The Biomedical Engineering Program

University of Nevada, Reno

cordially invites you to a PhD defense

Computational Neuroscience: Theory, Development and Applications in Modeling The Basal Ganglia

A colloquia submitted in partial fulfillment of the
requirements for the degree of Doctor of Philosophy
with a major in Biomedical Engineering.

by

Corey M. Thibeault

Abstract:

Inspiring entire computing paradigms, hardware platforms and theories of nervous system function, the field of computational neuroscience has grown steadily since its emergence in the mid-1980s. The motivation behind it is to mathematically describe the nervous system in terms of how the structures process information. Simulating the brain this way can be done at varying levels of abstraction and biological realism; providing insight into the function of the nervous system or supporting empirical evidence. This dissertation presents a snapshot of the computational neuroscience landscape. It begins begins with the mathematical theory, moving to implementation, and finally ending with its application. It is by no means a complete picture but provides a basic understanding of how mathematical modeling contributes to neuroscience. This begins by presenting the design considerations behind high-performance neural simulation environments. A concept which is then extended with a novel implementation for the exchange of spiking information in high-performance cluster environments. A framework for creating virtual environments for embodied modeling is then developed and discussed. Finally, a toolkit for efficiently analyzing the large amounts of data generated by these spiking models is presented. Once these tools are established the focus is shifted to models of the basal ganglia. After a brief background, spiking models capable of action-selection through reinforcement learning are described. These borrow from the basal ganglia but are developed for implementation on neuromorphic hardware and are therefore necessarily simplified. The networks are embodied in virtual environments and their performance based on two tasks is explored under varying conditions. Finally, the use of a simple hybrid neuron is explored in several published models of the basal ganglia; demonstrating the first example of a hybrid neuron in biologically faithful models of the basal ganglia

12:00 pm, Wednesday, December 12, 2012

Scrugham Engineering and Mines (SEM) room 201

For more information contact Dr. Fred Harris @ 784-6571 (Fred.Harris@cse.unr.edu)