Learning Analytics Tools

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Week 11

Lecture 11.4

Eye Tracking

In this video, we will talk about eye gaze detector. This is another sensor to detect a human's eye gaze or eye trackers.

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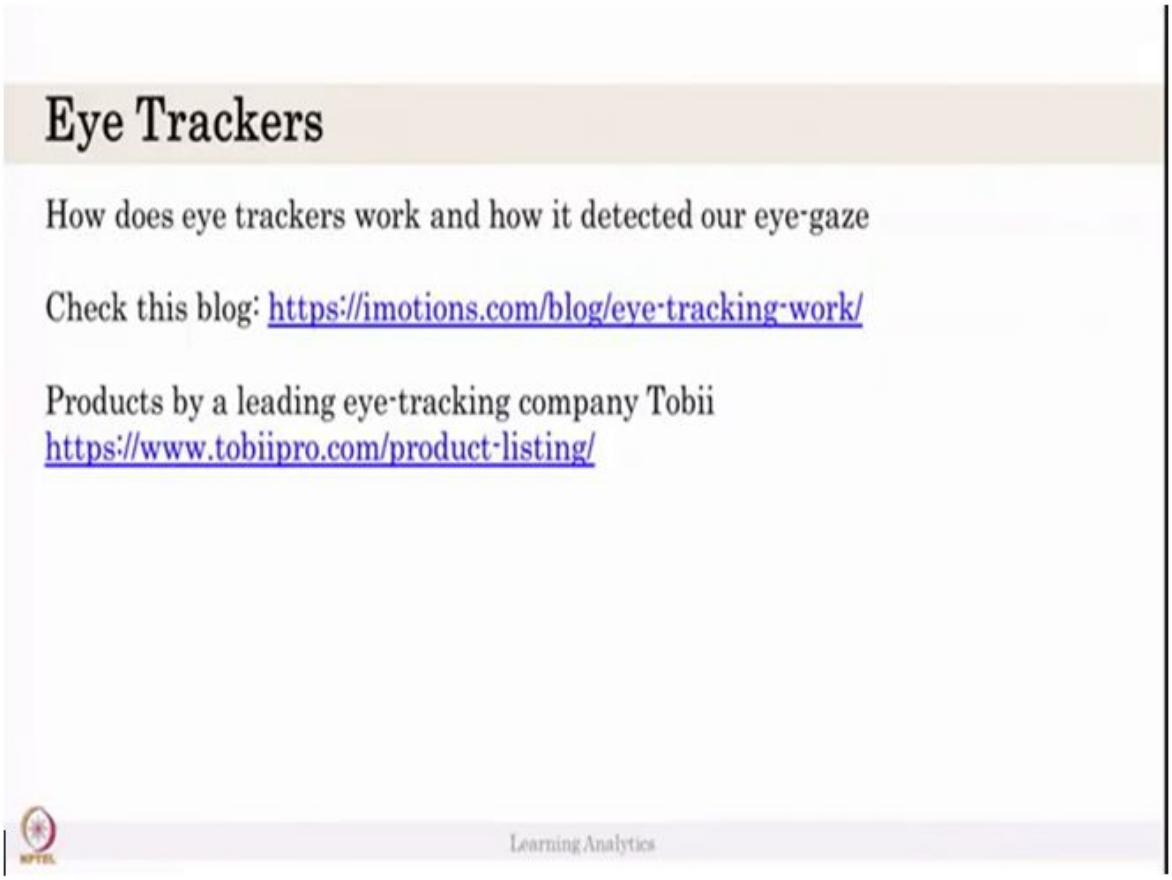

So how does eye trackers work? How it is detecting the eye gaze? So please check this blog in details right, and so let me show the blog.

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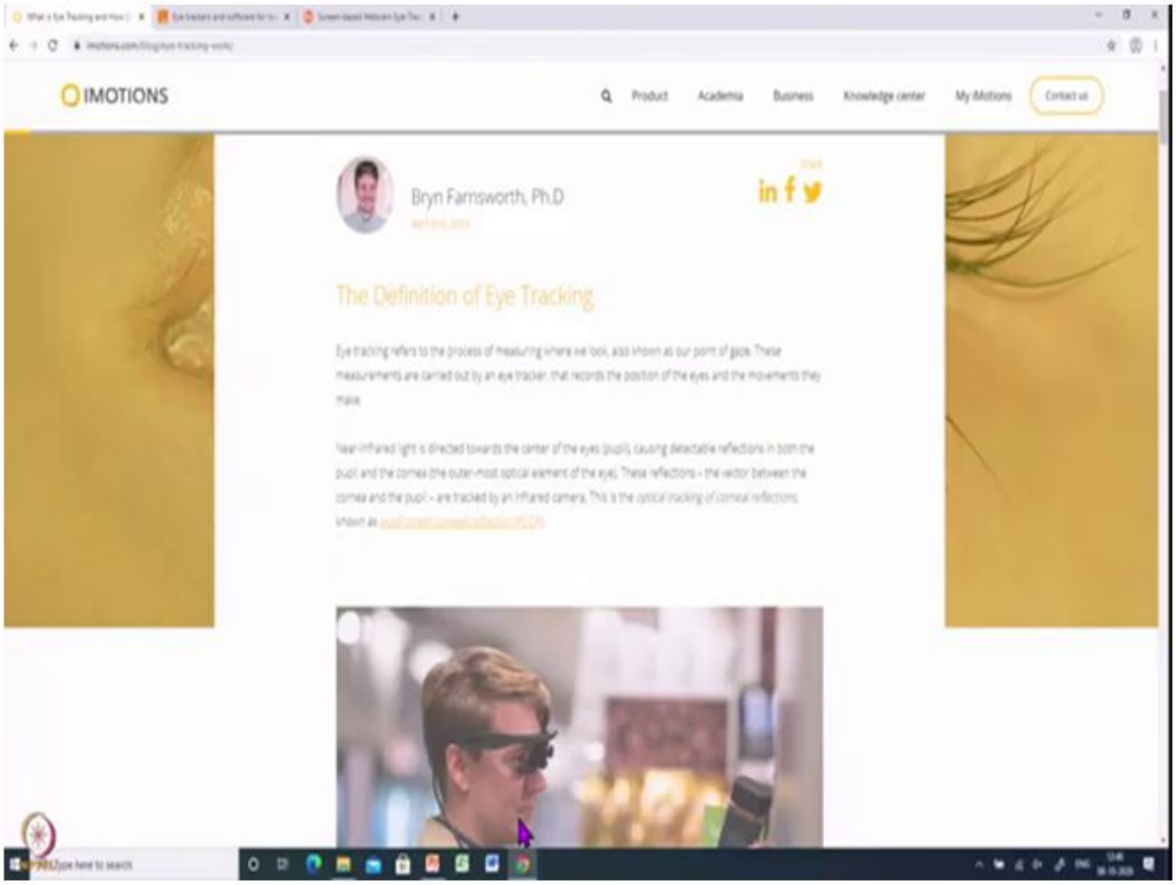

Again the blog is from Imotions because I mentioned that Imotions is a company which integrates different sensors and they created a core engine which combines the data from different sensors to provide you with the combined one single system so that you can do analysis better.

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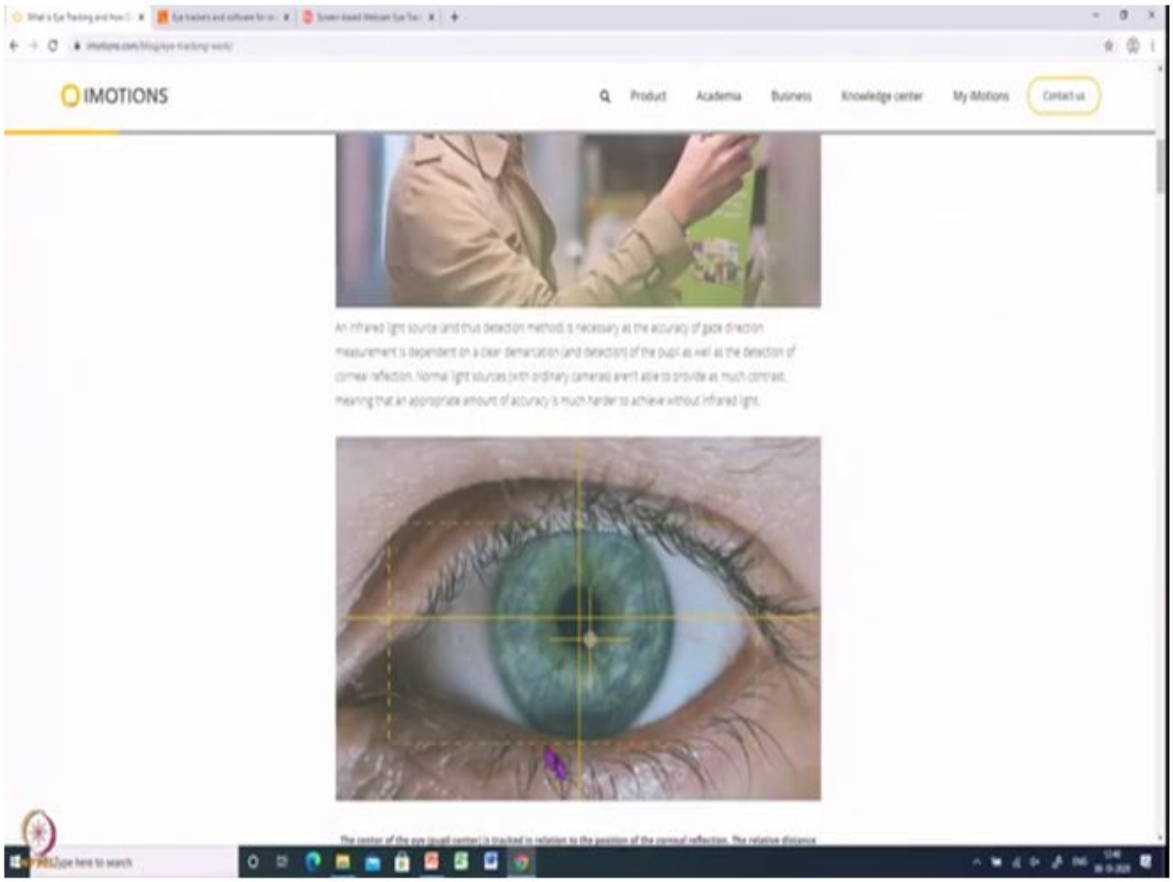

So eye gaze is detected using your eye pupils, and the reflection of some light or some reflection happens right that direction is used to say which direction you are looking at and your distance from the screen. If you are watching a laptop that distance from the screen is used to say are you looking at which place and what are the locations you are looking at and that is how the eye trackers work. So read this blog, which is interesting.

