Online Privacy
Professor. Ponnurangam Kumaraguru ("PK")
Indian Institute of Technology, Hyderabad
Identity Resolution

Welcome back, NPTEL students, this is week 4. In this week we will cover topics like, Identity resolution and privacy nudges. These are very, very relevant topics to privacy. And we will also cover something around this topic also in this week.

(Refer Slide Time: 0:34)

I hope you are enjoying the class, I hope you are able to consume the content not necessarily only from the content that we discuss, but also watch the videos, have discussions in the mailing list. And I sincerely hope that you are also taking the topics outside just the NPTEL course, particularly having a conversation with your friends, having conversation with your parents.

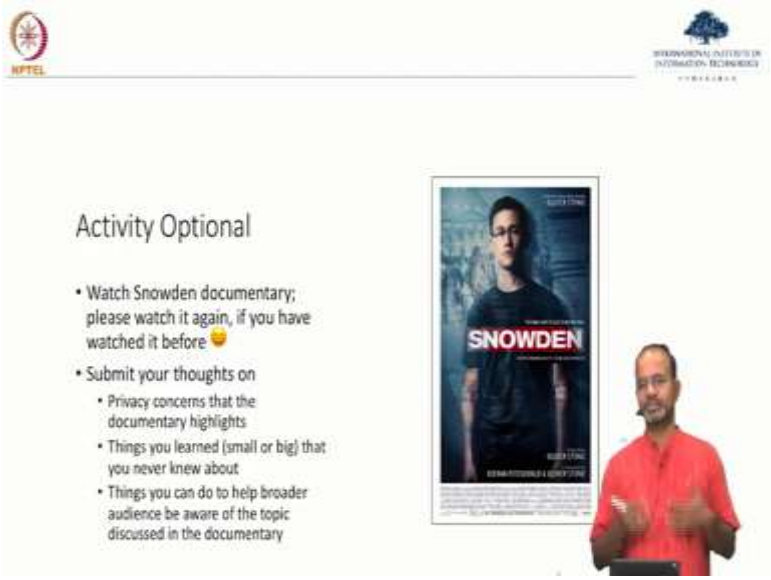
And also just when you are doing activities yourself, when you are buying a product on amazon, or when you are ordering some food on Swiggy or on Zomato, you get this conscious about what is going happening to my data, or they doing what are the company's policies about the data that they collect from me and things like that. I think that kind of consciousness will come, if you are involved in the class.

I hope some of you are being conscious about all these active not necessarily only these ordering, but generally even having conversations with people, I think these are great ways to probe and understand the topics, that you are learning from the class.

Last week we covered privacy enhancing technologies, privacy invasive technologies, privacy decision making and social media privacy. The idea being giving you a sense of what these technologies are, which can help you protect privacy, which are including your privacy, both of it was the content that we saw in week 3. And great to have some of you on the mailing list active, but I would really, really like more people to participate in the mailing list.

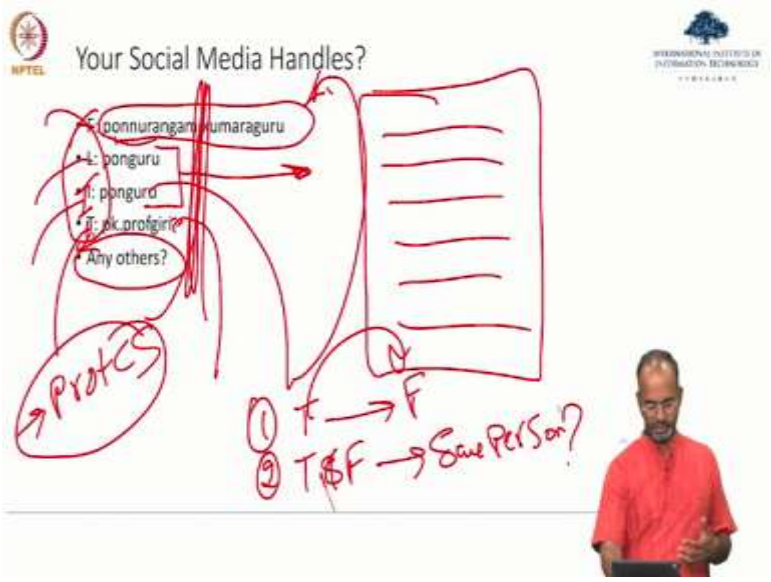
And if you have any questions about any of the content that we are covering on even beyond that anything that is relevant to the course for the online privacy, feel free to put it on the mailing list, or if you want to send it to me feel free to send it with the appropriate subject line. So, I get to see the email and have a discussion either one-on-one, or probably as I have been suggesting that we can do a one-to-many discussion, where we discuss many questions together and take some interesting discussions forward.

(Refer Slide Time: 2:39)



I requested you to watch this video and documentary. Good to see some discussions on the mailing list, but again more people participate will be very, very nice. And the goal is also every week I am going to get you to watch some of these videos, short sometimes shorter, sometime a little longer, just to get you connected to the topic outside, just the content that we are seeing in the class.

(Refer Slide Time: 3:07)



Now, let us get into the topic of identity resolution itself. As you look at this slide, just take a pen and a paper, or even in your laptop pause the video, and just write down your social media handles for any of these platforms, or any others also. What is this Facebook, LinkedIn, Insta,

twitter. Go to your browser, go to your profile take the URL and put it together in a sort of a text pad, or something. So, you will have 1, 2, 3, 4, 5, 6, how many ever profiles that you have.

If you look at them, there is some interesting questions that you can ask, which is in this case, it to start with my Facebook handle is ponnurangam dot kumaraguru, my twitter handle, my Insta handle, this is my instant, this is my twitter, my Insta handle is pk dot profgiri, my LinkedIn and twitter handle is ponguru.

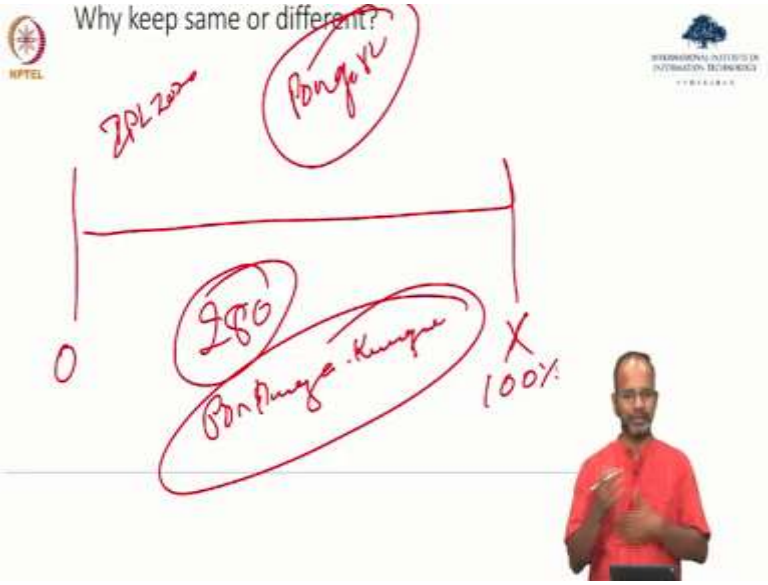
So, now if you want to go from one social network to another social network with this handle, for example, if I give you my twitter handle, can you go from my twitter handle to my Facebook handle? Can you find that with my twitter handle my Facebook handle? Or that is the first set of problem, which is given twitter can you go to Facebook. Second problem is given my twitter and Facebook handle, can you find it is the same person? Same handle, same user all that.

These are the two problems, which can help, if you are able to address these two problems many, many fundamental questions can be answered. I will go through one by one. But for now I will let you to digest this question, which is if you see your own profile is here, just look at your text pad now, and I am sure many of you have handles which are like mine, where there is very many similarity between each and every profile punnurangam, kumaraguru from ponguru, there is this match, if you just do a edit distance of these two profiles much larger.

So, you are able to find that many characters are overlapping. But if you look at my Insta handle and my twitter handle, probably that is lesser. So, similarly I am sure in your case you are able to find out that where there are similarities, where there is dissimilarities, where it is varying differently and all of that. I am sure many of you have handles like completely different, for example one thing that I have been saying is profcs, let us take if I create a, if I create a tinder account, which profcs.

So, profcs is so much different from any of the others. I am sure you have handles like that. So, this is identity, identities on social media. And the question that we want to ask is can we resolve them, which is can we do this or this.

(Refer Slide Time: 6:37)



Why do we keep our handle same or different? I will let you to think for a second. And if you think about it, there is many reasons to keep it same, for example in my case I generally for many, many years I think initial use of internet and emails all that, I just had the ponguru, everywhere it was ponguru, meaning I think my CMU, email address was ponguru at cs dot cma dot edu, my yahoo id.

So, as you can see my LinkedIn, my twitter all of that, just to be consistent across handles and anybody figuring out that meaning who is punnurangam, kumaraguru these accounts, finding ponguru they will just think that okay this is the same person, who is using this handle. Hopefully there are other things that may differ, but to start with. Why do you want to keep it different? You want to keep it different, because you do not want people to figure out, that it is the same person.

So, that is why this continuum will be very, very helpful to think about, we kind of discussed about this continuum even earlier about the anonymity, which is 0 anonymity, which is keep the same handle in all platforms. So, anybody coming to any of these handles will know that it is pk here, all of them being I mean my I want very high, or so to say 100 percent anonymous, I want to be, in that case my handles will be different.

And therefore, people will not be able to find out that it is the same person. I am sure you have other reasons, if you think of other reasons that are more plausible, I mean I think in twitter and

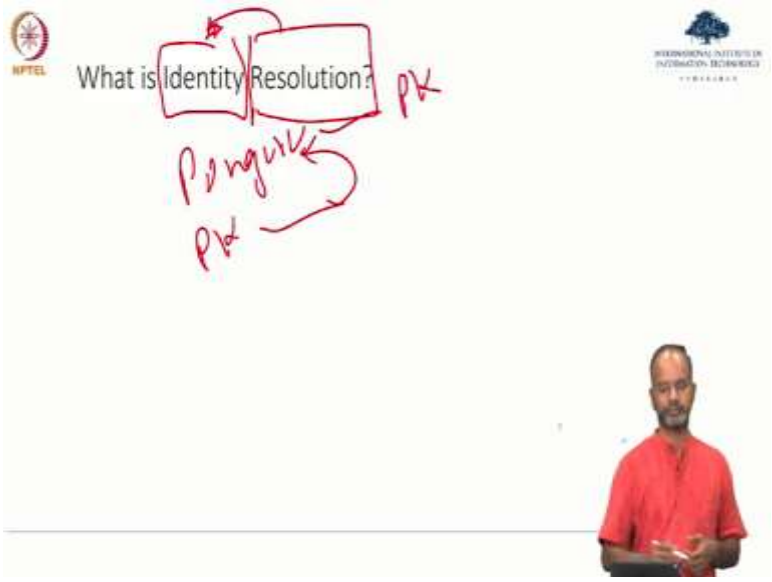
all people do the same, people try to change the handles, because they want to also keep the characters lesser. Because if you were 280 characters is their total imagine if I had a handle as ponnurangam kumaraguru so many characters are getting lost in just trying for.

Let us take if people were to tag me and say something, if you if they were to do that, they are going to lose like 20, 22 characters, just by my user handle, instead ponguru just helps, because it is just about 6, or 7 characters, which allows them to write more 270 characters in the post. Many I think the one of the biggest reasons why people have these handled shorter is to save some space.

But people have been also changing their user names for many reasons, I am sure you would have seen let us take during elections there was this during 2019 elections, you would have seen many, many people adding chowkidaar on their twitter handle, or any of their social media handles.

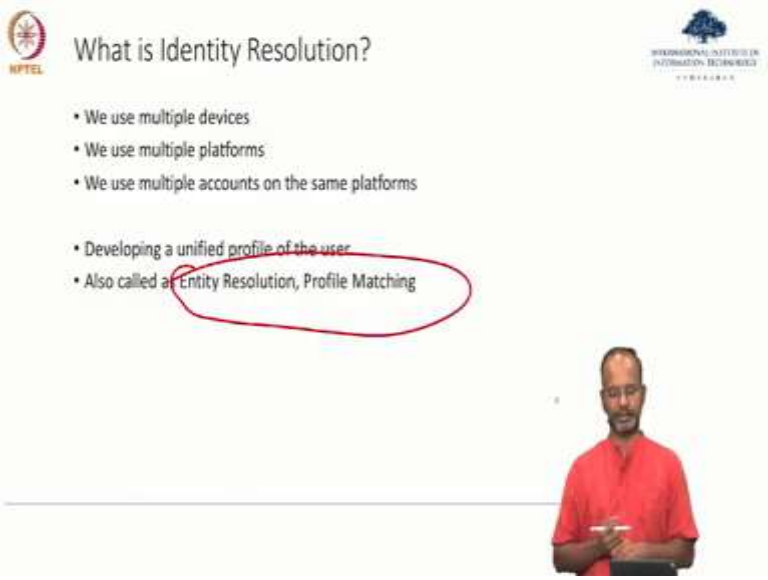
For example, IPL, people want to people would probably add IPL 2020, in their twitter handle. So, that when somebody searching for IPL, that handle shows up, you want to keep it different, you want to keep it same, all this is happening on social media.

