Deep Learning
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Lecture – 02
McCulloch Pitts Neuron, Threshold Logic, Perceptrons, Perceptron Learning Algorithm and Convergence, Multilayer Perceptrons (MLPs), Representation Power of MLPs

So, welcome to lecture 2 of C S 7015 which is the course on deep learning. So, we will talk about McCulloch Pitts Neuron Thresholding Logic, Perceptrons and a Learning Algorithm for Perceptrons and talk about the Convergence of this algorithm, and then we will talk about Multi layer network of Perceptrons and finally, the Representation Power of perceptrons.

So, let us start module 1, which is on biological neurons. So, remember during the history we had started all the way back in the 1880s when we spoke about biological neurons. So, we will just start there spend a few minutes on it and then go on to the computational models which is McCulloch Pitts neuron.

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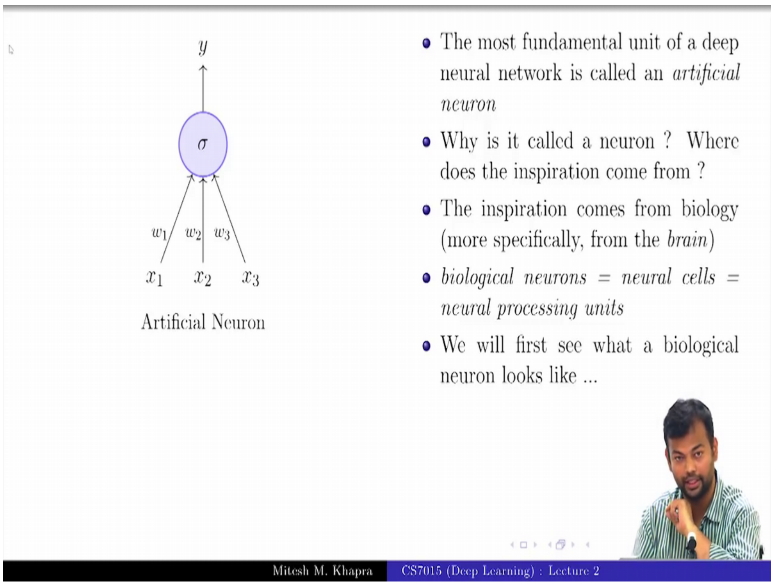

So, now this is a course on deep learning. So, we are going to talk about deep neural networks now the most fundamental unit of a deep neural network is something known as an artificial neuron.

And the question is, why is it called a neuron right, where does the inspiration come from right. So, we already know that the inspiration comes from biology and more specifically it comes from the brain, because we saw that way back in the 1890s, this term neuron was coined for neural processing units or the cells in our brain right.

So, now before we move on to the computational neurons or the artificial neurons, we will just see the biological neurons in a bit more detail and then we will move on from there right.

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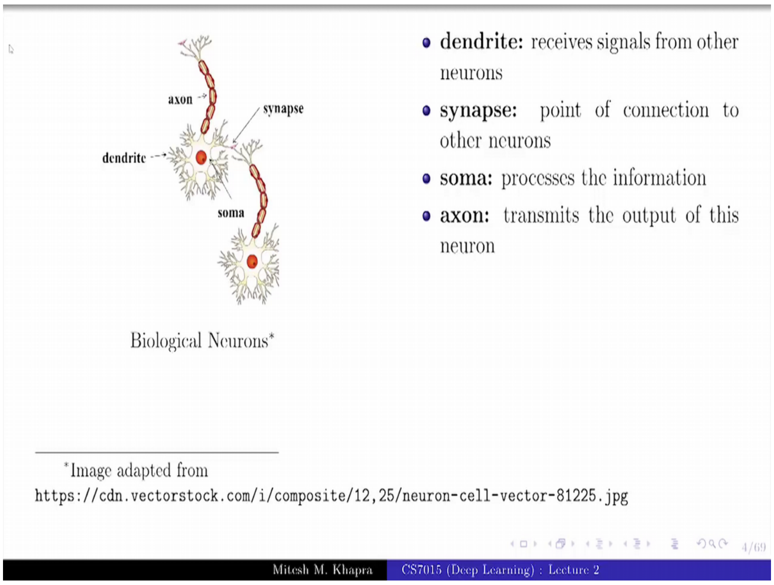

So, this is what a typical biological neuron looks like. So, here actually there are 2 neurons ah. This portion is called the dendrite, so it is used to receive inputs from all the other neurons right.

So, that is the place where the input comes in. Then remember we said that in 1950s we discovered that these neurons are actually discrete cells and there is something which connects them. So, that connection is called a synapse and it decides the strength of the connection between these 2 neurons. So, there is an input, there is some strength to the connection.

