Hierarchical Neural Network Model with Intrinsic Timing

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Abstract

In order to overcome some of the challenges that current, conventional computing faces, a large set of research is being performed into unconventional computing platforms, most often inspired by discoveries in neuroscience. This tends to result in Artificial Neural Networks, which are commonly an oversimplified version of their biological equivalent, where various aspects are being ignored, e.g. the aspect of time. This tends to prevent these networks from handling temporal sequences directly in the time domain. Hence, this research studies how the intrinsic timing of a neuron cell can be used to design a hierarchical neural network with feedback. The network is based on a simple Leaky Integrate and Fire RC-model for each neuron where the intrinsic timing is determined by the capacitor discharge. The results show that the model is able to differentiate between temporally different stimuli. Moreover, feedback allows the model to put lower level cells in a predictive state. Finally, the hierarchical model allows for higher-level cells to remain stable for a longer period and therefore allow for a better combination of sequential information at lower levels.

Keywords: Artificial Neural Network, Intrinsic Timing, Leaky-Integrate and Fire, RC Neuron Modelling