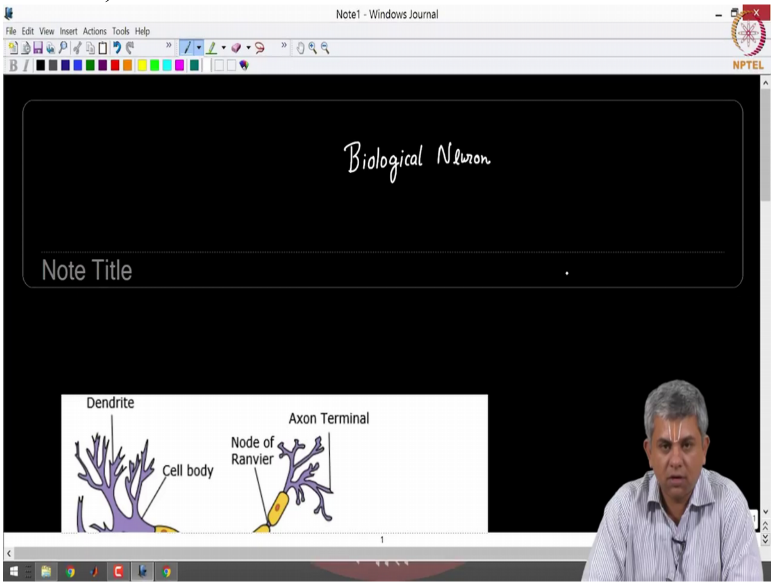
Machine Learning for Engineering and Science Applications
Professor Doctor Balaji Srinivasan
Department of Mechanical Engineering
Indian Institute of Technology Madras
Biological Neuron

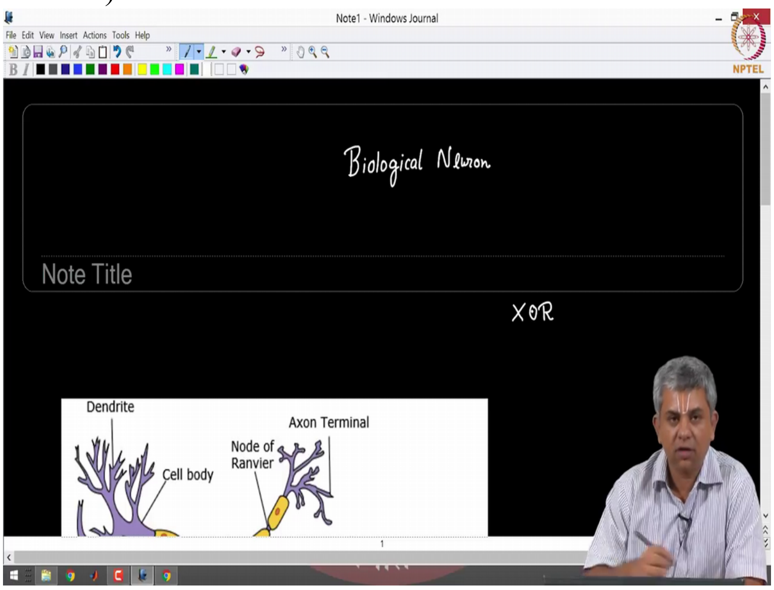
(Refer Slide Time: 00:13)



Welcome back. In this video we will be looking at the basic idea of a biological neuron. The reason for talking about this is historical.

As we saw in the last videos, when we looked at the XOR gate,

(Refer Slide Time: 00:31)



we required one extra layer between the input and the output in order to actually represent the XOR function accurately.