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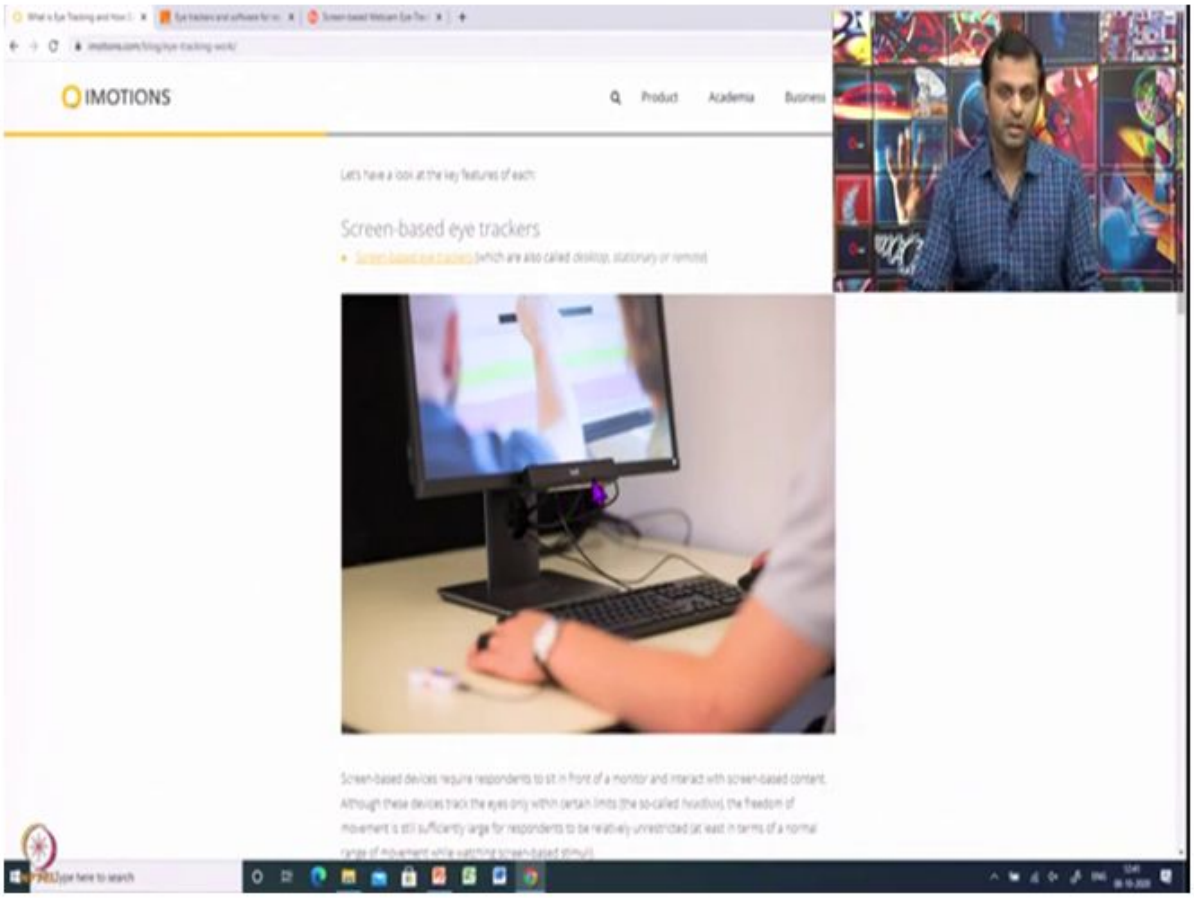

And the typical eye tracker in a portable eye tracker category is this, this is a simple eye tracker Tobii eye is the company, it is a leader in eye-tracking devices. It is a typical eye tracker small device which can be attached to your laptop screen and then you can start collecting the data.

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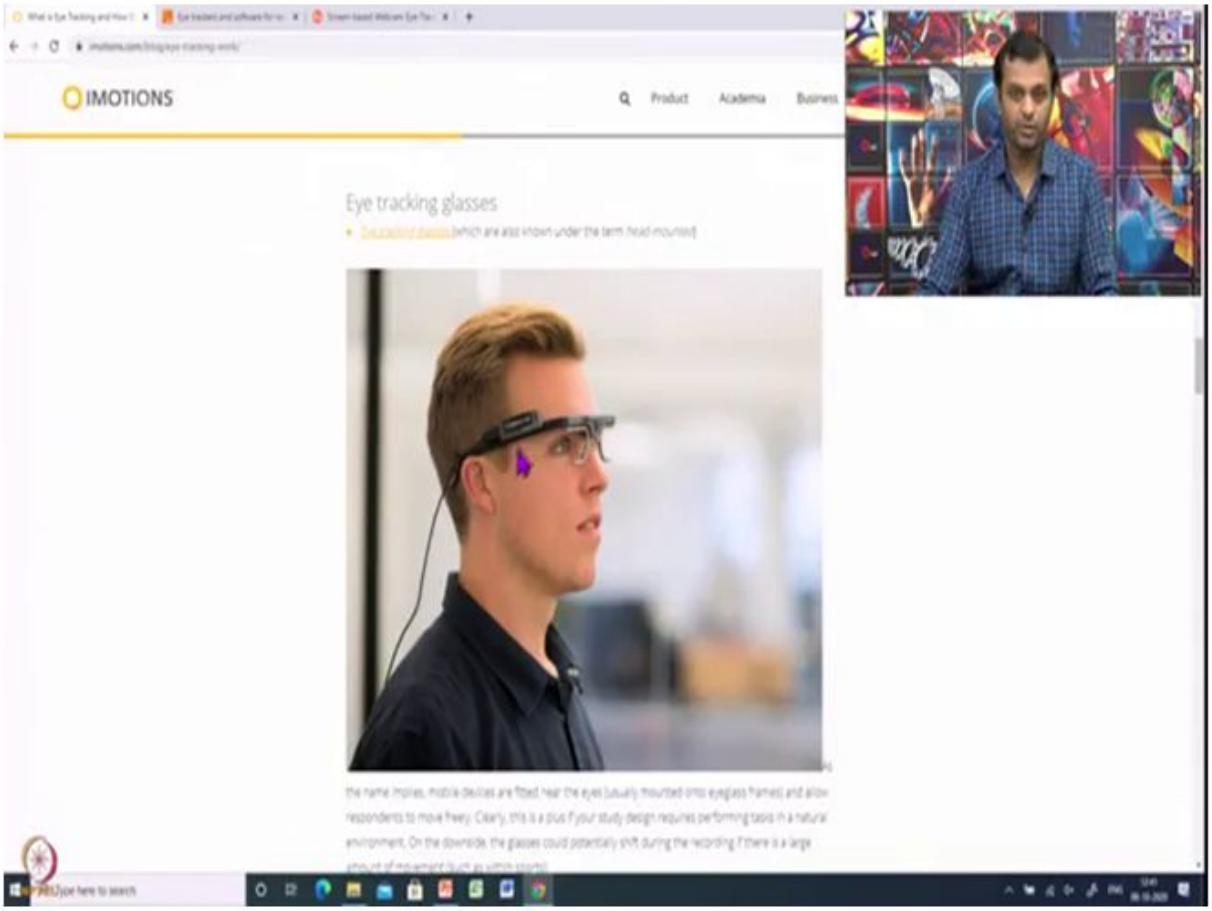

And what happens or there are other eye trackers like wearable eye trackers like glass you can put those eye trackers, these are a bit old, I will show the latest ones from Tobii eye. So what happens is the eye-tracking data collect the participant's eye gaze data.

