Social Networks
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Rich Get Richer Phenomenon – 2
Lecture – 132
Basic Reproductive Number

In the last lecture, we said that just based on the probability p that is the contagiousness of the pathogen and number 2 by just looking at the number of children every node has, we can comment on whether a disease is going to become an epidemic or not. How do we do that?

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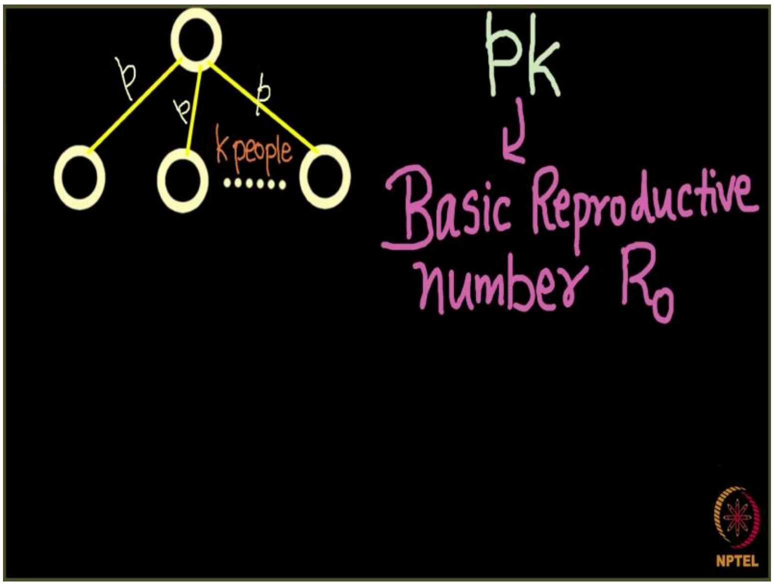

Let us look at that. Here is a node this node has some k people, or this node has some k children. Each of these children gets infected with the probability p. This is what we have studied till now. We looked at this number p * k here, what was this number p * k? This number p * k was the expected number of people who are going to be infected here.

If you can see what is this expected number of people who are going to be infected here. You can see if this node is infected p * k tells us the number of secondary infections produced by one person; primary infection here and it creates some number of secondary infections and that number the expected value of that that number is p * k. This number p * k is important. It is called the basic reproductive number denoted by R0 and it is very

very important, because this number is going to reveal a lot of secrets. This number itself is going to tell us whether a disease is going to become an epidemic or not.

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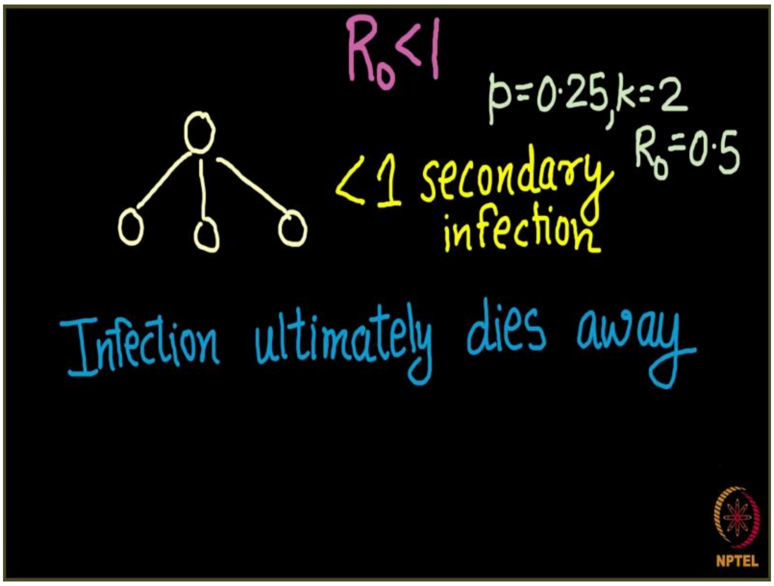

And I tell you here that if this number R0 < 1. Let us see what will happen. So, this number R0 < 1. Recall what is R0? R0 is nothing, but p * k that is the number of secondary infections. If R0 < 1, what happens? There are less than 1 secondary infections. If you look at this node over here, it creates less than 1 secondary infection what does it mean? It is unable to infect even one person here. You see that disease dies over here itself and let us say by hook or crook, the disease somehow survives here. But then in the next iteration, it has a very high probability of dying out. First of all, it dies away here only, even if here it somehow survives is able to infect one node. In the next iteration, it will not be able to infect even one node.

