

Spiking Neuron Architecture for Inference

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The Artificial Neural Networks (ANN) require a large number of nodes to achieve a certain level of accuracy for many applications. As the number of nodes grows, the power demand will increase exponentially. Hence, researchers are increasingly focused on creating technologies that can harness the power-efficiency of the human brain for artificial intelligence applications. Spiking Neuron Networks (SNN) is one such promising approach that aims to replicate the event-driven information processing of biological neuron networks. In this study, we successfully replicated the decision-making accuracy of ANN inference by implementing an equivalent SSN using Izhikevich neurons. In our approach, we first choose an ANN that produces acceptable results and then construct the same network using Izhikevich excitatory neurons. We import the weights calculated in ANN into the SNN. The power benefit of the SNN stems from the fact that only the signals corresponding to the spiking neurons need to be propagated, while in an ANN, all signals at all nodes have to be computed. To showcase our approach, we constructed a 3-layer ANN with 100 nodes. We then used a set of images to evaluate the accuracy of an SNN. The SNN network is able to produce 92% accuracy, whereas ANN accuracy is 94%. However, on average, 18% of neurons show spikes, which is a significant reduction in processing and then power consumption. For the implementation of the SNN, we utilized Xilinx's PYNQ FPGA (Field Programmable Gate Array) board, with the prime focus of extending the method to energy-critical remote applications. This method provides a way to harness the efficiency of the spiking neurons. We demonstrated that the event-driven nature of spiking neurons significantly reduced the number of calculations required while still achieving comparable results.

Keywords: Spiking Neuron Network (SSN), Artificial Neuron Network (ANN), FPGA, Power Efficiency, Event-Driven Computing

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