OR 635

Discrete System Simulation

Fall 2011

Class time: 4:30pm-7:10pm, Thursday

Room: West 1004

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Course Description:

Many complex engineering, operations, and business systems can be modeled as discrete-event systems, including call center; manufacturing companies' 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 analytic 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: Students should be familiar with basic probability and statistics at the level of OR 542, or STAT 346, or STAT 354, or equivalent. Students should also be familiar with one scientific programming language.

Grading: Homework 25%; Midterm 25%; Term Project 25%; Final 25%

In class midterm is scheduled for Thursday, October 13. The final exam will be on Thursday, 12/15, from 4:30pm-7:10pm. Make up exam for certified medical reason only.

Late homework and term project report are allowed. However, the penalty for late homework and term project report is 30% for the first day and then 5% per day. No exemption. Homework problems should be worked out independently but discussions are encouraged. Teams with 2-3 members will work on the term project. Please respect academic integrity.

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 which is relevant with your current work. 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. Team work is encouraged. Each team should have 2 to 3 members.

Textbooks

Required text:

- M. Law, "Simulation Modeling & Analysis," 4th Ed. (You may use the 3rd Ed., but be aware of the changes). 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 2nd, 3rd, or 4th edition (NO 1st edition!) of this book but be aware that they were written for earlier versions of Arena.

Other useful books on simulation that may be of interest

- S. Asmussen, P.W. Glynn, “Stochastic Simulation: Algorithms and Analysis”. This book provides in-depth coverage of many advanced topics in stochastic 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 education version of Arena is free of charge if you use it for class homework or term project. You can download the software at the Arena Book Web Site. 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 Version 12.0 is available at the IT&E PC Lab. Please note that Arena version up to version 11 is not supported on Windows Vista and click "Issues about Installing Arena at Windows Vista" for details. The student version of Arena is essentially the same as professional version except the limit on the size of model you can run. The professional version allows you to run much bigger models. However, please 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 for 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	Optional reading
Introduction to discrete-event systems and simulation	1.5	Law 1.1-1.4.5 (except 1.4.4), 1.7, 1.9	For those interested in C implementation of the simulation model, Law 1.4.4
Review of basic probability theory and statistics	0.5	Law 4.1-4.2, 4.4	Law 4.3, 4.5, 4.6
Simulation software package	3	Law 3.1-3.3, Kelton Chapters 3, 4.1-4.5	Law 3.4-3.7, Kelton 5
Input modeling	1.5	Kelton 4.6, Law 6.4	The rest of Law Chapter 6
Generating random numbers from uniform distributions	0.5	Law 7.1-7.2	Law 7.4
Generating random numbers from non-uniform distributions	1	Law 8.1-8.5	Law 8.6

Simulation output analysis	2	Law 9.1-9.5.2	Law 9.5.3-9.6
Comparing alternative system configurations & optimization via simulation	1	Law 10.1-10.4	
Variance reduction techniques	0.5	Law 11.1-11.2.2, 11.3	11.2.3-11.2.4
Monte Carlo Simulation	0.5	Law 1.8.3	
Term project presentation	1		