IE 3553 / 5553 Simulation
Syllabus - Fall 2024

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Course Description:

This course is an introduction to computer simulation. We will cover fundamentals of simulation modeling and analysis: generation of psuedo-random numbers, generation of random variables, input probability distributions, variance reduction techniques, analysis of simulation output, and comparison of system configurations using experimental design. We will also learn how to construct Monte Carlo simulations to answer questions about probability models. For discrete-event simulation models with a time-advance component, we will use Simio, a special-purpose software package to create and analyze simulation models that are commonly encountered in industries such as manufacturing, service operations, healthcare, and transportation. For static Monte Carlo simulations, I will demonstrate techniques using the R programming language; however, you are free to use Python or any other programming language that you prefer.

Textbooks:

1. *Simulation Modeling and Analysis*, 5th edition, Averill Law, McGraw Hill, 2015.
2. *Simio and Simulation: Modeling, Analysis, Applications*, 7th edition, Jeffrey S. Smith and David T. Sturrock, published by Simio LLC, 2024, available at https://textbook.simio.com/SASMAA/.
3. Additional reference: *Simulation*, 5th edition, Sheldon M Ross, Academic Press, 2013.

Prerequisites:

IE 3553: CSE Upper Division, CSci 1133 Introduction to Programming (or equivalent), IE 3521 Probability and Statistics for Engineers (or equivalent).
IE 5553: Upper division or graduate student; familiarity with probability/statistics

Course Goals and Learning Objectives

1. Implement Monte Carlo simulations in a general-purpose programming language such as R or Python.
2. Create discrete-event simulations with a time-advance component using Simio.
3. Understand the operation of the simulation clock in discrete event simulation.
4. Analyze data to select appropriate input distributions.
5. Construct and interpret confidence intervals from simulation output.
6. Use proper simulation modeling and design to compare alternative system configurations.
7. Utilize variance reduction techniques such as common random numbers.
8. Properly design and execute simulation studies using factorial designs.

Workload

This class requires reading, working problems by hand, and creating and running models using simulation software. While we will demonstrate the simulation software in class, you will need to investigate and experiment with it on your own. In the end you will gain a marketable skill for Industrial and Systems Engineering professionals.

Grade Components

The contributions toward the overall course grade are as follows.

Homework	35%
Short assignments	10%
Project	15%
Exam 1	20%
Exam 2	20%

Tentative Schedule of Topics

Week	Topic
1	Introduction to simulation modeling
2	Basic probability and statistics
3	Simulation output and model credibility
4	Modeling with Simio
5	Input distributions
6	Random number generation
7	Modeling with Simio
8	Exam 1
9	Analyzing simulation output
10	Comparing alternative systems
11	Experimental design
12	Variance reduction techniques
13	Project presentations
14	Selected topics in simulation, e.g. financial simulations
15	Agent-based simulation, Markov Chain Monte Carlo simulation