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Enabling brain-scale spike-timing dependent plasticity by incorporating axonal and dendritic transmission delays in massively parallel spiking neural network simulations

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NEST, a distributed neural network simulator, is capable of simulating large, sparsely interconnected networks, wherein axons and dendrites are represented as simple transmission delays. The synapses in these networks can incorporate plasticity mechanisms, including the widely used spike-timing dependent plasticity (STDP). Presently, NEST employs purely dendritic delays, which are suitable for networks up to approximately one cubic millimeter. To accommodate larger networks and enhance the accuracy of STDP weight dynamics, the specification of both dendritic and axonal delays is crucial. However, the introduction of axonal delays presents a causality dilemma, as pre-synaptic spikes may be processed internally prior to reaching the synapse, necessitating knowledge of future post-synaptic spikes. Several strategies to circumvent this issue are explored, with one requiring minimal alterations to the existing code and others involving a comprehensive overhaul of low-level simulator code for a cleaner solution. The most promising strategies are assessed using performance and memory benchmarks.

Acknowledgements

References

Preferred form of presentation

Talk (& optional poster)

Keywords

STDP, transmission delays, simulator performance

Topic area

Simulator technology and performance

Speaker time zone

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