Social Network Analysis
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Chapter - 10
Lecture - 02

Let us assume that you have you know created a phone right a mobile phone it is called F o n e ok the name of your brand is F o n e.

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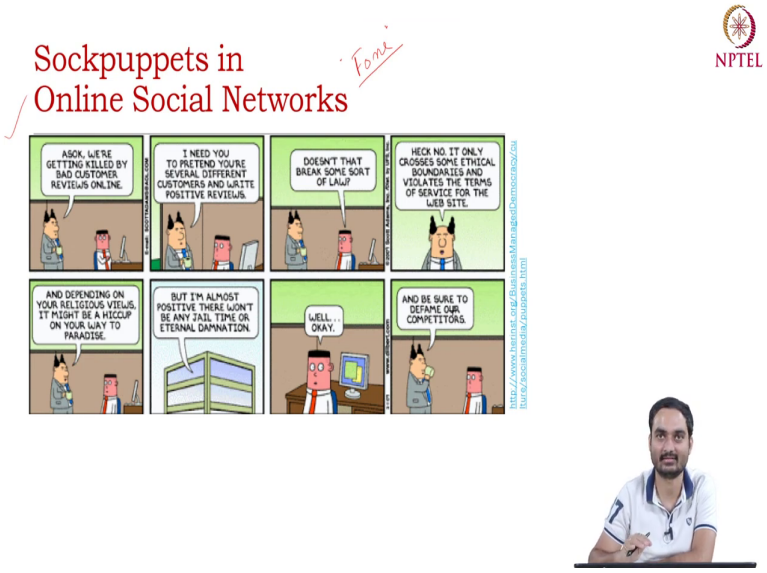

And you want to sell your phone right and you have multiple competitors you have iPhone, Samsung right Nokia and all other competitors and so, now, you are wondering how to sell this phone right. So, what you can do? You can go to Amazon or Flipkart or any Ecommerce services right yeah.

And then you know create your profile you know create a good description of your phone and you start doing some marketing and then you convince customers to buy right, but over the time you realized that it is not that easy; because brands like iPhone right Samsung these are really famous brands and why people essentially buy your phone rather than buying the other phones right.

So, what you do? You may start thinking about you know doing something crap right. So, what you can do? You can say create 20 30 such 20 30 accounts right on Amazon on Flipkart

for example, and start writing you know good comments about your product right and all these 20 30 accounts are controlled by you right because we you know that people generally look at the comments read the comments and then decide whether to buy a product or not right.

So, then over the time you realize that you are exhausted be resources because 20 30 accounts may not be enough right to write good reviews of your products right. So, what you can do in that case? You can you may talk to your friends and ask them you know start doing some you know some negative advertisement of your competitors right.

You may ask your friends to write bad reviews about Samsung phones, about iPhones right with the hope that when people read those bad reviews people may start exploring new types of phones and maybe your phone will pop up and they will decide buying your phone right. So, the and I am pretty sure most of you have experienced the following thing at least I have experienced right.

Say in many times we have seen that when we buy something from these Ecommerce services right with many products right there is a; there is a hidden coupon and in the coupon it is written sometimes written that if you go and like rates the product on the Ecommerce services with high rating and write good reviews right and you write it and take the snapshot of your comments and ratings and send it to us this is the WhatsApp number send it to us and we will give you 500 or 100 you know Paytm cash back.

I have experienced this thing many times right. In fact, I have also written these things on the on the comments that look these are the ways people these days are you know you know inorganically boosting the ratings or comments of a product right. So, all these things come under the broad umbrella of offensive activities harmful activities on social network. So, this is the cartoon example let me just read this cartoon right.

Say the first cartoon says that Asok, we are getting killed by the bad customer reviews online. So, this guy has possibly launched some product and many customers have written bad reviews now their product is essentially the popularity of the popularity of the product is basically diminishing right. So, then he is saying that I need you to pretend you are several different customers and write positive reviews right.

Then the other person is saying does not that break some sort of laws? Then he is saying no it only crosses some ethical boundaries and violates the terms of services for the website and depending on your religious views it might be a hiccup on your weight paradise think of the kind of language that he is using.

But I am almost positive there will not be any jail in a right any jail time or eternal you know damnation then he is saying well ok and be sure to defame our competitors. Just a cartoon example you know I am basically trying to say how people essentially react ok.

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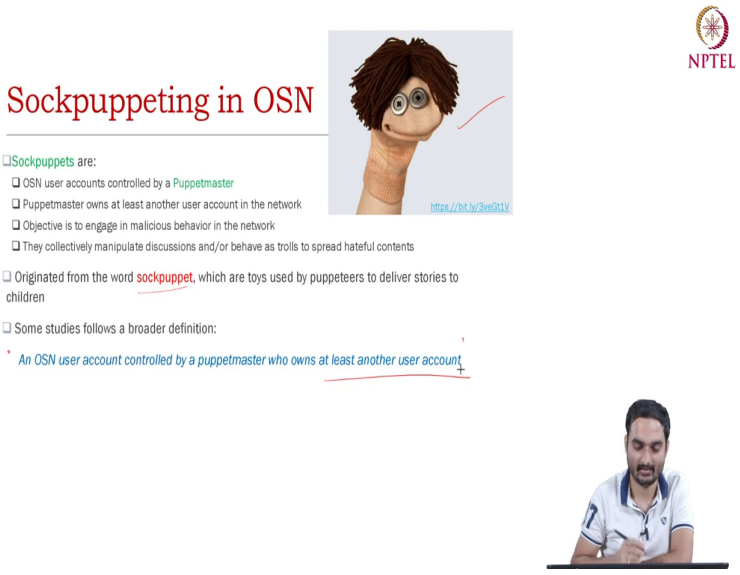

So, we will discuss something called sockpuppets ok. So, what are sockpuppets? Sockpuppets are online social network user accounts controlled by a puppet master right. Puppetmaster owns at least another user account in the network right which is his or her own account right objective is to encourage to engage in malicious behavior in the network, they collectively manipulate discussions and or behave as trolls to spread hateful contents right.

