Game Theory and Economics

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Module No. # 01
Introduction to Game Theory
Lecture No. # 02
Interacting Decision Makers

Welcome to the next - the second lecture of the course called game theory and economics. This second lecture will focus on things like interacting decision makers and of course, we shall continue this lecture from the previous lecture. If you remember, in the previous lecture, we talked about the basic idea of games; what is meant by games and game theory.

We said that in game theory, we try to study how decision makers interact. These decision makers may be people like husband and wife. They are trying to decide where to spend their evening or these decision makers may not be people, but firms.

For example, two companies deciding on what price to charge for their products or these decision makers could be two countries' governments deciding on what tariff to charge for the imports that they take from other countries.

So, decision makers try to interact with each other and decision of a particular player, we shall use the word player for a decision maker, the decision of a particular player affects what the other player is getting, the benefits that he is getting out of this whole process and that is what makes it more interesting because not only my decision affects my benefit; it is the decision of the other player also, which affects my benefit.

So, this is what game theory is. This is what we try to study in game theory. How we can analyze such situations and is there a way to influence such kind of interactions through our understanding of game theory.

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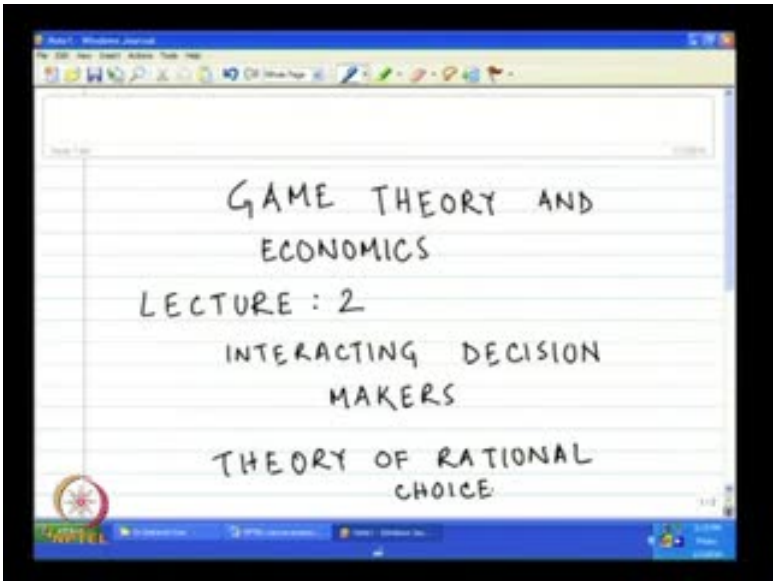

This is the starting point that we discussed in the previous class. We said that one of the founding stones of this game theory is the theory of rational choice. What does it mean? Theory of rational choice essentially, says that it basically says that any player or what in economics, we call economic agent, at any point of time has a number of actions to take. He or she takes that action which is best suited for him, which maximizes his benefits.

Now, when you say that it maximizes his benefits, one must also have an idea about the preference pattern of that person, of that player. When you talk about the theory of rational choice, two information are known to us. One - what are the actions available to a particular player and number two - what is the preference pattern of that player? If we have an idea of these two things of a particular player, then you can immediately say, look this is the choice that will be made; this is the action that will be taken by that player.

This is the first thing, but at the same time we know that it might happen that out of all the actions that an individual has access to, there are more than one action which can be taken which is best or which are best for that player.

In that case, we are not very certain, which exact action that player will take, but we can say that this, this and this may be three actions that are best for him and he will take one of them and not the others; that we can of course, say.

Also, theory of rational choice also implies that the choices made by the players or the economic agents must be consistent. By consistent, we mean that if he chooses any action a, suppose over another action b then if there is another situation where a and b are available to him, then he will never take action b, if a is available. So, this is what is meant by consistency. Consistency also means that if a is preferred to b and b is preferred to c then a should be preferred to c. This principle is known as the principle of transitivity.

In the remaining part of this course, we shall continue with this assumption that the decision makers, the players in the games follow the theory of rational choice; they abide by the theory of rational choice.

Whenever they are face to some choice of actions, they take that action which is best suited for him or her. This is again something, we have discussed in the previous class. I am just trying to recapitulate what we have done very briefly.

Now, let me go a little bit further and say that this is the framework that we have in economics - basic economic theory. That people may take actions, which is best for him or her and that basically, what we say maximize that action or more than one action may be, those actions maximize the utility of an individual.

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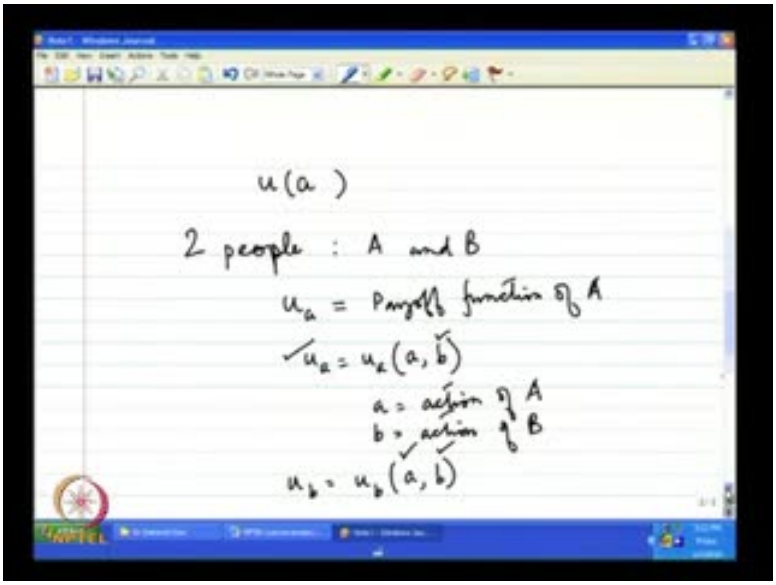

Now, here a particular variable is maximizing a particular individual's utility function or what we defined in the previous class as the payoff function. So, payoff function in the standard economic theory where there is no game theory, the payoff functions. Suppose, u is a function of a single variable, there is no other variable here.

If a is chosen in such a way that u is the highest value, then u is the action that is going to be taken by the player, but in game theory, we are moving away from that framework. We are moving away from that framework because if you remember, here we are talking about interactions.

So, it is not the case that a single individual is taking action and that is the only thing that is affecting his payoff. It is the case that this individual, his payoff or what he is getting out of this situation is being affected by the decision of other players also.

It might be the case that there are two people, maybe A and B and suppose, u a is the payoff function of A, then we know u a is of the form, this u a is a function of small a, small b, where a is the action of A and b is the action of B and that makes it more complicated, but interesting because here when capital A is choosing his action may be small a, that is affecting u a, but that is not the only thing that is affecting u a; it is being affective by u b also. I mean it is affecting it is being affected by small b also.

If b changes, that affects the utility of a and it can work the other way also. I mean you have u b which is a function of small a, small b which means the benefit that capital B is getting, it is getting affected by the action that he is taking which is small b, but it is also getting affected by the action that is taken by capital A and there we have an interaction and we want to see how in game theory, these interactions take place.

How I take into account, the actions that are going to be taken by the other player. Similarly, for the other player how he is going to figure out, what action I am going to take and ultimately, what is likely to happen in these situations.

