ENFORCING EFFECTIVE SYNAPTIC LEARNING VIA A NEURONAL REGULATION MECHANISM

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While Hebbian synaptic plasticity is believed to underlies memory storage in the brain, a delicate balance between LTP and LTD is requiered to allow successful memory storage in associative neural networks. By analysing the space of synaptic modification rules we show it contains a sub-space of effective learning rules, characterised by a zero covariance between the incoming synapses of the post synaptic neuron. We describe how a biologically plausible mechanism that normalizes the incoming synapses of the post synaptic neuron, enforces the zero covariance constarint and transforms non-effective synaptic learning rules to near-optimal ones. Moreover, we show that this transformation may be implemented by Neuronal Regulation - a mechanism recently obsereved experimentally [Turrigiano *et al.* Nature, 1998] to modify the efficacy of incoming synapses on the postsynaptic neuron. The neuronal mechanism drastically improves the network memory performance when using a non-effective synaptic learning rule, such as the Hebb rule. In some cases, e.g. when storing memory patterns with different coding levels, such a normalization is essential, as it is impossible to use any pre-determined effective rule. These findings suggest a new computational role for LTD, that of removing synaptic covariance, and strengthen the idea that processes at the neuronal level must shape the Hebbian synaptic learning.