the role of spatiotemporal correlations in the encoding and retrieval of synaptic patterns by STDP in recurrent spiking networks

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Abstract of Thesis

Spike-timing dependent plasticity (STDP) is considered to be an important synaptic mechanism to encode information within and between cerebral cortical networks. It remains unclear, however, how temporal and spatial correlations of signals and ongoing background spiking activity interact with STDP mechanisms to give rise to long-term memory. A recent computational study by Davison and Frégnac suggests that a spiking neuronal network with correlated signals acting through STDP can encode a coordinate transformation from one group of neurons to another, where both groups incorporate only feed-forward connections. Yet, because cortical networks mostly contain local recurrent connections, it is critical to explore STDP-based encoding and decoding in such architectures. To investigate their dynamics, we applied a phenomenological STDP model within recurrent networks, and between recurrent and feed-forward networks. We find that emergence of transient spatiotemporal correlations of ongoing activity lead to the storage of self-organized, stable synaptic patterns in the recurrent networks. These networks can be probed at a later time to reconstruct the encoded patterns by projecting them onto another network in a feed-forward, readout fashion with highly correlated spatiotemporal structure. We hypothesize that transient spatiotemporal correlations among networks can serve as a biologically plausible mechanism of memory storage and retrieval based on STDP.

Keywords: STDP, Computational Model, Spatiotemporal Correlation, Ongoing Activity, Synaptic Pattern, Recurrent Network.