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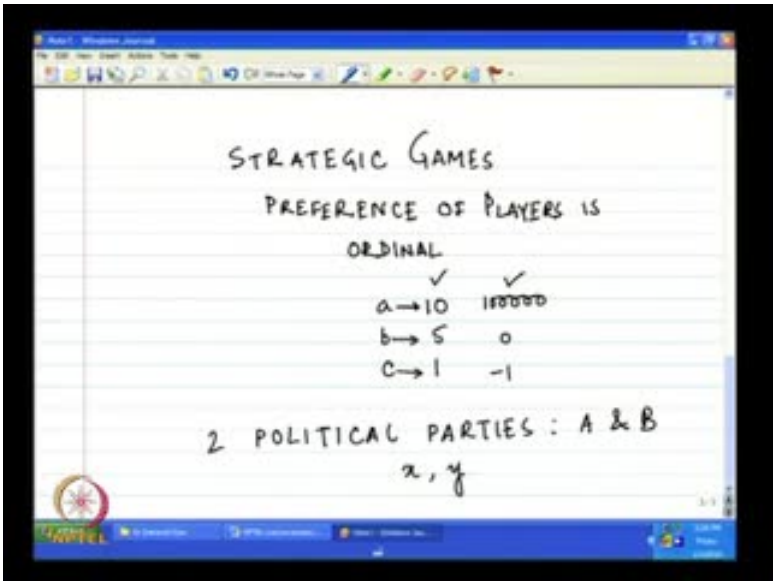

This is what we are going to study in game theory in brief. In this class, we are going to start from this framework. I am going to introduce some preliminary games of a particular kind. I am going to describe that particular kind. That particular kind will be called strategic games. So, this is a class of games, which are called strategic games.

If you remember, in the last class we say that the payoff functions that we have, are called ordinal payoff functions or another way of saying this is the following. We say that the preference of players is ordinal. What does it mean? It means that if an individual, ranks the choices available to him, in this case, the choices are not merely his actions it is more complicated because the actions of other players are also involved.

Whatever it is, if a player ranks the choices then the absolute value of the rankings do not matter. What matters is relatively what the rankings are. So, if the rankings are such that suppose, bigger number means more liking for that option. If this is one ranking; this is suppose a, this is b and this is c; this is the first choice, this is the second option, this is the third option.

So here, suppose this is the player 1. Player 1 is attaching number 10 to the first choice, 5 to the second choice and 1 to the third choice. This is one ranking. What ordinal preference will say is that if the ranking is something like 1 lakh, 0 and minus 1, they will do just as well. There is no difference between this ranking and this ranking in the

ordinal sense because in the first ranking 10 is greater than 5, 5 is greater than 1; in the second ranking also 1 lakh is greater than 0, 0 is greater than minus 1.

What matters is relatively how a and b and c are ordered. Here, a and b and c are ordered in the same way, qualitatively same way. So, this is ordinal preference. We are going to assume that the individuals have ordinal preference. The payoff function that we have, they reflect ordinal preference of the individuals.

Let me now begin with the next topic that is, I am going to introduce some strategic games, some standard strategic games and I am going to define what is a strategic game, but before that just a way of introducing. I said that here when the players interact what matters is the action of others also.

This was an abstract way of saying something, but let me try to give you some examples in which, it can be seen that how the action of other players can affect me. Let me take the case of a two political parties, for example. Again suppose, A and B. What is the action that they are taking? Maybe before the election, they are announcing how much money that they are going to spend, if they get elected.

Now, the money that A is going to spend after and if it gets elected, is going to affect the amount of votes that it gets because the people who are the voters, they may think, let us assume that they will think that the more money the government spends, it is better for them; some part of it at least will trickle down to them.

So, here suppose capital A is deciding x, the amount of money that it is going to spend and y is the amount of money that B is going to spend, if and when it is elected to the office. Here, you see the value of y is going to affect the prospect of A's winning; it is going to affect the prospect of winning of B also. So, x and y affect the chance of winning of both the parties. It is not that x is affecting on the chances of A, it is affecting chances of B also. This is what is meant by the interactive process. That is, what I am deciding, what I am doing is affecting you.

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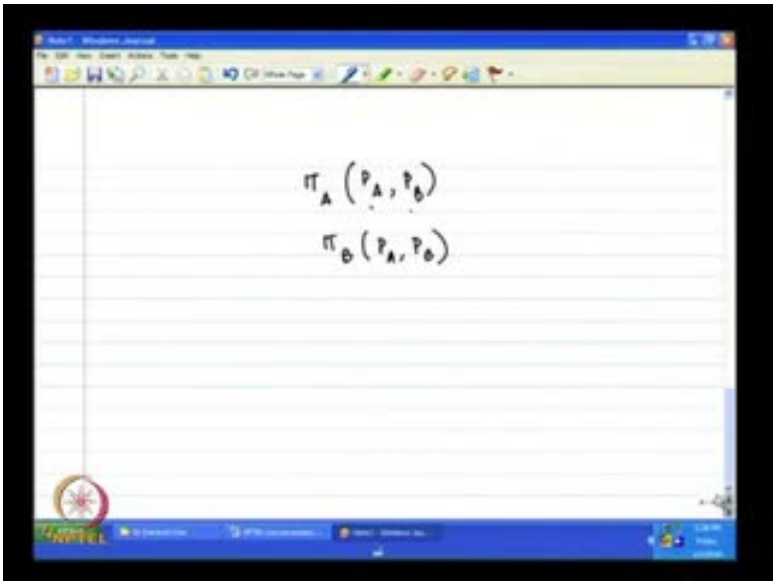

I can give you some other examples also. The standard economics example that we often make, that two firms are interacting in the sense that suppose this is the profit that is made – pi; pi is the profit made by a particular company A.

Now profit by company A depends on the price it charges. Suppose, it charges a price P A, but it also depends on the price that is charged by another company B to make it simple; in reality, it is more complicated. To make it simple, suppose there are only two companies which are selling similar products. So, what price the second company charges, which is P B, is going to affect what is the market share or how many goods, the first company, that is company A can sell in the market.

So, both of these things are affecting the profit of A. Similarly, pi B is a function of P A and P B. So, the examples can be given. Plenty of examples can be given. I am just giving you some introductory examples, very simple kind of examples.

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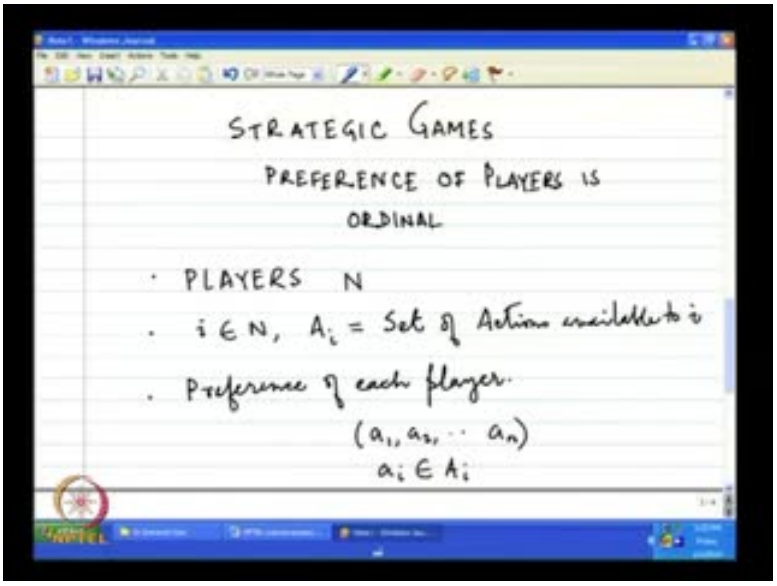

So without much ado then, let me start with this topic of strategic games with ordinal preference. now what is meant by strategic game with ordinal preference? I am trying to define it very briefly.