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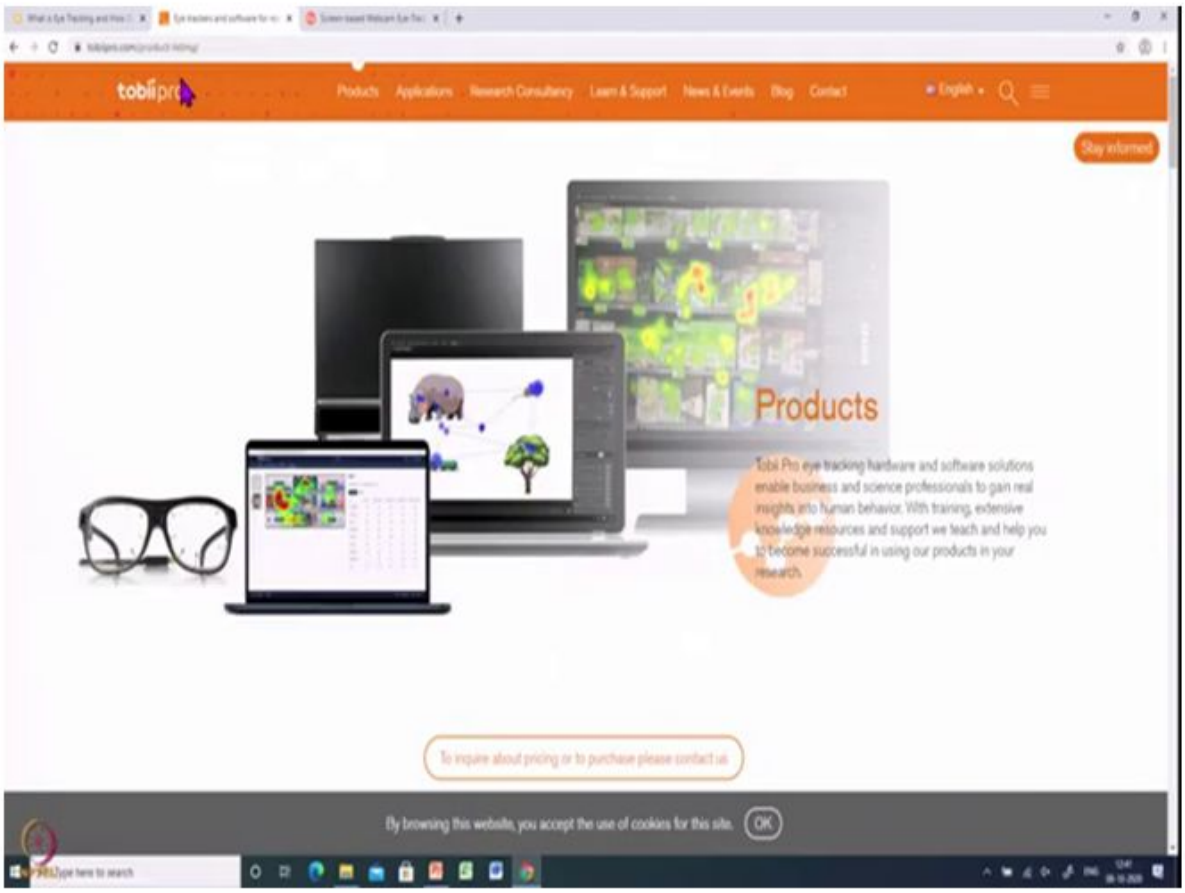

These are the products by Tobii eye, Tobii is the company which is the pioneer in this field and they make eye trackers devices.

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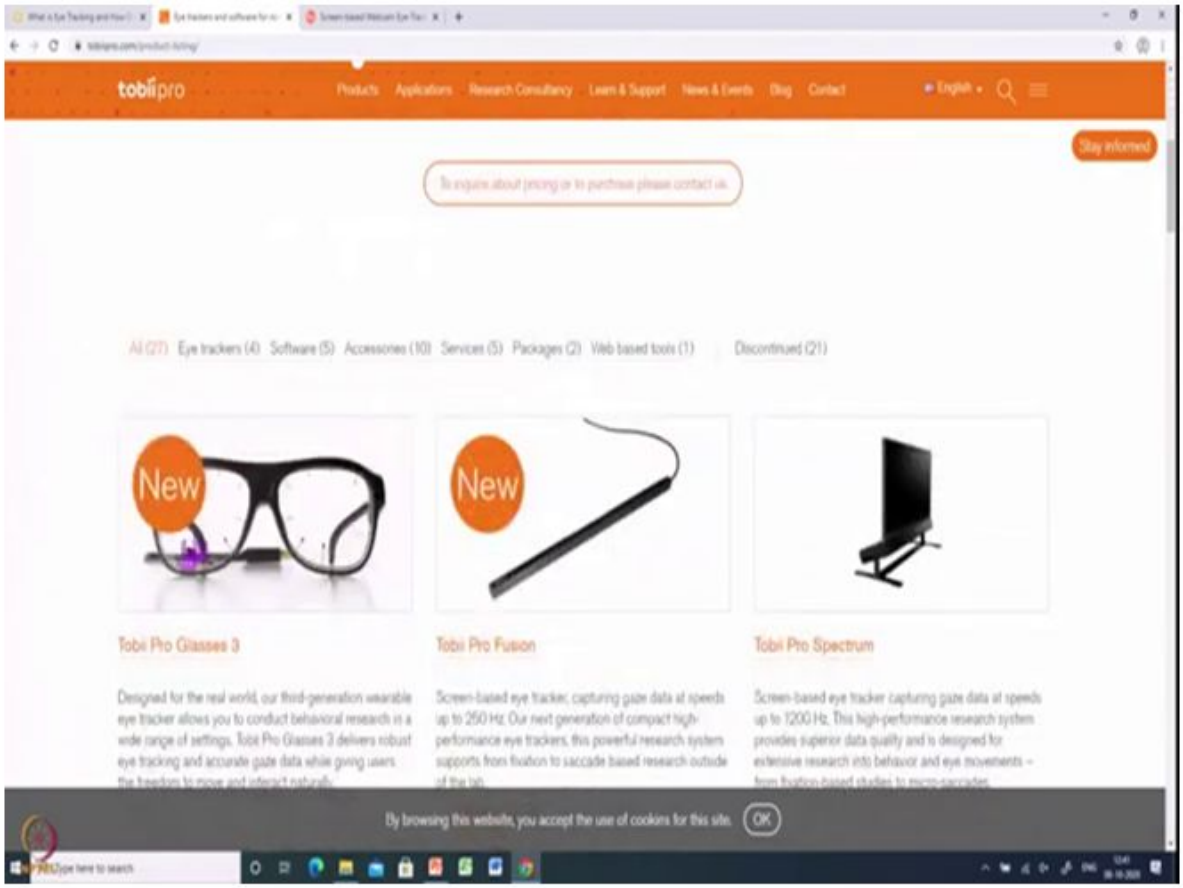

The latest one is Tobii pro glasses, there is no need to have some extra device. Now based on this new technology they are able to detect I gaze even when you are interacting with an object, you are looking at some product or something like that. And this is the Tobii eye pro you know such level eye tracker.

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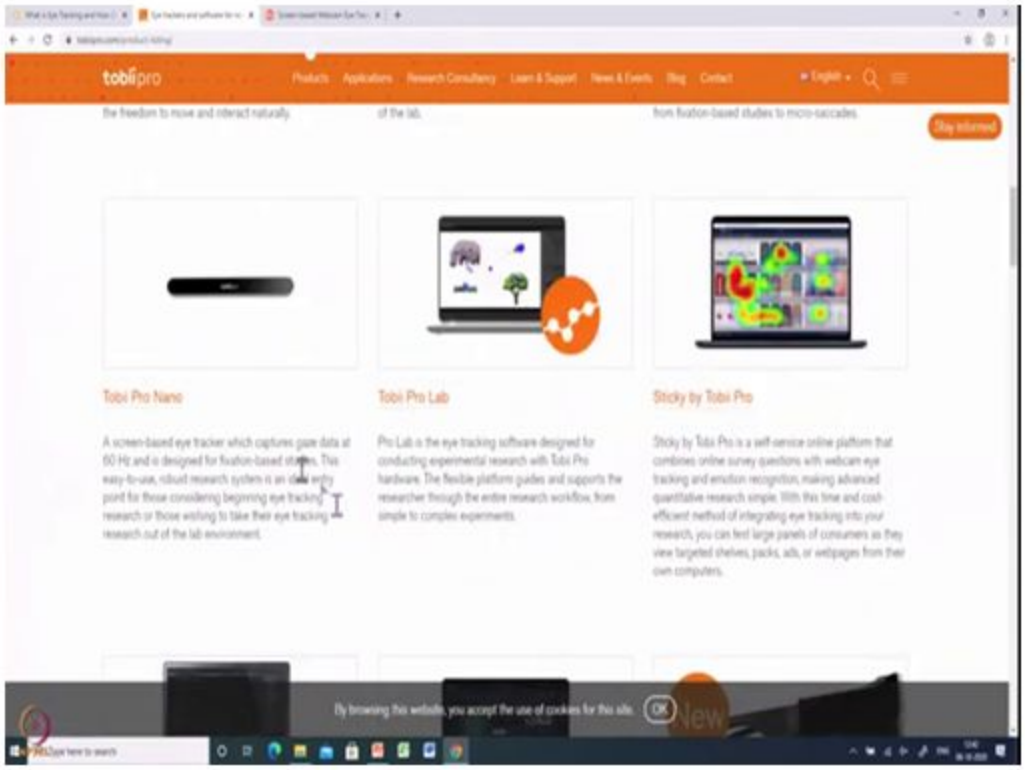

Eye Trackers

How does eye trackers work and how it detected our eye-gaze

Check this blog: https://imotions.com/blog/eye-tracking-work/

Products by a leading eye-tracking company Tobii
https://www.tobiipro.com/product-listing/

Also, something called Tobii eye nano, this is very small and can be used for the research also. And there more devices you know, the one Tobii eye also have one device called Tobii eye foresee. Tobii eye foresee is developed especially for the gaming purpose, it is very, very low cost.

The Tobii foresee is around say $100 or in India you can get on Amazon after import and everything you just get it for 13,000 to 15,000 rupees. So in research, it is very easy and you can collect say 10 eye trackers and can collect data, but the purpose of Tobii eye foresee is for gaming so you cannot use Tobii eye for research purpose that is the declaration says that you cannot copy data, analyse data or analyse data from the foresee, so yeah beware do not use forsee.

If you are using foresee, talk to Tobii eye company and get the license permission, again you have to pay huge money for getting the license. So for research purpose, they have Tobii profusion, Tobii eye XL120 kind of devices or Tobii eye nano has 68 eye tracker that is really good and that not really costly, it may cost 2 to 3 lakhs so that it is easy for people to start buying and making some research out of it to collect data and create some research. So Tobii eye tracker collects data at a particular frequency. So let us see.

