STRATEGIES TO ASSOCIATE MEMORIES BY UNSUPERVISED LEARNING IN NEURAL NETWORKS

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Memories, and everything that is processed by the brain, are associated with the connections among neurons. It is well established that learning includes mechanisms based on Hebb's hypothesis, which consists basically on potentiating and depressing connections among neurons with correlated and uncorrelated activities, respectively. The main mechanism of synaptic modification that is responsible for the emergence of associative memory in an unsupervised way is Spike-Timing-Dependent Plasticity (STDP), which is a hebbian-like rule. In this work, we study the effects of three different strategies to associate memories in a neural network composed by excitatory and inhibitory Izhikevich neurons [1], connected randomly through recurrent excitatory and inhibitory synapses. The system is intended to store a number of memories, which are associated to spatial external inputs. The strategies consist in the presentation of the storage patterns through trials in: i) ordered sequence; ii) random sequence; iii) clustered sequences. A trial is defined as a period that includes a specific external spatial pattern input and the network response. In the first strategy, each spatial pattern is presented in an ordered way through the trials. The second strategy consists in presenting the patterns randomly and, in the third one, each pattern is presented repeatedly for a defined number of trials. The synaptic modifications are applied to excitatory connections, including a homeostasis rule and STDP, as described in ref. [2]. The homeostasis rule is used to increase the synaptic weights until the network presents a desired activity and to maintain a stable activity after. As expected, each strategy affects the synaptic weights differently, which is shown through a detailed analysis of synaptic matrices evolution compared to the spatial input patterns. In addition, an order parameter indicating the correlation between trials' activities is introduced to compute memory association capacities and the quality of memory retrieval.

[1] Izhikevich E. M. and Edelman G. M., PNAS **105**, 3593 (2008).

[2] Liu, J.K. and Buonomano, D.V., J. Neurosci. **29**, 13172 (2009).