

CS451: Advanced Modeling and Simulation

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Class Time/Place: 2:00 – 3:15PM, Tuesday and Thursday, Olsson 005

Course Webpage: https://toolkit.itc.virginia.edu/cgi-local/tk/UVa_SEAS_2007_Spring_C_S451-2

Prerequisites: Some maturity in Computer Science, eagerness to explore M&S challenges.

While a beginning M&S course such as Sys 362 is desirable, it is not a prerequisite. We will review essentials at the beginning of this course.

"All science is simulation these days," --Stephen Lee, Deputy Division Leader,
Computational Sciences, Los Alamos National Labs.

--- Wired Magazine, Jan, 2006. <http://www.wired.com/wired/archive/14.01/birdflu.html>

Course Objectives: Modeling and Simulation (M&S) is ubiquitous. In most science disciplines, simulation has replaced many experiments in labs and in the field. Historians and social scientists use simulation to explore and validate theories. Manufacturers use simulation in design to replace construction of expensive prototypes. The military uses simulation extensively, to train soldiers and to design and evaluate equipment.

Unfortunately simulationists frequently use simulation naively, i.e. they lack understanding of critical M&S technology, relating e.g. to model uncertainty, model semantics, composability, coercibility, multi-resolution modeling and federations. Invariably simulation users wish to construct larger simulations from smaller ones (composing) or study phenomena at varying levels of abstraction (multi-resolution modeling), but the knowledge to do so, and an awareness of known challenges and limitations, is lacking. CS451 is designed for students, scientists and non-scientists alike, who wish to acquire a technical appreciation for existing capabilities, challenges, and limitations in M&S technology. There will be significant detailed exposure to existing, socially significant, modeling and simulation applications.

Evaluation: Class participation (20%) four projects during the semester (30%), a final student selected project (25%) and a final oral exit interview (25%),

Reading: Weekly. Assigned papers and material on the web.

Key topics:

- Overview of M&S essentials
- Overview of M&S grand challenges as identified by the experts
- Uncertainty in simulation and public policy
- Model semantics; abstraction and fidelity; paradigms and contexts
- Interface and semantics standards; semantic consistency; ontologies; interoperability
- Multi-resolution modeling
- Yucca Mountain TSPA
- Model repositories; model reuse; composability, model families
- Chaotic systems and weather forecasting
- Agent based simulation and epidemic disease spread
- DDAS and COERCE; designing for coercibility
- Parallel and distributed simulation (time permitting)
- Model validation
- Human behavioral modeling
- Case study presentations

Additional notes:

We will have some guest speakers. I have a number of contacts in industry, government and academia who have faced many of the challenges that will be exposed and discussed in the class. Their practical experience is invaluable.

Projects (four) will be related and form a “project sequence”. Project sequences will consist of applications of material recently learned to various case studies to real uses of simulation. Student projects can be derived from one of a handful of possibilities, including: 1) building a working, adaptable simulation, 2) infusing course-related technologies into the on-going simulation effort of a research program; 3) supporting a PhD student performing research in simulation technology, or 4) supporting a professional simulationist conducting work in simulation technology. I’m quite open to other project suggestions. The goal of the student project is to apply knowledge and skills learned in this class to ongoing M&S research or study related activities.

If you have any questions, feel free to contact me at reynolds@virginia.edu or at 434 924-1039.

Pledge Policy:

You are strongly encouraged to work together. Your exit interview is the only time you will be required to operate on your own. In all matters relating to this class you should conduct your activities consistent with your student honor system expectations.