Affective Computing

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Week - 07
Lecture - 22
Tutorial Emotions in Physiological Signals

Hello, I am Shrivatsa Mishra. In the last lecture, we saw how we could use PsychoPy to present stimuli as well as collect sensor data. PsychoPy allows us to integrate several devices to collect multiple different types of data including physiological signals. Since we have also seen how emotions can be extrapolated from physiological data, in this lecture, I shall explain how we can analyze Electrodermal Activity or EDA using Python.

EDA has been closely linked to autonomic emotions and cognitive processing. And EDA is widely used as a sensitive index for emotional processing and sympathetic activity. Investigations of EDA have also been used to eliminate wider areas of inquiry such as physiology, personality disorders, conditioning and neuropsychology.

We shall use sample EDA data collected through an Empatica E4 device. This is a device that can be worn and streamed data through Bluetooth or store that data locally. We can extract that data using an Empatica E4 app and for analysis, we will use flirt module in Python.

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Hello, I am Ritik Vatsal and I will be introducing you to the Empatica E4 wristband data collection device. The Empatica E4 is a wristband that collects your physiological data. It has a single button and a LED light on the surface and two sensor points on the back with electrodes that need to touch your skin when you wear the device. To wear the device, just place it on your wrist with this side on the top and just make sure that it is comfortable enough that you can do daily task.

But it is tight enough that both the electrodes at the bottom touch your skin at all times. After that, we are ready to start the device. To start the device, just press and hold the top button for three seconds. A blue light would come on indicating that the device has started.

The blue light would start blinking for about 15 to 20 seconds while the device initializes the setup and checks all the sensors and all. After the watch has finished blinking for up to a minute, the light turns red. When the light is red, you know that the recording has started.

After some time, the red light would fade off and the light would turn black. That would mean that the data is still being recorded, but the watch has turn of the light to preserve battery. While recording, you can single press the button to mark events in real time on the watch like this.

The watch light would again turn on for a small time. Finally, to turn off the watch and stop the data from stop data recording, you can just press and hold the button for three seconds and that is it. The watch has now stopped data recording.

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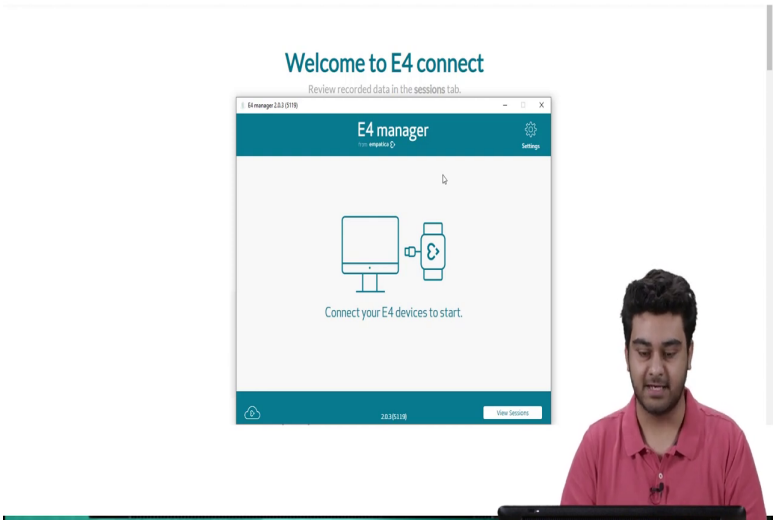

This is the splash screen of the E4 manager device that you would be greeted by when you will first log into the application. On this screen, you now need to connect your device to the USB port on your laptop or PC. I will do that now, ok.

