Strategy: An Introduction to Game Theory
Prof. Vimal Kumar
Department of Humanities and Social Sciences
Indian Institute of Technology, Kanpur

Lecture – 46

Hello, welcome to mooc lectures on Strategy, An Introduction to Game Theory and in this module, I am going to introduce a new concept evolutionary game theory.

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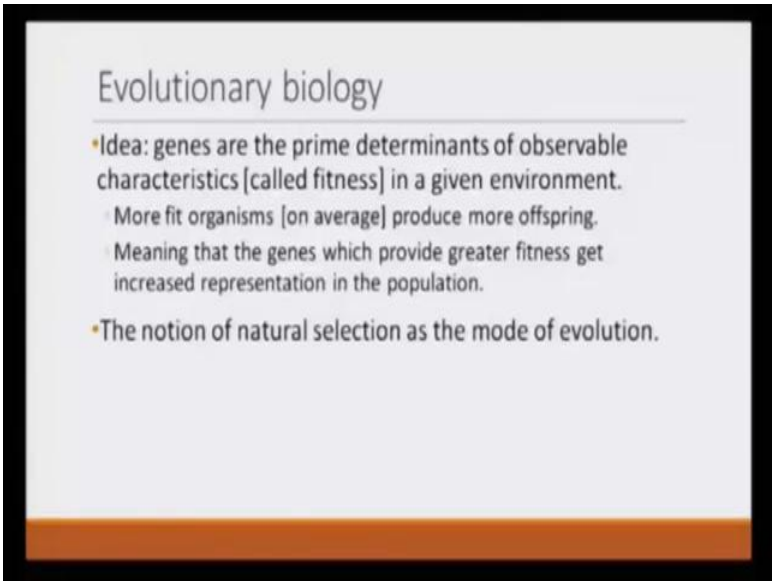

Before, we begin with evolutionary game theory, we should understand basic of evolutionary biology. What is the basic of evolutionary biology? The idea there is very simple, that genes the genetic code present in all the animals are the prime determinants of their observable characteristics, this observable characteristics is called fitness. So, what do we say, more fit organisms on average, typically they have better reproductive success, it means they produce more offspring they produce more kits.

Meaning, that the genes which provide greater fitness get increase representation in the population. So, a particular gene, let us say that a particular gene represents a particular characteristics in the animal and if it is, it has greater fitness this will spread in the whole population of that animal. And, the fundamental of evolutionary biology is that the notion of natural selection as the mood of evolution.

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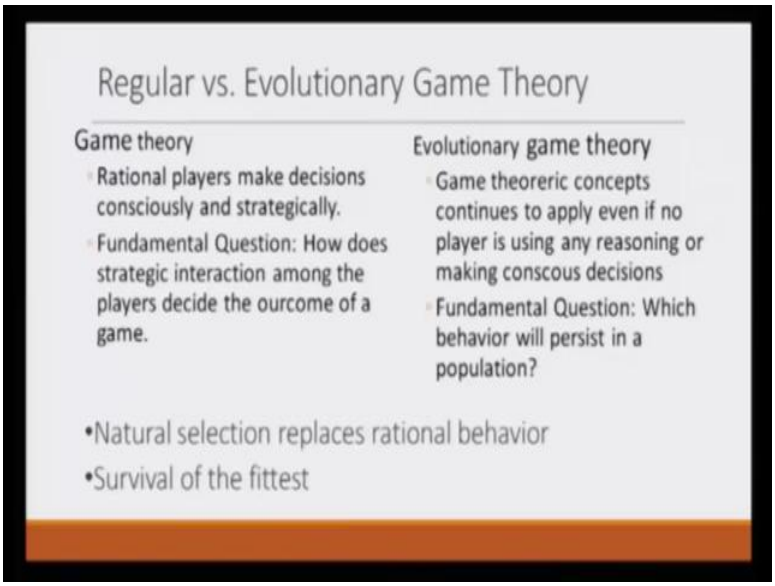

So, what we have now, we have only be discussed for four weeks regular game theory, now we are calling it regular game theory in the sense as suppose to evolutionary game theory. What happens in the regular game theory? We have players and the players are rational, they rationally they make decision. Not only they make decision rationally, but they make those decision consciously and also the important thing is that they strategically they make decision. So, there are three factors players, who make decisions rationally, consciously and strategically.

As oppose to regular game theory, if we look at the evolutionary game theory, because it concerns with the evolution, what happens the players there and animals would be the players, animals a particular animal would not consciously or rationally or strategically would be making any decision. But, what we say that game theoretic concepts would continue to apply, even if no player is using any reasoning or making conscious decision.