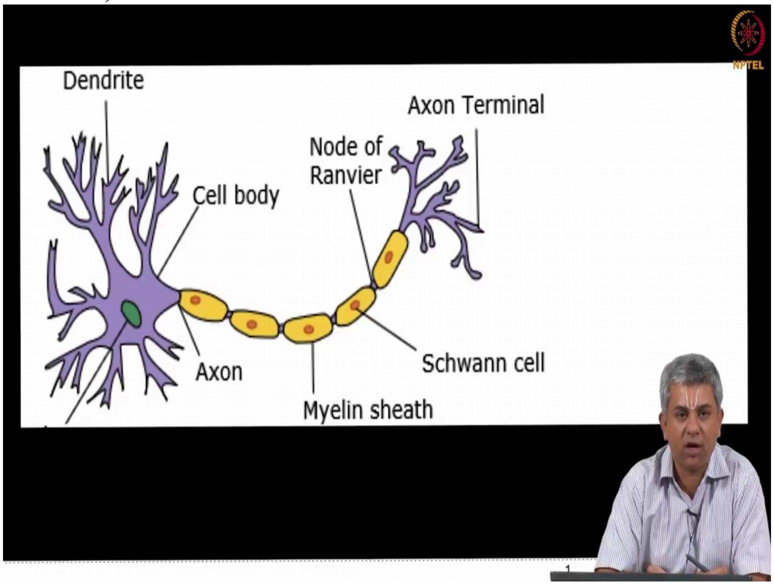
Now as it turns out, even before the XOR gate example lot of people had the idea that if they could somehow replicate the functioning of the human brain or at least of a, the neuron in the brain that they could somehow replicate all of human thinking.

Now before I discuss the biological neuron I will do it very, very briefly, but I want to point out that this analogy is in my opinion at least, and in the opinion of Doctor Ganapathy also, it is not quite sound. Several people say this.

Neuroscience is completely different area and even computational neuroscience is very, very different from what we do in actual neural networks which we will be seeing in the next few videos.

Computational neuroscience works on extremely complex phenomena and they try to replicate what we will be showing here

(Refer Slide Time: 01:31)



far more accurately than what we will be doing. When we show the artificial neuron which we will do in the next video, that is just going to be a toy case.

And the reason why it works is basically mathematical rather than anything to do with a physical analogy between the brain and the neural network.

Despite it being very popular in the media to talk about neural networks as if they were simulations of brains and this is certainly a buzzword today, we think that this is not accurate.

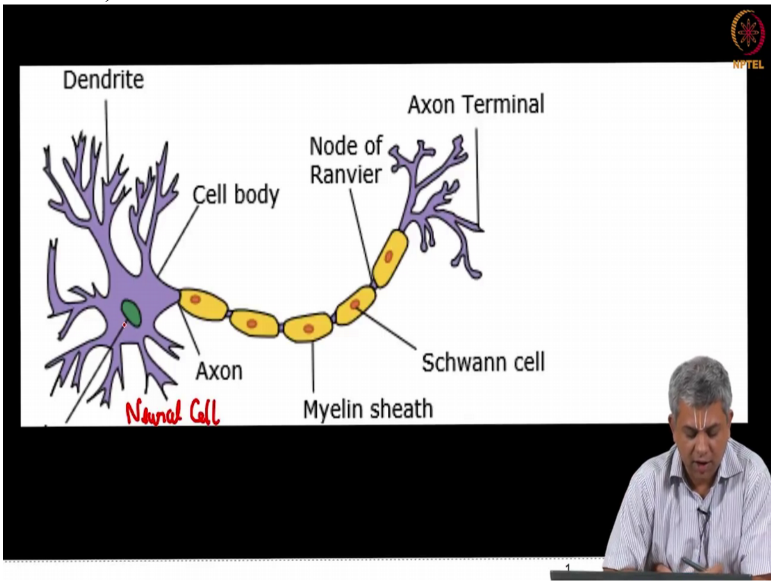
Much like birds fly and aero planes are not actually trying to replicate what birds do, you know, you do not have flapping wing aircraft even today. But nonetheless, you can take some inspiration from birds. But what you are looking at is the basic principle.

