SNNs with adaptive Leaky-Integrate and Fire Neurons

Spiking Neural Networks (SNNs) are a neural network model closely inspired by biological neural networks. Novel neuromorphic hardware implements SNNs in order to achieve high energy-efficiency. SNNs do not communicate analog values but rather events in times (spikes). The most prominent neuron model for machine learning with SNNs is the leaky-integrate-and-fire (LIF) neuron model. Whilst being very simple and fast to compute, this neuron model suffers from significant limitations. Not only is it incapable of resembling several key properties of biological neurons, it also performs poorly in decoding precise temporal information contained in its input.

In this project, we will explore the capabilities of a powerful alternative to the vanilla LIF neuron, the adaptive LIF (adLIF) neuron. The adLIF neuron possesses the interesting property of oscillating dynamics, which have so far not been extensively investigated in the context of machine learning. These oscillations allow the neuron to respond to precise temporal information in its input, for example specific frequencies in speech data. We investigate some possible variations of this adLIF neuron that allow it to dynamically adapt to changes in the temporal structure of the input, for example time-warped speech data.

Goals & Tasks

- Review literature on time warped neuronal processing and adaptation in SNNs.
- Develop potential candidate implementations of neuron models with adaptive oscillations
- Perform simulations of SNNs for speech recognition on benchmark tasks.

Qualifications

- Interest in computational neuroscience.
- Experience with Python and Tensorflow or PyTorch.
- Course Principles of Brain Computation and Deep Learning is recommended.
- Registered to one of the following:
  - ✓ **Bachelor Thesis**
  - ✓ **Seminar Project**
  - ✓ **Master Thesis**

Contact

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