

Project Proposed By:	Intelligent Sensory Microsystems Laboratory, Electrical and Computer Engineering, University of Toronto
Supervisor:	Professor Roman Genov
Project Title:	<b>Exploring Hardware-Efficient Machine Learning Algorithms for Bioelectronic Medicine Therapies (4 Positions)</b>
Project Description:	<p>Bioelectronic medicine is an emerging field that uses electrical stimulation of nerves or select brain regions, to treat various diseases and disorders, such as diabetes, arthritis, chronic pain, epilepsy, Parkinson’s disease, and depression. However, bioelectronic medicine therapies require hardware devices that can perform real-time and accurate machine learning classification of neural signals and deliver optimal stimulation for therapeutic effect.</p> <div style="text-align: center;"> </div> <p>Figure: Overview of closed-loop bioelectronic medicine [1]</p> <p>This project aims to explore hardware efficient machine learning algorithms that can operate At -the-Edge with low power budget on microcontrollers or field-programmable gate arrays (FPGAs), with a path towards translation to implantable Application Specific Integrated Circuits (ASICs). The project will involve the following tasks:</p> <ul style="list-style-type: none"> <li>• Reviewing the state-of-the-art machine learning algorithms for bioelectronic medicine, such as deep neural networks (DNN), spiking neural networks (SNN), Reinforcement learning, Transfer learning, etc.</li> <li>• Selecting one or more machine learning algorithms that are suitable for hardware implementation and neuromodulation tasks, such as signal classification, feature extraction, or parameter optimization.</li> <li>• Developing and testing hardware efficient machine learning algorithms using software tools, such as TensorFlow Lite, PyTorch Mobile, or Xilinx Vitis AI.</li> <li>• Evaluating the performance of the machine learning algorithms on simulated or real neural data recorded from neuromodulation experiments by our team.</li> </ul> <p>For this project, we are seeking highly motivated and talented students with a background in EngSci, ECE or CS. They should have knowledge in the following areas (min. GPA: 3.5)</p> <ul style="list-style-type: none"> <li>• Good knowledge of Machine Learning algorithms</li> <li>• Experience or interest in Neuromorphic Computing</li> <li>• Proficiency in Python</li> <li>• Experience in HDL programming such as Verilog is a plus</li> <li>• The Candidate(s) must have a self-driven attitude, ability to debug and solve problems, and ability to work independently.</li> </ul>
Contact Person:	Kindly reach out to Mustafa Kanchwala at ( <a href="mailto:mustafaa.kanchwala@mail.utoronto.ca">mustafaa.kanchwala@mail.utoronto.ca</a> ) and copy to Prof. Roman Genov ( <a href="mailto:roman@eecg.utoronto.ca">roman@eecg.utoronto.ca</a> ). Please include your cover letter, resume and transcript (unofficial is ok)

[1] Ganzer, P. et. al., Opportunities and challenges for developing closed-loop bioelectronic medicines. Neural Regeneration Research (2019)