In a strategic game, three components must be specified. Firstly, who are the players or who are the decision makers? The identity of the players and how many are there should be given. Secondly, Often we say the set of players to be capital N, obviously it is a matter of convention.

Secondly, what are the actions that are available to each of the players? These are called action sets. If i belongs to capital N, then I should have an idea what is A i, where A i is the set of actions available to i.

So, A 1, A 2, dot dot dot, A n, n sets will be there. Each will have some elements and it is not necessary that the number of actions available to a particular player is same as the number of actions available to another player.

Thirdly, what we need to know is the preference of each player. What is meant by this is that since this is an interaction interactive process that we are talking about, what happens is that at any play of the game, some action has been taken by some player.

So, in a particular play of the game, what we have is a list of actions, each taken by one player. It will like look like this. Suppose a 1, a 2, dot dot a n, where there are small n

number of players. Now, let us call it like this; small a i belonging to capital A i, which means that a i action has been taken by the ith player and a i belongs to capital A i.

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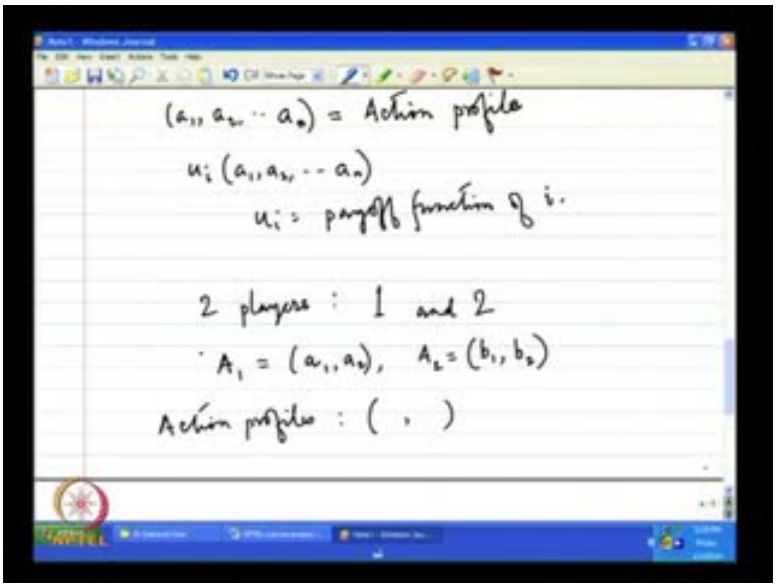

Now, this vector or this list of actions taken by each of the n players is called an action profile. It is a profile of all the actions taken by all the players. If there are n number players, then it is a vector of n elements.

What we need to know is that how the players are ranking these action profiles. There will be plenty of action profiles in any game. Now, the players will be required to tell us or it should be known to us, if we want to analyze the game that which action profile is preferred by particular player over other action profiles. How he ranks these action profiles?

So, by the third element of strategic games which is we have defined it as preferences, preference of each player. What we mean is that, this should be properly defined. u i, if you remember is the payoff function - ordinal payoff function of i and u i is defined over action profiles and we have to know what are the values of E u i for each possible action profile and if I know that, I know the preference of each of the players.

For example, let me give you an example so that it becomes clear. Suppose, there are two players, again let us suppose A and B. No, let us not take A and B because A stands for action. Let us take the players to be 1 and 2.

Suppose A 1 which is the set of actions of player 1 is equal to small a 1, small a 2 and A 2 which is the set of action of the second player is consisting of two elements small b 1, and small b 2. In this case, how many action profiles can be constructed?

So, action profiles will be here, 4 in number. It is obvious because the first element of the profile should come from the action set of the first player. Now, there are two possible actions which can be taken by the first player.

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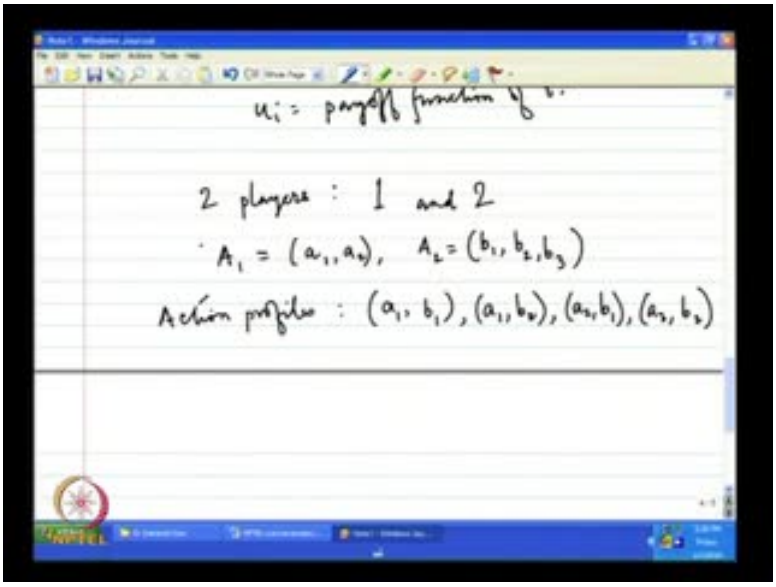

So, the first position here, in this action profile can be filled up in two ways. The second position can be filled up in two ways. Two multiplied by two is equal to 4 and what are they? Just for the sake of detail a 1 b 1, a 1 b 2, a 2 b 1, a 2 b 2. If it had been the case that instead of b 1 b 2, we had a third action for player 2, then the number of action profiles which would have gone up to 6 because then the first position could have been filled up in two ways, the second position could have been filled up in three ways - 2 multiplied by 3 is equal to 6.

Depending on the size of the action sets of each player, the number of action profiles can go on rising.

Of course, you can see if the number of players is also more, here there were 2 players, but suppose there were more players, n number of players then each action profile would have consisted of n elements.

Now, this is by way of introduction, what is the main point? The main point is that the preference, when you say that the strategic game should tell us what is the preference pattern of in each individual. By that we mean that how the payoff function of an individual is defined over the action profile; that should be known to us. That is what is meant by the knowledge of the preference of each player. This is the first thing.

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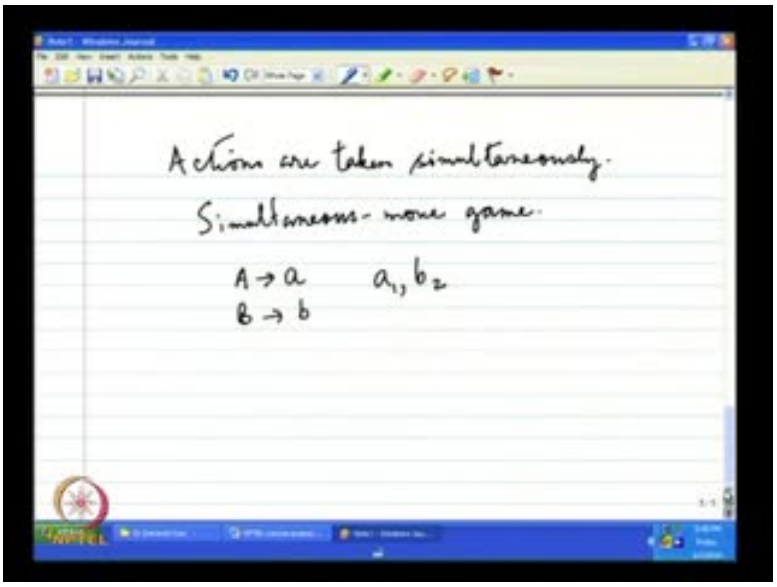

One very important aspect of strategic games is that here, when you say that this is the action of the first player, that is the action of the second player, the idea is that these actions are taken simultaneously, which means that when I am taking an action, I do not know what is the action taken by the other player because both the actions are taking place at the same time. If they are taking place at the same time, I do not know beforehand, what is the action that is going to be taken by the other player.

