Game Theory and Economics

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Module No.# 02

Strategic Games and Nash Equilibrium

Lecture No.# 02

Matching pennies, Stag Hunt and Nash Equilibrium

Welcome to the second lecture of second module of this course Game theory and economics. Before we start this particular lecture, let me briefly take you through what we have discussed so far in this course. We have been discussing strategic games, we have given the definition of strategic games.

A strategic game is a situation where the players take their action simultaneously, they have a set of actions and we know what the preferences of the players are. So given the preferences of different players, we try to figure out what are the outcomes which are possible and then we shall try to see which will be the outcome that will prevail ultimately but, that is sometimes later in the course.

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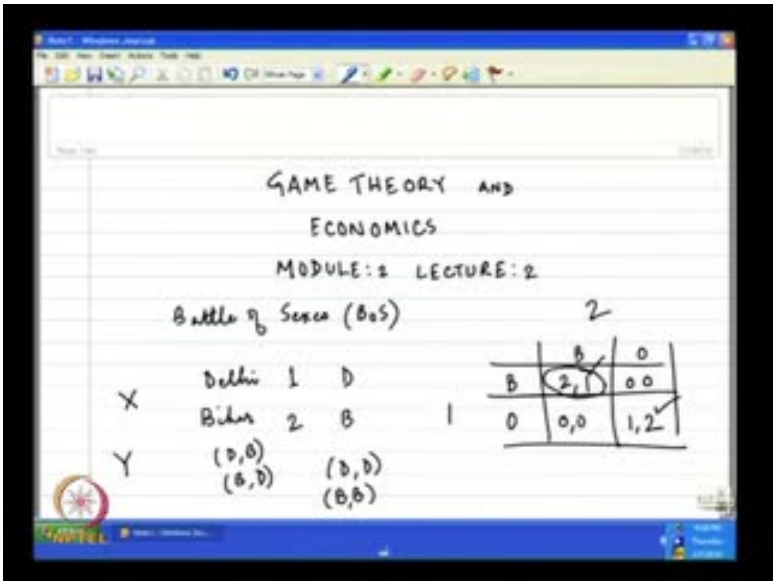

Presently, we are describing basically different sorts ofgeneric gameswhich are well known in the literature of game theory.So far we have discussedthe Prisoner's dilemma game- the first game that was and we have also given youmany examples of Prisoner's dilemma game which can beseen in real world.

Secondly, we were discussing the second sort of game which was called Battle of Sexes or ensure BoS game.So like in every game it has a typical structure,this sort of game and we have discussed the structure of the game before, it was like the following:2 players,1 and 2 and their actions are B and O and the payoffs that they get are 21 (Refer Slide Time: 02:36), these are the payoffs.

So ifplayer 1 plays B, player 2 plays B, we are talking about this box here (Refer Slide Time: 02:45).Here player 1 gets 2 and player 2 gets 1similarly, like the other boxes.So these are payoffs and B B will be calledan action profile.

Now,the interesting thing about this game is that both of the players can see that if their actions are the same that is if both of them play B B or they play O O then there are some games that the both can make.Compare to the case, where both play actions here different from each other.For example, if B O is the action profile or O B is the action profile, they get 0 which is bad for both of them but, they differ as to which co-operation whether it is the B B co-operation or the O O co-operation which is thething that they should took.

I have given one example in the previous lecture, how this kind of situation can be seen in real world also.The story is the following; suppose there are 2 politicians,one is fromsuppose Delhi and the other is from let us say Bihar.These 2 politicians belong to the same political party and this political party let us call it X is running an election,it isrunning nationwide election.Now what are the actions?There are 2 players here, 2 politicians and what are the actions?The actions are that they can announcewhether if the parties elected to the office, the parties going to spend money in Delhi or it is going to spend money in Bihar,so these are the two actions.

The point is that these 2 politicians belong to the same party.If theytake different stands suppose, this politician from Delhi, suppose this is 1 andthis is 2.Suppose 1 says that D is the action that is going to be taken, that is the party is going to spend money in Delhi and 2 says thatB is the action that is he makes the announcement that if party is elected, the

money will be spent in Bihar.Then there is a difference in their opinion and then the voters will be confuse as to whether there is a conflict within the party, with there is infighting in this party.In that case, the voters will not like to vote for this party they may be vote for Y the other party in which case, this X party loses and both this candidates are worse off.

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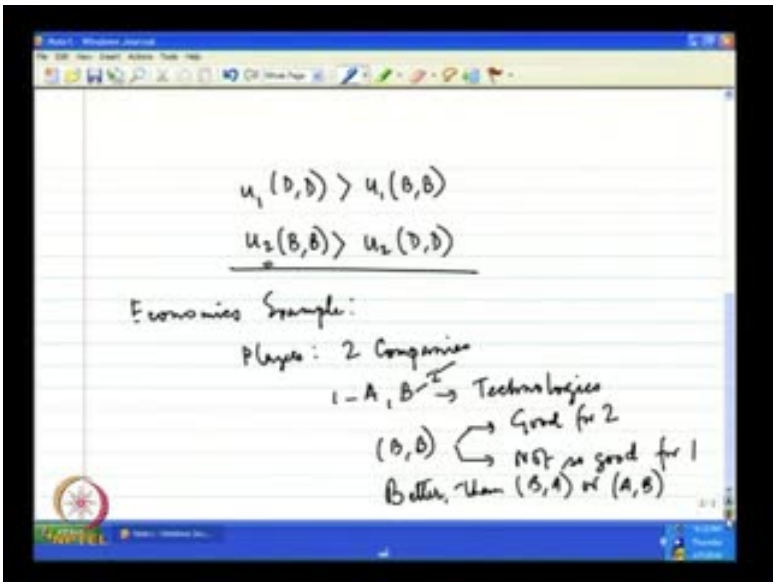

So, there is an incentive for both of this candidates 1 and 2 to say the same thing that we have an united platform,either it canbe D D that is both of them are saying that the money is going to be spent in Delhi or the money is going to spend in Bihar.So, there are gains if these are the stands, butif the stand is D Bor B D then there is a problem.Then the party might lose or though they can see that there is a benefit from taking the same stand in case of D D, first let us call this as the payoff function.

But this is also true, even if thestand is unitedeven thenthere is a difference as how the candidates evaluate these two profiles.The candidate from Delhi he sees D D as better than B B because if the money is going to be spent in Delhi then his voters or even this prospective voters were not currently voting for himwill be tempted to vote for this party that is for him.Therefore, he is standing in that locality in that constituency will rise but, this spending money only in Delhi does not benefit the second candidate that much, so that is why we have this one.

So this is like a battle of sexes game; there is an incentive for both of them two co-operate however, they differ whether which co-operation is better.This generic situation, this battle of sexes situation can beseen in all other cases also.

