PRINCIPLES OF BEHAVIORAL ECONOMICS

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Week 51

Lecture 51

Hello everyone. This is the course on Principles of Behavioral Economics and today we are going to begin discussions on strategic interactions. So, what are strategic interactions? What do they imply? And what are we going to cover in strategic interactions that anyway you will get to know over a period of time, but broadly, we can divide strategic interactions into three components. In the first, we are going to introduce the standard or analytical game theory, followed by the problems that are observed empirically with analytical game theory.

Then, we will discuss the alternatives suggested by behavioral economists, or rather, we can say that we are also going to discuss behavioral games. So first of all, let's try to define strategic interactions. When people are engaged in a social interaction and are aware of how their actions affect others and vice versa, we call this a strategic interaction. A strategy is defined as an action or a course of action that a person may take when that person is aware of the mutual dependence of the results for themselves and for others. The outcomes depend not only on that person's actions but also on the actions of others.

And that's why we call it strategic interaction. Models of strategic interactions are described as games. Game theory is a branch of mathematics that studies strategic interactions, meaning situations in which each actor knows that the benefits they receive depend on the actions taken by all. So the benefits, which you call payoff in this case, are not solely dependent on what I do but also depend on what others do.

So that's why we need to define strategies, and that's why game theory is a part of strategic interactions. A game is a model of strategic interaction that describes the players, the feasible strategies, and the information that the players have. and their payoffs. Game theory is a way of understanding how people interact based on the constraints that limit their actions, their motives, and their beliefs about what others will do. Experiments and other evidence show that self-interest, a concern for others, and a preference for fairness are all important motives that explain how people interact. In most interactions, there is some conflict of interest between people but also some opportunity for mutual gain. The pursuit of self-interest can sometimes lead to results that are considered good by all participants or to outcomes that none of the participants would prefer. Self-interest can be harnessed for the general good in markets by governments limiting the actions that people are free to take and by one's peers imposing punishments or actions that lead to bad outcomes though

if you remember in the very beginning we said that Adam Smith was a proponent of the invisible hand which basically said that we are all driven by our self-interest but then that leads to mutual gains for each other. But that might not be true in all circumstances, and as a result, government interventions might be required to limit the actions that people are free to take. For example, my self-interest could be, on some day, to play music very loudly, but then that may disturb my neighbors and could be inconvenient to many others.

As we often see during the wedding seasons, the procession actually blocks the roads, creating traffic jams. So these kinds of actions are driven by self-interest. We are not really bothered that there are thousands of vehicles on the roads, and sometimes important roads are blocked by such activities. So in those situations, we actually need interventions from some authorities to limit our actions so that our self-interest is not detrimental to others. A concern for others and for fairness allows us to internalize the effects of our actions on others and so can contribute to good social outcomes.

If you are actually concerned about others and if we try start judging about what is fair and what is unfair then probably we will not indulge in any activities despite of how important it is. That is going to cause certain inconvenience to others as I was talking about wedding processions. So it is always possible to route the wedding processions through some other ways so that main roads, national highways are also at times blocked. So that should not happen.

That may lead to major inconveniences. Suppose on that road, that road takes to some important airports and people need to arrive in airports or in train stations well within time. There is specified time. Unless and until you reach on time, you're going to miss your train or your flights. So very sudden unexpected traffic jams, which generally do not clear off in another 30 minutes, 45 minutes.

may cause extreme inconveniences to others so having a concern for others, having the understanding of what is fair or unfair that will help us in internalizing the effects of our actions on others and then accordingly we will not do anything that will be detrimental to others. Bow let us define the elements of a game, a description of social interaction which specifies the players, that is, who are interacting and with whom. Alternatively, these are the relevant decision-making identities whose utilities are interdependent. They may be individuals, firms, teams, social organizations, political parties or governments.

