Cognition and its Computation
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Lecture - 60
Topics in Current Research - V

Welcome to the last lecture of our course on Cognition and its Computation and we are at the last also the last lecture of our open questions. So, the while it is not possible to fully give you a list of open questions, we have put together only some specific ones that we in our understanding and maybe many other scientists understanding think of these as the most important questions.

However, there are many others if equally important if not more important that also might exist and so, it becomes look like first of all questions of all the diseases most of the neurodevelopmental and neurodegenerative diseases they are origin of the source or cause of the dysfunction or disease, how it manifests itself and how it can be cured. These are totally open questions.

We have no cure for let us say autism spectrum disorders although there are some clinical trials for a particular kind which is the Rett syndrome and we also do not have any cure for neurodegenerative disorders. Although we can only stop the process from getting worse further, but ultimately we have to lose to the disease and so, that aspect is there.

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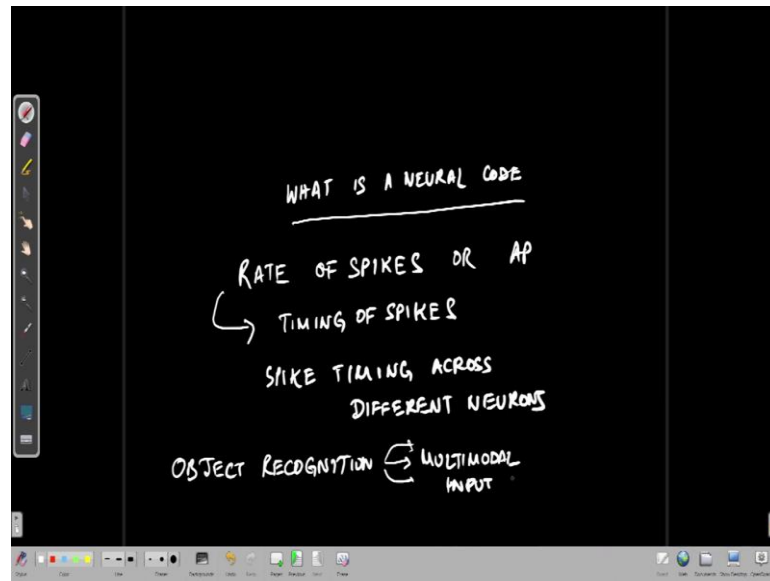
So, in spite of that what we will talk about now is actually is somehow ties everything up together and that is the big question is what is a neural code. I mean we have talked about spiking activity the firing rate of neurons, spike timing of neurons, spike timing across neurons in a network of neurons how it may appear.

So, these are actually the most most fundamental questions in order to finally, understand the how the brain computes in order to produce a particular perception and hence consciousness. So, it is very difficult to define that, but define consciousness or even perception to some extent.

However, everything finally, comes down to this question that what is a neural code. What aspect of the neurons activity is actually producing the percept I am having or actually making me aware of the surroundings in the way I am feeling it, what that is totally an open question.

And, to understand that we are we have taken an approach over the last 50 years where as we spoke in the earlier lecture has been restricted to understanding spiking activity. And, that too in the most cases we have been talking about rate of spikes or action potentials and implicit in that when we say rate of spikes or action potentials implicit in that is actually also the timing of spikes.

So, if we say that the rate of neuron is 20 spikes per second for one stimulus and for another stimulus it is 30 spikes per second, does it mean that we are able to discriminate the stimuli because of those two? It is not clear unless as we in the very introductory lectures talked about unless we do causal experiments that are relating these observations to the behavior of the organism or the human being or any subject. We cannot conclude that.

Similarly, about the same thing applies to timing of the spikes where a lot of literature has shown that especially in the auditory system and also in other places that relative spike timing and coincident spike timing across different neurons matter in terms of coding certain aspects of the auditory inputs across different neurons.

So, while these are direct observations and making correlations with the external world that does not take us anywhere close to like. How the ultimately the percept of that particular sound or the ability to discriminate those two sounds or ability to discriminate two colors based on the activity of the neurons is actually happening.

What we mean is definitely throughout the pathway of any system visual or auditory if we think of only that particular system, there are many events that correlate with the observation that the brain is differentiating two types of stimuli, but still that does not tell us that it is because of only these or rather ultimately it is the difference between some set of neurons producing a different firing pattern and some set of neurons producing another firing pattern. This distinction is making us perceive those two stimuli in a different manner.

How that is encoded in the activity of a single neuron and a group of neurons in a network and where it is a totally open question we have. So, people who have approached this problem from the side of object recognition and when we form the percept of the object it is actually bound together based on multimodal inputs.

That is, if we think of let us say my mother or your mother we immediately probably visualize our mother and her voice may be even her cooking or food or how she teaches in the I mean or how she does her job well and many things.

So, this holistic understanding of one particular object we will call an any of these as object how these this thing forms is actually tied to the question of what is a neural code

what do we mean by neural code? All of neuroscience most of neuroscience is based on this rate and timing of spikes and also some of it also relies on population, correlation activity, how the neurons are synchronized with each other like we saw in the case of attention and so on.

So, there are many possible ways that we have seen that neuronal responses in a population is influenced by changes in stimuli or state or brain state or the context of the of the subject or the context in which the subject is performing a task or perceiving a particular stimulus.

So, this holistic observation how that forms and where that is and what is the underlying code is completely open and there are a variety of approaches that people are taking. However, we are far from really understanding fully what the neural code is and what how that leads to perception and ultimately consciousness.

So, with this particular question we will be ending our overall discussion in this course of cognition and computation. I hope you have enjoyed the lecture so far and by both of us and I hope that it has produced in interest in at least many of you and you would like to pursue in into one of these domains and actually try to answer some of these open questions or maybe you have your own question that you would like to pursue.

So, I thank all of you for attending the lectures and I hope to see you again. Bye.