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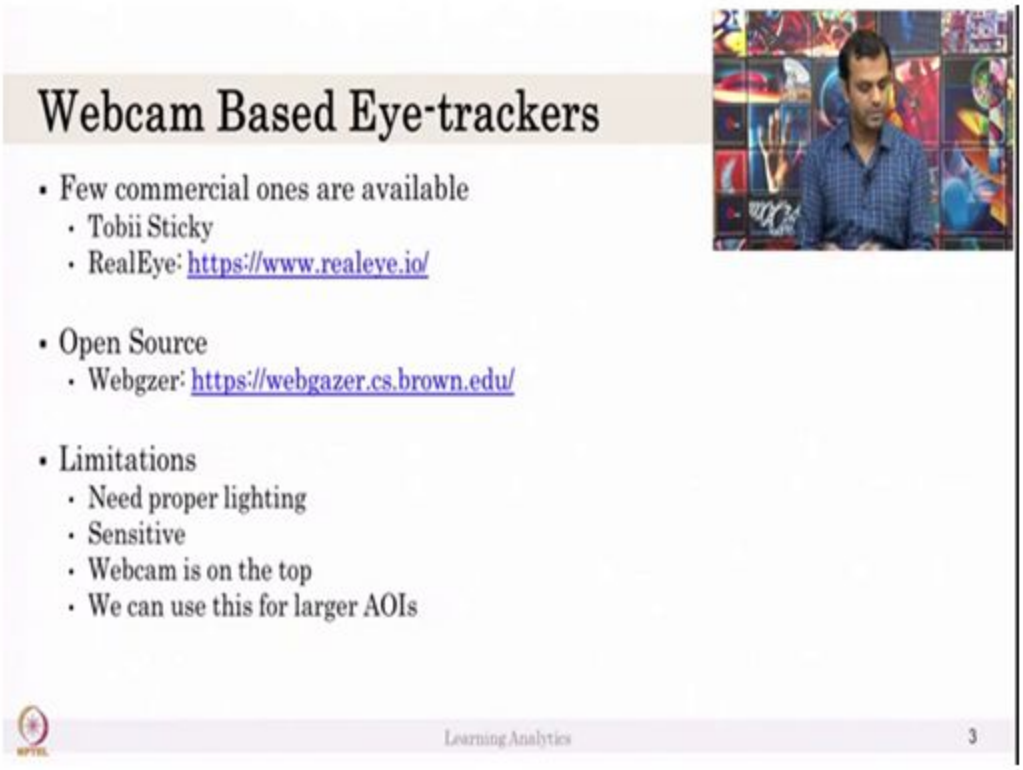

There are other eye trackers which are not based on an external database, just based on the webcam. Commercial ones such as Tobii eye Sticky, Tobii eye is also giving things called sticky, it is web cam based detector anybody can use it. And another one is called Real eye, Real eye is very interesting one, just see what is the Real eye.

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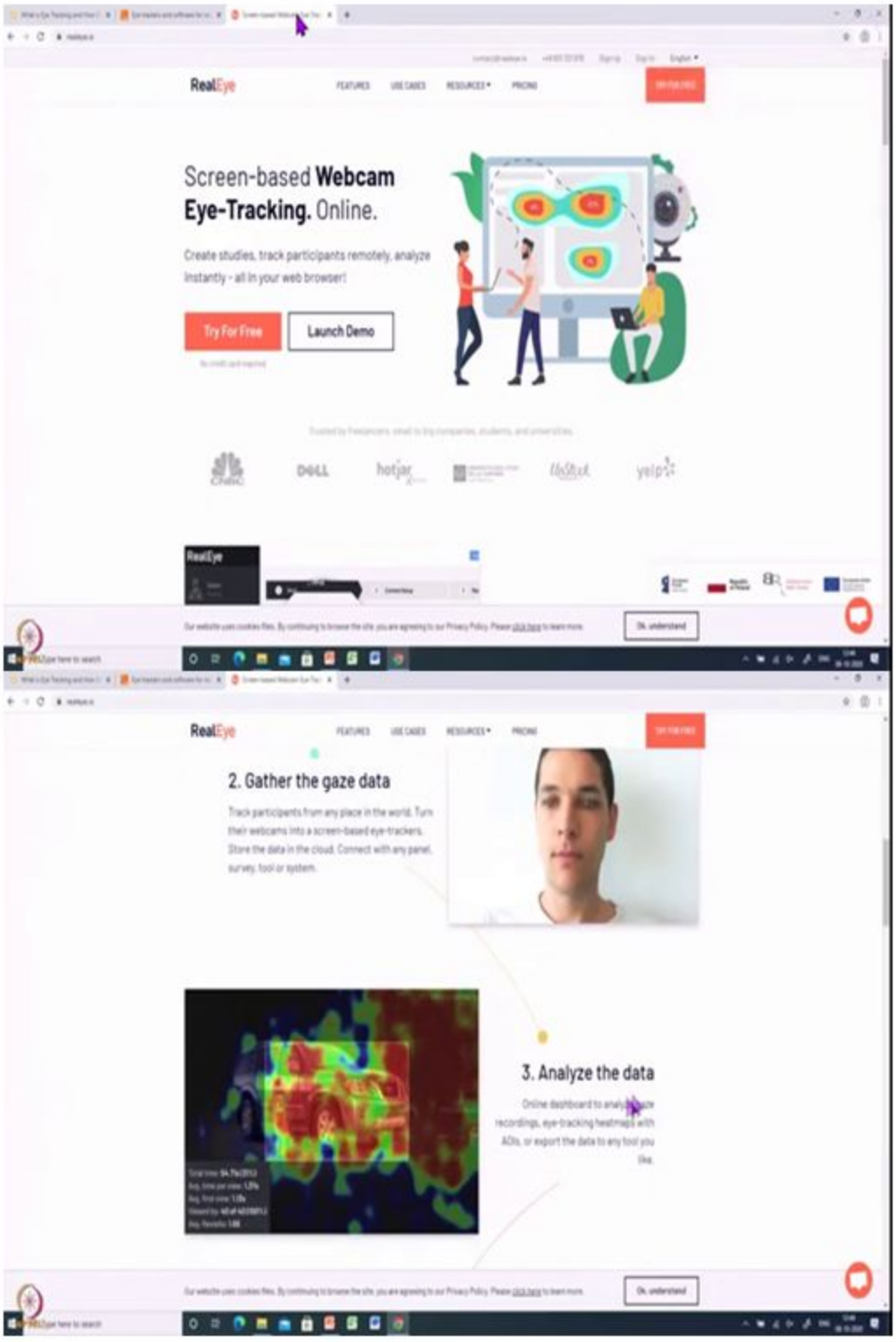
RealEye
FEATURES
USE CASES
RESOURCES
PRICING
Screen-based Webcam Eye-Tracking. Online.
Create studies, track participants remotely, analyze instantly - all in your web browser!
Try For Free
Launch Demo
DELL
hotjar
yelp
RealEye
Ok, understand
RealEye
FEATURES
USE CASES
RESOURCES
PRICING
2. Gather the gaze data
Track participants from any place in the world. Turn their webcams into a screen-based eye-trackers. Store the data in the cloud. Connect with any panel, survey, tool or system.
3. Analyze the data
Ok, understand

So Real eye is a screen-based webcam eye tracking, you can give a try, try it for free, just launch demo, and actually detects where the student is looking at. And after that, it gives the analysis of data. It is not much costly compared to Tobii for the research purpose.

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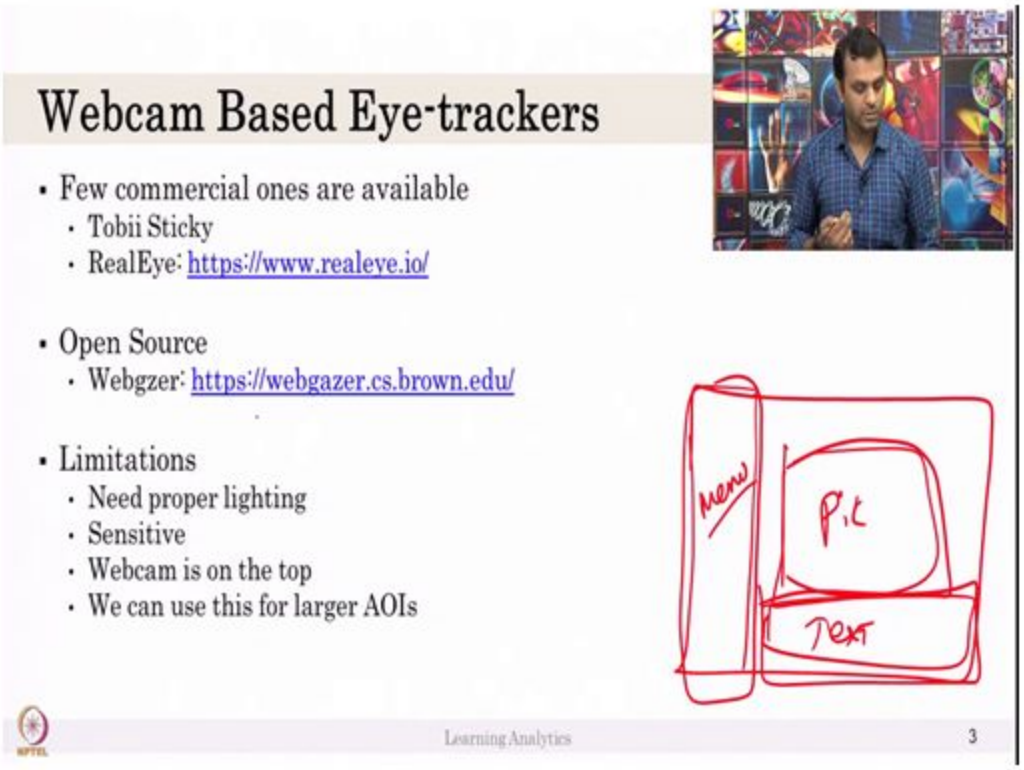

But there is one more from Brown University. It is called a web gazer it is also free, it is open source, so use it. The challenge is when you test all of them, it needs proper lighting, it is that the student is interacting with a computer or laptop, its lightning should be in our face so that it can detect the light from the screen and the pupil correction has to be detected to find where on the screen the student is looking at it. And it is very sensitive, it cannot detect if I look at a particular piece, if I am looking at W or not. It is not so accurate like Tobii eye detectors like the screen external eye trackers.

