is represented as a row in a two-dimensional array (matrix) representing the list

A person in a queue list, an event in the event list

A record is composed of one or more *attributes*

Attribute: A data field of each record

By convention, attributes are in columns

Examples of records (lines) of attributes (columns):

Queue list: [time of arrival, customer type, service requirement, priority, …]

Event list: [event time, event type, possibly other attributes of the event]

1 Approaches to Storing Lists in a Computer

Sequential allocation – approach used in Chap. 1

Records are in physically adjacent storage locations in the list, one record after another

Logical position = physical position

Linked allocation

Logical location need not be the same as physical location

Each record contains its usual attributes, plus *pointers* (or *links*)

Successor link (or *front pointer*) – physical location (row number) of the record that's logically next in the list

Predecessor link (or *back pointer*) – physical location of the record that's logically before this one in the list

Each list has head pointer, tail pointer giving physical location of (logically) first and last records

Advantages of linked over sequential allocation

Adding, deleting, inserting, moving records involves far fewer operations, so is much faster … critical for event-list management

Sequential allocation – have to move records around physically, copying all the attributes

Linked allocation – just readjust a few pointers, leave the record and attribute data physically where they are

Reduce memory requirements without increasing chance of list overflow

Multiple lists can occupy the same physical storage area … can grow and shrink more flexibly than if they have their own storage area

Provides a general modeling framework for list processing, which composes a lot of the modeling, computing in many simulations

2 Linked Storage Allocation

Will treat *doubly*-linked lists (could define *singly*-linked)

Physical storage area for all lists (max of, say, 25 lists)

Array with (say) 15 rows, 4 columns for attributes, a column for back pointers, a column for forward pointers

Also need array with 25 rows, 2 columns for head and tail pointers of each list

Physical row	Backward pointer	$attrib_1$	$attrib_2$	$attrib_3$	$attrib_4$	Forward pointer
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						

Head and tail pointers:

List number	Head pointer	Tail pointer
1		
2		
3		
. . .	. . .	. . .
24		
25		

Example: Two queues (FIFO, Shortest-Job-First), event list (see text for different examples)

FIFO queue: $attrib_1$ = time of arrival

SJF queue: $attrib_1$ = time of arrival, $attrib_2$ = service requirement; insert new records (customers) to keep list ranked in increasing order on $attrib_2$; remove next customer to serve off top of list

Event list: $attrib_1$ = (future) event time, $attrib_2$ = event type.

Q13 What is simulation model?explain usage.

Ans A **simulation model** is a mathematical model of a system or process that includes key inputs which affect it and the corresponding outputs that are affected by it. If the model explicitly includes uncertainty, we refer to it as a Monte Carlo simulation model. For example, it can calculate the impact of uncertain inputs and decisions we make on outcomes that we care about, such as profit and loss, investment returns, environmental consequences, and the like. Such a model can be created by writing code in a programming language, statements in a simulation modeling language, or formulas in a Microsoft Excel spreadsheet. Regardless of how it is expressed, a simulation model will include:

- **Model *inputs*** that are uncertain numbers -- we'll call these uncertain variables
- Intermediate calculations as required
- **Model *outputs*** that depend on the inputs -- we'll call these uncertain functions

It's essential to realize that model *outputs* that depend on uncertain *inputs* are uncertain themselves -- hence we talk about **uncertain variables** and **uncertain functions**. When we perform a simulation with this model, we will test many different numeric values for the uncertain variables, and we'll obtain many different numeric values for the uncertain functions. We'll use **statistics** to analyze and summarize all the values for the uncertain functions (and, if we wish, the uncertain variables).

Simulation modeling is the process of creating and analyzing a digital prototype of a physical model to predict its performance in the real world. Simulation modeling is used to help designers and engineers understand whether, under what conditions, and in which ways a part could fail and what loads it can withstand. Simulation modeling can also help predict fluid flow and heat transfer patterns.

Uses of Simulation Modeling

Simulation modeling allows designers and engineers to avoid repeated building of multiple physical prototypes to analyze designs for new or existing parts. Before creating the physical prototype, users can virtually investigate many digital prototypes. Using the technique, they can:

- Optimize geometry for weight and strength
- Select materials that meet weight, strength, and budget requirements
- Simulate part failure and identify the loading conditions that cause them
- Assess extreme environmental conditions or loads not easily tested on physical prototypes, such as earthquake shock load
- Verify hand calculations
- Validate the likely safety and survival of a physical prototype before testing

Typical Simulation Modeling Workflow

Simulation modeling follows a process much like this:

1. Use a 2D or 3D CAD tool to develop a virtual model, also known as a digital prototype, to represent a design.
2. Generate a 2D or 3D mesh for analysis calculations. Automatic algorithms can create finite element meshes, or users can create structured meshes to maintain control over element quality.
3. Define finite element analysis data (loads, constraints, or materials) based on analysis type (thermal, structural, or fluid). Apply boundary conditions to the model to represent how the part will be restrained during use.
4. Perform finite element analysis, review results, and make engineering judgments based on results.

Chapter 4

Design of simulation experiments and Output Analysis

Q1 What is Randomized Block Design ?

Ans In the statistical theory of the design of experiments, blocking is the arranging of experimental units in groups (blocks) that are similar to one another. Typically, a blocking factor is a source of variability that is not of primary interest to the experimenter. An example of a blocking factor might be the sex of a patient; by blocking on sex, this source of variability is controlled for, thus leading to greater accuracy.

- Suppose a researcher is interested in how several treatments affect a continuous response variable (Y).
- The treatments may be the levels of a single factor or they may be the combinations of levels of several factors.
- Suppose we have available to us a total of $N = nt$ experimental units to which we are going to apply the different treatments.

The ***Completely Randomized (CR) design*** randomly divides the experimental units into t groups of size n and randomly assigns a treatment to each group.

The Randomized Block Design

- divides the group of experimental units into n homogeneous groups of size t.
- These homogeneous groups are called blocks.
- The treatments are then randomly assigned to the experimental units in each block - one treatment to a unit in each block.

Example 1:

- The following experiment is interested in comparing the effect four different chemicals (A, B, C and D) in producing water resistance (y) in textiles.

- A strip of material, randomly selected from each bolt, is cut into four pieces (samples) the pieces are randomly assigned to receive one of the four chemical treatments.
- This process is replicated three times producing a Randomized Block (RB) design.
- Moisture resistance (y) were measured for each of the samples. (Low readings indicate low moisture penetration).
- The data is given in the diagram and table on the next slide.

Diagram: Blocks (Bolt Samples)

9.9	C	13.4	D	12.7	B
10.1	A	12.9	B	12.9	D
11.4	B	12.2	A	11.4	C
12.1	D	12.3	C	11.9	A

Table

Blocks (Bolt Samples)

Chemical	1	2	3
A	10.1	12.2	11.9
B	11.4	12.9	12.7
C	9.9	12.3	11.4
D	12.1	13.4	12.9

Q2 What is Factorial Designs ?and give the example.

Ans In statistics, a full factorial experiment is an experiment whose design consists of two or more factors, each with discrete possible values or "levels", and whose experimental units take on all possible combinations of these levels across all such factors. A full factorial design may also be called a fully crossed design. Such an experiment allows studying the effect of each factor on the response variable, as well as the effects of interactions between factors on the response variable.

For the vast majority of factorial experiments, each factor has only two levels. For example, with two factors each taking two levels, a factorial experiment would have four treatment combinations in total, and is usually called a 2×2 *factorial design*.