So, this is one reason why strategic games are also called simultaneous move game. By move, it means the actions are taking place at the same time and since the actions are taking place at the same time, they are called simultaneous move game.

This is one way of looking at strategic form game. Another way of looking at strategic game is not to visualize that the actions are taking place simultaneously, but to say that well, it is possible that the actions are taking place; suppose, here A is taking an action; here B is taking another action, that is they are occurring one after another, but the point is that when A has taken an action, B cannot change his action which means that at the

beginning of the game itself B is saying that I am going to take suppose b 2; that he is announcing in the beginning of the game once and for all.

When the game begins, it is an A has taken an action, suppose a 1 then B cannot say he has taken the action a 1 now. I will not take b 2. I will take some other action; that is not allowed because he has already announced that I am going to take b 2 in the beginning of the game.

So, here though the game is not simultaneous move, it is happening one after another. It is a sequential form of game, but since the second player who is to move next has already announced what he is going to do in the beginning of the game itself, it is as good as simultaneous move game because here also nobody knows what the other player is going to do. So, this is the other interpretation of strategic form game.

So, this is by way of introducing strategic form game. We shall now start with a real stuff. We are going to introduce one game after another and as I have told you in the last class, games are nothing, but abstract models. When we introduce a particular game, it is not the case that the description in that game is very much important to us, the details of the description. It is the case that essentially, that game is capturing a situation which we can find in many different forms, maybe the details are little different, but essentially they are the same; essentially, qualitatively, they depict the same kind of situation.

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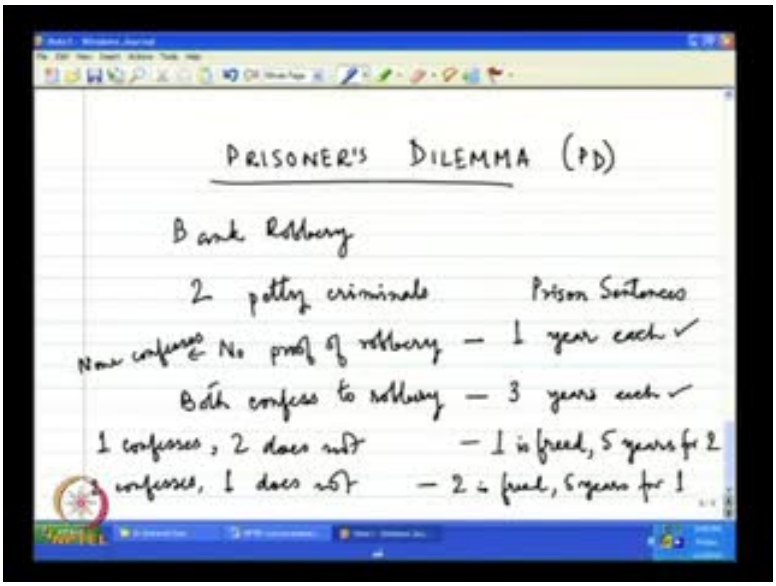

Let me give you an example and this is the first game that I am going to introduce here. This is a strategic form game with ordinal preference and the game is called Prisoner's dilemma. In short, it is also called P D - P for Prisoner's, D for dilemma. Now, one very interesting thing about study of game theory is that each game has a story and we like stories so that maybe makes game theory little interesting than other boring subjects.

So, what is Prisoner's dilemma? What does it describe? Here the story is the following. Suppose there is a town, since all these examples mostly come from US, let us suppose this town is in America and in that town there is a big crime like maybe a bank robbery.

So, it is a big time crime and the police have apprehended two suspects from that locality who could be the real criminals, but these two people who the police have captured are basically known petty thieves of the locality. So, we have 2 petty criminals who have been captured and it is known that if any of them has been involved in this robbery, it must have been the case that the other person was also involved; these two are partners.

Now these 2 people - petty criminals have been put in two prison cells by the police. The significance of the 2 prison cells is that they cannot communicate with each other. The police can interrogate them separately; they cannot talk to each other.

Now, the police have enough evidence to put them both of them to jail for petty thievery because they are known to be, you know local level criminals.

When they cannot prove that these people have committed this big crime, the bank robbery and even if they say that we have not committed this bank robbery and police cannot prove that they have robbed that bank, even then they can be put to jail. If they go to jail, they go for 1 year each. So, this is the case when the people are not confessing, they are saying that we have not committed the crime and the police can cannot prove that they have committed the crime - this big crime.

Second case: let us say both of them say that we have committed this crime, we have robbed the bank. If both confess let us say, to robbery then obviously the charge is more serious. They have committed the crime. It is admitted by them, then both of them go to jail for 3 years each.

So, these are prison sentences. Now, just let me specify. When there is no proof of robbery, that is, the same case where these criminals, these petty criminals, are not confessing. This is the case where nobody confesses - none confesses. If none confesses, the police cannot prove anything and they are given 1 year imprisonment each.

What can be the other possibilities? The third possibility could be that one confesses, the first prisoner confesses that he has robbed the bank.

Now, remember when he says that I have robbed the bank, obviously he implicates the other person also because it is known that if anyone has committed the crime, the other person has been an accomplice.

So, if one confesses, he is in effect standing to be the state's witness, he is helping the police to solve the case in which case, his crime is suppose to be lessened. He is then not put to prison at all; then he is let free; he is freed.

So, in that case the first person is freed, but as we know that these people may have committed the crime together. So, if one confesses two does not, then two is in effect implicated in that crime and his charges are more serious now because not only had he committed the crime, which has been proved by one's confession, but he did not confess either. So, he did not cooperate with the police.

So, his charges are now more serious. He goes to jail for 5 years. for two. Similarly, the other thing will be if two confesses, one does not; in this case two is freed and 5 years for one because he is not cooperating, but he had committed the crime too.