Let us take a case of economics for example.Let us say there are2 companies, so here players are 2 companies.One of these companies is an old company, established company and it has a product in the market which is sold well and there is a challenger in the market, a new prospective company.This new company since it is not too much well known in the markets, it is not likely that if it once to sell it goods on itsown,the people will buy its products because people got trust products which has sold by new companies they try to stick to the products sold by the oldcompany.

These companies are different but, we are thinking of merging, so they want to merge and become a single company.The point is thatbefore the merger is taking place these companies are using different technologies, suppose different computer technologies.This technologies are A and B, so these are the technologies used by these 2 companies.

Now, look what can happen?After the merger takes place, if they continue to follow these two different technologies then there might be problem because if there is a single company and within the single company two different technologies are being followed there will be problem communication within the company which is bad for both the parts of the company.That is currently there are separate companies, so both this companies understand that ifwe merge then, it is better that we follow the same technology.

Now, problem is who is going to adopt its technology to the technology of the other company.For example, suppose 1 has been using A and 2 has been using B.If suppose,1 changes its technology to Bif it does not now follow A but, goes to B then there is some benefit because they arenow having at common technology which is the benefit; but, there is a cost part also because it has to spent some money to change its current technology to a new technology.

So there is some benefit but, there is cost also; but, from point of view 2 it is completely beneficial because firstly, it does not have to incur any further costs, secondly the new technologythe common technology that is going to come aboutis its own technology.So, it does not have to make any adjustments.In this case, if the stand is that they are going

to follow this B B technology then, it is good for 2 not so good for 1 but, these things are better for both of them, better than either B A or A B because if there is B A or A B then obviously, there is a differential technology and there will be problem of communication.

So here there is again it is similar, because people understand that there is some benefit from co-operation but, they differwhether this is the better co-operation or that is the better co-operation because there can be two kinds of co-operations. This is a more or less the battle of sexes, we shallcome back to battle of sexes to find out what could be the solution concept, that is what outcome will likely to prevail in thiskind of games.

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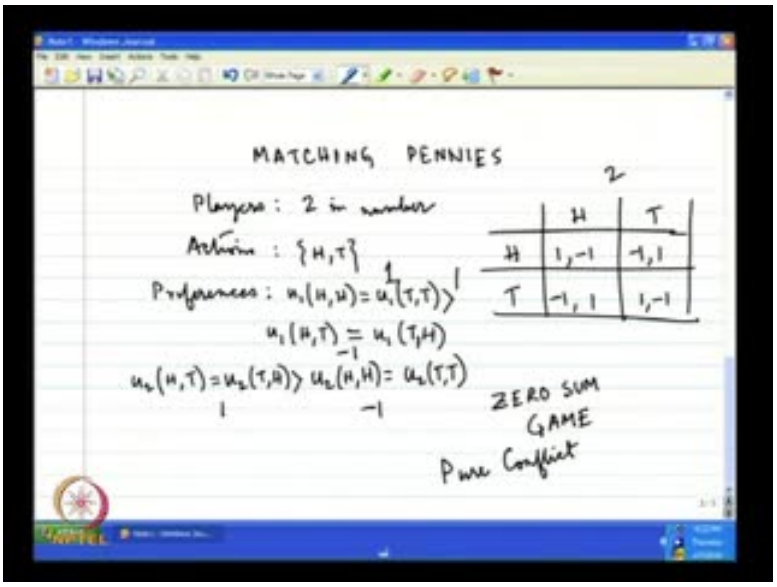

Now the third kind of game that we shall talk about today is calledMatching pennies.Here also like the game start, we have discussed before there are 2 players,2 in number,1 and 2 let us suppose.What are they playing?Each of the players has a coin, a penny, now obviously a coin, has 2 phases the head and the tail.Now the game is of the following kind, that at the same point of time they flash a side of the coin to the other place.

Now, if these phases of these2 coins which are with these 2 players match, then the second player is going to give 1 rupee to the first player.So, there might be 2 cases where the second player is going to give 1 rupee to the first player.These 2 cases are both of them flash heads and if both of themflash tails, in that case they are matching and player 1 is gaining.What happens if there is a mismatch?For example, player 1 flashes head but,

the player 2 flashes tail or the vice versa, player 1 flashes tail and player 2 flashes head; in that case, there is a mismatch and just the opposite thing will happen that is player 1 now will pay 1 rupee to player 2, so this is the game.

Hereobviously, there are two actions for each player I can decide either to flash head or to flash tail.So let me call this H and T, these two actions and this is same for both the players, both the players have two actions each H and T.What are the preferences?Obviouslyplayer 1 likes that the phases of the coins match and that is best for him.The second best is that they do not match, in which case he loses.

So, u 1H H is equal to u 1T T, here we are matching but, this is strictly greater than H Tand which is same as T H and for player 2it is just opposite.So, this is how the preferences look (Refer Slide Time: 16:16).

Now without much loss of generality, we can attach number 1 here, the first and minus 1 here why becauseif they match for player 1he is getting 1 rupee, so this is plus 1; if they do not match, he is losing 1 rupee which is minus 1.Since,I could have use to 1 and 0 alsothis is the preferences are ordinal it does not matter.

So like before,I can use a payoff matrixto show what is happening here.So, this is how it looks; interesting thing about this game is that,in this game there is pure conflict.Whenever player 1 is gaining, player 2 is losing and when player 1 is losing, player 2 surely is gaining, this sort of games is also known as Zero sum game because in each case the summation of the payoffs that the players are receiving they add up to 0.This is a situation of pure conflict;there is no chance of co-operation unlike if you remember in Prisoner's dilemma or in battle of sexes, there was a chance that people could co-operate and getbetter payoffs both of them could gain.

For example, in case of battle of sexes if the husband and wife go to separate places from there they could go to a same place and both of them would havemake some you know positive payoff.For example, from 0 0 they can move to 2 1 or 1 2or in case of Prisoner's dilemma also if both of them confess it is 1 1 but, if they do not confess it is 2 2, so from 1 1 to 2 2 it is not that one is gaining, the other person is losing, both of them are can stand to gain.

