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Mapping RNNs to in-memory neuromorphic chips

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The increasing need for compact and low-power computing solutions for machine learning applications has triggered significant interest in energy-efficient neuromorphic systems. However, most of these architectures rely on spiking neural networks, which typically perform poorly compared to their non-spiking counterparts in terms of accuracy. In this paper, we propose a new adaptive spiking neuron model that can be abstracted as a low-pass filter. This abstraction enables faster and better training of spiking networks using back-propagation, without simulating spikes. We show that this model dramatically improves the inference performance of a recurrent neural network and validate it with three complex spatio-temporal learning tasks: the temporal addition task, the temporal copying task, and a spoken-phrase recognition task. We estimate at least 500x higher energy-efficiency using our models on compatible neuromorphic chips in comparison to Cortex-M4, a popular embedded microprocessor.