SEMINAR NOTICE

Preston M. Green Department of Electrical and Systems Engineering

Normative Modeling of Neural Circuit Dynamics to Meet Control and Detection Objectives
PhD Preliminary Exam

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PhD Candidate

Abstract: A fundamental research problem in theoretical neuroscience is to understand how sensory networks encode information received from the environment. This information is subsequently routed to intermediate and higher brain regions where it is used to modulate behavioral outcomes. The proposed dissertation research revolves around the identification and analysis of specific decoding objectives that generates sensory activity as is observed *in vivo* in the early olfactory system. The investigation centers on how the architecture and dynamics of these networks allows information from odor cues to be efficiently transduced into formats usable by the downstream brain regions. In the proposed thesis, I will examine the dynamics of neural coding in the olfactory system through the lens of a normative framework, using concepts and techniques from system science and control theory. In the first part of the thesis, I propose focusing on the problem of sensory detection. I approach the problem by first formulating a mathematical criteria that is relevant for sensory detection. Thereafter, by formal optimization, I obtain models of neural circuitry that best accomplish the proposed criteria. It turns out that the characteristic response patterns observed in the model are due to information being processed over multiple timescales. Furthermore, the synthesized model predicts activity of sensory circuits at both individual neuronal and at population levels under diverse sensory input patterns. In the second part of the thesis, we shift our focus to the behavioral end of stimulus-response paradigm. Here, through mathematical modeling, I identify how internal and external factors influence high-level decisions. I opt for a probabilistic approach, which at every time step generates a belief about a finite set of behavioral states. It turns out that similar to the sensory network, it is possible to express the evolution of belief in terms of first order dynamics that combines prior beliefs with sensory information. I will discuss the technical details involved in deriving these solutions, their interpretations in the context of systems theory and systems neuroscience and, finally, motivate several open questions and challenges.

Date: Friday, May 15, 2020
Time: 10:00 a.m.
Zoom Meeting: https://wustl.zoom.us/j/91110353714
Zoom Meeting ID: 911 1035 3714
Password: Please contact Francesca Allhoff at: f.allhoff@wustl.edu

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