So, the term sockpuppet basically originated from the word sockpuppet we all know what is sockpuppet example of sockpuppet is here which are toys used by puppetmaster to deliver stories to children ok. So, this is the formal definition of a puppetmaster an online social network user controlled. So, the sockpuppet is an online social network user account controlled by a puppetmaster who owns at least another user account right.

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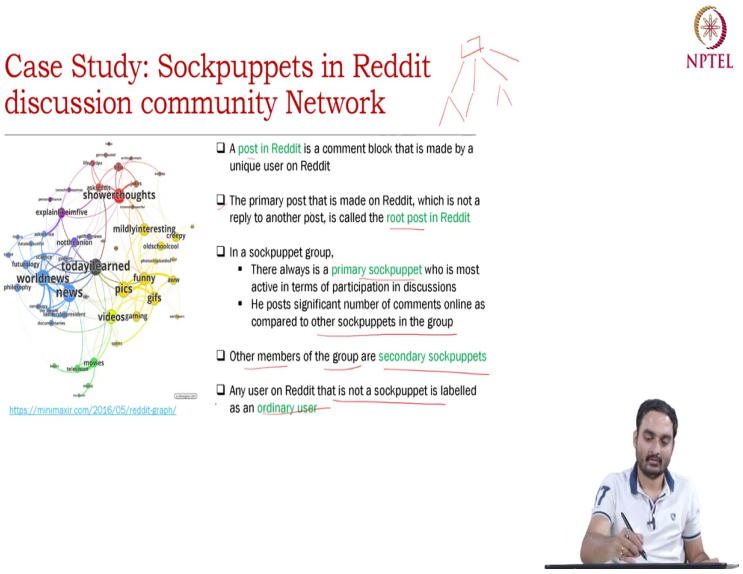

So, the question is how do we detect sockpuppets and puppetmasters from social networks right? If you look at Reddit right we know what is the post in a Reddit right, a post in Reddit is basically comment block that is made by a unique user on Reddit right the primary post that is made on Reddit which is not the reply to another post is called the root post right you have root post and you have different comments ok tree like structure again.

In a sockpuppet group there always is a primary sockpuppet who is almost active in terms of participation in discussions right. He or she posts significant number of comments online as compared to other sockpuppets in the group right. Other members of the group are secondary sockpuppets you can think of the puppetmaster at the primary sockpuppet and the others are the secondary sockpuppets any user on Reddit that is not a sockpuppet is labelled as ordinary user.

So, I am I will use the term post, root post, primary sockpuppet, secondary sockpuppet, ordinary user in the remaining part of this lecture ok.

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So, what is the task here? The task is to identify sockpuppets in online social network. So, sockpuppets cannot be explicitly recognized due to the amount of anonymity allowed in registering users in online social network, you may not want to reveal your own name you can use some toy names or dummy names to indicate your account. So, several alternative strategies employed to obtain ground truth.

So, that is the difficult task right how do you say let us say you have some hypothesis right and based on the hypothesis you detect sockpuppets, but how do we identify the ground truth sockpuppets? How do we evaluate it right? So, in a research by Leskovec and his group published in 2017 the paper is called army of me an army of me right.

They used the Wikipedia definition of sockpuppet to identify the ground truth sockpuppets right. So, what they said is that, a sockpuppets account that make similar edits on Wikipedia remember we are considering Reddit, but we are taking the definition of Wikipedia sockpuppets to identify the ground truth sockpuppets so on Reddit.

So, sockpuppets are accounts that make similar edits, accounts that post at similar duration right accounts that post from the same IP Address right. But remember IP Address cannot be IP Address can be can easily be masked can easily be shielded using several techniques such as say using proxies right that makes the method you know if we use simple IP Address right that may not be suitable for identifying the ground truth sockpuppet.

But nevertheless, they I mean they basically came up with some ways to identify sockpuppet ground truths right.