The reason is, the webcam is on top. For example, if you are looking at laptop the webcams are at the top. If I am reading the bottom of the page, my eyelids are kind of closed I am reading so

the webcam may not be able to detect. So why I would say that go ahead and try realeye.io a demo and start looking at the bottom side of this page, you will see the accuracy is not so correct.

But if you are conducting research where the area of interest is large, this webcam-based eye-trackers will be beneficial. The reason is, buying such great eye tracker from Tobii eye and conducting a study in a real classroom of 30 students is not possible even if you have a lot of money. So when I say AOI, suppose this is my screen, the computer-based learning screen, and maybe this is the menu and there is a big picture and there is some text.

In your search if your area of interest is very big, such as you want to capture how much time a student spent on the menu, how much time a student is looking at picture, how much time a student is looking at text, that is the thing. And by using this information you want to know to understand student's learning, then this is perfect, you know this, this webcam base detector might work for you. So check it out, I will not suggest you to go for real eye or web gazer works pretty much same compared to the real eye, you just have to integrate it and collect data on it. And some of the feature extraction, analysis is not really tough, it is easy. I will show how to do that.

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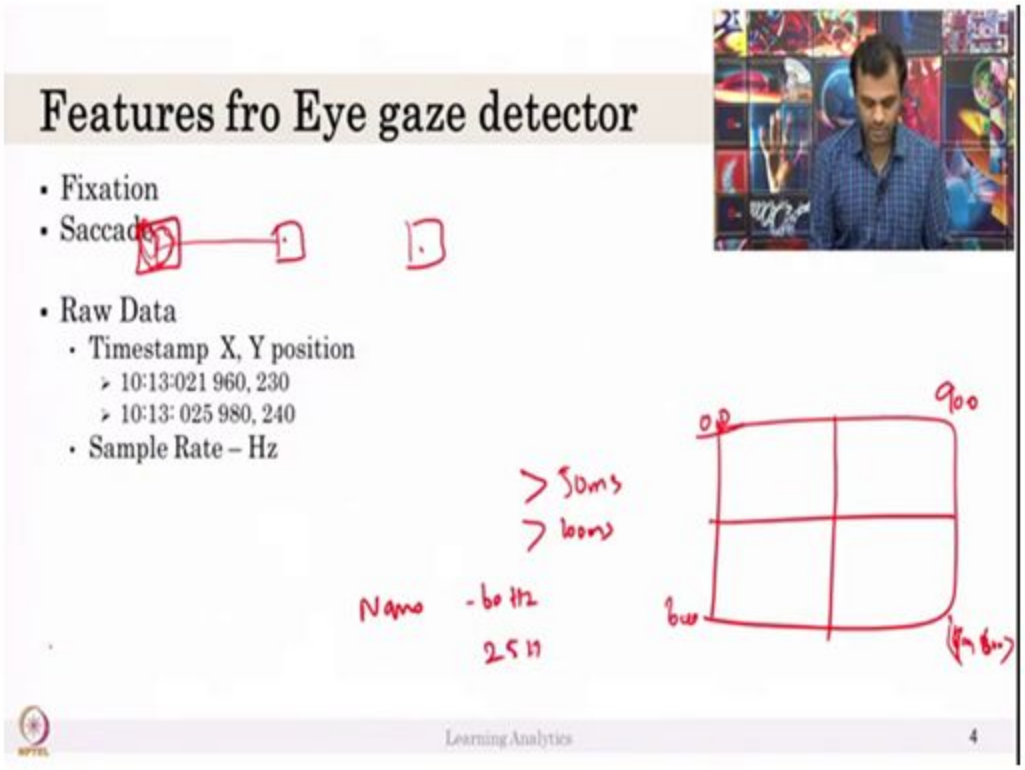

So, there are two features key in I gaze detector, one is called fixation, the other one is called a saccade. Fixation is, your eye is fixating on a particular point and how much time you have to fix it, what is that point? You know, is it a single point or some square bracket it depends on your research question or the way you want to decide your duration and the bracket.

For example, if I am fixating on this particular moment, now this is one part, you know, if you are fixating on here and I would say anywhere my fixation I am looking at anywhere in this box for more than say 50 milliseconds or more than say 100 milliseconds, I call it as a fixation, it is a fixation.

So, when you are reading something, actually you are fixating from point to point. So you fix it here, then you fix it here, then you fix it here, then you might fix it here something like that. The moment between the fixation right is called saccade, so the transition between fixation is called saccade that is the two key features in the Eye gaze detector.

So, you get a raw data from eye gaze eye detectors, so raw data looks like this, timestamp and the X-Y portion. So raw data looks like this, you know, just a timestamp and X-Y portion. So, what is X-Y portion, for example, if the screen size is you know 900X600 or something, then this will be 900 to 600 because x is 900 so something like that.

Or you can change where to start 00, or how it works is basically it takes the centre, this is actually 00, for me, it actually takes the current value and eye tracker might give you the values in this kind of 00, you can convert it based on the way you want it. So, the raw data looks like this, you know, the timestamp, x portion, y portion.

If you want to know the orientation like your eye movement also it can also be added because it is a point of reference from where you are looking at it. So, the important thing is sample rate, I mentioned in some slides above that there is a sample rate of 60 hertz or 90 hertz, there is Tobii eye nano, it says 60 hertz. What 60-hertz means, they collect 60 samples per second, which means at every 50 milliseconds you will have X-Y portion.

So, the eye gaze is so accurate and in a research in a reading kind of research, the sample rate is around 1300 hertz that is the really recommended version, high rate transition rate because are you looking at each word, at which letter you are looking such kind of analysis, but I would say 90 hertz to 120 hertz or 60 hertz is better, do not go for a high-end kind of sample rate. If we use a webcam-based eye tracker the sample rate will be 25 hertz, it is not much. So you have to make sure that is also an issue there, okay?

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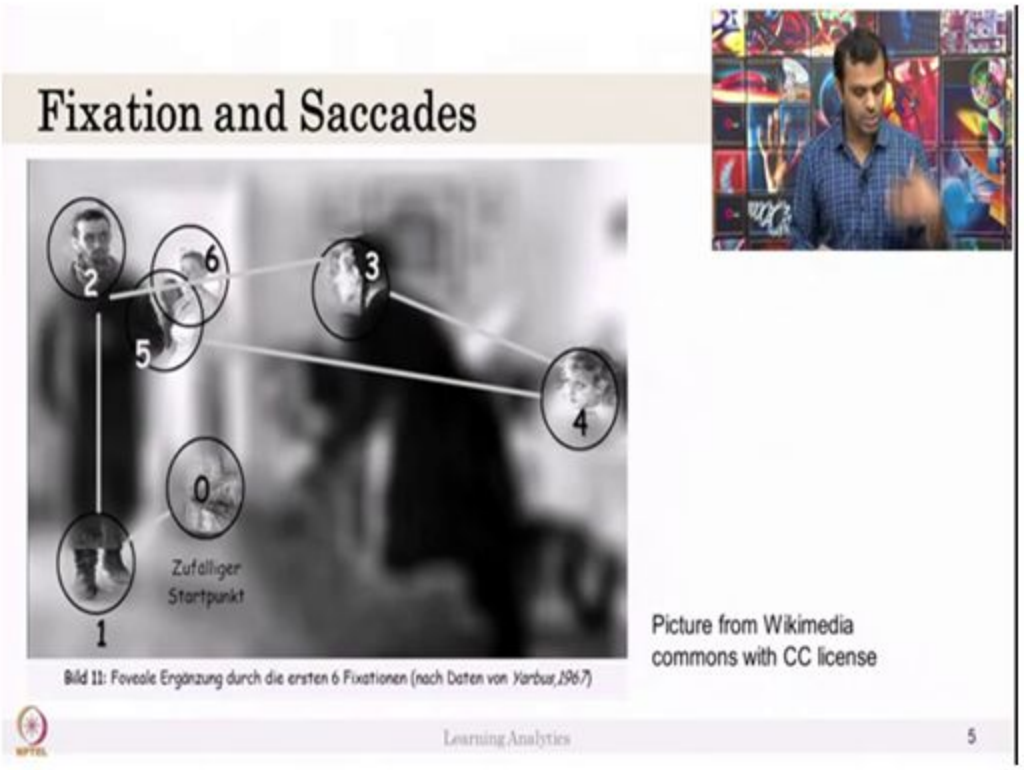

So, I will say what is fixation and saccade, this is a picture from Wikimedia, the creative commons license. So, this person actually fixated on this particular locations, and here first then you fixated at the face then you fixated here then fixated here, fixated here then. So this is how the fixation moment happened. And the line 1, 2, 3, 4 indicates the sequence and this line is a saccade that is a fixation.

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Also, eye trackers give you other kind of information that is called heat map, heat map in the general means that after you look at this particular Wikimedia page after 5 minutes, where you spend more time fixating, it is not talking about sequence or saccade instead it is giving where you focus more, this is a more focused area, these are likely but this area were not actually looked at all.

So this is very helpful if you make advertisements or marketing some product, why are these customers are looking at this spot? So that is what very useful for marketing areas. But we can use this eye-tracking data and get also for the learning analytics that is the whole idea of this.