So, a game basically describes certain entities, one of them being the players. The second is strategies. These are different components or elements of a game. The term 'strategy' refers to a complete plan of action for playing a game. So, what are the alternative actions that I have, given my opponent's alternative actions?

It is important to understand that in many games, there may be many actions involved. A complete plan means that every possible contingency must be accounted for. A rule means a complete plan of action, and a strategy means a specific action or move. The feasible strategies are basically the actions that are open or available to the players. Strategies often involve either cooperating or defecting.

In the context of game theory, defection refers to a strategy where one player chooses an action that increases their own payoff at the expense of the other player. We will discuss specific games where such concepts are extensively used. Cooperation involves making a risky move where the opponents may take advantage of you and reduce your payoff or make a decision in favor of both, making both better off as a result so you may decide to cooperate if the other player also decides to cooperate then that is going to result in better payoffs for both of you but suppose you decide to cooperate but the other player does not decide to cooperate

then in that case there could be a substantial reduction in the payoff of yours while the other player benefits from that. Another component or element is the information—what each player knows while making their decisions. Payoffs are the third element, or rather, the fourth element. They tell us what the outcomes will be for each of the possible combinations of actions. These represent changes in welfare or utility at the end of the game and are determined by the choice of strategy by each player. It is normally assumed that players are rational and have the objective of maximizing these utilities or expected utilities, which we call payoffs.

Notice that the word 'each' is important. What distinguishes game theory from decision theory is that in decision theory, outcomes depend only on the decision of a single decision-maker. And that's why they are not part of strategic interaction. While game theory is part of strategic interaction because the outcomes of one individual may depend on the decisions of other individuals or players involved in the game.

Now, we will briefly talk about forms of games. The most common form we come across is the normal-form representation of a game, which specifies the strategies, payoffs, and players. They are assumed to move simultaneously by default. So, the moves are simultaneous. These games are represented by tables or matrices.

The normal-form representation helps clarify the key elements in the game. When the players do not move simultaneously and the sequence of moves is important, it is necessary to use an extensive-form representation, which usually involves a game tree. So, whenever the moves are sequential, so you can consider say the game of chess, the moves are sequential that can also be considered as a game and that is sort of an extensive form representation. We will be talking in details about extensive form representation with examples later.

Now we begin with an example of an analytical game so far we are basically talking about analytical game or standard game or classical game theory whatever you call it that is basically the beginning of the game theory so as I was trying to tell you that strategic interactions are going to cover three things the first is the analytical game or standard game or classical game theory followed by its criticism and then followed by behavioral game. Behavioral game and criticism they probably go hand in hand nevertheless we would be going in this sequence so first we are going to talk about analytical game or standard game theory we'll begin with an example to basically clarify

the different elements that we have just introduced. So the example goes as follows. One year there were two students taking chemistry. They both did so well on quizzes, midterms and labs that they decided to leave town and go partying the weekend before the exam. They mightily enjoyed themselves.

However, on the last day, they overslept and did not make it back to the campus in time for the exam. So they called their professor to say that they had got a flat tire on the way to the exam, did not have a spare and had to wait for a long time. The professor thought about it for a moment and then said that he was glad to give them a makeup exam the next day. The two friends studied all night.

At the assigned time, the professor placed them in separate rooms, handed them the exams and asked them to begin. The two friends looked at the first problem, which was a simple one about molarity and solutions and was worth five points. Easy, they thought to themselves. Then they turned their page and saw the second question, which was worth 95 points or marks. Which tire?

Now, this is a game. where you understand that one friend's benefit payoffs or marks are going to depend on the other friend's answer as well because there are four possibilities. They are mentioned here. So there are basically all of us know that there are four tires of a vehicle and that's why there are four possibilities

and each friend is going to mention one of those four possibilities like which tire was flat. So, we generally measure player one across the rows and player two across the columns. That is the standard practice. So, player one is one student, and player two is the other student.

What are the options each one of them has? The options are the same. Front left, front right, rear left and rear right. Now you can see that if both of them right front left Then they clear the exam.