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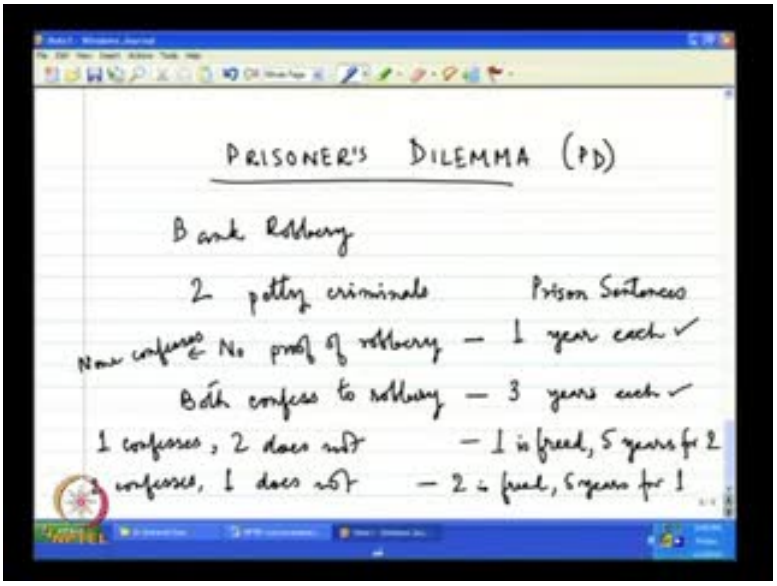

These are the incentives that are given by the police to the prisoners. The prisoners are stationed in two cells. The police have given them these choices that look if you confess and the other person also confesses then both of you will go for 3 years. If neither of you confess then again you will go to jail, but not for bank robbery and so that will be less years - it will be 1 year. If you confess, the other guy does not confess then you will be freed and the other person will go for 5 years and vice versa. If you do not confess, other person confesses then you will go for 5 years, the other person will be freed.

This is what the police tell the prisoners. If this is the situation then we can frame this entire situation, this story what the prisoners will do, what will be done and that we shall look into a little later, but this entire story can be framed in terms of the tools that we know of strategic games. What we need to know in strategic games as I have just told you is that, we need to be sure about three elements.

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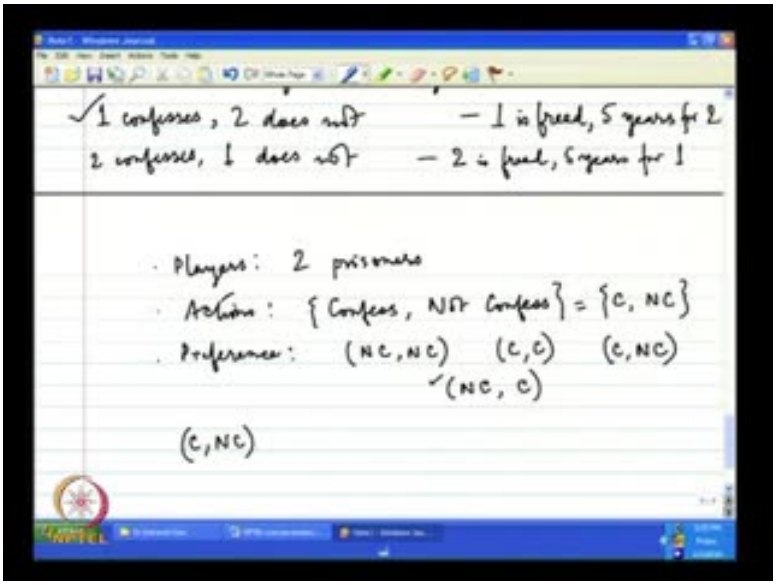

First is the number of players. Here, who are the players? Here, the players are obviously these 2 thieves - these 2 prisoners because now they are going to make a decision. What they are going to do, confess or not confess. So, players here are 2 prisoners. Secondly, the second element of a strategic game is that we need to know the actions possible - actions available to the players.

Here for both the players, the action set is the same and what is that action set? It is confess - they can either say that we have committed this bank robbery or not confess. He says that I did not commit to the crime. We shall in short, write it as C and NC alright.

Thirdly preference we need to know: what is the preference of each prisoner? Now, given what I have presented before, it is easy to see what the preference of the prisoners is. There are how many action profiles? Since there are 2 players and each has 2 actions, so that 2 actions, so that means, there will be 4 possible action profiles. The 4 possible action profiles are the following.

NC, NC; this is one, where nobody is confessing; another will be C, C - both are confessing and another will be C, NC and another will be NC, C. These are the possible 4 profiles.

Now, what is the order of these two elements in a particular action profile? The first element is the action of the first player. So, NC, NC means first player is not confessing; second player is also not confessing. What about NC, C? It means that the first player is not confessing, but the second player is confessing.

Now, given the information I have given to you just now, it is easy to see which one will be preferred by the first player, which will be the second best for the first player, third and fourth.

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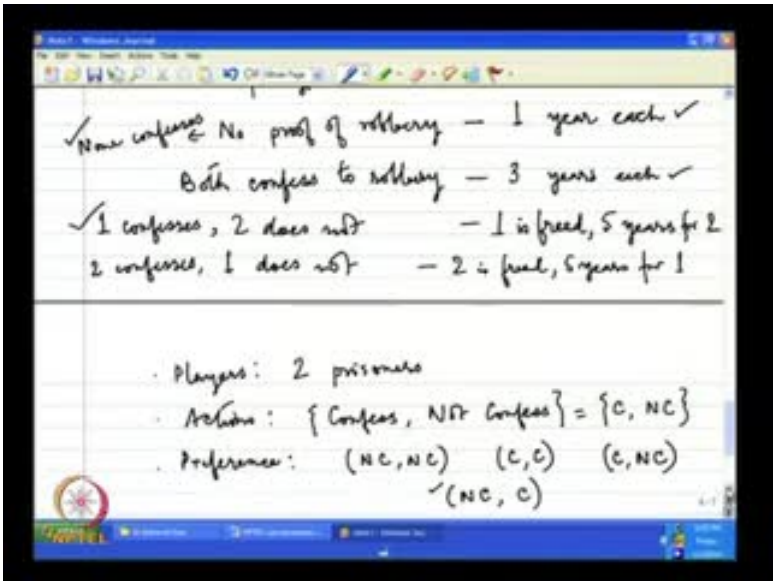

The first best for the first player is that he is freed, he is not put to jail at all and when does that happen? The first player is freed and this happens if first player confesses and the second player does not. This is the case of C and NC; this is the action profile; this is the best for the first player. What is the second best? The second best is that the first player goes to jail, but for a short period of time for 1 year and which happens, if nobody confesses. So, NC, NC is the second best for the first player – NC, NC.

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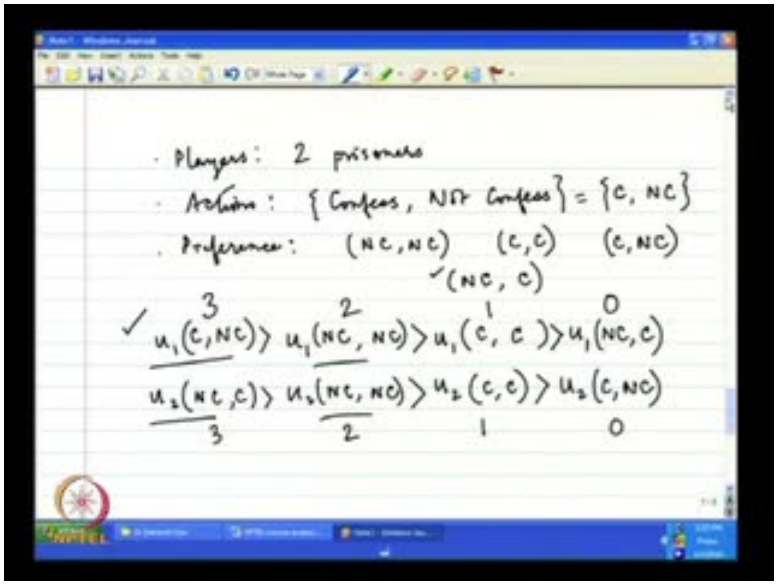

So u 1 of C, NC should be greater than u 1 of NC, NC. u 1, if you remember this is a payoff function of first player. So, u 1 of C, NC is the highest. That is why, I have written it in the left most part, then comes NC, NC where both of them are going to jail, but not for bank robbery and that is for only 1 year.

