Simulation and Modeling
COMP 406

Prerequisites: comp 305, stat 201

Text Book: Simulation Modeling and Analysis , 4rd edition

by: Averill Law & W. Kelton

Objectives

- To encourage “system” thinking
- Provide background to systems modeling concepts
- Opportunity for a practical appreciation for discrete event simulation
- Combine theory and practice

Outline of the course

- Introduction to Simulation.
- Hand Simulation.
- Review of basic Probability Theory.
- Random Number Generation
- Generation of Random Varieties.
- Analysis of Output.
- Elementary Queuing Models

Modeling and Simulation

Model

- It is a simplification or abstract representation of the real world
- A (usually miniature) representation of an actual system; an example for imitation or emulation
- A description of observed behavior, simplified by ignoring certain details.
- Models allow complex systems to be understood and their behavior predicted within the scope of the model
- A model can be **Analytical** (Queuing Theory) or by Simulation.

Rules for Modeling

- All models are approximate; Some models are better than others.
- Always avoid complicated model when simple ones are possible
- The deduction stage must be carefully checked
- Models should be validated before implementation.
- Models should not replace reality and human intuition
- A model cannot be better than the information that goes into it

Modeling and Simulation

Simulation

- Simulation reflects the behavior of the real world in a smaller and simpler way.
- Simulation involves the modeling of a process or system in such a way that the model mimics the response of an actual system to events that take place over time. (Schriber 1987).
- It is a program that mimics (imitate) the behaviour of the real system

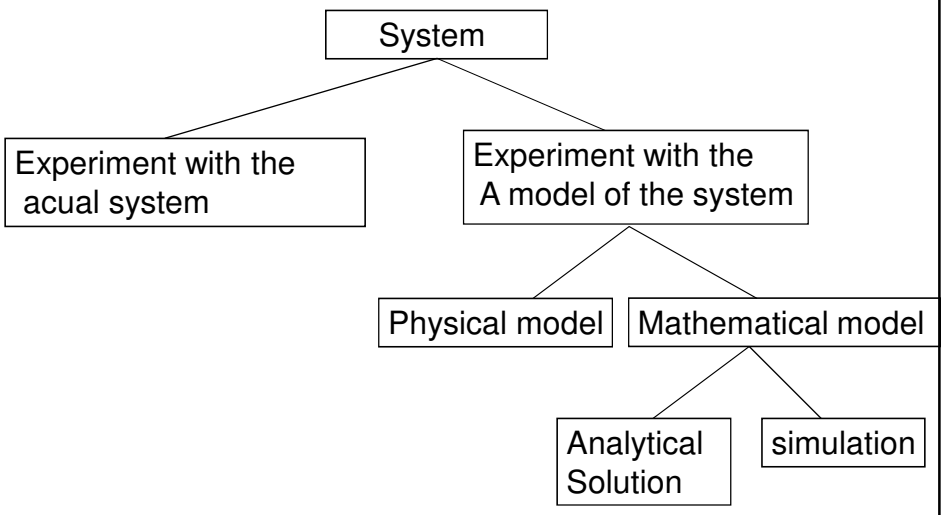
Rules of Simulation

- Never simulate unless you have to.
- Set the objective of your study clearly: What questions do you want answered.
- Model building.
- Data collection (input analysis): Estimate parameters using accurate statistical procedures.
- “Coding” (using a computer) to develop the model.
- Validation and verification.
- Output analysis: Experimental design, statistical sampling, decide on number of runs and replications.
- Documentation. Report results. Implementation.
- Suggest improvements.

Why do we use Simulation

- Provides a way to study complex, real-world systems that cannot be accurately described by a mathematical model that can be evaluated analytically.
- It may be too difficult, hazardous, or expensive to observe a real, operational system
- Parts of the system may not be observable (e.g. internals of a silicon chip or biological system)
- Allows estimation of the performance of an existing system under some projected set of operating conditions.
- Allows comparison of alternative proposed system designs to see which one best meets a specified requirement.

Ways to study a system



Simulation versus Analytical Modeling

- Simulation is not used when a suitable mathematical model exists
- Simulations are often complex pieces of software
- Simulation only produce approximate answers
- Simulation can take a LONG time to execute
- Mathematical models are less flexible, but they are exact and efficient

Examples

- Consider a system when a given object move
- This system can be modelled by the equation

S= V * t

Where S is the distance run through, V is the speed of the object, t is the time that has been observed.

- This is a simplification of the real world
- **Another model** can take into account the direction of movement, or the three dimension coordinate …
- It is therefore to study the behaviour of the system based on a specific model

Computer Simulation

- a computer program that models the behavior of a physical system over time.
- Program variables (state variables) represent the current state of the physical system

How it works?

- The behavior of the system is described by **state variables**
- The simulation program modifies the states variables to emulate the evolution