University of Msila

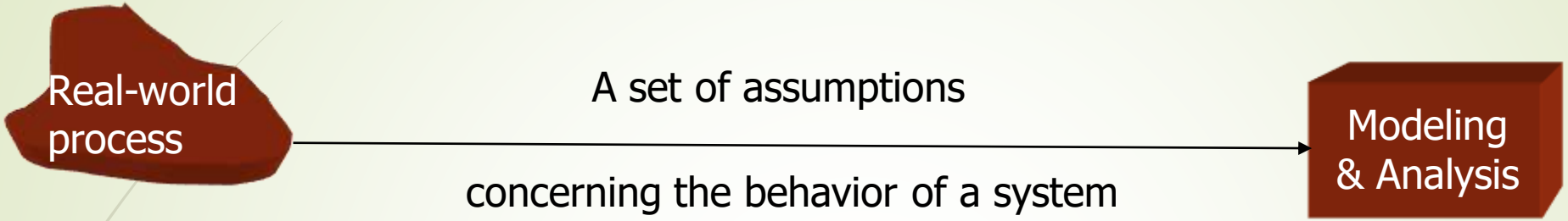
FACULTY OF MATHEMATICS AND INFORMATICS

DEPARTMENT OF COMPUTER SCIENCE

MODELING AND SIMULATION

Introduction

Introduction



- Simulation
  - the imitation of the operation of a real-world process or system over time
  - to develop a set of assumptions of mathematical, logical, and symbolic relationship between the entities of interest, of the system.
  - to estimate the measures of performance of the system with the simulation-generated data

- Simulation modeling can be used
  - as an analysis tool for predicting the effect of changes to existing systems
  - as a design tool to predict the performance of new systems

Introduction

- A computer simulation is an application designed to imitate a real-life situation. A good example is software which simulates the experience of piloting a plane.

Introduction

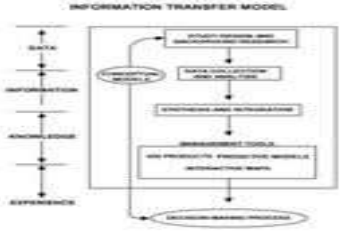
Introduction

Quick results. Simulation can be speeded up.

Much cheaper than using the real thing.

The advantages of **modelling**

Allows for data to be changed to see the consequences.



Can simulate dangerous situations.

When Simulation is the Appropriate Tool ?

- Simulation enables the study of, and experimentation with, the internal interactions of a complex system, or of a subsystem within a complex system.
- Informational, organizational, and environmental changes can be simulated, and the effect of these alterations on the model's behavior can be observed.
- The knowledge gained in designing a simulation model may be of great value toward suggesting improvement in the system under investigation.
- By changing simulation inputs and observing the resulting outputs, valuable insight may be obtained into which variables are most important and how variables interact.
- Simulation can be used as a pedagogical device to reinforce analytic solution methodologies.
- Animation shows a system in simulated operation so that the plan can be visualized.
- The modern system (factory, wafer fabrication plant, service organization, etc.) is so complex that the interactions can be treated only through simulation.

Advantages and Disadvantages of Simulation

- **Advantages**
  - New polices, operating procedures, decision rules, information flows, organizational procedures, and so on can be explored without disrupting ongoing operations of the real system.
  - New hardware designs, physical layouts, transportation systems, and so on, can be tested without committing resources for their acquisition.
  - Hypotheses about how or why certain phenomena occur can be tested for feasibility.
  - Insight can be obtained about the interaction of variables.
  - Insight can be obtained about the importance of variables to the performance of the system.
  - Bottleneck analysis can be performed indicating where work-in-process, information, materials, and so on are being excessively delayed.
  - A simulation study can help in understanding how the system operates rather than how individuals think the system operates.
  - “What-if” questions can be answered. This is particularly useful in the design of new system.

