Bachelor/Master Thesis

How do bump activations emerge?

Natural brains perform miraculously well in learning new tasks. The level of generalization and speed of adaptation achieved by human brains remain unmatched by machine learning approaches, despite tremendous progress in the last years. How natural brains accomplish these outstanding skills is still largely unclear. This project is based on our recent paper [1], in which we showed that population codes together with continuous attractor mechanisms and probabilistic synapses permits fast learning of low dimensional functions. It is wildly believed that continuous attractor mechanisms emerge from the circuit motif of local excitation and global inhibition, that is neurons that encode similar parameter values excite each other, whereas neurons that encode far apart parameter values inhibit each other. This circuit motif causes bump-like activity states to be stable points in the networks dynamics. In [1] we assume this circuit motif as given. The goal of this project is to investigate how these bump-like activity states emerge and how the circuit motive of local excitation and global inhibition is learned in an unsupervised way. Starting point of the problem is to investigate the BCM rule [2], a classical learning mechanism.

Prerequisites: A solid understanding of discrete probability theory, willingness to combine theoretical intuition, creativity, and simulations.

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