LIF Neural Network Project Information

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I Info

LaTeXdocuments will contain information regarding various aspects of this project. These documents will contain information on:

- How the Neural Network works.
- Libraries the Neural Network utilizes.
- The data the Neural Network is going to be trained on.
- Build information.

Design Ideas

Neuron and Neuron Clusters

Overview of Neuron

A neuron acts as an I/O machine gaining input from data (*if it is the first layer*) or neurons from higher-up layers. If a neuron recieves input from neurons in higher-up layers, randomized weights will be calculated for the synapse and used in the activation function for that current neuron (where j represenents the current neuron):

$$V_j(t) = \sum_{i=1}^{n} x_i(t) \cdot \omega_{ij} - \text{leak}$$

where

- $x_i(t) \in 0, 1$: spike from presynaptic neuron (in previous layer) at time t
- w_{ij}: synaptic weight from neuron i to j
- *leak* is a constant factor subtracted from the membrane to show decay.

For the neuron to spike it must follow that:

$$\text{spike}_j(t) = \begin{cases} 1 & \text{if } V_j(t) \geq \theta \\ 0 & \text{otherwise} \end{cases} \tag{1}$$

where θ represents the *threshold potential.*

Neuron Clusters and Associations

If it follows that $V_j(t) \geq \theta$, then the neuron i or j (or any neuron) will fire with a value of 1. The activation function represented by $V_{\text{tag}}(t)$ represents the electrical charge accumulation within a neuron over time. If that charge surpasses a threshold (θ), the neuron is thought to *spike.*

Neurons are held together by *synapses* which act as bridges between a sender neuron and a reciever neuron. These bridges between neurons transmits an electrical signal between any sender and reciever, and contains a strength parameter to allow for associations to be formed.

An association between any two neurons is modelled as a *likelihood* for any neuron to fire after reciving input from a preceeding neuron. The activation function: $V_{\mathrm{j}}(t) = \sum_{i=1}^{n} x_i(t) \cdot \omega_{ij} - \text{leak}$ sums the product of the previous neuron (*neuron i*) with the synaptic weight value between the neurons i and j (with the difference of a *leak* factor). The stronger the ω value is between neurons *i and j*, the more likely neuron j will fire subsequently. This weight factor allows any neuron to formulate an association to a pattern. So if neuron j has a stronger ω value with neurons *i, k, and l*, neuron j will, over time, serve the purpose of recognizing whatever pattern *i, k, and l* represent.