Affective Computing
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Week - 03
Lecture - 02
Part - 2
Experimentation Methodology

Hello friends. So, let us look at now at the Experimental Methodology in which you will learn how to design the experiments using which we can collect the data and we can annotate the data. And, we can possibly use all the effective computing methods to understand how to what are the emotions and how to make use of that to make use to develop emotionally intelligent machines and services perfect.

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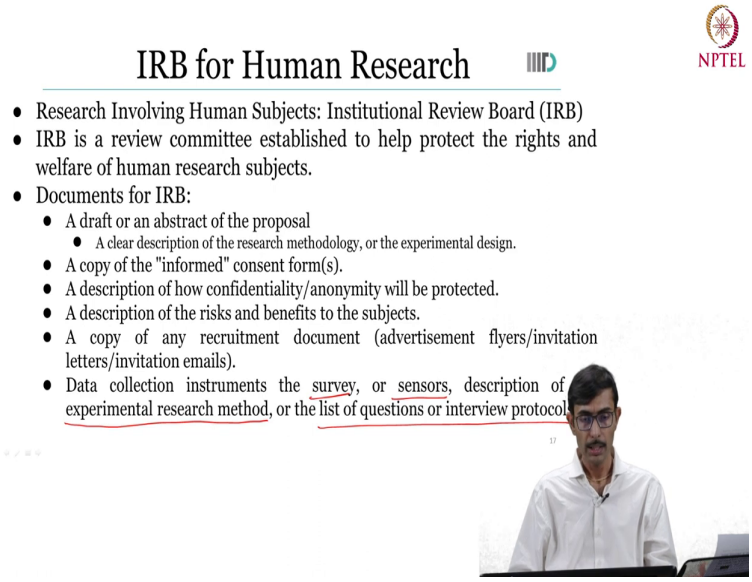

So, let us just dive in ok. So, first thing first whenever we are involving research around humans, we have to take care of the their rights and the welfare of the human research subjects. And, to do so, precisely we have a committee in place which is known as the institutional review board. Now, depending upon the institution administrative hierarchy and logistics, you may or may not have the committee with the same name.

But, please take my advice on it whenever you are planning to do some experiments around the humans, please approach that your head of the organization, head of the department in your company in your institution. And, check with them that if there is any institutional review board with that is already in place. If not then, please ask them to help you out on how to proceed further this approval.

And so, that you can get this approval for the experiment that you are trying to do. Now, this IRB there is a reason that IRB is there in all the institutions and it takes care of as I said the rights and the welfare of the human research subjects. Because of course, what we want to do we do not want to just make use of the humans in the way that we want and all the data that we are collecting it has to be ethical and of course, it has to be valid data and it has to be done in an ethical fashion right.

So, without of course, to cover the entire spectrum of the IRBs out of the course out of the scope of this course, but nevertheless I will touch upon some points that what are the documents that you will have to prepare and maybe what exactly they need in that document. And, this is something that you must have and must submitted have must have submitted to the IRB.

So, first thing first for the first you of course, need a draft or an abstract for the proposal ok. And, in the draft or the abstract for the proposal basically what you have you may have of course, a clear description of the research methodology that what exactly is the sub hub for example, what exactly is the type of the data that you are interested in, what is the type of the stimulus that you are going to use.

And, how you are going to recruit the participants and the design of your experiments, the experiment lab conditions and so on so forth right. So, basically this is a draft or the abstract. This is a very important thing, you need to also have and prepare a informed consent form right. So, basically the informed consent form is what?

This is a form that you must present and get an approval from the all the participants, that are participating in your experiments which says that ok here I hereby provide my consent to participate in the study under these, these, these conditions and circumstances right.

So, this is a fairly detailed form maybe up to one page or two page form that you need to create. There are lots of templates that you can find online and there are lots of guidelines from the APA and similar agencies and you can use those guidelines to create the informed consent forms which must be part of the your IRB application packet.

Third thing of course, you know when you are preparing this draft or the abstract for the proposal, it needs to have a dedicated paragraph on how exactly you are going to protect the confidentiality and the anonymity of the participants as well as maybe the privacy of the data as well right.

So, basically anonymity has to be protected for all the participants. And to do so, maybe you would like to adhere to certain guidelines, IT related guidelines for example, that are there from the Government of India or from the international bodies right. So, this is something that you must spend some time and decide that how exactly this will be done. And, you must convince the committee that ok your design is going to take care of the privacy of the data and the anonymity of the users.

Of course, other thing that you would like to describe is there any risk associated with the experiment that you are going to do. For example, may be the type of the images that you are going to show to the participants, that type of the videos that you are going to show the to the participants or maybe the type of the posture that you are going to ask the participants to do.

Maybe not very comfortable, may induce certain negative emotions and may have some psychological effects afterwards right.

So, all these things you need to clearly understand and accordingly you need to provide a detailed description of the risks that are there. And of course, accordingly maybe what are some of the benefits of to the subjects of course, maybe you know some positive emotions if you are reducing, what is going to be the benefit of that. What is going to be the benefit of the data itself that you are collecting or the experiment that you are doing in general and so on so forth.

Other thing of course, that is very important is the how exactly are you going to recruit the participants right. So, basically for the participant recruitment maybe you are going to prepare some advertisement flyers, some invitation letters, some mails, maybe you are going to make a post on the social media. Whatever method that you decide that ok, this is the method that I am going to use to contact the participants, you need to provide a copy of that particular data to the IRB committee as well right perfect.

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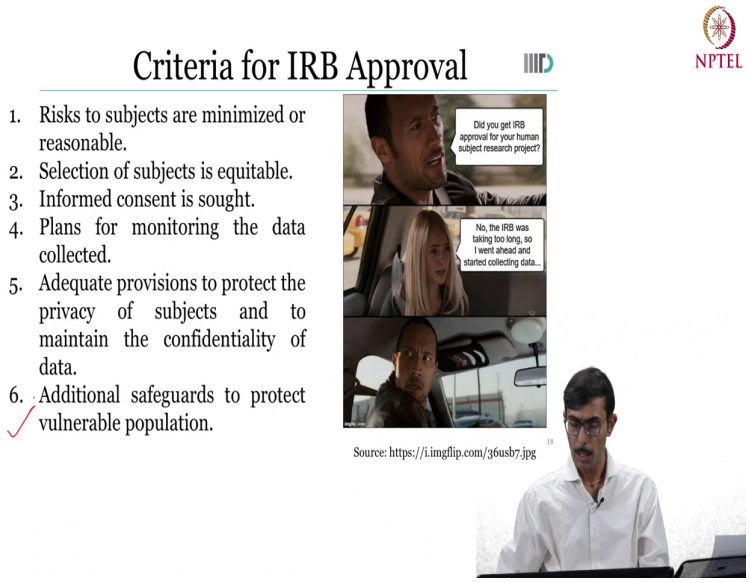

So, now other thing that you may want to look into the what are the data collection instruments that you are going to use to collect the data from the participants. So, for example, when I say the data collection instruments it consist of so many different things. Of course, it consist of the surveys, the questionnaires that you may want to use to assess the ground truth.