(Refer Slide Time: 10:06)



So, identity resolution is basically what I said, which is going from ponguru to pk, or given pk go to ponguru, one of that, any of these combinations, basic idea is I want to resolve the identity of a given user.

(Refer Slide Time: 10:31)



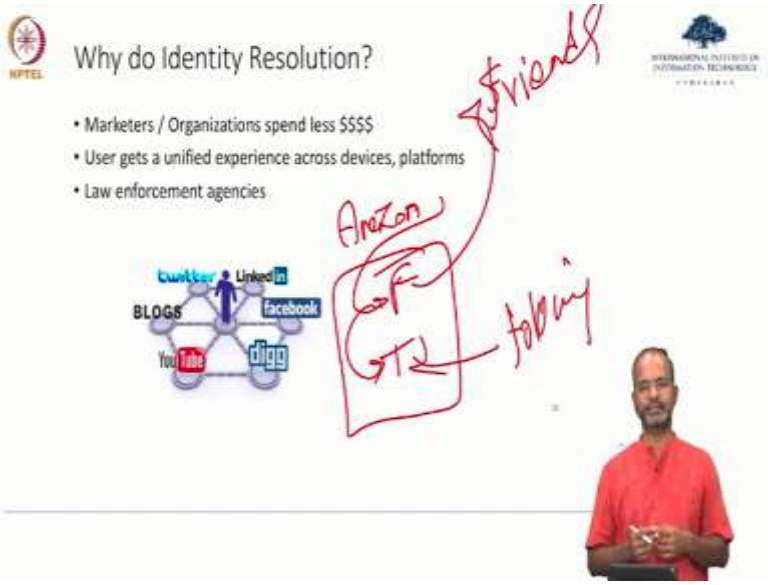
So, there is also the so here very formally listed the reasons why identity resolution is needed is we use multiple devices. So, I am using my Ipad to do the lecture, I have a laptop, I have a phone. So, now giving multiple devices, the identity resolution does not have to be only in the social platform, it can be even figuring out all these three devices are the same users of pk, we use multiple platforms, multiple platforms on multiple devices.

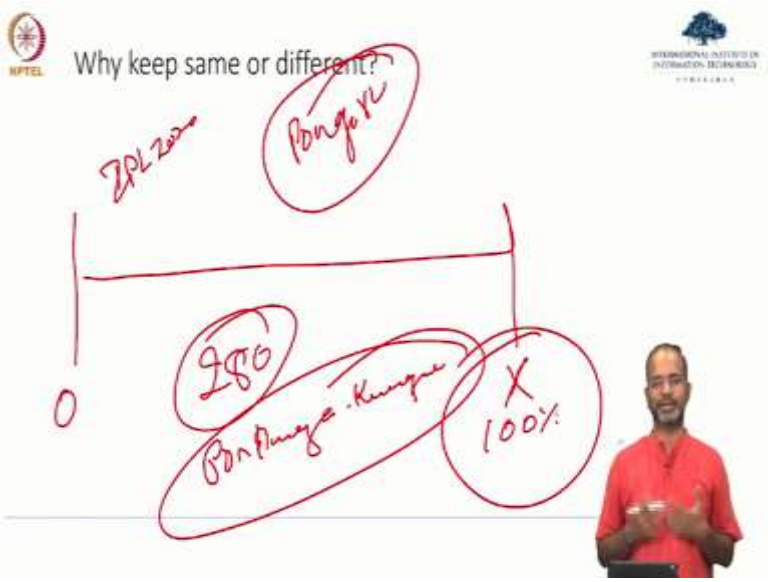
We use multiple accounts on the same platform for first lecture, or the second lecture, I asked you how many of you have more than one handle on the same platform. If you use multiple accounts on the same platform, do you want the platform, or do you want an adversary to figure out that it is the same user who is on using this two accounts in the same platform. Resolving all of this has both business and other implications also, which we will get in a few seconds.

So, knowing that it is all the these three devices are of the same user, helps the helps providing personalization helps, providing content to me accordingly all of that. The word identity resolution is also referred as entity resolution, profile matching. If you look for any of these words they all mean the same.

In this course, I am going to use the word identity resolution consistently for referring to this idea of resolving identities across multiple devices, multiple platforms, same platform, multiple users all of that.

(Refer Slide Time: 12:34)





So, what are the business values of or what is the value of doing identity resolution? Just think for a second, take a second to think about what identity resolution is? And why do identity resolution? So, there is many reasons for identity resolution, here are a couple of them that i have listed marketers, organizations, spend less dollars. What does this mean? For example if a company amazon has to send ads to promote information of the new products, new sale, sale day all of that. If they know that ponguru and ponnurangam.kumarguru is the same user, they can just send one ad instead of two ads.

Let us take in the different platforms, let us take if I was in my Facebook and in my twitter, if they if amazon has to send ad instead of two ads that they have to spend money on, they can just do only one spend money resources any of that, they have to send only one now, because they know that it is the same user. If they did not know that, they have to do two which is probably increasing their expenses on doing this ads.

I will repeat again let us take for triple Id Hyderabad's scenario, if triple Id Hyderabad has to send a send an ad for its new program to the students in the Hyderabad, or to the parents in Hyderabad, who have kids between a certain age. If you know that their handles on LinkedIn and Facebook are same, I have to send only one ad instead of two ads, because two ads is more expensive, two is okay just think about it, if we were going to use Insta, twitter, or LinkedIn and Facebook as a platform to do this promotion, then I am going to be spending four times for potentially, the cost what I am otherwise to send spend on it, that is one.

Doing this identity also helps the user experience across the devices to be more, to be more seamless. So, my iPad is connected to my Gmail, my laptop is connected to my Gmail. If all of them are connected to the same account, it just helps getting moving information for YouTube, I watch something here, my history gets created on my iPad, the same thing is available on my phone. So, it is easy across multiple devices.

This is using the same user, what I said now is just my own id across, but even if that my own I do not connect these devices to the same account. If it could be figured out, then your user experience can be much, much better. There is also the third reason, why identity resolution becomes useful is at the law enforcement agencies level.

So, same thing let us think that if pk handle is doing something malicious, for law enforcement to understand, that whether they are targeting two user, or one user, it just helps them. And if they have information from these two platforms, which are different, for example Facebook they can get probably a stronger friends, stronger friends in this they can get all the accounts, that they are following.

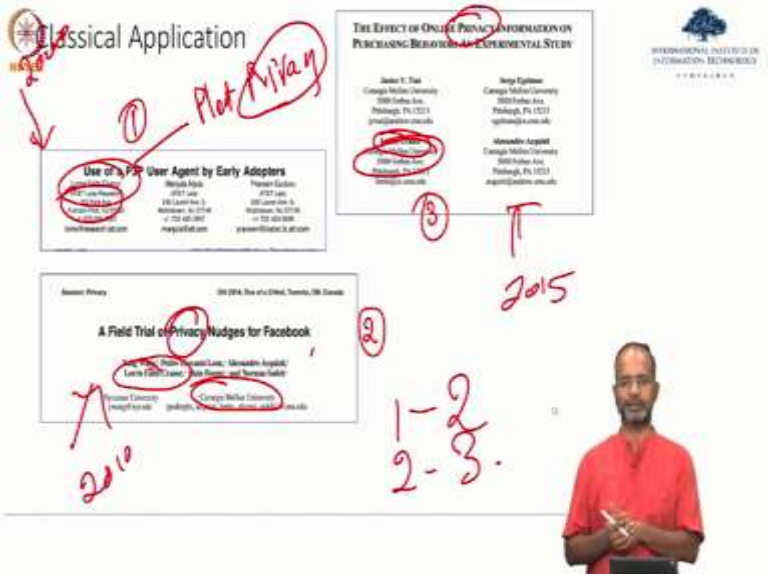
So, to get different pieces of information to solve the puzzle of identifying the sort of malicious actor in the sense which is pk, it is easier for the law enforcement agencies, if they can resolve the user is that making sense. I hope I hope it is helping you to understand with these multiple

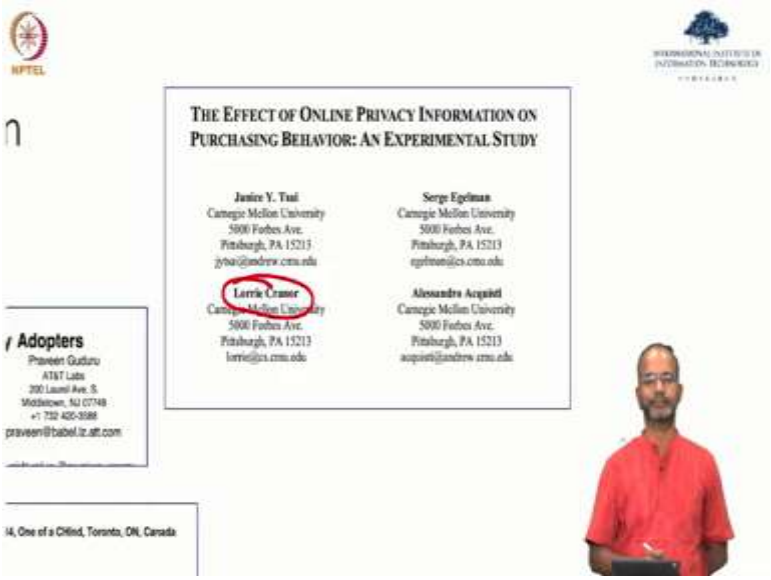
examples and keep your own user handles look at them again, you will get a sense that resolving that will help in some other ways that I just now said.

Of course, going back to the going back to the point of the spectrum, of course this resolution will be harder for people who want to have 100 percent anonymity on these platforms, I consciously want to stay away from being resolved, then for them I think putting the handles together is probably not the something that they not like. You yourself I am I also mentioned this previously, that yourself may be having multiple accounts on the same platform and you consciously must be also keeping the content, keeping the network all of that separately.

Imagine if Facebook figuring it without it is you or Facebook the platform that you are on is the same user it is probably slightly more easier. But if somebody else were to figure it out maybe something that you do not like, you do not want.

(Refer Slide Time: 17:38)





THE EFFECT OF ONLINE PRIVACY INFORMATION ON PURCHASING BEHAVIOR: AN EXPERIMENTAL STUDY

Janice Y. Tsai
Carnegie Mellon University
5000 Forbes Ave.
Pittsburgh, PA 15213
jytsai@andrew.cmu.edu

Serge Egelman
Carnegie Mellon University
5000 Forbes Ave.
Pittsburgh, PA 15213
egelman@cs.cmu.edu

Lorrie Cranor
Carnegie Mellon University
5000 Forbes Ave.
Pittsburgh, PA 15213
lorrie@cs.cmu.edu

Alessandro Acquisti
Carnegie Mellon University
5000 Forbes Ave.
Pittsburgh, PA 15213
acquisti@andrew.cmu.edu

/ Adopters

Praveen Guduru
AT&T Labs
200 Laurel Ave. S.
Middletown, NJ 07748
+1 732 420-3588
praveen@babel.lz.att.com

14, One of a CHInd, Toronto, ON, Canada

Use of a P3P User Agent by Early Adopters

Lorrie Faith Cranor
AT&T Labs-Research
180 Park Ave.
Florham Park, NJ 07932
+1 973-360-8607
lorrie@research.att.com

Manjula Arjula
AT&T Labs
200 Laurel Ave. S.
Middletown, NJ 07748
+1 732 420 3587
manjula@att.com

Praveen Guduru
AT&T Labs
200 Laurel Ave. S.
Middletown, NJ 07748
+1 732 420-3588
praveen@babel.lz.att.com

5000 Forbes A
Pittsburgh, PA 1
lorrie@cs.cmu.

Session: Privacy

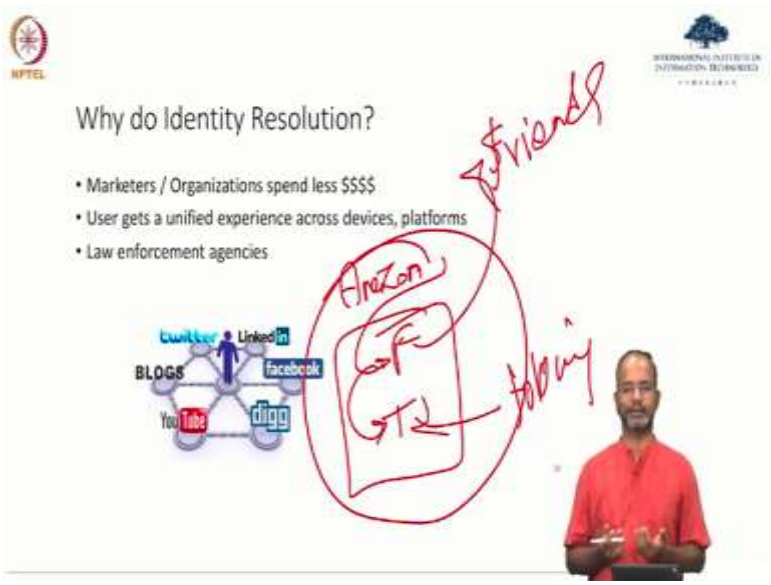
CHI 2014, One of a CHInd, Toronto, ON, Canada

A Field Trial of Privacy Nudges for Facebook

Yang Wang,[1] Pedro Giovanni Leon,[2] Alessandro Acquisti,[2]
Lorrie Faith Cranor,[2] Alain Forget,[2] and Norman Sadeh[2]

[1]Syracuse University
ywang@syr.edu

[2]Carnegie Mellon University
{pedrogln, acquisti, lorrie, aforget, sadeh}@cmu.edu



Here is a so even though the explanations that I am giving you now until now I have been giving you all the social media examples. This topic has been very, very prominent across many years now, in a much more classical and a fundamental way. Here is an example to look at.