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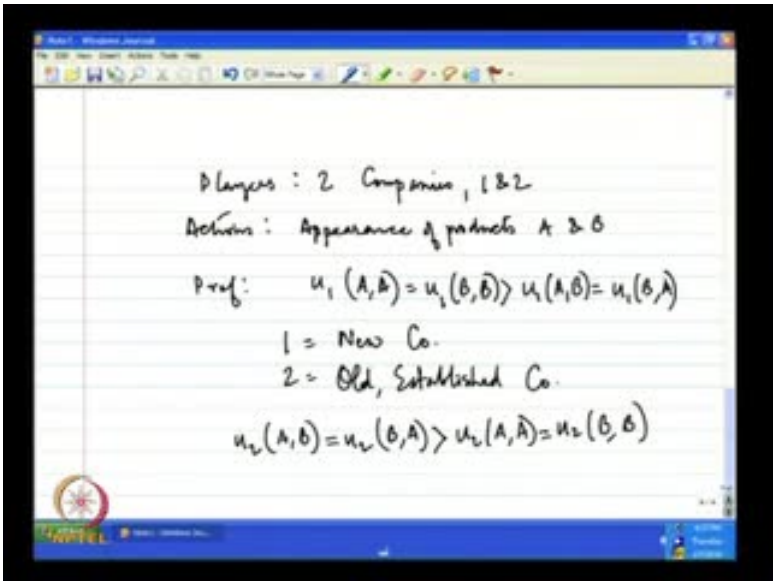

Here however,if we move from one cell to another you cansee that one person can gain but, at the cost of other person;it is not that both of them will gainat the same time.What can be the possible examples of matching pennies?One possible example is that suppose, there are 2 companies andwhat are the actions?Before I tell you about the actions,what about the description of the companies?

There is a difference between these companies in the sense that the first company is an old company,it is an established company; so it is products have a reputation in the market.When people see the products of the first company they know that the product is good whereas, the second company is a new comer,its products are not known to the people.So,if the second company just launches its products on its own without bothering about anything else,it is slightly that it is not going to get a lot of customers.

Now in that case, what is best for the second company?Then the second company will like that it is products look like the first companies product; so that the customers are a little bit confused whether it is coming from the first company or the second company. I am assuming that the people when buy their products do not look very carefully as to which company, they just look at the appearance of that product and if the color looks like the same, the design looks the same, then they might buy the products of the other company.

So in that case, it is good for the second company because it is trying to steal the reputation of the first company. So, for thesecond company it will like the case, where the they are matching it is like second company like the first playerthey arelaunching their product without knowing what the product of the other company will look like but, if the products is look like the same then, the second company is benefiting because it is basically taking a part of the reputation of the first company's product.

However,since first company's products are not being sold at the cost of the second company's product, first company will lose.Sofrom the first company's point of view, it will like that the appearance of these2 companies product they are different because if they are different, then the company can tell thecustomers very openly look this is how it is different, this is my product; but, if they looklike the same then, it might be difficult for the first company to tell to the customers how different they are.This is one case ofexample a matching pennies, so I can write this actions as the following; appearance of products and suppose there are two appearances A and B.

Here, preferences are the following:if the appearances are same then company 1 gains here, company 1 is the new companywhereas, 2 is the old company established company.So from 2's point of view this just opposite that the appearances are chosen to be different, so the rest of the story is like the matching pennies.

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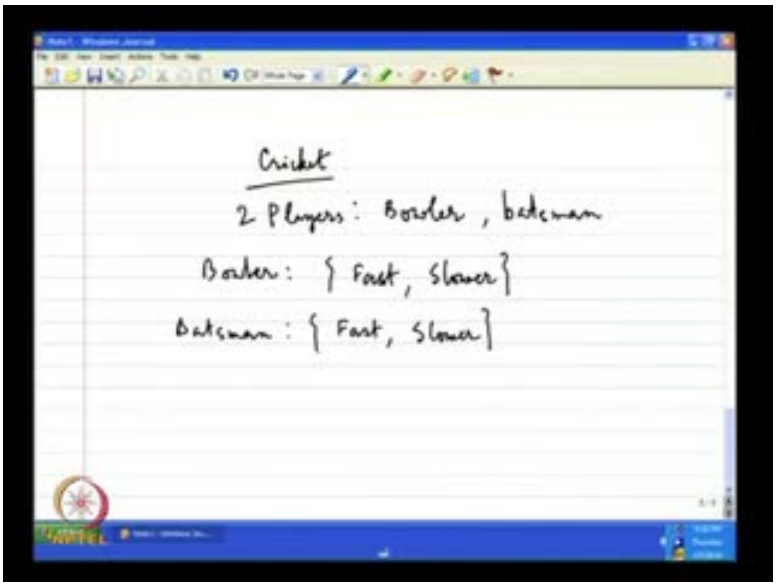

I can give you another example from suppose cricket and a game tomake the story simple. There are 2 players and the players are the bowler and the batsman.What are the actions?For the bowler he has two actions,bowling a fast ball and suppose, bowling a slower.

What about the batsman?Well, batsman can do two things; either he canplay according to the anticipation if the ball is fast or he can play according to the anticipation if the ball is slow.So, play according to fast ball or play according to the expectation that the ball is slow.

Now see again, it is like the similar case of matching pennies.If this things match that is bowler is bowling a fast bowl at the batsman had anticipated a fast ball and has played accordingly, then who is benefiting?The batsman is benefiting because he has correctly anticipated, then may be that the ball can go according to his wishes, the batsman wishes.

However, if there is a mismatch if he had expected up slower ball and the ball is fast then there might be problem for the batsman,he may get out in that ball.Soin that case, if there is a mismatch between what the bowler is doing and what theexpectation of the batsman is and what action is accordingly, if there is a mismatch it is the batsman who is losing and it is the bowler who is gaining.Here, the batsman is like the player 1 matching pennies why because if it is a match, then he is gaining whereas, the bowler is like the second player in the matching pennies because if there is a mismatch, thenthe bowler is gaining.

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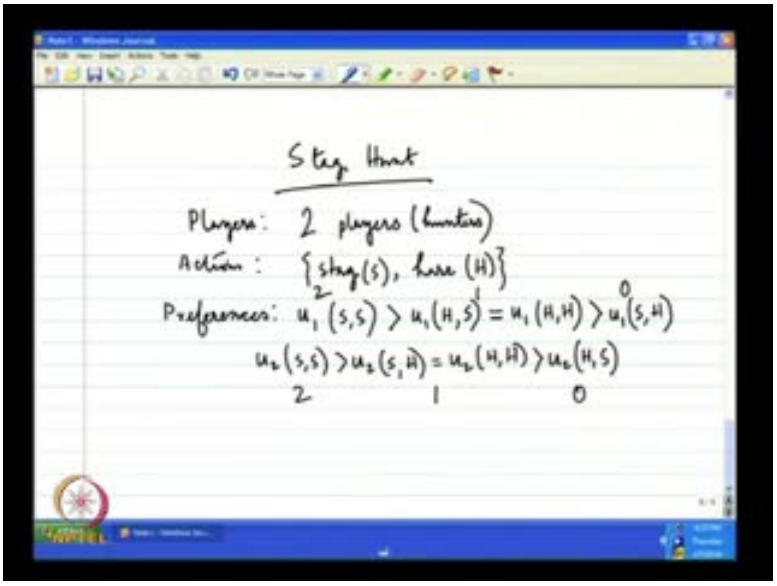

Let me give youone last class of games and then we shall move to the next section.This game is called the game ofstag hunt. So the description of the game is as follows: there are number of players, hunters, who have gone to a jungle to hunt a stag.Stag is a male deer,so players here are in general,there can be I can talk about n players;n players that is n hunters.