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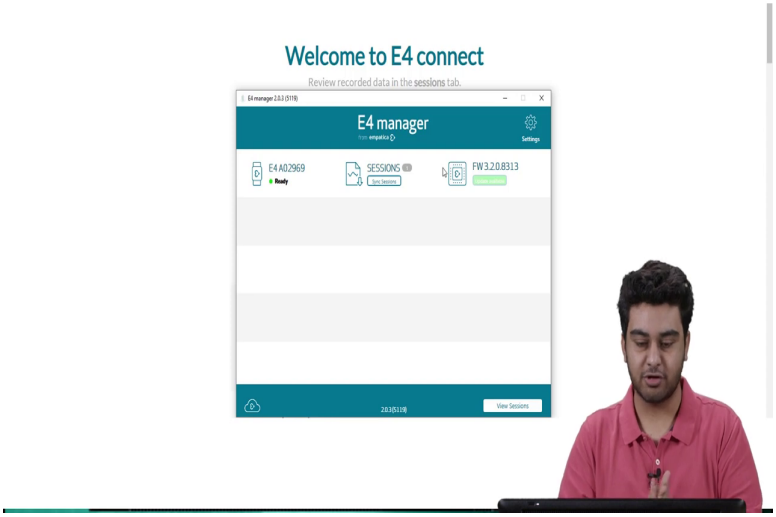

Now, as you can see, my watch is ready and I see the one session that I just recorded. To move forward with this, I just simply click the Sync Sessions button and all the sessions would be synced and would be available for me to view, ok.

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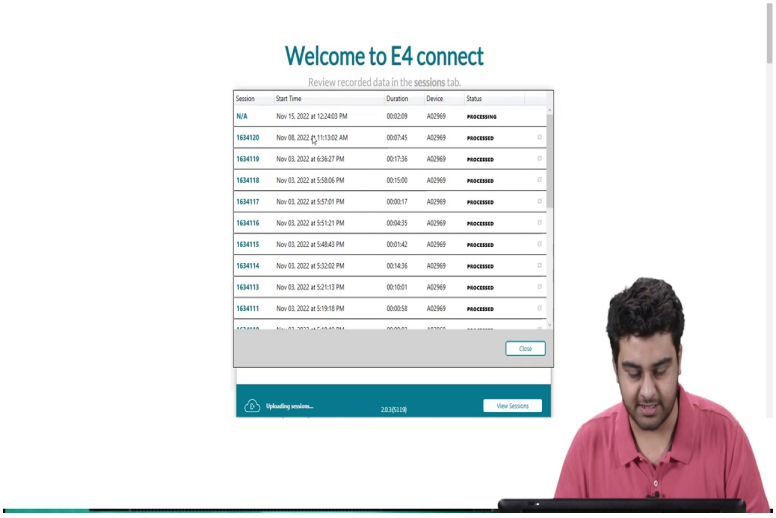

Now, we can click the view session button and we can see all the sessions that have been recorded. This is the session for today's date which has just been processed, ok. By clicking this button, we can view more about the session, yeah.

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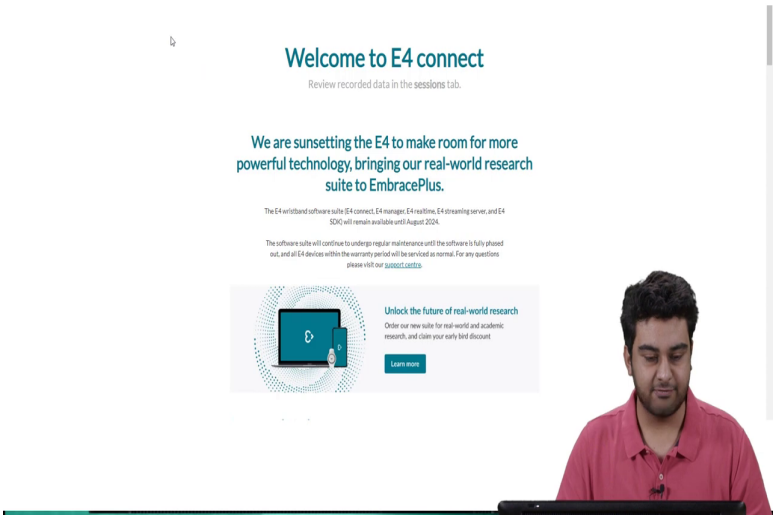

