CSE/ECE 6730: Modeling and Simulation: Fundamentals & Implementation

Spring 2015

Meeting Time and Place: MWF 11:05 - 11:55 AM, 2443 Klaus Advanced Computing Building
Most weeks two of the class meetings (Monday and Wednesday) will be devoted to lectures. The third (Friday) will focus on discussion sessions to further develop topics and team meetings for collaborative work on projects, and short quizzes scheduled throughout the semester.

Instructor

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Teaching Assistants

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Email is the preferred mode of communication.

Course Description

Modeling and simulation (M&S) has become indispensible in virtually all fields to analyze, understand, and design systems. This course will provide students the necessary knowledge and skills to formulate and solve modeling and simulation problems. A second objective of the course is to develop the necessary skills to create efficient simulation software in a high level programming language such as C or Java. A third goal is to develop and demonstrate interdisciplinary communication skills. This course focuses on the creation and application of discrete-event simulation.

M&S is a topic that is best learned by doing. M&S projects usually involve a team, often including individuals from different disciplines. The course is structured around projects where topics and skills are developed in the context of solving problems. This approach emulates how modeling and simulation is typically applied in practice.

The topics covered in the course are divided into three parts:

- Part I: M&S Methodology and Discrete Event Simulation. This part focuses on the major steps in the life cycle of a modeling and simulation project, from problem formulation to development and application of the simulation model, to analyzing and reporting results. These steps will be completed in the context of completing the first course project.
- Part II: Parallel and Distributed Simulation. This part addresses topics concerned with distributing the execution of simulations, especially discrete-event simulations across multiple processors. Parallel discrete event simulation is concerned with executing the simulation on tightly coupled multiprocessors, e.g., many-core processor architectures. Distributed simulation is concerned with executing on loosely coupled distributed computing platforms and addresses important issues such as simulation interoperability.

- Part III: Complex Systems and Agent-Based Simulation. This part focuses simulations used to study aggregated behaviors that emerge in systems composed of many interacting components, or agents. The emphasis of these simulations is on understanding the system as a whole rather than dissecting the system and understanding the individual components in isolation. Complex systems arise in many areas of practical importance today.

Course Materials

The bulk of the course will be based on material from the following textbooks. The first is available free of charge from the library. The others may be purchased through standard outlets such as Amazon.

- L. G. Birta and G. Arbez, Modeling and Simulation: Exploring Dynamic System Behavior, Springer, 2007 (available online from the Georgia Tech library).
- R. M. Fujimoto, Parallel and Distributed Simulation Systems, Wiley Interscience, 2000.
- M. Mitchell, Complexity: A Guided Tour, Oxford University Press, 2009.

Additional readings will be made available on t-square. Other recommended textbooks include:

- A. M. Law and D. Kelton, Simulation Modeling and Analysis, McGraw-Hill, 2014.
- J. A. Miller and S. E. Page, Complex Adaptive Systems, Princeton University Press, 2007.
- Y. Bar-Yam, Dynamics of Complex Systems, Addison Wesley 1997 (available online at http://necsi.edu/publications/dcs/index.html).

Schedule

The detailed schedule of topics and reading assignments for the course follows.

BA:Birta-Arbez; M: Mitchell; F: Fujimoto

Wk	Monday	Wednesday	Friday (Q=Quiz)	Reading
1/5	Introduction	M&S Life Cycle; Conceptual Models	Project: problem statement	BA:ch 1,2
1/12	Conceptual models	Simulation model	Lit. survey	papers; BA: ch 4 F:ch 2
1/19	Holiday (no class)	Priority queues	Sim. model	papers
1/26	Random numbers	Random variates	Q1; Group meeting	BA:3.4
2/2	Input Analysis	Output Analysis	Statistical Analysis	BA:3.1-3.3; ch 6
2/9	Verification, Validation	Parallel Simul., CMB	Q2; Group meeting	Papers, F:ch 1,3
2/16	Synchr. algorithms	Time Warp	Posters; Project due	F:ch 4
2/23	GVT Algorithms	Distrib. Virtual Env.	Q3; (Drop Date)	F:7.1-7.4
3/2	Dead Reckonning	HLA, Interoperability	Project 2 Teams	F:7.5-7.8
3/9	Metamodels	Data distribution	Group mtg	Papers, F:8.5-8.6
3/16	Spring break	Spring break	Spring break	
3/23	Complex systems	Emergence	Q4; Group mtg	M:ch1,2
3/30	Cellular automata	Logistics equation; chaos	Group mtg	M:ch 10
4/6	Power laws; scaling	Networks	Group mtg	M:ch15,16,17
4/13	Presentations	Presentations	Q5; Presentations	

4/20	Presentations	Presentations	Pres. Project due	

Final Exam: Wednesday, April 29, 2015, 8:00 AM – 10:50 AM

Projects

The course is organized around two projects, each involving a team of 3-4 students each. The first project will be one assigned to the entire class. The second project will be one proposed by student teams based on your own particular interests.

Quizes and Exams

The philosophy used in this course is learning is best facilitated by reviewing and understanding the material over a prolonged period of time. Quizes are intended to provide a time for you to review course material and better understand key concepts and principles. There will be 5 brief quizzes scheduled throughout the semester covering material covered in the lectures. Each quiz will last approximately 15 to 20 minutes. Four quizzes (the ones receiving the highest scores) will count toward your final grade. With the exception of unexpected medical emergencies of the student him/herself, there will be no excused absences from quizzes and no make-up quizzes.

A final examination will take place during the regularly scheduled exam period. This exam will be comprehensive, covering all material covered in the semester, emphasizing material covered in the lectures.

Grading and Due Dates

Grading will be based on the following weights:

- Project 1: 30%
- Project 2: 30%
- Quizes (best 4 scores): 20%
- Final Exam: 20%

All deliverables (reports, literature reviews, software) must be submitted electronically through T-Square and are due at 11:59 PM of the specified due date, unless other instructions are specified.

Collaboration, Citing, and Honor Code

All students are expected to follow the Georgia Tech Honor Code. Projects will involve team efforts and are expected to entail close collaboration within each team. However, each student within the team must have a clearly identifiable contribution, and each student is required to develop software for the simulation model. Individuals or teams may discuss the project with other teams, however, no software may be disseminated between teams except when explicit permission is granted by the instructor.

If you use the Web or other sources for any information, you must cite these sources in your reports. You will need to use the Web for information, and may use software available on the web with proper citation. Utilizing code from the Web without citation violates the Honor Code.