If the number of combinations in a full factorial design is too high to be logistically feasible, a fractional factorial design may be done, in which some of the possible combinations (usually at least half) are omitted.

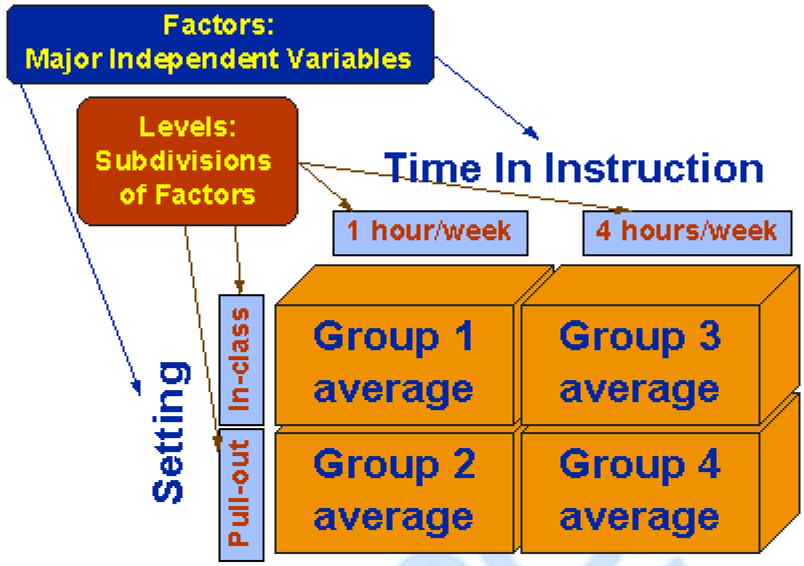
- Intervention studies with 2 or more categorical explanatory variables leading to a numerical outcome variable are called Factorial Designs.
- A factor is simply a categorical variable with two or more values, referred to as levels.
- A study in which there are 3 factors with 2 levels is called a 2^3 factorial Design.
- If BLOCKING has been used it is counted as one of the factors.
- Blocking helps to improve precision by raising homogeneity of response among the subjects comprising the block..

Advantages of factorial Designs are:

- A greater precision can be obtained in estimating the overall main factor effects.
- Interaction between different factors can be explored.
- Additional factors can help to extend validity of conclusions derived.

A Simple Example

Probably the easiest way to begin understanding factorial designs is by looking at an example. Let's imagine a design where we have an educational program where we would like to look at a variety of program variations to



see which works best. For instance, we would like to vary the amount of time the children receive instruction with one group getting 1 hour of instruction per week and another getting 4 hours per week. And, we'd like to vary the setting with one group getting the instruction in-class (probably pulled off into a corner of the classroom) and the other group being pulled-out of the classroom for instruction in another room. We could think about having four separate groups to do this, but when we are varying the amount of time in instruction, what setting would we use: in-class or pull-out? And, when we were studying setting, what amount of instruction time would we use: 1 hour, 4 hours, or something else?

With factorial designs, we don't have to compromise when answering these questions. We can have it both ways if we cross each of our two time in instruction conditions with each of our two settings. Let's begin by doing some defining of terms. In factorial designs, a **factor** is a major independent variable. In this example we have two factors: time in instruction and setting. A **level** is a subdivision of a factor. In this example, time in instruction has two levels and setting has two levels. Sometimes we depict a factorial design with a numbering notation. In this example, we can say that we have a 2 x 2 (spoken "two-by-two) factorial design. In this notation, the *number of numbers* tells you how many factors there are and the *number values* tell you how many levels. If I said I had a 3 x 4 factorial design, you would know that I had 2 factors and that one factor had 3 levels while the other had 4. Order of the numbers makes no difference and we could just as easily term this a 4 x 3 factorial design. The number of different treatment groups that we have in any factorial design can easily be determined by multiplying through the number notation. For instance, in our example we have 2 x 2 = 4 groups. In our notational example, we would need 3 x 4 = 12 groups.

We can also depict a factorial design in design notation. Because of the treatment level combinations, it is useful to use subscripts on the treatment

R	X_{11}	O
R	X_{12}	O
R	X_{21}	O
R	X_{22}	O

(X) symbol. We can see in the figure that there are four groups, one for each combination of levels of factors. It is also immediately apparent that the groups were randomly assigned and that this is a posttest-only design.

Now, let's look at a variety of different results we might get from this simple 2 x 2 factorial design. Each of the following figures describes a different possible outcome. And each outcome is shown in table form (the 2 x 2 table with the row and column averages) and in graphic form (with each factor taking a turn on the horizontal axis). You should convince yourself that the information in the tables agrees with the information in both of the graphs. You should also convince yourself that the pair of graphs in each figure show the exact same information graphed in two different ways. The lines that are shown in the graphs are technically not necessary -- they are used as a visual aid to enable you to easily track where the averages for a single level go across levels of another factor. Keep in mind that the values shown in the tables and graphs are group averages on the outcome variable of interest. In this example, the outcome might be a test of achievement in the subject being taught. We will assume that scores on this test range from 1 to 10 with higher values indicating greater achievement. You should study carefully the outcomes in each figure in order to understand the differences between these cases.

Q3 What is Network simulation?Example and usage of Network simulation.

Ans In communication and computer network research, **network simulation** is a technique where a program models the behavior of a network either by calculating the interaction between the different network entities (hosts/routers, data links, packets, etc) using mathematical formulas, or actually capturing and playing back observations from a production network. The behavior of the network and the various applications and services it supports can then be observed in a test lab; various attributes of the environment can also be modified in a controlled manner to assess how the network would behave under different conditions. When a simulation program is used in conjunction with live applications and services in order to observe end-to-end performance to the user desktop, this technique is also referred to as network emulation.

Network simulator

A **network simulator** is a piece of software or hardware that predicts the behavior of a network, without an actual network being present. A network simulator is a software program that imitates the working of a computer network. In simulators, the computer network is typically modelled with devices, traffic etc and the performance is analysed. Typically, users can then customize the simulator to fulfill their specific analysis needs. Simulators typically come with support for the most popular protocols in use today, such as WLAN, Wi-Max, UDP, and TCP.

Simulations

Most of the commercial simulators are GUI driven, while some network simulators require input scripts or commands (network parameters). The network parameters describe the state of the network (node placement, existing links) and the events (data transmissions, link failures, etc). An important output of simulations are the trace files. Trace files can document every event that occurred in the simulation and are used for analysis. Certain simulators have added functionality of capturing this type of data directly from a functioning production environment, at various times of the day, week, or month, in order to reflect average, worst-case, and best-case conditions. Network simulators can also provide other tools to facilitate visual analysis of trends and potential trouble spots.

Most network simulators use discrete event simulation, in which a list of pending "events" is stored, and those events are processed in order, with some events triggering future events -- such as the event of the arrival of a packet at one node triggering the event of the arrival of that packet at a downstream node.

Some network simulation problems, notably those relying on queueing theory, are well suited to Markov chain simulations, in which no list of future events is maintained and the simulation consists of transiting between different system "states" in a memoryless fashion. Markov chain simulation is typically faster but less accurate and flexible than detailed discrete event simulation. Some simulations are cyclic based simulations and these are faster as compared to event based simulations.

Simulation of networks can be a difficult task. For example, if congestion is high, then estimation of the average occupancy is challenging because of high variance. To estimate the likelihood of a buffer overflow in a network, the time required for an accurate answer can be extremely large. Specialized techniques such as "control variates" and "importance sampling" have been developed to speed simulation.