Of course, they are the vehicle, if as things are happening in a particular manner, because players are interacting a strategically rational players are interacting rationally. Here, what is happening, that the behavior is encoded in as a gene. And, if a behavior leads to better outcome, then that gene would have better success in spreading in the whole population, so that is the key.

Fundamental question in the regular game theory is, that how does strategic interaction among the players decide the outcome of a game. Here, the fundamental question in evolutionary game theory would be which behavior will persist in a population. If, a

particular behavior leads to better fitness, notice the gene gets represented by behavior, can lead to better fitness, better fitness means better reproductive success. So, if gene is having better productive success, then it will get the spread out in the population. Here, natural selection replaces the rational behavior.

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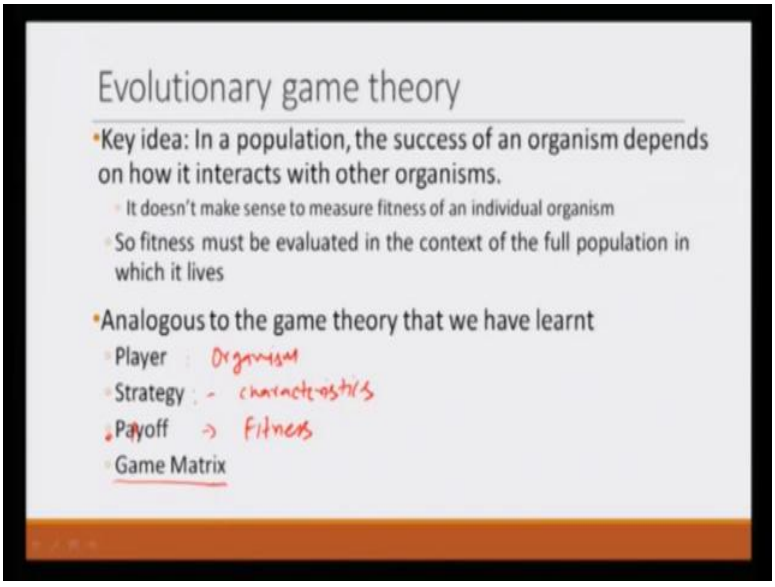

So, coming back to again evolutionary game theory is, that the key idea is that in a population the success of an organism, depends on how it interacts with other organism. Notice, that when we started talking about game theory and also in the middle, we talked about two different scenario, in which a decision maker, does not have to worry about the strategic consideration, there he gets guided by the parameters like in a market, when you buy an object typically, when you know you do not bargain and all you know the prices fixed, in that case there is no strategic consideration.

But, whenever two players are interacting, then strategy becomes important. What happens in the animal world? The animas interact with each other to grab food, to grab resources to help them grow to help them remain fit. So, the interaction place very, very important role, so although that interaction is no longer as strategic interaction, but nevertheless, there is an interaction. And, the role of the strategy would be played by genetic code that will be reflected in the particular behavior.

So, in the animal world it does not make sense to measure fitness of a particular individual organism or particular individual animal. What we are interested in is, that we should measure fitness in the context of full population in which it lives. How does a

particular animal do, we saw we other animals in the same population that becomes important. So, if we think evolutionary game theory is analogous to our regular game theory, what do we have, who are the players, the living organism, animal or living organism, animal planet they are the players, so organism.

What are the strategies in coded behavior or characteristics? What is the payoff? Payoff is fitness and this fitness should be evaluated in context of other players. So, that would be in the game matrix, the payoff should be, these are region one animal interact with the other animal, what happens.

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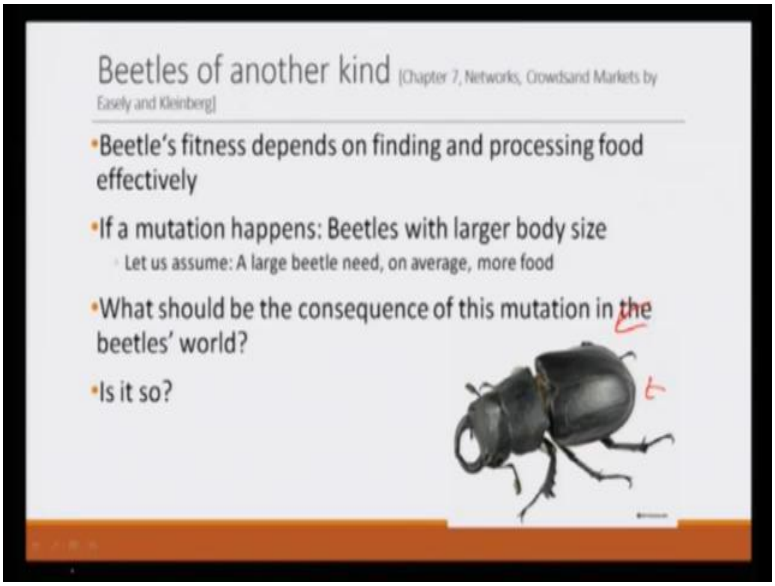

