Krembil Relentless.

Neuron to Brain LABORATORY

December 14, 2020

Multi-scale Computational Neuroscience and Epilepsy

Brief Project Description

Epilepsy is a distinctly multi-scale neuropathology, where a variety of micro-level changes to individual neurons or neural microcircuits are known to contribute to the macro-level onset of seizure. Computational neuroscience is uniquely suited to investigate how neural features at distinct scales influence each other and is thus a necessary tool for understanding how the derangement of the interactions between the micro- and macro-scales of neural activity might be culpable in this pathology. These studies not only have the potential to uncover new pathways to seizure onset, and in turn novel targets for clinical intervention in the treatment of epilepsy and prevention of seizure, but can help us to better understand the importance of multi-scale interactions in the healthy brain. Indeed, understanding how these multi-scale interactions are disrupted in a pathology such as epilepsy serves to elucidate the physiological role of these interactions.

The Neuron to Brain laboratory is engaged in multiple collaborative computational neuroscience investigations in pursuit of this general goal, all of which exploit the rare access to electrophysiological recordings from live human tissue available thanks to the relationship between the Krembil Research Institute and Toronto Western Hospital. Such projects range from the development and study of detailed models of single human neurons, vital in fully understanding the micro-level dynamics of the healthy brain and serving as a tool in understanding the impacts of epilepsy on single neuron activity, to models of larger neural networks in which various micro-level features observed experimentally can be implemented to understand their role in dictating macro-level network dynamics. A graduate student joining the lab to work on these projects can expect to be involved in a wide range of cutting edge computational neuroscience investigations making use of this experimental data and with a direct application to not only the neuroscientific understanding of epilepsy, but the clinical treatment of the disease.

Level of Study

Masters and/or PhD

Project Specific Technical Skill Requirements

- The candidate's educational experience should include a primary focus either on neuroscience or a field with direct application to computational investigations (mathematics and/or computer science are typical, although others are possible provided the candidate can explain how their educational focus prepared them for computational neuroscience research).
- In the field listed above that was not the "primary focus" of the candidate's previous education, the candidate should have some level of training or be able to demonstrate their interest/engagement in the field. At minimum, the candidate should be familiar with advanced topics in the study of differential equations and the basics of neuronal electrophysiology. If this is not the case, further explanation as to why the candidate wants to transition into this new domain, what skills prepare them for this transition, and how they will learn any additional necessary skills will be required.

- Prior programming experience and/or the ability to quickly learn new coding languages is required. The candidate will likely use, at minimum, MATLAB, C/C++, and NEURON during their project.

General Skill Requirements

- Communication skills are vital to any interdisciplinary and collaborative project, and thus are a major asset for these projects.
- Strong writing skills are a major asset.
- Experience with both mathematical and neuroscientific academic literature will be an asset

Required Soft Skills

- Intellectual curiosity across a variety of disciplines including mathematics, computer science, and neuroscience.
- Ability to communicate and serve as a "liaison" across disciplines and with collaborators with diverse backgrounds.
- Ability to take initiative, be self-motivated and work with minimal supervision
- Creativity, Problem Solving and critical thinking
- Team player & Integrity

How to Apply

To apply for this opening, please email Dr. Scott Rich (scott.rich@uhnresearch.ca), Anett Schumacher (anett.schumacher@uhnresearch.ca) and Tania Dias (tania.dias@uhnresearch.ca) with the subject line "PROSPECTIVE STUDENT: Computational Neuroscience". In this initial e-mail, please include all of your post-secondary academic transcripts, a summary of any research experience you have (including published or in preparation academic manuscripts), and a brief statement regarding your interest in and fit for this position.

Please note that all prospective graduate students must simultaneously and independently apply through the School of Graduate Studies (SGS) at the University of Toronto. Dr. Taufik Valiante holds a primary appointment in the Institute of Medical Sciences, and cross-appointments to the Institute of Biomedical Engineering and Electrical and Computer Engineering. Prospective graduate students interested in joining the Neuron to Brain lab can apply to any of these departments. Alternatively, prospective students with more interdisciplinary interests can consider a co-supervisory situation with Dr. Valiante and one of the other members of the "KCNHub" (see KCNHub.com), particularly if they wish to apply for a graduate program with a more mathematical or computational focus, although this will require them to independently suggest and contact this co-supervisor.