Just like in the, for bird flight or for aircraft flight, the basic principle is whatever lift the wing generates, that has to be balanced by the weight of the body, whether it is an aero plane or a bird. Similarly we are trying to replicate some very, very, very rudimentary principles in learning, which is what we will try to do.

So to come back to a biological neuron, I am certainly not a biologist so this image roughly represents what happens in a biological neuron.

So this is the neuron cell

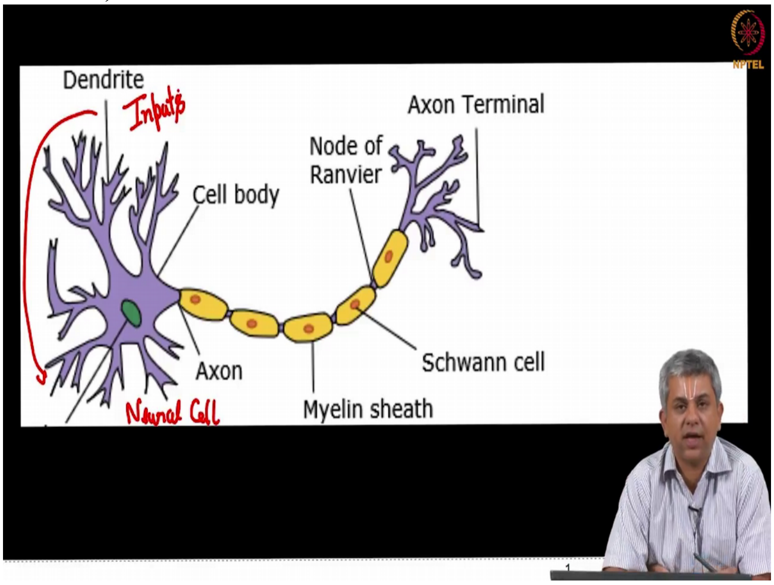
(Refer Slide Time: 02:51)



at the cell body and what happens whenever we get an input whether it is through the eyes which Doctor Ganapathy will be covering in detail in the next week, you know how, you know our visual system works.

But whether it is the eyes or your auditory system, finally when it goes to the brain you actually have multiple source of inputs.

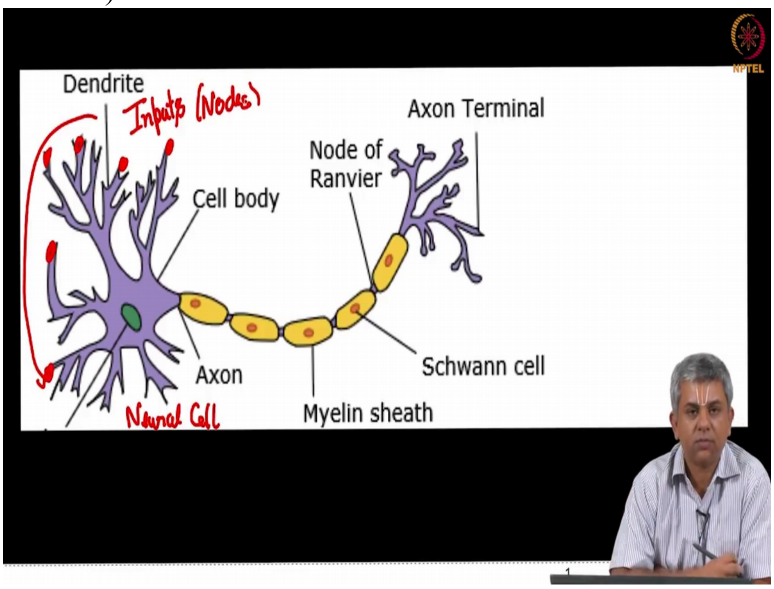
(Refer Slide Time: 03:14)



Let us take the analogy of an eye. Just like we, in an image you have pixels, a lot of information comes from various sources.