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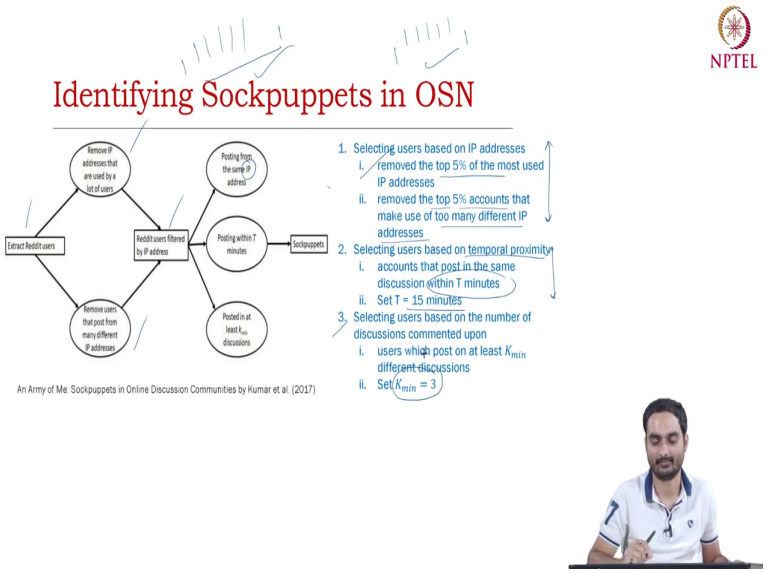

So, what they did is as follows. So, they first extract all the Reddit users right they removed you know they removed 5 percent of such users right which used which basically used similar type of IP right say for example, there are thousands of such users who use a single IP.

Now, this has only the this has only I mean this is only possible if somebody can use say some sort of country wise proxy right. So, they removed all such users who use this kind of country proxy right they also used they also removed top 5 percent accounts that make use of too many different IP addresses. Say if I use say 100 or 200 IP addresses, it means that I am sharing you know my IP Address to others and I am using others IP Address to for my purposes right.

So, they first removed these two kinds of users right then whatever is whatever is the set is remaining, they identified their posting behavior right. So, then they select users based on the temporal proximity right basically the idea is that if the accounts if the user accounts you know the post around the same time within a gap of T minutes right within a duration of T minutes where T is say 15 minutes it means it means that those account those accounts are controlled by somebody else right.

Say within 15 minutes you see post by a set of users again another 15 minutes duration you see the same set of users have posted it means that you know the puppetmaster was active at this time and at this time right. The third strategy was to select users the remaining users based on the number of discussions they commented on right.

So, the idea is that if some account is used as a puppet as a sockpuppet that account can be used for many I mean for writing many such comments right. So, they used at least three such comments for each user to write to identify the sockpuppets. So, if there is a group of accounts group of users who passed this who qualified this filtering strategy who qualified this filtering strategy and who participated at least three such comments right wrote three such comments those accounts have been filtered as sockpuppets.

Now this is the heuristic based approach as you see, but remember this is the ground truth right why it is a ground truth? Why this is not a method? Because IP Address is something that you cannot get right. Say if you are a normal user right how do we get the IP Address of another user?

IP Address can only be accessed by the administrator say Reddit administrator Wikipedia administrator. So, this group of researchers Leskovec and his team they collaborated with Reddit most probably they collaborated with Wikipedia and they obtained the IP Addresses and based on that they identified the ground truth sockpuppets.

Now, the task is to come up with a method to detect sockpuppets without using these IP Addresses can we look at the network structure? Can we look at the post behavior right to identify sockpuppets? And then we will tally we will kind of measure whether the proposed method is similar to the way you know we basically created the ground truth ok.

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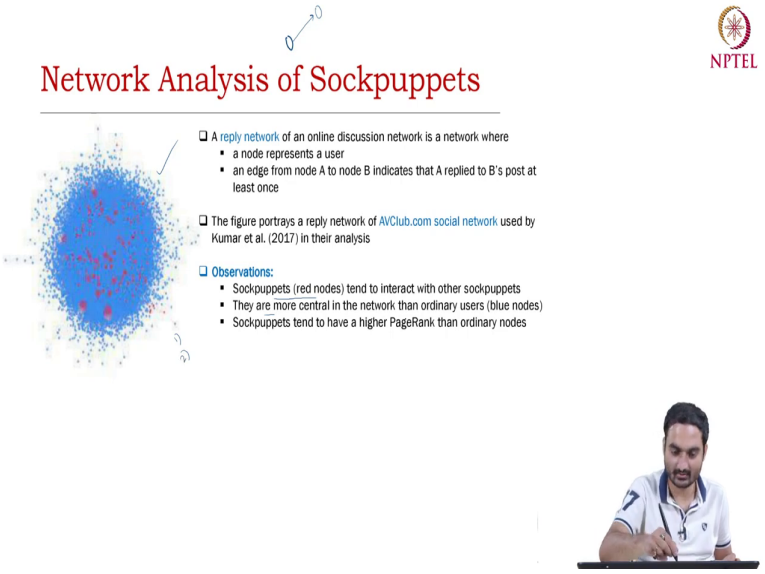

Now, let us look at how we can use social network techniques to identify sockpuppets. So, we have seen how to you know how to identify the ground truth sockpuppets using IP Addresses right. So, what they did? They created a reply network ok. So, in a Reddit setting if user A has replied to user B then there is a directed graph directed edge right.

So, a replay network of an online discussion network is a network where A node represents A user and an edge from node A to node B indicates A replied to B B's post at least once ok. So, then they I mean on the replied network replied network they tried to understand different structural properties.

The first one was the PageRank of sockpuppet accounts and the ordinary accounts right it turned out that the sockpuppet you know sockpuppet accounts sockpuppets in a network are more central ok. If you also look at this figure here you see these red dots it is a red dots are sockpuppets they are essentially the center of the network right.