They get a grade because you have already an easy question like five marks. And then 95 for this. You give the same answer. The professor is convinced. They are sitting in different rooms.

They are sitting in separate rooms. So they cannot consult each other. In case they did not already decide or discussed it among themselves, then there are high possibility that they will not be coming up with the same answer. So the long they come up with the same answer, like front right, front right, rear left, rear left, and rear right, rear right, they are going to get A grades.

But if they do not or if their answers do not match, like one writes front right and the other one writes front left, player one writes right left, player two writes front left, sorry, rear left and player two writes front left, player one writes rear right, Player 2 writes front left. In all possible situations, their answers do not match, and they are going to get 5 out of 100, which is as good as failing the exam. So, you can see that whenever their strategies do not match with each other in all those cells, I have put 'F,' meaning they are going to fail.

But generally, this is not how we write the payoffs. I will come to the payoffs next or later. So, this is a payoff matrix. What else? These are strategies. RR is one strategy, RL is another strategy, FR is one strategy, and FL is another strategy. So, these individual moves are strategies, and then this is a strategy profile.

strategy profile like FL and FL, a strategy profile could be FL and FR so a strategy profile basically consists of strategies of each of the two players so here there are only two players so when whatever you know strategies we pick each of each player combine them together so it's a vector of each strategy from all the players involved—here, in this case, two players—we call it a strategy profile. So, FL-FR, FL-RL, FL-RR—all these are strategy profiles. Now, analytical game theory has something called Nash equilibrium and we are talking about Nash equilibrium in Pure Strategies.

So, what is Pure Strategy that we may tell you a little later. For the time being, analytical game theory is built around the concept of an equilibrium. The most prominent equilibrium concept is that of Nash equilibrium. Nash equilibrium is defined as A strategy profile such that each strategy in the profile is a best response to the other strategies in the profile.

To say that you are playing a best response means that you can do no better by switching to another course of action, given what the other players are up to. In other words, it means that there is no alternative strategy available to you that would give you a strictly higher payoff, again given what the other people do. So here, I am giving you the same problem with payoffs. So if both of them give the same answer, then they are getting 100 out of 100. So see for all the cells where we have FR - FR, then RL-RL and RR-RR, they are getting full marks.

So these are their payoffs. And whenever their answers do not match, then they are getting only 5 marks. So these are their payoffs. And what is the Nash equilibrium here in this case? How do we determine the Nash equilibrium?

So we consider individual players, individual strategies, and check that given this strategy, what the other player is going to do. For example, if player 1 writes FL, what is best for player 2 to write? Of course, this is FL. Another thing I need to mention here is that in each cell, as you can see, I have two numbers. The first number always represent player 1's payoff and the second number always represent player 2's payoff.

So in each cell, the first number is player 1's payoff and the second number is player 2's payoff. So if player 1 writes FL, player 2 is better off or the best strategy is to write FL. Player one writes FR, again the best strategy for player two to write FR. Player one writes RL, best strategy for player two to write RL. Player one writes RR best strategy for player two is to write RR. now I look at player two if player two writes FL then it is best for player one to write FL. Player two write FR best for player one to write FR.

Player 2 writes RL. Again, best for player 1 to write RL because I am comparing all these numbers. This is the highest. So, this is what is best to write. And then again, when player 2 writes RR, by comparing all these numbers, I find that this is the highest. In this game, there are 4 Nash equilibrium.

namely FL-FL, FR-FR, RL-RL and RR-RR. The long they give the same answers, they are going to be equally better off and these are the best responses for them. So in a Nash equilibrium, therefore everyone does as well as they can given what the others are doing. This is different from saying that the outcome will be as good as it can get. As you will see, being in a Nash equilibrium does not mean that the outcome is particularly good for anyone.

