

<http://www.eecs.harvard.edu/cs285/>

**General Information**

Algorithmic, game-theoretic and logical foundations of multi-agent systems, including distributed optimization and problem solving, non-cooperative game theory, learning and teaching, communication, social choice, mechanism design, auctions, negotiation, coalitional game theory, logics of knowledge and belief, collaborative plans and social systems.

**Instructor**

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Maxwell-Dworkin 229

Office Hours: Tuesdays, 1-2 PM

**Teaching Fellow**

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Maxwell-Dworkin 217

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**Course Goals**

A multi-agent system is composed of multiple autonomous entities, with distributed information, computational ability, and possibly divergent interests. Multi-agent systems may be cooperative, as in those of sensor networks and mobile robots in a warehouse, or competitive, as in those of electronic commerce, or for resource or task allocation to competing firms. The agents in a multi-agent system may be both artificial and human (and often humans are present at least on the "edges" to provide preference information.)

The goal of this class is to provide a broad and rigorous introduction to the theory, methods and algorithms of multi-agent systems. The material spans disciplines as diverse as computer science (including h artificial intelligence, theory and distributed systems), microeconomic theory, operations research, and linguistics. Of course, we will seek to emphasize computational perspectives where appropriate. The class is designed both to provide a survey of this exciting area for students of computer science, applied mathematics and microeconomics, and will provide an excellent basis for continued research in this area.

**Prerequisites**

The stated requirement is Computer Science 181 or 182. A level of comfort with mathematical formalisms and proofs is required. Students should also have familiarity with basic computer science (algorithms, complexity; e.g., CS 121 and CS 124), and basic probability theory (e.g. Stat 110 or ES 101). Familiarity with mathematical programming (AM 121), game theory (EC 1051 or EC 1052), and classical logic is helpful but not required. Definitely talk to the instructor after class on Feb 3 if you have any questions. Students with a background in mathematical economics (e.g. EC 1011a) and an interest in computational issues should be able to appreciate the class materials.

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**Course Reading**

Required text: Multiagent Systems: Algorithmic, Game-Theoretic and Logical Foundations, by Yoav Shoham and Kevin Leyton-Brown, Cambridge University Press 2008. (Available at the COOP)

**Course Structure**

This class will be mostly lecture-based, but with an intent to facilitate class discussion. Students will be expected to submit comments on the reading before each class, to stress questions that they have about the material and possible areas of discussion. Moreover, there will be two classes dedicated solely to discussion and reflection on the material covered in the class. There will be three problem sets, that will not require any programming. In lieu of a final exam there will be an expositional paper, on a topic of the student's choice.

**Expositional Paper**

In place of a final exam, students will write a short (maximum 10 page) expositional paper on two related technical papers of their choice that are related to the course material. The survey must include an exposition of two formal results in these papers, and must also provide a critical discussion of assumptions made by the authors along with some suggestions about future work.

**Grading**

The final grade in the class will breakdown as: participation and comments 20%, homeworks 60%, exposition paper 20%.

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### Schedule

<b>Introduction</b>	Feb 3	
<b>Game Theory</b>	Feb 5	Cooperation: Distributed Constraint Optimization
	Feb 10	Cooperation: Distributed Optimization
	Feb 12	Non-cooperative Game Theory
	Feb 17	Nash's Theorem
<b>Computation in GT</b>	Feb 19	Computation for Normal-Form Games
	Feb 24	Lemke-Howson Algorithm
<b>Types of Games</b>	Feb 26	Games with Sequential Actions
	Mar 3	Repeated Games, Stochastic Games, Bayesian Games
	Mar 5	Congestion Games, Potential Games, Price of Anarchy
	Mar 10	Graphical Representations
<b>Learning</b>	Mar 12	Learning and Teaching
	Mar 19	Class Discussion
	Mar 31	Aggregating Preferences
<b>Social Choice Protocols</b>	Apr 2	Protocols for Strategic Agents I
	Apr 7	Protocols for Strategic Agents II
	Apr 9	Protocols for Strategic Agents III
	Apr 14	Protocols for Multi-Agent Resource Allocation I
	Apr 16	Protocols for Multi-Agent Resource Allocation II
	Apr 21	Teams of Selfish Agents
<b>Topics</b>	Apr 23	Logics of Knowledge and Belief
	Apr 28	Probability, Dynamics and Intention
	Apr 30	Class Discussion