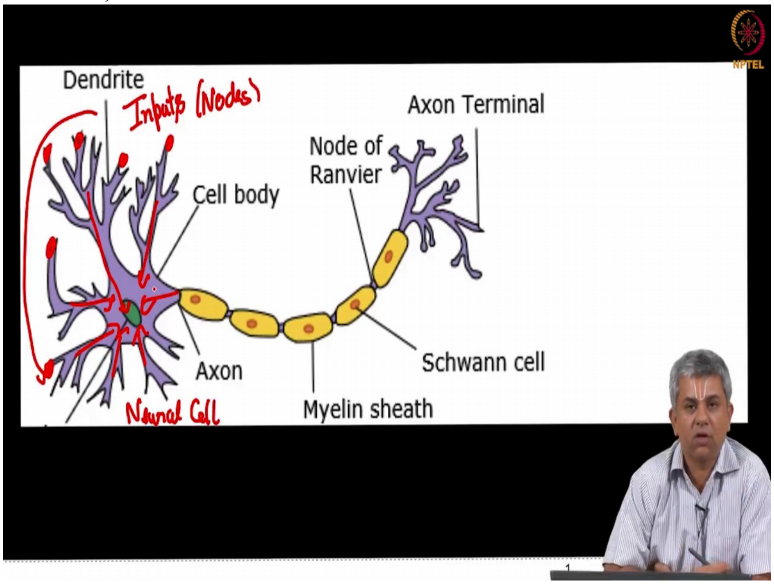
So we can see input nodes,

(Refer Slide Time: 03:28)



these are called dendrites, so all these finally feed in, into one single neuron,

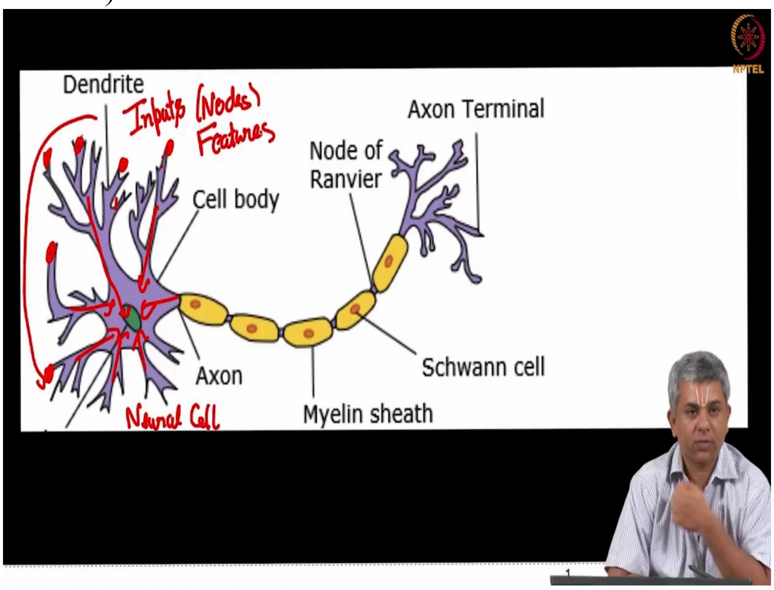
(Refer Slide Time: 03:39)



Ok. It is possible that, you know a single neuron can have as complex a feature, function as recognizing a specific face, say that of your mother or something of that sort.

So in that case you will get all these inputs from your mother's photo or from your mother's picture coming in from each input cell you can think of this as analogous to the features that we have