Of course, it is going to consist from time to time the sensors for example, the hardware devices; sorry the hardware devices that you are going to use to collect the data such as the audio-visual maybe a webcam, maybe a physiological sensor, maybe a sensor to collect the brain signals and so on so forth right.

And of course, a description of the experimental research method so, basically what exactly will be the research method that you are going to use and what is the analysis method; maybe

you are going to do certain quantitative analysis, certain qualitative analysis. So, of course, all these are you know discussion of exact those things are bit out of the scope of this course, but I am just mentioning the keywords.

So, that you know you can go and look at it some of you may be already familiar with all those things, but you may want to look into this. So, that you can prepare a nice proposal before even start collection of the data right. And, similarly if you are going to use some questionnaire or if you are going to conduct some interviews, then what are the protocols for the interview, what are the questionnaires that you are what are the questions that you are going to use.

And, similarly you know if you are going to conduct some focus group discussions, then what is going to do the format of that and so on so forth right. So, basically you have to understand that this these documents or these things are not only there for you to submit to the IRB. But, also if you look at all these things together collectively they will help you in understanding and developing your research proposal, your research methodology in a bit better way right.

And, then at the end it will help you to collect the data in a better way in and then you will be able to use that data effectively afterwards right perfect. So, on the right side you have a bit of theme which is very very common scenario especially when you do the research around the human subjects.

So, you prepare the IRB approval documents some many times, you submit it, but you never wait for the IRB approval to arrive and you start collecting the data. So, please do not do that, that is not ethical, that is not acceptable. So, you have to wait to get the IRB approval in order to begin the data collection right. So, and you have to of course, maybe you want to have a discussion with the IRB committee that you know like how should I proceed about it.

If you there is a way that you can expedite the process and so on so forth. But, please do not do this thing that do not wait, do not just start collection of the data or do not collect the data or conduct the experiments without the IRB approval. Now, quickly speaking like there are the five six different things not of course, not an exhaustive list that the IRB committee would

like to look into and would like to ensure in order to approve the your research method that you have designed right.

So, of course, first thing that you would like to look at that whether the risk that you are describing are to the subjects it has to be minimized. And, if not minimized, then at least it has to be reasonable in relation to the anticipated benefits of the study itself right. So, they would like to look at the importance of the knowledge that you are planning to generate in the result.

And, maybe if the risks are higher in relation to the let us say the knowledge that you are planning to generate, then maybe the IRB committee would not be very happy about it and may not provide the approval for it. Of course, the selection of the subjects has to be equitable.

The IRB committee would like to look at that there is going to be no bias, no prejudices while doing the selection of the subjects. And, this is something that you have to ensure as well while doing the recruitment of the participants. As I said before, informed consent has to be sought from each and every single participant. In case the participant is minor, you may want to consult the guardian of the or the parent of the participants.

And, maybe you want to discuss with the IRB committee that if the participant is a minor, what should I do and how should I proceed. Now, the IRB approval committee would also like to look into you know like how what are the different plans in which you are going to monitor the data collection. And, then how you are going to ensure the privacy and as I said the confidentiality of the data and of course, the anonymity of the subject.

So, these are some very very important points and then on the top of it of course, you know if you are conducting some experiments with the vulnerable population. So, as to say let us say children, minors, many times you know for example, individuals with intellectual or certain type of behavioral disorders so on so forth. So, then you may want to put some additional

safeguards to ensure that there are no additional harms for this particular type of population right perfect.

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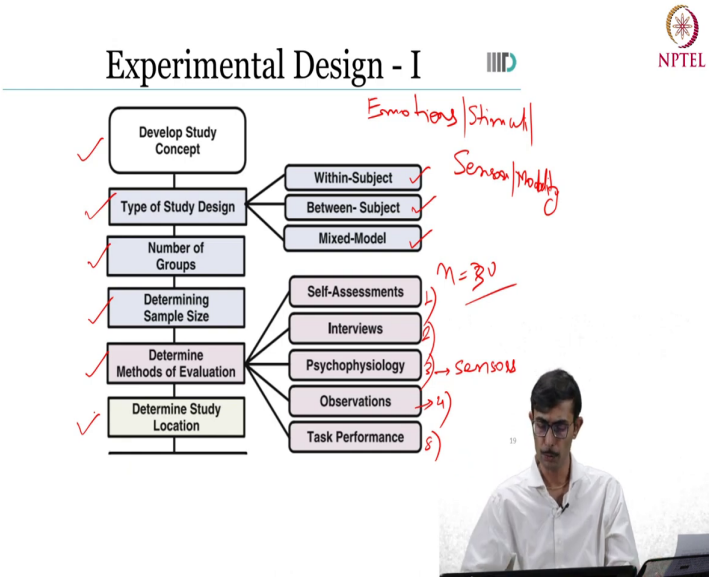

So, enough about the IRB approval. Now, we have already obtained our IRB approval, now we are ready to dive in and start doing the experiments. In order to do so of course, this is a very simple chart that is there which helps you to understand what are the different things that you need to do in the order right.

Of course, the very first thing you need to develop the study concept. You may want to understand what type of emotions I am trying to study, what is going to be the type of the stimulus that I am going to look into. So, maybe roughly I am going to put here. So, for example, you know you may want to look into what is the different type of emotions that you want to study.

Once you have understood the different types of emotions, you may want to study look into like ok what is the different types of stimuli that you may want to use. Once you have understood the stimuli, maybe what is the different types of sensors or modalities using which you are going to collect the data.

And, then of course so on so forth then you want to understand the setup of the experiment and all that right. So, this is what comes under the development of the study concept. Once you have done this, then there is something known as study design. Now, some of you may be already familiar with the study design and those who are not familiar with this thing, quickly speaking there are three different types of study design that you can do.