If R0 < 1, what is going to happen is let us take this example first. Let us say p is 0.25 that is the probability of infection is 0.25 and every node is having two neighbors, then a basic reproductive number R0 is going to be 0.5. That is this node here on an expectation, it is going to infect half of its child, half of its children. Half of its children says that it is unable to infect even one person here and the disease dies away in this case. What happens? So, when R0 < 1, your infection ultimately dies away which means that this contagion is not going to become an epidemic.

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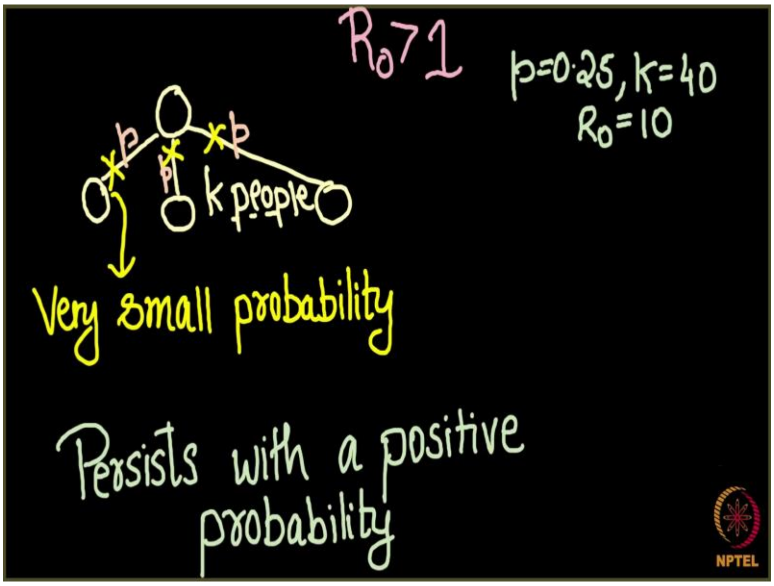

What happens in the other case, R0 > 1? If R0 > 1, we again take the same network k people probability of infection p across every edge and let us see, let us say p is 0.25, k is 40. There are 40 people and each person gets infected with the probability of 0.25. The basic reproductive number is 10. So, you would see what will happen here. This node here will infect 10 people here and then those 10 people will infect almost 100 people and those 100 will infects some 1000 people.

So, you see how this disease is going to become an epidemic. So, in this case when a very sorry so, in this case when your R0 > 1, your disease becomes an epidemic. There is a slight difference between both of which is very important. Previously here when your R0 < 1, we said that infection ultimately dies away, and it dies away with probability 1. It is for sure that this infection will die away. I am not going to tell you now, exactly how, I will be covering that in the advance part of this lecture, but you take my words in this case infection will ultimately die away for sure that is with probability 1 infection will vanish from this network.

But in this case here what is going to happen is, your infection yes it persist in the network it is an epidemic, with the high probability it is an epidemic, but still here is a chance that it will die away. So, in this case when R0 > 1, your infection your contagion is an epidemic, but not with the 100 percent certainty. There is still a very small probability that it can die away. How it can die away is let us say at the first level itself.

All of these links fail and the probability of happening that is very small. There are 40 links and out of this 40 links each of these links fail, very less probability. But still it is positive; there is some positive probability that all of these connections fail. And if all of these edges fail will very sorry; if all of these edges fail in transmitting a disease, it means that your infection is died away. So, when R0 > 1 with some positive probability which is high or infection persists become an epidemic, but with a very small probability it can die away also. So, persists with a positive probability.

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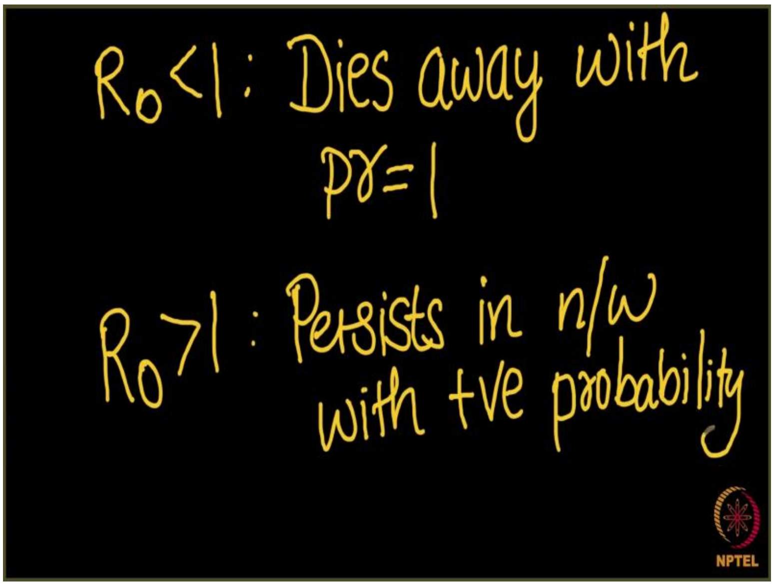