Examples of network simulators

Examples of notable network simulation software are, ordered after how often they are mentioned in research papers:

1. ns2/ns3
2. OPNET
    1. NetSim

Uses of network simulators

Network simulators serve a variety of needs. Compared to the cost and time involved in setting up an entire test bed containing multiple networked computers, routers and data links, network simulators are relatively fast and inexpensive. They allow engineers, researchers to test scenarios that might be particularly difficult or expensive to emulate using real hardware - for instance, simulating a scenario with several nodes or experimenting with a new protocol in the network. Network simulators are particularly useful in allowing researchers to test new networking protocols or changes to existing protocols in a controlled and reproducible environment.

Network simulators, as the name suggests are used by researchers, developers and engineers to design various kinds of networks, simulate and then analyze the effect of various parameters on the network performance. A typical network simulator encompasses a wide range of networking technologies and can help the users to build complex networks from basic building blocks such as a variety of nodes and links. With the help of simulators, one can design hierarchical networks using various types of nodes like computers, hubs, bridges, routers, switches, links, mobile units etc.

Various types of Wide Area Network (WAN) technologies like TCP, ATM, IP etc and Local Area Network (LAN) technologies like Ethernet, token rings etc., can all be simulated with a typical simulator and the user can test, analyze various standard results apart from devising some novel protocol or strategy for routing etc.

There are a wide variety of network simulators, ranging from the very simple to the very complex. Minimally, a network simulator must enable a user to represent a network topology, specifying the nodes on the network, the links between those nodes and the traffic between the nodes. More complicated systems may allow the user to specify everything about the protocols used to handle traffic in a network. Graphical applications allow users to easily visualize the workings of their simulated environment. Text-based applications may provide a less intuitive interface, but may permit more advanced forms of customization. Others, such as GTNets, are programming-oriented, providing a programming framework that the user then customizes to create an application that simulates the networking environment to be tested.

Q4 What is Estimation theory? Explain Estimation process.

Ans **Estimation theory** is a branch of statistics and signal processing that deals with estimating the values of parameters based on measured/empirical data that has a random component. The parameters describe an underlying physical setting in such a way that their value affects the distribution of the measured data. An estimator attempts to approximate the unknown parameters using the measurements.

For example, it is desired to estimate the proportion of a population of voters who will vote for a particular candidate. That proportion is the unobservable parameter; the estimate is based on a small random sample of voters.

Or, for example, in radar the goal is to estimate the range of objects (airplanes, boats, etc.) by analyzing the two-way transit timing of received echoes of transmitted pulses. Since the reflected pulses are unavoidably embedded in electrical noise, their measured values are randomly distributed, so that the transit time must be estimated.

In estimation theory, it is assumed the measured data is random with probability distribution dependent on the parameters of interest. For example, in electrical communication theory, the measurements which contain information regarding the parameters of interest are often associated with a noisy signal. Without randomness, or noise, the problem would be deterministic and estimation would not be needed.

Estimation process

The entire purpose of estimation theory is to arrive at an estimator, and preferably an implementable one that could actually be used. The estimator takes the measured data as input and produces an estimate of the parameters.

It is also preferable to derive an estimator that exhibits optimality. Estimator optimality usually refers to achieving minimum average error over some class of estimators, for example, a minimum variance unbiased estimator. In this case, the class is the set of unbiased estimators, and the average error measure is variance (average squared error between the value of the estimate and the parameter). However, optimal estimators do not always exist.

These are the general steps to arrive at an estimator:

- In order to arrive at a desired estimator, it is first necessary to determine a probability distribution for the measured data, and the distribution's dependence on the unknown parameters of interest. Often, the probability distribution may be derived from physical models that explicitly show how the measured data depends on the parameters to be estimated, and how the data is corrupted by random errors or noise. In other cases, the probability distribution for the measured data is simply "assumed", for example, based on familiarity with the measured data and/or for analytical convenience.
- After deciding upon a probabilistic model, it is helpful to find the limitations placed upon an estimator. This limitation, for example, can be found through the Cramér–Rao bound.
- Next, an estimator needs to be developed or applied if an already known estimator is valid for the model. The estimator needs to be tested against the limitations to determine if it is an optimal estimator (if so, then no other estimator will perform better).
- Finally, experiments or simulations can be run using the estimator to test its performance.

After arriving at an estimator, real data might show that the model used to derive the estimator is incorrect, which may require repeating these steps to find a new estimator. A non-implementable or infeasible estimator may need to be scrapped and the process started anew.

In summary, the estimator estimates the parameters of a physical model based on measured data.

Basics

To build a model, several statistical "ingredients" need to be known. These are needed to ensure the estimator has some mathematical tractability instead of being based on "good feel".

The first is a set of statistical samples taken from a random vector (RV) of size *N*. Put into a vector,

$$\mathbf{x} = \begin{bmatrix} x[0] \\ x[1] \\ \vdots \\ x[N-1] \end{bmatrix}.$$

Secondly, we have the corresponding *M* parameters

$$\theta = \begin{bmatrix} \theta_1 \\ \theta_2 \\ \vdots \\ \theta_M \end{bmatrix},$$

which need to be established with their continuous probability density function (pdf) or its discrete counterpart, the probability mass function (pmf)

$$p(\mathbf{x}|\theta).$$

It is also possible for the parameters themselves to have a probability distribution (e.g., Bayesian statistics). It is then necessary to define the Bayesian probability

$$\pi(\theta).$$

After the model is formed, the goal is to estimate the parameters, commonly denoted $\hat{\theta}$, where the "hat" indicates the estimate.

One common estimator is the minimum mean squared error estimator, which utilizes the error between the estimated parameters and the actual value of the parameters

$$\mathbf{e} = \hat{\theta} - \theta$$

as the basis for optimality. This error term is then squared and minimized for the MMSE estimator.

Q5 What is Confidence Interval Estimation?explain with example.

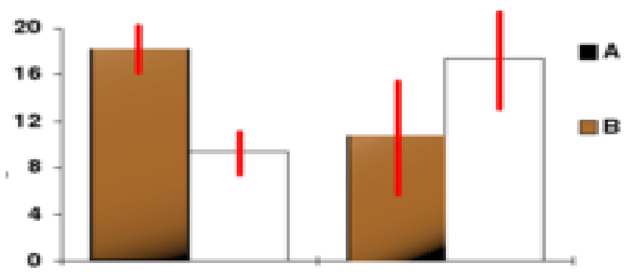
Ans In statistics, a confidence interval (CI) is a particular kind of interval estimate of a population parameter and is used to indicate the reliability of an estimate. It is an observed interval (i.e. it is calculated from the observations), in principle different from sample to sample, that frequently includes the parameter of interest, if the experiment is repeated. How frequently the observed interval contains the parameter is determined by the confidence level or confidence coefficient.

A confidence interval with a particular confidence level is intended to give the assurance that, if the statistical model is correct, then taken over all the data that *might* have been obtained, the procedure for constructing the interval would deliver a confidence interval that included the true value of the parameter the proportion of the time set by the confidence level. More specifically, the meaning of the term "confidence level" is that, if confidence intervals are constructed across many separate data analyses of repeated (and possibly different) experiments, the proportion of such intervals that contain the true value of the parameter will approximately match the confidence level; this is guaranteed by the reasoning underlying the construction of confidence intervals.