This actually indicates that sockpuppets are more popular than the other ordinary users right and while also calculating the PageRank value, it turned out that sockpuppet accounts tend to have a high PageRank value compared to the other accounts and this is quite surprising finding ok. The second one was to understand the ego network structure one hop ego network structure of the sockpuppet accounts and the ordinary accounts.

And once again it turned out that you know that actually there are three observations based on the ego network, the first observation was that there is almost no difference in terms of the number of nodes and number of and the density of ego network in case of puppet ego network and you know ordinary ego network.

So, there is no difference between the no difference between these two types of ego networks with respect to the number of nodes and the density ok number 1. Number 2 observation was that the average clustering coefficient right of the sockpuppet account is you know is basically much higher than the clustering coefficient of the other sockpuppet I mean of the same of the same for the you know ordinary users.

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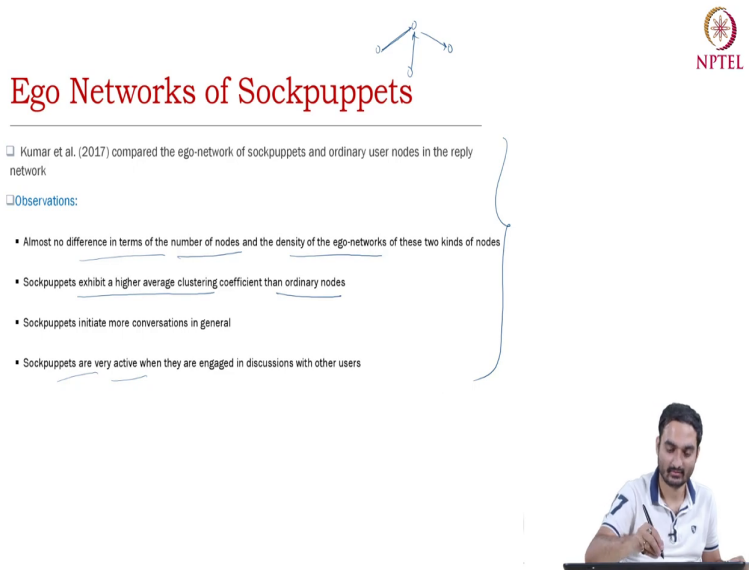

So, average clustering coefficient then the higher average clustering coefficient than the ordinary nodes right. Almost no difference in terms of the number of nodes and the density right and the third observation was in most of the cases sockpuppet initiated the discussion right. How do we how do we identify this? Let us say. So, this links indicates these links indicate the discussions I mean the replies right.

So, if you look at the posting time right it turned out that majority of the discussions majority of the replies right majority of the discussions initial discussions right sockpuppets initiates the discussion ok you can easily identify it based on the time of posting right.

So, in general sockpuppets are very active when they are engaged in discussion with other users right. Now all these things have been all these observations have been made based on the ground truth that the sockpuppet groups that we have already identified based on the IP addresses right.

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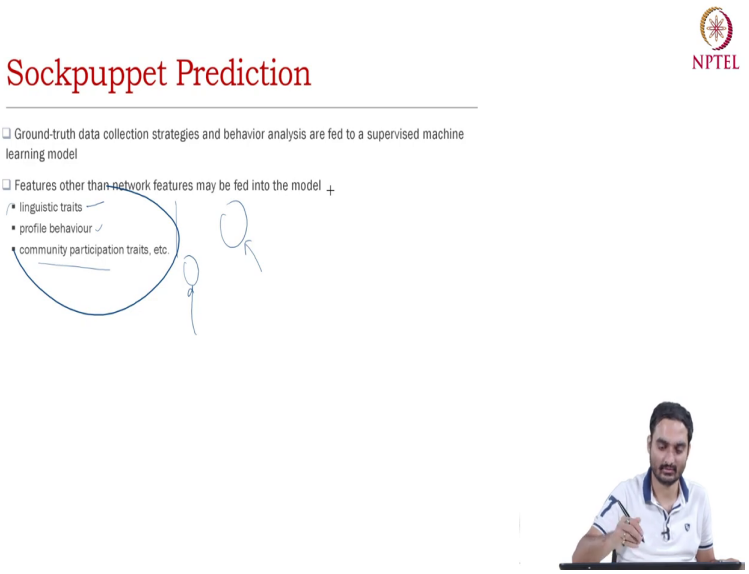

Let us also look at the you know the linguistic properties ok. Say sockpuppets are aggressive or not right whether sockpuppets use you know more violent content right whether sockpuppets use a lot of pronouns lot of adjectives right based on that you can get linguistic traits of both sockpuppets and normal users right. You can also get the profile behavior based on say the frequency of post, the number of post, the duration of post right and different activities right.

You can also get the community participation trait based on the groups where they belong to and how they react right. So, what this suggest is that, you can use these properties right to some classifiers right and then classify normal sockpuppets and you know I mean sockpuppets and ordinary users right. You can use them in any statistical ml kind of models say SBM or decentric kind of models and then you can classify them. You already have the ground truth and you can use it ok.