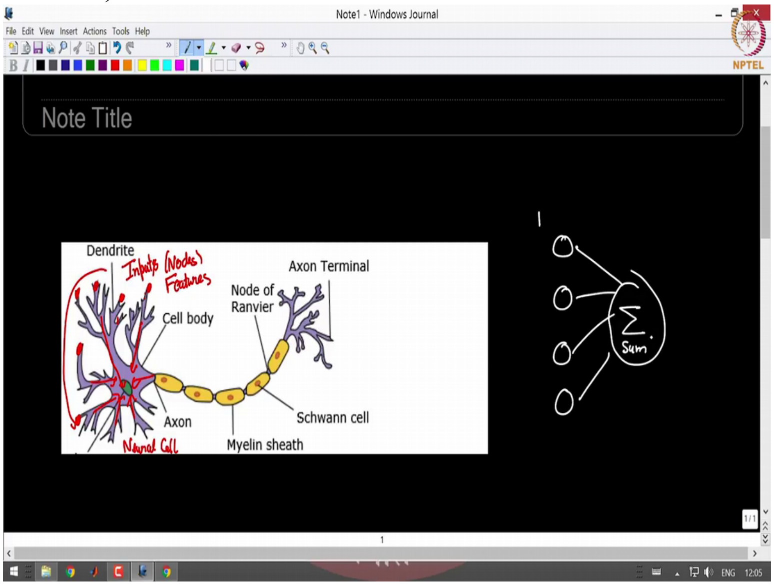
(Refer Slide Time: 04:05)



in our usual diagram.

And all these feed in into one place. Now when all of them feed into one place we can think of that operation as if it is a summation,

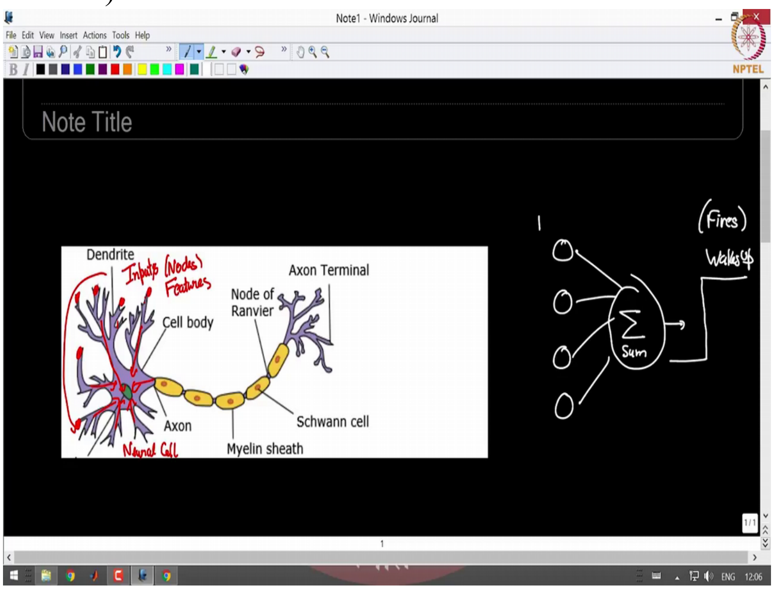
(Refer Slide Time: 04:26)



Ok. Now what you do, what the neuron apparently does is when all these come, the electrical signal either fires or it does not fire, Ok. Or it fires somewhere in-between.

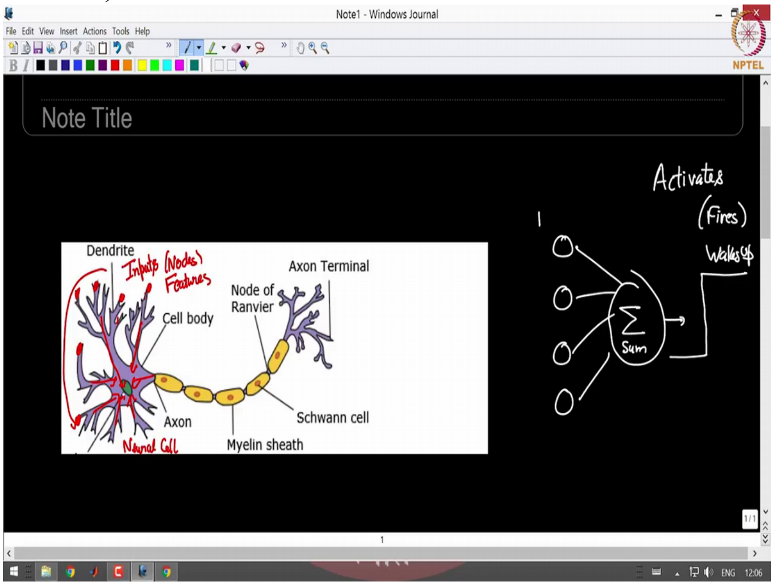
Again I am not a neuroscientist so I am just going to give an approximate picture of what happens. So now all these things come in and then, may be below a certain threshold, the neurons so to speak does not wake up. And above a certain threshold it wakes up, Ok or it fires.