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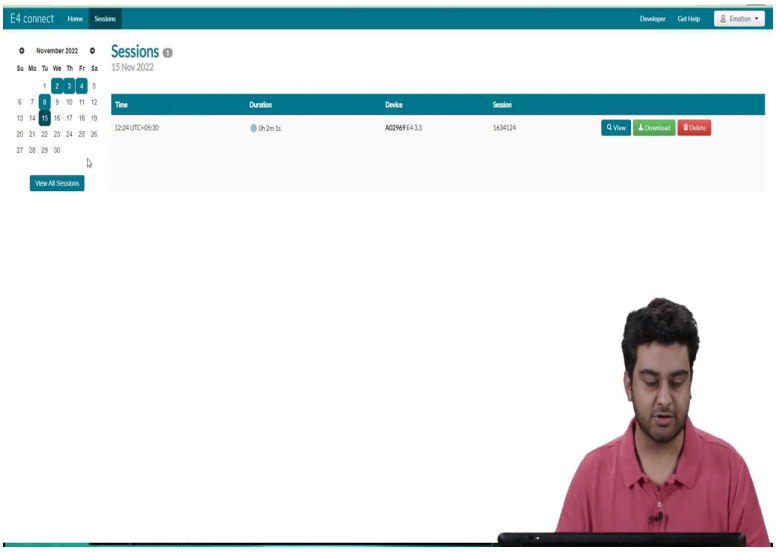

So, this is the E4 website where all the session details are stored. You can just click on the sessions icon and there. The sessions are sorted in a date wise manner which you can see in the top left menu. We just click on today's date and we can see today's session which was of 2 minutes and 1 second. We can either download this or view this in more detail.

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The red lines denote the markers that we placed on the watch by pressing the button. By going back to the Sessions menu, we can download this whole session in a zip file format.

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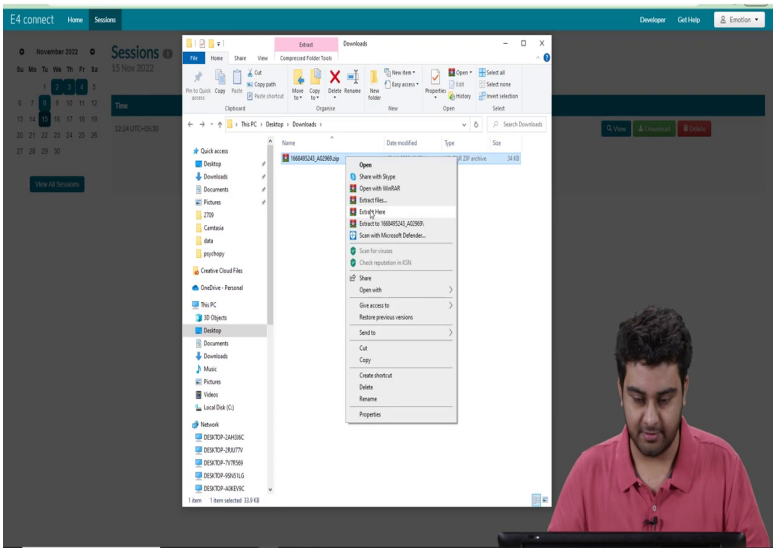