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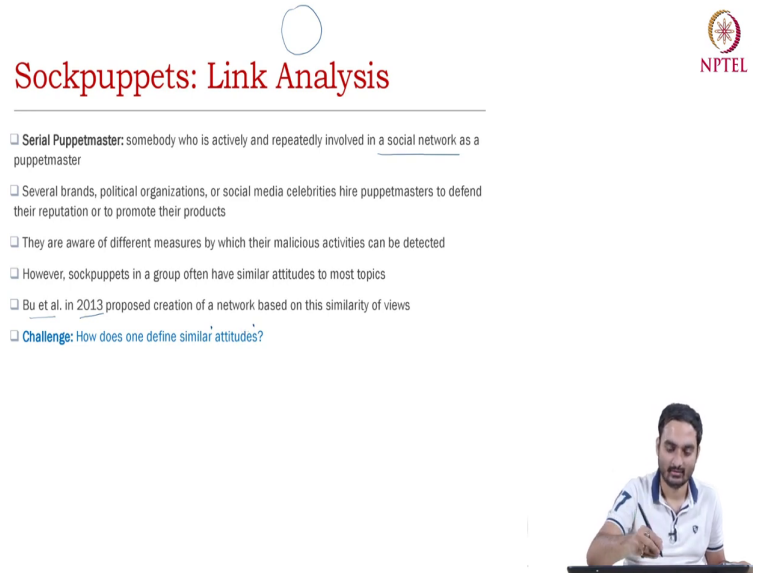

So, they Leskovec and his team they did not look at another important factor which is the trust right. So, you know there is some there is something called serial puppetmaster right serial puppetmasters are I mean serial puppetmaster is somebody who is actively and repeatedly involved in some in some social network.

And say for example, there is a political agenda, there is a brand advisement, there is a social media campaign these puppetmasters are always these puppetmaster is always invited always recruited to create such dummy accounts sockpuppets and you know promote or demote this agenda or brands or whatever right. So, they are called serial puppetmasters right.

So, now if you look at this sockpuppets in a group right individual sockpuppet detection does not make much sense right if you are able to detect the group together you would be able to identify the puppetmaster as well. So, the method that I have discussed so, far right it can identify sockpuppet accounts and ordinary accounts right, but it is not able to identify sockpuppet groups right.

So, in 2013 right there was method proposed by Bu et al right and in this method they you know they basically came up with a simple approach, but effective approach to identify sockpuppet groups ok based on some heuristics we will discuss this process here. So, they defined something called the attitude. So, attitude of a user towards a post attitude of a user towards a an event right.

Now, this attitude can be thought of as terms right or emotion or sentiment right whatever right. So, if you look at the attitude of this group of sockpuppets right their attitude should always be same towards certain product which they want to promote or demote right.

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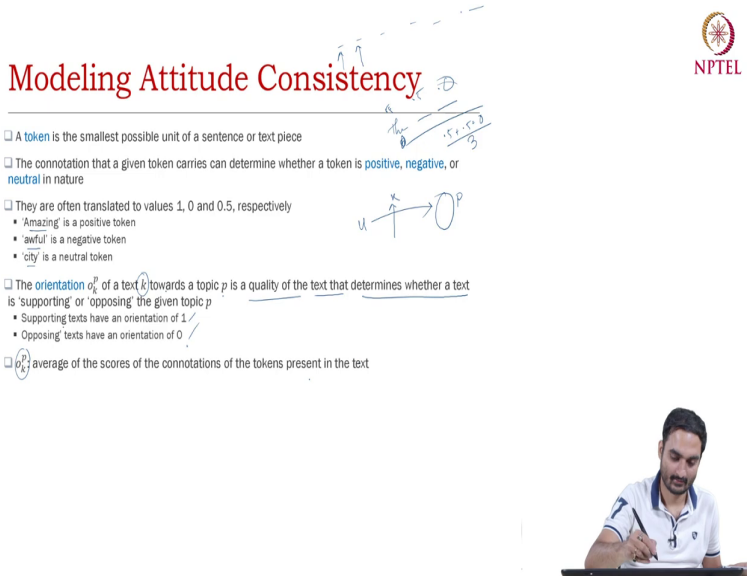

So, in this research they want to identify they want to formulate a way to measure the attitude ok. So, they model attitude using a normal simple NLP based approach right. So, in a sentence if you are aware of NLP in a sentence constituting of different words. So, these words are called tokens ok.

So, let us assume that let us assume that each such word is associated with some sort of connotation right some sort of sentiment right say there is a word called amazing it is a positive token right there is a word called awful this is a negative token and there is a word called city is a neutral token right.

So, to every token we can associate some sort of score some sort of sentiment score or whatever connotation that you want to assign right. So, then the orientation right orientation of a text k a text is a sentence a post right towards a topic p say there is a user u who has written a post write k right on a topic p you want to identify the orientation of this post towards topic p right.

So, this is a quality of the text that determines whether a text is supporting or opposing that particular topic right supporting texts have orientation one and opposing text have orientation

0 ok. So, the orientation of a post k is the average of the scores of the connotations of the tokens present in the text. Say the movie is awful if you look at the connotation the is a neutral statement neutral token, movie is a neutral token and awful is a negative token right.

So, the overall 0 say if neutral is 0 or say if neutral is 0.5 plus 0.5 plus 0. So, the overall you know overall connotation is 0.5 plus 0.5 plus 0 by 3 1 by 3 ok.