One is the within subject design, other is the between subject design and then there is a mixed model design. Without speaking too much, as I said like all these are bit outside of the scope of the course. Nevertheless, I want to touch upon these things so, that you do not feel completely unfamiliar about this and more importantly I would invite the interested readers and the audience to explore more about this.

So, for example, the within subject design as the name itself suggests; so, within subject design is the design in which you make use of the same participants to study different conditions of the experiment. So, for example, you may want to understand that how the participant respond to emotions in VR versus how the participant respond to the emotions in computer settings for example, right.

So, there are different groups that you have created. Now, you may want to put the same set of users in the VR and then you may want to use the same set of users in the computer system as well and see how they are responding to the emotions, that is what is known as the within subject design.

Now, the between subject design is just opposite of this. In the between subject design what you want to do? You want to put one set of users in the VR experiments, you want to put other set of users in the PC experiment design right. So, these are there are different groups,

there are different set of users and that is how you want to conduct the understand the effects and analyze the effects of this thing, that is what is the between subject design.

And, when you do a mix of within and the between subject, that is what is known as the mixed model design. So, please go ahead and I would invite you to please explore more about it and see the pros and the cons. Now, which is the best design for a study? That depends on so many different things right. So, there is no short answer to it of course, you will have to look into it.

Long story short, if you are going for the within subject design as you can very easily imagine, within subject design you will need less number of participants, for the between subject design you will need more number of participants. The duration for the experiments for the between subject design is going to be shorter in comparison to the session for the within subject design so and so on so forth.

So, there are so, many different things you may want to look into this further. Accordingly, the next thing that you want to do is like you understand how many different groups are going to be there. Now, the number of groups usually speaking there are like you know you can have for example, two groups. One you can have a control group, one you can call it as a treatment group.

So, control group is basically where you may want to induce you want to understand the effects of a motion in a particular setting. And, then you want to understand when the emotions are not elicited in that particular setting for example. So, there is one control group, there is one treatment group.

And so, basically this also depends on what are the different variables, how many different independent variables that you want to analyze in that particular setting right. And, once you have decided the type of the study design, the number of groups then that is very very important to determine the sample size.

So, when we say the sample size, it simply means the number of; the number of participants that are going to be there in the group that you are envisioning. So, then again there are so many different rules and ways to understand what should be the exact ideal sample size. And, long story short especially talking from the perspective of the statistics and machine learning, you never get enough samples right.

The large the larger the sample size, the larger the number of participants the better it is. But then of course, depending upon the resources, depending upon the time that you have at hand and so many different things, you may want to have a feasible sample size and that may depend on the study. So, usually there is a thumb rule which says that you know for study of one particular variable, you may want to have let us say some sample size which is going to be something which is equal to be equal to the n is equal to 30.

So, 30 participants like for one particular group is ideally is frankly speaking is a good number is a thumb rule that we usually use. Nevertheless, there are different ways to calculate the sample size for a particular study and to understand its power perfect. So, we know how to we have designed our we have develop the study concept. We know what are the different types of design, we already know what are the different number of groups, we already know what is the sample size.

Next quickly speaking this is very very important, you want to determine the methods of the evaluation. Now, when I say the determine the methods of the evaluation, you want to understand that what how exactly you are going to collect the emotion expression of the emotions. Now, to collect the expression of the emotions there are so many ways and roughly they can be divided into five different categories.

So, for example 1, category is the self-assessment category, is as simple as that you showed an image to the participant and you simply ask the participant after showing the image ok; what was the how did you felt after looking at the image? Or, you simply presented a video clip to the participant and at the end of the video clip you ask ok; how did you feel about the this particular video clip? What was the emotion that you felt?

And so, there are different ways in which you can ask the question that the participant about the emotions that the participant is feeling. So, this is known as the self-assessment. You want the participant himself or herself to answer that what was the emotions that they felt and what was the intensity maybe as well. Second thing rather than asking them directly that what did you felt and then not, maybe you want to conduct certain interviews right.

So, maybe at the end you showed them certain number of clips and then at the end you want to conduct an interview. And, then its more informal setting where you want to understand that in general how did you felt and you want to deduce from that what exactly was the emotions that was prevalence throughout the experiment.

Third which is really interesting is the psycho physiology, you may want to understand what is the you may want to maybe you want to understand that ok while going through this particular condition one particular condition let us say, how the emotions were being expressed in the brain signals for example. So, that is where you know you may want to look at the easy signals and that is where; that is where you want to look at the psycho physiology of the participants.

And of course, to do that you will have to have some sensors in place and using that sensors you will have to collect a particular modality which could be brain signals which could be heart rate as simple as that which could be your skin conductance which could be so many different things right. There are lots of physiological signals that you may want to look into.

So, that is of course, in order to do so, you will need certain sensors or some certain external hardware many a times. Observations is as simple as that you know; so, in the observations you are neither asking the participant, you are not making use of any let us say sensors to collect the physiological signals, but rather you are simply observing the entire video maybe.

So, for example, you presented some certain images to the participants, you are recording the entire thing and at the end of it maybe you are just looking at the entire recording, you or maybe you appointed some experts. Let us say some psychologist, some psychiatrist who is

looking at the entire video and after looking while looking at the video, the expert or the you are making some annotations and saying ok this is how maybe the user felt and this is how the participant felt at this particular point of time.

And, an accordingly you are getting the what we call it as a ground perfect; so, this is the fourth method. Now, 5th method is again is known as the task performance. So, this is more commonly also known as the behavioral data. So, basically what you are going what you are doing? You were you will be looking at the behavioral performance of the user while the user is doing something.

So, imagine that you are just the user is performing a particular task, maybe you ask the user to look at certain images, look at certain video clips, look at a music. And, while the user is looking at the music, maybe you wanted to understand ok; when the user is exposed to a positive music whether the performance of the user in solving arithmetic problems has improved or not for example, a very interesting question right.

So, you may want to simply say you need not to ask any question here to the user. You are simply putting a positive music and you are asking the user to do some arithmetic problems right. And, at the same time maybe you are putting some negative music and you are asking the users to solve certain arithmetic problems.

Now, depending upon the number of correct answers, that the user got at the end of this experiment, you may simply use that to say that ok what was the performance of the user. And, that is what you are going to use as the ground truth to analyze that what type of effect, the positive music had and what type of the effect the negative music had for example, right. So, that is one particular way to get the ground truth from the users, perfect.

So, having determined the method of the evaluation and an any particular experiment, you may want to use a mix of all these five. You may want to use one only, you may want to use two only, three only or any mix of these different five categories of the evaluation or

obtaining the ground truth. Having determined the method of the evolution, you may want to quickly look at them location of the study as well.