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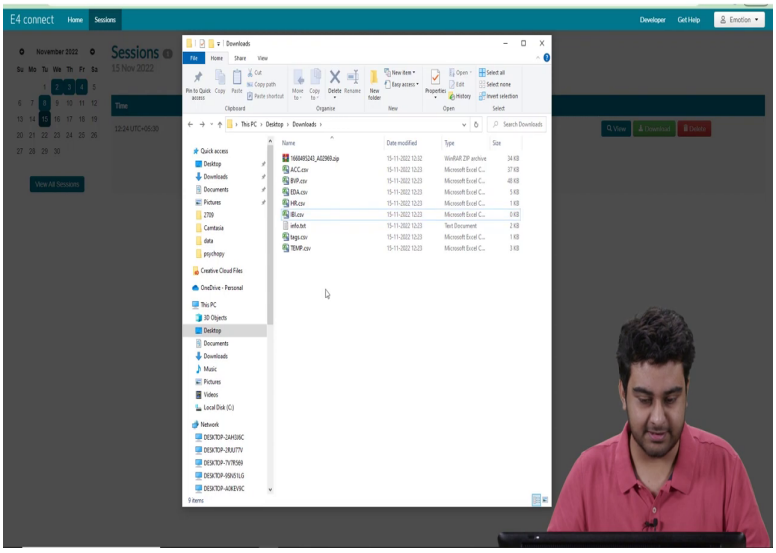

So, after we download the zip file, we can simply extract the file, extract here and we will see all the different modalities that the device has recorded in a simple and convenient CSV format. Shrivatsa will explain how to extract the data further from this. Thank you.

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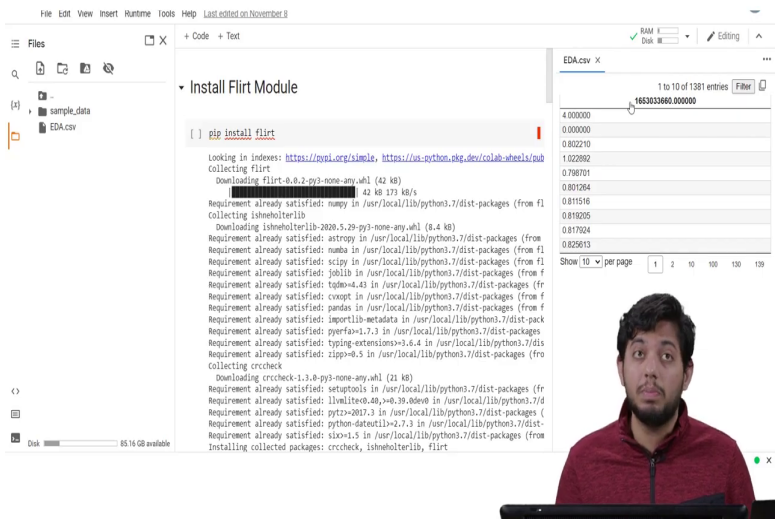

The Empatica E4 device provides us with multiple types of data such as the heart rate variability; inter beat intervals as well as electrodermal activity. For this assignment, we should just be using the electrodermal activity. Now, this data is stored in a CSV file. The first value in the CSV file is the start time of the entire data. This is stored locally on the Empatica E4 or using the computer if you are streaming it on (Refer Time: 05:13)

You can reset the clock according to whatever system you want by just connecting it and using the Empatica app. The second value is the frequency at which the data is collected. This is in hertz. So, since the example for the EDA is 4, it means 4 data points are collected every second. Now, let us move on to the code. For this, I shall be using Google Colab as it is easy to use and readily available.

