CSE 691: Advanced Topics in Computer Science
Computational Game Theory and Economics
(Fall 2008)
Department of Computer Science
Stony Brook University (SUNY)

Syllabus

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General Information (2008-2010 Graduate Bulletin)

Course Description: An advanced lecture course on new topics in computer science. This course is primarily designed for Ph.D. students, but can be taken by M.S. students as well.

Prerequisites: Limited to CSE gradate students; others, permission of instructor.

Credits: 3

Grading: ABCDF

Fulfilling Program Requirements: May be repeated for credits as the topic changes, but cannot be used more than twice to satisfy CSE major requirements for M.S.

Overview

Computational game theory and economics is an emerging yet quickly developing area at the interface of computer science and economics. The area seeks to build on classical results in game theory to provide practical models and effective algorithms better suited to study and solve problems in large complex systems in modern society. Of major interest are compact models and efficient algorithms to understand and predict the complex global behavior that emerges from local interactions. Auctions, the Internet, social networks, computational biology, and interdependent security are some example application domains.

Purpose: To introduce students to fundamental concepts and results in the new and exciting area of computational game theory and economics, to expose them to the state-of-the-art and applications, and provide them the ability to make significant contributions to this quickly developing research area.

Objectives: To provides an introduction to the area of computational game theory and economics (and its applications), to study the latest developments in this recent research area, and to identify open problems and opportunities for future research, as well as potential, novel application domains.

Goals: At the end of the course, students should be able to

- describe and explain game-theoretic computational models and algorithms;
- describe, summarize, and present previous work;
- review and critic the scientific literature;
- recognize research opportunities and open problems;
- apply existing models and algorithms to new domains; and
- identify potential novel applications.

Content

Organization: The course format involves formal lectures, discussions and presentations, some led by the students themselves. Classical and recent research papers, possibly supplemented with textbook readings in the area, represent a large portion of the reading material for the course.

Textbook:

Noam Nisan, Tim Roughgarden, Éva Tardos, and Vijay V. Vazirani. *Algorithmic Game Theory.* Cambridge University Press, 2007.

Tentative List of Topics

- Game theory fundamentals: noncooperative game theory, classical game representations, zero-sum and general-sum games, stochastic games, solution concepts such as Nash and correlated equilibria, existence theorems
- Basic concepts in mathematical economics: abstract economies, Fisher and Arrow-Debreu models of competitive economies, general (market) equilibria and the existence of equilibrium prices in exchange markets
- Compact representations of large-population games: graphical games, potential games
- Graphical economies and the effect of network structure on market prices
- Computational complexity and algorithms for classical and modern game-theoretic models
- Connections to artificial intelligence and probabilistic graphical models (e.g., Bayesian and Markov networks) and inference methods (e.g., belief propagation) for reasoning under uncertainty
- Learning in games: fictitious play, best-response (gradient) dynamics, no-regret learning
- Evolutionary game theory: classical and network models
- Revealed preferences and learning games
- Mechanism design and combinatorial auctions

- Applications: network routing, network formation, interdependent security, vaccination, computational biology, multi-agent systems, (online) auctions, sponsored search

NOTE: *The list of topics, as well as the emphasis on each topic, will likely vary depending on the background and interests of the course participants.*

Assessment

Course Project: Students complete a research project on a relevant topic. The specific problem requires the instructor's approval. The project can be theoretical or experimental in nature. Ideally, the problem will address an open research question and the report will lead to a submission to a scientific conference. Students periodically submit progress reports to monitor the project's development. Students give a presentation and submit a written report on the results of the project by the end of the course.

Student Evaluations: Students performance will be evaluated based on their level of participation during the discussions, and the quality of their topic oral presentation and written report, as well as their project's proposal, progress reports, oral presentation and final written report.

Grades: The following table shows the amount and weighting of each evaluation component in the course.

Criteria	**Quantity**	**Percent**
Class participation		20%
Topic report	1	10%
Topic oral presentation	1	10%
Project proposal	1	5%
Project progress reports	2	5%
Project oral presentation	1	20%
Project final report	1	30%
Total		**100%**

Final grades will be assigned using the traditional grading scale (90-100=A, 80-89=B, 70-79=C, 60-69=D, 0-59-F), with deviations at the instructor's discretion.

General University Statements

Americans with Disabilities Act: If you have a physical, psychological, medical or learning disability that may impact your course work, please contact Disability Support Services, ECC (Educational Communications Center) Building, room128, (631) 632-6748. They will determine with you what accommodations, if any, are necessary and appropriate. All information and documentation is confidential.

Academic Integrity: Each student must pursue his or her academic goals honestly and be personally accountable for all submitted work. Representing another person's work as your own is always wrong. Faculty are required to report any suspected instances of academic dishonesty to the Academic Judiciary. Faculty in the Health Sciences Center (School of Health Technology & Management, Nursing, Social Welfare, Dental Medicine) and School of Medicine are required to follow their school-specific procedures. For more comprehensive information on academic integrity, including categories of academic dishonesty, please refer to the academic judiciary website at `http://www.stonybrook.edu/uaa/academicjudiciary/`

Critical Incident Management: Stony Brook University expects students to respect the rights, privileges, and property of other people. Faculty are required to report to the Office of Judicial Affairs any disruptive behavior that interrupts their ability to teach, compromises the safety of the learning environment, or inhibits students' ability to learn. Faculty in the HSC Schools and the School of Medicine are required to follow their school-specific procedures.