Many times you may want to conduct the experiment in a more lab like settings where you the conditions are more under your control. And, you can precisely put the user in a place, you can precisely put the stimulus on a particular screen. You can control the lighting for example, that is there, you can control maybe the noise that is there and so on so forth including the temperature of the room and many different things right.

Or, maybe you want to decide that ok you want to collect the data in a more natural setting, you may want to put the user in a park in like an outside space and you may want to observe everything in a bit more the naturalistic settings.

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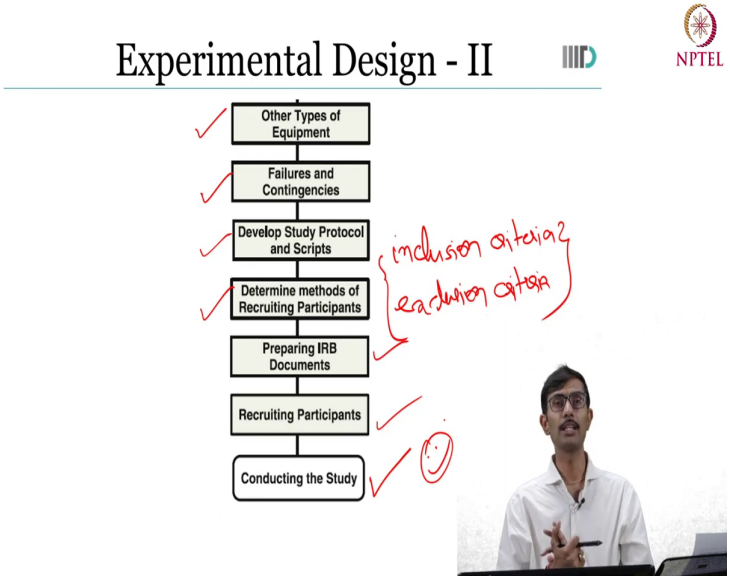

Of course, you will have to take a call depending upon the type of the question that you are trying to answer here perfect. And, then accordingly once you have understood what is the type of the location, you may want to use other types of the equipments apart from the sensor hardware right. So, other types of equipment would include let us say including of course, you may want to use a cam as a system, a PC, a computer system to maybe even present the stimulus for example, if you are talking about an image.

A video clip or for example, you may want to use a headphone if you are trying to present a music or for example, you may want to may be as simple as that the screen could be rather than being a computer screen, it could be a mobile phone as well. And, there are lots of studies where the researchers have tried to understood what is the emotions, how the emotions vary when the user is looking at something on a mobile phone versus on a computer screen right.

So, there are different types of equipment, other equipment types of equipment data can be there and you may want to look at all those things. Accordingly, quickly speaking when there is going to be lots of sense hardware and software in place then of course, there are going to be lots of different types of failures that may happen.

And, you may want to create a protocol trying to understand that ok what are the different types of failures that can happen; while doing the data collection, while doing the annotations, while getting the ground truth. And, accordingly what is the contingency, what is going to be your contingency to deal with these type of failures.

So, as an example maybe you have decided to use three different sensors to collect three different types of physiological signals; heart rate, brain signals and your skin conductance right. But, then what happened that during the experiment itself, you figure out that ok maybe one of the sensor is not working, but the other two sensors are working.

Now, your contingency could be ok maybe I do not have any spare hardware, but maybe I can continue the data this experiment with only the remaining two sensors. Because, at least

having two data is better two sets of modalities is better than not having any modality at all right. So, these are the different types of contingencies that you can also plan in accordance with the failures that you can envision perfect.

So, you have develop the study protocol and you have develop the scripts, the softwares, the algorithms that are required to put all these thing together. You have now you also need to determine the methods for the recruitment of the participants as I said. So, here there is something we call it as a two different types of criterias that are very common to determine these methods which is known as the inclusion criteria and the other is known as the exclusion criteria right.

So, you may want to look into the inclusion and the exclusion criteria that on what basis of what criteria you are going to include the participants in a study or on the basis of what criteria you are going to exclude the participants from a study. As an example, I am going to include for example, for a particular type of study, I would be you may be interested in including the participants who are of age between 18 to 24, as simple as that.

Maybe you want to study only the college going students and maybe 18 to 24 could be a good number, that is that could be your inclusion criteria. Now, one simple exclusion criteria could be so, for example, you are doing the study maybe after the post pandemic period and maybe you want to exclude the participants who just have had may be COVID for example, as simple as that right.

Maybe, because COVID may impact certain things so, you may want to include the participants who just have been you know who have just recovered from the COVID and so on so forth. So, you may want to list the criteria on the basis you are going to include the participants. You may want to list the criteria on the basis of which you are going to exclude the participants perfect. We already talked about in detail that you need to prepare the IRB documents, I already talked about what are the different things.

Of course, once the IRB hopefully IRB approval is done fingers crossed, you will start the recruitment of the participants and then at the end of everything goes well; this is where you

will be conducting them study right. And, then at the end of the study hopefully you will have your data, you will have your ground truth using which you can do the analysis that you wanted to do perfect. So, this is in brief how to design the experiment.

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Having understood how to design the experiments, let us now quickly look at the what are the different tools that the community, that the researchers that we use in the affective computing fit right. And, these tools they are very very helpful not only for the individuals who are the beginners in the field, but also many times the individuals who may be the experts in the domain.

Because, they not only make your life easier, they save the time, they save the resources, they save the cost. And, they improve the performance, they improve the efficiency of the system

that we are trying to build or the system that we are trying the services that we are trying to build.

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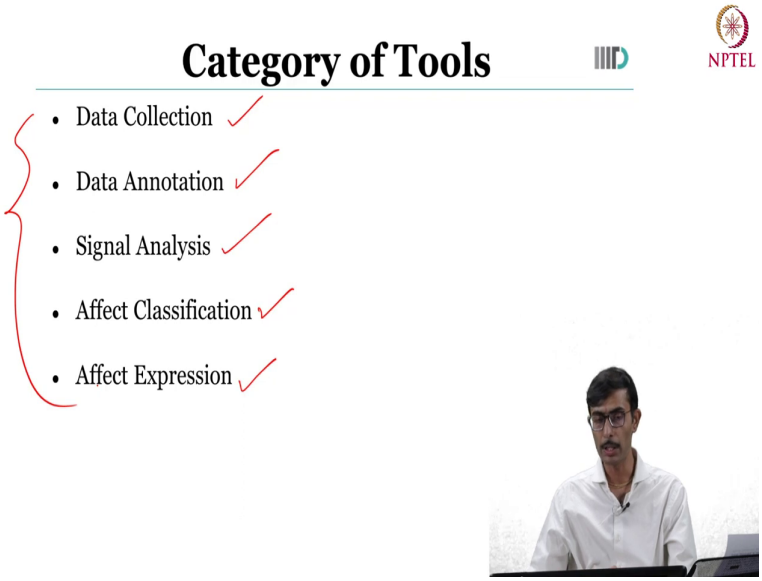

Roughly speaking so, there are all the tools that we the we use in the effective computing field can be categorized into five different domains. One is the data collection category, tools can be of for the data annotation. We also use different set of tools for the signal analysis, we also use a tools for the affect classification; mostly of course, you may have; you may have guessed it well.