What is the third best? The third best is that well, they both confess and go to jail for 3 years. This is the case of C, C; both of them are confessing to the bank robbery and since both of them are cooperating with the trial, they are going to jail for 3 years and what is the worst possible case is that the first player does not confess, but the second player his friend is confessing.

This is the case where the second player basically who was the partner of the first player is ditching him; he is cheating him; he is not only getting scot free, but he is putting his friend to 5 years in jail.

So, this is the last element in this chain. This is the case where he is not confessing NC, but his partner has confessed and in effect, the partner has implicated him to this bank robbery. So, this is the preference pattern of the first player. What about the second player? It will be just kind of opposite thing, not exactly opposite, but nearly. For the second player, the best is that he is freed and the first player goes to jail because if he is freed, automatically the first player goes to jail for 5 years.

So here, he is confessing - the second player, but the first player does not - NC, C. Similarly, the second best will be both of them are not confessing and going to jail for 1 year, third best is that both of them are confessing going to jail for 3 years.

Lastly is the case, when the first player is cheating. So, he is confessing, the first player is cheating - the first element, but the second player does not confess. So, he is put to jail for 5 years now. This is what we know that This is how the payoff functions. The value of the payoff function should look like and If you remember, we have ordinal preference here. Now, since ordinal preference is the thing that we have here, it does not matter what numerical value I attach to each of this u 1, of this u 2, etcetera.

It does not matter what absolutely numerical value I attach, as long as those four numerical values are ordered in this fashion relatively. they are ordered in this fashion.

So, the numbers that we shall choose, the numerical values that we shall choose will be the simplest possible numerical values to deal with and the simplest possible I can choose is 0, 1, 2, 3 whole numbers. Whole numbers are easier to deal with and easier to understand also - whole numbers and positive numbers 0, 1, 2, 3. Here also this is 3, 2, 1, 0; 3 is greater than 2, 2 is greater than 1, 1 is greater than 0.

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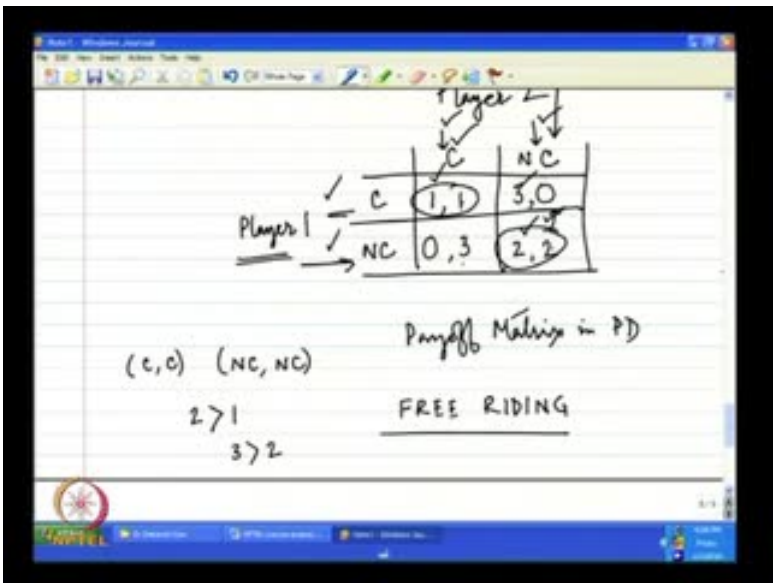

This is how the preference looks like. Again the entire story and the players, what are the actions available to them can be summarized in a very cute fashion by what is known as a payoff matrix. What is a payoff matrix?

Payoff matrix is obviously, a collection of cells as any matrix is. Let me write it some else and Player 1 is situated here; player 2 is situated here. This is the first row, first column, second row and second column.

What it means is that player 1 is When I wrote player 1 on the left hand side just beside the rows, it means that the player 1 is choosing the row. He can choose either the first row or the second row and each row is standing for each action.

Since the player 1 has two actions to choose from - C and NC, here the rows are called C and NC. He is choosing any of these actions. Similarly, player 2 can choose either of these two actions, but here they are columns, not rows. Given this, there are four cells and each cell basically is representing an action profile. For example, this cell, the first cell is representing the action profile C, C. This top right cell is representing the action profile C, NC - that is, first player is choosing confess, the second player is choosing not confess, etcetera.

Now, what we are going to write in these cells, in each of these 4 cells is the payoffs that the players are getting. If you remember the numbers that I have imagined for this payoff functions, value of the payoff functions. If C, NC is the action profile, the first player gets 3 – C, NC, this is 3. However, if C, NC is the action profile, what does player 2 get? It is this one, last one here. Player 2 is getting 0. So, this is how this box is filled up; this cell is filled up. Let us concentrate on C, C. If C, C is the action profile, then I can check from the previous page that both are getting 1.

Then let me come to NC, C. If NC, C is the action profile then this is the best case scenario for player 2. He is getting 3, but this is the worst case scenario for player 1 because he is not confessing, the other person is confessing. So, player 1 will go to jail for 5 years. So, this is 0. Lastly, if both of them do not confess, then they are going to jail for 1 year. If they are going to jail for 1 year, then that is what we have represented by the number 2. So, this is 2, 2.

So, this is the idea of a payoff matrix. This is called a payoff matrix. A little bit of observation into this payoff matrix will be very helpful. Firstly, if I compare these two outcomes, these two action profiles of C, C and NC, NC which is basically this and this, what do I find? I find that it is better for both of them to not to confess. If they do not confess - either of them does not confess, then they are getting 2 which is greater than 1.

By rational theory of rational choice, both of them will like this outcome. NC, NC to the outcome C, C which means that if they could have communicated with each other that look let us have this common strategy that neither of us confesses, then that will be better if both of us confess.

If they could have done that, they would have gone for NC, NC. In this case, there is a kind of cooperation, there is a kind of coordination between the prisoners which would have given them a better payoff 2, compared to the case where both of them are confessing.

But the question is does this happen, will this happen? Let us think it from the point of view of player 1. Player 1, if he knows that the player 2 is not going to confess alright, then is it better for him to not to confess. (Refer Slide Time: 51:10) You can see that if player 2 has chosen this column, that is, not confess, then player 1 will compare between this and this and if he chooses C, what is it that he is getting, he is getting 3.

If he is choosing NC, that is, he is also not confessing like player 2, then he is getting 2. Since 3 is greater than 2, by the theory of rational choice we know that if player 1 knows that player 2 is not going to confess, then player 1 will go and confess.

