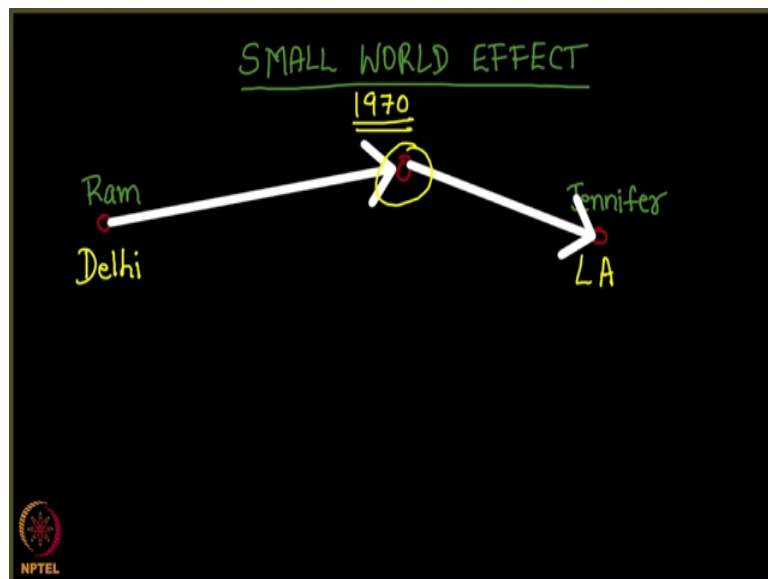


**Social Networks**  
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**The Small World Effect**  
**Lecture - 143**  
**Small World Effect – An Introduction**

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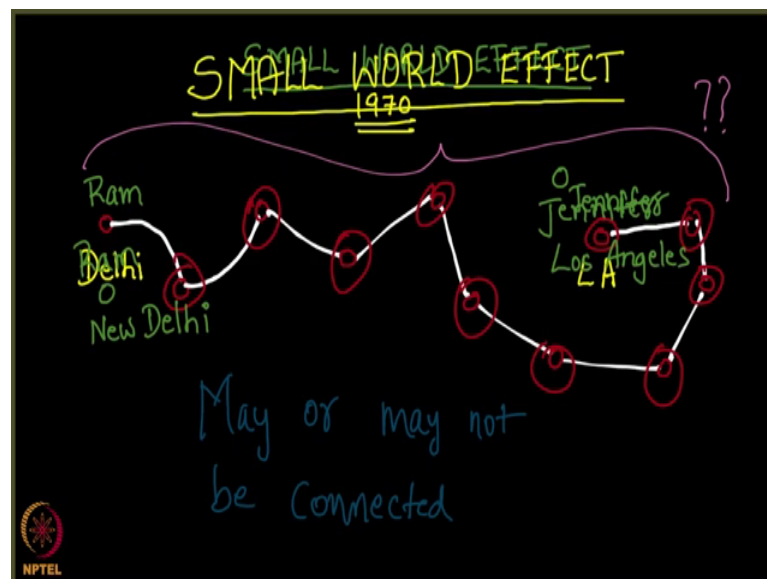


Let us start with the brand new chapter by name the Small World Effect, you would have heard of this or experienced this more than many times in your life although it comes quiet counterintuitive a fact. It is indeed quiet experienced by many of us, you will indeed you will you will in fact, realise that all that I am going to talk right now in this chapter is nothing, but obvious. But, then the looking at the science part of it is actually less obvious although, it is obvious in the sense that it is intuited.

So, let us start with a nice question as and always; assume you are let us say in India in some part of let us say Delhi and you have this question let us say your name is Ram R a m Ram and the question is there is someone at Los Angeles by name Jennifer, whom you would like to contact right. So, how will you contact this person called Jennifer? Assume, it was back in let us say in 1970 where you would not make use of something called the internet, you would know nothing about Jennifer who is at Los Angeles.

