Mathematical Ideas: Game Theory (Math 120)
GEM 238, Tuesdays & Thursdays 1:20-2:35pm
Spring 2008

Instructor
David Housman will be on campus Tuesdays and Thursdays. It is best to call ahead or schedule an appointment. His office is GEM 215, email address is david.housman@valpo.edu, office telephone is 219-464-5343, and home telephone is 574-875-0339.

Description
Quantitative skills are important for understanding our world and making wise personal, business, and societal decisions. This course will improve your quantitative skills through a study of the mathematics of conflict and cooperation. You will critically read and complete exercises in preparation for intense, team-oriented learning experiences during class time.

Prerequisite
MATH 110 or placement higher than MATH 110 on the math placement examination.

Learning Objectives and Outcomes
1. Modeling: Model situations of conflict and cooperation as games, that is, define important assumptions, convert assumptions into mathematical formalism, identify and use appropriate mathematical techniques and solution concepts, and interpret the results of the mathematical analysis.
2. Game Theory: Describe and compute solutions for strategic, sequential strategic, bargaining, coalition, and fair division games.
3. Quantitative Tools: Use arithmetic, graphs, algebra, probability, and expected value correctly in applied contexts.
4. Communication: Communicate quantitative information and analysis effectively in written and oral forms.
5. Collaboration: Become more effective at achieving goals, obtaining help, contributing information, and supporting others in a collaborative learning environment.
6. Critical Thinking: Improve ability to critique an argument and to evaluate a purported solution.
7. Appreciation: Develop a greater appreciation for the usefulness of mathematics for making personal decisions, understanding our world, and engaging in public discourse.
8. Enjoyment: Experience a vibrant and enjoyable learning environment for mathematics in which new ideas are explored, techniques are evaluated, and assumptions are challenged.
9. Integration: Identify situations that a quantitative approach would enhance performance in making a decision, understanding a phenomenon, or solving a problem; seek and obtain the required knowledge to apply to the situation; build, analyze, and interpret appropriate quantitative models; and then communicate this new understanding to others in order to actually enhance performance.

Resources
The required textbook is *Models of Conflict and Cooperation* by Rick Gillman and David Housman. A copy of the current draft of this book can be obtained from Housman on the first day of class for $20. Please bring cash or a check made out to Valparaiso Math Dept. There are a number of good game theory books in the Christopher Center. The course web site is at CourseVU.

Grade
Your grade will be based upon participation (20%), homework (20%), project (20%), two midterm exams (10% each), and a comprehensive final exam (20%). Earning a 90% average guarantees an A, 80% guarantees a B, 70% guarantees a C, and 60% guarantees a D.

Participation
The study of mathematics is not a spectator sport! Essential to your success is (1) regular study and reflection outside of class, and (2) an active and thoughtful participation during class activities, lecture, and discussion. Attend class and devote several hours each week in preparation.

Homework
Solving problems, writing explanations, reflecting upon ideas, and instructor feedback are essential to learning mathematics. Completion of the homework will prepare you for class discussion. Designated homework will be collected and graded.

Project
The project will be an opportunity, either individually or collaboratively, to examine some topic in greater depth. The final product will consist of a paper and a class presentation scheduled during the last classes of the semester. Potential topics will be mentioned as the term progresses. Details about the mechanics and grading criteria will be distributed after the first midterm exam.

Exams
The exams will be opportunities to exhibit your ability to describe and apply some of the basic concepts and techniques of game theory. The midterm exams will be taken on-line outside of class.

Honor Code
"I have neither given nor received, nor have I tolerated others' use of unauthorized aid." For homework, collaboration is encouraged, but copying is prohibited. It is okay for a group to work together to solve a problem, but written materials produced during the group interaction should be destroyed before each person writes his or her own solution. Acknowledge in writing any collaborations or other resources used. The midterm and final exams are closed book, closed notes, and the only human assistance is the instructor.

Cell phones
Cell phones and all other electronic devices (except calculators) should be turned off during class.