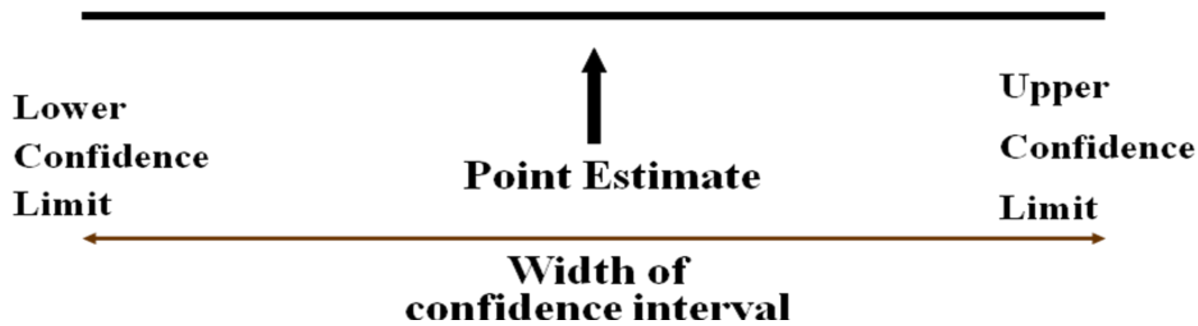
A confidence interval does *not* predict that the true value of the parameter has a particular probability of being in the confidence interval given the data actually obtained. (An interval intended to have such a property, called a credible interval, can be estimated using Bayesian methods; but such methods bring with them their own distinct strengths and weaknesses).

Interval estimates can be contrasted with point estimates. A point estimate is a single value given as the estimate of a population parameter that is of interest, for example the mean of some quantity. An interval estimate specifies instead a range within which the parameter is estimated to lie. Confidence intervals are commonly reported in tables or graphs along with point estimates of the same parameters, to show the reliability of the estimates.

For example, a confidence interval can be used to describe how reliable survey results are. In a poll of election voting-intentions, the result might be that 40% of respondents intend to vote for a certain party. A 90% confidence interval for the proportion in the whole population having the same intention on the survey date might be 38% to 42%. From the same data one may calculate a 95% confidence interval, which might in this case be 36% to 44%. A major factor determining the length of a confidence interval is the size of the sample used in the estimation procedure, for example the number of people taking part in a survey.



- we had information about the population and, using the theory of Sampling Distribution (chapter 7), we learned about the properties of samples. (what are they?)
- Sampling Distribution also give us the foundation that allows us to take a sample and use it to estimate a population parameter. (a reversed process)
- A **point estimate** is a single number,
  - How much uncertainty is associated with a point estimate of a population parameter?
- An **interval estimate** provides more information about a population characteristic than does a point estimate. It provides a confidence level for the estimate. Such interval estimates are called **confidence intervals**



- **An interval gives a range of values**:
  - Takes into consideration variation in sample statistics from sample to sample
  - Based on observations from 1 sample (explain)
  - Gives information about closeness to unknown population parameters
  - Stated in terms of level of confidence. (Can never be 100% confident)
- **The general formula for all confidence intervals is equal to:**

  Point Estimate ± (Critical Value)(Standard Error)

  - Suppose confidence level = 95%
  - Also written $(1 - \alpha) = .95$
  - α is the proportion of the distribution in the two tails areas outside the confidence interval
  - A relative frequency interpretation:
    - If all possible samples of size n are taken and their means and intervals are estimated, 95% of all the intervals will include the **true value of that the unknown parameter**
  - A specific interval either will contain or will not contain the true parameter (due to the 5% risk)
  - Confidence Interval Estimation of Population Mean, μ, when σ is known

- Assumptions
  - Population standard deviation σ is known
  - Population is normally distributed
  - If population is not normal, use large sample
- Confidence interval estimate:

(where Z is the normal distribution's critical value for a probability of α/2 in each tail)

Example:

Suppose there are 69 U.S. and imported beer brands in the U.S. market. We have collected 2 different samples of 25 brands and gathered information about the price of a 6-pack, the calories, and the percent of alcohol content for each brand. Further, suppose that we know the population standard deviation ( ) of price is $1.45. Here are the samples' information:

Sample A: Mean=$5.20, Std.Dev.=$1.41=S

Sample B: Mean=$5.59, Std.Dev.=$1.27=S

1. Perform 95% confidence interval **estimates of population mean price** using the two samples. (see the hand out).

   - Interpretation of the results from
     - From sample "A"
   - We are **95%** confident that the true mean price is between $4.63 and $5.77.
   - We are **99%** confident that the true mean price is between $4.45 and $5.95.
     - From sample "B"
   - We are **95%** confident that the true mean price is between $5.02 and $6.16. (Failed)
   - We are **99%** confident that the true mean price is between $4.84 and $6.36.
   - After the fact, I am informing you know that the population mean was $4.96. Which one of the results hold?

  - Although the true mean may or may not be in this interval, 95% of intervals formed in this manner will contain the true mean.

- Confidence Interval Estimation of Population Mean, μ, when σ is Unknown
- If the population standard deviation σ is unknown, we can substitute the sample standard deviation, S
- This introduces extra uncertainty, since S varies from sample to sample
- So we use the student's t distribution instead of the normal Z distribution
- Confidence Interval Estimate Use Student's t Distribution :

  (where t is the critical value of the t distribution with n-1 d.f. and an area of $\alpha/2$ in each tail)
- t distribution is symmetrical around its mean of zero, like Z dist.
- Compare to Z dist., a larger portion of the probability areas are in the tails.
- As n increases, the t dist. approached the Z dist.
- t values depends on the degree of freedom.
- Student's t distribution
- Note: t Z as n increases
- See our beer example
- Determining Sample Size
- The required sample size can be found to reach a desired margin of error (e) with a specified level of confidence ($1 - \alpha$)
- The margin of error is also called sampling error

  - the amount of imprecision in the estimate of the population parameter
  - the amount added and subtracted to the point estimate to form the confidence interval
- Using
- If unknown, σ can be estimated when using the required sample size formula
  - Use a value for σ that is expected to be at least as large as the true σ
  - Select a pilot sample and estimate σ with the sample standard deviation, S
- Example: If $\sigma = 20$, what sample size is needed to estimate the mean within ± 4 margin of error with 95% confidence?

Chapter 5

Languages for Discrete System Simulation

Q.1 Give General description of GPSS.

Ans. The system to be simulated in GPSS in described as a block diagram in which the block represents the activities and lines joining the block indicates the sequence in which the activities can be executed. The use of block diagrams to describe system is of course. Very familiar. However the form taken by a block diagram description usually depends upon the person drawing the block diagram. To base a programming language on this descriptive method. Each block must be given a precise meaning. The approach taken in FPSS is to define a set of 48 spceitve block types each of which represents a characteristic action of system.

Each block type is given a name that descriptive of the block action and is represented by a particular symbol.

Moving through the system being simulated are intitis that depend upon the nature of the system for example a armmunecation system is concerned with the movement of messages a road transportation system with motor vehicles, a data processing system with records and so on in the simulation these entities are called transaction. The sequence of events in real time is reflected in the

Q.2 Explain Mid-Square method for generating pseudo Random Numbers.

Solution

This is one of the commonly used method for generating the sequences of pseudo random numbers. The method works as follows-

Select a four digit integer or seed to initialize the generator. The first random number is obtained from the seed in the following manner:-

The seed is required the reselling number is supposed to contain 8 digits (if less digits are there, reading zeros are inserted) from this number the middle four digits are extracted as the required random number. This no. is subsequently used as the new seed pseudo random numbers are generated in this manner, each time using the previous random number as the new seed.

For example- Consider the first seed as 2714. by squaring are go the number 07365796.

From this number four middle digits 3657 are escheated which is the first random number. This process is repeated until the required number of random number are obtained.