Then once this neuron receives inputs from various other neurons, it starts processing it right, so that is the central processing unit which is called the SOMA, and once it is done this processing it will, it is ready to send its output to other set of neurons right. So, that output is carried on by the axon. So, we have inputs, we have some weights attached to the input, we have some processing and then an output right. So, that is what a typical biological neuron looks like.

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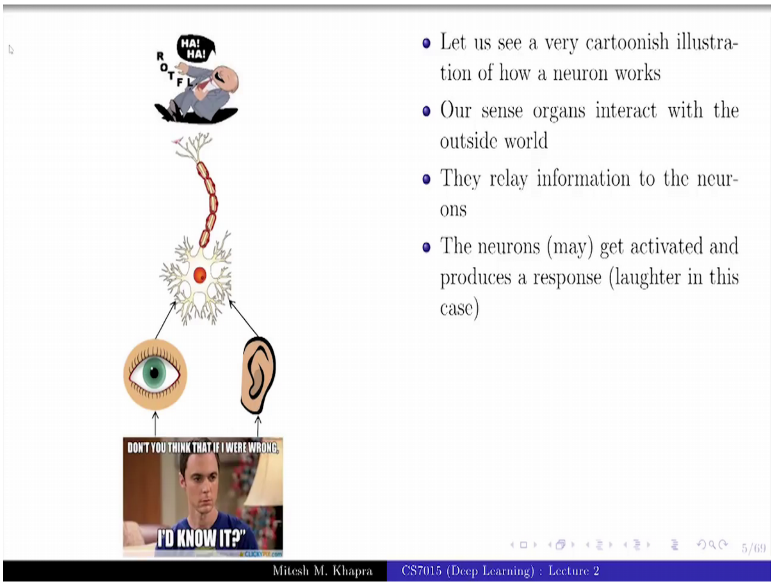

And let us see a very very cartoonish illustration of how this works right, how the neuron works. So, our sense organs interact with the outside world and then they pass on this information to the neuron and then the neuron decides whether I need to take some action. In this case the action could be whether I it should laugh or not right, whether the input is really funny enough to evoke laughter. So, if that happens this is known as something that the neuron has fired.

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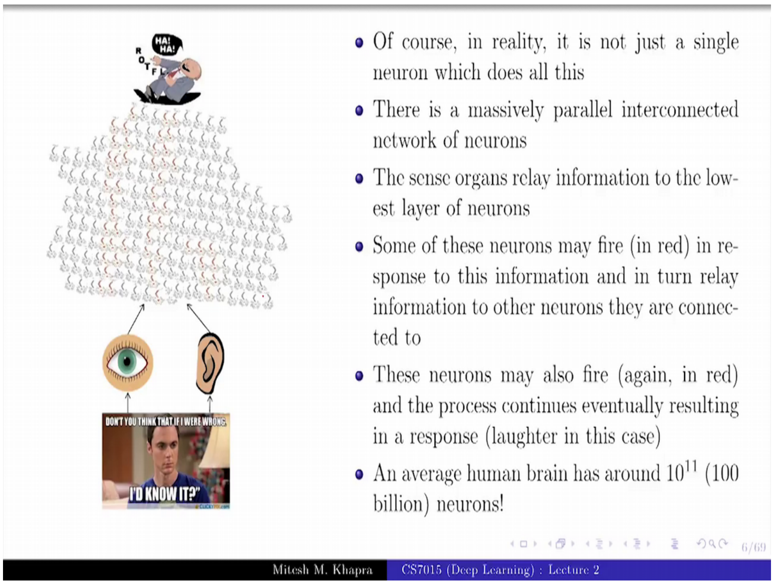

Now, of course, in reality it is not just a single neuron which does all this. There is a massively parallel interconnected network of neurons right. So, you see a massive network here. Now the neurons in the lower level site, so these neurons. They actually interact with the sensory organs, they do some processing based on the inputs, so they decide whether I should fire or not.

And if they fire they transmit this information to the next set of neurons right and this process continues till the information is relayed all the way back and then finally, you decide whether you need to take any action or not, again in which this case it should be laughter right, so that is how it works. And when I say massively parallel interconnected network I really mean it, because there are 10 raise to eleven which is roughly 100 billion neurons in the brain right.

