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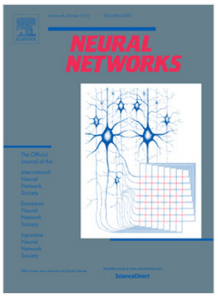

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The Impact of Encoding-Decoding Schemes and Weight Normalization in Spiking Neural Networks

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Abstract

Spike-timing Dependent Plasticity (STDP) is a learning mechanism that can capture causal relationships between events. STDP is considered a foundational element of memory and learning in biological neural networks. Previous research efforts endeavored to understand the functionality of STDP's learning window in spiking neural networks (SNNs). In this study, we investigate the interaction among different encoding/decoding schemes, STDP learning windows and normalization rules for the SNN classifier, trained and tested on MNIST, NIST and ETH80-Contour datasets. The results show that when no normalization rules are applied, classical STDP typically achieves the best performance. Additionally, first-spike decoding classifiers require much less decoding time than a spike count decoding classifier. Thirdly, when no normalization rule is applied, the classifier accuracy decreases as the encoding duration increases from 10 ms to 34 ms using count decoding scheme. Finally, normalization of output weights is shown to improve the performance of a first-spike decoding classifier, which reveals the importance of weight normalization to SNN.

Keywords: Spiking Neural Network, Spike-Timing Dependent Plasticity,

Learning Window, Encoding, Decoding, Normalization.

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