SYLLABUS

MATHEMATICS OF COMPETITIVE BEHAVIOR

CTY Summer Session 2015
Princeton, NJ

INSTRUCTOR: Tom Ottinger
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 and statistics 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 (The Unfinished Game) Afternoon: Introduction to probability: dependent and mutually exclusive events, expected value, class lottery Strategy: *To Lead or Not to Lead* 2-person - 2 strategy zero-sum games: matrix games, dominance, saddle points, Maximin-Minimax, mixed strategies Evening: 2x2 game exercises, read chapter 2, exercises p. 11 #2, 3, 4
2	Morning: Matching Pennies 2-person - N strategy zero-sum games: dominance, saddle points Application: Jamaican Fishing Game trees: competitive decision making Afternoon: 2-person zero-sum games: Graphical solution of M x 2 or 2 x N games Application: The problem of free will (Newcomb's Problem) Strategy: *The Other Person's Envelope Is Always Greener* (backward induction) Evening: Strategy: *Cab Ride in Israel*, read ch. 3 through p. 18, exercises p. 21 #2, 3, The Umbrella Problem

3	Morning: 2-person – n-strategy zero-sum games: importance of unpredictability Probability: Bayes' Rule, using permutations and combinations to calculate probabilities, *Let's Make a Deal* Afternoon: Mixed strategies: Rock-paper-scissors tournament and analysis Games against nature Project introduction Evening: Bayes Rule questions, permutations-combinations-probability problems. Strategy: *Red I Win – Black You Lose!* Read ch. 4, exercise p. 26 #2
4	Morning: 2-person non-zero-sum games: introduction and Nash Equilibria Checkup and review Afternoon: Project research (computer lab) 2 hrs. Evening: Probabilities of poker hands, read ch. 6, exercises p. 36 #1, p. 43, #5, p. 47 #2, Bayes' Rule questions
5	Morning: Utility Theory Application: Chicken, Stag Hunt Afternoon: Application: Stag Hunt Project research (computer lab) Evening (Sunday): Exercise p. 60 #1, read ch. 11, exercises pp. 71-2 #1, 2a, b, 3a, b, c, 4a, b

WEEK TWO

DAY	TOPICS
6	Morning: History of game theory Prisoner's Dilemma interrogation, discussion Strategic moves Afternoon: Evolutionarily Stable Strategies (ESS) N-person games: representations, part 1 Evening: Project work, review for midterm test

7	Morning: Project presentation preparation (computer lab) Midterm test review, part 2 Slope as a rate of change (using calculator based ranger) Afternoon: Introduction to differential calculus Application: Economics – supply and demand, marginal cost and marginal profit The Trust Game Evening: Midterm test, read ch. 12, exercises p. 54 # 1, 5, p. 80 #4, 6
8	Morning: Application: Cournot Duopoly N-person Prisoner's Dilemma (Tragedy of the Commons) Afternoon: Project presentation: evolutionary game theory Trust, suspicion, and the F-Scale Evening: Project preparation (2 hrs.)
9	Morning: Project preparation (2 hrs.) Discuss midterm test Afternoon: Voting preparation Project presentations Sample games Voting games: methods Evening: Read ch. 14, exercise p. 91 #1,
10	Morning: Project presentations Voting games: fairness, Arrow's Impossibility Theorem Afternoon: Characteristic function form Strategic voting, voting power Sample games Evening: Read chapter 19, exercise p. 132 #2, voting exercises

Sample games (as time allows):
Traveler's Dilemma
El Farol Bar Game
Diner's Dilemma
Volunteer's Dilemma
Pirate Game
Guess 2/3 of the Average

WEEK THREE

DAY	TOPICS
11	Morning: Braess' Paradox Afternoon: Fair Division: divider-chooser, lone divider Sample Games Evening: Apportionment activity: *Can We Divide It Fairly* Article: *The Maths of Lords Reform*
12	Morning: Sample games Afternoon: Apportionment and the Alabama Paradox Estate division by sealed bids Evening: Apportionment exercises, fair division exercises
13	Morning: Review for final exam Fair division: last diminisher Auctions: sealed bid, Vickrey auction, English auction, Dutch auction Afternoon Movie: Dr. Strangelove Evening: Final exam
14	Morning: Proof that sincere bidding is best in a Vickrey auction Cooperative games, characteristic function form, and imputations Coalitions game Afternoon: Course evaluation Video: A Brilliant Madness, discussion Evening 3-way duel Discuss final exam
15	Coalitions, round 2 Class auction, part 2 Game Theory: What is it good for?

Additional topics:
Noblesse Oblige
Bankruptcy

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.