OR 335/ SYST 335
Discrete Systems Modeling and Simulation
Spring 2013

Class time: 9:00am-10:15am, Tuesday, Thursday, Jan 22 – May 2, 2013
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Course Description:
Many complex engineering systems and business processes can be modeled as discrete-event systems. Examples include call center, supply chain, hospital emergency rooms, airport terminals, and air traffic control systems. The complexity of the systems and the uncertain nature of the environment often make simulation the only feasible analytical tool to model and study the design and operations of these systems. This course studies the important topics in discrete-event simulation theory and practice. Topics will include stochastic modeling of discrete-event systems, input modeling, random number generation, statistical analysis of simulation output, and techniques to improve the efficiency and accuracy of simulation results. A very important part of this course is for the students to learn to actually use simulation to model and analyze a discrete-event system. Simulation packages such as Arena will thus be extensively used through the course.

Prerequisites: CS 211 or grade of C or better in IT 206 or equivalent; and STAT 344, or STAT 346, or MATH 351, or grade of C or better in STAT 250. **Prerequisite requirements will be strictly enforced.**

Grading: Homework 25%; midterm 35%; term project 40%.

Late homework submissions are allowed. However, the penalty for late homework is 30% for the first day and then 5% per day. No exemption. Homework problems should be worked out independently but discussions are allowed.

In class midterm is tentatively scheduled on Tuesday, April 2. Make up exam for certified medical reason only.

Teams with 3-4 members will work on the term project. More details about term project will be given during the semester. You may choose any discrete-event simulation related subjects. You are strongly encouraged to do a simulation project motivated by a real problem. However, you should be careful to define the scope of the problem you want to address in the project and make sure that your peers can understand the problem you are trying to model and study, and

you can finish the project on time. Term project presentations are tentatively scheduled on April 30 and May 2. Every team member is required to present.

Textbooks

Required text:

J. Banks, J. S. Carson, II, B. L. Nelson, and D. M. Nicol, "Discrete-Event system Simulation," 5th Edition, 2010. Earlier version of this book is fine too. (You may use the 4th Ed., but be aware of the changes, especially exercise questions assigned for homework). This book provides a comprehensive coverage of the fundamentals in simulation modeling & analysis. It is also a valuable reference book for successful simulation applications. It is independent of any specific simulation software package.

Recommended text:

W. D. Kelton, R. P. Sadowski, and D. T. Sturrock, "Simulation With Arena," 5th Edition, 2010. ARENA is the probably the most popular simulation software package used in industry. Since ARENA is very powerful in its modeling capability and provides many useful features to assist in building simulation model and analyzing simulation results, many earlier students used it for their term projects. It is highly recommended that each project team buys at least one copy of this book if Arena is used. You may also use the 3rd or 4th edition of this book but be aware that they were written for earlier versions of Arena.

Another useful book on simulation:

C. H. Chen and L. H. Lee, "Stochastic Simulation Optimization: An Optimal Computing Budget Allocation," 2010. This book gives an introduction to simulation and focuses on the use of optimization via simulation, i.e., optimizing system design using the simulation model of the system.

Simulation software

Arena:

ARENA is a very popular simulation software package and will be used in this class. The student version of Arena is free of charge (http://www.arenasimulation.com/Arena_Home.aspx). The student version of Arena is essentially the same as professional version except the limit on the size of model you can run.

Please read the instructions in the appendix of the book carefully before installation. If you have a Windows-based computer, you can install Arena on your own PC. In addition, Arena professional version 14.0 is available at the IT&E PC Lab on the first floor of the engineering building. The professional version allows you to run much bigger models. However, you must only use it for educational purpose!

Excel add-in software packages for simulation:

@Risk and Crystal Ball are two popular Excel add-in Monte Carlo (note that they are not developed for discrete-event simulation) simulation software packages. We will not use them in this class. But keep in mind that in practice, many simulation studies are done on a spreadsheet using software tools like them. Some useful reference books for these tools are: (1) Crystal Ball: "Introduction to Simulation and Risk Analysis" by J. R. Evans & D. L. Olson, Prentice Hall. (2) @RISK: "Simulation Modeling using @RISK", by W. L. Winston, Duxbury.

High-level programming languages:
In principle, all simulation models can be built using a high-level programming language like C++ or Java as long as there is a good random number generator. It gives you the most control and flexibility to build the simulation model but requires much more time and expertise than readily available simulation software packages.

Tentative Course Schedule & Reading Assignment:

Topics	Lectures	Reading Materials
Introduction to discrete-event systems and simulation	1	Chapter 1
Review of basic probability and statistics	2	Chapter 2 and section 3.1
Building simulation model	2	Chapter 5, Arena book Chapter 3
Generating random numbers from uniform distributions	1	Sections 7.1-7.3
Generating random numbers from non-uniform distributions	3	Chapter 8
Input modeling	2	Sections 9.1-9.6
Simulation output analysis	2	Chapter 11
More on Arena	6	Arena book Chapters 4, 5
Comparing alternative systems & optimization via simulation	2	Sections 12.1-12.2, 12.4
Monte Carlo Simulation	2	Section 2.3
Verification and validation	2	Chapter 10
Term project presentation	2	