What are the actions that they have?They can according to the plan pursue the stag, soone action is stag,we shall call it s. However here, the story becomes a little interesting is that when they are pursuing the stag all of them together then there is temptation.

The temptation is that there is a hare which will pass them by and they could as well catch the hare instead of going after the stag but, if even one of them goes after the hare, he will be able to catch the hare and he will get some benefits because he is getting the hare.But, for the rest of the hunters who have been trying to get the stag they will get nothing.So, my action Iam a hunter, if I go after the hare it is judgmental to the benefit of other hunters, so that is the story.

Eachof the hunters has two actions to follow; one is pursuing the stag which is s or they can choose to go after the hare.There aremay be n number of hares in jungle also and each of the hares will tempt 1 player;so there is no shortage of hares.Now, what are the preferences?This is important.

The preferences are as follows that if all of them concentrate only on the stag then they will catch the stag and what is the amount of stag that they get, if there are n number of players?They get 1 nth of the stag; this 1 nth of the stag is better than 1 hare.So, if all of my friends are pursuing the stag onlyand I also pursue the stag,I get 1 nth of the stag.That is better than the case where Ido not think about my friends and I just go after the hare,what is outcome?I get the hare but, it is not preferable to the 1 nth of the stag.

Since what we are doing is to construct payoff matrices because in payoff matrices it is easy to see how the game works.Payoff matrices can be constructed if we have2 by 3 game 2 by 2 means I have only 2 players of course, if the players have more than one action that can be done but, if I have 2 players it is easy toshow this in terms of payoff matrix.

So I shall take for the timing, a 2 player caseand the preferences are the following.From player's one point of view, best is s s because in that case c is getting half of the stag which is better than getting a hare.

Now, s s is better than what? s s is better than if he gets a hare which is the second best.So if he gets a hare, what can be the possibilities when he gets a hare? He goes after the hare, other person goes after the stag,and in that case he will get the hare; so this is the second best.He will get the hare in another case also which is that both of them go after the hare, hereno one is perusing the stag hunt but, there is a last possibility and which is worst for him.That he is still perusing the stag but, his partner has gone after the hare.In that case, he is getting nothingbecause without your partner he cannot catches stag.

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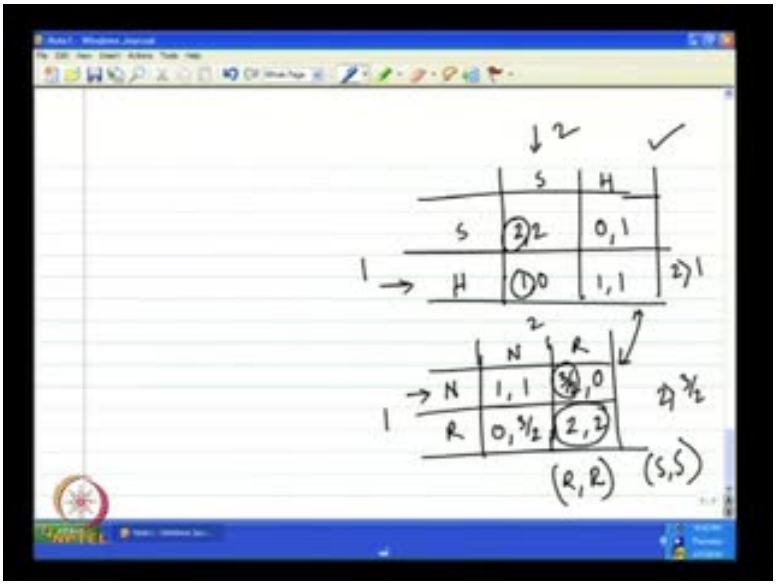

So, this is the preference pattern.For player 2 it will be a similar.The worst possibility is that he is perusing the stag,whereashe is not able to catch it because the other person that is player1 has gone after the hare.So, this I can attach number to this basically three numbers I need so,0 1 2.This is how the game looks (Refer Slide Time: 33:56).In this gameinterestingly,this game can be seen as a variant of the Prisoner's dilemma game.How can I say that?In the Prisoner's dilemma game, if I draw that Prisoner's dilemma game or let us draw thearms race game, should be better which is like the Prisoner's dilemma game of the samepattern.

Here in the arms race game, there were two actions available to each player,each country.One was to build the nuclear bombs N,what to refrain which is R if it is better for both of them if they refrain.It is worse for both of them if they go and built nuclear arms because, it cause money.If I built nuclear arms but, the other person does not, it is good for me and vice versa.

Now, whyI am saying that this first one, the stag hunt game can be seen as a variation of the second one.You see that in the arms race game had it be in the case that if the other fellow is not building nuclear weaponsthen,I also do not built nuclear weapons and if I do built nuclear weapons that in fact is worse from my personal point of view also.It can be seen like this (Refer Slide Time: 36:00),that if the otherperson is refraining and I built

nuclear weapons then what do I get?I get suppose3 by 2, what about the other person?He is not earning himself,so he is getting suppose 0.

Now you see here, it is more or less like the stag hunt case because here alsothis 2 2 that is where none of them is building in a nuclear weapons.Thatis R Ris similar to the case, where both of them are going after the stagand none of them given the other fellow isgoing Rhas an incentive to play this N.Here also similarly, if the second player isgoing after the stag, the first player has no incentive to go afterhare because if he goes after the hare he is getting 1 but, if he pursues the stag he gets 2.It is the comparison like 2 and 3 by 2 is less than 2; here 1 is less than 2.

Sodepending on people preferences, how much they preferred the case of a peaceful world?Peaceful world means R Rif I attachtoo much importance to that situation where none ofusis building nuclear weapons, if I attach more importance to that to the case where I am building nuclear weapons whereas, the other country is not building nuclear weapons which is giving me 3 by 2 and 3 by 2 is less than 2,this can be seen similar to the stag hunt.

So, stag hunt can be seenas a variation of preferences compare to the Prisoner's dilemma case.This is more or less about the different kinds of games that the basic four kinds of games we have discussed.Now the question is if these are the situations the mainimportant kinds of situations that one encounters then, one may ask thequestion in each of these games there are 4 possibilities that can occur,4 action profiles we can talk about now, which action profile will actually prevail?

