THE UNIVERSITY OF CHICAGO | THE COMMITTEE ON COMPUTATIONAL AND APPLIED MATHEMATICS

COLLOQUIUM

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Novelty and Reward Computations with Cortical Cell Types

THURSDAY, January 14th at 4:00 PM
Jones 303, 5747 S. Ellis Ave. Chicago, IL 60637

ABSTRACT

The brain efficiently processes sensory information by generating an internal model of the environment, which is shaped by learning the statistical regularities of the environment and continuously updated by incoming novel observations—a process known as predictive coding. Recent experimental evidence supports the implementation of predictive coding through cortical cell types; however, the detailed circuit implementation remains unclear.

By mapping algorithmic components onto neuronal subtypes, our study generates experimentally testable predictions about cell-type-specific responses to expected and unexpected information. We show how different computational objectives, such as prediction error minimization, energy efficiency, and reward maximization, shape cell-type-specific responses to distinct forms of expectation violation, including contextual, absolute, and omission novelty. Furthermore, by training a biologically grounded network model of cortical cell types, our work uncovers context-dependent functional connectivity that reflects the communication of predictions and prediction errors across cortical circuits. Our study thus integrates a multi-objective normative framework with a biological circuit model, offering a unified account of how predictive coding, energy efficiency, and reinforcement learning map onto cell-type-specific mechanisms.

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