Synthesizing Deep Neural Network Architectures Using Biological Synaptic Strength Distributions

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Submitter Amir-Hossein Karimi

Affiliation University of Waterloo

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Presentation Abstract Summary Experimental studies have shown that synaptic formation in the biological brain follow commonly repeating synaptic strength distributions. Motivated by this, we explore different uncorrelated and correlated probabilistic generative models for synaptic strength formation in deep neural networks and their potential for modelling performance particularly for the scenario associated with small datasets.

We specifically looked into a CNN where the synaptic strengths of the convolutional layers were drawn from various underlying biologically-inspired probability distributions. These synaptic strengths were frozen and not trained, while the fully connected layers of the CNN were trained and fine-tuned. This setup allowed us to localize the effect of the different synaptic strength distributions on classification and modelling performance.

As expected, the small training dataset led to a relatively poor performance for a fully-trained CNN, resulting in performance similar to that of a CNN where all convolutional layer synaptic strengths were set randomly. Most surprisingly, a CNN with convolutional layer synaptic strengths drawn from biologically-inspired distributions such as log-normal or correlated center-surround distributions performed relatively well suggesting a possibility for designing deep neural network architectures that do not require many data samples to learn, and can sidestep current training procedures while maintaining or boosting modelling performance.

Co-author Information

* Presenting Author

First Name	Last Name	Affiliation	E-mail
Amir-Hossein *	Karimi *	University of Waterloo	amirhkarimi@gmail.com
Mohammad Javad	Shafiee	University of Waterloo	mjshafiee@uwaterloo.ca

Ali	Ghodsi	University of Waterloo	aghodsib@uwaterloo.ca
Alexander	Wong	University of Waterloo	a28wong@uwaterloo.ca

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