The University of Chicago
Department of Statistics

Seminar Series

URI EDEN

Department of Mathematics and Statistics, Boston University

Point Process Filters Applied to the Analysis of Spiking Neural Systems

TUESDAY, February 26, 2008 at 4:00 PM
133 Eckhart Hall, 5734 S. University Avenue

Refreshments following the seminar in Eckhart 110.

ABSTRACT

Although it is well known that neurons receive, process and transmit information via sequences of sudden stereotyped electrical events, called action potentials or spikes, most analyses of neural data ignore the highly localized nature of these events. In this talk, we discuss a point process modeling framework for neural systems that allows us to perform inference, assess goodness-of-fit, and estimate a state variable from neural spiking observations.

We develop a state space estimation and inference framework by constructing state models that describe the stochastic evolution of the signals to estimate, and conditional intensity models that define the probability distribution of observing a particular sequence of spike times for a neuron or ensemble. Posterior densities can then be computed using a recursive Bayesian framework combined with the Chapman-Kolmogorov system of equations for discrete-time analyses or the forward Kolmogorov equation for continuous-time analyses. This allows us to derive a toolbox of estimation algorithms and adaptive filters to address questions of static and dynamic encoding and decoding. In our analysis of these filtering algorithms, we draw analogies to well-studied linear estimation algorithms for continuous valued processes, such as the Kalman filter and its discrete and continuous time extensions.

We will discuss the application of these modeling and estimation methods to two important neural estimation problems. The first is an analysis of place field plasticity in the firing properties of cortical neurons in the hippocampus and deep entorhinal cortex of a rat. Using a spatio-temporal spline model, we were able to characterize and track changes in the firing properties of these neurons. The second estimation problem involves predicting an intended reaching arm movement from neurons in primate primary motor cortex. We find that it is possible to maintain accurate estimates of intended movements, even as the population of neurons being observed changes.

Please send email to Mathias Drton (drton@galton.uchicago.edu) for further information. Information about building access for persons with disabilities may be obtained in advance by calling Karen Gonzalez (Department Administrator and Assistant to Chair) at 773.702.8335 or by email (karen@galton.uchicago.edu).