So, all these three are research papers written by, so the first topic is the first paper is use of a P3P user agent by early adopters. And if you see that author that is Lorrie Faith Cranor, a field trial for privacy nudges for Facebook, this is a paper that we will also look at in the course. This has Lorrie Faith Cranor. And then the last one here the effect of online privacy information on purchasing behavior and experimental study. This has Lorrie Cranor in it.

And let us keep this as 1, 2, let us keep this as 3. In 1, Lorrie Faith Cranor, in 2, Lorrie Faith Cranor and 3, Lorrie Cranor. Now, in 1, the affiliation is different, which is AT&T labs, in 2, the affiliation is CMU, in 3, the affiliation is CMU, again the name match between 1 and 2 is common, the affiliation match between 2 and 3 is common.

Now, how do you figure out that it is the same person? That is the question. And this question has been primarily studied in databases, studied in understanding, which meaning citations, researchers name has to be added, this paper all of these questions can be answered, once you figure this out, just think about it, it is a super interesting problem. And it is also slightly hard problem, some cues that you can get which is easier here, probably there is also this idea called let us also look at the topics.

If you look at what P3P is, again platform for privacy preferences. So, you will find privacy common in all the three. So, can you now put together saying, probably all three are same person, because of AT&T and the temporal information available may also help, this must have been in probably early 2000s, this must be 2010, or something, this must be 2015.

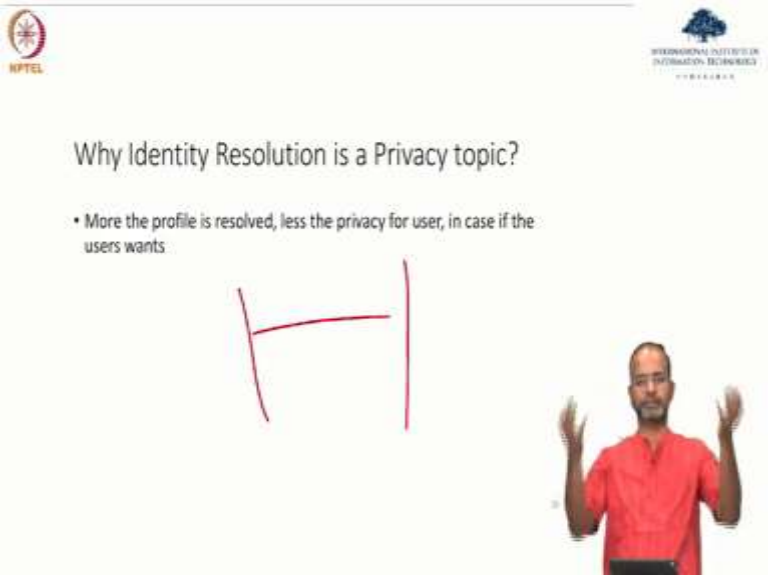
So, if you have the temporal information also, you will be able to say that look I think probably earlier the association was AT&T and then she moved to CMU, and then in CMU she is been working on privacy and these two papers have CMU affiliation probably, it is the same person. And you can look at other information of some other articles, that she has written with AT&T is very similar to privacy here, blah blah blah all that.

So, this is a classical identity resolution problem. The importance of change, the important fundamental thing that changed in the examples, that I told you earlier on this, is that in this I am not going to create and write a paper with Lorrie Faith Cranor as a name, because when I write a paper I want to have the attention for the paper, citations for the paper, people should read and know that I did this work.

Whereas, in in social platforms, I could easily have an account called Lorrie Faith Cranor and run it legitimately also. So, that is the fundamental difference between the classical paper dblp area versus the social platform, because the assumption that the users have more credibility and doing it with their name is not there in the social platform.

So, therefore the problem becomes much harder, this problem is definitely hard, it is not that trivial so to say, if you go to the social platforms, it gets much, much more harder, at least here Lorrie Cranor and Lorrie Faith Cranor, the edit distance you can find more of overlaps is there. But just ponguru and profgiri, just it is super hard to go from one to other, or figure out whether that is the same person.

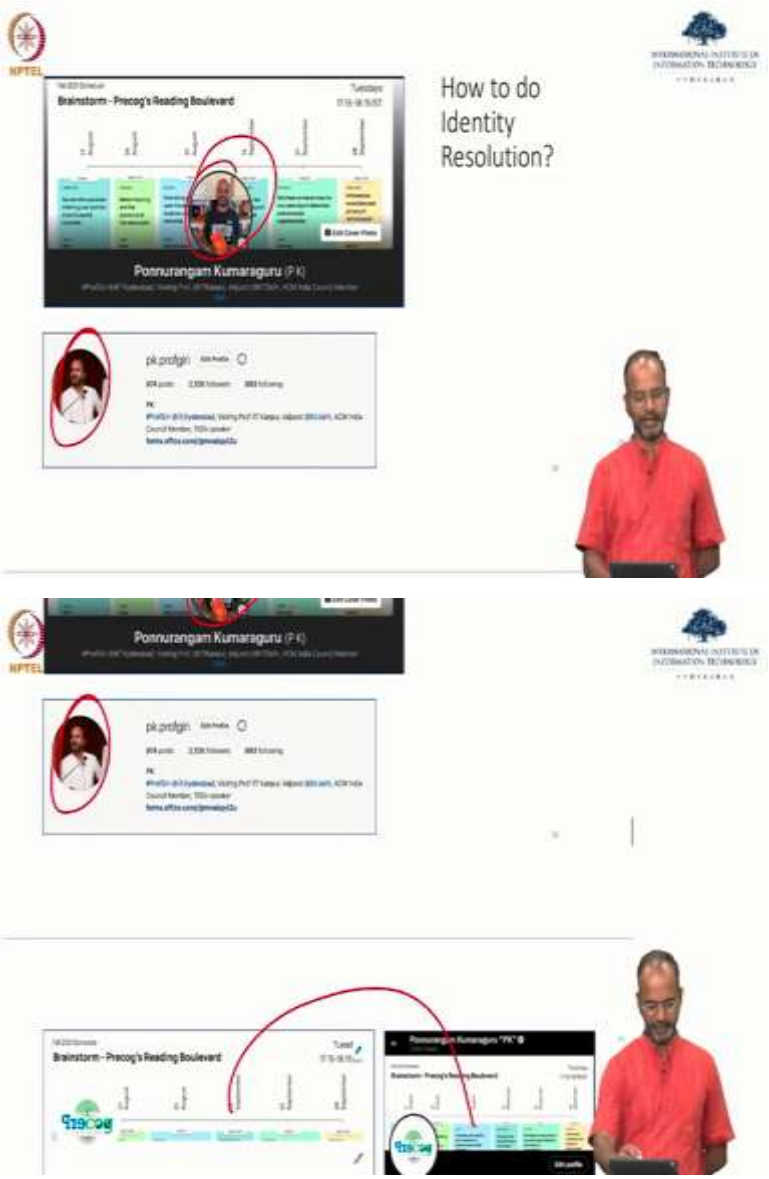
(Refer Slide Time: 22:36)

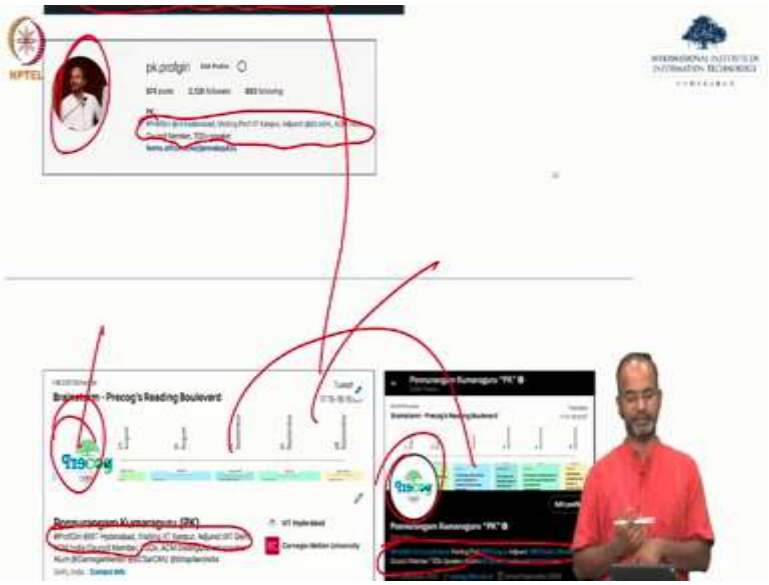


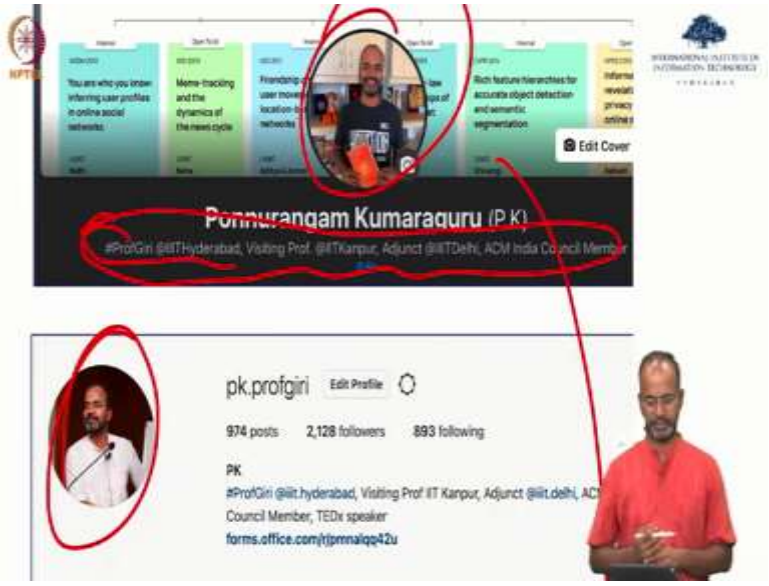
Why identity resolution is a privacy topic? So, if you just think about it for a second again, the anonymity topic that we talked about is what makes it makes it interesting, makes it relevant to privacy. So, more the profile is resolved, less the privacy for a user, in case if the user wants. It is the same, it is the same thing that I said earlier about the spectrum, the more I want to have anonymity, if my accounts are getting resolved, then my privacy is getting lost.

So, that is the idea, that is the idea why that is the relationship why identity resolution is more a privacy question. I do not want my identity to resolve and using the information, that is available, technologies, platforms, companies, can resolve it.

