Course Title: An Introduction to Game Theory

Course Instructor: Arjun Kilaru

Course Overview:

Game theory is the study and application of mathematical models relating human, rational decision-making. Concepts studied in game theory usually stem from the disciplines of mathematics, economics, and logic. In this course, students will learn six concepts integral to the fundamentals of game theory. These concepts have been adapted from college and high-school level courses to fit the mental bandwidth of middle schoolers with limited mathematics education. No knowledge of calculus, precalculus, or any economics is needed to succeed and enjoy the course. In order, the discussion and instruction of concepts will be as listed:

Simultaneous Games

Sequential Games

Strategic Moves relating Strategic & Simultaneous Games

Voting

Auctions

Bargaining

I will now provide a detailed overview of what each lesson entails (regarding lessons, games, and topics to be known)

1. **Sequential Games**

    a. Sequential games – the easiest game theory concept to digest – will be taught first. Before any numbers or diagrams are laid out, the students will first play a series of sequential games. This will include the counting game, ultimatum game,

the flag game, and tic tac toe. After the games are played, students will learn the

basics of the game tree and the method of backward induction, which is used to

solve game trees. They will then learn the concept of "Nash equilibria" as the

ultimate solution to a game. Students will lastly learn the idea of first and second

mover advantage and try constructing games themselves that illustrate these ideas.

2. **Simultaneous Games**

   a. The class will begin learning the simultaneous game unit by participating in a

   prisoner's dilemma type of activity relating to the allocation of a good (money or

   candy). Once the activity is over, the students will watch a clip of the TV show

   Golden Balls, where this concept is again showcased in an entertaining way.

   Then, they will learn the idea of the prisoner's dilemma and how it relates to

   simultaneous decisions. I will introduce the concept of a matrix with payoffs and

   the students will learn how to solve it simply. Then, we will introduce and play a

   variety of simultaneous games, such as the battle of the sexes, the game of

   chicken, and assurance and pure coordination games. The concept of focal points

   will be introduced as well.

3. **Strategy in Games**

   a. Students will combine their knowledge of simultaneous and sequential games in

   this unit. They will learn various strategies real people use to bend the outcomes

   of these games. These strategies include commitment, burning bridges,

   unreliability, threats, promises, and credibility. The students will draw what is

   learned to plenty of real-world scenarios ranging from American history to the

current business landscape. Any other game not covered so far (⅔ of average) will be played here as well.

4. **Voting**

    a. Students will now shift from mathematical reasoning to more logical reasoning in this unit. They will begin the unit by conducting a mock election of one from a few individuals in the class, utilizing various different voting methods. This will include plurality, Borda Count, Condorcet, and runoff voting methods. After the "election" the students will learn the basis of each voting method – how they operate and what the drawbacks of each are – , as well as Arrow's Impossibility Theorem (which states that no method will result in a clear winner). We will then look at the voting tendencies and rules of various nations and compare them to one another. Lastly, the students will learn how to essentially "game" each voting system– the concept of strategic voting. This interesting idea includes topics like agenda setting and the power of abstaining from the ballot. Again, we will look at examples of each occurring in real life.

5. **Auctions**

    a. Students will begin this unit by attending an "auction" that utilizes various methods. Vickrey, English, and Dutch auctions will be conducted. They will then learn about private and common value actions, as well as the concept of the "Winner's Curse". They will then look at auctions from a selling perspective and learn how actions such as shilling can be used to the seller's advantage. Lastly,

Vickrey Auctions will be further examined and drawn to one of the basic tenets of economic theory: the demand curve.

6. **Bargaining**

   a. The last unit – which can be combined with Auctions if time is scarce – is about negotiation. Students will first play negotiation games with one another involving known BATNA's (a BATNA is someone's second-best alternative, meaning what they receive if a successful negotiation is not met). They will then play another round of games involving hidden BATNA's. They will then learn how to draw and interpret a bargaining graph involving surplus and BATNA's. Then, they will learn extremely real-world applicable bargaining tactics with a basis in game theory. If time permits and the students can understand, they will learn the concept of decaying value negotiations and impatience negotiations and how to solve problems relating to them (incorporating and not incorporating BATNA's).