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THE HONG KONG UNIVERSITY OF SCIENCE & TECHNOLOGY

Department of Mathematics

PHD STUDENT SEMINAR

Memory Capacity Enhancement Through Bias-Corrected Plasticity in the Sparse Coding Mushroom Body Circuit

By

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Abstract

The mushroom body in fruit flies plays a crucial role in associating odors with positive or negative reinforcement signals. Despite extensive experimental and theoretical studies, the precise mechanisms of learning and synaptic plasticity remain open. Using a minimal circuit model to store the sparse binary patterns, we show that the classic Hebbian learning rule introduces systematic bias in the readout neuron, which accumulates and limits the accuracy. In contrast to direct bias correction applied at the readout level, our approach implementing bias correction at the synaptic connection level achieves significantly better performance.

Memory capacity, defined as the maximum number of patterns stored with a high accuracy probability, exhibits distinct scaling orders to the network size depending on finite and vanishing coding sparsity regimes. The capacity of bias-corrected synaptic plasticity can scale linearly with network size whereas the capacity from readout correction is always sublinear despite the growth with sparsity vanishment. The sufficient conditions for readout distribution normality have also been investigated in the vanishing sparsity scenario so that our methodology applies. Furthermore, we will extend to learn more complex cognitive tasks in the dynamical recurrent neural networks through reward-modulated Hebbian rule.

Date : 14 May 2025 (Wednesday)
Time : 3:00pm
Venue : Room 1409 (near Lifts 25/26)

All are Welcome!