Neural signal processing analyses: from decoding spike trains to decoding emotions

David Tam
University of North Texas, Denton, USA

Computational neuroscience is a subdiscipline of neuroscience that relies on the computational power of computers to solve complex problems with the goal that underlying principles of neural processing can be extracted by reducing the number of independent variables.

To this end, this talk will explain how statistical techniques can be designed to extract unique firing patterns in a neural network, uncovering the underlying subthreshold input/output (I/O) relationships among neurons using extracellular recordings of spike trains without relying on invasive intracellular recordings. In particular, the multi-unit spike train analysis is a class of methodology for reverse-engineering (decoding) the processing-function (i.e., mathematical / probabilistic mapping-function between multiple inputs and outputs) of a network based on the spike train signals alone.

By the same token, other statistical techniques (principal component analysis) can also be used to validate the internal variables of an emotional model (that I developed) for the brain by uncovering the confounding variables used in processing emotional signals that are needed to aid in creating an internal model of the external world for an autonomous being (i.e., either a self-actuating autonomous robot or a human being).

Thus, these statistical techniques aim to reduce the number of variables in a complex system to a small number such that the basic principles of neural processing can be revealed, and ultimately an equivalent/simplified model of the brain can be created in the future.