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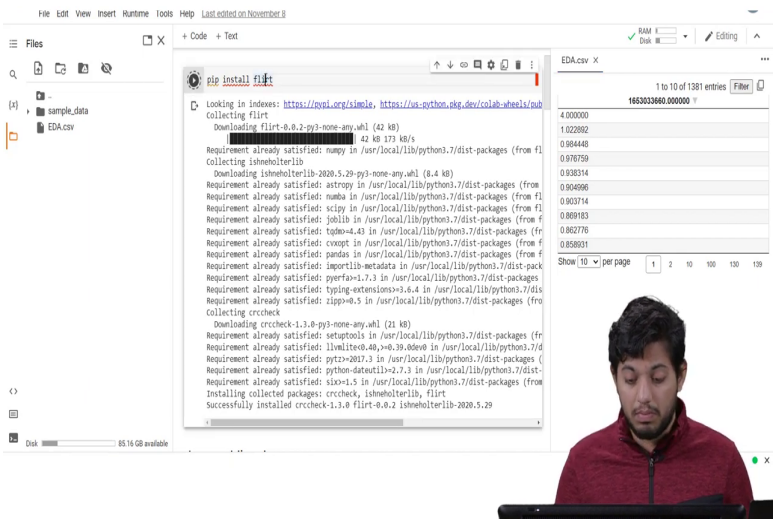

The data used is 5 minute sample collected during another study using the Empatica E4 itself. We will start by installing flirt module in Python using the pip command. This will take some time, but flirt is a library that will allow you to extract the data very easily as well as extract the features from the same data.

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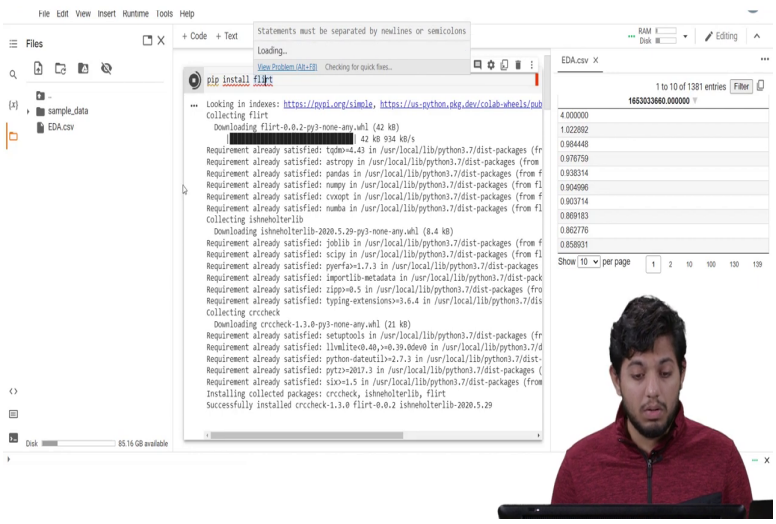

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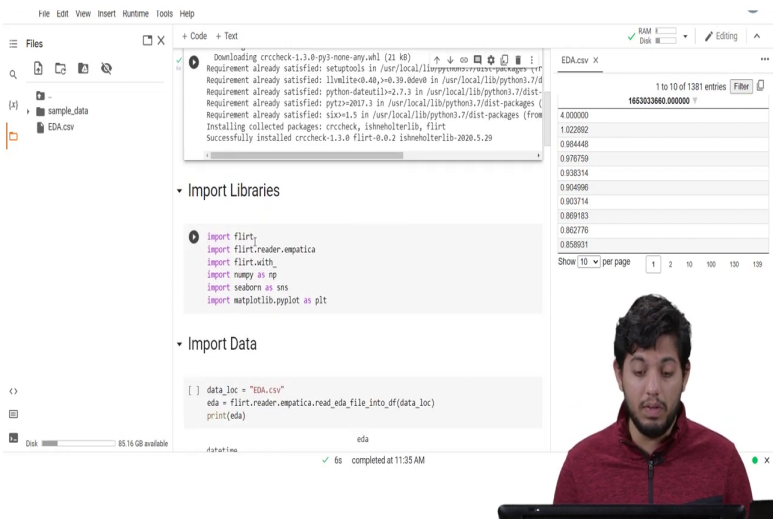

Now, that this has been installed, we will import the library. We will be importing flirt library as well as its reader. We will also be importing NumPy, C-Born as well as Matplotlib to graph the data itself.