For example, if there is a Prisoner's dilemma situation will the Prisoner's confess both of them, will both of them not confess or is it the case one of them will confess, theother prisoner will not and if there is such a situation then which one of the Prisoner's will confess and which will not.

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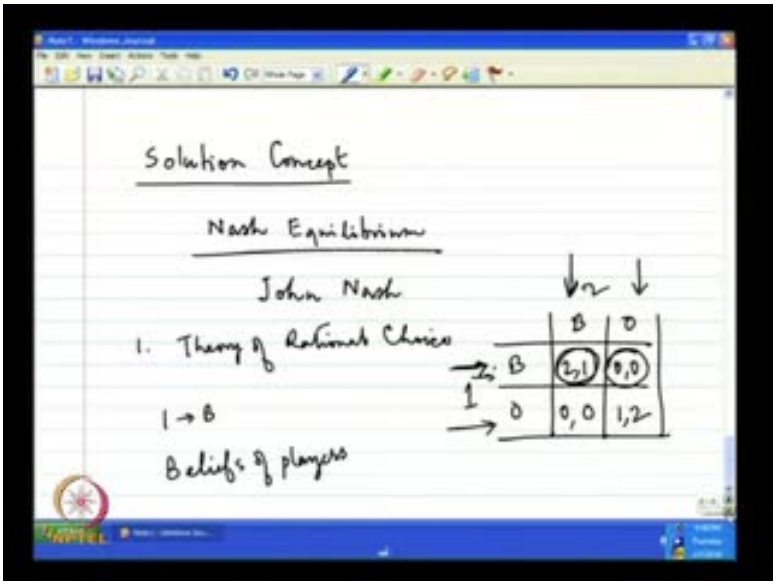

We want to say something about which outcome will occur or likely to occur in each of this games and what we do now is to explore this thing and this idea that which outcome will actually occur is known as - the theory of this is called - a solution concept. We shall start withthe most well-known solution concept which is Nash equilibrium.Nash equilibrium the name comes from John Nash who proposed this idea of Nash equilibrium back in 1950and it is a very powerful tool to explore different kinds of games.

So, what is the story?Before going to the story first let us remember that in this entire course about game theory we are going to assume that the players behave according to the theory of rational choice.What is thistheory of rational choice?It says that each playerwill take that action which is best for him according to his preferences.

Now in game theory, the story is a little bit complicated because what my best action is also depends on what actions other players are taking; it does not merely depend on my own action.

Let me give you one example, the idea is simple.Suppose in battle of sexes game, this is the structure of the game now, when one decides which action he will take whether B or O, which is bestfor him it depends on what 2 is doing.For example, if 2 is playing B,what is best for 1?

Then for 1,B is best because if he plays O he get 0 which is less than 2.On the other hand, if 2playO, 1's best action is no longer B, now once best action is also O.So what is best for medepends on what the other players are doing.

If I have to say that look in this game, if this particular outcome will prevail then for that outcome to prevail it must be the case that what each player is thinking his best action is that should depend on what the other players are also doing.

If I say that B B is going to be the actual outcome that will prevail in the game.Now why should B B be the actual outcome?B B will be the actual outcome if 1 plays B.Why should 1 play B because one may think one may believe that 2 will also play B and that is why 1 will play B.

This depends on belief of players regarding other player's action.So, if a particularsituation like B B has to occur it must be the case that players are belief regarding each other and those beliefs must also come to be true.For example, suppose I belief1 beliefs that player 2 is going to play B and that is why he plays B but, at the end of day player 2 does not play B, player 2 plays O then what will happen?This outcome will occur,0 0 will occur and if that is the outcome that will occur.Then this outcome cannot sustain for a longtime because at this play of the game one has learnt the lesson that 2 is not going to play B.In the next play of the game,whoever the person in 1's plays is that person will not have the same kind of belief that this player 1 had.

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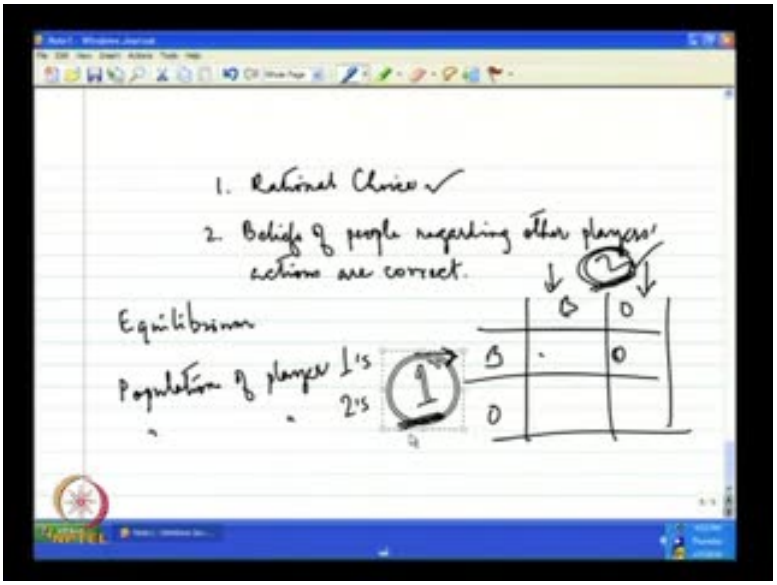

So,in case of Nash equilibrium two things are important.One is that theory of rational choice, as I have said and the second is thatbeliefs of people regarding other player's actions are correct.

If the beliefs are not correct then there is a problem as I have said just now that if I belief that player 2 is going to play this and therefore, I play this but, in fact player 2 plays this then I get this one which is worse then what I could have got here (Refer Slide Time: 45:45). So, at the end of the game it must be the case that what my belief was at the start of the game is proved to be true.

If this does not happen, then what action I took before was notthe best action.In this idea of Nash equilibrium, we are going to invoke the idea of steady state that if the players are taking their action then for none of them there is a tendency to move away from that action.This is the idea of basically equilibrium; in the economics weuse the idea of equilibrium often to describe a situation of a state of rest.

So, here it is a state of rest in this Nash equilibrium also.What we are trying to describe is a state of rest in the sense that given what I started with my expectations are fulfilled and therefore, if since my expectation are fulfilled therefore, I would not change my action in the next period also.

Now from this it might appear that whatI am trying to say is that player 1 remainsthe same, player 2 remains the same and they are playing the game over and over again. That is wrong idea,that is a wrong way of conceive the game.What we are suggesting is the following that there is a population of player 1's and there is a population of player 2's.

There is a large population from which any player can be picked up and he or she can be put in player 1's place and there is a big population from which any one randomly can be picked up and put in player 2's place and they play the game with each other.