This is the machine learning methods, mostly based on the machine learning methods and then we also use the tools for the expression of the affects right. So, these are the different five different sets of tools that we use. We will quickly look at the what are the different

softwares that are available here, what are the different tools that are available in each of the categories.

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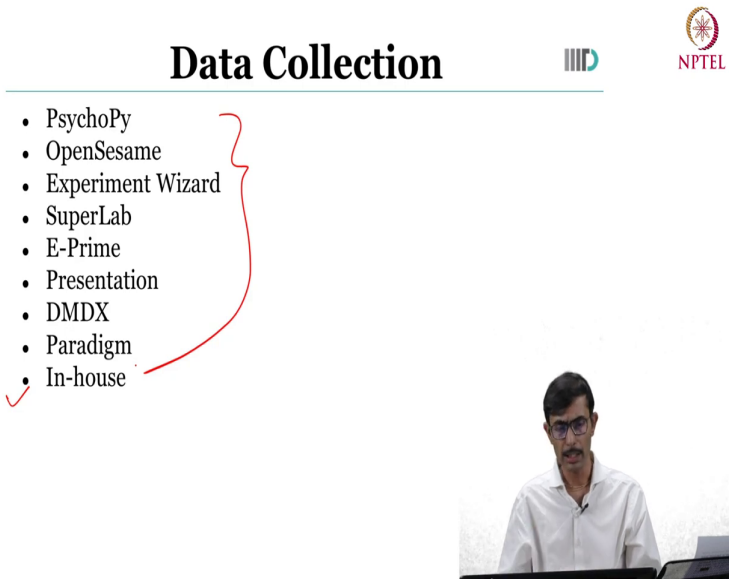

And, maybe we will look at one example very quickly and at the end of it we will also have a tutorial on one particular tool. So, for example, the data collection; what are the data collection tools? So, basically data collection tools are the softwares that simply help you conduct a wide range of experiments right. And, then here is a brief not an exhaustive list by any means brief list of softwares that are available.

Some of them are open source, some of them are paid softwares that you can look at look at the internet and they have their own set of advantages and disadvantages. And of course, not to mention that apart from these tools that are here, you can always if you have a good hands

on experience on the programming, you can always create your own customized script which is developed in house by you and by your groups right.

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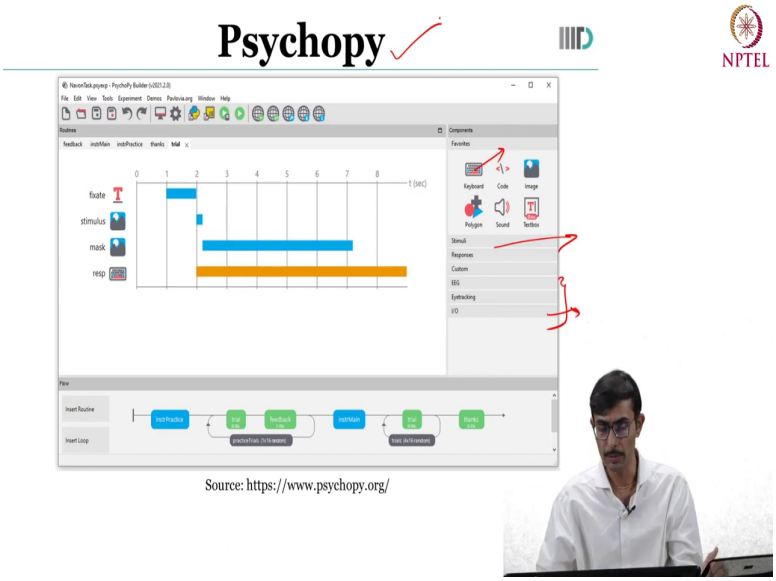

So, quickly speaking let us look at for example, one tool which is known as the which is a very very popular tool which is known as the PsychoPy tool. So, and at the end of this particular class module, we will also have a tutorial on the PsychoPy tool which is going to give you a bit more information. So, PsychoPy basically is a very very interesting tool. It is a free package first thing, it is a cross platform tool and it allows you as I said to run a wide range of experiments and you can conduct experiments.

And, this is fairly commonly used by the neuroscientists, psychologist, linguistics and so on so forth right. So, you can see that it has a very very flexible and intuitive builder interface, as you can rightly see on the screen right. So, this is it is kind of a home screen that you can see

here. So, the good thing about this particular package or the tool is that it provides you a builder interface in which you can just you know drag and drop things from here.

So, for example, you can select what is the type of the stimulus that you want to use, what is the type of the response that you want to study. So, for example, maybe the keyboard response, if you look at the stimulus maybe you can select image, video, music and so on so forth. Similarly, if you have if you want to integrate with some sensors, it already gives you some list of options. You can integrate it with easy for example, some easy devices, some eye tracking devices.

Apart from that, it also allows you to integrate certain input output devices which can be used for example, for the integration of additional sensors which may not already be there in the list. So, this is a build builder interface in which you can simply drag and drop and create some experiments right. More importantly, for the code lovers, this is also this is completely based in Python.

So, you apart from the using the builder interface, you can definitely use the Python scripts to generate the experiments here. And, when I say that you can use the Python, it means all the practically speaking all the libraries that are available with the Python, you can very well use here and that definitely increases and expands the scope like anything right.

So, basically it is it makes it very very powerful, if you can do a bit of programming in Python. And, for those who cannot do the programming, there is already a build interface that you can use to design your own trials and do the experiments right. So, this is a very nice set of tool and for the same reason at the end of this thing, I would definitely we will definitely have a have some hands on experience, some tutorial on the PsychoPy which is going to make you familiar with the tool.