(Refer Slide Time: 04:59)



You can think of this as if you know somebody is shaking you in order to wake you up and below a certain threshold if they do it very, very lightly you will not wake up but if they shake you heavily you will wake up. Similarly the neuron activates

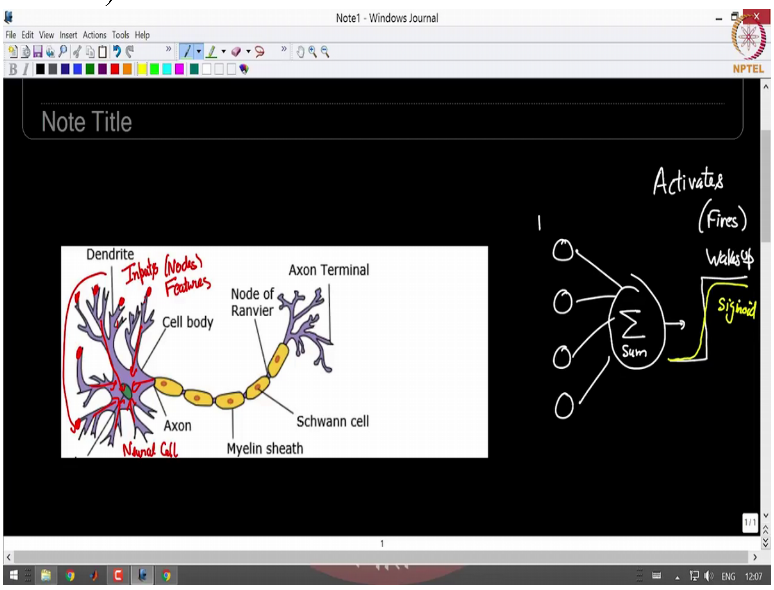
(Refer Slide Time: 05:19)



only after a certain amount of electrical signal, all these inputs coming together activate.

You will notice that this picture is somewhat similar to the sigmoid

(Refer Slide Time: 05:34)

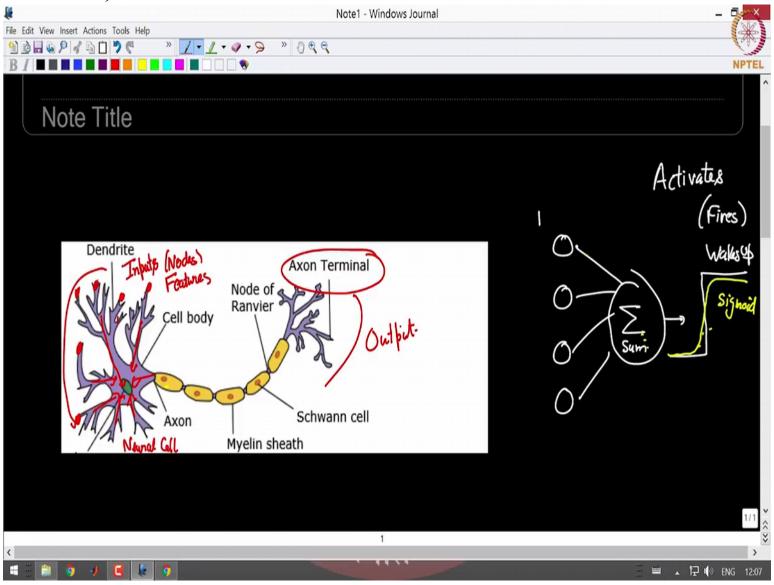


that we had when we were dealing with logistic regression. So as it turns out, this simple combination is what more or less defines a neural network.