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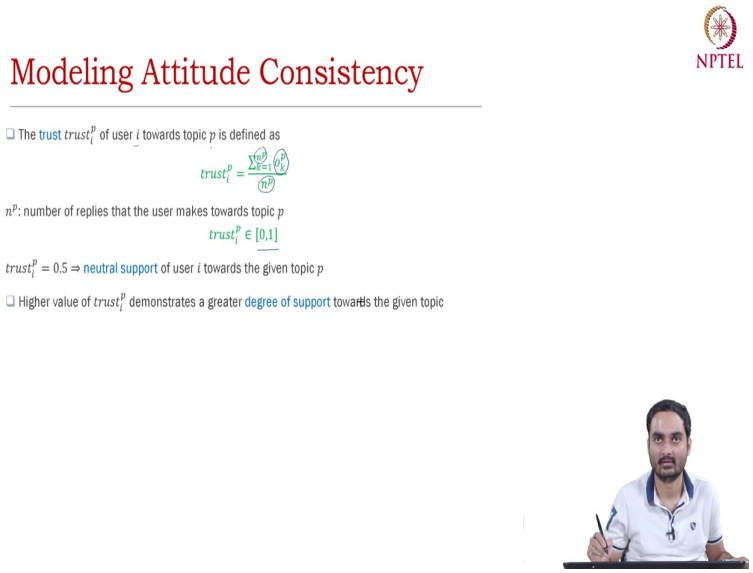

Now, trust right of a user i towards a topic p is the sum of orientation of all the posts that the user has written so, far towards the topic p right in p is the number of replies the user has written so, far ok p is the is the orientation and it is normalized right. So, average orientation it lies between 0 to 1 right. So, if it is 0.5 then it is neutral, if it is greater than 0.5 the positive otherwise negative right. So, higher value of trust determines a greater degree of support towards a given topic ok.

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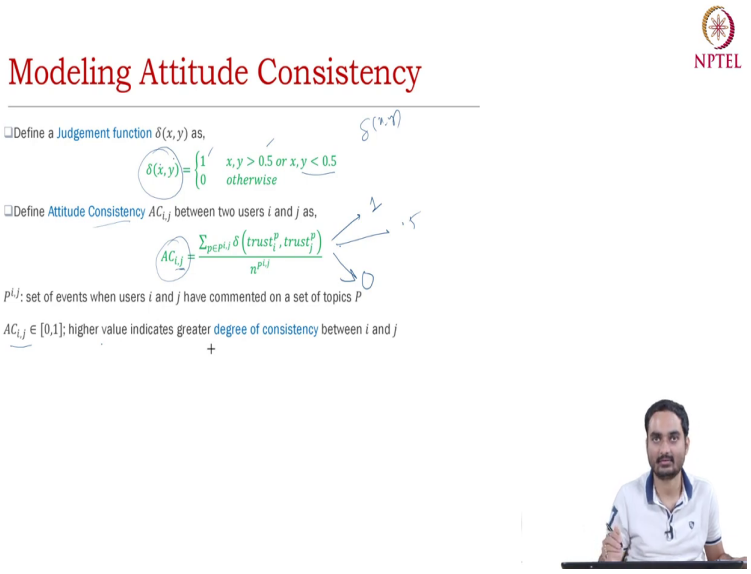

Then let us you know define another quantity it is called attitude consistency. So, the attitude consistency is defined by this judgement function delta right. So, delta x, y if both x and y are greater than 0.5 then it is or both x and y are less than 0.5 then this is 1 otherwise 0 ok.

So, the attitude consistency is the sum of all the posts of i and j towards topic p and then we look at the judgment function. If both I and j together support a few topics or together support all the topics then it would be it would tend to be 1 right. If they together oppose it would be 0 if they are both neutral it would be 0.5. So, for a pair of users now I have something called attitude consistency ok. So, as you see here attitude consistency is higher right indicates greater degree of consistency right.

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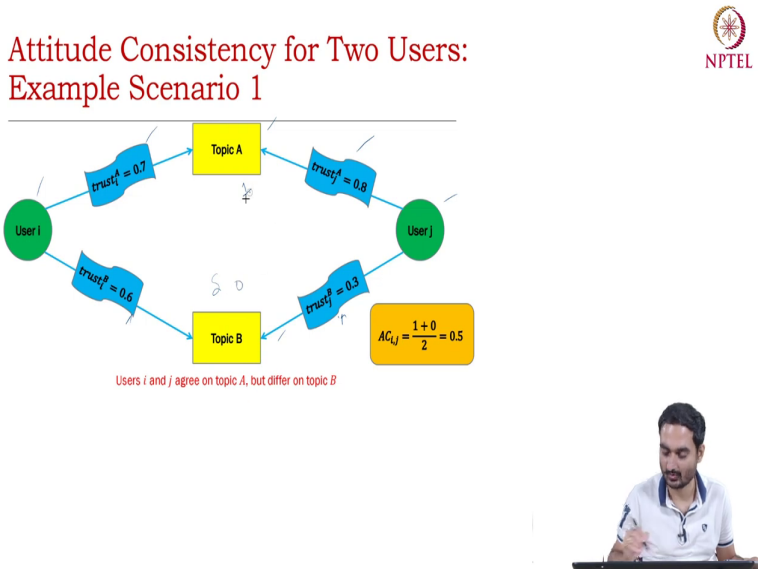

Here is an example. So, user i user j topic A topic B you see that both of them have high trust which is greater than 5 therefore with respect to topic 1 attitude constituency is 1 for this is positive this is negative. So, different delta would be 0 this would be 0. So, 1 plus 0 by 2 ok.

