Bocconi

17 OCTOBER 2023
04:00 PM

Bocconi University
Room 3-E4-SR03
Via Röntgen 1, Milano (3° floor)

Probing the operating principles of cortical circuits with theory and optogenetics

Speaker

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Abstract

Cortical circuits play a pivotal role in processing sensory information and generating neural representations that are instrumental for learning and behavior. This processing is shaped by the intricate dynamics arising from massive recurrent interactions within these circuits, giving rise to emergent properties that are absent at the individual neuron level. In this presentation, I will discuss theoretical modeling and perturbation experiments aimed at uncovering these properties and the underlying mechanisms. First, I will explore the mechanisms responsible for maintaining dynamical stability in distinct regions of the mouse cortex. Strong recurrent interactions among excitatory neurons create a positive feedback loop that can destabilize network dynamics. I will present evidence suggesting that inhibition is instrumental in preventing this instability. Next, I will delve into how cortical circuits integrate multiple inputs, drawing from experiments conducted in the visual cortex of mice and monkeys. I will show that unstructured, heterogeneous excitation within these circuits has the surprising effect of reshuffling visual responses—strongly modulating neural responses while having only a weak impact on the distribution of firing rates. I will conclude discussing a theoretical model aimed at elucidating the mechanisms underlying this phenomenon. This research unveils shared operational principles governing the cortex, revealing both commonalities and differences across cortical areas and species.

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