This is our abstraction or cartoon picture of how a neuron works, which is lot of inputs come through the dendrites. They come into the neuron cell. They sum up there which we also did, whether we did a linear regression or logistic regression. We sum it up.

And then it either activates or it does not, or it activates intermediately which is what we did with the sigmoid, Ok. Now after that the output is called an axon.

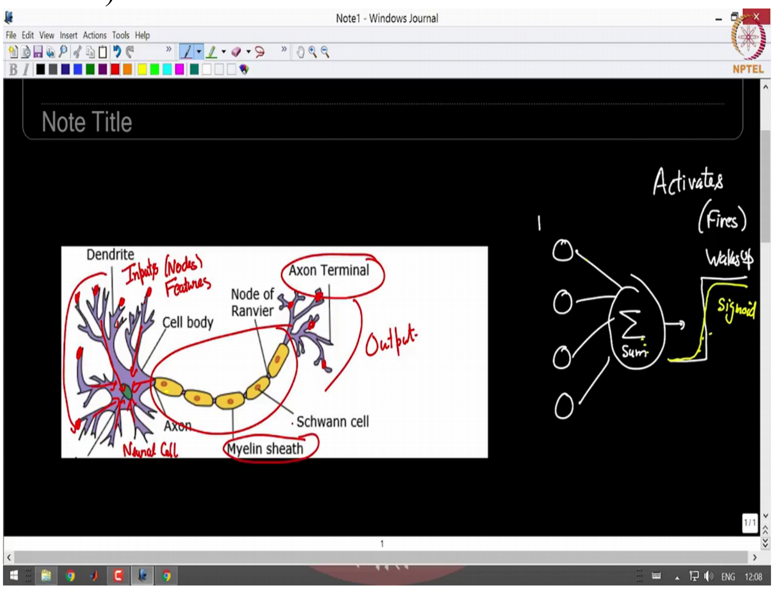
(Refer Slide Time: 06:19)



Now the output could be single or it could be multiple, Ok depending on whether you have one class or multiple class when we are doing neural network.

And what connects it in between in neuroscience terminology is what is called the Myelin sheath.

(Refer Slide Time: 06:34)

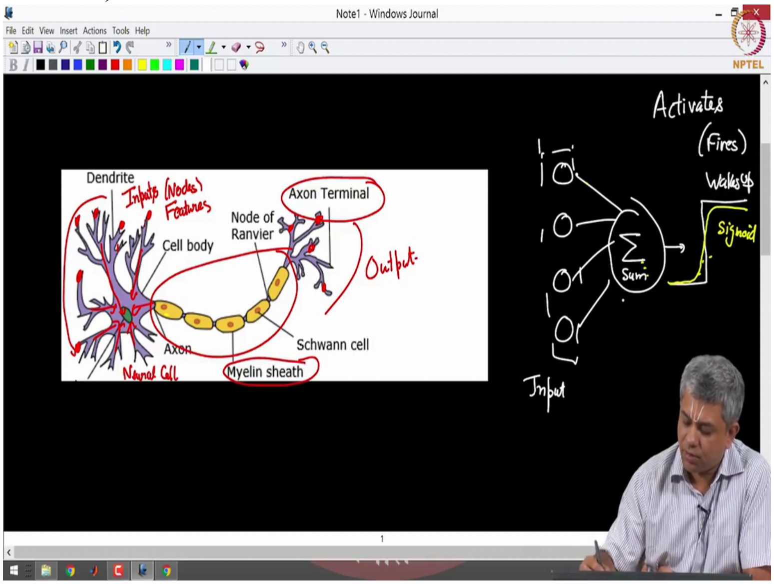


What happens with Myelin sheath is that they get thicker and thicker as you generate memories which are stronger and stronger.

