

Introduction to Game Theory

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Office hours: By appointment. I am available after school on most days.

Course Description: This class is an exploration of the mathematics of conflict and cooperation situations. It is intended to provide students with an understanding and appreciation for the many instances of human (and animal) interaction that can be analyzed mathematically. We will be covering most of the first 22 chapters of the text:

- I. Introduction
 - A. What is game theory?
 1. The birth of game theory: John von Neumann, RAND, and the Cold War
 2. What can we model using game theory?
 - B. General terms and definitions
 1. Players, strategies, and payoffs
 2. The game matrix
- II. Two person zero-sum games
 - A. Dominance and saddle points
 1. Maximin and minimax
 2. Movement diagrams
 3. Dominated strategies
 4. Applications
 - B. Mixed strategies
 1. Expected value
 2. The value of a game
 3. Graphical solutions for $(2 \times n)$ and $(m \times 2)$ games
 4. Solving (3×3) games
 5. Applications
 - C. Game trees
 1. Perfect and imperfect information
 2. Truncation

3. The role of chance
 4. Applications
 - D. Utility theory
 1. Ordinal and cardinal utilities
 2. Transforming utilities
 3. Utility fallacies
 - E. Games against nature
 1. The difference between nature and a human opponent
 2. Different strategies against nature
- III. Two person non-zero-sum games
- A. Nash equilibria
 1. Equalizing strategies
 2. Pareto optimal
 3. Payoff polygons
 4. Prudential and counter-prudential strategies
 5. Security level
 6. Solvable games
 7. Applications
 - B. The Prisoner's Dilemma
 1. General form
 2. Repeated play in theory and practice
 3. Arguments for choosing cooperation
 4. Applications
 - C. Strategic moves
 1. Commitments
 2. Threats and promises
 3. Lowering payoffs
 - D. Other common two person non-zero-sum games
 1. Game of chicken
 2. Stag hunt

3. Deadlock
 4. Traveler's dilemma
 - E. The Nash arbitration scheme
 1. Negotiation sets
 2. Status quo point
 3. Threat strategies
- IV. N-person games
- A. Basic N-person games
 1. Coalitions
 2. Prudential strategy and security levels for N-person games
 3. Cooperative games
 4. Characteristic function form
 5. Superadditivity
 6. Applications
 - B. N-person Prisoner's Dilemma
 1. Alone vs a coalition
 2. Free riders and the tragedy of the commons
 - C. Voting
 1. Strategic voting
 2. Voting coalitions

Textbook & Required Material: The book for this class is Game Theory and Strategy (Straffin). We will be using the TI-83 calculator on occasion in this class, so make sure that you have it with you for every class period.

Course Goals & Benchmarks:

- 1) Understand the historical roots of game theory.
- 2) Recognize the many diverse situations that can be modeled using game theory.

- 3) Solve two-player zero-sum games and find the value of the game for each player.
- 4) Use game trees to model and solve two-player zero-sum games.
- 5) Determine the relative worth of outcomes using utility theory.
- 6) Determine viable strategies for two-player non-zero-sum games.
- 7) Understand the Prisoner's Dilemma for both single and repeated play.
- 8) Explore some of the common non-zero-sum situations (Chicken, Stag Hunt, Deadlock, Traveler's Dilemma, Dollar Auction).
- 9) Use the Nash arbitration scheme to solve conflict situations.
- 10) Solve simple N-person games.
- 11) Determine voting strategy for N-voter situations.

Grading policy: Your grade for the class will be (approximately) 40% chapter tests, 25% final, 20% quizzes, and 15% homework and blog assignments. The grading scale is the standard 90-80-70-60 scale. Homework will be assigned on a regular basis, and checked periodically. Homework should be organized, legible, and should demonstrate that some time and effort was put into it. I will occasionally collect a homework assignment and grade it for credit; I will let you know when I want to do this. If you are absent on the day that I collect an assignment, it is your responsibility to turn it in when you return. We will also have some blog assignments based upon readings from Prisoner's Dilemma (Poundstone).

We will have a quiz over most chapters, about 4 or 5 tests throughout the semester, and a final at the end of the semester. Ordinarily, if you miss a quiz or a test due to absence, you will make it up on the day that you return (I strongly prefer that tests and quizzes NOT be made up during class time, so if you miss a test or quiz, plan on coming in early or staying after school to take it the next day). However, if you are absent for several days, we can make arrangements when you get back. If you know in

advance that you will be absent on the day of a quiz or a test, talk to me and we will try to work something out.

General Classroom Expectations: The school policy on absences and tardies can be found in the student handbook. If you are absent from class, it is your responsibility to get the notes and any homework assignments from that day. When you are absent, please check the website for any homework assignments and upcoming quizzes/tests. When in class, you will conduct yourself with the honor and dignity that is expected of an Immaculate Heart student. This means that, among other things, you will pay attention, not create distractions for yourself or others, and always adhere to the academic integrity code of this school.