While write this statement here for you if your R0 < 1, then your disease your contagion dies away certainly, dies away with probability equals to 1. But if your R0 it is greater than 1, then it persists in the network. It becomes an epidemic; your infection persists in the network with positive probability. I do not say that this probability is 1, but with some positive probability your infection persists in the network. So, we have looked at the importance of the value of R0. If R0 < 1, the diseases for sure going to die away; if R0 > 1, the disease becomes an epidemic. Do you see something very interesting there? The importance of this value R0.

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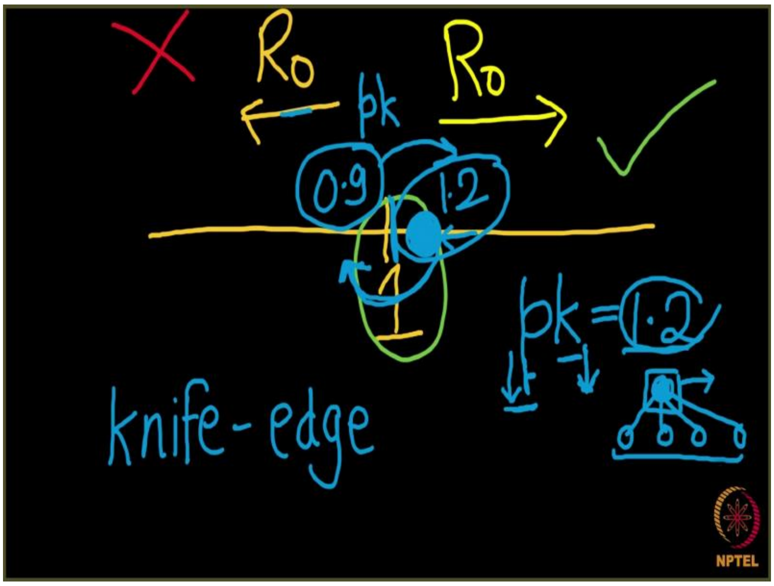

So, here let us see here is the value 1 and we say that if R0 it is less than 1, your infection dies away; infection no longer exists. But if your R0 it is greater than 1, R0 is on this side then your infection is going to become an epidemic. So, this value of 1 here it is becoming so very important. Why so very important? Let us say you have a disease, a contagion is spreading on a network and let us say the value of R0 > 1 right and let us say this value lies somewhere here.

So, here is your value of R0 let us say it is some 1.2 and it means that your disease is going to become an epidemic. Now you see what is happening. If somehow, I can do something here and bring this value a little bit down from 1 let us say from 1.2, I make this value to be 0.9. Do you see the disease suddenly dies away? So, this disease, which was an epidemic here, this disease was an epidemic here; I played little bit with its value of R0 and suddenly this disease will die from this network. Is not it so very interesting and so very important also? We have looked at R0, what was R0? It was p * k so, p * k is 1.2 here and I get you know play a little bit here.

I can maybe decrease the value of p a little bit or maybe k a little bit. How can I decrease p a little bit? Now what is p? p is the probability that the disease will attack you. So, I can decrease that probability. So, let us say a contagion is a spreading and epidemic disease is spreading, viral disease is spreading; I can put an advertisement on TV, I can ask people to take better health measures to have proper hygiene and this will you know decrease my value of p. So, I can either decrease my value of p. Decreasing the value of k is also very easy. What was k? k was the number of people with this infected person was in contact with.

So, if we can decrease this number of people who are encountering this person. Basically, what I can do? I can for some time I can ask this person not to come out of his room that is called quarantining. So, I can isolate this person. So, as soon as I isolate this person, the value of k comes down. Either p comes down or k comes down, this value 1.2 even if it gets a little bit reduced; it will come on this side of the network and the disease will vanish. And the same thing happens here, here is a disease and the disease is not an epidemic but let us say the value of R0 is 0.9, a little bit increase in p or a little bit increase in k can now cause this disease to become an epidemic.

So, this particular property of this R0 is called knife-edge nice property. It is like the edge of an knife right, edge of an knife here. So, little bit on the side you come the disease will vanish from the network and little bit if it if there is an increase here a little bit, the disease will become an epidemic. So, that is the importance of this value, the basic reproductive number. It very well defines whether your disease is becoming an epidemic or not.