Let us take one example to understand this concept and this is a game that is being played in the beetled world. I have taken this example from a very popular book and very nice book, Networks, Crowds and Market, which is written by Easley and Kleinberg. This example is from chapter 7, you do not have to read the whole chapter, I have captured the essential and this is a beetle I have given the picture of a beetle. So, what we have this beetle's fitness depends on finding and processing food effectively.

Now, let us say that all beetles are of the same size of this size, let us say this picture represents the size and there is a mutation for some reason, some genetic reason. Now there are some beetles with the larger body size, imagine a size choice bigger than or 1.2 times bigger than this size. Of course, it is safe to assume that a large beetle will need on average more food in comparison to a regular or the small size beetle.

So, what should be the consequence of this mutation this change, that now you have

beetle with larger size. What should be the consequence? One thing that one can think, that larger beetle will on average need more food, so their fitness would be less than a small beetle and so that, they would on average do worse than a small beetles. So, eventually they will be wide doubt from the population, why less fitness means they will be able to, their reproductive success would be worse than the normal beetle. So, eventually their pro there proportion would short decreasing in the whole population and over the period through the evolution, they will be wide doubt from the whole population.

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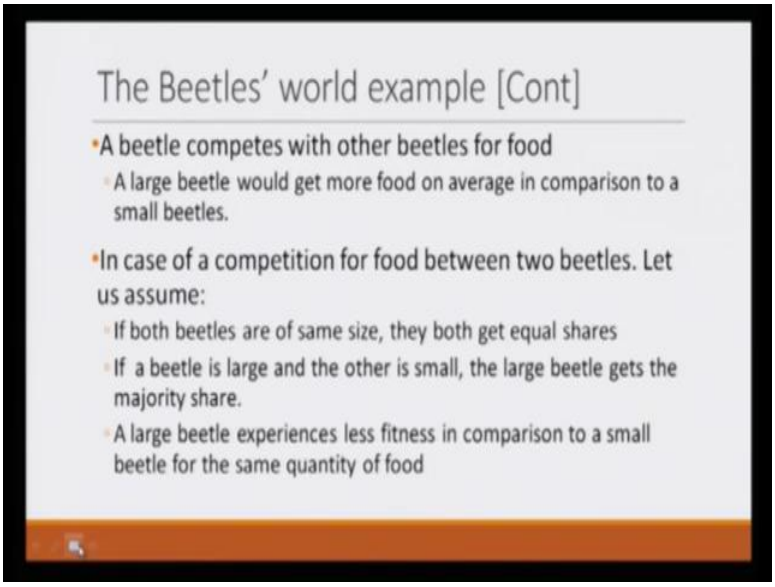

But, the question is it, so we will see we will use game theoretic notion to understand that and what we are saying that a beetle typically competes with other beetle for food it is not like the food getting food depends on one beetle alones, so the compete with each other. So, we are making some assumption, now a large beetle would get more food on average, because of their larger size in comparison to a small beetle.

Then, we can say that, if two if, let us say that is true all the time, but if there is a competition between two beetles. And then, if beetles are the of the same size on average they will get equal share, they will be able to divide the whole resource in equal proportion. And, if a beetle is large and other is small in the competition, then the large beetle get the majority share, because we assume larger size would help in capturing larger resources.

But, we should not forget that a large beetle experiences less fitness in comparison to a

small beetle for the same quantity of food, why to maintain that metabolic activity in the body in the larger body, you need more food. So, if amount of the food is the same, then the larger beetle would experience less fitness, so here is the size game between two beetle and these numbers are made up adjust to satisfy all the assumption, that we have made here.