Now, whenever some particular player is picked up and he is asked to play thegame with the other player, suppose player 2 then, it is not the case that this player,suppose player 1 he has dropped from the sky.He had some experience or he has seen other players playing the game before and he knows what are the actions which are typically followed by these players who is in player 2's place.Since he has seen what are the actions that arefollowed by player 2's place and those actions are steady actions like those actions are

being repeated over and over again and that is why he forms the belief that when I am picked up to play the game, the same action which has been played by player 2 before or the likes of a player 2 before will be repeated.If that action is repeated, he is taking his action according to that expectation.

Similarthing can be said aboutthis second player also.Second player he has seen the play of the game in the previous times and he has seen that whoever is in player 1's place he has played a particular action and therefore, player 2 according to the rationalchoice takes that action which maximizes his payoff given but, he express from player 1.

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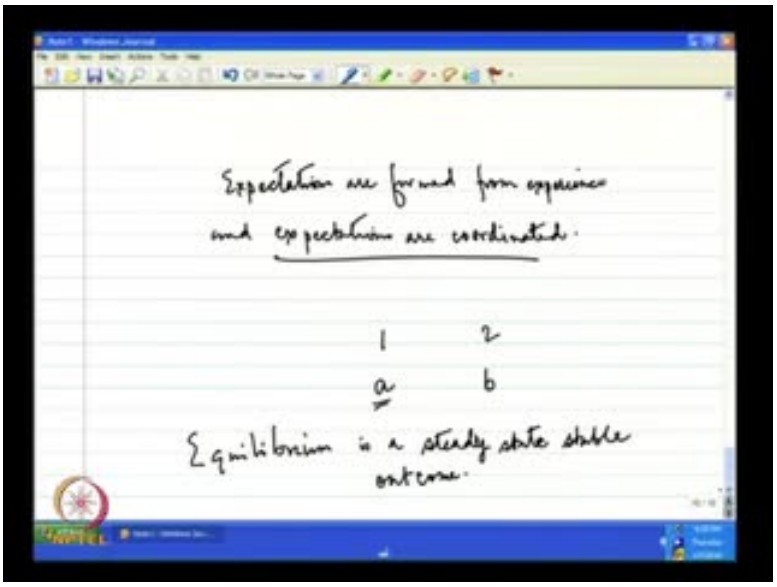

It also meansthat the expectations are formed from experience and expectations are co-ordinated.What I mean by the phrase that expectations are co-ordinated?It is that suppose 1 takes action a, believing 2 to take action b.

So, given player 2 takes action b, a is best and this is true from player 2's point of view also.That is what is meant by co-ordinated, player 2 takes b expecting that same action a will be taken by 1.

So, these two actions are basically reinforcing each other.These two actions are reinforcing the expectations of both the players and if there are more than 2 players there,I can say that the actions of each of the n players are basically reinforcing the

expectation of each of the players.So, the equilibrium notion that we have can be seen is a steady state stable outcome.

Why it is a steady state because given what the other players have been doing I form my expectation and I do my best and that basically reinforces the expectation of other players and they continue to play the same action.This happens for each and every player and that is why this state repeats itself over and over again.

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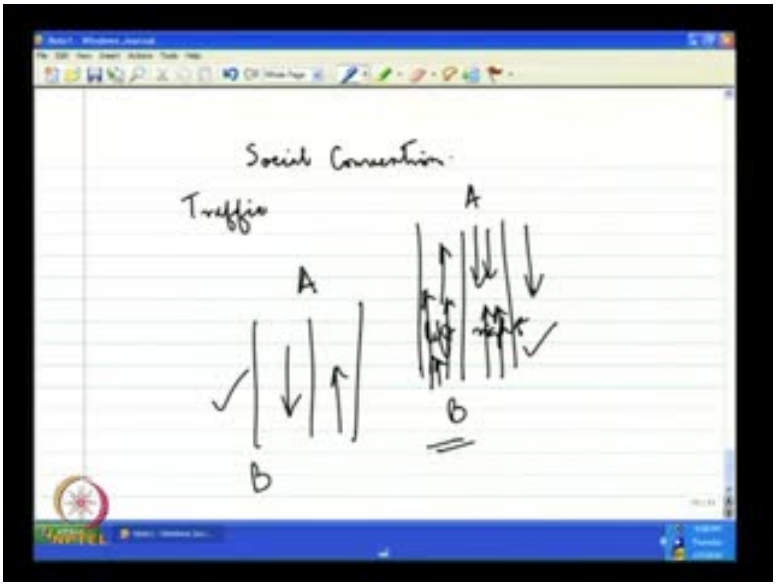

Realistically if I have to say this,it is like a social convention.So other people have been behaving in a particular way, so as an individual I believe that in future also they will continue to behave in that way and I take my action according to that.That action in fact reinforces other people belief that my actions have been repeated over the years and so the same set of actions is being repeated as a social convention. I can give you one example,take the case of where traffic.

Let us suppose that there is a road and there is a place A and there is a place B. There is a left side of the road and there is a right side of the road from thisB's point of view.

Now if any person wants to go to A, he can take either of two actions.Either he can take the left side of the road or he can take the right side of the road.But, what we generally do incountries like India is that when we go to the road,we generally take the left side, we generally do not take the right side why because of our experience.We have seen that

people when they go from B to A in this direction, they follow the left side and when people who come from A to B they take the right side; there left side that is my right side and if that is the action that has been a followed by everyone.What is best for me, if I want to go through this side that is my right side I will collide with the vehicles or people who are coming from this side,so that is not a very good idea;whereas, if I follow the left side all this vehicles may be moving this direction, so I will also have some space to move in this direction and that is best for me.

So this is an idea social convention people learn from their experience, people observe other peoples behaviors and they calibrate their actions according to those behaviors.There is nothing sacrosanct in this behavior, as we can see because in India it might be there people are following the left side of the road but, incountries like America or many Europeancountries it will bejust the opposite.So, they will go like this and the traffic coming from the side A will be coming towards my left, sothere is nothing sacrosanct with this equilibrium or this equilibrium; both may prevail it depends on what has been the convention and given the convention everybody is doing his or her best.

So before I close today's class, let me just go over what we have seen in today's lecture. First, we have talked about two other generic sorts of game; in the same threat of discussion that we have been having from last class.

