MULTI-AGENT SYSTEMS & GAME THEORY

MATH/CSCI 8480

Course Description:

This course covers advanced topics in the area of coordination of distributed agent-based systems with a focus on computational aspects of game theory. The main topics covered in this course include distributed constraint satisfaction, distributed constraint optimization, and competitive and cooperative game theory. **3 credits**

Prerequisites:

CSCI 4450/8456: Introduction to Artificial Intelligence. Suggested background courses: CSCI 4480/8486: Introduction to Multi-agent/Multi-robot Systems; CSCI 8080: Design and Analysis of Algorithms.

Overview of Content and Purpose of the Course:

This course covers techniques for interactions between multiple agents using principles of game theory. Students will be introduced to both competitive and cooperative agent interaction settings. Students taking this course will learn the technologies necessary to design and analyze rules of encounter between adversaries in real-world and fictitious settings. The topics studied in this course can be used in various applications such as robotics, game design, distributed systems, social and p2p networks, etc.

Anticipated Audience/Demand:

Anticipated audience: Advanced professionals as well as graduate/Ph.D. students will benefit from the course. The course maintains a good balance between theory and practice by supplementing the theory taught in class with software or hardware projects implemented by the students.

Major Topics:

1) Introduction to Multi-agent Systems

2) Distributed Constraint Satisfaction

3) Distributed Optimization
- **a.** Negotiation, Auctions and Optimization

4) Normal Form Games
- **a.** Introduction
- **b.** Pareto Optimality and Nash Equilibrium
- **c.** Other Solution Concepts for Normal-Form Games

5) Computing Solution Concepts to Normal Form Games

a. Computing Nash Equilibrium of 2-Player Games: Complexity, Lemke-Howson Algorithm
b. Computing Nash Equilibria of N-Player Games
c. Computing Minimax Strategies
d. Dominated Strategies and Iterated Dominance
e. Computing Correlated Equilibria

6) Other Types of Game Representation

a. Repeated Games
b. Stochastic Games
c. Bayesian Games
d. Congestion Games
e. Graphical Games, Action-Graph Games, Influence Diagrams

7) Mechanism Design

a. Mechanism Design with Unrestricted Preferences
b. Quasi-Linear Preferences
c. Vickrey-Clarkes-Groves (VCG) Mechanism
d. Applications of Mechanism Design
e. Contracts, Bribes, and Mediators

8) Auctions

a. Single-Good Auctions
b. Multi-Unit Auctions
c. Combinatorial Auctions
d. Two Sided Auctions and Prediction Markets

9) Coalitional Games

a. Introduction
b. Shapley Value, Core, Refinements to the Core
c. Compact Representations of Coalitional Games

Methods:

In-class lectures are the main method of instruction in this course. The instructor and the students will also present papers related to the course topics published in recent conferences and journals.

Student Role:

1) Attend lectures, participate in discussion topics in class, complete assignments.

2) Present papers from recent conferences and journals in class.

3) Complete one or two projects given in the course, and give a presentation and report on the project.

Textbook:

Shoham, Y., and Leyton-Brown, K., "Multiagent Systems," Cambridge University Press, 2009.