Modeling and Simulation

Lecture 2

Introduction

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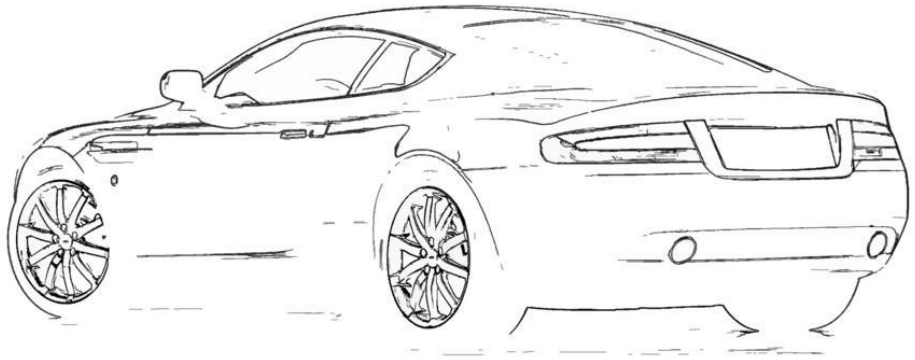
Types of Models

- All models can be grouped into three types:
  - Graphic models
  - Mathematical models
  - Physical models

Types of Models - Graphic models

- Typical graphic models are conceptual drawings, graphs, charts, and diagrams.

- Football coaches develop them to show how players (components) should interact during an offensive or defensive play (system).



Types of Models - Physical models

- **Physical models** are three-dimensional representations of reality. Examples: Model Airplane, Model House, Model City
- Two types of physical models exists: mock-ups and prototypes.

Types of Models - Physical models

- mock-up. It is used to evaluate the styling, balance, color, or other aesthetic feature of a technology artifact.

- Mock-ups are generally constructed of materials that are easy to work with. Commonly these materials include wood, clay, Styrofoam, paper, and various kinds of cardboard.

Types of Models - Physical models

- The second type of physical model is a **prototype**.
- A prototype is a working model of a system.
- Prototypes are built to test the operation, maintenance, and/or safety of the item.
- They are generally **built of the same material** as the final product.

Types of Models - Mathematical models

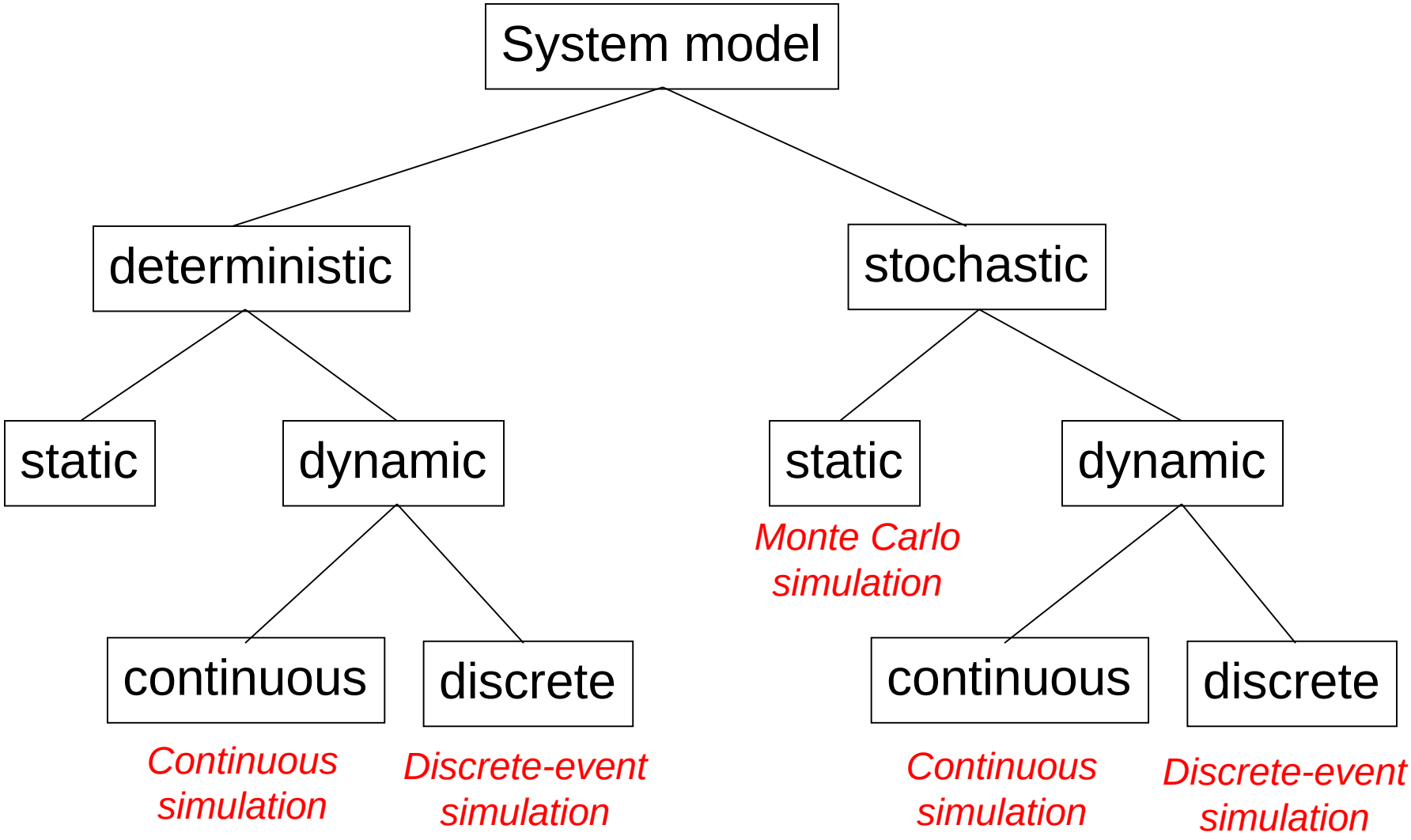
- **Mathematical models** show relationships in terms of formulas. For example, the relationship among voltage, amperage, and resistance in an electrical circuit is shown by the formula E=IR, where E = electromotive force measured in volts, I = electrical current in amperes, and R = electrical resistance measured in ohms.