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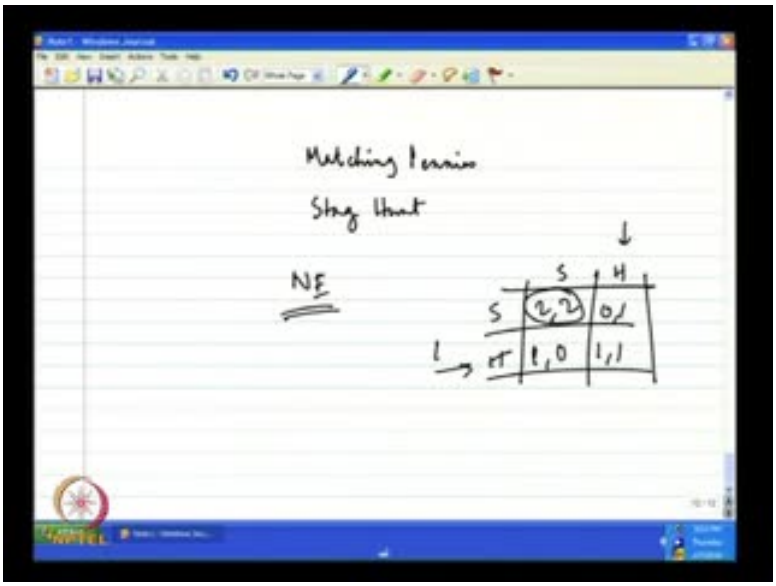

These areone wasmatching pennies and the other wasstag hunt.We have seen that there are some similarities and differences of matching pennies with what games we have studied before.In matching pennies,it is a completely conflictual game,there is no scope ofthe players co-operating with each other and being better off,they are interested directly diametrically opposite to each other; that is one difference.This sort of games is often called Zero sum games.

In stag hunt, we saw thatpeople can have two sorts of situationswhich are best for them; in the sense that they may both go for stag or they may both go for hare but, going for stag is better than going for hare but, even in that casegoing for stag may not prevail.

For example,if one believes that the second player is going after hare he is going to go after hare; soboth going after the stag is better. So that is what we have seen and we have also seen that this stag hunt can be seen as a variation of the Prisoner's dilemma game.Lastly, you have introduced the concept ofNash equilibrium.

We have seen that it has two important components Nash equilibrium.First is that it uses the theory of rational choice and secondly it must be a situation where the beliefs of the people regarding other peoples actions they must come true, they must be correct.If that is the case, the Nash equilibrium gives us a kind of social convention,it is a set of actions which is repeated over and over again and nobody has any incentive to deviate from that; we shall continue with this discussion in the next class.

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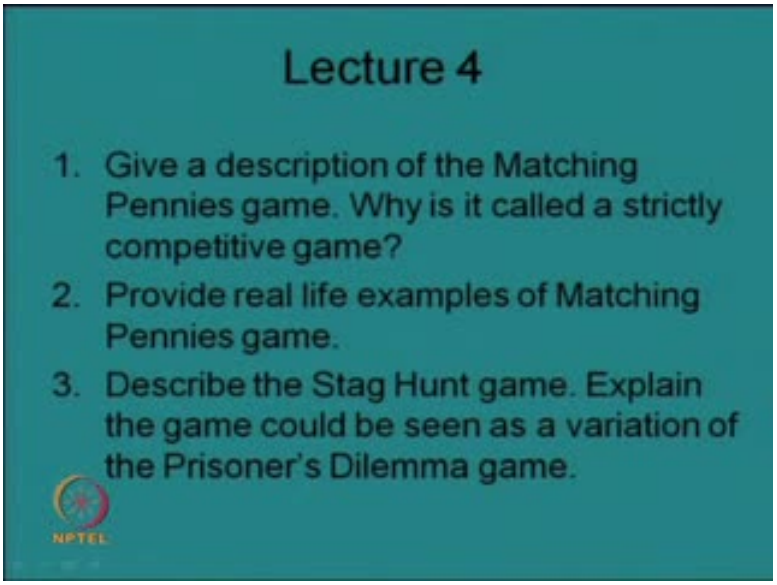

We have 3 questions here.Give a description of the matching pennies game, why it is called a strictly competitive game?

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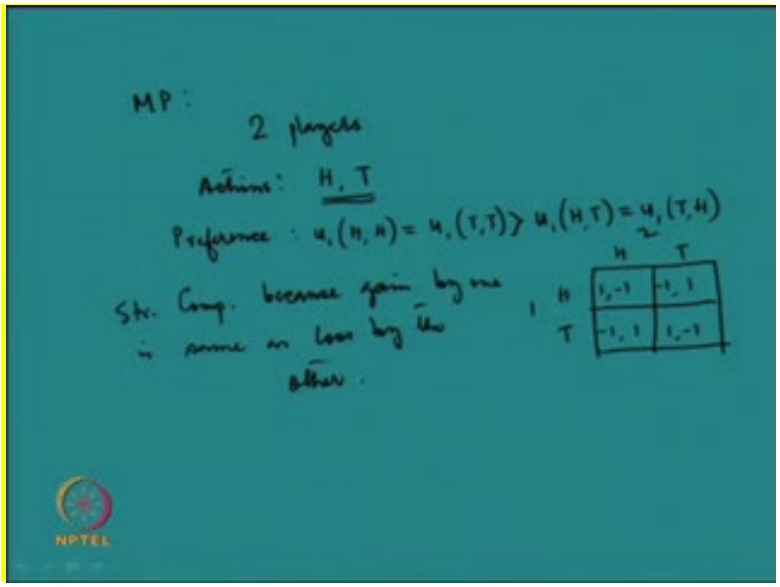

So, matching pennies gamelet me specify the three important components of any strategic game.There are 2 players and action of each player either to show head or to show tail to the other playerfrom a penny that is why it iscalled matching pennies.Thirdly preferences, let us talk about preference of first player, if the coins match that is best for him and he gets the same payoff in both this cases whereas, if they do notthat is what he does not like, that is ifH T occurs that is the first player is showing H heads, the other player is showing tailsor vice versa then the first player is worse of them, the coins are not matching in this case.

So it can be shown in terms of this payoff matrix again.This is how it is looks like, why is it called as strictly competitive game?It is called a strictly competitive game because gain by one is same as lose by theother.

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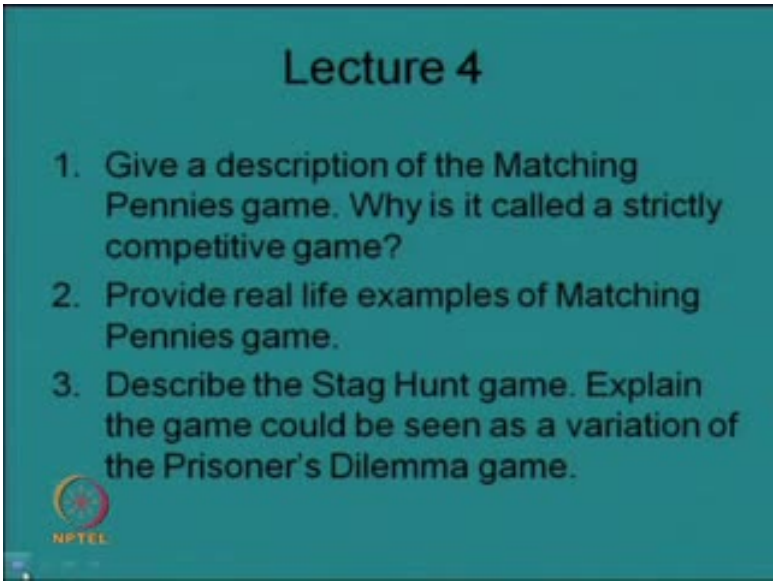

Second question, provide real life examples of matching pennies game.