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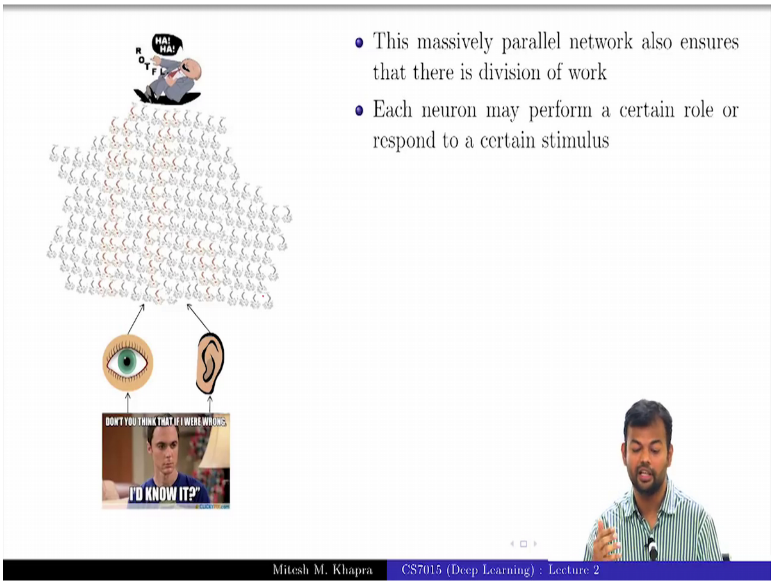

Now, this massively parallel network also ensures that there is some division of work. Now what do you mean by that is not that every neuron is responsible for taking care of whether I should laugh or not or not every neuron is responsible for processing visual data, some neurons may possess visual data, some neurons may possess speeds data and so on right. So, there is this division of work, every neuron has a certain role to play;, for example, in this cartoonish example that we took right.

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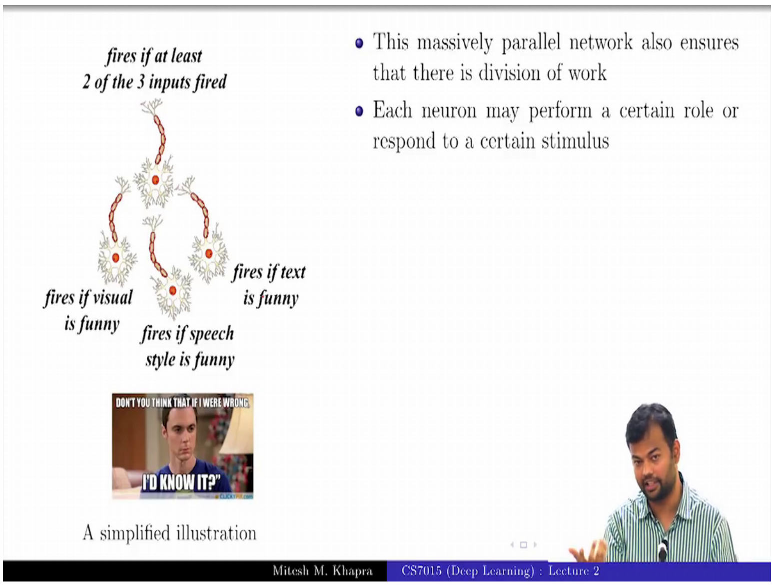

So, there might be this one neuron which fires if the visuals are funny right whatever you are seeing is funny. There will be one neuron which finds Sheldons speech to be funny right, the way he speaks, so that might be funny and there might be another neuron which actually files the dialogue content to be funny right. And now all of this pass on the information to the next level and this guy would fire if at least 2 of these 3 inputs are funny right. So; that means, I have some threshold based on which I decide whether to react or not right, if it is really funny then only I laugh it; otherwise I will not laugh right.

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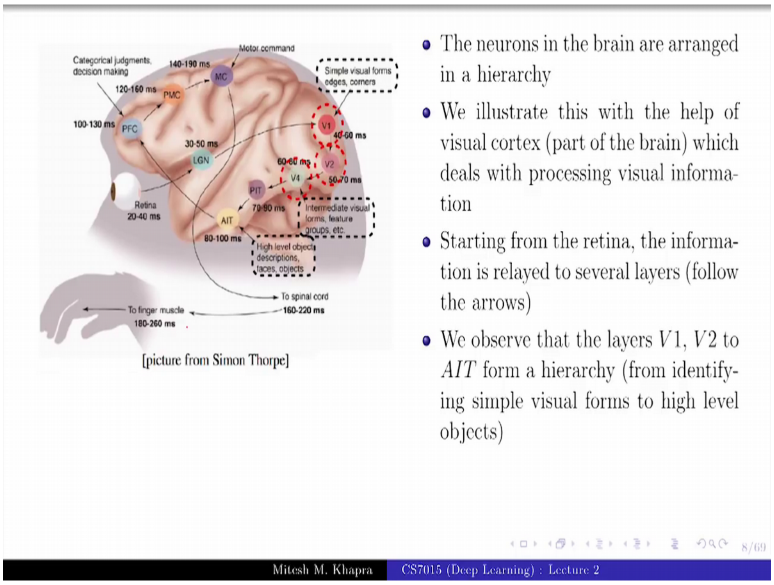

So, the neurons in the brain as was obvious in the previous slide are arranged in a hierarchy and I will take a more realistic example, where we look at the visual cortex. So, is this is the portion of the brain, which is responsible for processing visual information right. So, as you see here you have our retina from where the information starts flowing, and it goes through various levels right.

