David Youngberg

Econ 280—Bethany College

**Lecture 16: Repeated Games**

1. Recall last class we played the chicken game and a coordination game. Let’s take a moment and remember how to play games with another coordination game: the stag hunt.
   1. Suppose two players, Alpha and Beta, go hunting together. Each player may either hunt a rabbit, which yields a small amount of food, or a stag, which yields a large amount of food.
   2. Hunting a stag, though, is very hard and requires both players to be successful. One player might scare the stag while the other uses the distraction to spear (or shoot) the stag.

|  |  |  |  |
| --- | --- | --- | --- |
|  | | Beta | |
| Stag | Rabbit |
| Alpha | Stag | 3 , 3 | 0 , 1 |
| Rabbit | 1 , 0 | 1 , 1 |

* 1. Note that while the best strategy for everyone is for both to hunt the Stag, it is easy to get locked into each player hunting a rabbit.
  2. The Stag Hunt game often occurs in business. Sometimes employees will work together on a project but sometimes group dynamics results in them working independently. You might have encountered this when working on group projects for class.

1. The Prisoner’s Dilemma
   1. Imagine Bonnie and Clyde rob a bank and kill someone during their escape. Thanks to cameras, the police have enough evidence for robbing the bank, but because the murder took place in a nearby alley, they lack the evidence to convict them on murder.
   2. They clearly want to get them on both so they put them in separate rooms and ask them to either confess or deny to the murder.
      1. If they both deny the murder, the police must arrest them for only the lesser charge; they don’t have enough evidence otherwise.
      2. If one denies while the other confesses, the confessor gets a deal and the denier gets time for not just robbing the bank and murder but also lying to the police.
      3. If the both confess, Bonnie and Clyde get time for the bank robbery and the murder.

|  |  |  |  |
| --- | --- | --- | --- |
|  | | Bonnie | |
| Deny | Confess |
| Clyde | Deny | -2 , -2 | -5 , -1 |
| Confess | -1 , -5 | -4 , -4 |

* 1. In this game, there is only one Nash Equilibrium. It is also the worst result (the highest total number of years in prison).
  2. The Prisoner’s Dilemma plays out in many different scenarios.
     1. Arms races
     2. Cartels
     3. Tragedy of the commons
     4. War over trade

1. Strategies
   1. The reason why the Prisoner’s Dilemma is so hard to get out of is that its Nash Equilibrium is made up of dominant strategies.
      1. *Dominant Strategy*—a strategy which outperforms all other strategies regardless of the other player’s strategy. Note it is independent of the other players’ payoffs.
      2. *Strictly Dominant Strategy*—a strategy which always produces a higher payoff.
      3. *Weakly Dominant Strategy*—a strategy which always produces a higher or equal-to payoff.
      4. *Dominated Strategy*—a strategy which always produces a less preferred result than another strategy.
   2. Because Confess is *always* the strictly dominant strategy, getting out of the prisoner’s dilemma is really hard. But there are ways: repeat the game, reward and punishment, and add leadership.
2. Repeat the game
   1. This is the most natural way to add cooperation in the Prisoner’s Dilemma: have *repeated play*—playing the same game with the same players multiple times.
   2. If the value of future cooperation is large, then each player will fear defection (or cheating) since neither player wants to be locked into that equilibrium for many periods.
      1. *Trigger strategy*—a result of a game “triggers” a period of punishment of a particular length. If you don’t cooperate once, I will refuse to cooperate with you for, say, three more games.
      2. *Grim strategy*—once there is a single non-cooperative play, the other player never cooperates again.
      3. *Tit-for-tat*—a non-cooperative play immediately follows another non-cooperative play but no longer than one game. (Though if there is non-cooperation in the following game, tit-for-tat would trigger again.) In international politics, it is sometimes called a proportional response.
   3. How many times the game is repeated matters.
      1. If it is repeated *finitely*—or both players know how many games they will play—then cooperation can and will break down as you approach the last game.
      2. But if the game is repeated *infinitely*—both players will either never stop playing the game or both don’t know when they will stop—then cooperation can persist. There is always the threat of the trigger strategy.
3. Reward and punishment
   1. Adding a system of rewards and punishments changes the payoff for the game. You are functionally transforming a Prisoner’s Dilemma into another type of game.
      1. For example if you Confess, my friends will beat up you in prison. Your one year will seem very, very long (say, 6 years).
      2. This is why “rats” (people who inform on the police) are treated so poorly by other criminals. The criminals are changing the payoffs.
   2. Ideally, the goal is to restructure the payoffs so Deny, not Confess, is the dominant strategy. Here, we don’t get quite that unless there’s punishment if they both Confess. Perhaps their boss, Tony Soprano, beats them up if they rat out each other.

|  |  |  |  |
| --- | --- | --- | --- |
|  | | Bonnie | |
| Deny | Confess |
| Clyde | Deny | -2 , -2 | -5 , -6 |
| Confess | -6 , -5 | -4 , -4 |

1. Leadership
   1. Leadership occurs when one player consistently chooses the cooperating option, even if the other player doesn’t cooperate.
   2. This often happens when the payoffs are disproportionate: when one player has more to lose by defection.
   3. Again, this changes the payoffs of the game. But instead of trying to achieve cooperation, the effect of leadership is one player to cooperate while the other defects.
      1. Suppose Clyde has prior convictions. If he Confesses to the murder, he’ll get the chair. But this occurs only if he Confesses: even with Bonnie ratting him out, there’s not enough evidence to execute him. (After all, she might be lying to get a better sentence).

|  |  |  |  |
| --- | --- | --- | --- |
|  | | Bonnie | |
| Deny | Confess |
| Clyde | Deny | -2 , -2 | -5 , -1 |
| Confess | -11 , -5 | -14 , -4 |

* + 1. Now the equilibrium cell is Deny / Confess.
  1. Both leadership and reward and punishment “cheat” the prisoner’s dilemma a bit since neither really solves the dilemma. They just change the game.
  2. Since changing the payoffs isn’t always an option, repeated games is generally considered the standard way to combat the prisoner’s dilemma.