Forum

Computational frameworks for integrating large-scale neural dynamics, connectivity, and behavior.

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Abstract

Modern neurotechnologies generate high-resolution maps of the brain-wide neural activity and anatomical connectivity. However, theoretical frameworks are missing to explain how global activity arises from connectivity to drive animal behaviors. I will present our recent work developing computational frameworks for modeling global neural dynamics, which utilize anatomical connectivity and predict rich behavioral outputs. First, we took advantage of recently available large-scale datasets of neural activity and connectivity to construct a model of mesoscopic functional dynamics across the mouse cortex. We found that global activity is restricted to a low-dimensional subspace spanned by a few cortical areas and explores different parts of this subspace in different behavioral contexts. Our framework provides an interpretable dimensionality reduction of cortex-wide neural activity grounded on the connectome, which generalizes across animals and behaviors. Second, we developed a circuit reduction method for inferring interpretable low-dimensional circuit mechanisms of cognitive computations from high-dimensional neural activity data. Our method infers the structural connectivity of an equivalent low-dimensional circuit that fits projections of high-dimensional neural activity data and implements the behavioral task. Our computational frameworks make quantitative predictions for perturbation experiments.

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