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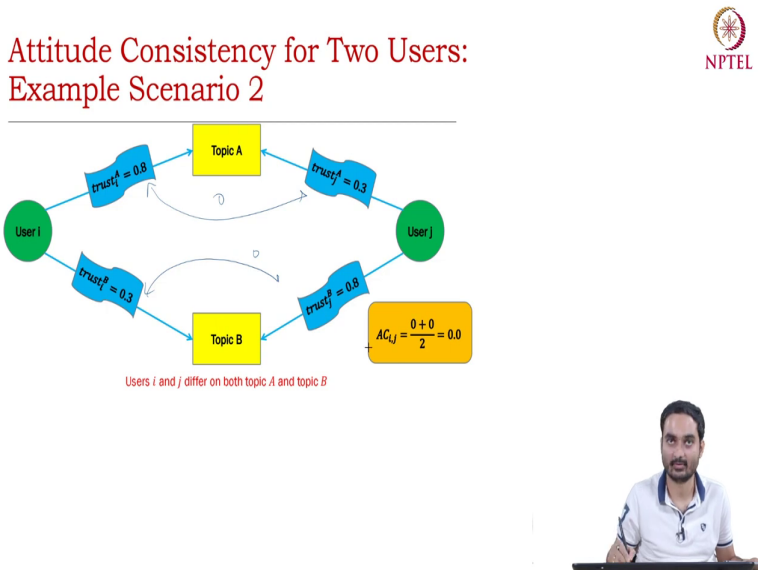

For this one different right 0 different 0 so, 0 plus 0 by 2.

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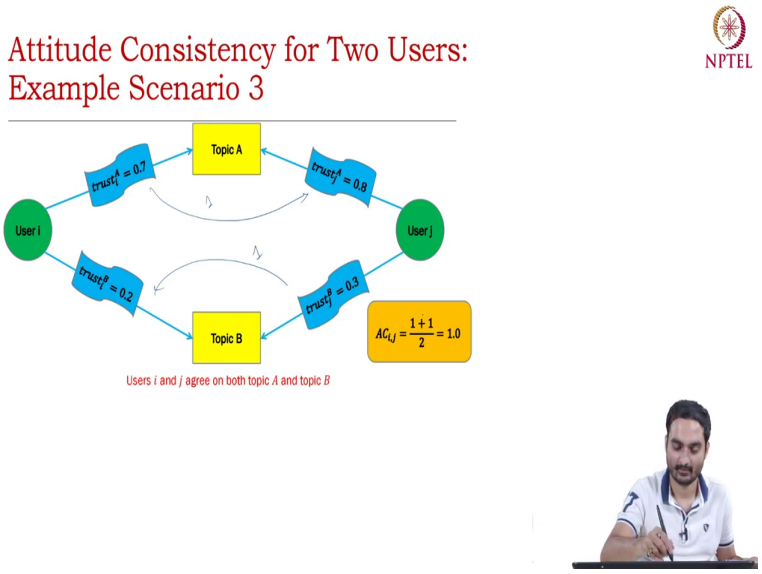

Same one different up this is also same negative, but same 1 so, 1 plus 1 by 2.

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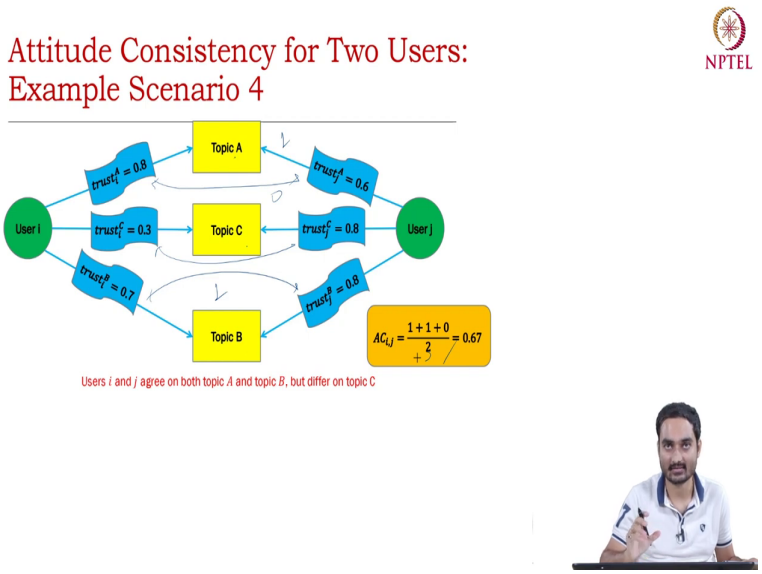

For this one with respect to A both of them have greater than 0.5. So, 1 with respect to B same 1 with respect to C different. So, 0 1 plus 1 plus 0 by 3 sorry this will be by 3 ok.