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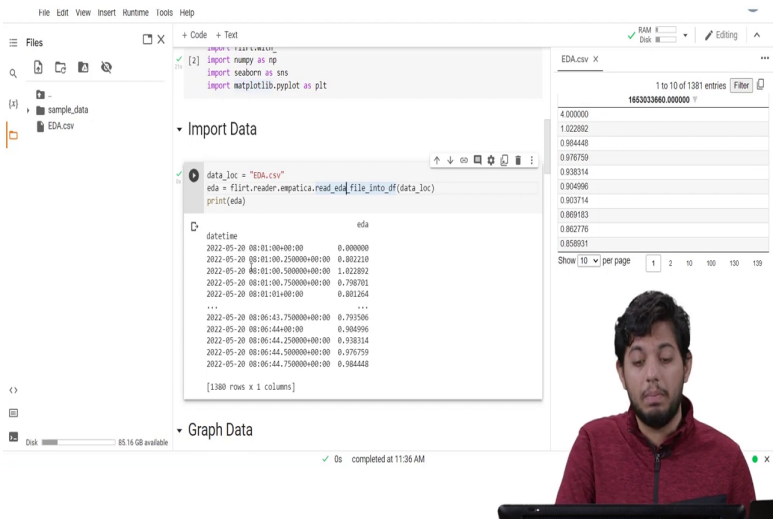

Importing these libraries usually takes some time. Now, that they have been imported let us import the data itself. The data is stored in an EDA dot csv file and we can simply get it through an reader function in the flirt module itself. Upon running it and printing it, we find that this is stored in a data frame.

A data frame is a pandas data type and in this, there are two columns. The date and time of when it was recorded as well as the EDA value for that. Since we know as we know the frequency is 4, therefore, as we see every successive frame is at a difference of point two fifth of a second.

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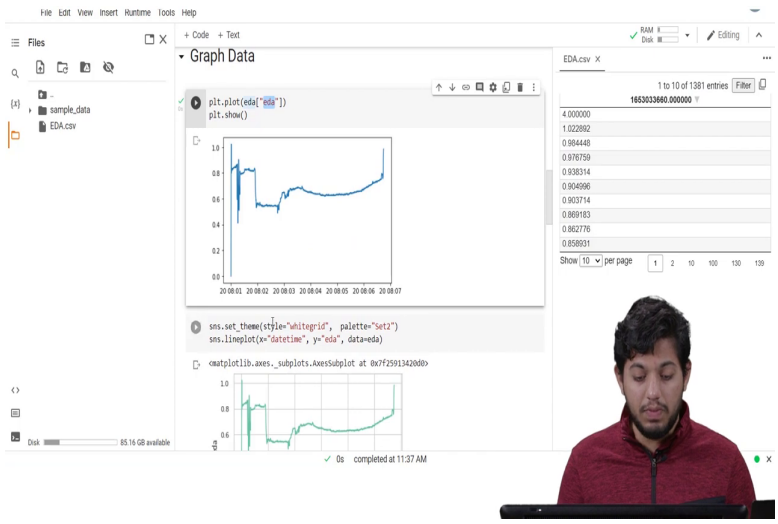

Now, let us just graph this data naturally. So, there are two ways we can graph. We could use Matplotlib or C-Born. I can show you using both. So, for Matplotlib, we will just use the plt dot plot function and plot the eda value in this as well as using the C-Born function.

