BCL 2023

Edition IV

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9 Jan | 14:00 - 15:30
11 Jan | 14:00 - 15:30

Hierarchical, Dynamic and Active Predictive Coding: Bayesian Theories of Brain Function

Abstract: "How does the brain learn an internal model of the world? What is the role of prediction in learning and using such a model? How can an 18th-century reverend help us answer these questions? In the first tutorial, we will review classical predictive coding models, from the retina to the cortex, making connections to concepts in mathematics, computer science and engineering such as Bayes theorem, Kalman filtering and robust statistics. In the second tutorial, we will review two new predictive coding models called dynamic and active predictive coding. In dynamic predictive coding, a higher-level network uses a "hypernetwork" to modulate the dynamics of lower-level neurons, enabling the learning of temporal response hierarchies. In active predictive coding, a "canonical cortical module" incorporates both a state-prediction network and an action-prediction network which feed into each other. These modules are in turn assembled to form a hierarchical network model of multiple interacting cortical areas. We show that these models can learn visual cortex-like space-time receptive fields, exhibit episodic memory and activity recall via a hippocampal associative memory, and solve tasks ranging from parts-based parsing of objects using eye movements to hierarchical planning.

References:

Predictive coding review:

https://arxiv.org/abs/2112.10048

Dynamic predictive coding:

https://www.biorxiv.org/content/10.1101/2022.06.23.497415v3

Active predictive coding:

https://www.biorxiv.org/content/10.1101/2022.12.30.522267v1

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Brief Bio: *Rajesh P. N. Rao is the CJ and Elizabeth Hwang Professor in the Paul G. Allen School of Computer Science and Engineering and Department of Electrical and Computer Engineering at the University of Washington (UW), Seattle. He is also the co-Director of the Center for Neurotechnology (CNT), Adjunct Professor in the Bioengineering department, and faculty member in the Neuroscience Graduate Program at UW. He directs the Neural Systems Laboratory in the Paul G. Allen Center for Computer Science and Engineering and is an IEEE Fellow. His awards include a Guggenheim Fellowship, a Fulbright Scholar award, an NSF CAREER award, an ONR Young Investigator Award, a Sloan Faculty Fellowship, and a David and Lucile Packard Fellowship. His research interests span computational neuroscience, brain-computer interfaces, and AI as well as the Indus script and classical Indian paintings.*