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Hueristic Approach to Spiking Nueral Networks

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Heuristic Approach to Spiking Neural Networks

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The discrepancy between the time encoded (TE) and the rate encoded (RE) models of computation in neural networks motivates the investigation of weight optimization in spiking neural networks. Optimized TE networks would not only provide a faster alternative to traditional RE systems but also could offer insight into the mechanisms of neural coding in biological systems, in which many computations are dependent on precise timings of individual spikes. We apply heuristic algorithms to optimize the weight matrices of leaky integrate and fire (LIF) networks. Spike trains were produced from both small world LIF model networks with light Gaussian input currents and from calcium microscopy measurements of the mouse visual cortex. Each of these spike trains serve as goal spiking behavior for each application of the optimization algorithm. The proposed algorithm first optimally matches corresponding output spike trains of a naïve network and with the goal spike trains. By making small, targeted variations to the presynaptic weights, we then eliminate spikes in the naïve network that were unpaired or produce new spikes in the naïve network outputs to match those unpaired in the goal outputs. For both the model data and the data from biological measurements, the algorithm does reproduce statistical features in the outputs including inter-spike interval and CV distributions, suggesting that the algorithm often reduces to optimizing the rate of firing. In addition, we found that post-optimization inter-spike interval histograms tended towards exponential distributions. However, the precise reproduction of spike times remains elusive. Further inquiry could indicate if improved versions of our algorithm or other similar heuristics can be used to reproduce exact spike timings.