This example illustrates the interactive or strategic nature of many decision problems. Here, the final grade of either friend will depend not just on his answer to the question but on the other friend's answer too. The two will get A's whenever they give the same answer to the question and F's whenever they do not. More formally speaking, you are playing a game whenever you face a decision problem in which the final outcome depends not just on your action and and on whatever state of the world obtains but also on the actions of at least one other agent.

According to this definition, the two friends are in fact playing a game against each other, and this is true whether or not they think of it as a game. Notice that you can play a game in this sense without competing against each other. Nash equilibria in which each player simply plays one of the individual strategies available to him or her. In all, there are four Nash equilibria in pure strategies, as I have already shown you. One for each tire in the previous example.

Let us look at another example involving Nash equilibrium in pure strategy. So, we call it a pure coordination game. A pure coordination game is defined as one in which the players' interests are perfectly aligned. Suppose you and your friend are planning to meet at noon at one of the two coffee shops, CCD and Starbucks. Unfortunately, you failed to specify which one, and you have no way of getting in touch with each other before noon.

If you manage to meet, you get a utility of 1, in the sense that if both of you end up arriving at the same shop you get a utility of 1 otherwise you get a utility of 0 so the long you are in different shops you are getting utility of 0 and that is true for both of you now draw the payoff matrix and find the Nash equilibrium pure strategy so it's a pretty simple game everyone has only two strategies going to CCD or going to Starbucks If both of them go to CCD, then they get 1, 1. If both of them go to Starbucks, they get 1, 1.

If one goes to CCD and the other goes to Starbucks, then it is 0, 0. Similarly, if one goes to Starbucks and the other goes to CCD, it is 0, 0. So, what is the Nash equilibrium here in this case? Again, we will see that when Player 1 goes to CCD, I will check the second numbers for Player 2. So, Player 2 is definitely better off by going to CCD. When Player 1 goes to Starbucks, Player 2 is better off by going to Starbucks.

When Player 2 goes to CCD, I check these two numbers, and Player 1 is better off by going to CCD. When Player 2 goes to Starbucks, then Player 1 is again better off by going to Starbucks. So, there are two Nash equilibria. One is CCD-CCD, and another one is Starbucks-Starbucks.

So, these are the two Nash equilibria that we have here. The convention is for the first number in each cell to represent the payoff of Player 1, whose strategies are listed in the leftmost column. The second number in each cell represents the payoff of player 2, whose strategies are listed in the top row. So, this is what I have already mentioned. The Nash Equilibria in pure strategies here are CCD, CCD and Starbucks, Starbucks.

The coffee shop game is an example of a pure coordination game. In some coordination games, however, interests fail to align perfectly. So some such game is called impure coordination game and very important kind of game is the battle of sexes. So, let us describe the game 'Battle of the Sexes,' but I must tell you that 'Battle of the Sexes' does not always refer to this game. Now, it has emerged as a type of game where, whenever there is impure coordination, we can call it a game of 'Battle of the Sexes.'

A husband and wife must decide whether to go to a concert or a theater. All things equal, both would rather go to a concert together than alone. But the man, whom we assume here to be player two, prefers the theater, and the woman, that is player one, prefers the concert. The man gets two units of utility if both go to the theater. One, if both go to the concert, because he does not like concerts much.

That's why he gets higher utility from the theater. But he gets zero if they go to separate places. So it's not that going to the theater alone is something which is preferred. So the first preference is that they want to stick together but then more enjoyment from theater for the man so that's why gets an utility of two while somewhat lesser so that's why utility of one from concert but if they go to separate places then it's zero. the woman alternatively gets two units of utility if both go to the concert, one if both go to the theater, and zero if they stay apart. Now draw the payoff matrix and find the Nash equilibrium pure strategies. so this is simply again the Nash equilibrium a two by two matrix game matrix of game we can see we're measuring player one the wife here and player two is the husband so when player one is going to concert she is getting two, husband is getting one when both of them are going to theater she is getting one and the man is getting two