Q3 Explain the following in brief:

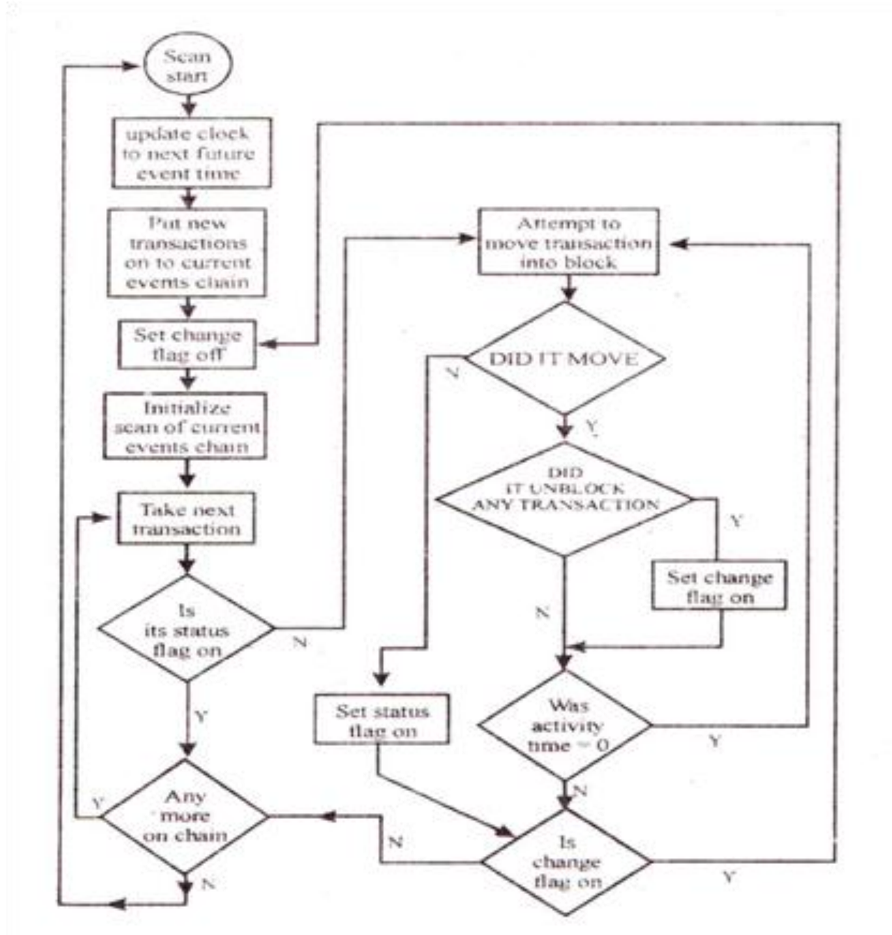
(a) GPSS (b) SIMSCRIPT (c) DYNAMO (d) CSMP-III

Ans. **(a) 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.



Sol.(b) SIMSCRIPT: SIMCRIPT was developed at the RAND corporation in the early 1960's and was first released in 1962. SIMSCRIPT is an event-statement oriented discrete language. A completely new version SIMSCRIPT II was released by the RAND Corporation in 1968. The latest version is SIMSCRIPT 11.5 which was released in 1972.

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.

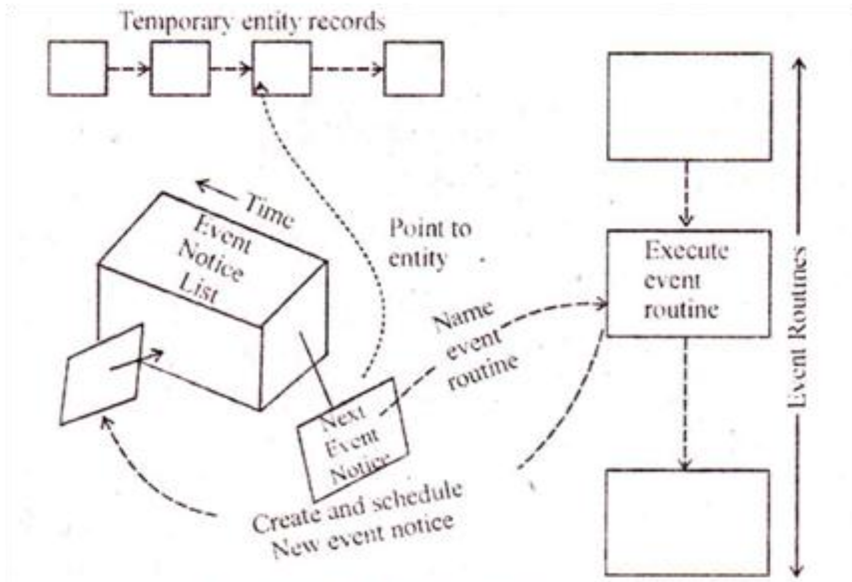


Fig. SIMSCRIPT execution cycle

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.

(C) **DYNAMO**: It is one of the most widely used simulation language among economist and social scientists. It was first order differential equation to approximate the model process.

The basic function of compiler to DYNAMO is:

(a) Error Control
(b) Sequencing equations according to the structure and concept of system dynamics.
(c) Compilation of the program and generation of O/P in a tabular one graphical form.
(d) Weakness of this language is to very primitive and inaccurate integration scheme (Euler's method).
(e) Latest version of DYNAMO is DYNAMO II which has additional features of an array.

(D) **CSMP III**: CSP III is a continuous system simulation language (CSSL) A CSMP III program is constructed from three general types of statements:

Structural statements, which define the model. They consist of FORTRAN-like statements, and functional blocks designed for operations that frequently occur in a model definition.

Data statements, which assign numerical values to parameters, constants, and initial conditions.

Control statement, which specify options in the assembly and execution of the program, and the choice of output.

Q4 Write a note one simulation of a time sharing computer system.

Ans Time-sharing system is a logical extension of multiprogramming. In a time-shared systems, the CPU executes multiple jobs by switching among them, but the switching occurs so frequently that the users can interact with each program while it is running.

A time-shared system allows many users to share the computer simultaneously. Since each action or command in a time-shared system tends to be short, only a little CPU time is needed for each user. As the system switches rapidly from one user to the next, each user is given the impression that the entire computer system is dedicated to his use, even though it is being shared among many users.

Chapter 6

Generation of random numbers and their applications

Q.1 Explain inverse transformation method

Sol. Let us consider a probability distributor function f(z) which is continuers and are want to generate n random samples Z_1, Z_2 ……….. Z_n from this distribution since every probability distribution function increases monotonically from 0 to 1 and the probability that a random sample lies in the internal (Z_1, Z_2) is equal to f(Z_2) - f(Z_1) for all pairs Z_1, d”Z_2 more ones f (Z) is continuous it takes all values b/w 0 and 1 and therefore for any number is 0d”µd”1, there exist a unique Z_u such that f(Z_u)-u symbolically this value of z may be represented by f^{-1}(u), the increase function.

First generate n uniformly distributed random number 4_1, 4_2 ……….. 4_n in the internal (0,1) then use take there increase transforms f^{-1} (4_1), (4_2) ……….. (4_n). the desired numbers are Z_1 = f^{-1} (4_1) for i=1,2—n which can be seen as follows:-

Consider any two numbers a and b in the range ($0_1$1) such that a d” b. By definition the probability that a uniform random number in the range ($0_1$1) lies between a and b is (b-a) for all 0 d” a d” b d” l. Let f^{-1} (o) = Z_a and f^{-1} (b) = zb. The inverse transform method would held if the actual probability of the random variables Z lying between Z_a and Z_b equals the generated probability (b-a). That is the actual probability of z lying between Z_a and Z_b should be f(Z_b)- F(Z_a) which indeed is the case because (b-a) = f(Z_b)- f)Z_a).