And, you will be immediately be able to jump on the software and start using it and I trust me you will immediately fall in love with this particular tool right perfect. So, that is so, now, you understand that this particular data collection tools they are used to create the experiments in which you present a particular stimulus maybe, you decide there what is the

type of the data that you are going to collect and then you do all this in a very controlled fashion.

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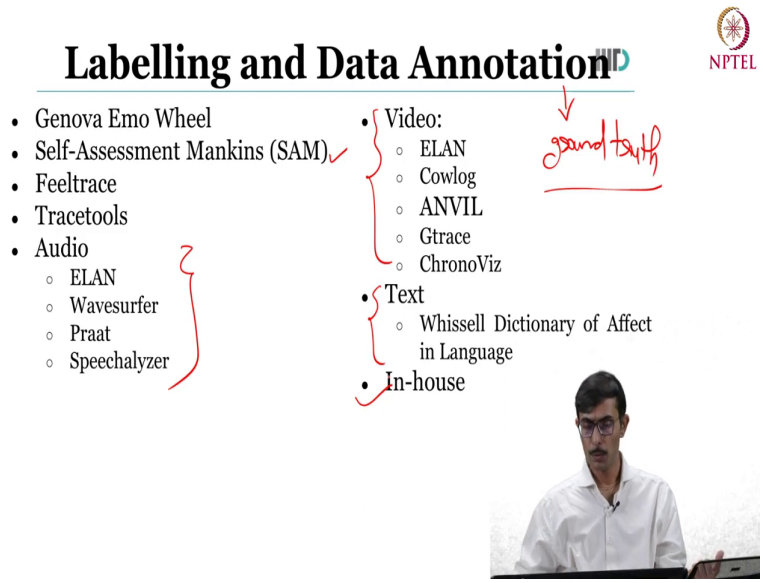

Now, once you have collected the data, the next part is that you may want to look at the data annotation. When I say the data annotation means what? Basically, when you do the data annotation, this is what gives you the ground truth right. And, why do we need the ground truth? Because, unless and until we have the ground truth, you will not be able to make the machines understand that what exactly this emotion stands for right. Of course, machines for machines the emotion itself is a very very abstract concept.

And, then now depending upon what is the different type of what is the modality type of the modality that you are using, there are different options that are available. So, for example, if I

look at the SAM tools which is Self-Assessment Mankins, it is a very very commonly used tools; mostly it is used for the self-assessment.

Similarly, if you are using for example, the audio modality and you want to do annotations in the audio you want to for example, look at it ok when the user was saying this, what was the emotion there. When the user was saying this, what was the emotion there; maybe you may want to use one of these tools to do that type of annotation.

Similarly, for the video modality, you have again a very nice list of tools that are available. For the text, again like this is only one, but certainly there are more options which are available in the market. And, nevertheless at the end you if you are a code lover again, you have the option of creating your customized scripts with which you can do the annotations, you can facilitate the annotations of the data.

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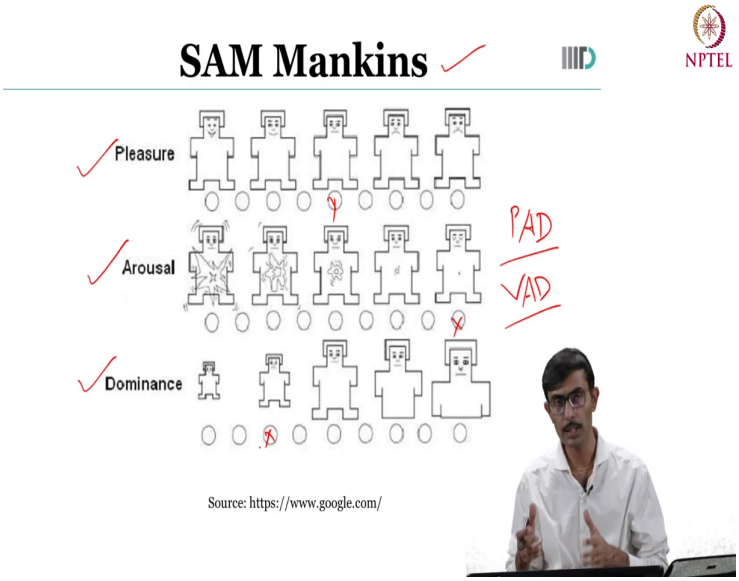

Now, let us quickly look at one particular tool which is very very popular in this set which is known as the SAM Mankins. So, as I said basically this SAM Mankins is a you can look at this, it is a non-verbal pictorial assessment technique that directly measures three different things. It measures pleasure, arousal, dominance. And, if you recall so, this is PAD is what? This is what it is you can very well imagine now that this is based on the PAD tool, PAD model of the PAD or the VAD.

We also called it as the VAD model of the emotion representation that we saw in the earlier lectures right. So, basically the idea is very very simple that you are going to present a particular stimuli to a participant. And, then at the end of the presentation of the stimuli, we are going to present give this Mankins to the user and you may want to ask that ok; on the scale of for example, here this is 2 to 4 6 8. This is a 9 scale Mankin, you can have a 7 scale Mankin, you can very well have a 5 scale Mankin as well.

So, for example, you may want to ask the user that ok, on the scale of 9 what was your level of pleasure and maybe the user is going to for example, mark this. Similarly, on the scale of 9, what was the level of arousal; maybe the user is going to mark this. Similarly, on the scale of 9, what was the level of dominance user can mark one of these and that is how you can collect the data using the SAM Mankins right.

So, this is of course, only valid for the self-assessment mode of annotations perfect. So, now, you know so, of course, as I said the SAM Mankins can only be used for the self-assessment mode of the data collection. But, for the others, there are other tools that are available perfect.