So, what do you badly want to contact Jennifer for some business requirement and Jennifer cannot be contacted directly. So, what you will do is you will try to contact Jennifer through someone ok, you will find someone who possibly might know Jennifer. And, you will request this someone to put in touch with you, put in touch Jennifer with you right. Now, how feasible is this? It all boils down to you knowing someone who knows someone who knows Jennifer; this may or may not be the case, but surely something in me tells me that there possibly is someone.

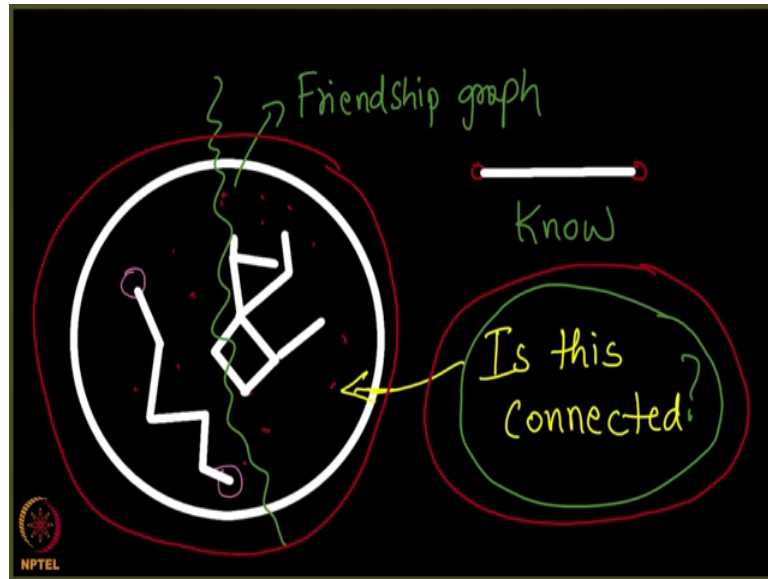
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Let us say there is someone that Ram knows and that someone might know someone else and that someone might know someone else and someone else so on and so forth. A long chain like this might know Jennifer. Let me put the ovals here which represents the nodes which represent people here. So, the idea is Ram might know someone who knows someone who knows someone who knows someone someone someone and so on and finally Jennifer. Now, this sounds a little funny to me, it is funny that these 2 people are indeed connected which 2 people Ram and Jennifer, are they even connected is my big question. They may or may not be connected right, they may or may not be connected; may or may not be connected. So, now let us try doing this experiment and see whether the world is connected or not. What do I mean by that?



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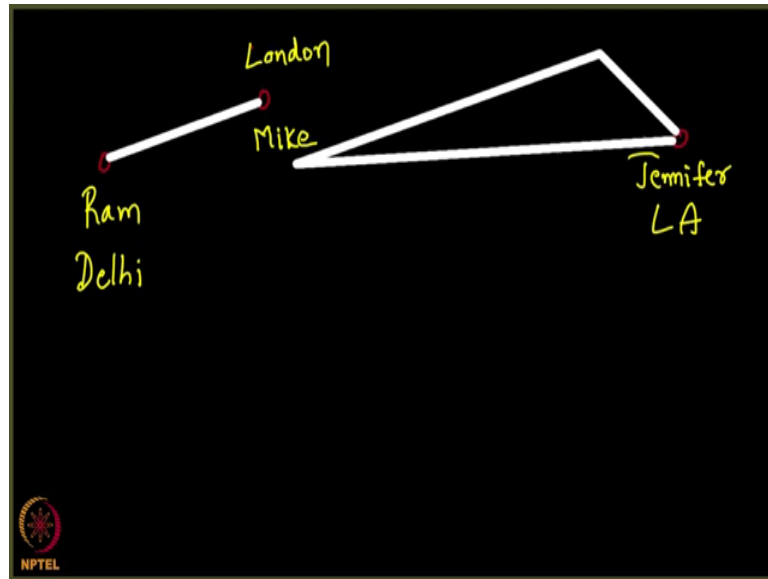


And if I were to consider all possible people over here and where between any 2 people let us say person 1 and person 2, you put an edge; you put an edge. If this person if they if they know each other if they know each other. Now, if you keep putting such edges between people here alright so on and so forth; so on and so forth alright.

