Energy-Efficient Neuromorphic Computing

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INTRODUCTION

General processing computers have progressed far faster in any kind of basic task than the human brain, biological systems have some well-known distinct capabilities e.g., recognizing a person from three-quarter of a face from the crowd. Not only that, but the biological system also consumes very less power to operate, particularly due to their densely connected architecture allows them to compute in parallel. Neuromorphic computing or Bio-inspired computing is intended to mimic the recipes of brain to improve the general and/or specific computing task. The ultimate solution for low-power bio-inspired computing is to fabricate devices specifically targeted to replicate the brains neural network.

Artificial Neural Network, ANN

ANN is a mathematical form of biological neural network. The biological neural network mainly consists of neurons, dendrites, and synapses. The neuron is the centre of processing of the brain, whereas dendrites and synapses serve the purpose of transmission of signals (input or output). Primarily the neuron receives the input signal through the dendrites and transmits the output through synapses. Apart from transmission, synapses also serve as a weight to the output. There are multiple dendrites connected to a single neuron, suggesting the neuron intakes multiple input, similarly the neuron has multiple synapses connected to it, suggesting the output of one neuron is connected to many other neurons. Inside a neuron, all the incoming signals received through the dendrites are summed up, if the summed of signal is equal to or more than a certain threshold, the signal is transmitted to the synapse, and hence to other connected neurons. This is how our biological neural network works. The artificial neural network or ANN works in a very similar way. ANN is mainly constituting of an artificial neuron, input edges and output edges. The input edges provide incoming input signal to the neuron, the output edges take away the output given out by the neuron. Inside the artificial neuron, like the biological neuron, there is a summation block, which sums up all the incoming signal, there is an activation function which decides whether the neuron should transmit the signal or not, with the help of a bias term. The bias term serves as the threshold.