Arvind Kumar

KTH Royal Institute of Technology

Title

Computational approaches to understand on brain diseases

Abstract

Brain diseases provides a unique window to understand brain function and identify crucial components of the neural hardware and neuronal activity dynamics that shape the brain function. Traditionally, much focus has been on identifying genetic, morphological or chemical causes of brain dysfunction. However, there is no one to one mapping between genetic/chemical changes and symptoms of brain diseases. Indeed, similar genetic mutations and chemical imbalances can result in very different behavioural deficits. In recent years, accumulating experimental evidence has suggested that independent of their genetic, biochemical, or morphological origins, behavioural symptoms of many brain disease (e.g. Epilepsy, Parkinson's disease, anxiety) are causally associated with changes in the electrical activity of the brain. When the disease-related activity is restored to normal levels (by brain stimulation), some of the symptoms of the disease are also alleviated. These observations have led to the development of computational approaches to understand brain diseases which are rooted either in the dynamical systems theory or decision-making and reinforcement learning. In my talk I will describe how brain diseases can be understood as diseases of brain dynamics or information processing. I will discuss recent progress in modelling of the aberrant activity in Parkinson's disease and anxiety. For both diseases, we investigated how low-level changes in the neuron excitability and synaptic connectivity lead to changes in network dynamics in the basal ganglia and amygdala and eventually high-level disease-specific functional deficits. Interestingly this investigation revealed common network mechanisms

shared by the two diseases. Finally, I will describe a closed-loop stimulation strategy that uses minimal stimulation to not only change the brain activity state to normal levels but also recovers the network computations lost due to the disease condition.

Biography

Arvind Kumar is an Associate Professor of Computational Neuroscience and Neuroinformatics at the KTH Royal Institute of Technology, Stockholm Sweden. He is interested understanding dynamical properties and information processing in spiking activity in neuronal networks. In particular, his research group is investigating the functional and dynamical consequences of neuronal diversity and how does the interplay of network connectivity and network dynamics affect the transfer of information across networks? In addition, he is developing computational models of brain disorders and neuralizing the control system theory to develop tools for the control of neural dynamics using brain stimulation methods.

Arvind Kumar studied electrical and electronics engineering and obtained a Masters in Engineering degree from the Birla Institute of Technology and Science, Pilani, India. He then worked at the Indian Institute of Technology, New Delhi, India, as a Senior Research Fellow. He was exposed to computational neuroscience at the RIKEN Brain Science summer school. In 2006 he obtained a Ph.D. in computational neuroscience under the supervision of Ad Aertsen and Stefan Rotter, at the University in Freiburg, Germany. He did his post-doctoral training with Mayank Mehta at the Brown University, Providence, USA.

He spends his free time either playing Cricket or analyzing Cricket related data.