TECHNISCHE UNIVERSITÄT
IN DER KULTURHAUPTSTADT EUROPAS
CHEMNITZ

Fakultät für Informatik

Informatik Kolloquium

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The effects of inhibitory plasticity and the emerging network dynamics on processing visual information

In recent years, deep neural networks have shown how a brain-inspired approach can lead to outstanding performance in object recognition and detection.
Despite their success in visual tasks, these artificial neural networks differ from the biological visual system in several ways: They have a predominantly feed-forward connectivity structure instead of many lateral and recurrent connections.
Understanding how information is processed in the brain can help to improve artificial visual systems and artificial neural networks in general.

There is a large corpus of neural networks in computational neuroscience that model different parts of the biological visual system to investigate the role of excitatory neurons and how different synaptic plasticity rules cause their representation of visual information, a core element for object recognition.
Despite the large number of studies on the visual system, one mechanism that has received little attention is the plasticity of inhibitory neurons and how it influences the emergence of neuronal representations.
Moreover, while these networks succeed in modeling different isolated parts of the visual pathway, such as the retina or the primary visual cortex, only a few models implement multiple areas to investigate how visual information is represented along different areas.

In my dissertation defense, I present a spiking neural network to model the early visual system up to the primary visual cortex (V1).
By extending the network with different key functions of the visual system, I show the importance of inhibition for spatial and temporal representation of visual information.
I found that the dynamics resulting from the interplay of excitatory and inhibitory synaptic plasticity are crucial for the development of the representation of different input features.
As this is relevant for object recognition, the usefulness of the input representation is supported by benchmarks of different standard object recognition datasets.
I show that the temporal encoding of visual information is rooted in the very early layers of the visual system, the retina, and the thalamus, and that the selectivity of motion detection in V1 is strongly influenced by temporal dynamics between these early stages and by tuned lateral inhibition within V1.

In summary, my thesis improves the understanding of plasticity dynamics and different circuit motifs in more brain-like networks and supports their potential as artificial visual systems.

Öffentliche Verteidigung im Rahmen des Promotionsverfahrens

“The effects of inhibitory plasticity and the emerging network dynamics on processing visual information”

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Alle interessierten Personen sind eingeladen.

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