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Modeling the habituation in artificial neural networks

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The objective of this research was to invent a neural network model, which is fast–learning and stop learning, without leading to network being paralyzed, when input patterns are adequately learned. We modeled habituation to achieve this objective. Habituation decreases in the frequency of firing by a neuron cell as a response to repeated rapid stimulations. According to the neurophysiology, habituation is associated with decrease release of neurotransmitter form presynaptic terminal, caused by decrease in the intracellular calcium ions due to gradual inactivation of calcium ion channels. The output generated by a neuron is proportional to level of presynaptic calcium ions and weighted sum (*net* = W^TX with the usual notation). Based on this we have modeled the actual net effect on a neuron as *k.net.Ca,* where *k* is a constant, *net* = W^TX and *Ca* is the calcium level. Hence calculation of output of a neuron is defined as

$$\text{Output} = f(k.net.Ca)$$

In each cycle, the calcium level is reduced by with a deletion rate *r.* So, the calcium level at the cycle j is represented as $Ca_j = Ca_{j-1}(1-r)$. If the current calcium level of a neuron goes down beyond a pre-defined threshold level, the particular neuron will stop its training and other neurons continue to train by changing weights.

We have experimented with this model by applying different learning rules and activation functions for different neural network topologies. Results showed that the novel neural network model could finish learning, comparatively within a shorter duration and with a comparable accuracy. The training time is shorter since the total number of neurons that has to be trained decreases gradually during the training process. It is also possible to determine when to stop training the entire neural network by considering the proportion of neurons, which are trained at a given time. Problem of Overtraining neurons, could be eliminated.

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