Advantages and Disadvantages of Simulation

- **Disadvantages**
  - Model building requires special training. It is an art that is learned over time and through experience. Furthermore, if two models are constructed by two competent individuals, they may have similarities, but it is highly unlikely that they will be the same.
  - Simulation results may be difficult to interpret. Since most simulation outputs are essentially random variables (they are usually based on random inputs), it may be hard to determine whether an observation is a result of system interrelationships or randomness.
  - Simulation modeling and analysis can be time consuming and expensive. Skimping on resources for modeling and analysis may result in a simulation model or analysis that is not sufficient for the task.
  - Simulation is used in some cases when an analytical solution is possible, or even preferable. This might be particularly true in the simulation of some waiting lines where closed-form queueing models are available.

Areas of Application

- **Manufacturing Applications**
  - Analysis of electronics assembly operations
  - Design and evaluation of a selective assembly station for high-precision scroll compressor shells
  - Comparison of dispatching rules for semiconductor manufacturing using large-facility models
  - Evaluation of cluster tool throughput for thin-film head production
  - Determining optimal lot size for a semiconductor back-end factory
  - Optimization of cycle time and utilization in semiconductor test manufacturing
  - Analysis of storage and retrieval strategies in a warehouse
  - Investigation of dynamics in a service-oriented supply chain
  - Model for an Army chemical munitions disposal facility
- **Semiconductor Manufacturing**
  - Comparison of dispatching rules using large-facility models
  - The corrupting influence of variability
  - A new lot-release rule for wafer fabs

Areas of Application

- **Construction Engineering**
  - Construction of a dam embankment
  - Trenchless renewal of underground urban infrastructures
  - Activity scheduling in a dynamic, multi-project setting
  - Investigation of the structural steel erection process
  - Special-purpose template for utility tunnel construction
- **Military Application**
  - Modeling leadership effects and recruit type in an Army recruiting station
  - Design and test of an intelligent controller for autonomous underwater vehicles
  - Modeling military requirements for nonwarfighting operations
  - Multi-trajectory performance for varying scenario sizes
  - Using adaptive agent in U.S Air Force pilot retention
- **Business Process Simulation**
  - Impact of connection bank redesign on airport gate assignment
  - Product development program planning
  - Reconciliation of business and systems modeling
  - Personnel forecasting and strategic workforce planning
- **Human Systems**
  - Modeling human performance in complex systems
  - Studying the human element in air traffic control

