1.0 Course Description

1.1. Overview of content and purpose of the course
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.

1.2. For whom course is intended
This course is intended for graduate students in computer science.

1.3. Prerequisites of the course
CSCI Section:
CSCI 4450/8456: Introduction to Artificial Intelligence
CSCI 8080: Design and Analysis of Algorithms. This course is a suggested pre-requisite.

MATH Section:
CSCI 3320 Data Structures OR comparable course on programming with data structures.

1.4. Unusual circumstances of the course
None

2.0 Objectives

2.1 List of performance objectives stated in terms of the student
Students taking this course will be introduced to concepts used for coordination multi-agent systems. Students who complete this course will be able to conduct advanced academic research or develop commercial agent-based systems. Students will also discuss and analyze different practical issues and problems related to multi-agent coordination.

3.0 Content and Organization (Contact Hours)
3.1 Introduction to Multi-agent Systems (0.5 week)
3.2 Distributed Constraint Satisfaction (1 week)
3.3 Distributed Optimization (1 week)
   3.3.1 Negotiation, Auctions and Optimization
3.4 Normal Form Games (1.5 weeks)
   3.4.1 Introduction
3.4.2 Pareto optimality and Nash equilibrium
3.4.3 Other solution concepts for normal-form games

3.5 Computing Solution Concepts to Normal Form games (2 weeks)
3.5.1 Computing Nash equilibrium of 2-player games: Complexity, Lemke-Howson algorithm
3.5.2 Computing Nash equilibria of n-player games
3.5.3 Computing minimax strategies
3.5.4 Dominated strategies and iterated dominance
3.5.5 Computing correlated equilibria

3.6 Other types of game representations (2 weeks)
3.6.1 Repeated games
3.6.2 Stochastic games
3.6.3 Bayesian games
3.6.4 Congestion games
3.6.5 Graphical games, action-graph games, influence diagrams

3.7 Mechanism Design (2 weeks)
3.7.1 Mechanism design with unrestricted preferences
3.7.2 Quasi-linear preferences
3.7.3 Vickrey-Clarke-Groves (VCG) mechanism
3.7.4 Applications of mechanism design
3.7.5 Contracts, bribes and mediators

3.8 Auctions (2 weeks)
3.8.1 Single-good auctions
3.8.2 Multi-unit auctions
3.8.3 Combinatorial auctions
3.8.4 Two sided auctions and prediction markets

3.9 Coalitional Games (2 weeks)
3.9.1 Introduction
3.9.2 Shapley value, core, refinements to the core
3.9.3 Compact representations of coalitional games

3.10 Game Theoretic Control of Multi-robot Systems (2 weeks)

4.0 Teaching Methodology

4.1 Methods to be used.
The course will be presented primarily by lecture, with opportunities for discussion with and questions from the students.

4.2 Student role in the course.
Students will be expected to attend lectures, complete written and programming assignments and periodic examinations. Students will also complete a significant programming project related to the topics taught in the course.

4.3 Contact hours.
Three hours per week.

5.0 Evaluation
5.1 Type of student projects that will be the basis for evaluating student performance, specifying distinction between undergraduate and graduate, if applicable. For Laboratory projects, specify the number of weeks spent on each project). Evaluation will be based principally on written and programmed assignments, and periodic examinations.

5.2 Basis for determining the final grade (Course requirements and grading standards) specifying distinction between undergraduate and graduate, if applicable.

<table>
<thead>
<tr>
<th>Components</th>
<th>Grading</th>
</tr>
</thead>
<tbody>
<tr>
<td>Programming Assignments</td>
<td>30%</td>
</tr>
<tr>
<td>Class Presentations</td>
<td>10%</td>
</tr>
<tr>
<td>Exam</td>
<td>25%</td>
</tr>
<tr>
<td>Project</td>
<td>35%</td>
</tr>
</tbody>
</table>

5.3 Grading scale and criteria. The following is the possible grading scale and criteria = accumulated grade points from 5.2:

<table>
<thead>
<tr>
<th>Points</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>97-100%</td>
<td>A+</td>
</tr>
<tr>
<td>93-96%</td>
<td>A</td>
</tr>
<tr>
<td>90-92%</td>
<td>A-</td>
</tr>
<tr>
<td>87-89%</td>
<td>B+</td>
</tr>
<tr>
<td>83-86%</td>
<td>B</td>
</tr>
<tr>
<td>80-82%</td>
<td>B-</td>
</tr>
<tr>
<td>77-79%</td>
<td>C+</td>
</tr>
<tr>
<td>73-76%</td>
<td>C</td>
</tr>
<tr>
<td>70-72%</td>
<td>C-</td>
</tr>
<tr>
<td>67-69%</td>
<td>D+</td>
</tr>
<tr>
<td>63-66%</td>
<td>D</td>
</tr>
<tr>
<td>60-62%</td>
<td>D-</td>
</tr>
</tbody>
</table>

6.0 Resource Material

6.1 Textbooks and/or other required readings used in course.

6.2 Other suggested reading materials, if any.

6.2.1.1 Books


6.2.1.2 Journals

6.2.1.2.1 Journal of Autonomous Agents and Multi-Agent Systems

6.2.1.2.2 Journal of AI Research

6.2.1.2.3 Artificial Intelligence

6.2.1.2.4 Games and Economic Behavior

6.3 Other sources of information (Paper-reading list)

6.3.1 S. Lavalle and S. Hutchinson, “Game Theory as a Unifying Structure for a Variety of Robot Tasks”

6.3.2 S. Lavalle and S. Hutchinson, “Path selection and coordination of multiple robots via Nash equilibria”

6.3.3 H. Chitsaz and S. Lavalle, “Exact Pareto-Optimal Coordination of Two Translating Polygonal Robots on an Acyclic Roadmap”


6.4 Current bibliography of resource for student’s information. None

CHANGE HISTORY

<table>
<thead>
<tr>
<th>Date</th>
<th>Change</th>
<th>By whom</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>12/15/2003</td>
<td>Initial version</td>
<td>Dasgupta</td>
<td>New course syllabus</td>
</tr>
<tr>
<td>02/23/2009</td>
<td>Major update</td>
<td>Dasgupta</td>
<td>Changed course name, request for new course number, updated course syllabus to include topics from game theory, added new textbook, added new references, new paper reading list</td>
</tr>
</tbody>
</table>