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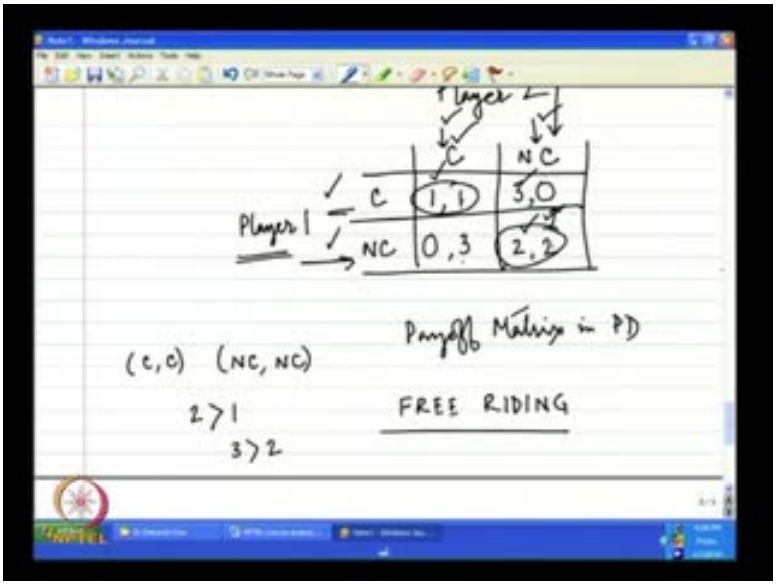

So, in a way he is going to ditch on his friend. He is going to break this kind of agreement, if there had been any agreement. If they had an agreement that let us not confess, then from the individual rational perspective of player 1, he would not have respected that agreement.

If he had known that player 2 is not going to confess, he would have gone and confessed. So, this outcome which would have been better than this - this is better than this, may not last because each of the players has a tendency or has an incentive of not confessing.

Because I have given you this illustration, from the point of view of player 1, the game is more or less similar from the point of view of player 2 also. The same logic can be applied to player 2. Let me just go over this. If player 2 knows that player 1 is going to choose NC, that is, not going to confess, then player 2 will compare what do I get if I confess? I get 3; what do I get if I do not confess? I get 2; 3 is greater than 2, in which case, I will confess.

If I know other person is not confessing, it is best for me to confess. So, this is the whole idea of prisoner's dilemma and this is known as free riding. So, what is meant by free riding is that if there is a good outcome which is coming out of some cooperation, in this case it is NC, NC. There is a cooperation among the Prisoners not the cooperation between the Prisoner and the police. There is a cooperation, a kind of understanding

between the prisoners, let us not confess, in which case it is better for both of us we are getting 2.

If that is the kind of situation that is likely to prevail, then from the individual rational perspective of each of the Prisoners, it is best to break that kind of understanding. Each will like to free ride on the other. Each will like to put the other partner into danger and will like to get safe from these jail centers; that is what is meant by Free Riding.

Another interesting thing is that, if you look at this game, a little bit carefully, at this payoff matrix, let us take it from the point view of player 2. If player 2 knows that player 1 is going to play NC, obviously, as I have said he is going to play C, but if the player 2 knows that the player 1 is going to play C, then what does he do again? You see that he is going to compare 1, which he gets if he plays C and 0, which he gets if he plays NC and he sees that 1 is greater than 0 in which case he will play C. So, it does not matter what the other player is doing, it is always better for each of the players to play C.

So, even if the other player is playing C, I am going to play C. I am never going to play NC. This is the another aspect of this Prisoner's dilemma.

Let me wrap up this lecture by a few observations and what we have covered in this lecture. What we have introduced today is firstly, we have said that game theory is different from the standard traditional for example, microeconomic theory, what we call microeconomic theory. In the sense that in microeconomic theory, the basic microeconomic theory, the individuals take their actions as if their action is all that matters to them.

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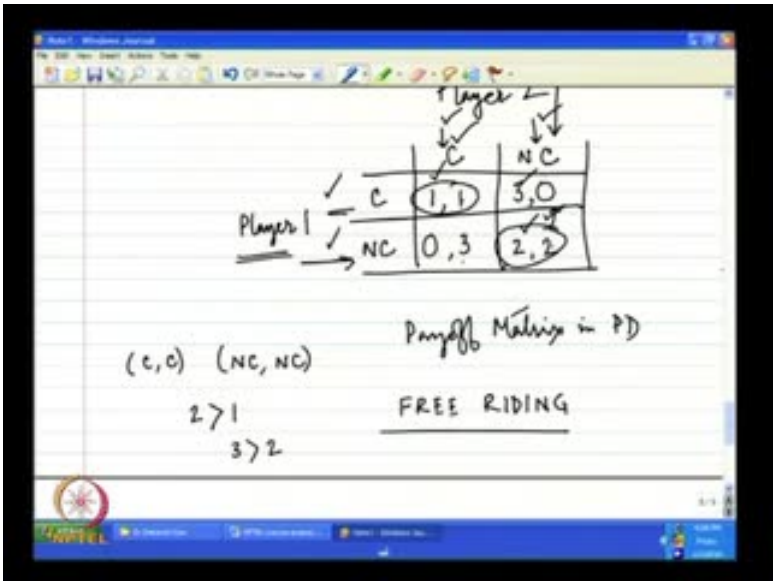

It is not taken into consideration that other player's activities may affect my well being, my benefits or my losses. So, that is not there in game theory; we move away from that frame work. We move away from that frame work in the sense that we take into account that our action is going to affect our benefit or losses, but we also take into account the fact that other people's action may also affect us; that is, the first and the most important thing about game theory; that there is a kind of interactive process. What you are doing is affecting me and vice versa.

That is the first thing we said and secondly we have introduced the idea of strategic form games or strategic games with ordinal preferences, what are the basic requirements of this strategic form game with ordinal preferences and we have also introduced the first game that which is known as Prisoner's dilemma. We have described the game, the essential points of the game, we have described.

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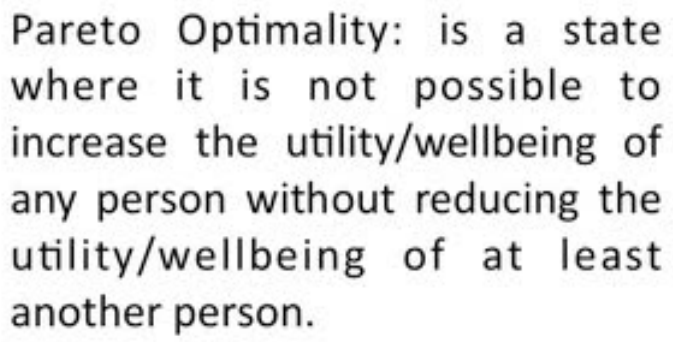

This is new notion Pareto Optimality, which we are going to use in the later lectures. So, I am introducing this concept here itself.

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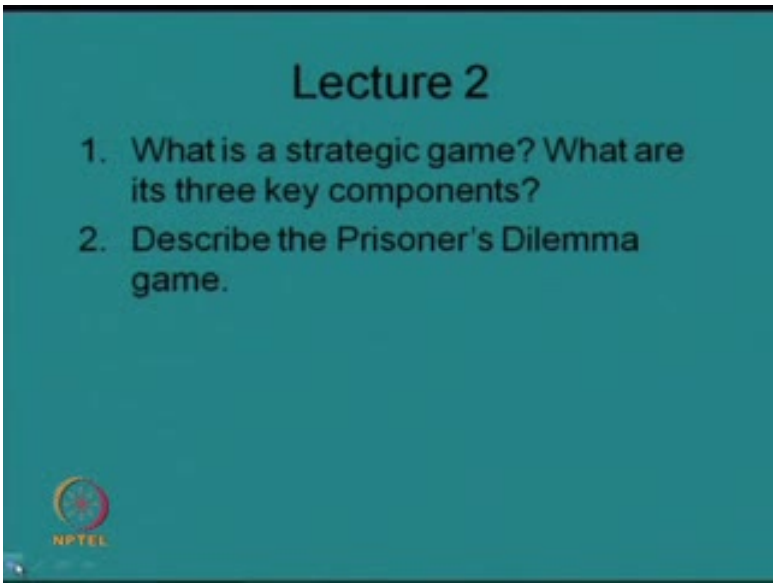

This is the exercise for lecture 2. We have two questions in this exercise. First question is what is a strategic game, what are its three components?