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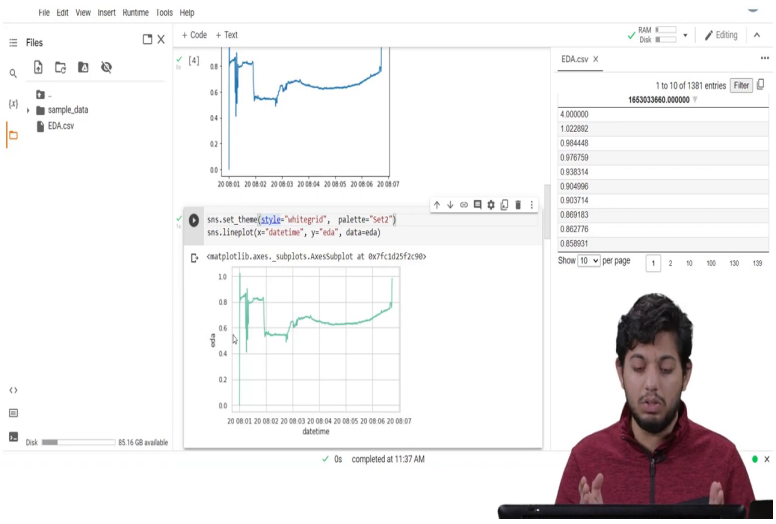

As we can see at the start, there is a large variation. This can be ignored as we usually take smaller chunk.

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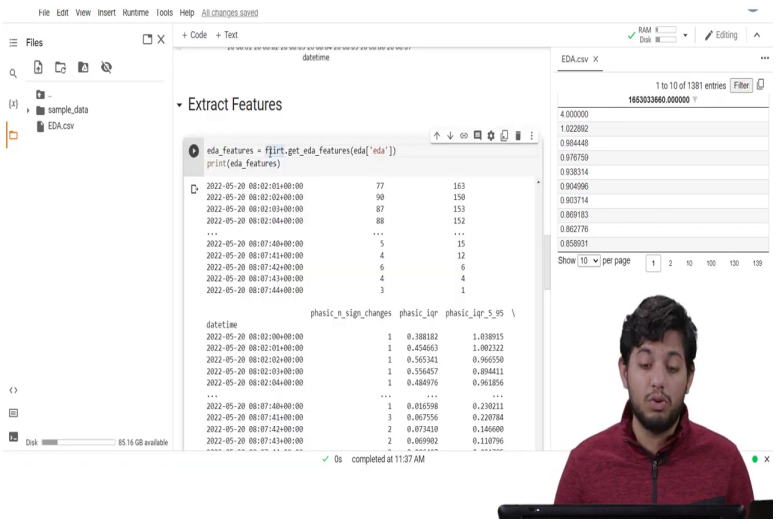

Next, let us move on to extracting the features. We can simply use the get eda features function in the flirt module to get the features. This will take some time. Now, that we have got the data.

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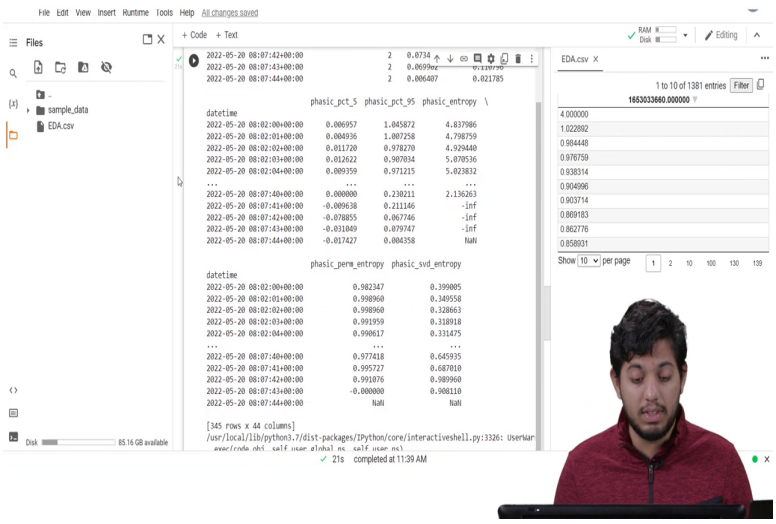