What kind of a network will you get? Is this network connected? If this is connected then between any 2 people that you might possibly pick there exists a path maybe right, there exists a path like this. But, in case it is disconnected there may not be a path between any 2 vertices. Now, the question that I am trying to ask for fun say is the graph, is the friendship graph of the world connected right. This is the friendship graph of the world friendship graph is this connected.

Now, of what use this such a question right in the first place; why would anyone bother to ask or answer such a question. So, let us get back to our question of Jennifer you would trying to know someone some person 1.

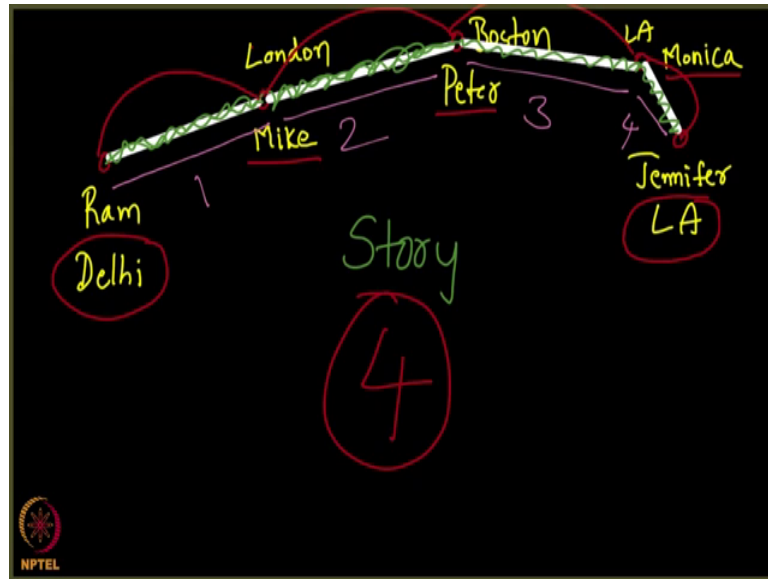
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Let us say I will call him Ram here in from New Delhi trying to contact someone by name Jennifer in Los Angeles right. So, how would he even try contacting someone who might know Jennifer, what Ram will do is Ram is from Delhi he has a friend in let us say London ok. So, this friend of his is in London someone by name Mo someone by name Mike is in London.

And Ram knows him first hand and he request Mike, Mike can you please put me to someone called Jennifer from Los Angeles. Now, here is a point to think. Ram thinks Mike might know someone who knows Jennifer, it is too much of a coincidence if Mike knows Jennifer first hand right that that may not really be possible. But, Ram still wants to explore the possibility of contacting Mike and requesting him to get him in touch with Jennifer. He knows for sure that Mike may not know Jennifer right.

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But still he would he would you like to give it a try and ask Mike, Mike do you know someone in Los Angeles who might know Jennifer and then Mike says well dude I do not know anyone in of course, Ram knows Mike and asks Mike do you know someone in Los Angeles by name Jennifer. And, Mike says I do not know anybody in Los Angeles, but I know someone in Boston ok. I know someone in Boston ok, this place is Boston by name by name Peter ok.

