The University of Chicago

Department of Statistics

Seminar Series

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"Using the State-Space Paradigm to Analyze Information Representation in Neural Systems"

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133 Eckhart Hall, 5734 S. University Avenue

Refreshments following the seminar in Eckhart 110.

ABSTRACT

Neural systems encode representations of relevant biological signals in the firing patterns of their spike trains. Spike trains are point process time-series and their codes are both dynamic and stochastic. Even though the signal is often continuous, its representation in the nervous systems is as a high-dimensional point process time-series. Because neural spike trains are point processes, standard signal processing techniques for continuous-valued data will have limited utility in the analysis of neural systems. Accurate processing of neural signals requires the development of quantitative techniques to characterize correctly the point process nature of neural encoding. The advent in the last 10 years of the capability to record with multiple electrode arrays the simultaneous spiking activity of many neurons (¿100) has made it possible to study information encoding by ensembles rather than by simply single neurons. Hence, an important question in neuroscience is developing algorithms to analyze dynamic, high-dimensional spike train (point process) measurements. The state-space modeling paradigm is a well-known engineering framework for studying systems that evolve through time. In this presentation, we will discuss the application of this paradigm in neural spike train data analysis. We use the Baye's rule, Chapman-Kolmogorov equations to derive algorithms useful for neural spike train decoding, dynamic analysis of neural encoding (neural plasticity) and adaptive-decoding. We will illustrate the methods in three examples: Decoding position from the ensemble activity of hippocampal pyramidal neurons, tracking the temporal evolution in hippocampal place receptive fields, tracking movement encoding in by neurons in the motor cortex.