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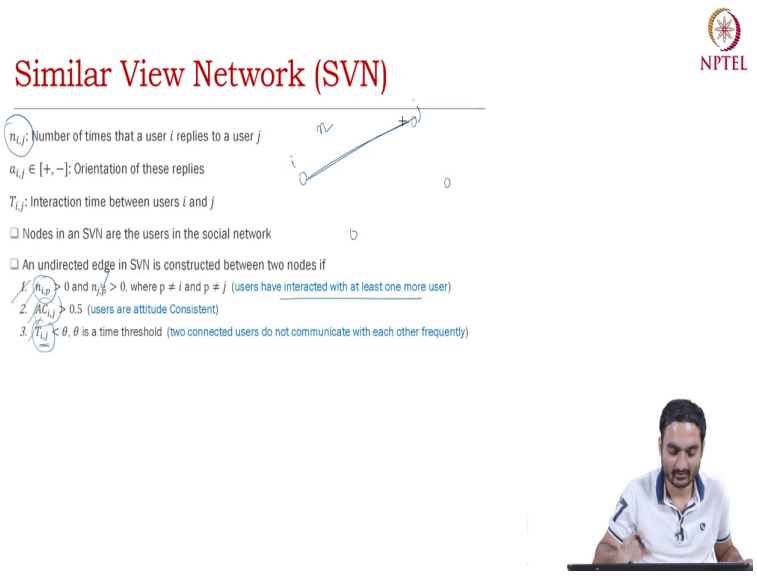

So, in this way you can identify the trust or some sort of attitude consistency between a pair of users right. So, then what you can do you can create a network right and this network is called similar view network ok here users are nodes right and if a pair of users is connected if they have you know replied to at least significant number of posts right.

And there is another. So, let us say this i and this is j right there should be a set of comments or set of replies that they have made to another user p which where p is not equals to i and p is not equals to c j it means, that i and j have interacted with at least another one more user ok this is condition 1 for creating an edge condition 2 is their attitude constituency should be greater than 5 right.

And the third you know the third condition is with respect to the time right. The time of posting should be less than theta; that means, they have more or less posted around the same time. So, if all of these three things satisfy then you create an edge between i and j ok. So, this is called similar view network.

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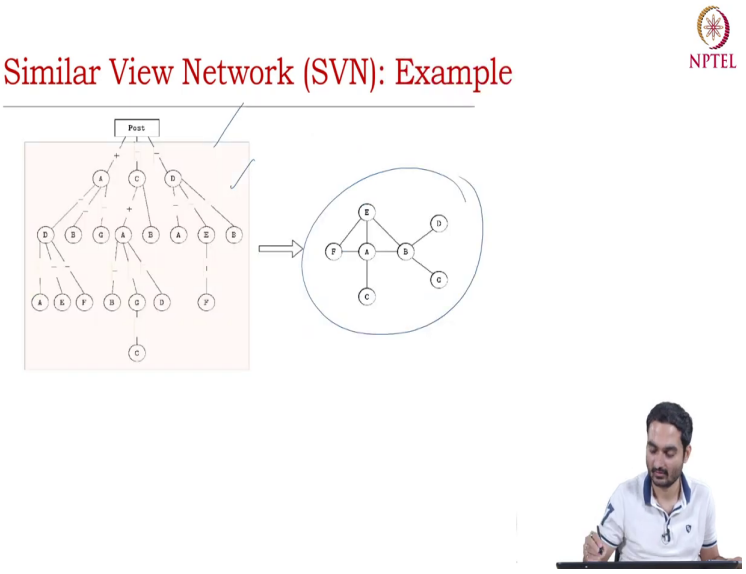

Example this is the activity orientation network. This positive negative views based on the attitude consistency, then from this you create you know a similar view network right.

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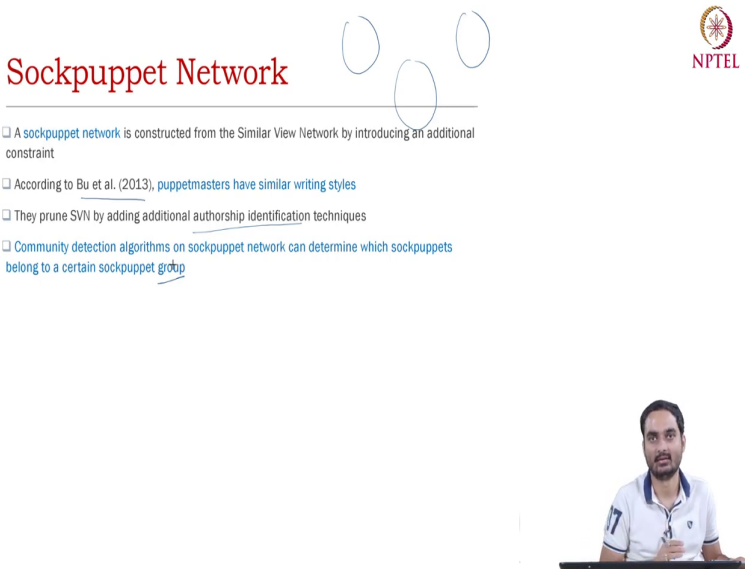

Now on the similar view network what this guy proposed is that you can actually filter out nodes based on their posting behavior ok. So, you can incorporate some sort of authorship identification techniques right and you can prune you know edges further from this SVN similar view similar view network right.

You can prune some edges right on that you can further run a community detection algorithm a clustering algorithm. So, when you run clustering algorithms you should be able to identify group of users who behave in a similar manner their attitudes are same right towards similar topics and they are they may be sockpuppets they may be sockpuppet groups right.

So, in this particular approach, they try to identify sockpuppet groups right whereas, the previous one they identified sockpuppets in individual accounts. So, this is about sockpuppet, in the next lecture we will discuss the black market driven activities and how we can detect those activities using social network theory ok.

Thank you.