- complex mathematical models track storms and space flights, predict ocean currents and land erosion, and help scientists conduct complex experiments.

Types of Models

- Useful dimensions of classification with regard to design/analysis: Dynamic vs. Static, Stochastic vs. Deterministic, Discrete vs. Continuous

Types of Models



Characterizing a Simulation Model

- **DETERMINISTIC**
  - no random variable in the model
  - is one whose behavior is entire predictable.
  - e.g. patients arriving at a clinic at scheduled appointment time (deterministic arrivals)
- **STOCHASTIC** (NON-DETERMINISTIC or PROBABILISTIC)
  - model has one or more random variables as inputs
  - is one whose behavior cannot be entirely predicted.
  - e.g. Bank - random customer inter-arrival and service times

Characterizing a Simulation Model

- **Static:**
  - No time element
  - Time Independent view of the system.
  - e.g. Class has same number of students in an year.
- **Dynamic**
  - Passage of time is important part of model
  - Time dependent view of the system E.g. ATM can accept card only when it is in ready state. ATM cannot read card when it is in ERROR state. Thus state of ATM is a dynamic aspect.

Characterizing a Simulation Model

- **Discrete system** - state variables change only at discrete set of points in time (a countable number of points in time).

- **Continuous system** - the state variables change continuously over time (infinite number of states)