That is, if you repeat an action, Ok whether it is writing, running, cycling etc the sheath tends to thicken as you do the same activity again and again.

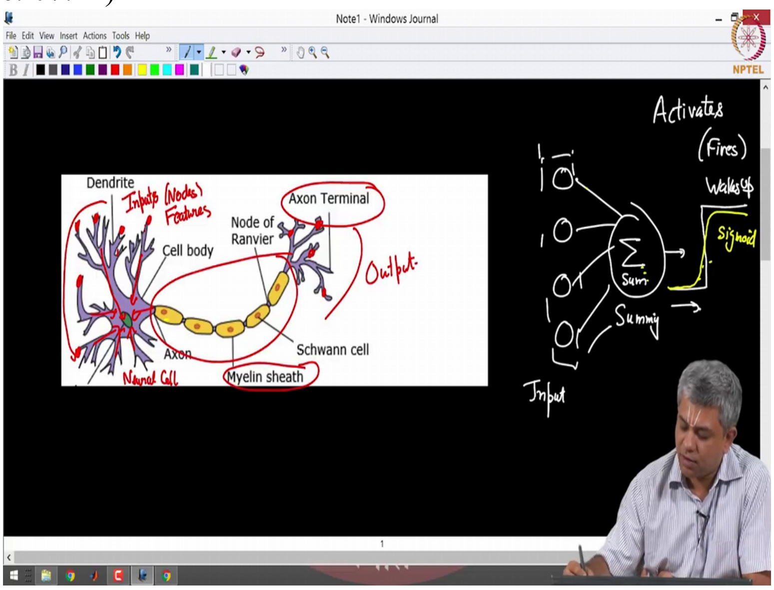
Now all that abstracted out, what I want to point out is this, a simple abstract structure for this whole process which is what we will be using for the rest of the course which is that of multiple features as input

(Refer Slide Time: 07:07)



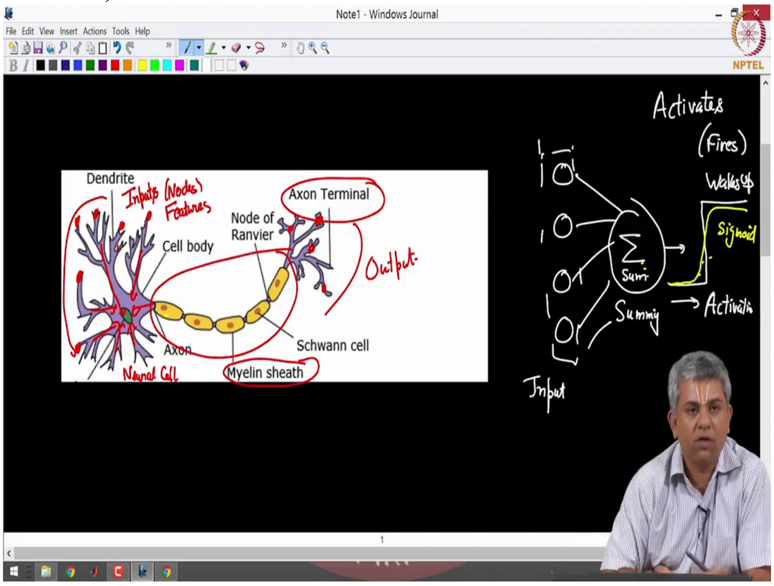
coming up together, summing

(Refer Slide Time: 07:12)



and then you have some kind of activation.

(Refer Slide Time: 07:18)



We will repeat this abstract picture in the next video where we will look at the idea of an artificial neuron instead of a biological neuron. Thank you.