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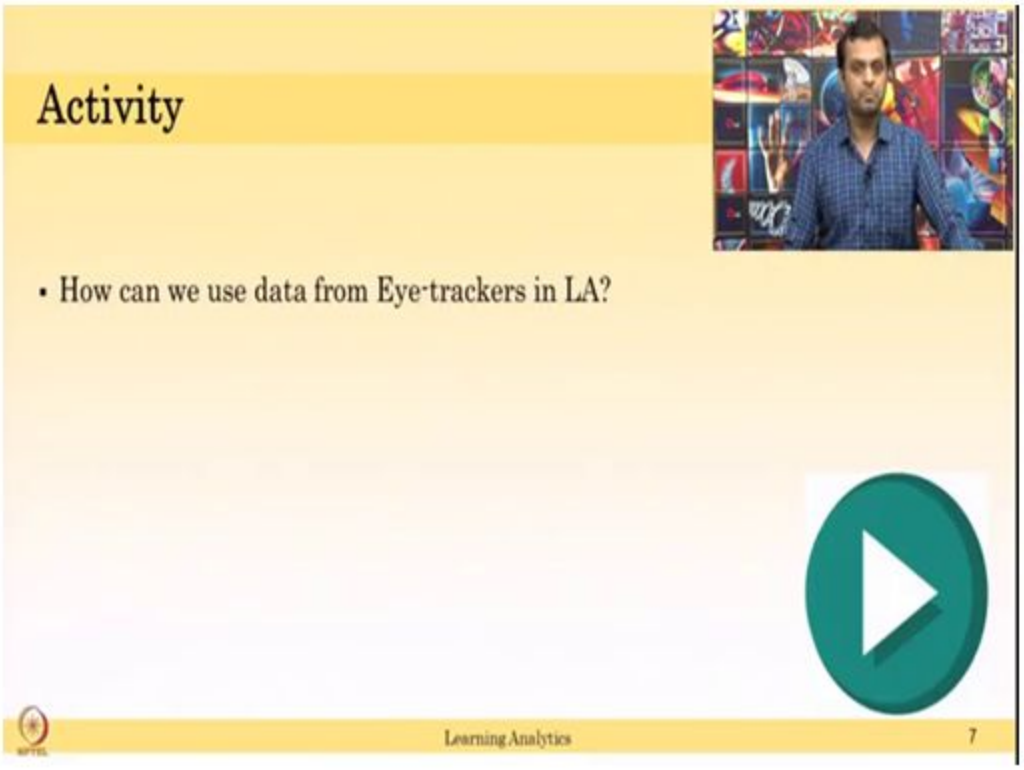

So I said we can use eye trackers for the learning analytics, how can we use that for learning analytics, so I want your answers after that listen to the video to continue.

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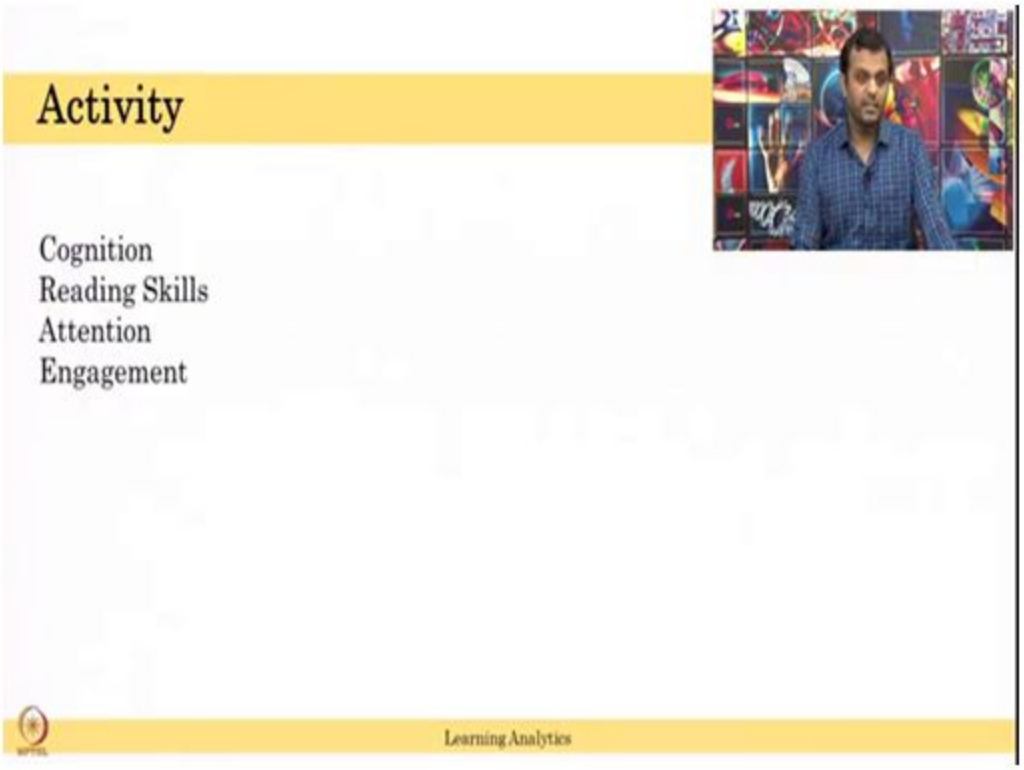

So you can detect learner's cognition, whether they understood things or not, are they reading? Are they focused, attention engagement, the performance, a lot of things can be detected from the eye-tracking data. I will show one example.

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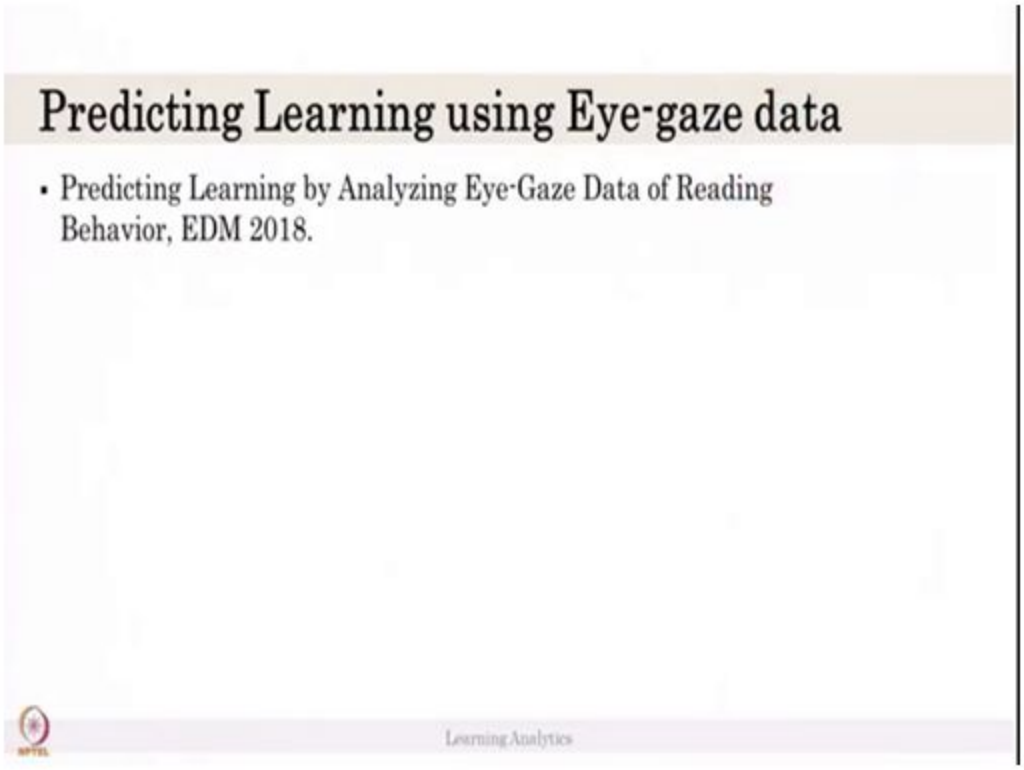

So in this paper, we are predicting learning by analysing eye gaze data of reading behaviour (2018 paper).

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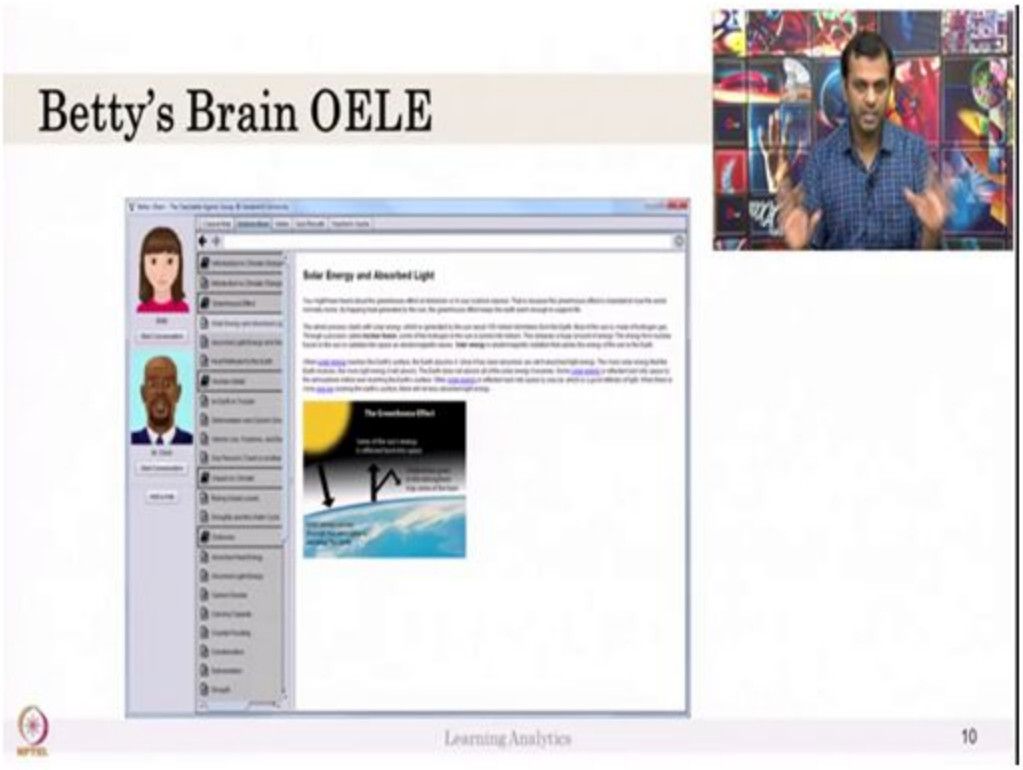

In this paper they use a system called Betty's brain open-ended learning element. What is Betty's brain? I will just give you a very brief about what is Betty's brain. If you are interested go and check the page called Betty's brain from Vanderbilt University. Betty's brain as you know, this is the agent Betty, the student's role is to teach this particular agent to solve a particular problem. Initially, Betty's brain is plain, there is nothing in it. And you can ask your teacher there is Mr. Davis, you can ask him if you need any help. But your goal is to teach Betty.