Thus to generate n samples from any continuous probability distribution function f(z) all we need to do is to generate n uniform random numbers 4_1, 4_2 ……. 4_n the internal (0,1) and apply inverse transform f^{-1}(4_1) to each.

Q.2 Write are steps for carrying out the Monte Carlo simulation.

Ans. The Monte Carlo method of simulations was developed by the two mathematicians john von Neumann and stains low ulam Von merman and stains low Ulan during world war II to study how for neutrons should trowel through different materials. Me technique provided an approximate but quite workable solution to the problem. The technique of Monte Carlo involves the selection of random observations within the simulations model.

This technique is restricted for application involving random numbers to solve deterministic and stochastic problems. The principle of this technique replacement of actual statistical nurture by another universe described by some assumed probability distribution.

The steps inversed in carrying out Monte Carlo simulations are-

1) Select the measure of effectiveness of the problem. It is either to be misaimed or minimized. Forex it may be idle time of service facility in the queuing problem or number of shortages in an inventory control problem.
2) Identify the variables that affect the measure of effeteness significantly. Foes no. of service facility in queuing problem or number of units in inventory control problem.
3) Determine the cumulative probability destitution of each variable selected in step (2). Plot these distribution with the values of the variables along as axis and cumulative probability values along the y-axis.
4) Get a set of random members.
5) Consider each random number as a decimal value of the cumulative probability distribution. Enter the cumulative distribution plot along the y-axis project this point horizontally till it meats the distribution curve. Then project the point of intersection down on the x-axis.
6) Record the value generated in step 5. substitute in the formula chosen for measure of effectiveness and find its simulated value.
7) Repeat step (5) and (6) until sample is large enough for the satisfaction of the decision maker.

Q.3 Reliance fresh deals with vegetables. The daily demand and purchases of which are random variable records in the post show the following.

Purchase		Demand	
Qty in kg	No. of days	Qty in kg	No. of days
10	40	10	50
20	50	20	110
30	190	30	200
40	150	40	100
50	70	50	40

The traders buys the commodity at Rs. 20 per kg and sells at Rs.30 per kg. It any of the commodity remains at the end of the day. It has no saleable value.

The loss through unsteadied demand is Rs. 8 per kg.

Given are the following random numbers. Simulate 6 day's trading and find the total profit. Random numbers are 31, 18, 63, 84, 5, 79, 07, 32, 43, 75, 81, 27. Use random numbers alternatively i.e. first to simulate purchase and second to simulate demand.

Purchase				
Qty	days	Probability	Causative Payability	Roadum members
10	40	0.08	0.08	00-07
20	50	0.10	0.18	08-17
30	190	0.38	0.56	18-55
40	150	0.30	0.86	56-85
50	70	0.14	1.00	86-99
	500			

Table - II

Purchase				
Qty	days	Probability	Causative Payability	Roadum members
10	50	0.1	0.1	00-09
20	110	0.22	0.32	10-31
30	200	0.4	0.72	32-71
40	100	0.2	0.92	72-91
50	40	0.08	1.00	92-99
	500			

Final Worksheet

Purchase			Demand					
No. of days	Random member	Qty. Purchased	Random Number	Old Demand	Cost	Revenue	Shortage Cost	Profit
10	31	30	18	20	600	600	-	0
20	63	40	84	40	800	1200	-	400
30	15	20	79	40	400	600	160	40
40	7	10	32	30	200	300	160	(60)
50	43	30	75	40	600	900	80	220
	81	40	27	20	800	600	-	200
								400

Herce are have simulated 6 days trading as above and the net profit after 6 days trading is equal to to Rs. 400.

Q. 4 Explain the algorithm and Pseudo code in detail.

Sol. **Pseudo code**: Pseudo code (derived from pseudo and code) is a compact and informal high level description of a computer programming algorithm that uses the structural conventions of programming languages, but omits detailed subroutines, variables declaration and language specific syntax. The programming language is augmented with natural language descriptions of the details, with convenient or with compact mathematical notation. The purpose of using pseudo code as opposed the language syntax is that it is easier for humans to read. This is often achieved by making the sample application independent so more specific items can be added later. Pseudo code resembles, but should not be confused with, skeleton programs including dummy code, which can be compiled without errors. Flowcharts can be thought of as a graphical form of pseudo code.

Syntax: A the name suggests pseudo code generally does not actually obey the syntax rule of any particular language there is no systematic standard form, although any particular writer will generally borrow the appearance of a particular language. Pseudo code may therefore vary widely in style, from a near exact limitation of a real programming language at one extreme, to a description approaching formatted prose at the other.

Example of pseudo code

```
If credit card number is valid
   Execute transaction based on number and order
else
   show a generic failure message
end if
```

Algorithm: An algorithm is procedure or formula for solving a problem. A computer program can be viewed as elaborate algorithm. In mathematical and computer science, an algorithm usually means small procedures that solve a recurrent problem. It is a definite list of well-defined instructions for completing a task; that given an initial state will proceed through a well defined series of successive states, eventually terminating in an end-state. The transition from one state to the next is not necessarily deterministic. The concept of an algorithm originated as a means of recording procedures for solving problems.

Example of Algorithm

Largest Number

Input: A non-empty list of number L

Output: The largest number in the List L

Largest L_O

for each item in the list L>1, do

if the item>largest, then

Largest the item

return largest

Multiple Choice Questions

1.) System is defined as:-
   a. aggregation or assemblage of objects
   b. Combination of objects
   c. Definition of Object.
   d. None of the above

2.) Factory is an example of:-
   a. System
   b. Attribute
   c. Activity
   d. Environment

3.) A simple market model is an example of:-
   a. Static Physical Model
   b. Dynamic Physical Model
   c. Static Mathematical Model
   d. Dynamic Mathematical Model

4.) In a Bank system, what is customer:-
   a. Entity
   b. Activity
   c. Environment
   d. None of the above.

5.) Aggregation is a:-
   a. Combining infinite objects to form system.
   b. is the extent to which the number of individual entities can be grouped together into larger entities.
   c. Both of above.
   d. None of the above

6.) A system with no exogenous activity is said to be:-
   a. Open system
   b. Closed System
   c. Both of above
   d. None of the above.

7.) A system which does have exogenous activity is said to be:-
   a. Open system

b. Closed System
c. Both of above
d. None of the above

8.) Where the outcome of the activity can describe completely in terms of its input, the activity is said to be:-
a. Deterministic
b. Stochastic
c. Endogenous
d. Exogenous

9.) System analysis, System design and system postulation are the examples of:-
a. Types of system
b. Types of system study
c. Types of entities
d. Type of environment.

10.) In Discrete system, changes are:-
a. Predominantly continuous
b. Predominantly discrete
c. Depend on the system
d. None of the above.

11.) In Continuous system, changes are:-
a. Predominantly continuous
b. Predominantly discrete
c. Depend on the system
d. None of the above.

12.) Which one of the following is false about model:-
a. Model is the body of information about a system gathered for the purpose of studying the system.
b. Since the purpose of study is varying, there is no unique model for a system.
c. Both of above are false.
d. None of the above.

13.) In system modeling, the task of deriving a model of a system may be divided broadly into two subtasks:-
a. Establishing the model structure.
b. Supplying the data.
c. Both of above

d. None of the above.