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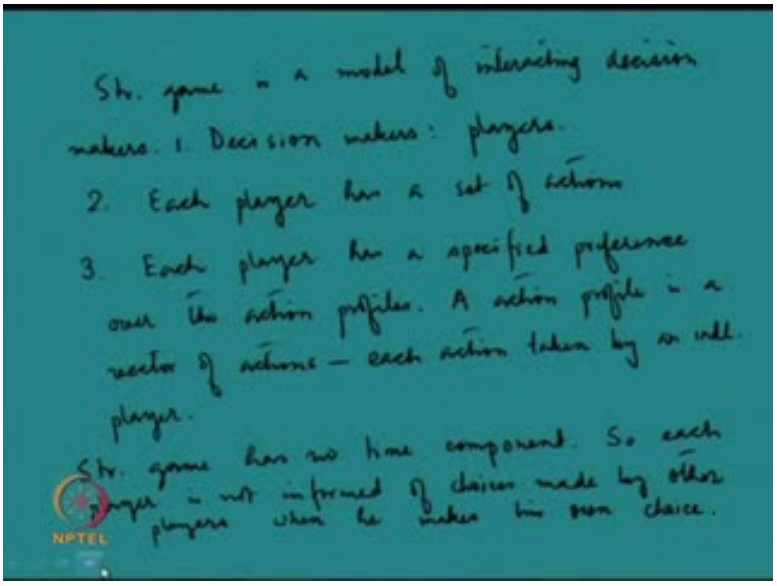

So strategic game is like any game. Strategic game is a model of interacting decision makers. Decision makers are called players. This is the first element. Second element: each player, that is, each decision maker has a set of actions to choose from and third, each player has a specified preference over the action profiles.

What is meant by action profile? An action profile is a vector of actions - each action taken by an individual player. One important component of strategic game has no time component.

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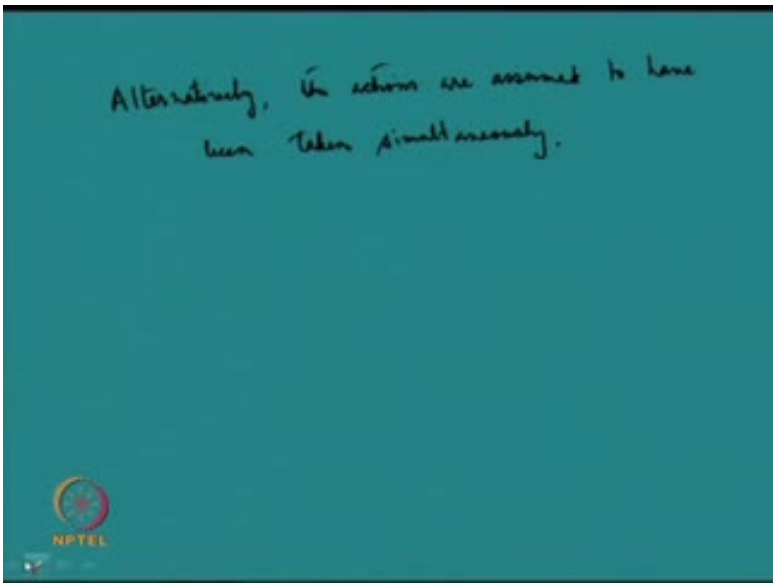

So we can think this in terms of the following conceptualization that each player is not informed of choices made by other players, when he makes his own choice. So, it is as if the game is being played and the games are alternatively the game is being played and the actions are taken simultaneously are assumed to have been taken simultaneously. So, this is the first question.

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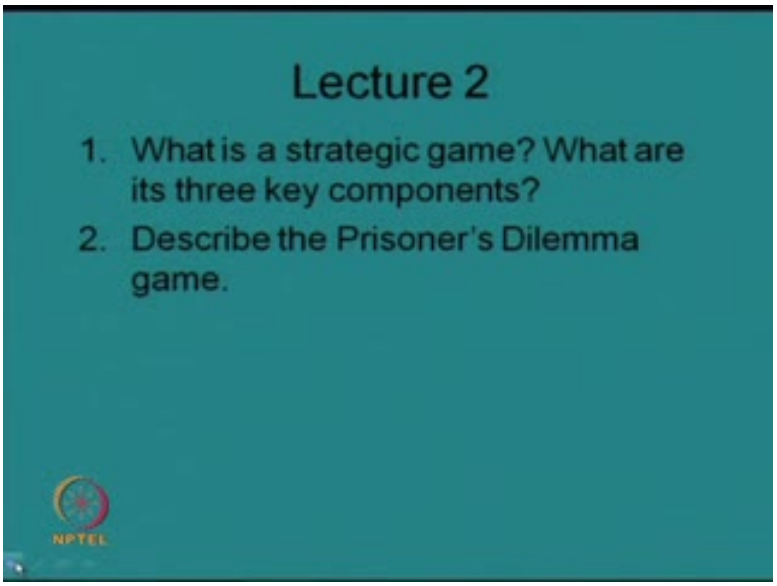

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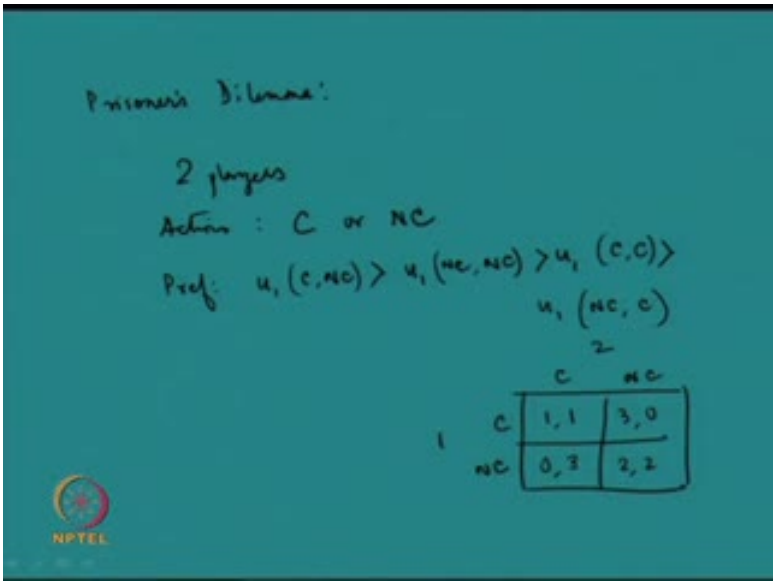

Second question: describe the Prisoner's dilemma game. Prisoner's dilemma game has two players. Actions: confess or not confess; Preferences: let me write it for just one

player, what is best for him. He confesses, the other player does not confess; this is better than neither confesses; this is better than both confess and the last and the worst case, he does not confess, the other player confesses. This is for player 1; likewise there will be for player 2 also and if we attach numbers to these payoffs, we get the following payoff matrix. This is the payoff matrix. So, this how the Prisoner's dilemma game is defined

In the next class, we shall take up from this. We shall see what are the other situations, which we find in real life and which is like the Prisoner's dilemma because at the end of the day, we are not really interested in what two Prisoners isolated in some American town should do.

We are more interested in knowing what real life situations can be understood from that basic Prisoner's dilemma kind of situation. Thank you.