# SEMINAR NOTICE

Preston M. Green Department of Electrical and Systems Engineering

## EXTRINSIC AND INTRINSIC CONTROL OF INTEGRATIVE PROCESSES IN NEURAL SYSTEMS

PhD Preliminary Research Examination

**Anirban Nandi**
PhD Candidate

Preston M. Green Department of Electrical and Systems Engineering
Washington University in St. Louis

**Abstract:** At the simplest dynamical level, neurons can be understood as integrators. That is, neurons accumulate excitation from afferent neurons until, eventually, a threshold is reached and they produce a spike. Here, we consider the control of integrative processes in neural circuits in two contexts. First, we consider the problem of extrinsic neurocontrol, or modulating the spiking activity of neural circuits using stimulation, as is desired in a wide range of neural engineering applications. From a control-theoretic standpoint, such a problem presents several interesting nuances, including discontinuity in the dynamics due to the spiking process, and the technological limitations associated with underactuation (many neurons controlled by the same stimulation input). We consider these factors in a canonical problem of selective spiking, wherein a particular integrative neuron is controlled to a spike, while other neurons remain below threshold. This problem is solved in an optimal control framework, wherein several new geometric phenomena associated with the aforementioned nuances, are revealed. Further, in an effort to enable scaling to large populations, we develop relaxations and alternative approaches, including the use of statistical models within the control design framework. Following this treatment of extrinsic control, we turn attention to a scientifically-driven question pertaining to intrinsic control, i.e., how neurons in the brain may be themselves controlling higher level perceptual processes. We specifically postulate that neural activity is decoded, or "read-out" in terms of a drift-diffusion process, so that spiking activity drives a latent state towards a detection/perception threshold. Under this premise, we optimize the neural spiking trajectories according to several empirical cost functions and show that the optimal responses are physiologically plausible.

DATE: Tuesday, December 6, 2016
TIME: 1:00 p.m.
PLACE: Green Hall, Room 0120

Thesis advisor:
Dr. ShiNung Ching

This seminar is in partial fulfillment
of the Doctor of Philosophy degree

Washington University in St. Louis
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