Predicting Epileptic Seizures Using Spiking Neural Network

Author(s): Gladys Addai-Domfe, Nekel Mitchell, and Hisham Daoud

Faculty Sponsor(s): Dr. Hisham Daoud

Affiliation(s): School of Computer and Cyber Sciences

ABSTRACT

Epilepsy is a neurological disorder characterized by sudden electrical discharges (seizures) that manifest in uncontrollable body functions. Their unpredictable nature has led to many applications of machine learning algorithms to predict seizure events. However, those methods present limitations in energy efficiency, computational costs, and hardware realization. This makes the feasibility of a seizure predicting wearable improbable. To mitigate those limitations, we propose predicting seizures using a spiking neural network (SNN). SNNs are brain-inspired networks that are trained in an event-driven manner which reduces both computations and power consumption. In this study, the main SNN components (the spike encoding algorithm, neuron model, and learning algorithm) were investigated. Spike encoding aims to encode the EEG data into spikes. A comprehensive review of encoding schemas revealed a combination of adaptive threshold and inter-spike-interval (ISI) algorithm to be a viable encoding schema. The capability of adaptive threshold to capture intricate information paired with ISI recognition of irregular firing patterns promises significant results. A neuron model has to accurately represent the biological neurons and synapses. The proposed neuron model is the Izhikevich model, known for its biological accuracy and computational efficiency. To train the network, we propose a surrogate gradient learning algorithm that utilizes backpropagation. The network is trained on an EEG dataset from CHB MIT. The ability of the model to discern between pre-ictal (before seizure) and inter-ictal (between seizures) phases would indicate success in training. A new batch of data would be tested on the model to calculate its accuracy in predicting seizures.

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Correspondence: Gladys Addai-Domfe, Augusta University, 1120 15th St. Augusta, GA 30912, gaddaidomfe@augusta.edu