14.) Physical models are based on:-

a. Analogy between such systems as mechanical and electrical
b. Use symbolic notation and mathematical equations to represent a system
c. All of the above
d. None of the above

15.) Mathematical models are based on:

a. Analogy between such systems as mechanical and electrical
b. Use symbolic notation and mathematical equations to represent a system
c. All of the above
d. None of the above

16.) Which model can only show the values that system attributes take when the system is in balance:-

a. Dynamic Model
b. Static Model
c. Analytical Model
d. Numerical Model

17.) Which model follows the changes over time that results from the system activities:-

a. Dynamic Model
b. Static Model
c. Analytical Model
d. Numerical Model

18.) Which system/model applies deductive reasoning of mathematical theory to solve a model:-

a. Dynamic Model
b. Static Model
c. Analytical Model
d. Numerical Model

19.) Which system/model applies computational procedures to solve equations:-

a. Dynamic Model
b. Static Model
c. Analytical Model
d. Numerical Model

20) ____________ is considered to be a numerical computation technique used in conjunction with dynamic mathematical models.

a. Analysis
b. System simulation
c. Dynamic computation
d. None of the above.

21.) DNA molecule Model or ionic model is an example of:-

a. Static Physical Model
b. Dynamic Physical Model
c. Static Mathematical Model
d. Dynamic Mathematical Model

22.) System postulation is a:-

a. To produce a system that meets some specifications.
b. To understand how an existing system or a proposed system operates.
c. To produce a system in which behavior is known but the process is not known.
d. None of the above.

23.) Traffic, Bank, and Supermarket are the examples of:-

a. Attribute
b. System
c. Activity
d. Environment

24.) Oscillator Model is an example of:-

a. Static Physical Model
b. Dynamic Physical Model
c. Static Mathematical Model
d. Dynamic Mathematical Model

25.) In Communication system, what is "Transmitting":-

a. Entity
b. Activity
c. Environment
d. None of the above.

26.) Principle/principles used in modeling:-

a. Block-building
b. Relevance
c. Accuracy
d. Aggregation
e. All of the above
f. None of the above

27.) Which of the following is true about subsystem:-

a. Any subsystem might, itself, be considered a system consisting of subsystem at a still lower level of
b. detail, and so on.
a. Each subsystem has its own inputs and outputs and, standing by itself.
b. Both of above.
c. None of above

28.) In a Corporate model, what is/are main segment/segments?

a. Environment
b. Plant/ Physical plant
c. Management
d. All of the above
e. None of the above

29.) Where the effects of the activity vary randomly over various possible outcomes, the activity is said to be:-

a. Deterministic
b. Stochastic
c. Endogenous
d. Exogenous

30.) System analysis is a:-

a. To produce a system that meets some specifications.
b. To understand how an existing system or a proposed system operates.
c. To produce a system in which behavior is known but the process is not known.
d. None of the above.

31.) System design is a:-

a. To produce a system that meets some specifications.
b. To understand how an existing system or a proposed system operates.
c. To produce a system in which behavior is known but the process is not known.
d. None of the above.

32.) Suspension model of an automobile wheel is an example of:-

a. Static Physical Model
b. Dynamic Physical Model
c. Static Mathematical Model
d. Dynamic Mathematical Model

33.) Depositing in Bank system is:-

a. Entity
b. Attribute
c. Activity
d. Environment

34.) Messages in Communication system is:

a. Entity
b. Attribute
c. Activity
d. Environment

35.) Speed and Distance in Traffic system are:-

a. Entities
b. Attributes
c. Activities
d. Environment

36.) Which of the following is simulation language:-

a. Java
b. GPSS
c. Javascript
d. None of the above.

37.) Which of the following is not a simulation language:-

a. GPSS
b. Simscript
c. Simula
d. all of the above
e. None of the above

38.) Advance, Link, Mark and Queue blocks are used in which language:-

a. Simscript
b. GPSS
c. Both of above

d. None of the above

39.) Which of the following separate system and system environment:-

a. Acitvities
b. Boundary
c. Entity
d. All of the above

40.) Block building principle of the system modeling says that:-

a. The description of the system should be organized in a series of blocks.
b. The description of the system should not be organized in a series of blocks.
c. There should be no clear distinction between the subsystems of the system.
d. None of the above.

1. (a)	2. (a)	3. (c)	4. (a)	5. (b)	6. (b)	7. (b)	8. (a)	9. (b)	10. (b)
11. (a)	12. (d)	13. (c)	14. (a)	15. (b)	16. (b)	17. (a)	18. (c)	19. (d)	20. (b)
21. (a)	22. (c)	23. (b)	24. (d)	25. (b)	26. (e)	27. (c)	28. (d)	29. (b)	30. (b)
31. (a)	32. (b)	33. (c)	34. (a)	35. (b)	36. (b)	37. (d)	38. (b)	39. (b)	40. (a)

Glossary

Adaptive
Subject to ADAPTATION; can change over time to improve fitness or accuracy.

Adaptation
An internal change in a SYSTEM that mirrors an external event in the system's ENVIRONMENT. Could be a consequence of LEARNING.

Always Cooperate
An ITERATED PRISONER'S DILEMMA STRATEGY that cooperates with its opponent under all circumstances (the exact opposite of ALWAYS DEFECT).

Always Defect
An ITERATED PRISONER'S DILEMMA STRATEGY that never cooperates with its opponent under any circumstance (the exact opposite of ALWAYS COOPERATE).

Autonomous Agent
An entity with limited perception of its ENVIRONMENT that can process information to calculate an action so as to be goal-seeking on a local scale.

Bottom-Up
A description that uses the lower-level details to explain higher-level patterns; related to REDUCTIONISM.

Cellular Automation (CA)
A DISCRETE DYNAMICAL SYSTEM that is composed of an array of cells, each of which behaves like a FINITE-STATE AUTOMATON. All interactions are local, with the next state of a cell being a FUNCTION of the current state of itself and its neighbours. CONWAY'S GAME OF LIFE is a CA.

Coevolution
Two or more entities experience EVOLUTION in response to one another. Due to FEEDBACK mechanisms, this often results in a biological ARMS RACE.

Conway's Game of Life
A CELLULAR AUTOMATON rule set that operates on a two-dimensional grid. Each cell changes its stat according to the states of its eight nearest neighbours: dead cells come alive with exactly three live neighbours, and cells die if they have anything but two or three neighbours. The Game of Life can display complex

patterns such as GLIDERS, FISH, and GLIDER GUNS, and is also capable of UNIVERSAL COMPUTATION.

Crossover
A genetic operator that splices information from two or more parents to form a composite offspring that has genetic material from all parents.

Difference Equation
An equation that describes how something changes in DISCRETE time steps. NUMERICAL SOLUTIONS to INTEGRALS are usually realized as difference equations.

Differential Equation A description of how something CONTINUOUSLY changes over time. Some differential equations can have an ANALYTICALLY SOLUTION such that all future states can be know without SIMULATION of the time evolution of the SYSTEM. However, most can have a NUMERICAL SOLUTION with only limited accuracy.

Dynamics/Dynamical
Pertaining to the change in behaviour of a SYSTEM over time.

Emergent
Refers to a property of a collection of simple subunits that comes about through the interactions of the subunits and is not a property of any single subunit. For example, the organization of an ant colony is said to "emerge" from the interactions of the lower-level behaviours of the ant, and not from any single ant. Usually, the emergent behaviour is unanticipated and cannot be directly deduced from the lower-level behaviours. COMPLEX SYSTEMS are usually emergent.

