Boston University Statistics Seminar Series

Recent and Upcoming Research in the Statistical Analysis of Neural Spiking Systems

Uri Eden
New Faculty
Department of Mathematics and Statistics
Boston University

Thursday, September 14, 2006, 4:00-5:00pm
Mathematics and Computer Science (MCS) Building, Room 149
111 Cummington Street, Boston

Tea and Cookies at 3:30pm in MCS 153

Abstract: Neurons transmit and process information about biological and behavioral signals via sequences of stereotyped spiking events that are localized in time. In previous work, we developed a point process statistical framework for studying neural systems that allowed us to perform inference, assess goodness-of-fit, and estimate a dynamic state variable from spiking observations. In this talk, I will present a new analysis of oscillatory spiking in the subthalamic nucleus of Parkinson's patients using point process models and outline new collaborative research directions that I plan to pursue in the immediate future.

Abnormal oscillatory firing patterns of neurons in the subthalamic nucleus (STN) of patients with Parkinson's disease (PD) have been postulated to play a role in the pathogenesis of motor deficits such as tremor, rigidity, and akinesia. In order to characterize the statistical firing properties of these neurons we examined neural recordings from the STN of Parkinson's patients undergoing surgery to implant a deep brain stimulating (DBS) electrode, while they performed a voluntary hand movement task in one of four cardinal directions. This data provides a unique opportunity to relate pathological mechanisms to dynamic features of spike train observations in human patients. We applied GLM and state space analyses to characterize and track changes in the firing properties as functions of movement initiation and ensemble spiking history. Our analyses suggest that synchronous oscillatory spiking may be caused by inhibitory feedback within the basal ganglia that must be overcome to initiate movements.

Planned future research in the analysis of spiking neural systems includes the development of state space methods to analyze empirical distributions of spiking rates in hippocampal data, methods to estimate parameters in dynamical systems models of subthreshold membrane potentials based on spike observations, and analyses of the generation or rhythmic spiking activity from networks of point process neural models.