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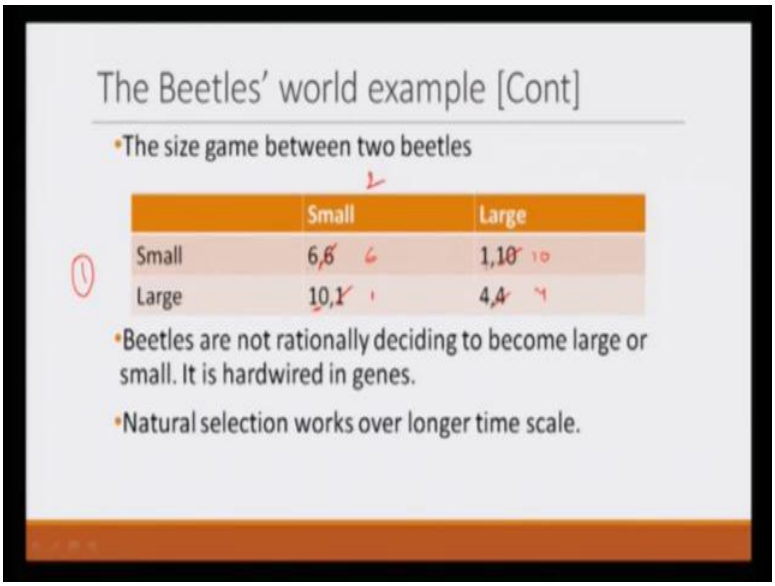

So, what we have, when a small beetle interact with the small beetle, they both get 6 comma 6. We can assume that the size of resources, let say 12 and they get half and half, when there is a large beetle and a small beetle, then there is a fight some of it get lost and so large beetle gets 10 and small beetle gets 1. And, when to large beetle interact lot gets last in fight and they both get 4 and 4 and also for the same amount of food a large beetle would have less fitness, that would also decrease this number to 4 and 4 rather than to 6 and 6, so you can justified in two different ways.

Now, what should you also notice, that I do not need to give the payoff of the second beetle, if I get rid of this second number. We, have just you are 6 1 10 and 4, what we do to get the payoff of the second beetle the beet beetle number 2 here, and beetle number 1, here how can we get we just transpose the matrix, we will get the payoff of the second beetle, let us transpose it 6 will be here this one will come here. This 10 will go here, and this 4 will be here, so exactly the same matrix we get, and here is natural selection of force works over longer times scale.

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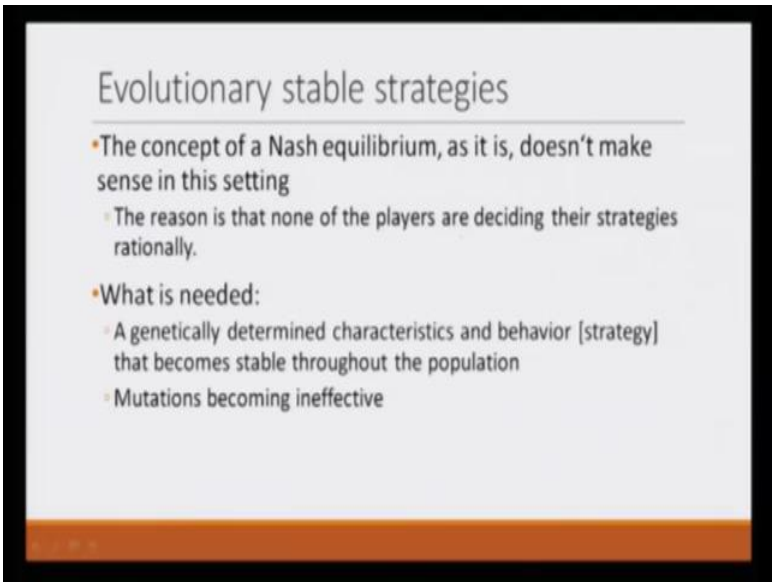

Now, what do we have, we are going to talk about new notion, a new concept, a concept of evolutionary stable strategies the idea is very simple. We cannot talk about Nash equilibrium any more, why because remember, how did, what is the Nash equilibrium that players are giving the best response up a player is giving the best response of all other players strategy and this is true for all the players.

In, other word also a player would not like to deviate, player would not like to change this strategy given, what other player are doing and the if this is true for all the player, then we say this is Nash equilibrium. Here, when we are talking about beetles then of course, beetles are not changing size they are they cannot simply this is not feasible that they would change size. So, it is not about taking deciding a strategy concisely or rationally it is just hardwired.

So, what is required here in the evolutionary biology? What is required that a genetically determined characteristics an behavior, we have already given it a name this is strategy that becomes stable throughout the population. What do we mean by becomes stable that if this is strategy if this particle, if animal of this particular characteristics are present in the population, if the same animal with some other different characteristics get introduced, they do not has they are not as fit as the previous one, then only we say that the previous one is the evolutionary stable one.

In other word, how again, how the new type would get introduced one process that is present in evolutionary biology is called mutation of some changes. So, this a change

would not persist, if there is a change it would eventually, why doubt, if a particular characteristics is evolutionary stable. So, we are looking for now evolutionary stable strategies rather than looking for Nash equilibrium.