If they are going to separate places, then their payoffs are 0, 0. Here, the two NE's are concert, concert and theater, theater. Because as you can see that, if the wife goes to concert, then by comparing these two numbers, we find that the husband is going to concert. If the wife is going to the theater, then again, the husband finds that he is better off by going to the theater. If the husband is going to the concert, then the wife,

if we compare 2 and 0 is better off by going to concert and if the husband is going to theater then the wife is better off by going to theater so as a result of which concert concert and theater theater are the two Nash equilibrium. because player 1 prefers one equilibrium and player 2 prefers the other the battle of sexes is an example of an impure coordination game theater theater is player 2's best outcome he cannot improve his payoff by changing strategies Although player 1 would prefer it if both switch to the concert, she cannot improve her payoff by unilaterally deviating also.

If she plays concert when player 2 plays theater, she will end up with a payoff of 0 rather than 1. Because player 1 prefers the one equilibrium and player 2 prefers the other, the battle of sexes, sometimes euphemistically called Bach or Stravinsky. As these games illustrate, there is no straightforward connection between Nash equilibria and the best outcomes for the players. As a result, it would be a mistake to try to identify the former, that is the Nash equilibria by searching for the latter, the best outcome. So it is not necessary that Nash equilibria ensures the best possible outcome for every player or each player.

Now, let us talk about some examples of games and derivations of NE's. We will also establish certain facts through this. So, this is one simple game again of 2 by 2 matrices. And what we observe is that suppose player 1 chooses U, then player 2 is better off by playing L because 2 is greater than 0. If player 1 decides to play D, then player 2 is better off by playing right or R.

Now, if player 2 decides to play L, then again by comparing 2 and 0, player 2 is better off by playing U. If the player 2 decides to play R, then player 1 is better off by playing D or down. So, these two are the two Nash equilibria. One is now you can see clearly inferior to the other. So this is 2, 2. This is 1, 1.

Both are Nash equilibria. But if both of them end up playing 1, 1, then there are always opportunities to make themselves better off. So Nash equilibria do not always imply that these are the best outcomes. Here the two outcomes are present.

One definitely offers the best possible outcome, but the other does not, while both are Nash equilibria. Now let us consider another example where if player 1 chooses U, then player 2 would be better off by playing L. If player 1 plays D, player 2 is better off by playing R. When player 2 plays left, then player 1 would be indifferent between up and down. And when player 2 plays right, then player 1 is actually better off by playing up. So, comparing 1 and 2, player 1 would choose 2.

So, here in this case, you can see that U, L Because player 1 was indifferent between 5 and 5, she can play both. So, 5, 1, U, L is the only Nash equilibrium. Though D, L is also as good as U, L, but it is not a Nash equilibrium. Because we cannot ensure that if player 1 chooses D, then player 2 will choose L. Of course, when player 1 chooses D, player 2 chooses R.

And when player 2 chooses R, then player 1 chooses U. So, as a result of which D, L is not a Nash equilibrium, even though the payoffs associated with U, L and D, L are the same. This is another example with a 3 by 3 payoff matrix. Here again, let us look at the payoffs and identify the Nash equilibrium. Now, for up, player 2 will choose R. For middle, player 2 will choose L. For down, player 2 will choose L again.

Now, when player 2 chooses L, player 1 chooses up. When player 2 chooses middle, player 1 chooses down or D, and when player 2 chooses R or right then player 1 chooses up. So as you can see that only here both the numbers are encircled so this is the only Nash equilibrium here so U, R is the Nash equilibrium though there are outcomes that are better for both players. For example MM is an outcome which is better for both players. DM is another outcome which again is better for both players. Still,

NE is the Nash equilibrium and these are not Nash equilibria. These examples show that there is no straightforward connection between Nash equilibria and the best outcomes for the players. So, with this, I conclude this module on the introduction to analytical game theory. We have just introduced the concept of Nash equilibrium. In the next module, we will continue with further discussions on analytical game theory.

Thank you.