Introduction

CS1538: Introduction to Simulations

Course Objectives

- Understanding the basics of computer simulation:
  - When/How is simulation useful?
  - How to develop / run a simulation?
  - How to interpret / analyze the results?
- Understanding some of the underlying mathematical principles:
  - Statistical models and probability distributions
  - Queuing theory
  - Random numbers
  - Analysis / generation of input data
  - Analysis / measurement of output data

What is Simulation?

- From *Discrete-Event System Simulation* (Banks et al., 2010):
  - "A simulation is the imitation of the operation of a real-world process or **system** over time."
  - It "involves the generation of an artificial history of a system, and the observation of that artificial history to draw inferences" about the real system

- From *Simulation Modeling & Analysis* (Law, 2007):
  - "we use a computer to evaluate a **model** *numerically*, and data are gathered in order to *estimate* the desired true characteristics of the model"

Systems, Models, and Simulation

- System
  - "a facility or a process, either actual or planned" (Kelton et al.)
  - "a collection of entities that act and interact together toward the accomplishment of some logical end" (Law)
- Model
  - An imitation, typically a simplified representation of something more complex for the purpose of studying the original thing.
  - Physical models vs. mathematical models
- Computer simulation is about developing and using mathematical models of systems

Examples of systems

- A computer network with servers, clients, printers, etc.
- A freeway system with road segments, interchanges, controls, and traffic
- Infectious disease

- Others?

Developing Simulations

1. Determine system to study and variables of interest
2. Decide on a model
   - Data-driven
   - Expert-driven
3. Translate model into simulation program
4. Run simulation *many* times
5. Summarize results

Usefulness of Simulations

- When might simulations be useful?

- When might simulations not be useful?