So in order to teach, you have to understand some climate change or some science concepts, So all the reading materials are given here and there is content, student has to read it, and they can take notes. And after taking notes or after reading it, their goal is to go and create a concept map.

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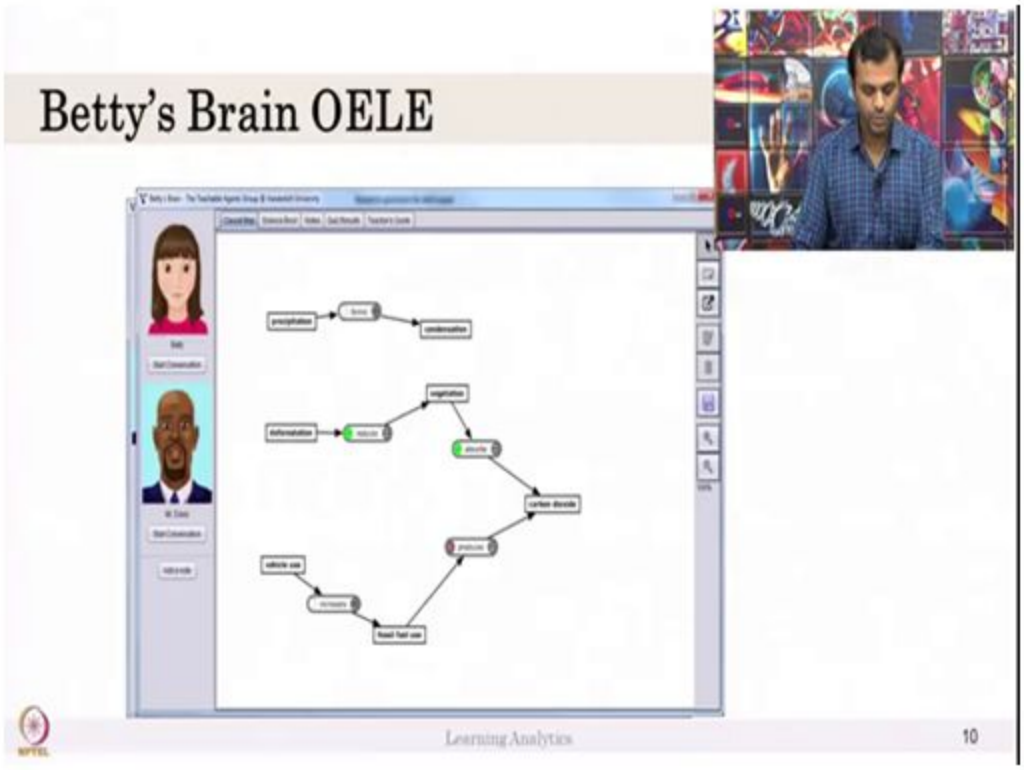

This face is called Betty's brain, initially, it will be empty, then you have to create a concept map, this is a concept and this is a relation between these two concepts, the causal relationship. And this increases the case if deforestation increases, vegetation will reduce decrease.

And this marking red and all is you can mark, it is not the system marking, you can tick mark it as correct. This marking is also based on your taking the quiz and based on answers you can think of it. Then after you create the map, you can ask Betty to take an exam.

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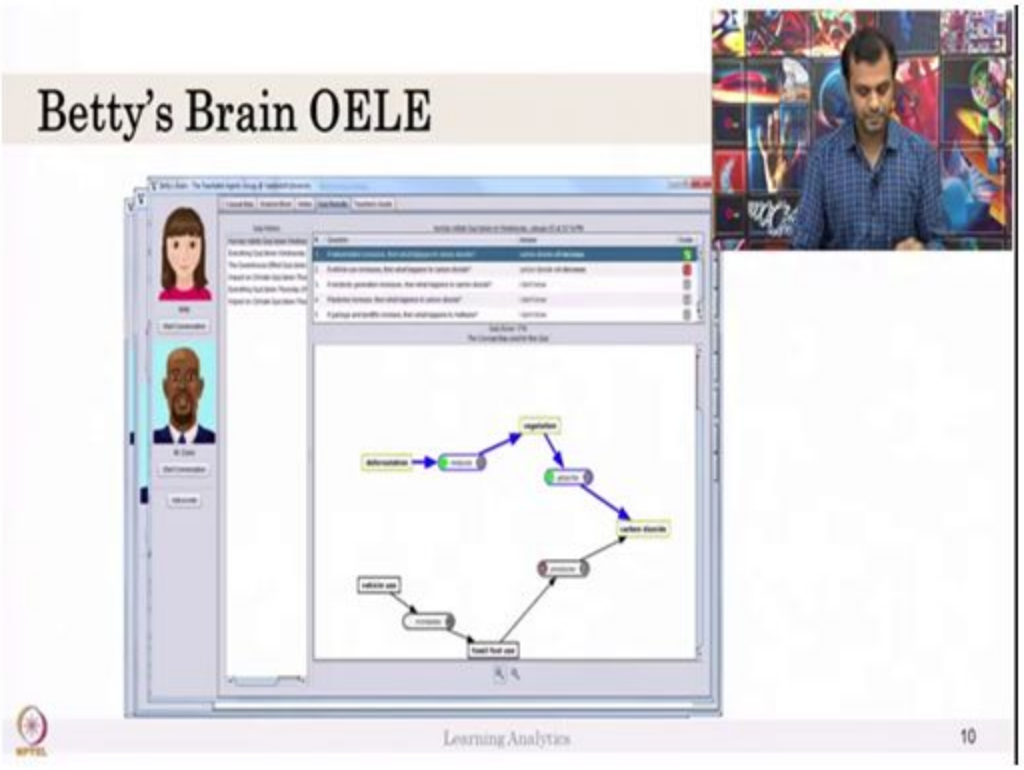

When the Betty takes the exam, you can take the exam on multiple sections or whole chapter or multiple subsections. And when the answers are correct, it is called mock data and if you select it, which particular path is used to answer, this particular question is given here, so you know that these two path is correct.

So then you can mark them in a green mark that is how the student marked here. So the idea is that a student is teaching Betty to do something when the student is not able to do that. It is not the student is failing, the Betty is failing, that is how the feeling goes on, the emotion is actually changed.

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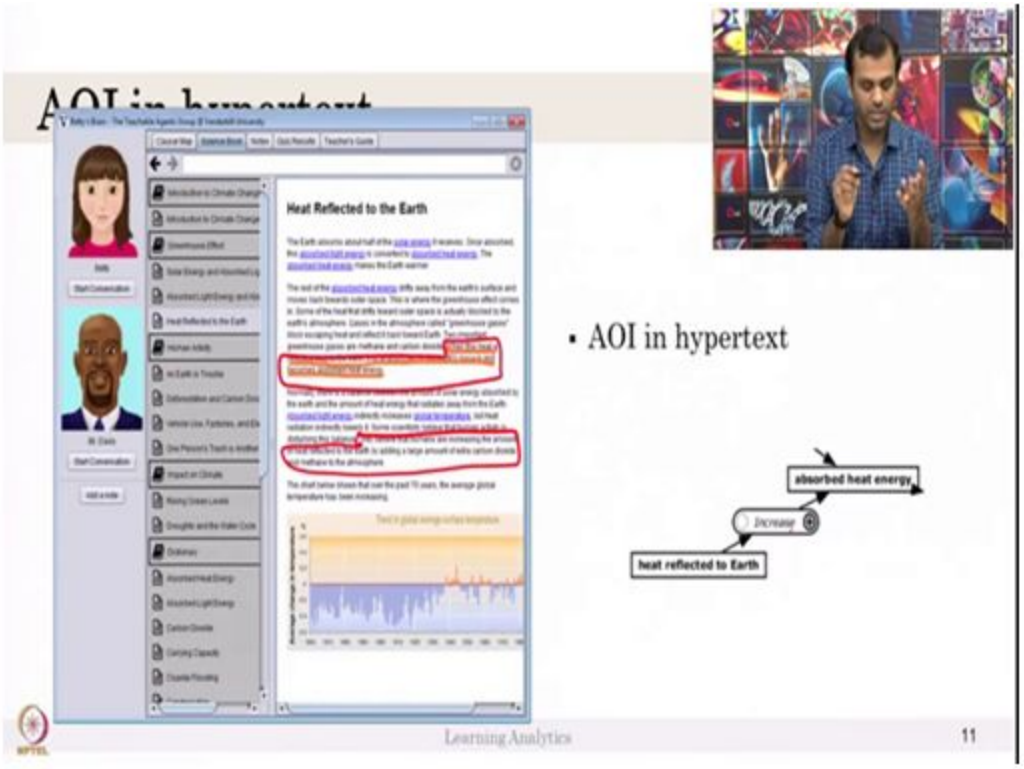

So this is Betty's brain, in this system, our area of interest in each text, I am just going to put the same title here because we will not be hiding it. So, when the student is reading a particular line, when this heat is reflected back to that, it is reabsorbed by the earth surface and becomes absorbed heat energy.

So there are two concepts involved, heat reflected to back head and absorbed heat energy. There are two concepts and there is a relationship, if there's a more heat reflected backwards, there will be more absorbed heat energy, that is how two concepts are related. Consider I am creating relationship between these two. And this heat reflected to earth and absorbed in it. If it increases, absorbed heat and energy also will increase. This is the cause of relationship between these two concepts.

So what I did, I took the science book and I marked each and every sentence here in this whole chapter, like some 7-8 pages, I marked everything mapped to a particular concept, and particular causal relationships, there were only 25 in it. So I mapped it, then I created an AOI know that my AOI is not very minute, but not very big also.