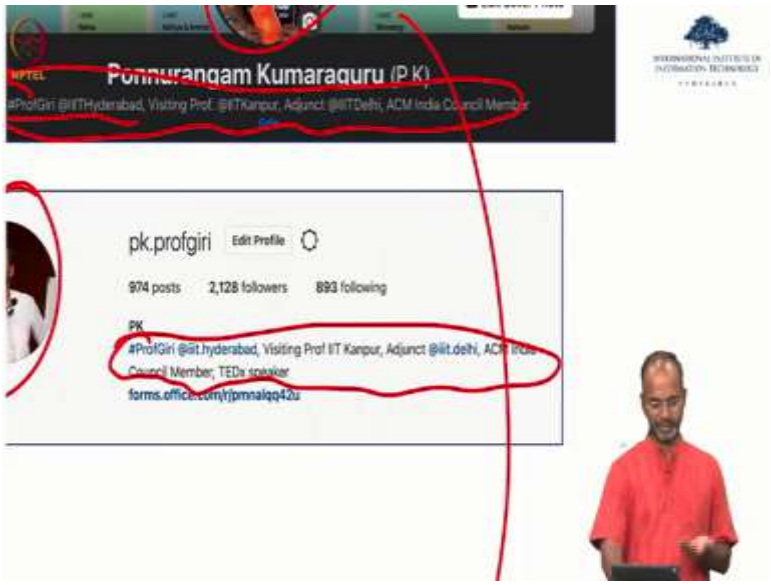
(Refer Slide Time: 23:37)




pk.profgiri
Brainstorm - Precog's Reading Boulevard
Ponnurangam Kumaraguru "PK"


You are who you know: Inferring user profiles in online social networks
Meme-tracking and the dynamics of the news cycle
Rich feature hierarchies for accurate object detection and semantic segmentation
Edit Cover
Ponnurangam Kumaraguru (P K)
#ProfGiri @IIITHyderabad, Visiting Prof. @IITKanpur, Adjunct @IIITDelhi, ACM India Council Member

pk.profgiri
Edit Profile
974 posts
2,128 followers
893 following
PK
#ProfGiri @iiit.hyderabad, Visiting Prof IIT Kanpur, Adjunct @iiit.delhi, ACM India
Council Member, TEDx speaker
forms.office.com/r/pmnaiqq42u


Ponnurangam Kumaraguru (P K)
#ProfGiri @IITHyderabad, Visiting Prof. @IITKanpur, Adjunct @IITDelhi, ACM India Council Member
pk.profgiri
Edit Profile
974 posts
2,128 followers
893 following
PK
#ProfGiri @iit.hyderabad, Visiting Prof IIT Kanpur, Adjunct @iit.delhi, ACM India
Council Member, TEDx speaker
forms.office.com/r/pmnalqq42u

Fall 2021 Schedule
Brainstorm - Precog's Reading Boulevard
Tues
17:15-18:1
24 August
31 August
7 September
21 September
28 September
Ponnurangam Kumaraguru (PK)
#ProfGiri @IIIT Hyderabad, Visiting IIT Kanpur, Adjunct IIIT Delhi
ACM India Council Member, TEDx, ACM Distinguished speaker
Alum @CarnegieMellon @SCSatCMU @bitspilaniindia
Delhi, India · Contact info
IIIT Hyderabad
Carnegie Mellon Univer

Here is my own profile. So, I am sure you can pause the video, if you want in a second and then go look at your own profiles, earlier I asked you to open the browser and do it, go to the same browser, all the tabs with your profiles, now look at your own profile. What all things that you can look at in your profile to decide, that it is the same user, or a different user. So, it becomes meaning this is feature engineering, you are looking at the context and you are saying that what features can help me make the choice, that this is the same user or different users.

Let us go through in my profile, which will help you to think about in your profile I guess. So, I can look at profile picture, you can do some matching and say that it looks probably the same user, probably a little harder in this, because the profile picture itself is different. And then I will also show you the other two platforms. So, probably maybe simpler.

So, here if you see the background image in these two, in these three Facebook, LinkedIn and twitter seems to be the same background picture, cover picture. So, to say the profile picture of these two seems to be exactly the same, probably that is the one cue that you want to keep, profile picture, covered picture of course the name and everything we already saw before, but let us do a little bit more.

So, if you look at this part let us look at this part, if you look at this part, which is it says profgiri IIT Hyderabad visiting professor ACM council member. If you look at this, it is exactly the same, some characters are not shown here, probably it is just the space constraint. If you look at this, it is exactly the same, probably it is the same here too. So, now you can look at profile

picture, cover picture, profile information itself, what have I written in my profile. So, you can use all that to figure out, that it is the same user potentially.

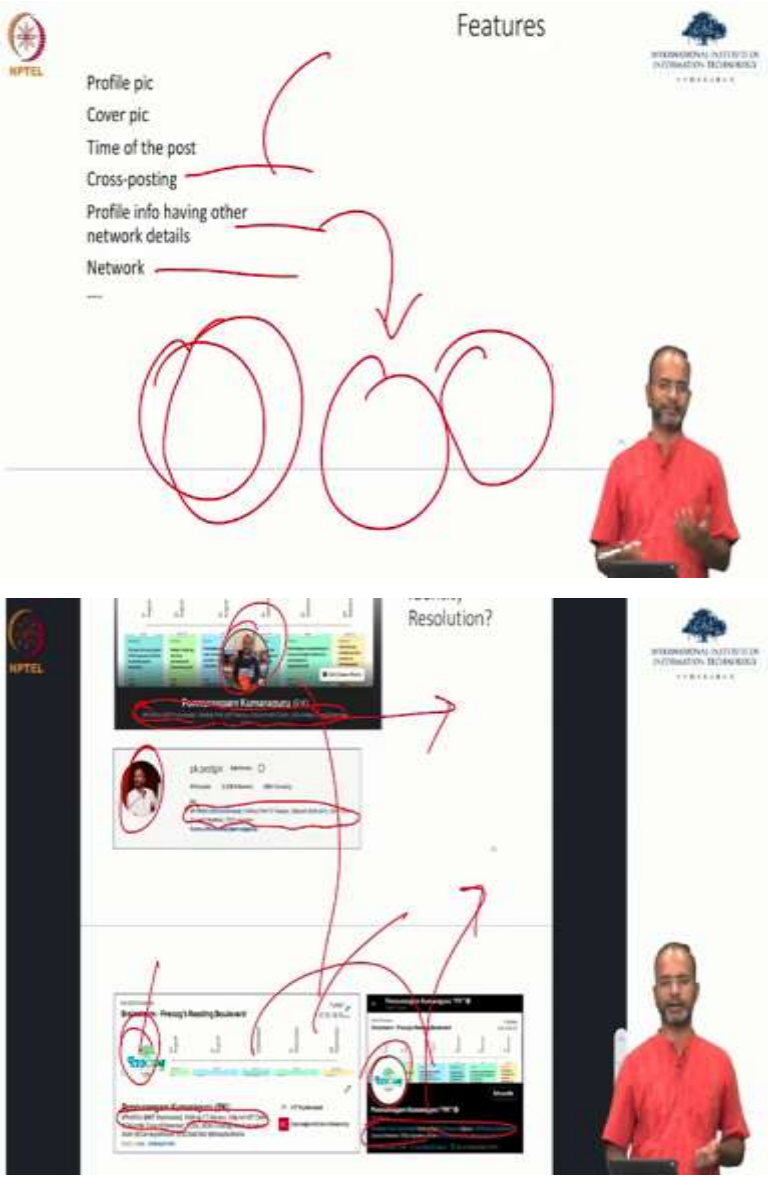
(Refer Slide Time: 26:14)

So, these are features that you can think of, these are features I am sure when you look at your own profile, you can look at them. And then think about any other interesting profiles, I am sure if you think about it for a second you can come up with many more lists, I think there are a lot more features you can use.

For example, the other very useful feature has been time of the post. When does the post come in each of the platforms? What is the post itself? I do so if you are curious to look at it, go take a look at my profile, any of the force any platforms all of them will be exactly same, for twitter I probably will cut off some characters, because of character limits. But exactly the same content, that I will post in probably a few seconds difference in time between the post, that I do.

So, which is to say that users have behavior probably I am not a representative user in this sense, which is when somebody is posting the content in multiple platforms, what is the need for it? I do not know how many people do that and I do not know how many people have the behavior of oh let us just post next to each other. But post content is definitely one of the features that has been very, very useful to decide, whether it is the same user.

(Refer Slide Time: 27:38)



I just listed the same thing here. Profile picture, cover picture, time of the post, cross- posting, profile info having another network details, I will tell you what this is, I will tell you what this is also, in a second, network also let us discuss.

Cross posting is this I take the content I do a post on twitter, I take the content from twitter and then go post it on LinkedIn, the same content. Earlier, I used to do something like a few years before a Facebook provides even now Facebook provides you a lot more storage space in terms of pictures, you can upload lot more pictures in one post also.

So, I will do let us take 50 pictures in one post, take the link from Facebook, go to a post on twitter, LinkedIn and Insta saying here are the pictures, because twitter allows me to post only 4 pictures in one post. So, therefore I kind of say that look there are more pictures of the event that I am talking about here is the link.

So, now I have cross-posted link and now there is a high probability, that you can find out that it is the same user, because when in twitter, when such posts are down it creates an FB dot me, which I will talk about it later, also FB dot me. So, now you can make some connect between the users, because of this. So, that is cross posting.

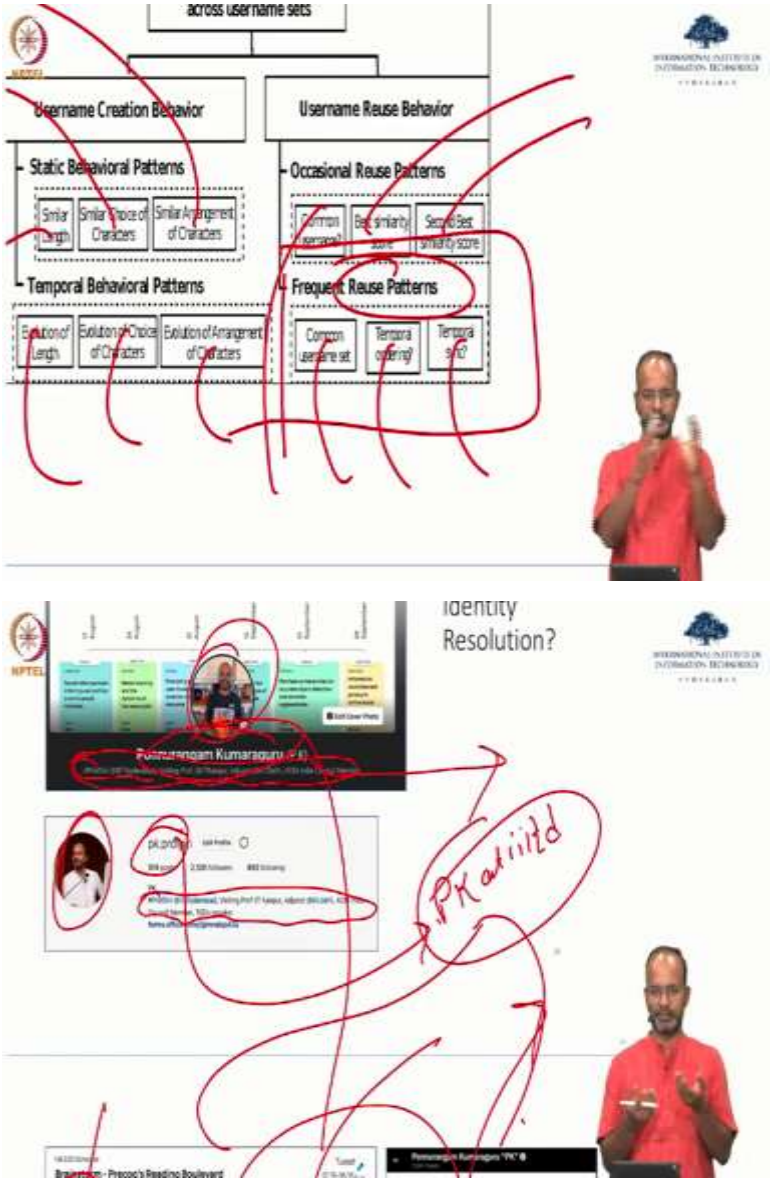
Profile info having other network details, I do not have for example, if you look at it here I do not say that what are my in Facebook I do not say my twitter handle, or in twitter I do not say my Insta handle. But you will see many, many profiles do that, which is they would go share their other platform, net profiles in this platform, put it like have your twitter handle on your Insta handle, have your Insta handle on your LinkedIn profile.

Network, network is also a good feature, which is the followers that I have on twitter, the followings that I have on twitter, how different or similar is it from LinkedIn, my connections on LinkedIn how different is it from my Facebook friends that I have, different, similar I think it is the same question asked in different ways.

So, now if the network is very similar, there is an overlap of if you take my LinkedIn, and if you take my Facebook, if the overlap is like that, there is again high chance that it is the same user, getting this data is going to be a little harder in all platforms you cannot get this details. So, conveniently, but if you get it, if you find this and for some user let us take it the overlap is like that, it is no use, probably this is of different users.

So, that is how network is useful, I am sure when you, when for students taking this class, if you think for yourself, you may have created two networks and where you have consciously kept the network far away from each other, which helps to share content differently have different kinds of conversations on these platforms, interact with different sets of people all of that also.