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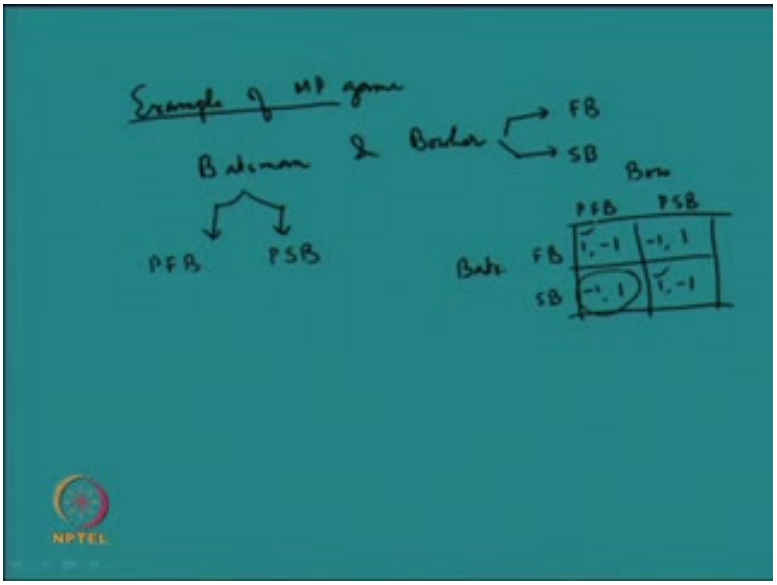

Example of matching pennies game; take the case ofbatsman and a bowler.Suppose, the action of the bowlers are the following; bowling a fast ball or bowling a slow ball and what are the actions of batsman? His actions areeither to play the fast ball or to play a slow ball.Let us assume that after the bowler has delivered the ball the batsman does not have any time tochange his decision.

So he makes of his mind before the ball is hold and goes through the motion.Now, what could be the outcomes in this case?

If the action of the bowler so, this is bowler suppose and this is the batsman, if they match with each other then, the batsman is gaining because he can anticipated correctly; where as if thebatsman is not anticipating the ballhe is playing a shot for a fast ball whereas, the ball is not a fast ball then the batsman could get out.

So, this is the case where the batsman is at loss;this is the bowler andthis is the batsman. If the first ball and play first ball match, then the batsman is gaining 1.

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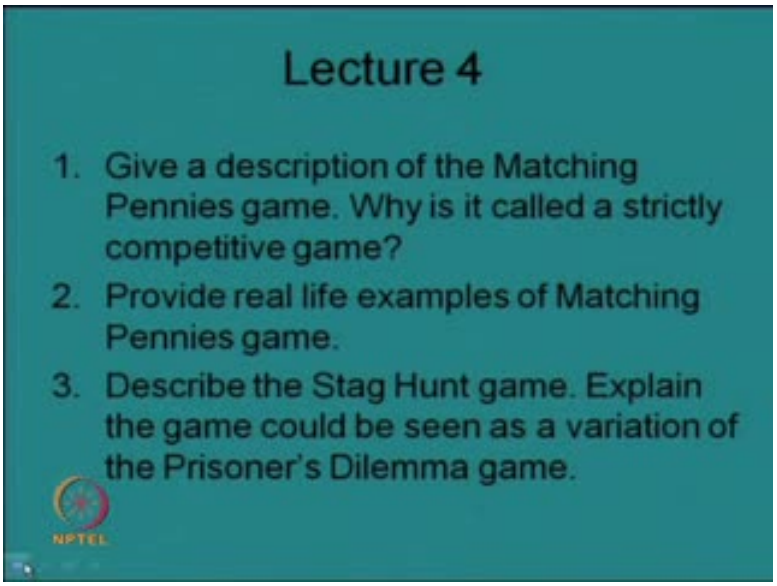

Last question: describe stag hunt game.Explain the game how the game could be seen as a variation of the Prisoner's dilemma game.

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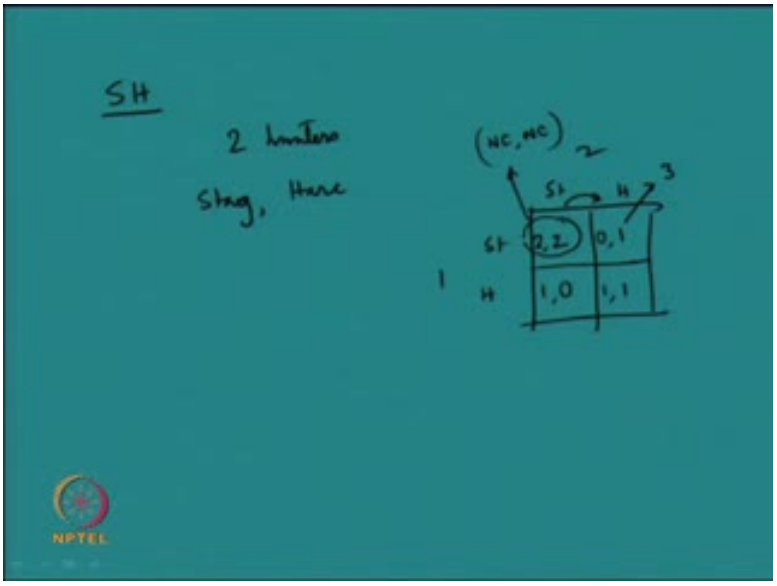

So in the stag hunt game, we have 2 hunters.They can go either after a stag or they can go after hareand how the preferences look like which is given by this payoff matrix.If both of them go after the stag, they get 2Hif either go after the hare,they get the hare but, that is worse.However if someone goes after the stag and the other does not go after the stag, then he is worse off.

This is how it looks like(Refer Slide Time: 63:20).What is the similarity with the Prisoner's dilemma game?The similarity is thatcompare to this co-operative outcome this is like you have the NC outcome in Prisoner's dilemma but, in Prisoner's dilemma if someone deviated from this not co-operation,then he would have got more so this would have like 3.

There was a tendency to deviateto ditch your partner but, here since this 1is less than 2this tendency to deviate from this co-operative outcome is not there.So that is the difference but, otherwise the game is similar to the Prisoner's dilemma game,thank you.