Introduction to Neural and Cognitive Modeling

Project Proposal

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1 Project Idea: Replicating and Extending the Application of Izhikevich Neuron Model in Pattern Recognition

1.1 Original Paper: Izhikevich Neuron Model and its Application in Pattern Recognition (Roberto Vazquez, 2012)

1.2 Motivation:

- The idea of a single spiking neuron being able to predict patterns is something that is very interesting.
- The paper by Roberto Vazquez. looks into this concept and uses the Izhikevich Neuron Model to identify classify items from different datasets (for example, the Iris Flower dataset).
- It then does a comparative study of performance of various models and algorithms (Back-Propogation algorithm, Levenberg-Marquartd algorithm, Proposed method using LIF, Proposed method using IZ), and states the results.
- Considering the relatively good performance of the two spiking neuron models, it is worth getting a better understanding of how these models are able to excel in this task of classification. Hence, I would like to replicate this paper and try to add another spiking neuron model (Non-linear LIF model) to see whether the choice of model makes a difference.

1.3 Plan:

- Get a better understanding of the Izhikevich Neuron Model.
- Prepare a conversion metric to convert a given dataset into a current input signal.
- Learn the prerequisite techniques to train the IZ model (for example: differential evolution algorithm).
- Train the IZ model on the Iris dataset and compare the results to the given paper.
- After successful replication of results, I wish to expand upon this paper in the following ways:
  - Use another classification algorithm not mentioned here to see how it stacks up to the proposed method.
  - Use another, potentially larger dataset, to see how this method scales with enormity of dataset.
  - Test another spiking neuron model (namely, the Hodgkin-Huxley model) to see how generalizable the proposed method is to different spiking neuron model.
- The aim will be to implement as many of the above extensions to the original paper as possible before the end of the alloted time for this project.

1.4 Potential Benefits of this Project:

- This project will help in better understanding the Izhikevich Neuron Model, and one of its lesser known applications (namely for classification).
- This project will also help give insight into the feasibility of these spiking neuron models to accomplish tasks beyond simply modelling single neurons.
- It will also help give a more optimistic outlook of the power of single-neuron models in a wider variety of applications.