(Refer Slide Time: 31:09)



So, username features. So, just by username you can do a lot of interesting things, this slide is showing you what are features from the username itself you can use. Similar length, similar choices of character, similar arrangement of characters, evolution of length, as I said ponguru, IPL 2021.

So, all of that evolution of choice of characters, evolution of arrangement of characters, common user name between common username, which is IPL 2021, best similarity score again you match two different handles. Second by similar sold, common users, username set, if you look at users.

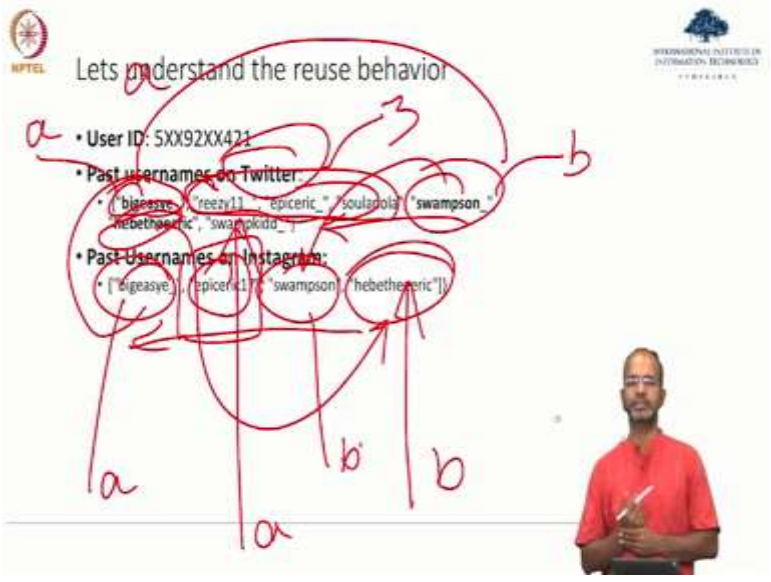
So, this is also a very interesting feature, that one can use, which is to resolve is not just the current username.

For example if you look at my handle currently, you see that this is ponguru, this is ponguru, this is pk dot profgiri, and this is ponnurangam dot kumarguru, interestingly about few months back I think in June until June my handle of Insta was pk at triple iiitd, I do not know whether this can resolve with other handles now, but if you had the access to the earlier usernames, which is not comparing only what my handle is right now.

If you compare it with the earlier user handles is it more effective. It looks like it is effective people have shown that it is effective, if you use the prior user names, that is the set what is shown here, this whole set, reuse patterns, which is I had ponguru on twitter earlier. Now, I have it is pk dot profgiri. And so now and my LinkedIn has always been ponguru.

So, when you compare current LinkedIn with current Insta handle, you are not going to get the comparison, whereas if you compare it to the earlier handles, you probably make more, I have a slide which is to show you more details, but I am just getting you the idea here. Temporal ordering, temporal sync, which is time, when did I have watch what handle can make a difference in resolving the user.

(Refer Slide Time: 33:57)



So, here is the here is a slide with some details of how the usernames are in temporarily done. So, this is twitter and so if you see the handles here, this all the handles that are in bold are the

handles that you can see in Insta also, the same order. So, first this came here, this user handles here and this is handle is here.

One question that I would like to ask you, is also is how many times have you changed any particular username in any of the platforms? I am not changed it very frequently, this is the first time I remember changing my user handle, for how long I have been using social networks. But there are people who change it very regularly, when you collect data you will see that a lot of people change their handles very frequently also, because I think there are many reasons for it.

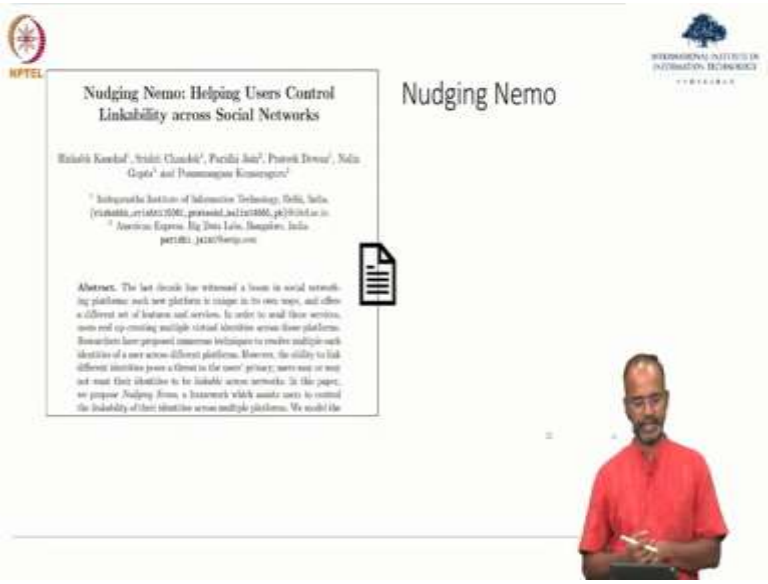
So, in this case, if you see this is the one I am saying having let us take if you were to compare this and this, let us take our snapshot of comparison is a and b, in that case, then I think the comparison is going to fail, saying that probably this looks very different. And therefore, they are not the same user, but as if you use the past, then there is this high probability, that you are going to converge that this user is the same user, because not just the same username has been kept even temporarily, it looks like the change has been the same, the order of change of this handle has been same, but in twitter there has been more additions in between the two.

For example there are three changes here, before they went from a to b, before they went from a to b, whereas here there is only one change, from a to b. Therefore, this becomes the prior username becomes much more useful in figuring out, whether it is the same user or not.

(Refer Slide Time: 36:09)

So, this is the one of the papers, so what we will do is we will go to the papers in few seconds to look at what the paper is but this is the paper that I mentioned or this is the idea that I mentioned earlier which is you do a post on Facebook, take the link from Facebook, go to a post on Twitter, it will show up as fb.me so you can figure out that there is highly likely that it is the same user it could be that you go take a Facebook link of the pictures that I posted and post it on your twitter handle still the fb.me will come and then probably in that case the resolution may be wrong.

(Refer Slide Time: 36:51)



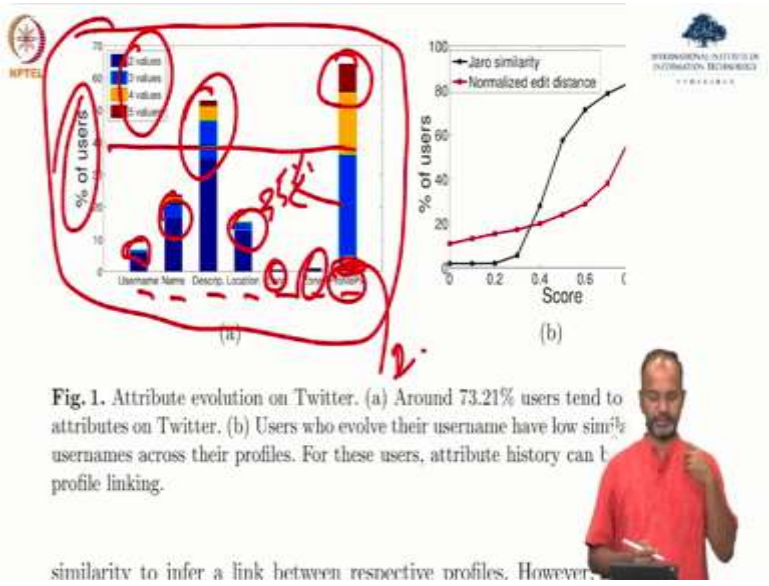
So, the next idea is continuing this idea of, now that we know resolution can be done, how to do it, what features can be used, again this is wide areas like I cannot do justice in the amount of time that we have for this class and for this topic in the course, but we will see as of now we only saw the idea of taking a user handle, comparing it with either the same handle or a different handle and figuring out what features to use to resolve that particular user.

Let us continue looking at the topic of identity resolution itself and this one is an idea about nudging users which you see when you know that your account is getting resolved can we tell you that your account is getting resolved and therefore you can change your behavior that is the idea.

(Refer Slide Time: 37:55)

Let us look at some of the related papers, so these are papers that will show up later although in the slides. So, this paper is about other times other values leveraging attribute history to link user profiles across social networks which is again building on all of this work of, what all features can you put together to resolve users.

(Refer Slide Time: 38:18)



Again we will not have time to go through all the details of all the papers but let me highlight some of it and again for the interest of for the students who are interested in, feel free to go take a look at it and I am sure you will have a lot of fun and getting more details about it. So, this graph

is a interesting one which shows that the question that I asked you, how many of you have changed, how many characters in the user profiles or what are the other details of your account you have changed this graph is showing you. The details of user name, name, description, location, language, zone and profile picture. These are the details that users can change.

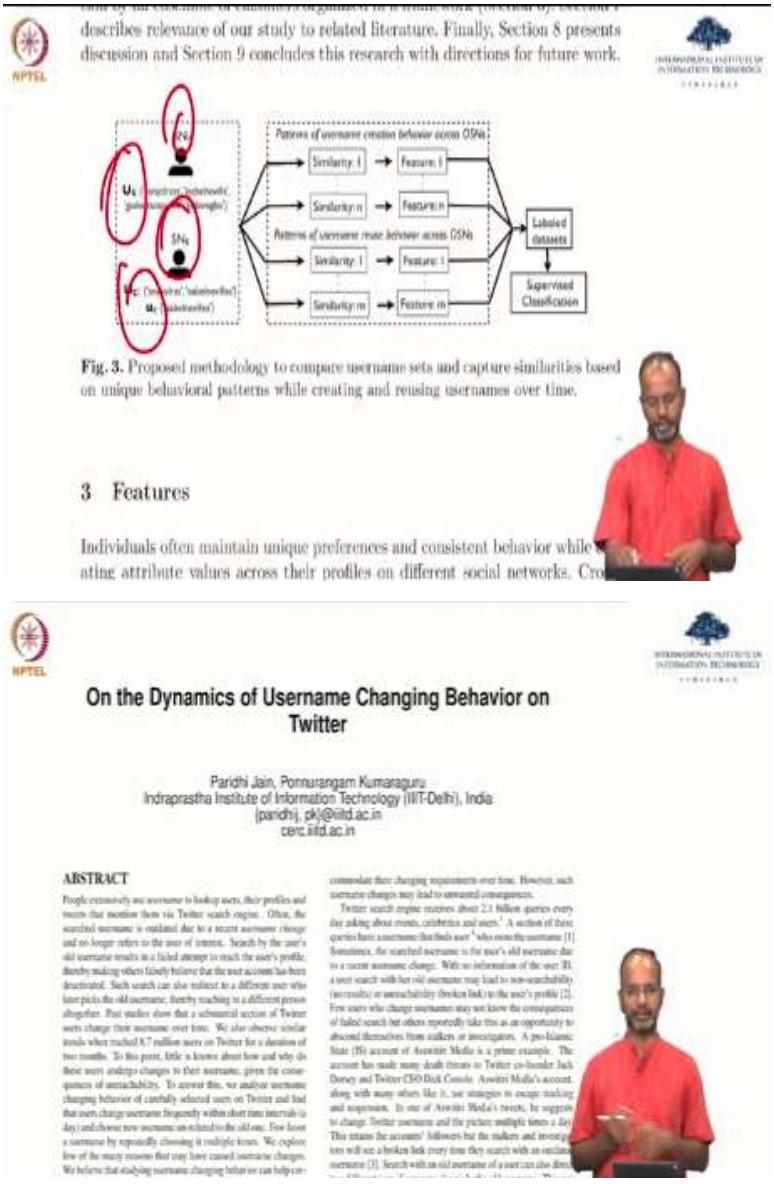
This is the percentage of users of some data that was collected. This is the number of times that feature was changed, how do you read this graph, this says that about let us take 2 percent of users here, change the profile picture twice, this one is probably 40 percent or 35 percent of users changed their profile picture 3 times in the period in which the data was collected, which also would show that profile picture has been probably about 10 percent of the users changed their profile picture five times during the time the data was collected, phenomenal, number of people who are changing their accounts.

This kind of information helps you to think about user behavior, make some, make some interesting inferences to build technologies, to build policies all that around, people have changed the username also a bit. And then, during elections if you were to draw the same graph, it would be very different because people changed a lot more times.

So, people have changed the name, people have changed their more number of times so to say, people have changed their description for example, I change my description very frequently, let us take 5, 6 times a year because something changes in the profile. So, for example I moved from IIIT Delhi to IIIT Hyderabad, I changed, I got into ACM council, I added that, all of this, you give a ted talk and then you add that, all of that edits probably is happening in the description of the profile itself.

