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Econ 280—Bethany College

**Lecture 15: Introduction to Game Theory**

1. Games
   1. In economics, a “game” is not frivolous or fun (not inherently, anyway). A game is a situation of interdependence between multiple players.
      1. Examples include: political negotiations, warfare, business competition, auctions, etc.
   2. When we “play the game” we determine each player’s strategy. Knowing each person’s strategy lets us determine the outcome of the game.
   3. In game theory, each player has no control over what the other player(s) does (we usually simplify to two players). This exists despite the fact that each player’s actions influence other players’ costs and benefits.
      1. For example, you don’t control Andy the Arsonist but his actions affect you if he decides to burn down your store.
   4. To determine what each player will do, we consider options each player has (usually two each) and their payoff in various combinations of actions.
      1. *Payoff* is a general term for the result to that player. It can be positive (e.g. dollars awarded) or negative (e.g. years in jail).
      2. For simplicity and clarity, payoffs combine costs and benefits. They are represented as a number.
2. Nash Equilbrium
   1. To determine what happens in a game, we find a point of equilibrium, when no player wants to change their strategy holding the strategy of the other player constant.
      1. Again, remember one player cannot influence the strategy of the other player.
   2. This equilibrium point is called *Nash Equilibrium*—when no player wants to change their strategy holding the strategy of the other player constant.
      1. It is possible to have one equilibrium, no equilibrium, or multiple equilibria.
      2. It is named after John Nash, a mathematician who won a Nobel Prize for inventing game theory.
      3. While it was a mathematician who invented game theory, for our purposes all the math game theory involves is of the most basic sort: which of a pair of numbers is biggest?
   3. An example of Nash Equilibrium sitting in class. Suppose someone is sitting in a seat you’d like to sit in more. Remember, you can’t make them sit elsewhere so you sit where you’re happiest given the choices. Note that people are not constantly changing their seats minute-to-minute (or even class to class). We’ve reached Nash Equilbrium.
   4. If people were to change their seat, that indicates that that person could take an independent action and make himself better off. Thus, we are not in Nash Equilibrium.
3. Structure of the game
   1. When both players move at the same time (simultaneous move game), the game looks like a table.
      1. Player 1 is indicated as Alfred. His payoff is first.
      2. Player 2 is indicated as Ben. His payoff is second.
      3. In this game, there are two strategies: Strategy 1, and Strategy 2.
      4. The payoffs are A1, A2, B1, etc.

|  |  |  |  |
| --- | --- | --- | --- |
|  | | Ben | |
| Strategy 1 | Strategy 2 |
| Alfred | Strategy 1 | A1 , B1 | A3 , B2 |
| Strategy 2 | A2 , B3 | A4 , B4 |

* 1. Because I have no values in for the payoffs, we cannot play the game. This is to remind you which payoff goes with which player.
     1. For example, if Alfred plays 2 and Ben plays 1, then Alfred gets A2 and Ben gets B3.

1. Chicken Game
   1. There are many, many different types of games. Here’s a standard, intuitive game.
   2. Suppose two people are walking toward each other. Who gets out of whose way?
      1. If dodge while the other doesn’t, the person that keeps walking straight gets a little ego boost. It’s a little humbling for the other.
      2. If both dodge, then no one has something over the other.
      3. If both go straight, they run into each other like idiots.
   3. I assign payoff to reflect these realities. The actual value doesn’t matter; only the relative value.

|  |  |  |  |
| --- | --- | --- | --- |
|  | | Ben | |
| Dodge | Straight |
| Alfred | Dodge | 0 , 0 | -1 , 1 |
| Straight | 1 , -1 | -3 , -3 |

* + 1. Where is Nash Equilibrium?
    2. One way to find it is by cell-by-cell inspection. For each resulting pair of strategies, ask if either person would like to change their behavior. Continue until all cells are inspected.
    3. At Dodge, Dodge, Alfred would like to change to Straight, holding Ben’s Dodge choice constant. We know this because a payoff of 1 is greater than 0. Ben feels the same way.
    4. At Straight, Straight, Alfred would like to change to Dodge, holding Ben’s Straight choice constant. We know this because a payoff of -1 is greater than -3.
    5. At Dodge, Straight and Straight, Dodge, neither is willing to unilaterally change their behavior. Both are Nash Equilibria.
    6. Note that in practice, this is often what happens.