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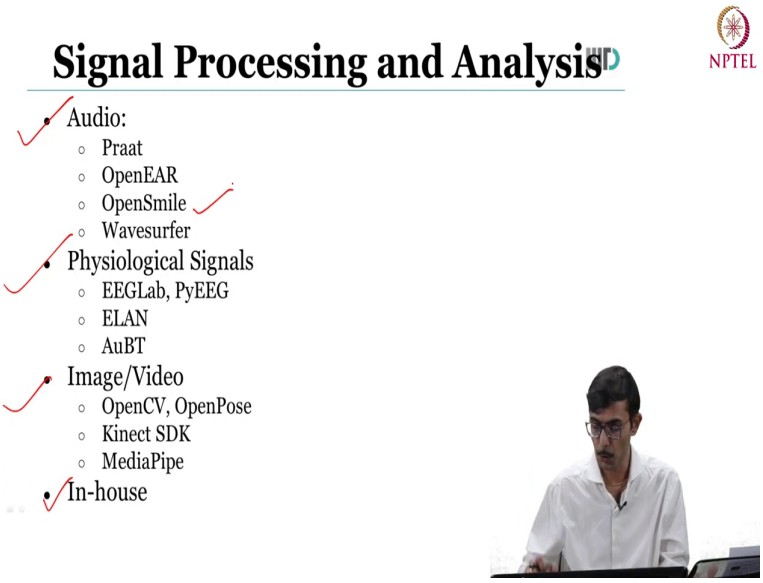

So, that was the second category of the tools. Now, quickly speaking the third category of tools is the signal processing and the analysis category. So, this is fairly broad category that we use to analyze the different types of modalities, that we have collected, that we are interested in and analyzing while doing the data collection. And of course, you know the type of the modalities that we roughly speak could be of audio type, could be of even physiological signals, could be of image or video type.

Roughly speaking, these are the three four categories and nevertheless you always have an option of making it in house right. So, for the audio category of course, then you have this Praat, OpenEAR, OpenSmile, Wavesurfer; very very popularly used tools. So, basically what they do? So, for example, they allow you to analyze, to preprocess the signals, to remove the

noise for example, from the signals; let it be audio, let it be physiological signals, let it be image or the video.

At the same time, after doing the preprocessing, they also allow you to maybe extract certain features, certain type of features that are there in the particular type of signal and then to get some inference from that particular type of modality right. So, audio is there physiological is there, image video is there and in-house option is there.

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Let us quickly look at for example, you know one particular tool that has recently come up and become very very popular is for the analysis of the image or the video modalities is known as the MediaPipe by Google. So, basically MediaPipe is a very very popularly used tool as of now for the analysis of the image and the video modalities. And, basically this is

the tool that you that is behind that runs behind when you interact with the Google assistant at your home and when you say ok Google.

So, basically you know in order to understand ok Google, what is going on behind is being facilitated by the MediaPipe. So, basically MediaPipe is just a framework which is used to develop machine learning algorithms for the video and the images as I said. And, it can very well be used for the analysis of the audio modality as well and it is a cross platform a platform cross platform framework that can run on the desktop, server, android applications and so on so forth.

And, that is what increases the applicability and then the popularity of this particular tool that you have. So, for example, if you look at some of the solutions that are readily available in the MediaPipe are already include. So, you can already do a face detection. Let us say if you are interested in the analysis of the facial expressions, face detection is the very first thing that you may want to do.

And, for that you need not to create any algorithm, you need not to create any even write a single piece of code. There are API's that are already available in the MediaPipe, you can very well use those API's and connect those API's with the code, with the videos or with the image that you have collected and then you can get the face detection done.

And, once the face detection is done then of course, as a next step you may want to do the and the analysis of the facial expressions there. Similarly, you know for example, it also allows you to understand and the poles, the type of the poles that the individual has. And, once you have once you understand what is the type of the poles that individual has, you can very well correlate with the emotions that they that the ground truth of the emotions that you have collected while doing the annotations right.

So, then there are so many different things and of course, there are certain other things which may or may not be of very use for the effective computing research. Nevertheless, it is a very very integrated and holistic pipeline, holistic framework that you may want to look into

further right. So, MediaPipe I will definitely encourage you to please go ahead and look into it perfect.

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So, then we have also have the other set of the category which is the fourth set of category, it known as the data mining tools. So, basically these data mining tools are what? Now, you may have very well understood that ok, we have already create an experiment, we collected the data, we annotated the data. After the annotation of the data, we already preprocessed the data and after the preprocessing, we were able to do certain type of analysis as well may be using the MediaPipe and similar type of tools.

And, then as the next step now you may want to understand the emotions that are exactly there on the data, that you have collected right. So, now in order to do so, of course, it becomes now here, here you have to involve the machine learning and the deep learning

tools. There are lots of sophisticated state of the art, machine learning and the deep learning tools.

And, the development of the machine learning and the deep learning algorithms, while it may be a very research focused topic in the effective computing community, there are lots of tools that are already available which develops lots of machine learning tools which implements machine learning tools for you. And, you can simply use that on that preprocessed data, that you obtained from the previous set of tools to understand the type of the emotion that you are looking at.

So, for example, of course, this is fairly a broad list of tools and those who are already working in the machine learning domain or the deep learning domain, you may already be familiar with some of these tools.

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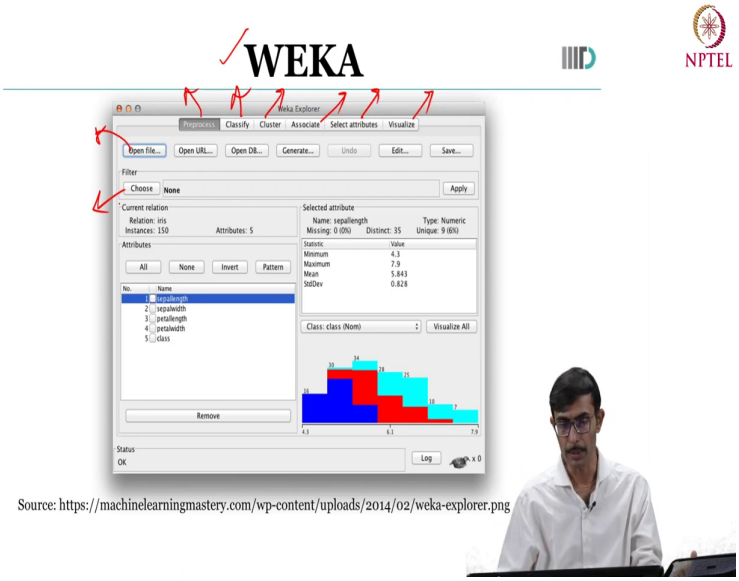

But for example, just for the roughly for the sake of the completeness, we will just discuss have a look at the WEKA tool. So, WEKA tool, you may be its again it is a very very fairly popular and common tool that is available. So, basically the WEKA is an open-source software again. The good thing is again it is an open source software and it makes available tools for the various algorithms in machine learning that you can see for example, that you can also see in this.

So, for example, it allows you to make use of the algorithms for the preprocessing for doing the classification, for doing the clustering, for identifying the association, for even doing the feature extraction and feature selection and of course, to do the visualization of the data that is there right. So, there are different categories in which the under which there are different algorithms that are available and implemented by the WEKA tool.