Location, less number of people have changed, language and zone probably even lesser number of people have changed it. So, this information can be very very useful in deciding strategies for doing identity resolution.

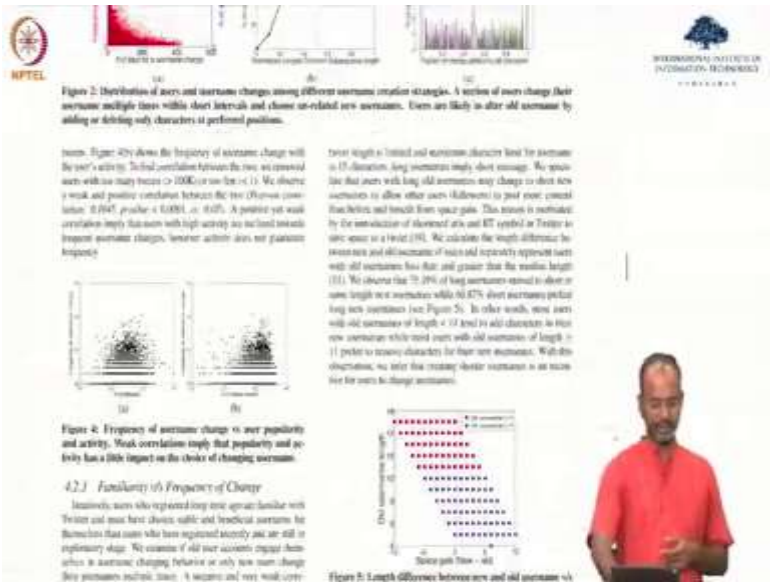
(Refer Slide Time: 41:11)



So, this one is about looking at different, so given two, so this figure is helping you to understand given two profiles what do you do to get to the whether they are the same profile or not, social network A, social network B, user here, user here, do all the similarity features that we talked about, similarity between network, similarity between the username, profile picture all of that and then figure out whether it is the same user, so yeah past information can be very useful, again comparison. So, I will let you to go through this to understand more about what is going on.

So, what I am going to do is I am going to create a webpage which I will float it for all the students where the slides in the annotated slides because I think you are getting the video here but it will also be nice for you to have the annotated slides side by side to use it wherever appropriate and I will also have all the supplementary content added to the website for each and every week, so that you can go to all these papers yourself, take a look at it.

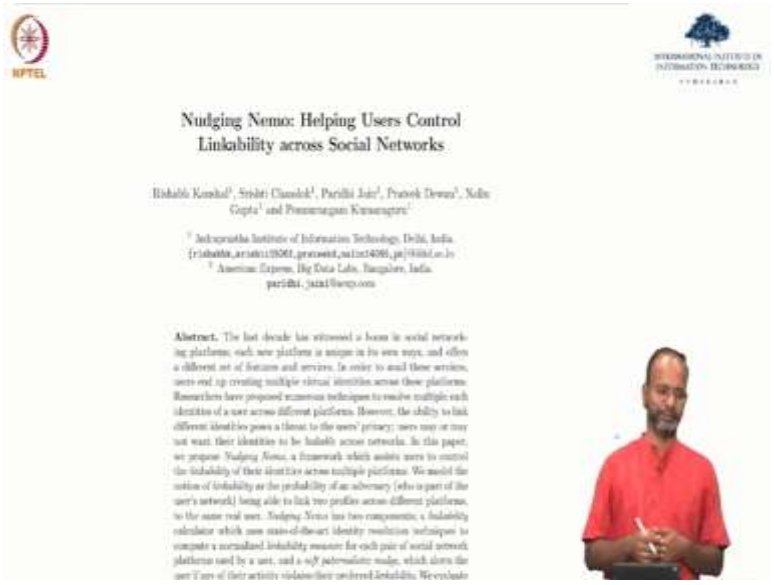
(Refer Slide Time: 42:37)



So, on the dynamics of user change behavior on twitter, this was same graph, this is the first paper which looked at the change in the user behavior of the users, we tried some interesting things also, but it was slightly harder which was, so can you let us take for example you are changing your twitter handle through our data collection we know that you are changing the username, can we go back, come back to you with let us take a tweet where you are tagged, saying look you have changed your profile username, can you fill this away and tell us why you are changing it all that.

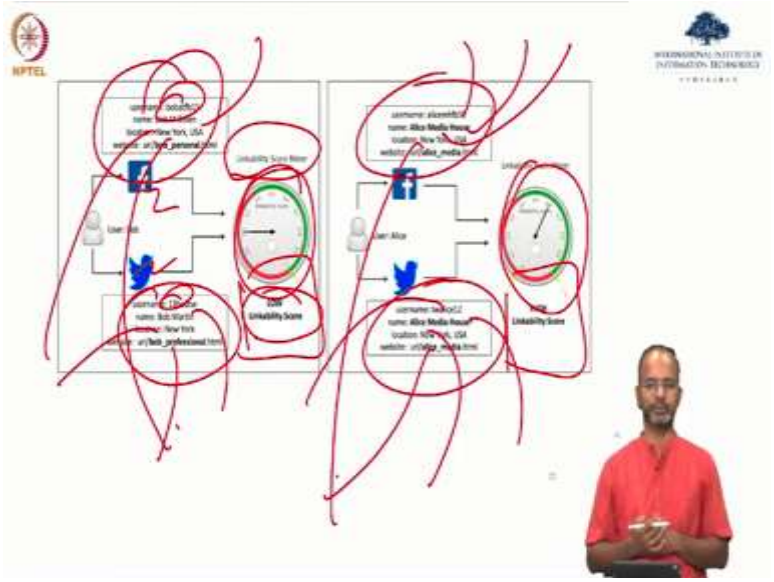
One can argue that this is also privacy, you are studying privacy and then you are going to the users and asking them probably the question is who are you to do the tracking of me to figure out when I change the user handle and why I am changing it, interesting questions there.

(Refer Slide Time: 43:42)



Nudging Nemo this is another interesting work which is to show the users, which is Nemo is the user here, can you nudge users to change the behavior? I clubbed this identity resolution and the privacy nudges together for week 4, again this nudging is an interesting topic in the context of privacy. We look at all this in the form of slides in a second, so nudging nemo, so this is about helping users to make a choice about this resolution.

(Refer Slide Time: 44:27)

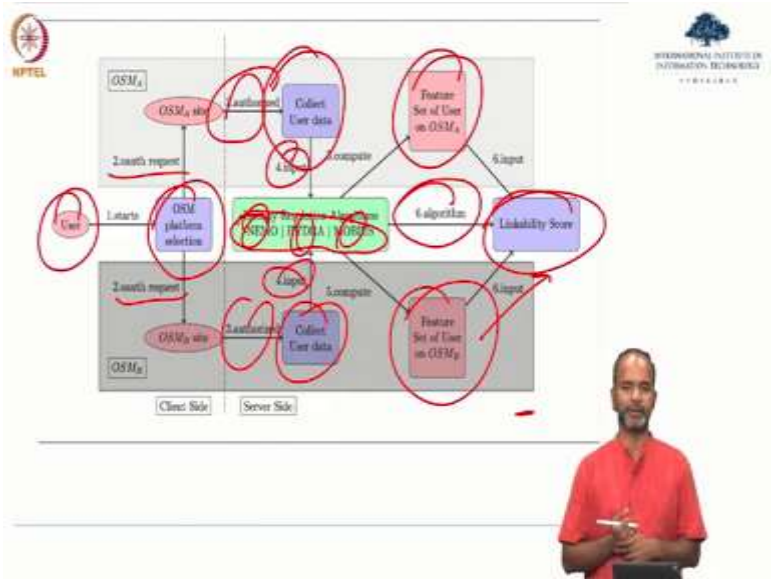


So, the idea here is look at these users details, username here, username here, username here and then some output here, your focus is here. So, for example in this case the Twitter, the Facebook

handle of the user so the linkability score meter is saying that it is slow because if you look at this username, this username and probably the name, name, location, location, url, url, it is hard to say that it is the same user,.

At least with this information that is given here compared to this user which is linkability score is high, because if you see the name which is exactly the same probably the edit distance between the username is pretty the match is very high, New York is the same and the url is also the same. So, the idea for us is to create the score now. What are ways to create the score, feature extraction we saw. But what are the ways to create these scores what we will be looking at.

(Refer Slide Time: 45:43)



So, in this case, in this figure how are we finding, so these are different methods to do the resolution nemo, hydra, mobius these are systems nemo is the one that is proposed here but hydra and mobius are the systems that is already there which does these kind of comparison of users and figure out whether it is the same user.

So, user starts over some platform selection which is I decide that I want to share my twitter and my Facebook authentication with the nemo and so it says authentication request which is for a third party which is other than you if I have to get access to your account I have to have your approval in some sense that is what is happening here.

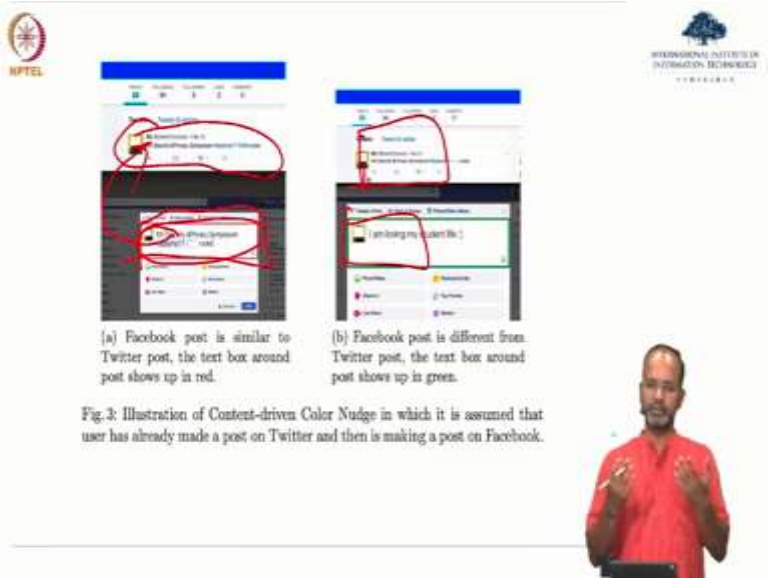
Authentication request is being done so that the app, third party app that I have built that you are using gets access to your user information. Authorization is done and then data for the user is

collected so this is an app nemo, let us assume the nemo is the app that you are downloading and using, you are authenticating nemo to go collect data on behalf of you from Facebook and twitter that is what has happened until now.

And the data is coming into nemo, hydra and mobius and then the feature selection as we saw before what I was building you to find your own features is here and then some algorithm all the methods will have different algorithms, you can say that look I do not want to look at profile picture, I want to look at network more, I do not have features of pictures and therefore, I will remove all the pictures and do the comparisons, you can do innumerable number of ways of figuring out the match.

And now then the input is given saying which features work and then the linkability score is created. So, that is what a simple system like nemo would work, how it works. Taking input, taking approval from the user, figuring out the features from the user and using that to find whether what the linkability score is, what is the probability that the users can, the handles can be linked. So, that was the architecture for finding out linkability score given to social networks.

(Refer Slide Time: 48:23)

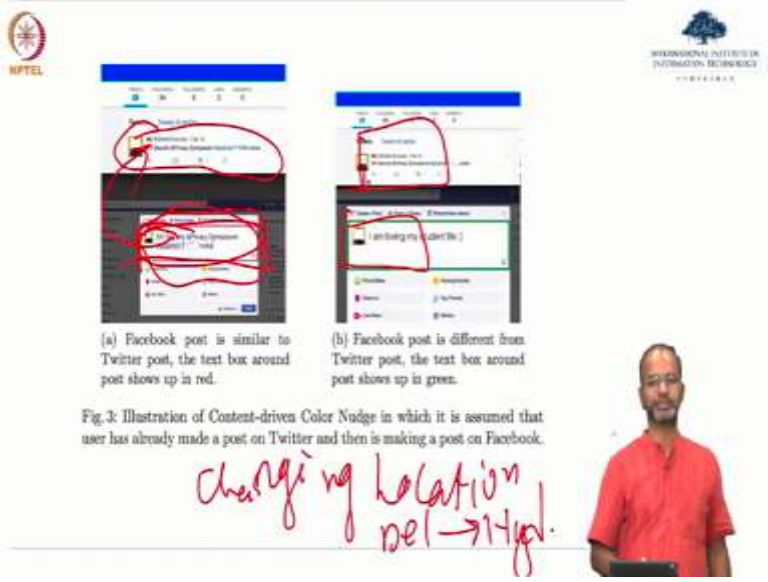


So, here is how you can present this linkability score to the user in different ways, one of the ways is presented here which is. So, this one is a Facebook post that the user is trying to do, this is already a tweet that the user has posted. Now, this post is very similar to this, so you are telling the user saying that look this post is very similar, do you still want to continue doing it, that is

why there is a red border around the text here to show that the post that you are doing on Facebook is very similar to the post that you had done on twitter, therefore, the linkability is higher do you still want to do it.

