

Probability and Game Theory (GAME)
CTY Summer Session 2016
Franklin & Marshall College, Lancaster, PA (LAN)

INSTRUCTOR: Brian Kim

TEACHING ASSISTANT: Andy Lee

Course Description:

Formally, Game Theory is the study of rational behavior in decision-making, asking: How do we make the decisions that we do? What factors and information go into it? What's the *right* decision? While we can study traditional "games" such as tic-tac-toe and rock-paper-scissors, these are only useful to deepen our understanding of the decision-making process. In Game Theory, "Games" actually refer to any situation that requires strategic decision making. Thus, the real value of Game Theory is in its real-world applications - in warfare, investments, buying cars, dating and courtship, college applications, etc. etc. In this course, we will focus on understanding Game Theory as a framework that will help us in improving our strategic thinking as a whole. Through mathematical models, demonstrations, debates, and conceptual thought experiments, we will work together (and sometimes, against one another) to hone our critical thinking skills.

Guiding Questions:

- How can we make better choices and decisions as individuals? As a society?
- How do situations of collaboration and competition affect our decision-making?
- What makes a decision "right" or "wrong"?

Learning Targets:

- Students will be able to apply insights from abstract game theoretic models to sharpen their critical thinking skills and inform their decision-making in real world situations.
- Students will be able to work collaboratively to refine their strategic thinking and decision-making in high-stakes situations

Expectations: *You, as the student, will...*

...participate to the best of your ability, foster a positive and supportive atmosphere, support other students in their learning, remove distractions and avoid behaviors that prevent others from learning, give me honest feedback about the course and class, communicate how I can best support your learning, come to class prepared to engage, produce only your honest, original work, and put learning as your highest priority in the class.

Expectations: *I, as your teacher, will...*

...provide clear guidelines for behavior and work, be transparent about assessments and grading policies, be understanding of all students, be responsive to your needs as an individual, respect you as an individual, create engaging and demanding class activities, require you to think "outside the box," clearly communicate how to further develop your skills and provide constructive feedback regularly, and put your learning as my highest priority in the class.

Textbooks: Dixit, Avinash K. and Barry Nalebuff. *Thinking Strategically*. W.W. Norton & Company, Inc., 1991.
 Straffin, Philip. *Game Theory and Strategy*. Mathematical Association of America, 1993.

Evaluation:

Major assessments in this course will include both a pre-test and post-test to measure the progress of your learning over the three weeks of the class. These are purely for me to see what you already know to better suit the class to your needs, and should not at all be a source of stress or anxiety.

We will also embark on a project throughout the summer to create our own models of real-world strategic situations. As we learn more of Game Theory, our ability to accurately represent reality will improve, and so our goal will be to apply what we learn in the classroom to situations we're familiar with outside of it. This will be crafted and refined over the last two weeks of the class, to be presented by the end of the session and analyzed for new or interesting insights.

Course Timeline:

WEEK ONE: Introduction to Concepts in Game Theory and Probability

DAY	TOPICS	ACTIVITIES
1	Syllabus Review Learning Pre-Test Overview of Key Game Theory Concepts and Terms Mathematical Foundations: Probability	- Rock-Paper-Scissors Tournament - Ultimatum Game - Yahtzee
2	Basic Game Models - (2-person, 2-strategy, Zero-sum, Simultaneous) - Game Matrices, Equilibria, Dominance, Expected Value, Mixed Strategy, Oddments, Saddle Points, "Order of Operations"	- Matching Pennies - Class Lottery - A Fascinating Game - "Beating Vegas"
3	Larger Game Models - (2-person, N-strategy, Zero-sum, Simultaneous) - Iterated Dominance, Saddle Points/Minimax, Mixed Strategies, Graphical Solutions - Higher Order Rationality and Strategic Terms Definitions	- "Pearls Before Swine" - Dictator's Island - Jamaican Fishing - <i>The Princess Bride</i> Scene - Game of Averages
4	Larger Games Modeling Practice - Mixed Strategies and Unpredictability Games Against Nature Introduction to Sequential Play and Backwards Induction Mathematical Foundations: Permutations and Combinations	- Four I win, Five you win - Newcomb's Problem - The Enigma Machine
5	Sequential Play - (2-person, 2-strategy, Zero-sum, Non-Simultaneous) - Game Trees, Subgame Perfect Equilibria - Games Against Nature, revisited: Bayes' Rule Game Theory and Morality Article Project Research	- Three Stooges Game - Medical Testing - "Kino" Gambling

WEEK TWO: Complicating Models with Real-World Scenarios

DAY	TOPICS	ACTIVITIES
6	Complex Game Trees - (2-person, N-strategy, Zero-sum, Non-Simultaneous) - Ultimatum Game, Pirate Game Asymmetric Payoffs: Non-zero-sum Models - (2-person, 2-strategy, Non-zero-sum, Simultaneous) - Nash Equilibria, Non-Cooperative Solutions - Prisoner's Dilemma	- <i>Golden Balls</i>
7	Real-World Applications - Repeated Play Large-Scale Strategic Moves - (2-person, 2-strategy, Non-zero-sum, Non-Simultaneous) - Commitment Devices - Repeated Play (con't) - Application: The Paradox of Benevolent Authority	- Battle of the Sexes - Chicken - Stag Hunt - Iterated Prisoner's Dilemma
8	Applying Game Theory: Writing Assignment and Consulting "Thirteen Days" Modeling and Discussion Application: Evolutionarily Stable Strategies	- Movie: <i>Thirteen Days</i> - The Traveler's Dilemma - Bumper Cars Game
9	Crowd Complications: N-player games - (N-person, 2-strategy, Non-zero-sum, Simultaneous) - Tragedy of the Commons - The Bystander Effect and the Volunteer's Dilemma	- Trust Game
10	Utility Theory Knowledge is Power: Imperfect Information - Bayesian Beliefs - Signaling - Perfect Bayesian Nash Equilibrium Final Project Work Sessions	- Pimsler's Dementia - Game of College

WEEK THREE: Crowd Strategy and Building Rigorous Models

DAY	TOPICS	ACTIVITIES
11	Modeling Theory, Framework, and Principles Cooperative Solutions - Fair Division (Discrete and Continuous)	- Project Work session - "Avalon"
12	Strategy and Cooperation - Strategic Voting - Application: Gridlock, Takeovers and Poison Pills	- Congress Game - Dictator Game - Coalitions, Pt. 2
13	Real-World Model Presentations - Work Session, Presentations, Play-Testing	- Final Exam
14	Limitations of Game Theory - Introduction to Behavioral Economics: Irrationality	- Research Project
15	Wrap-up	- Final Auction