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Mitigating Catastrophic Forgetting in Biologically Plausible Learning

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Eligibility Propagation (e-prop) is a biologically inspired learning algorithm providing a plausible alternative to Backpropagation Through Time (BPTT) [1]. Despite its biological realism, e-prop inherits BPTT's vulnerability to catastrophic forgetting (CF), a phenomenon in which neural networks lose previously acquired knowledge when trained on new tasks.

Elastic Weight Consolidation (EWC) is a prominent regularization-based method known for reducing CF in artificial neural networks [2]. Due to its compatibility with the locality constraints of biological synapses, EWC holds considerable promise for integration into biologically plausible learning algorithms. However, EWC relies on separate phases for task learning and weight importance estimation and necessitates explicit task boundaries, limiting its biological plausibility and practical applicability in real-world scenarios lacking clear task delineations.

In this poster, we propose the integration of EWC principles directly into the e-prop algorithm. Our approach concurrently estimates Fisher Information and weight importance during learning, eliminating the requirement for distinct training and estimation phases. Furthermore, we extend our neural network with a Bayesian inference-based novelty detection layer, enabling it to autonomously identify task transitions without explicit external cues. This detected novelty is signaled to all neurons, facilitating effective parameter consolidation.

We evaluate our proposed method on the Permuted Neuromorphic MNIST dataset and demonstrate substantial reductions in catastrophic forgetting, significantly improving the network's continual learning capabilities without compromising task-specific performance. Our results represent a step forward in developing biologically plausible learning algorithms with enhanced robustness for continual learning.

Acknowledgements

References

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- [2] Kirkpatrick, James, Razvan Pascanu, Neil Rabinowitz, Joel Veness, Guillaume Desjardins, Andrei A. Rusu, Kieran Milan, et al. 2017. "Overcoming Catastrophic Forgetting in Neural Networks." *Proceedings of the National Academy of Sciences of the United States of America* 114 (13): 3521–26.

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Models and applications

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