So, again I mean of course, it is a it has a builder interface as you can see, it is a very it has a very nice GUI. It has a very nice builder interface, you can simply use this builder interface. So, for example, from here whatever data you have collected, you can simply open that file and you can simply you know choose a particular type of filter that you want to run on the data. You can simply select one of them one of the; one of the techniques that you want to apply on that particular data.

And under which you can simply select the type of the algorithm maybe that you want to do. So, for example, if you are selected the classification, as simple as that you may want to do a classification using for example, disease entry or for example, using a support vector machine. So, of course, what exactly will be the type of the algorithm that you will be using? All those will depend on so many different things right.

So, here of course, if you have a bit of understanding of the machine learning and deep learning that will be really helpful. If not then definitely, I will encourage the users to please go ahead and then take some courses on the machine learning and deep learning or take some tutorials in order to understand at least what these different means. And, if you already have a background in machine learning and deep learning, you are really good to go for it right.

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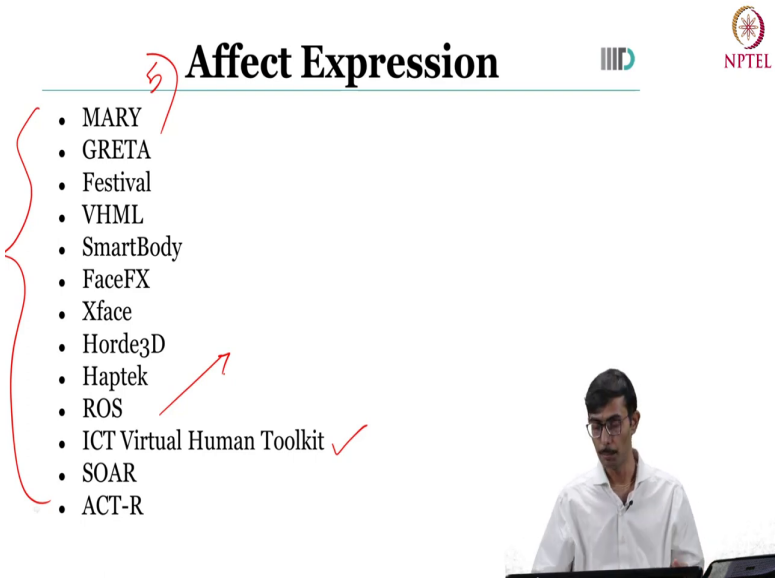

So, this is a very very simple tool, but very very powerful and commonly used tool to analyze the data that you already have right. So, that is the about the WEKA tool. Now, this is the fifth set of category of tools. So, fifth set of tools that we have lies under the affect expression. So, now, until now what we have seen? We have already collected a data, we have already annotated the data, we have already preprocessed the data using some signal processing tools.

On the pre-process data, we also applied the certain machine learning algorithms using WEKA like tools perfect. So, far it looks good and at the end of it you should be able to understand the emotions that are there in the data right. But, now next what? Using these emotions, you may using these emotions or like without maybe going through all this exercise

as well, you may want your machines or your services to be expressive; they should be able to express the emotions right.

And, these expression of the emotions could be in accordance with the emotions that you have detected. For example, using the previous set of tools or maybe you want them to express certain emotions because that is how you have designed your service or the machines right. And, then again here there are lots of tools that are readily available and frankly speaking the expertise that you need to make use of these tools varies hugely.

So, for example, on one hand you have ICT Virtual Human Toolkit which is fairly popular and again its a bit easy to use. But then again for example, you have ROS like frameworks which is Robotics Operating System which is a bit sophisticated tool. And, you may need to have a bit of more experience in order to we have to use this thing right. So, you may want to explore like all these different tools and you may want to see that ok which fits your need better.

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So, quickly for the sake of the completeness, we would just see that you know this is the ICT Virtual Human Toolkit. So, basically this is a ICT Virtual Human Tool Toolkit is again you can see right for example, in the on the right hand side, if you can look at on the right hand side quickly. It is basically a collection of modules, tools and the libraries which are designed to aid the researchers and the developers in creating virtual human conversational agents.

So, for example, you can see so, there are different options. So, for example, if you can see here under the category of the resources, you may want you can pick like all different types of agents that are already available. And, once you have picked one of those agents, then you may you know like you may want to you can customize those agents depending upon by using them by using the different options that are available in the panel on your right-hand side.

So, basically it has different modules also that allows you to emphasize on the natural language interaction with the agent the non-verbal to analyze the non-verbal behavior of the agent and to also look at the perception of the agent and the its environment that is around right. So, I will definitely invite the users to go ahead and explore the toolkit to understand and to gain a bit more of understanding about it right.

So, with that then we quickly came to the conclusion where quickly speaking again, we looked at different category of tools that are available for you to explore for the in the under the category of data collection, annotation, analysis, classification and expression.

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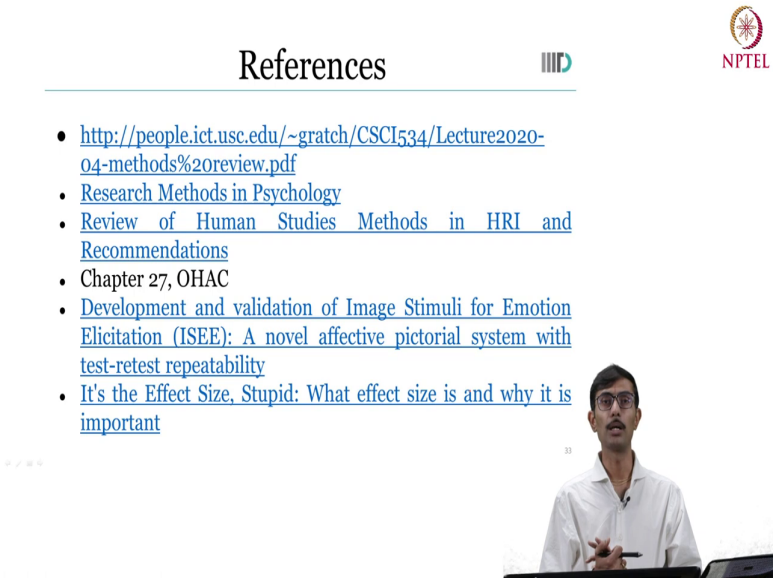

So, all the references that we have used, I have already given here in the references list. And, definitely it will be uploaded separately to you, it will be made available separately to you as well right. So, with that now I finish here and I wish you happy learning.

Thanks.