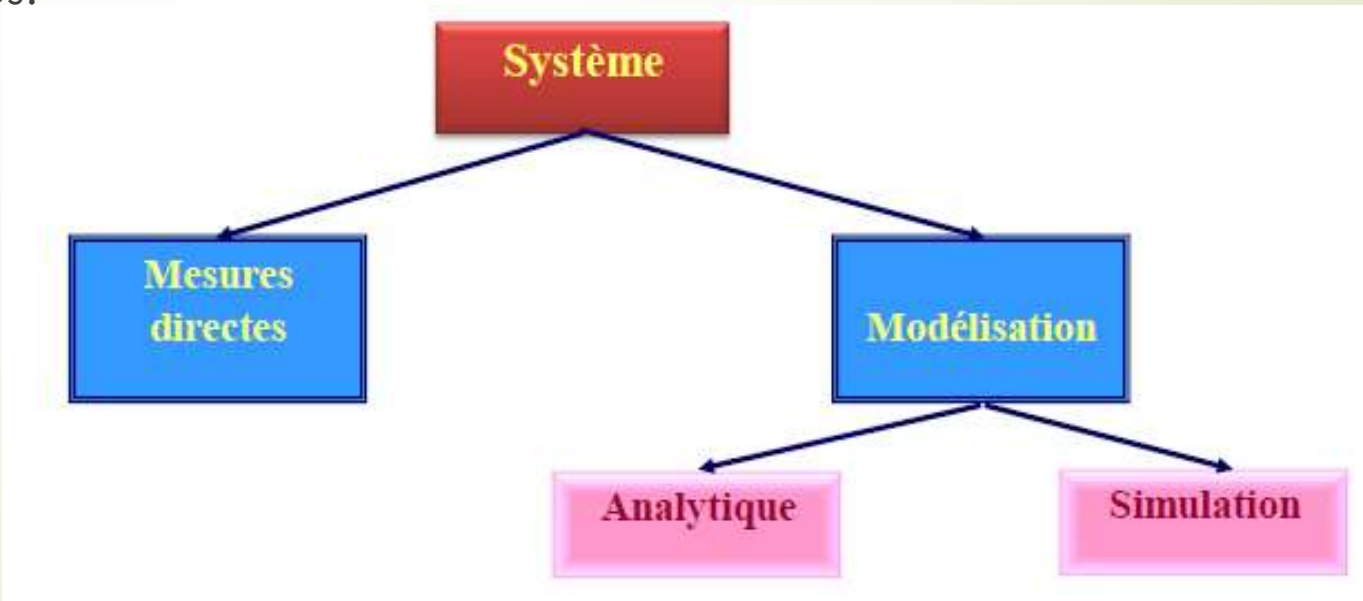
Introduction

- **How do you evaluate system performance?**
  There are two types of analysis:

  1- **Qualitative analysis**: consists in defining the structural and behavioral properties of the system and verifying its logical correctness, such as the absence of deadlocks. The most commonly used formalisms include Petri nets and process algebras.

  2- **Quantitative analysis:** consists in calculating the system's performance parameters (after carrying out a qualitative analysis).

  The various methods of quantitative performance analysis can be divided into three broad categories:



Introduction

- System modeling and computer simulation, recently has become one of the premier subject in the industry as well as Defence.
- It helps an engineer or a scientist to study a system with the help of mathematical models and computers.
- system simulation is nothing but an experiment with the help of computers, without performing actual experiment. It saves lot of money which is required, if we actually perform experiments with the real system.

Concept of system

- **what a system is?**
- a system is, "*Any object which has some action to perform and is dependent on number of objects called entities, is a system*"
- University consists of number of colleges (which are *entities* of the system called university) and a college has class rooms, students, laboratories and lot many other objects, as *entities*.
- Each entity has its own attributes or properties. For example attribute of a student is to study and work hard. Each college in itself can be treated as a complete system.
- There are also certain interactions occurring in the system that cause changes in the system. A term ***entity*** will be used to denote an object of interest in a system and the term ***attributes*** denotes its properties
- If we combine few of these objects, joined in some regular interactions or inter-dependence, then this becomes a *large system*.
- A function to be performed by the entity is called its ***activity***. For example, if system is a class in a school, then students are entities, books are their attributes and to study is their *activity*.
- we can say university is a large system whereas college is a system.

Concept of system

- Systems broadly can be divided into two types, ***static system*** and ***dynamic system***.
- If a system does not change with time, it is called a *Static System*
- if changes with time, it is called a *Dynamic System*.
- Study of such a system is called ***System Analysis***.

Concept of system

- **Different types of system:**

1. **Deterministic system**: Works in a predictable way. The interaction between its different parts is known with certainty. If we have a description of the state of the system at a given moment, the next state of the system can be given exactly and without error.

Example:

- The solar system: the motions of the planets around the sun are well known.

- A program running in monoprogramming mode is deterministic.On the other hand, in multiprogramming, there may be unforeseen interactions between programs.programs.

2. **Probabilistic (stochastic) system**: It is described in terms of probable behavior (which depends on chance). A certain margin of error always accompanies the prediction of what the system will do.

Example:In an inventory management system, average demand, replenishment time and other factors may be defined, but their exact values at any given time are not known. (since purchase requisitions arrive randomly).

Concept of system

3. **Continuous system:**

Changes in the state of the system occur continuously over time (it depends on a variable related to time: speed, acceleration, etc.).

Example:

- The movement of an aircraft's wings during flight.
- Population growth (births and deaths)

4. **Discrete (discontinuous) system:**
   The system is characterized by events that occur at non-fixed times and cause changes in the state of the system. The system retains this state until the next event.

Example:

- A customer arrives at a post office counter. If the employee is free, the customer is served immediately, otherwise he joins a queue. The system state changes each time a customer arrives or leaves.