How Do Biological Neural Networks Encode, Learn, Memorize and Generalize as a "Learning Machine"?

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Presentation Abstract Summary A computational model of biological neural networks that explains how biological neural networks encode, learn, memorize, recall and generalize is proposed. The model is a hierarchical multilayer network of processing units (PUs) each comprising novel models of dendrites (for encoding), synapses (for storing code covariance matrices), spiking/nonspiking somas (for evaluating empirical probabilities and generating spikes), unsupervised/supervised Hebbian learning schemes, and maximal generalization mechanism. Most of these component models are supported by the neurobiological literature. Those that are not are conjectured to integrate the component models into a "learning machine". Learning by the Hebbian rule, the "learning machine" learns with a photographic memory and can learn even data online that stream in. A PU is either a unsupervised or supervised processing unit (UPU or SPU), each being a pattern recognizer. While UPUs act like clusters, SPUs translate their outputs into a human language. Handcrafted labels are required only for learning by SPUs. Once the label of a member of a cluster is available and learned, the members of the entire cluster are assigned with the same label, greatly reducing the labels needed. Numerical experiments on small data sets show the effectiveness of the learning machine.

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Keywords

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