14.12 Game Theory

Game Theory is a misnomer for Multiperson Decision Theory, the analysis of situations in which payoffs to agents depend on the behavior of other agents. It involves the analysis of conflict, cooperation, and (tacit) communication. Game theory has applications in several fields, such as economics, politics, law, biology, and computer science. In this course, I will introduce the basic tools of game theoretic analysis. In the process, I will outline some of the many applications of game theory, primarily in economics and political science.

Game Theory has emerged as a branch of mathematics and is still quite mathematical. Our emphasis will be on the conceptual analysis, keeping the level of math to a minimum, especially at a level that should be quite acceptable to the average MIT student. Yet bear in mind that this still implies that you should be at ease with basic probability theory and calculus, and more importantly, you should be used to thinking in mathematical terms. Intermediate Microeconomics is also a prerequisite (simultaneous attendance to one of the intermediate courses is also acceptable). In any case, if you are

taking this course, you should be prepared to work hard.

Textbook The main textbook will be

> Robert Gibbons, *Game Theory For Applied Economists,* Princeton University Press, 1992.

This is the only required textbook and covers the majority of this course's topics. I recommend that you buy it. The book

> Prajit Dutta, *Strategies and Games*, 1999

will also be very useful, especially for the exercises. (You need to solve a lot of problems to learn Game Theory.) I will also refer to

> David Kreps, *A Course in Microeconomic Theory,* 1990, Harvester.

The last two books will be on reserve at Dewey; you are not required to buy it. All the lectures will be supplemented with detailed notes as well.

Those who want more advanced treatment should look at Drew Fudenberg and Jean Tirole, *Game Theory*, MIT Press, 1991 or Martin Osborne and Ariel Rubinstein, *A Course in Game Theory,* MIT Press, 1994. These two books are very good but harder than the level at which the course is pitched. Those who need an easier — and longer — exposition of the topics can read Avinash Dixit and Susan Sekeath, *Games of Strategy*, 2000. There have been several textbooks published recently, e.g., Joel Watson, Strategy. I encourage you to look at these books for extra problems to solve.

Grading There will be two midterms and a comprehensive final exam. ALL EXAMS WILL BE OPEN BOOK. Also approximately 5 problem sets

to be handed in. Each midterm is worth 25%, the final is worth 40%, and the problem sets will make up the remaining 10% of the final grade.

(There will be two more lectures after the final.)
A portion of the last class before each exam will be devoted to problem solving and the review of the material.

In addition, there will be in-class quizzes. In these quizzes you will be asked to play various games. In most of these games you will not know who the other players are. The points (normalized to 5%) you get in these games will be bonuses. They will be added to your final grade after the cut off values for the letter grades are determined. (In this way, you will not be given any incentive to care about the other players' payoffs in the game.)

Course Outline The following is a rough outline. Depending on the interests and the inclinations of the group, the topics and their weight may change a little. The number in square brackets denotes the expected time to be devoted to each topic. G. refers to Gibbons' textbook.

1. Introduction to game theory [1 lecture]
2. Payoffs in games: Rational Choice Under Uncertainty [1 lecture]
   (a) Expected Utility Theory; Risk aversion, Kreps, Chapters 3.1-3.3
   (b) Applications; risk sharing, insurance, option value.
3. A More Formal Introduction to Games [3 lectures]
   (a) Extensive Forms and Normal Forms, G., Ch. 1.1A and 2.1A
   (b) Strategies, Dominant Strategies and Iterative elimination of strictly dominated strategies, G. 1.1B

(c) Nash Equilibrium, G. 1.1C

(d) Applications of Nash Equilibrium, G. 1.2

4. Backward Induction, Subgame Perfection, and Forward Induction [3 lectures]

   (a) Analysis of Extensive-Form Games, G. 2.1A

   (b) Backward induction

   (c) Subgame Perfection, G. 2.2A

   (d) Applications, G. 2.2B,C,D and 2.1B,C.

   (e) Bargaining and negotiations, G. 2.1D

   (f) Forward induction.

   (g) Applications.

5. The First Midterm

6. Repeated Games and Cooperation [2 lectures] G. 2.3

7. Incomplete Information [2 lectures]

   (a) Bayesian Nash Equilibrium, G., 3.1A,C

   (b) Auctions

   (c) Applications, G. 3.2

8. Dynamic Games of Incomplete Information [2 lectures]

   (a) Perfect Bayesian Equilibrium, G. 4.1

   (b) Sequential Bargaining Under Asymmetric Information, G. 4.3B

9. The second Midterm

10. Reputation, G. 4.3C [1 lecture]

11. Problems of Asymmetric Information in Economics [3 lectures]

    (a) Signaling and the Intuitive Criterion, G. 4.2A and 4.4

    (b) Applications of Signaling, G. 4.2B,C

    (c) The principal-agent problem, Kreps Chapter 17

    (d) Applications; lemons, efficiency wages, credit-rationing, price-discrimination.

12. Final Exam

13. Evolutionary foundations of equilibrium; evolutionarily stable strategies and replicator dynamics. [2 lectures]