Euler's Method The simplest method of obtaining a NUMERICAL SOLUTION of a DIFFERENTIAL EQUATION. There are many other numerical techniques that are more accurate; however, an ANALYTICAL SOLUTION (i.e., a closed form of an integral) is always preferred but not always possible.

Evolution
A process operating on populations that involves VARIATION among individuals, traits being INHERITABLE, and a level of FITNESS for individuals that is a FUNCTION of the possessed traits. Over relatively long periods of time, the distribution of inheritable traits will tend to reflect the fitness that the traits convey to the individual; thus, evolution acts as a filter that selects fitness-yielding traits over other traits.

Finite-State Automation (FSA)
The simplest computing device. Although it is not nearly powerful enough to preform UNIVERSAL COMPUTATION, it can recognize REGULAR EXPRESSIONS. FSAs are defined by state transition table that specifies how the FSA moves from one state to another when presented with a particular input. FSAs can be drawn as GRAPHS.

Fish
A simple object in CONWAY'S GAME OF LIFE that swims vertically or horizontally.

Fitness
A measure of an object's ability to reproduce viable offspring.

Fitness Landscape
A representation of how MUTATIONS can change the FITNESS of one or more organisms. If high fitness corresponds to high locations in the landscapes, and if changes in genetic material are mapped to movements in the landscape, then EVOLUTION will tend to make populations move in a uphill directions on the fitness landscape.

Genetic Algorithm (GA)
A method of SIMULATING the action of EVOLUTION within a computer. A population of fixed-length STRINGS is evolved with a GA by employing CROSSOVER and MUTATION operators along with a FITNESS FUNCTION that determines how likely individuals are to reproduce. Gas perform a type of SEARCH in a FITNESS LANDSCAPE.

Genetic Programming (GP) A method of applying simulated EVOLUTION on PROGRAMS or program fragments. Modified forms of MUTATION and CROSSOVER are used along with a FITNESS function.

Glider
A simple object in CONWAY'S GAME OF LIFE that swims diagonally through the grid space.

Glider Gun
An object CONWAY'S GAME OF LIFE that builds and emits GLIDERS, which can then be collided in purposeful ways to construct more complicated objects.

Graph
A construct that consists of many nodes connected with edges. The edges usually represents a relationship between the objects represented by the nodes. For example, if the nodes are cities, then the edges may have numerical values that correspond to the distances between the cities. A graph can be equivalently represented as a MATRIX.

Iterated Prisoner's Dilemma
The PRISONER'S DELEMMA game played in an ITERATIVE manner for a number of rounds that is unknown to both players.

Iterate/Iterative
Doing something repeatedly. Doing something repeatedly. Doing something repeatedly. Doing something repeatedly. Doing something repeatedly.

Lamarckism
A method of heredity that does not apply to genetics but is applicable to social ADAPTATION. Lamarckism posits that acquired traits can be passed from parent to offspring.
Learning
A process of ADAPTATION by which a set of adjustable parameters is automatically modified so that some objective is more readily achieved.
Meme
A unit of cultural information that represents a basic idea that can be transferred from one individual to another, and subjected to MUTATION, CROSSOVER, and ADAPTATION.
Model
In the sciences, a model is an estimate of how something works. A model will usually have inputs and outputs that correspond to its real-world counterpart. An ADAPTIVE SYSTEM also contains an implicit model of its ENVIRONMENT that allows it to change its behaviour in anticipation of what will happen in the environment.

Monte Carlo Method
Any technique of statistical sampling employed to approximate solutions to quantitative problems. This technique is not what we mean by "simulation."

Mutation
A RANDOM change in any portion of genetic material. For a GENETIC ALGORITHM, this means that a value in a BIT STRING is randomly set.

Natural Selection
The natural filtering process by which individuals with higher FITNESS are more likely to reproduce than are individuals with lower fitness.

Neural Network (NN)
A network of NEURONS that are connected through SYNAPES or WEIGHTS. In this book, the term is used almost exclusively to denote an artificial neural network and not the real thing. Each neuron performs a simple calculation that is a FUNCTION of the AVTIVATIONS of the neurons that are connected to it. Through FEEDBACK mechanisms and/or the NONLINEAR output response of neurons, the network as a whole is capable of performing extremely complicated tasks, including UNIVERSAL COMPUTATION and UNIVERSAL APPROXIMATION. Three different classes of neural networks are FEEDFORWARD, FEEDBACK, and RECURRENT NEURAL NETWORKS, which differ in the degree and type of CONNECTIVITY that they possess.

Numerical Solution
A solution to a problem that is calculated through a SIMULATION. For example, solving the THREE BODY PROBLEM is not possible in the worst case; however, with the DIFFERENTIAL EQUATIONS that describe the motions of three bodies in space, one could simulate their movements by simulating each time step. Nevertheless, numerical solutions are usually error-prone due to SENSITIVITY and, therefore, can be used to estimate the future for only relatively short time spans, in the worst case.

Prisoner's Dilemma
A NON-ZERO-SUM game in which both players have the incentive not to cooperate independently, no matter what. But collectively they would be better off if they did cooperate. This tension between individual incentive and collective incentive is what makes the PD intriguing.

Simulate/Simulation
EXPERIMENTATION in the space of theories, or a combination of experimentation and THEORIZATION. Some numerical simulations are PROGRAMS that represent a MODEL for how nature works. Usually, the outcome of a simulation is much a surprise as the outcome of a natural event, due to the richness and uncertainty of COMPUTATION.

Simulated Annealing
A partially RANDOM method of SEARCH and OPTIMIZATION usually used for COMBINATORIAL OPTIMIZATION problems. The technique is modeled on how the molecular structure of metals is disordered at high temperatures but very

ordered and crystalline at low temperatures. In simulated annealing, a problem instance is reformulated so that it loosely resembles disordered material. Gradually, the temperature is lowered such that the ordered states correspond to good solutions to a problem.

Strategy

In GAME THEORY, a policy for playing a game. A strategy is a complete recipe for how a player should act in a game under all circumstances. Some policies may employ RANDOMNESS, in which case they are referred to as mixed strategies.

System

Something that can be studied as a whole. Systems may consist of subsystems that are interesting in their own right. Or they may exist in an ENVIRONMENT that consists of other similar systems. Systems are generally understood to have an internal state, inputs from an environment, and methods for manipulating the environment or themselves. Since cause and effect can flow in both directions of system and environment, interesting systems often posses FEEDBACK, which is SELF-REFERENTIAL in the strongest case.

Top-Down

A method of examining things that first looks at higher-level phenomena and then tries to explain lower-level patterns in terms of the higher-level observations. This is the exact opposite of BOTTOM-UP.

Turing Machine

A MODEL OF COMPUTATION that uses an underlying FINITE-STATE AUTOMATON but also has a infinite tape to use as memory. Turing machines are capable of UNIVERSAL COMPUTATION.

Universal Computer

A computer that is capable of UNIVERSAL COMPUTATION, which means that given a description of any other computer or PROGRAM and some data, it can perfectly emulate this second computer or program. Strictly speaking, home PCs amd Macintoshes are not universal computers because they have only a finite amount of memory.

Case Study

1.) Name three or four of the principal entities, attributes, and activities to be considered if you were to simulate the operation of:-

a.) A gasoline filling station

b.) A cafeteria

c.) A Barber shop.

2.) Extract from the following description description the entities, attributes, and activities of the system. Ships arrive at a port. They dock at a berth if one is available; otherwise, they wait until one becomes available. They are unloaded by one of several work gangs whose size depends upon the ship's tonnage. A warehouse contains a new cargo for ship. The ship is loaded and then departs. Suggest two exogenous events that may need to be taken into account.

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