

SYLLABUS
MATHEMATICS OF COMPETITIVE BEHAVIOR
CTY Summer Session 2016
Princeton, NJ

INSTRUCTOR: Austin Landini
TEACHING ASSISTANT: Ben Cohen

Textbook: Straffin, Phillip. *Game Theory and Strategy*. Washington, D.C.: Mathematical Association of America, 1993.

A calculator is necessary for this course. Although a graphing calculator may be helpful for a few activities, a scientific calculator is sufficient.

Mathematics of Competitive Behavior includes some probability content, but the primary focus is the mathematical theory of games. Formally, game theory is the study of rational behavior in social decision making. While it includes traditional games such as tic-tac-toe and matching pennies, the real value of game theory is in its real-world applications. Students will play games, analyze their play, and develop successful strategies. They will frequently present their findings to other class members, and will explore applications to social interaction, politics and voting, business strategies, biology, and anthropology.

COURSE SCHEDULE

WEEK ONE

DAY	TOPICS AND ACTIVITIES
1	Morning: Introductions, pretest, course and topic overview, historical introduction to probability (<i>The Unfinished Game</i>) Afternoon: Introduction to probability: dependent and mutually exclusive events, expected value, class lottery Strategy: <i>To Lead or Not to Lead</i> 2-person - 2 strategy zero-sum games: matrix games, dominance, saddle points, Maximin-Minimax Evening: <i>Matching Pennies</i> , mixed strategies
2	Morning: 2-person - N strategy zero-sum games: dominance, saddle points <i>The Umbrella Problem</i> Application: Jamaican Fishing Game trees Afternoon: 2-person zero-sum games: Graphical solution of $M \times 2$ or $2 \times N$ games Application: The problem of free will (Newcomb's Problem) Evening: Strategy: <i>Cab Ride in Israel</i> , read ch. 2, exercises p. 11 #2, 3, 4, read ch. 3 through p. 18, exercises p. 21 #2, 3, read ch. 4, exercises p. 26 #1, 2

3	<p>Morning:</p> <p>Strategy: <i>The Other Person's Envelope Is Always Greener</i> (backward induction)</p> <p>2-person – n-strategy zero-sum games: importance of unpredictability</p> <p>Probability: Bayes' Rule, using permutations and combinations to calculate probabilities</p> <p>Afternoon:</p> <p>Mixed strategies: Rock-paper-scissors tournament and analysis</p> <p>Games against nature</p> <p>Evening:</p> <p>Read ch. 6, exercises p. 36 #1, permutations-combinations-probability problems</p> <p>Strategy: <i>Red I Win – Black You Lose!</i></p>
4	<p>Morning:</p> <p>2-person non-zero-sum games: introduction, Nash Equilibria, non cooperative solutions</p> <p>Applications: Chicken, Battle of the Sexes</p> <p>Checkup and review</p> <p>Afternoon:</p> <p>Application: Stag Hunt</p> <p>Utility Theory</p> <p>Evening:</p> <p>Bayes Rule questions</p>
5	<p>Morning:</p> <p>History of game theory</p> <p>Prisoner's Dilemma interrogation, discussion</p> <p>Strategic moves</p> <p>Afternoon:</p> <p>Evolutionarily Stable Strategies (ESS)</p> <p>Evening (Sunday):</p> <p>Exercise p. 60 #1, read ch. 11, exercises pp. 71-2 #1, 2a, b, 3a, b, c, 4a, b</p>

WEEK TWO

DAY	TOPICS
6	<p>Morning:</p> <p>Project introduction</p> <p>N-person games: representations</p> <p>Midterm test review, part 1</p> <p>Afternoon:</p> <p>Project preparation</p> <p>Evening:</p> <p>Project preparation, review for midterm test</p>

7	<p>Morning:</p> <ul style="list-style-type: none"> Slope as a rate of change, introduction to differential calculus Project preparation Midterm test review, part 2 <p>Afternoon:</p> <ul style="list-style-type: none"> Application: Economics – supply and demand, marginal cost and marginal profit The Trust Game <p>Evening:</p> <ul style="list-style-type: none"> Midterm test, read ch. 12, exercises p. 54 # 1, 5, p. 80 #4, 6
8	<p>Morning:</p> <ul style="list-style-type: none"> Application: Cournot Duopoly N-person Prisoner's Dilemma (Tragedy of the Commons) <p>Afternoon:</p> <ul style="list-style-type: none"> Trust, suspicion, and the F-Scale <p>Evening:</p> <ul style="list-style-type: none"> Project preparation (2 hrs.)
9	<p>Morning:</p> <ul style="list-style-type: none"> Project preparation (2 hrs.) Discuss midterm test <p>Afternoon:</p> <ul style="list-style-type: none"> Voting preparation Project presentations Sample games Voting games: methods <p>Evening:</p> <ul style="list-style-type: none"> Read ch. 14, exercise p. 91 #1,
10	<p>Morning:</p> <ul style="list-style-type: none"> Project presentations Voting games: fairness, Arrow's Impossibility Theorem <p>Afternoon:</p> <ul style="list-style-type: none"> Characteristic function form Strategic voting, voting power Sample games <p>Evening:</p> <ul style="list-style-type: none"> Read chapter 19, exercise p. 132 #2, voting exercises

WEEK THREE

DAY	TOPICS
11	Morning: Coalitions game Cooperative games with transferrable utility: individual rationality, collective rationality, and imputations Afternoon: Fair Division: divider-chooser, lone divider, last diminisher, sealed bids Evening: Apportionment activity: <i>Can We Divide It Fairly</i> Article: <i>The Maths of Lords Reform</i>
12	Morning: Apportionment and the Alabama Paradox Coalitions or other game Afternoon: Movie: Dr. Strangelove Evening: Apportionment exercises, fair division exercises, review for final exam
13	Morning: Review for final exam Imputations, domination, and stable sets Afternoon: Auctions: sealed bid, Vickrey auction, English auction, Dutch auction Evening: Final exam
14	Morning: Proof that sincere bidding is best in a Vickrey auction New directions and new applications of game theory Afternoon: Course evaluation Video: <i>A Brilliant Madness</i> , discussion Evening: 3-way duel Discuss final exam
15	Game Theory: What is it good for? Class auction

PROJECT:

Working in groups, students will select a topic from a list provided by the instructor. The students will then conduct research using the internet and print materials and make a 30 minute presentation to the class describing their findings.

EVALUATION:

There will be two tests during the course: a midterm and a comprehensive final exam. Evaluation of student performance and achievement will be based on completion and accuracy of written assignments and tests, active participation in class discussions, and presentations of projects.