Schedule

Class	Date	Topic	Reading	Homework [points]
1	R Jan 10	Rules of the Game	1.1-2	1.2 #2-6, 8 [10]
2	T Jan 15	Heuristics and Strategies	1.3	1.3 #1-3, 4 or 5, 6, 7a-e, 8a, 9-10, 12 [25]
3	R Jan 17	Game Trees	1.4	1.4 #1, 3, 6 or 7, 9, 8 or 10 [25]
4	T Jan 22	A Solution for Nim	1.5	1.5 #1, 3-5, 8 [20]
5	R Jan 24	Zermelo and Nash	1.6	1.6 #1-4 [16 bonus]
6	T Jan 29	Fair Division	8.1-2	8.2 #1-3 [30]
7	R Jan 31	Fairness Properties	8.3	8.3 #2-3 [30]
8	T Feb 5	Ordinal Preferences	2.1-2	2.2 #1-4, 6 (choose 3 rankings), 7-8 [25]
9	R Feb 7	Cardinal Preferences	2.3	2.3 #5-8 [25]
10	T Feb 12	Review		
11	R Feb 14	Strategic Games	3.1-2	3.2 #1, 7, 11 [30]
12	T Feb 19	More Strategic Games	3.2	Exam 1
13	R Feb 21	Strategic Solution Concepts	3.3	3.3 #4, 7, 10-11, 13, 17 or 18 [30]
14	T Feb 26	Game Trees Again	3.4-5	3.4 #1 & 6 [20]
15	R Feb 28	Game Trees Again	3.4-5	3.4 Presentation [40]
16	T Mar 18	Game Trees Again	3.4-5	
17	R Mar 20	MARPS	4.1-2	
18	T Mar 25	Mixed Strategy Solutions	4.2	4.2 #1, 5, 9, 11, 14 [30]
19	R Mar 27	2 by 2 Games	4.3&5	4.3 #2, 5, & 8 and 4.5 #1ab & 2ab [60]
20	T Apr 1	Review & Coalition Games	7.1	Exam 2
21	R Apr 3	Simple Methods	7.2	Describe & apply method to 7.2 #1-4 [60]
22	T Apr 8	Shapley Method	7.3	
23	R Apr 10	Nucleolus Method	7.4	7.3 #1-4 and 7.4 #1, 2ae, 3ae, 4 [100]
24	T Apr 15	Bargaining Games	6.1-2	
25	R Apr 17	Egalitarian and Raiffa Solutions	6.3-4	6.2 #1, 3 and 6.3 #1acde, 3acde [100]
26	T Apr 22	Nash Solution	6.5	
27	R Apr 24	Prisoner's Dilemma	5.1-3	6.4 #1, 3, 5 and 6.5 #1, 3, 6 [120]
28	T Apr 29	Project Presentations		
29	R May 1	Project Presentations		
30	T May 6	A Last Game or Two & Review		
F	S May 20	1:00 - 3:00pm		Final Exam

Math 120 Game Theory (Spring 2008)
Project

Overview

The project is your opportunity, either individually or collaboratively, to examine some game theory topic in greater depth. The final product will consist of a paper, a class presentation, and individual evaluations.

Mechanics

1. Project topics and teams must be posted at http://valpomath120.pbwiki.com/Project-Topics-and-Teams, finalized, and approved by noon, Monday, April 14.
2. The presentations will be given during classes on April 29 and May 1. The paper and evaluations are due via the CourseVU Homework link by 8:00am, Monday, May 5.
3. Groups of one to four students are permissible.
4. Until a project topic and team has been approved, David is available for *ad hoc* brainstorming of potential topics and negotiating grading criteria in the same ways that he is available to answer questions about course content.
5. Once a project topic and team has been approved, David is available for up to 20 minutes per team member for consultation services. This could include answering questions, suggesting literature to read, critiquing rough drafts, negotiating grading criteria, and so forth. You may either schedule an appointment to meet with David, or you may send him something electronically. If you do the later (say with a question or a draft to be critiqued), be sure to indicate how much of your consulting time you want to be used.
6. There is no preordained number of pages for the paper: use the number of pages necessary to fully explain your work well.
7. Each group has $5 \times$ (the number of team members) minutes for the presentation and audience questions and participation.
8. Each member of the group should submit a written evaluation (project contributions, strengths, and improvement areas) for each member of the group, including him or herself.
9. The grading rubric is given on the other side. The same rubric will be used no matter the size of the team, although the content quantity expectations will increase somewhat with the size of the team.

Grading Rubric

Mathematics and Modeling Content

- 70 points: At a level above the most sophisticated work presented in the class or required reading with no errors in the mathematics or facts.
- 60 points: At a level of the most sophisticated work presented in the class or required reading with no errors in the mathematics or facts.
- 45 points: At a level of a class example or homework exercise with no errors in the mathematics or facts.
- Errors in the mathematics or facts will result in point deductions.

Presentation

- 10 points: Engaging, important aspects emphasized, interactive, organized, and clear.
- Deviations from the above criteria will result in point deductions.

Paper Mechanics

- 10 points: Complete, typed words and neatly drawn diagrams, organized, clear, no spelling or grammatical errors, and proper acknowledgements.
- Deviations from the above criteria will result in point deductions.

Evaluations

- 10 points: Accurate and clearly articulated project contributions, strengths, and improvement areas for each member of the group.
- Deviations from the above criteria will result in point deductions.