So, you see, you follow the arrows and you will see there are several levels; there is one level here, then another here another here and so on right. So, it is again as I was trying to illustrate in that cartoon the information is relayed through multiple layers, and then it goes all the way back to the spinal cord which decides that, in this case I need to move the muscle right.

So, that is what is being decided here right. So, the information flows through a hierarchy of layers. And in this particular case I am going to focus on these three circled layers which are V 1 V 2 and A I T right. So, these actually form a hierarchy and let us see what this hierarchy does right.

So, at layer 1 you detect edges and corners. So, I am looking at you all, I just see some dots and some shapes, so that is what layer 1 recognizes. I just recognize some edges and some dots and so on.

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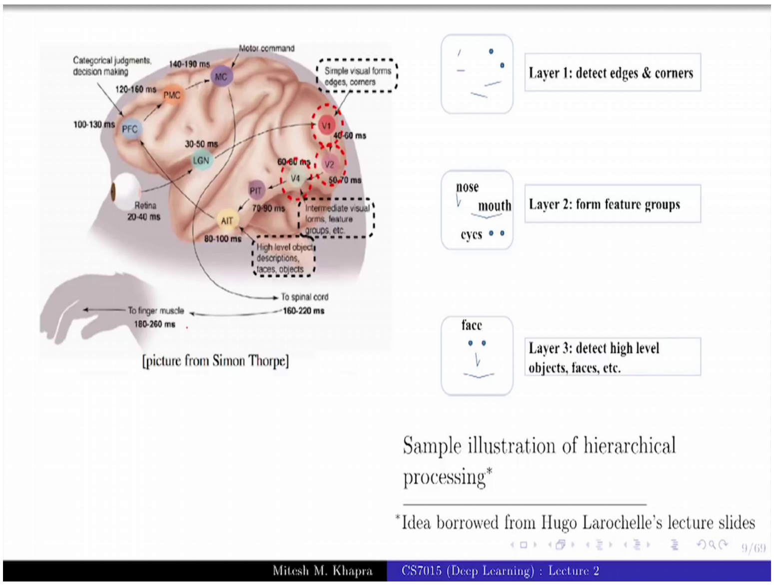

Now, layer 2 tries to group all of these together and come up with some meaningful feature groups right. So, it realizes oh these 2 edges actually form the nose, these two dots actually form the eyes and these 2 edges actually form the mouth right. So, that is slightly higher level of processing that it is doing and then layer 3 further collects all this and leads to higher level objects right.

So, now it is realizing all these things put together is actually a human face right. So, you add edges and circles or dots, then you had some feature groups and then the feature groups combine into objects right. So, that is how this hierarchy processes.

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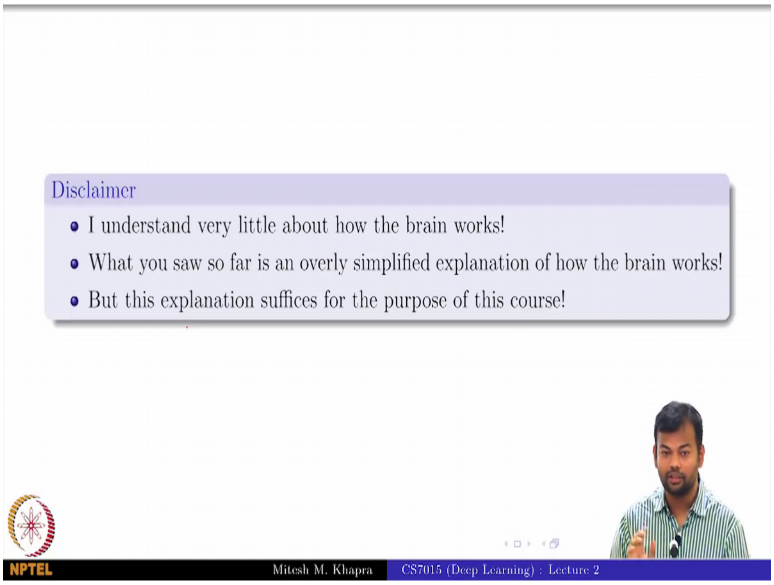

So, here is a disclaimer, I understand very little about how the human brain works right and what you saw is a very oversimplified explanation of how the brain works right. What I told you is there is an input a layer of networks which does a network, which has many layers which does some processing and then you have an output right; that is the very simplistic view that I gave you. This is an oversimplified version, but this version suffices for everything that we need for this course right. This is not a biology or a neural processing course right. So, it is enough for this course. So, that is where we will end module 1.