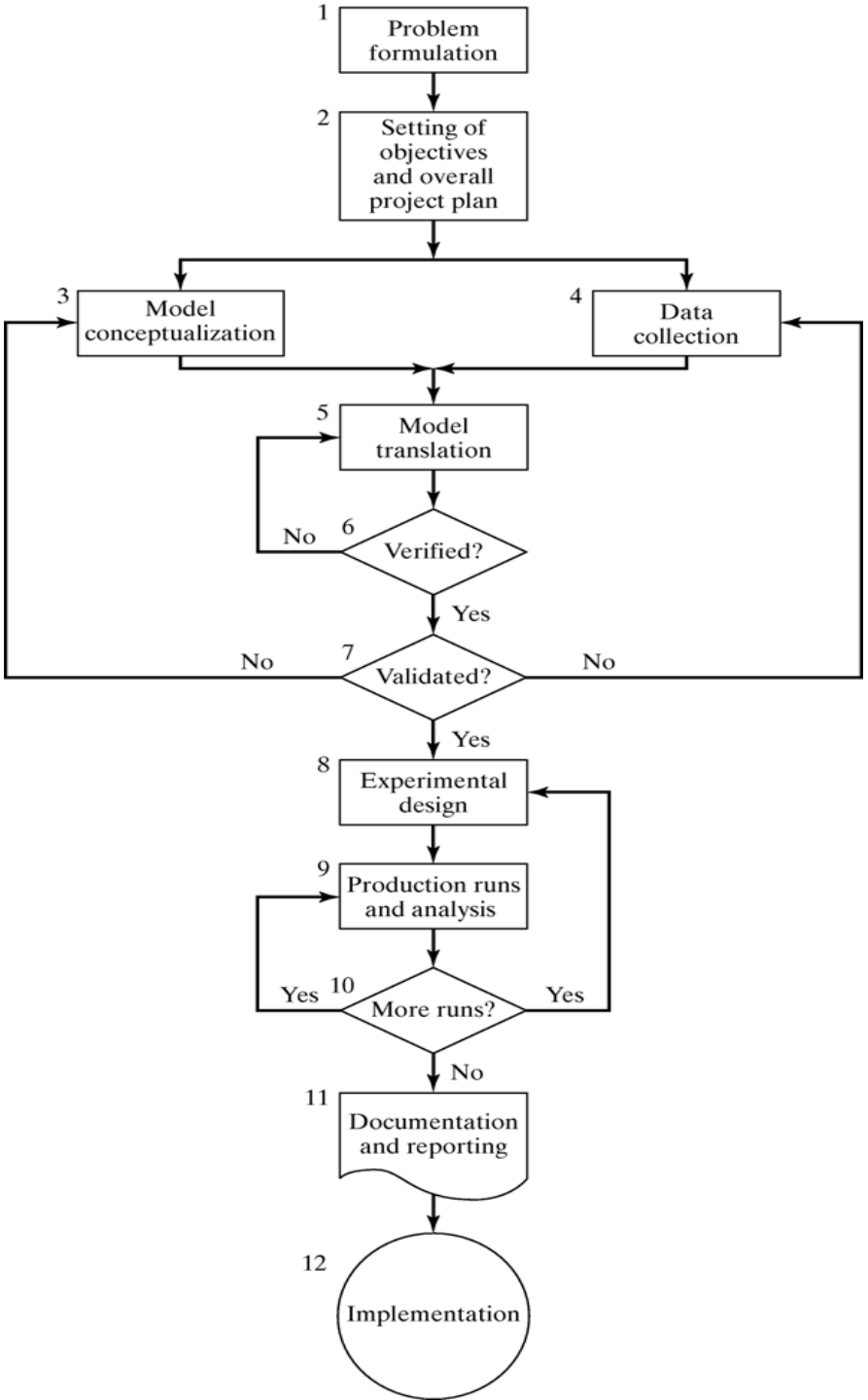
How to develop a model?

1. Determine the goals and objectives
2. Build a **conceptual** model
3. Convert into a **specification** model
4. Convert into a **computational** model
5. Verify
6. Validate

Three Model Levels

- **Conceptual**
  - Very high level
  - How comprehensive should the model be?
  - What are the state variables, which are dynamic, and which are important?
- **Specification**
  - On paper
  - May involve equations, pseudocode, etc.
  - How will the model receive input?
- **Computational**
  - A computer program
  - simulation language?

Steps in Simulation Study



Quiz

Fill in the Blank:

A system is defined as ……..

The behavior of a system that evolves over time is studied by developing ……..

Simulation can be used as …….. And ……..

Endogenous is used to ……

Quiz

True or false

1. It is better to do simulation before Implementation.
2. The concept of simulation can be applied to study a wide variety of problems.
3. a manager must generate significant amounts of information about a problem in order to develop a good simulation model.

Quiz

Answer the following:

1. In Banking System mention Entity, Attribute, Activity, Event, State variable.
2. Define Simulation
3. Show the different the ways to study a system.
4. Mention the Types of Models
5. Mention four Areas of application
6. What are the various steps in simulation study?
7. When Simulation Is Appropriate Tool?
8. What is the three Model Levels? Describe them.