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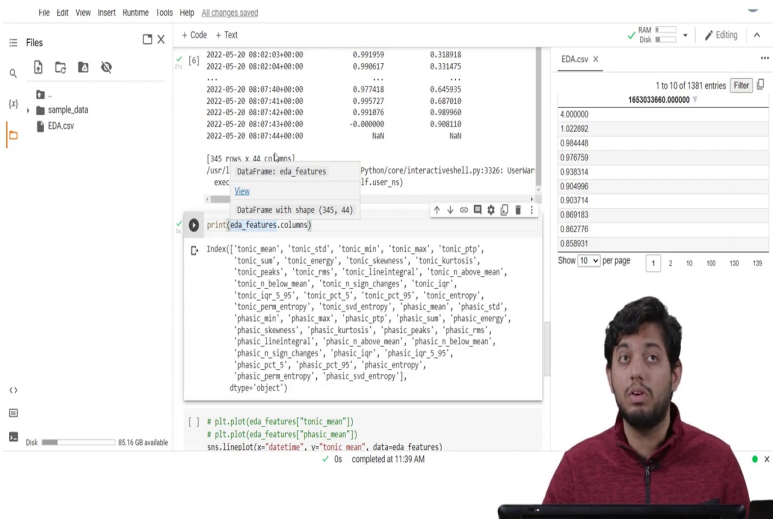

We can look at what all features it has extracted. There are two main components to the overall complex refer to as the eda. The first is the tonic level eda. This relates to the signals slower acting components as well as background characteristics. The most common measure of this component is the skin conducting level on SEL.

And changes in the SEL are thought to reflect general changes in the autonomic response. The other components is the phasic component, which refers to the signals faster changing elements. The Skin Conductance Response or the SCR is what is the major component in this.

Recent evidences suggest that both components are important and rely on different neural mechanisms. Crucially, it is important to be aware that the phasic SCR, which often receives the most attention, only makes up a small proportion of the overall EDA complex.

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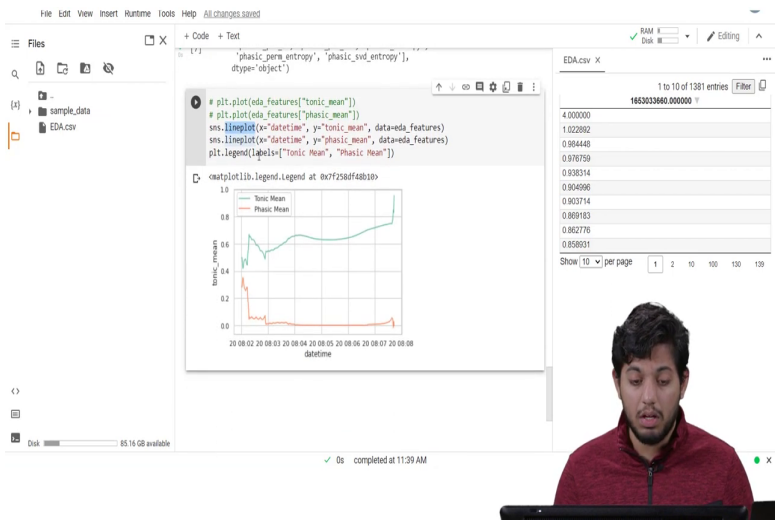

Now, let us graph the two different values. First, we have the tonic value as well, tonic mean as well as the phasic mean. We graph this using C-Born, this lineplot function. Over here, we put the x value as the datetime in the y value as the tonic mean. Upon graphing it, in our case, we obtain this graph. As we can see, the tonic value is always greater than the phasic value. This is because as stated, phasic values make up a smaller percentage of the total value as compared to the tonic values.

In summary, what we have done is imported the library for flirt, imported the data which stored in a CSV file, read it, graph the base EDA data, extracted the phasic and tonic levels

from the EDA data, as well as graph them. Using just these two basic datas, we are able to extract a lot of different things about the data itself and we will need to look into greater depth into these to understand more. Even now, there is much research being done on the field and new advances are being made.

Thank you for listening to me.