Developing Filter&Fire and Integrate&Fire Neural Networks to Assess the Role of Dendritic Cable Filtering

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The most common biological neuron spiking computational model is the Integrate&Fire (I&F) model. It computes the neuron's potential by summing its inputs and fires spikes accordingly. The Filter&Fire (F&F) model is a more advanced spiking neuron model. It is based on the I&F, but it applies another key feature: the dendritic cable filtering. The F&F model can reach higher accuracy than the I&F model in tasks of recognizing digits and thus the dendritic cable filtering contributes to the amount of data a single neuron model extracts from its inputs. However, this finding is limited, as neurons in the brain act in a network. My research examined the dendritic filtering and the accuracy of F&F and I&F neural networks. I developed a Pytorch based architecture integrating single neuron models into a network. The models were arranged in layers where the outputs in a given layer became the inputs in the following layer. Next I trained the networks by using the Gradient Descent ML algorithm. This algorithm runs and checks the errors made by the network and updates its parameters in order to reduce its error rate until reaching maximal accuracy. My research was the first to study the computational capabilities of an F&F neural network. It showed that in most of the cases the F&F network reached higher accuracy than the I&F network regardless of the its size or tasks. Thus the F&F model has an advantage over the I&F model at the network level as well. In conclusion the utilization of the biological dendritic cable filtering impacts positively the accuracy of neural networks. This can contribute in the better understanding of the dendritic cable filtering in biological neural networks, as well as contribute in ML in order to create AI with stronger computational capabilities

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