Management Science and Engineering 336
Topics in Game Theory with Engineering Applications

Mondays and Wednesdays, 10:00-11:50 AM
Huang Engineering Center, Room 203
3 units

Instructor:

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Note that there will be no lecture on Weds., April 27, or Weds. June 1.

Course webpage: http://eeclass.stanford.edu/msande336

Course description:

The goal of this course is to introduce students to the frontiers of the intersection between game theory and engineering.

This year, our investigation will focus on "large" markets and "large" games—i.e., markets and games with many players. In particular, the course will focus on two related goals: first, to understand markets behave as the number of participants increases; and second, to exploit large scale as a vehicle for development of approximation methods for large dynamic games. The course will develop a theoretical foundation, as well as discuss of topics of active research.

1. Introduction
2. Part I: Price equilibrium (general equilibrium; applications to resource allocation; tatonnement processes and the Walrasian auctioneer; convergence to general equilibrium)
3. Part II: Equilibrium with asymmetric information (no-trade theorem; rational expectations equilibrium; information aggregation)

4. Part III: Herd behavior (herding in a sequential model; herding with network structure; herding in financial markets)

5. Part IV: Large stochastic games: theory (Markov perfect equilibrium; mean field equilibrium; existence and approximation results)

6. Part V: Large stochastic games: applications (auctions; oligopoly models; network effects)

The course will be taught using a mix of lecture format and seminar-style guided discussion. Much of what we will discuss is active research, so the reading material will be drawn from relevant papers in the literature; this material will be available from the course website. The focus will be on encouraging discussion of both open theoretical questions and modeling issues. This is particularly important since the course content draws from a range of disciplines (operations research, economics, network engineering, computer science). The course should provide a unique forum for a lively exchange of ideas across these boundaries.

Given the advanced nature of the material, it is emphasized that the course should be viewed as a *research seminar* by prospective students.

Grading

The grade will be based on a project to be completed at the end of the quarter. The choice of topics for the final project will be quite broad: students can choose to either discuss and present recent research results in the field, or develop their own problem statement and analysis.

Prerequisites

Above all, the course requires broad mathematical maturity. Despite the applied interest in the material, this is a course with significant theoretical content; an ability to read, write, and think rigorously is essential to understanding the material.

The following are all required prerequisites; if you do not meet them, you may audit the class but should not register:

1. Real analysis, at the level of Math 115 or preferably Math 171, or equivalent.

2. Optimization, at the level of MS&E 211 or equivalent.

3. Probability and random processes, at the level of MS&E 220 and 221, or equivalent.

4. Game theory, at the level of Econ 203 or MS&E 236/246, or equivalent.

In addition, dynamic optimization at the level of MS&E 251 or equivalent is strongly recommended.

Intending students who are not comfortable with the material from the prerequisites listed above should expect to audit the course; any questions or concerns can be directed to Prof. Johari at the e-mail address above.

Textbooks

There will be no required textbook for this course; almost all of what we discuss will be drawn from research papers. However, you may find some of the following books helpful.

Game theory books:

1. *Game Theory*, Fudenberg and Tirole. This reference should be on the shelf of every game theorist, but it is not necessarily the easiest book to learn from.

2. *A Course in Game Theory*, Osborne and Rubinstein. This is a good introductory level text in game theory, that still is quite rigorous. Although many game theory books are out there, I have found that this one is a good introduction for engineers.

3. *Game Theory: Analysis of Conflict*, Myerson. This is a more mathematically sophisticated treatment of the subject.

4. *Microeconomic Theory*, Mas-Colell, Whinston, and Green. This very large textbook is an encyclopedic reference on the subject, and likely very useful for many parts of this course.

5. *Game Theory for Applied Economists*, Gibbons. This is a basic undergraduate level text in game theory, appropriate if you have never seen the subject before; it provides an elementary treatment of most of the major topics.