MIT Biophysics Special Seminar

Controlling Neural Dynamics To Evoke Complex Behaviors In *C. Elegans*

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The brain is the most complex organ in nature. Remarkably, the massive number of interactions between its component neurons can orchestrate complex internal dynamics to generate precise and robust behavioral outputs. Understanding the detailed network dynamics leading specific behaviors is a challenging task even in the simplest nervous system of nematode *Caenorhabditis elegans* (*C. elegans*), which has only 302 neurons interconnected through 7000 synapses. To approach this challenge we asked whether we could control the dynamics of neural network well enough to be able to evoke specific behaviors. To make this approach possible, we combined optogenetics and novel imaging systems that could visualize, identify and specifically illuminate the neuron(s) of interest to drive any pattern of electrical activity in the nervous system of freely moving *C. elegans*. As a particular example, we used this system to control food search behavior of *C. elegans*. To produce this behavior, the nervous system processes environmental information received through the sensory neurons and coordinates all necessary motor activities, leading animal to food. We discovered that controlling the dynamics of activity in one key pair of interneurons was sufficient to evoke this complex behavior. By remotely controlling this pair of neurons we could make the animal to turn right or left, go forward or backward and finally make it to track virtually defined chemoatractive gradients or more complex spatial profiles. In this talk, I will start by describing the challenges and our achievements to control neural activity patterns to evoke behavior in virtual environments. Next, I will describe our recent complementary tools and techniques for whole-brain imaging of neural activity patterns in a freely moving *C. elegans*. Finally, I will argue that combination of these control and imaging-based approaches will provide powerful avenues for studying the complex dynamics of entire nervous systems.

Host: Mehran Kardar
Date & Time: Tuesday, February 18 @ 10am
Room: 4-331 (Duboc Room)

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