RESEARCH SCHOLAR PROGRAM – 2018

SUPERVISOR & PROJECT INFORMATION FORM

Please complete and return, via email only (crems.programs@utoronto.ca) by ***November 3rd 2017*** *(forms received after this date will not be posted).*

Supervisor Information

Name: Andrew Lim

Email: andrew.lim@utoronto.ca

Degree: MD, MMSc

SGS Appointment (IMS, IHPME, LMP etc..): IMS

Academic Rank:

Field of Research:

Research Institution Affiliation (if applicable): Sunnybrook Research Institute

Allocation of student contact time (number of hours per week YOU are available to the student for any concerns or to review progress): I am available in the laboratory at least 30 hours a week. At least 2 hours per week is spent in formal group lab meetings. An addition 2-4 hours a week is available for formal face-to-face instruction of each student.

Project Information

Title: A framework for hybrid machine and human computation for the accurate and scalable analysis of human clinical EEG recordings

Description (max 500 words):

Electroencephalography (EEG) is a key tool in the diagnosis of epilepsy and sleep disorders. In current practice, EEG recordings are visually analyzed by specialist technicians and physicians. However, this is a slow process and dependent on the availability of these expert annotators. This limits EEG as a diagnostic medical tool in smaller communities. Even in larger centers, the time consuming nature of human EEG analysis can lead to backlogs and significant delays in diagnosis and treatment. Thus, there is a need for rapid, scalable, cost-efficient, accurate EEG interpretation that is not heavily dependent on the time of highly trained specialists. These limitations have motivated efforts to develop fully automated algorithms for the interpretation of human EEG signals. Unfortunately, to date, these approaches have had limited success, in part because many aspects of EEG interpretation are fundamentally image classification problems that while straightforward for trained humans, are difficult to fully automate. The field of human computation developed to address such problems where humans may have some advantages over pure automation. In this paradigm, problems are decomposed into a massive number of very simple, carefully designed, human micro-tasks to be carried out by an array of "human processors," whose answers can be combined with automated algorithms to solve the original problem. This maximizes the advantages of both humans and computers in one algorithm, overcoming the limitations of either. The overall goal of this project is to design a framework for hybrid machine and human computation to achieve accurate and scalable analysis of human clinical EEG recordings. We have established a multi-site collaboration between the University of Waterloo, McGill University, the Clinical Neurophysiology Laboratory at Sunnybrook Health Sciences Centre, and the Epilepsy Program at the University Health Network to achieve the following aims: **Aim 1.** Develop a general set of algorithms to decompose EEG analysis into micro-tasks, and integrate the responses of non-expert and expert human processors with automated algorithms to solve EEG-related clinical problems. **Aim 2.** Develop a general framework to compare these algorithms against fully automated approaches and specialist analyses, and an iterative approach to improve these algorithms. **Aim 3.** Apply the algorithms to the interpretation of clinical EEGs from Canadian hospitals.

This project is funded by CIHR CHRP grant 140200 (PI's Lim and Law)

If human subjects are involved, have Ethics been obtained?

☒ YES ☐ NO ☐ Application Submitted ☐ N/A

Do you expect this work will be published within the 20 months?

☒ YES ☐ NO ☐ Uncertain

Student's roles and responsibilities (please be specific)

Please indicate who will serve as the student's direct report (PI, PhD student, technician etc…)

This is a collaborative effort between Dr. Lim's laboratory at Sunnybrook Research Institute, and the laboratories of Dr. Edith Law (Computer Science, University of Waterloo) and Dr. Joelle Pineau (Computer Science, McGill University). While the Law and Pineau labs are doing the bulk of the coding and algorithm development, the Lim laboratory plays the key role in 1) guiding the integration of the machine learning algorithms and expert (e.g. neurologist, technician) input 2) developing and implementing studies to validate the developed algorithms and validate against gold standard human EEG interpretation. The student's primary role will be with regard to the latter and will be primarily analytic in nature, leveraging EEG data collected as part of routine clinical care through the Sunnybrook clinical neurophysiology laboratory. The anticipated manuscript(s) will detail the equivalency (or superiority) of hybrid human-machine learning approaches to EEG interpretation in terms of accuracy, and superior of these approaches in terms of timeliness and resources expended. As the work will involve a reasonable degree of programming and data analytics, the ideal student will have programming (especially R and MATLAB, although any language acceptable) and statistics experience, coupled with an undergraduate-level knowledge of mathematics and neurobiology.

A recent manuscript from a student working on this project was:

Thodoroff P, Pineau J, Lim AS. Learning Robust Features using Deep Learning for Automatic Seizure Detection. Journal of Machine Learning Research. 2016 Nov;56.