



THE HONG KONG UNIVERSITY OF SCIENCE & TECHNOLOGY

Department of Mathematics

## PHD STUDENT SEMINAR

**Generalizing bias-corrected learning across temporal windows and multi-compartment structures in the mushroom body**

By

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### Abstract

The precise synaptic plasticity and learning algorithms governing associative memory in the *Drosophila* mushroom body (MB) remain a subject of intense debate. While experimental evidence highlights the Kenyon cell-MB output neuron (KC-MBON) synaptic depression, theoretical work suggests that bias-corrected plasticity, consistent with observed bidirectional changes, yields superior performance. Here, we extend the signal-to-noise ratio analysis to compare simple and bias-corrected rules, deriving rigorous memory capacity bounds of linear and sublinear orders, respectively. Furthermore, we evaluate these rules within the MB's multi-compartment architecture. Numerical simulations reveal that multi-compartment models with nonlinear decoders follow similar capacity scaling as the single-compartment case. Our results suggest that the multi-compartment structure optimizes behavioral performance and reduces the evolutionary pressure for high-precision bias-correction in individual synapses. Broadening our scope beyond the static case, we investigate the optimal subtraction magnitude for temporal plasticity rules, which provides analytical predictions for the required potentiation magnitude when the associative coincidence time window is modulated. This unified framework bridges molecular mechanisms and circuit-level organization, offering testable predictions for future perturbation experiments.

**Date : 11 May 2026, Monday**

**Time : 4:00pm**

**Venue : Room 5402 (Lifts 17/18)**

*All are Welcome!*