In this case, this post is very different from this post and therefore, it is green color and so the linkability is not there for the post and for the content for the time all of that, and therefore, the user can make a choice accordingly. So, this is just one mechanism by which the information about the nudge can be shown, but this much can be done in many different ways, this is only looking at posts.

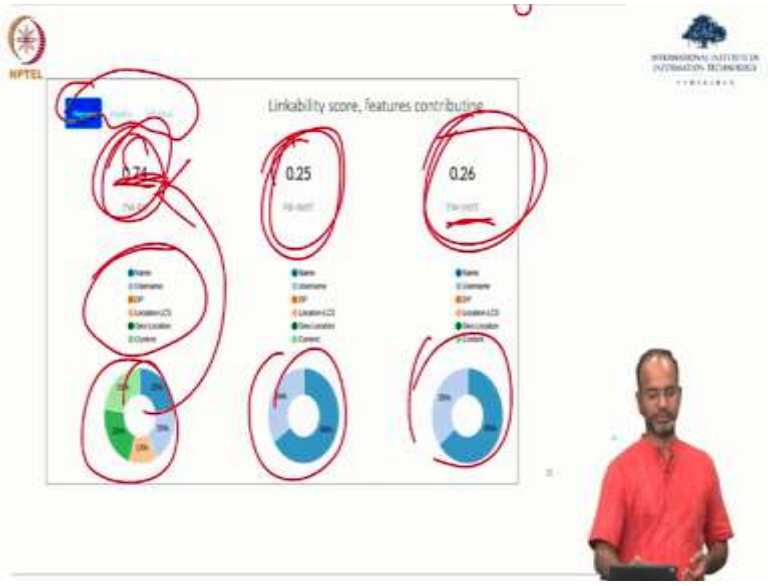
(Refer Slide Time: 49:42)

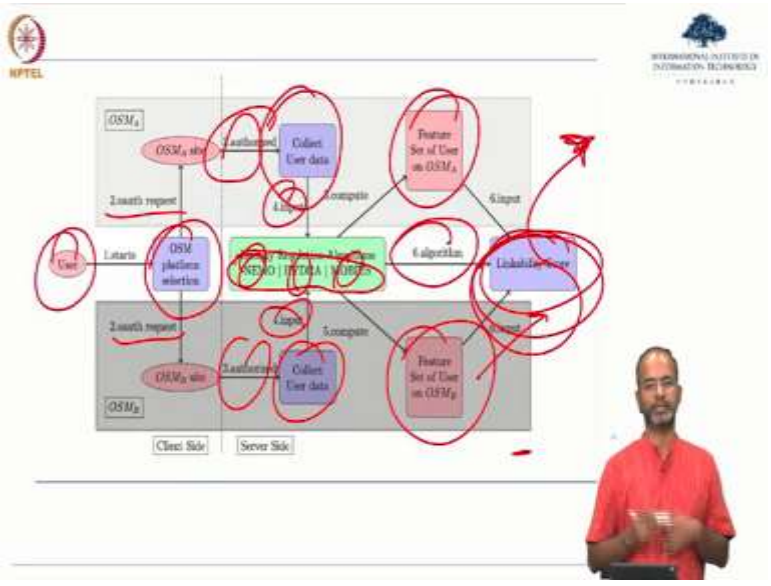


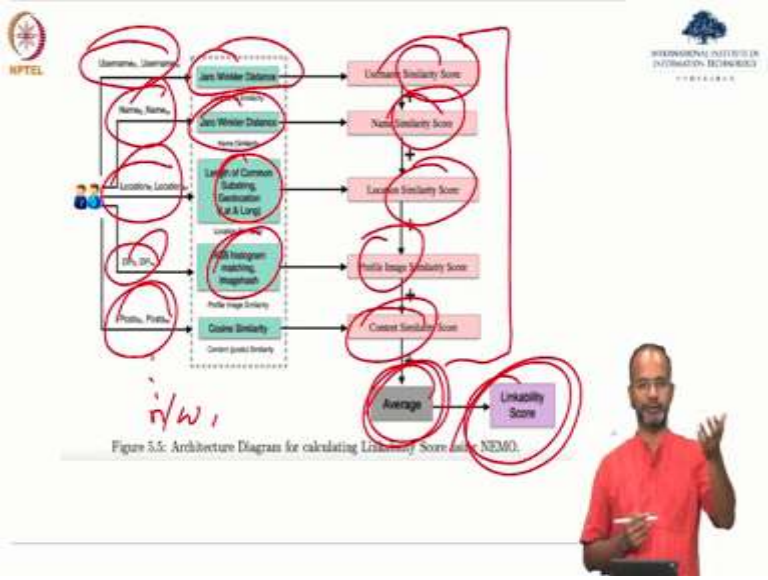
Let us take if you are going to your profile and changing the, we saw earlier changing the location from let us take in my case Delhi to Hyderabad, if I were to do that the system can also say that look you are doing it in Hyderabad, moving to Hyderabad from your other profiles also it is shown that it is in Hyderabad, now it is easier to profile that it is here, and so you make a choice whether you want to change that Hyderabad or not.

So, that is another way of presenting, another feature where you can give this nudge to the user, every update that we saw where a user can, user is doing a change in description and profile picture these kind of nudges can be done very very easily.

(Refer Slide Time: 50:31)







So, this is a dashboard which is providing information about the linkability score which can, which is basically saying the linkability score between Twitter and Facebook is 0.74 which is higher, the higher the value is the more linkable the accounts are, the lower the value is the harder the linkability is or it is hard to figure that these two profiles are same. So, it is only 0.26 between Twitter and Instagram.

And what are these? These are basically features that have contributed in figuring out that the score there and it also gives you proportion of how much those features contributed in the linkability score. So, what does this help? This helps the user to get a good view of where the linkability is possible, how much the linkability is, which features are getting contributed into the linkability score.

So, this is basically building on this architecture, getting this linkability score, how this is presented to the user is what this this chart is showing you here. This is a dashboard so again if you see this can be seen for different platforms. So, you can get a sense of through nemo how much the linkability score is and depending on that you make your choice, you as a user make your choice. That makes user more comfortable in making the choices are more informed, I think the fundamental thing that we are also looking for is informed decision making.

So, now let us look slightly delve into detail about linkability score itself, it is just representing the same content that we have already spoken or features that we have already spoken, it just gives you a few metrics that you can use to find out given the input of the features. So, this is

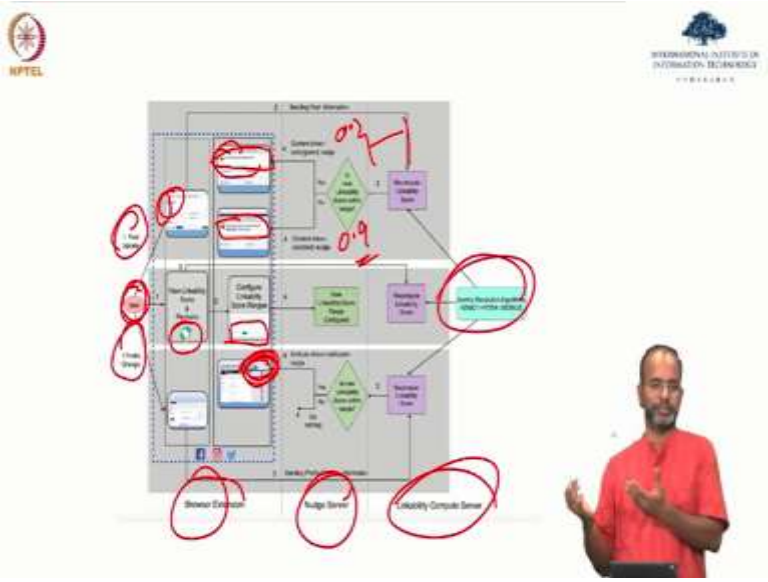
two username given you can do a Jaro Winkler Distance, simply edit distance between the two users and you can get a similarity score.

Then the name of the two (())(52:53) distance, metric and a score, two locations given. Now, you can say that you can find out substring of the locations given, can you find out the lat-long, can you reverse look up the location let us take if it says that I am from Hyderabad, can you reverse look up get a lat-long and then in the different network get the lat-long of the same user and do some comparison of the lat-long, gives do some comparison of the text let us say it is Hyderabad, Secunderabad, Cyberabad, all of that, so that is what this comparison is doing and then similarly a score can be got for a location.

This is two pictures, profile pictures taken using computer vision techniques can you find out how similar how different these pictures are, provide a score for that and use that score, profile image score, use that score for finding the linkability score. This is posts, exact post, the exact same example that I showed you here it takes the entire post and then find the distance, cosine distance between the posts that you have done in multiple platforms and use that to argue whether it is the same or different, find a score which adds to the linkability score.

So, you can get all of these similarity scores, user name, name, location, profile image, content, you can keep adding this, you can keep adding this as network many other features that we saw you can add it. And then you do some method here, here it says average but you can figure out and any function that you want to do and then a linkability score is derived. We saw 0.4, 0.5, 0.24 earlier slide, these values are derived only like that and these contributing to creating these values.

(Refer Slide Time: 54:54)



So, that should give you a sense of how the linkability score can be got, if you put all of this together into one diagram this is how it will look what I mean I will also walk you through what the diagram is and how it can be done. So, here is a user, user is trying to do a post or an update, profile change.

So, update is being done, post is done, same post if you look at it is same post that I showed you earlier it is a green color so it is different, it is a red color it is same that is the post side. So, this is the dashboard that I showed you the user can get access to the dashboard and then using the dashboard they can also see that the 0.74, 0.24 values in the browser so they can make a choice of how linkable the profile is.

Profile image being changed, profile being changed and then here there is an information about the Hyderabad, Delhi example that I gave, somebody is changing your profile information from Delhi to Hyderabad you are nudging the user saying look this can increase the linkability.

So, then of course, all of these distances are made with a threshold, you want to make a meaning, for me the linkability score 0.9 is also there do not bother I do not really care let the resolution happen but for some people it could be just 0.2 this is the same thing as spectrum that I mentioned earlier.

Depending on the threshold you make a choice saying that look this is above the threshold, lower the threshold all of that. I hope that makes sense in terms of three different components of the

decision making itself, this is the browser extension, this is the server which is making all the choices, this is the linkability score, computing and presenting the values and of course the nemo, hydra and mobius are all of them use the same kind of architecture to decide the score.

(Refer Slide Time: 57:09)

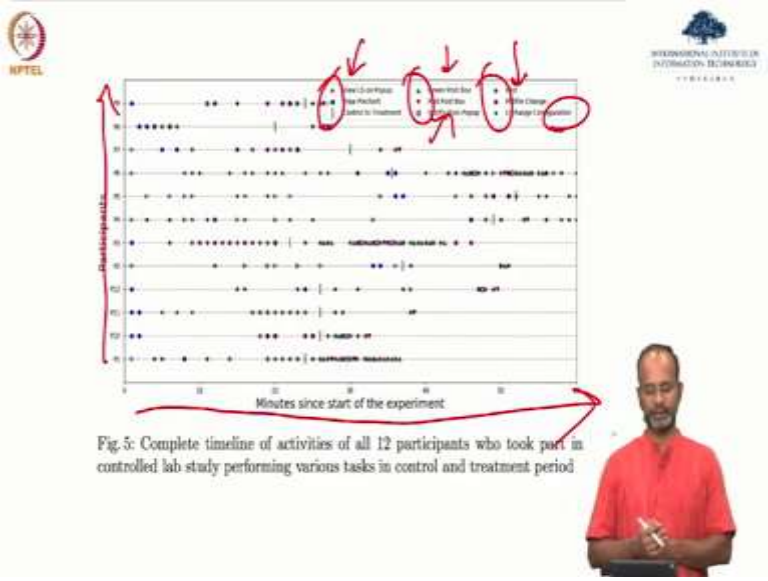
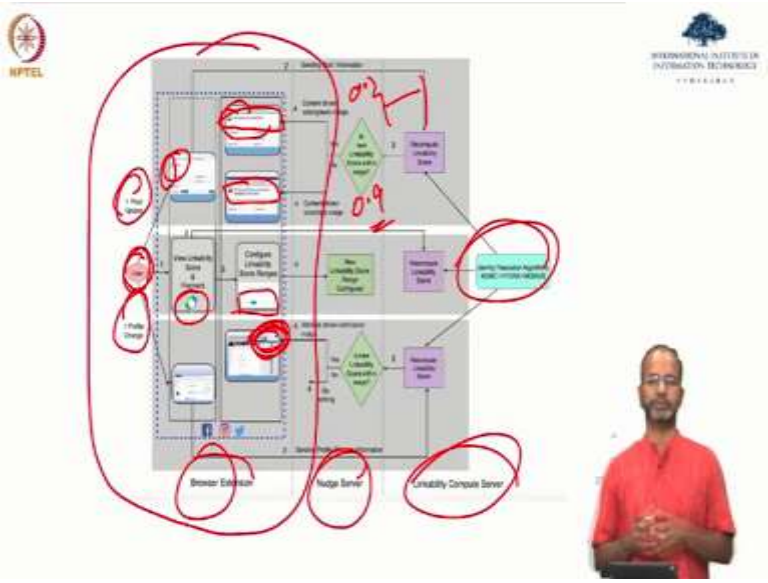