So my AOI is this, something like this, or my AOI be like this. So, whenever a student is looking at this page, and if the student looks at this particular AOI, and if he converts his knowledge to the concept map, it makes the map correctly, I would say that the student understood what he is reading. If the students spent a year still he is not able to convert that into a correct causal relationship, then the student did not understand yet.

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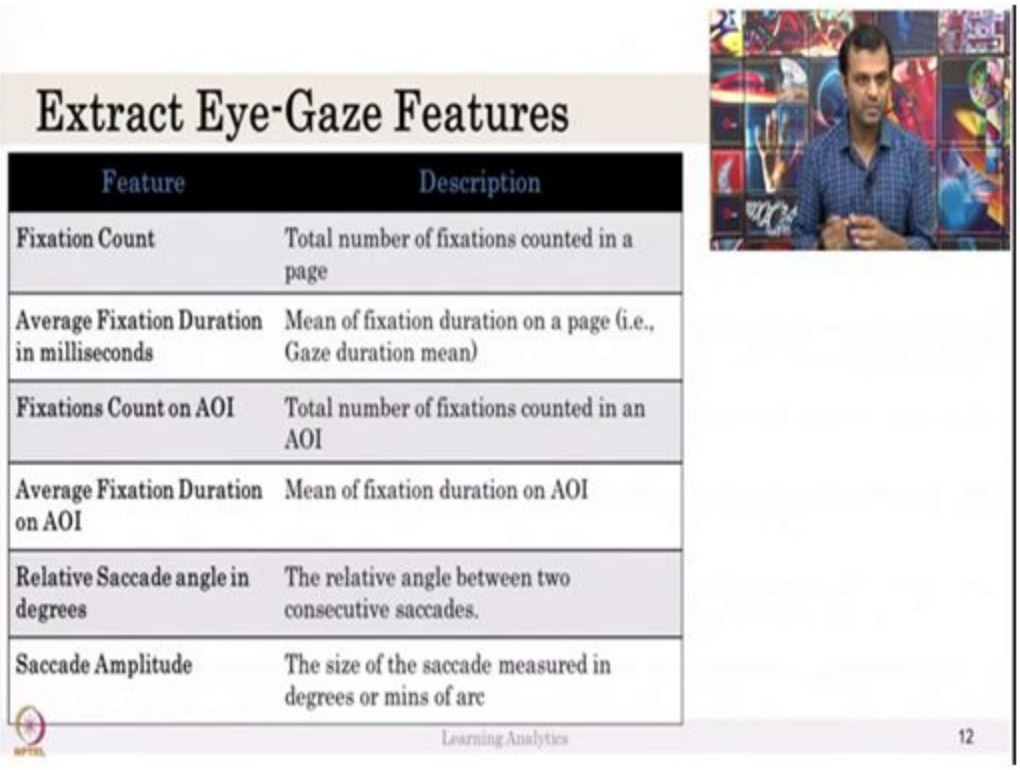

So, using this data, we created simple classifier, and we use the features from the eye gaze data, like a fixation count, fixation count on the AOI, average fixation on that particular AOI and saccade angles, saccade amplitude, kind of more extended features from the fixation and saccade only.

By using this Eye gaze features from the eye trackers on the exact AOI, and the corresponding concept map or corresponding relation between two concepts we label them and we try to predict the student's ability to make the concept correct just by the Eye gaze, information.

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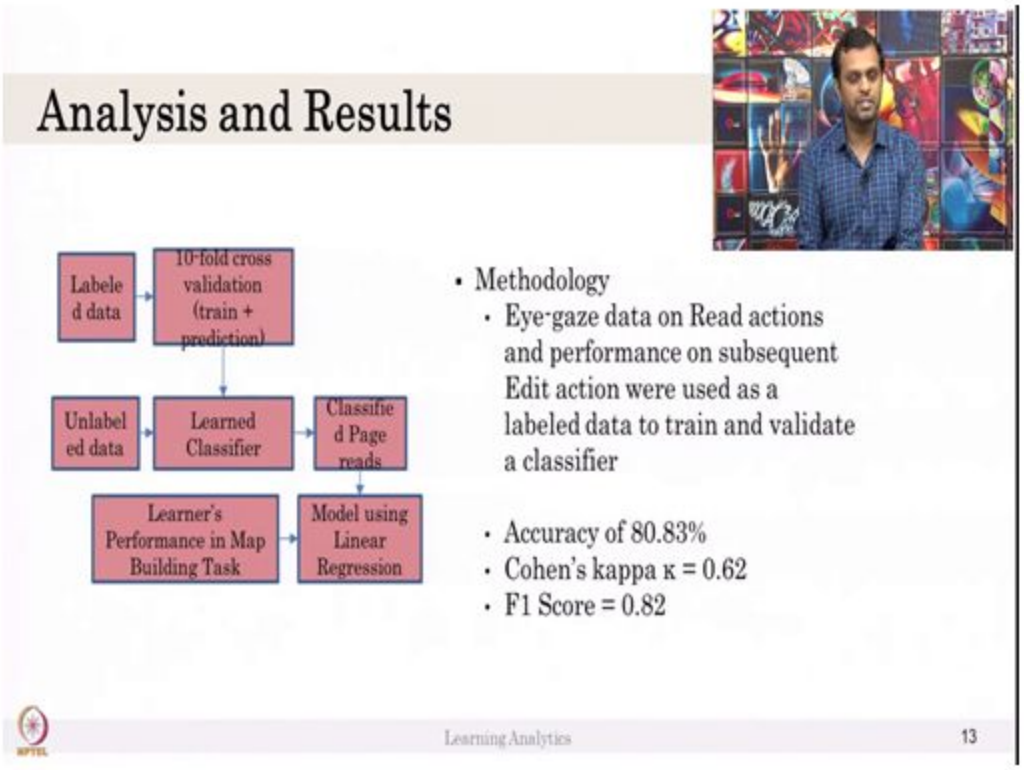

So Eye gaze data and read actions and performance of subsequent edit actions are used to label data to train and validate classifiers, this is a simple idea that label data we use 10 fold cross-validation kind of prediction, and unlabelled data is given to the classifier, the classified pages are read.

Then we used to have a linear equation to model the student's ability to classify the information, whether they are able to pass it, are they able to create concept map correctly or not, just based on the eye gaze data, and we got a good accuracy to say 80 per cent, but Cohen's kappa is really good.

It indicates that just by looking at student's fixation, saccades and on particular AOI, we can tell whether the student understood the concept or not at 80 per cent accurately, that is what this whole exercise is about. So, what I am saying is if we use eye tracker, webcam or any eye tracker and you can actually predict where the student is learning, is the student learning, is he really learning, is just simply reading, his reading is converted to knowledge or not, these kinds of information can be obtained and can be predicted easily by using eye trackers.

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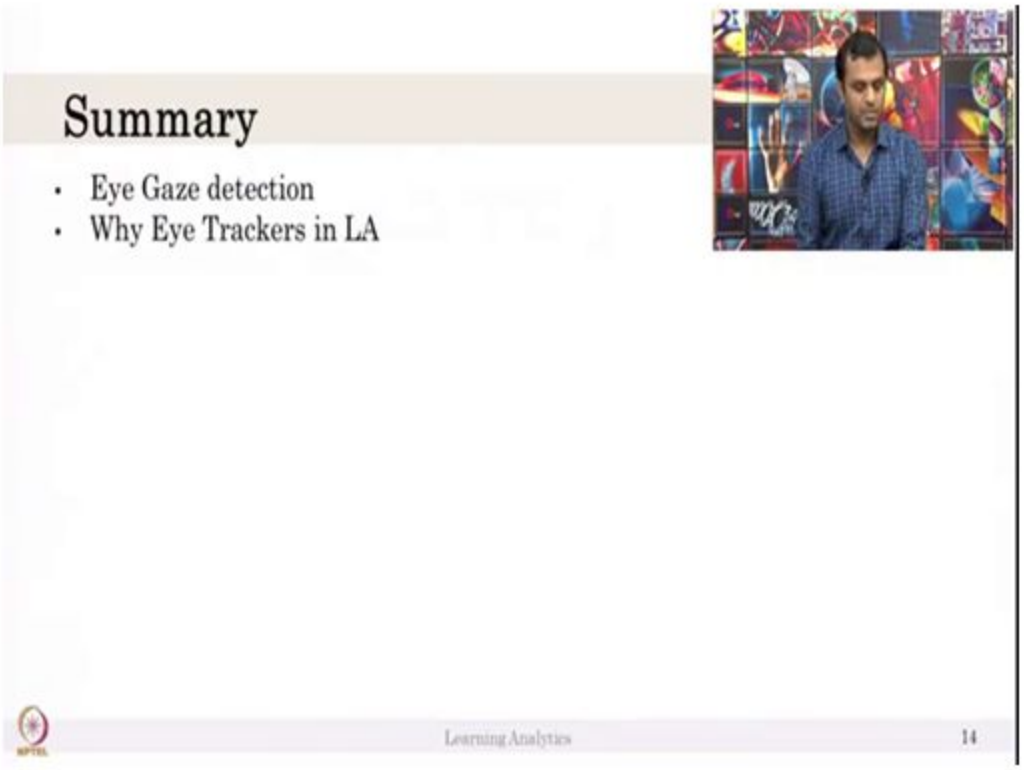

So, in this slide we saw what is Eye gaze deduction and why eye trackers are used in LA and I also give one example. In this week we saw that I try to motivate you there will be data not just from log data or the human observers, we can have a data about the students facial expressions, data can be collected from different sensors like Eye gaze detector or GSR other data.

And we can combine this data to provide a complete model of the learner like a holistic approach. The challenge in multimodal learning analytics is combining data and providing the useful information to students. That is still a challenge and a lot of people are working on that. And I motivated you on a field called multimodal learning analytics. As I mentioned, this is not a one week lecture, but it needs almost a semester course to teach multimodal learning analytics and play with the data. So thank you, next week that is our final week, we will talk about next steps in learning analytics. Thank you.