October 19, 2021

Applying computational neuroscience to studying the role of neural heterogeneity in seizure resilience

Project Description: Heterogeneity is the norm in all biological systems, including similarly classified neurons in the human brain. Recently, the Valiante Lab experimentally identified that this heterogeneity is reduced in seizure-producing brain regions, and showed via computational simulation that this reduced heterogeneity makes neural circuits more vulnerable to seizure-like behavior. Taken together, this presents support for a "recontextualization" of epilepsy as a disorder associated with a progressive loss of neural heterogeneity.

The Neuron to Brain Lab is recruiting a Master's student to contribute to our computational investigation of the role of heterogeneity in seizure resilience. This project will be directly mentored by Dr. Scott Rich, a senior postdoc under the supervision of Dr. Taufik Valiante and leader of the lab's Computational Pillar. The project will focus on constructing a cortical neural network containing multiple populations of inhibitory interneurons, and using this network to assess how heterogeneity amongst inhibitory cells might uniquely contribute to seizure resilience. This project will utilize the lab's unique access to electrophysiological data from live human cortical tissue to constrain neuron models, as well as a wealth of collaborations between the lab and other computational neuroscientists at the Krembil Brain Institute and the Krembil Centre for Neuroinformatics.

Level of Study: Master's

Skill Requirements:
- The candidate's education should include a primary focus either on neuroscience or a computational field (e.g., mathematics, computer science, engineering, applied physics).
- 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 the ability to quickly learn new coding languages is required.
- Strong communication, collaboration, and writing skills are vital for successful interdisciplinary work.

Soft Skills:
- Intellectual curiosity across disciplines including mathematics, computer science, and neuroscience.
- Creativity, problem solving, and critical thinking.
- Ability to serve as a "liaison" across disciplines and with collaborators with diverse backgrounds.
- Initiative and self-motivation.

Learning Outcomes: The prospective student will gain direct experience in computational neuroscience research under the supervision of Dr. Rich, and hone skills including the modeling of individual neurons and neural circuits, the optimal implementation of these models computationally, and the application of computational results to experimental and clinical neuroscience. The student will be further exposed to the variety of neuroscience research comprising the Neuron to Brain Lab, including wet lab electrophysiology, clinical iEEG, and the design of neuromodulatory devices. The student will participate in weekly lab meetings of the Neuron to Brain Lab and biweekly meetings of the "KCN Hub", the group of computational neuroscientists at the Krembil Brain Institute; through this latter experience, the student will be exposed to a variety of computational neuroscience research and techniques.

How to Apply: To apply, please fill out this Google Form: https://forms.gle/bZbNKCcdRhrdurtEA. Indicate that you are interested in joining the lab as a Master's Student in the Computational pillar, and mention this specific job posting. Please include all your post-secondary transcripts, and as part of your Resume include a brief statement (~1 page) outlining any research experience you have and your interest in 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. You may apply directly to be a Master's Student in the Valiante Lab via the Biomedical Engineering (BME) program; you may also apply via the Electrical and Computer Engineering (ECE) program provided a co-supervisor can be found. Alternatively, prospective students for whom an engineering department might not be appropriate can consider a co-supervisory situation with Dr. Valiante and one of the other members of the Krembil Research Institute's Computational Neuroscience hub (see KCNHub.com), particularly if they wish to apply for a graduate program with a more mathematical or computational focus; this will require them to independently contact this co-supervisor.