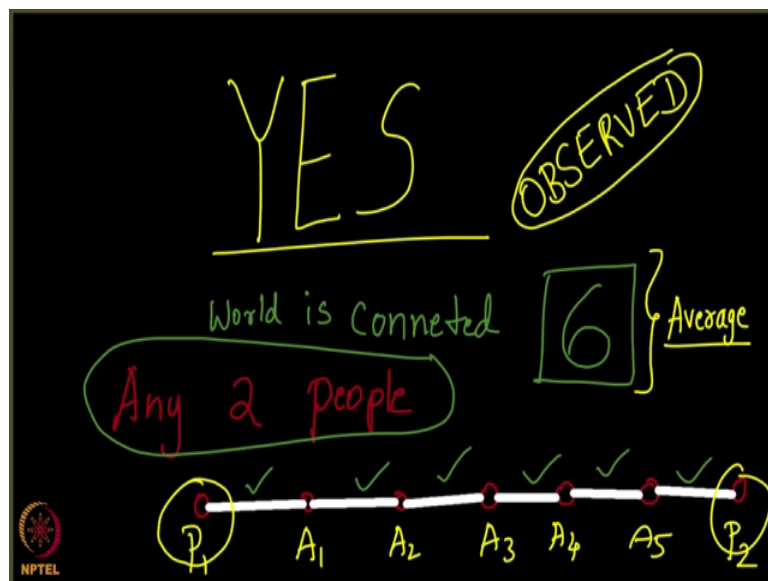
Someone called Peter alright and he says this Peter is actually from Los Angeles although he stays in Boston he might know Jennifer ok. And, Mike does in fact, contact Peter. So, initially Ram contacts Mike and Mike contacts Peter and asks Peter could you please help me get in touch with someone called Jennifer in Los Angeles who works for so and so company. And, Peter says although I am from Los Angeles I do not know anyone by name Jennifer in so and so area, but I know someone in that area who might know this person called Jennifer and that person's name is Monica and she is actually from Los Angeles ok.

And, Peter contacts Monica and Monica it so, happens that Monica indeed stays very close to Jennifer's place and she happens to be Jennifer's friend. And, Monica says yeah I do know Jennifer and this is how the connection from Jennifer to Monica to Peter to Mike to Ram has ok. It is surprising that is the connectivity only 1 from here to here, from here to here was 2, from here to here was 3, from here to here was 4. I told you a

story, this is actually a story this may not be true, a story of someone by name Ram in Delhi who wants to contact someone by name Jennifer in Los Angeles and gets through by asking a friend called Mike who asks a friend called Peter, who asks a friend called Monica. Right, is this always true that we can find anyone whom we want in a few hops like this, let us say here is 4 hops.

By hops I mean 1 friend and then second friend, third friend and then the fourth friend; is it always true that we can find someone through this quick single digit hops in this case it was 4. Is it always a small number as you know in the previous slide, we indeed asked this question. Is it at all connected, if it is connected we can ask for distance between 2 people it is may not be connected. Now, here goes the big question the friendship network that we were discussing is it connected, if it is connected what is the distance between 2 people on an average. So, this is the big question. The answer for this is a big yes.

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Yes, we are indeed connected, yes we are what is connected the world is connected the world is connected; connected in what sense? Connected in a very surprising sense, that any 2 people of your choice if you take in the world. Let us say a person 1 and person 2 it is known that these 2 people are separated by 1 2 3 4 let me push this fellow this side 5 and 6 a in just 6 hops. You know which means a person here let me call him P 1 person here P 1 knows this person P 2 through intermediate people let us say A 1 A 2 A 3 A 4 A 5

and the sixth person is the person you are you are. So, 1 this is a 1 hop, this is 1 hop, this is second hop and this is the third hop, fourth hop, fifth hop, sixth hop. So, 1 2 3 4 5 6, in 6 connections any 2 people in the world are connected. So, this is not actually exactly 6 by 6, I mean on an average it is 6 between any 2 people and this is what scientist have observed, note this they have observed.

Now, this is observed word that I said is actually slightly absurd you see. How can anyone even conduct such an experiment and conclude that there are 6 intermediary people between any 2 people on an average; does not sound true you see even if it is true how would you go about checking it correct. So, if I say the average number of friends per person in the world is let us say 200 ok, it could be a ridiculous statement just like that made up right. How would you substantially a validate it correct. Similarly, if I say any 2 people in the world are connected by near 6 hops on an average so, this is average; how will anybody validate such a claim. So, we will see in our next lecture how exactly the scientist validated this claim and why it is actually true.