Fig. 5: Complete timeline of activities of all 12 participants who took part in controlled lab study performing various tasks in control and treatment period

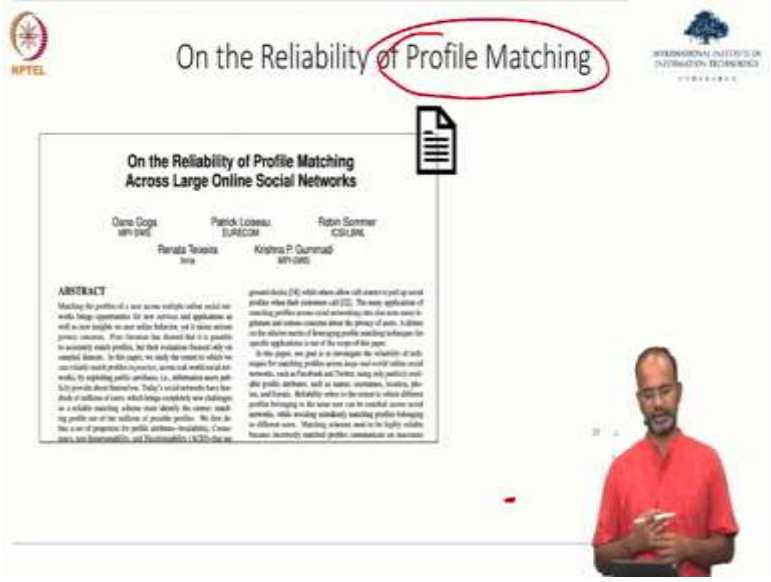


So, this is an experiment that was done to show that the nudging is working, nudging helping users to make the choice all of that this is 12 participants the way to look at this graph is so you look at all the participants here, this is the time, minutes in start of the experiment, these are the different activities that was done.

So, for example post, profile change, configuration changes, then green post box which is when the comparison was similar, a red post box, notification pop-up that is presented to the user and the user went and saw the pie chart. So, everything that I showed you here is captured. So, now what can you do using that you can argue that look the users end up if you look at the chart there are people who are going and changing their, deciding to change the post, deciding to change the profile, deciding to change the profile picture all of that depending on the nudge that the nemo is providing them.

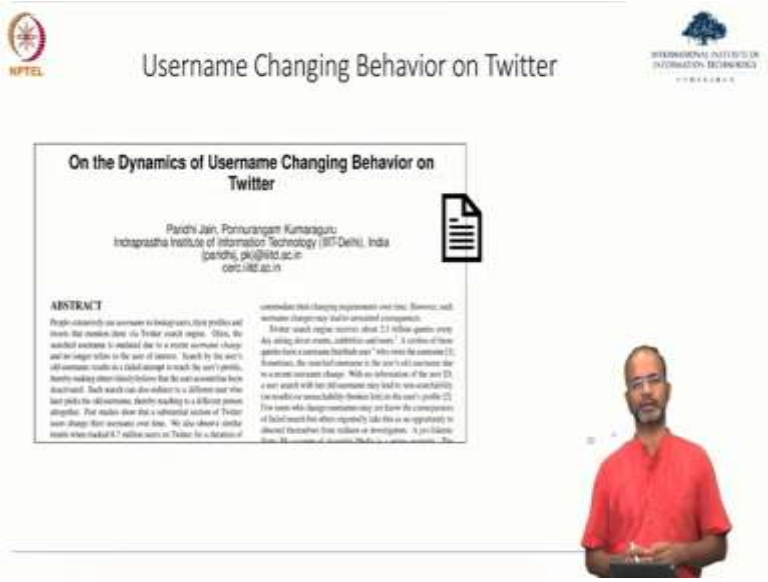
The argument is that such a nudge will help users make better choices, such a nudge will help user behavior change and which is probably more keeping in mind the linkability score of the user itself.

(Refer Slide Time: 58:40)



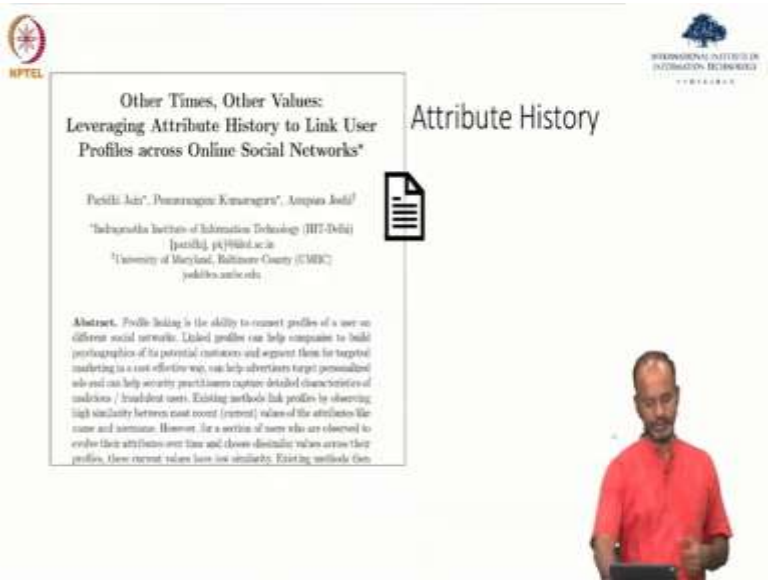
Moving on with the identity resolution some of the research work done on the reliability of profile matching. Since you remember I said the different words for identity resolution itself earlier, so profile matching is one idea where people had worked, this work was one of the initial works to look at this on social networks.

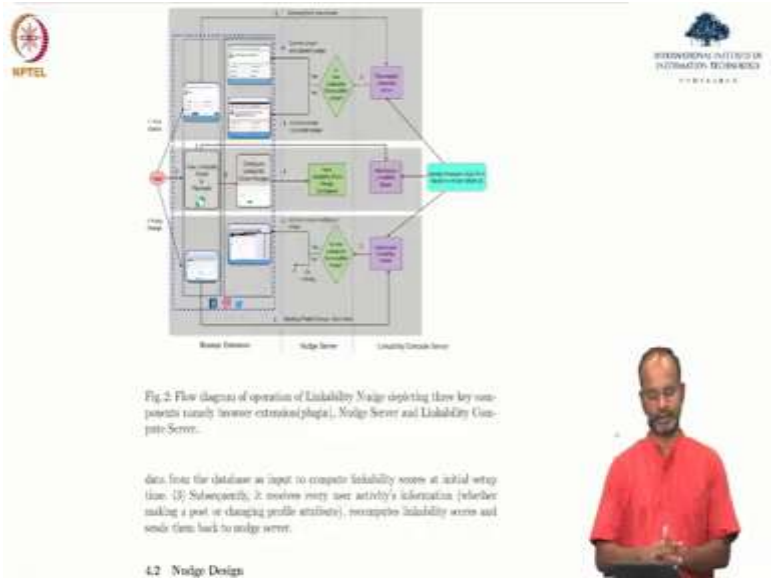
(Refer Slide Time: 59:02)



So, this work is based on the username changing so which is the one that I told you earlier Punguru to Prof Giri, can you use the earlier part of the username change whatever usernames that users had to make a choice whether the user that you are comparing is the same or different.

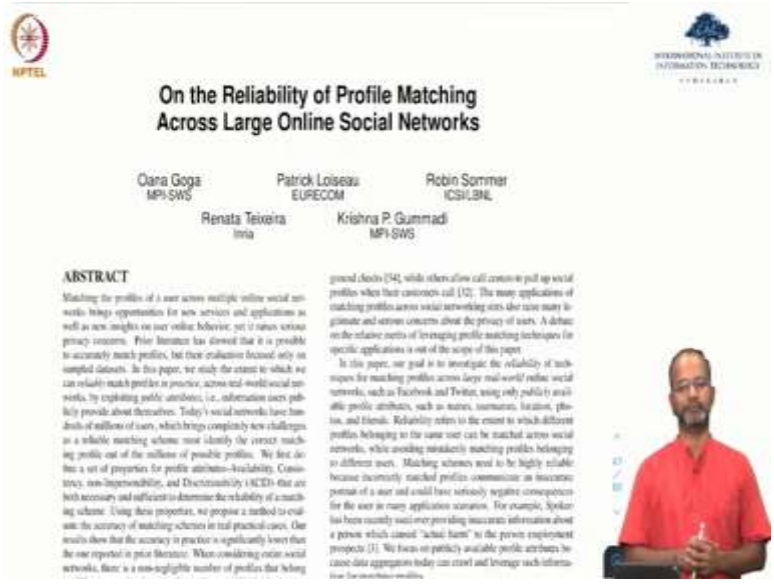
(Refer Slide Time: 59:24)





This paper I already showed you. Let me go through the papers again before we finish, so this is the architecture that I already showed you in detail. So, this paper walks you through more details about every image that I showed you walking through the different parts of the linkability.

(Refer Slide Time: 59:46)



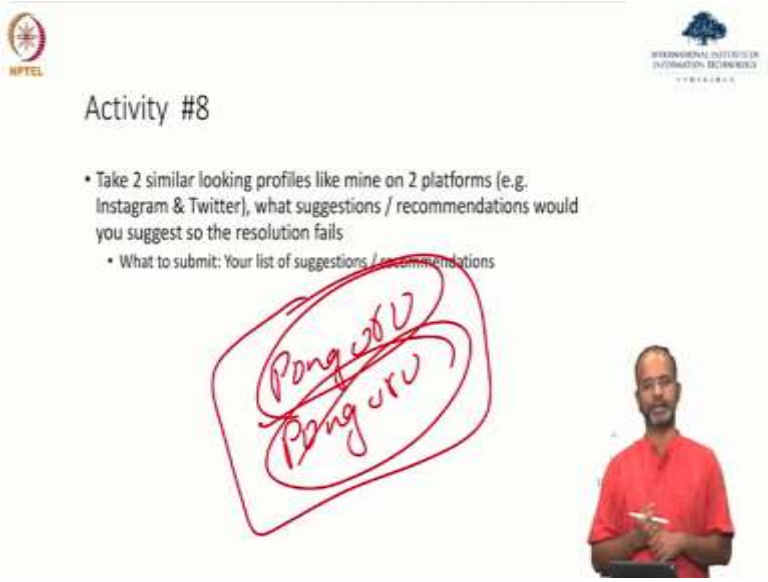
This is the paper I would refer now on the reliability of profile matching across large social networks deciding on linkability again, they gave some mathematical foundation for how the linkability should be done, everything.

(Refer Slide Time: 60:02)

And this is the Facebook and the Twitter comparison paper that I mentioned in the slides using the Facebook post. Even today if you look at the post let us take if you are listening in music on Spotify and you want to share it on twitter you click a button share it on social and it gets posted on twitter. The link in twitter will be same as open.spotify.com for all posts that you are doing from Spotify to, from twitter to, sorry, from Spotify to twitter.

So, if you do that now any analysis that you could do on Spotify could be easily done collecting data from twitter. So, that is the idea here, some of these things we already discussed in terms of how the profile matching should be done, what metrics to use and why people are changing the usernames all that. So, that gives you a sense of what the identity resolution some of the workers.

(Refer Slide Time: 61:13)



Here is my activity for this week, one of the activity, one part of the activity for this week. Take two similar looking profiles like mine on platforms, example Insta, Twitter, LinkedIn, Facebook, all of that, do not take mine please take somebody else's. What suggestions or recommendations would you suggest, so the resolution fails which is in my case Punguru in Twitter, Punguru in LinkedIn, same profile picture all of that.

What would you suggest PK to do so that this resolution when any techniques are applied the resolution should fail. We have already discussed some of them I hope you can put them together and share it on the mailing list we can take a look at it, I hope you will come up with some interesting ideas.

So, that wraps up the identity resolution part which is essentially the idea for figuring out given two users can you identify whether they are the same user which has many different applications. So, we will stop here with the identity resolution and we will continue with privacy nudges.