Seminar/Talk

Modeling the neural control of movement: performance limitations and data-driven inference

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Host: Gasper Tkacik

We have a remarkable ability to effortlessly perform complex and fast movements. While these movements are fundamentally constrained by the biophysics of the neurons and dynamics of the muscles involved, how these factors act together to limit our ability to make agile movements in health and disease has not been rigorously quantified. In the first part of the talk, I will focus on performance limitations of sensorimotor control. Using a biophysically based model of neuronal dynamics, we predict undesirable phenomena that occur when tracking high frequency inputs, including skipped cycles, overshoot and undershoot. Notably, these specific errors are well documented for humans and monkeys. We derive an analytical bound on the highest frequency that we can track without producing such undesirable phenomena, as a function of the neural computation and muscle dynamics. Our theoretical analysis can be used to guide the design of therapies for movement disorders by enhancing performance with assistive neuroprosthetic devices.In the second part of the talk, I will focus on methods for the data-driven inference of the relationships between high-dimensional cortex-wide neural activity and the ensuing behavior. Widefield calcium imaging enables recording of large-scale neural activity across the mouse dorsal cortex. Here, it is critical to demix the recordings into meaningful spatial and temporal components that can be mapped onto well-defined brain regions. To this end, we developed Localized semi-Nonnegative Matrix Factorization (LocaNMF) to extract the activity of different brain regions in individual mice in a data-driven manner. The decomposition obtained by LocaNMF results in interpretable components which are robust across subjects and experimental conditions. We also uncover the relationship of these neural signals to the resulting high-dimensional behavior. I will end by providing insights into how we can leverage theoretical analyses as well as data-driven models of large-scale cortical activity to restore impaired movements due to compromised neural transmission.

Monday, March 9, 2020 10:00am - 11:00am
Mondi Seminar Room 2, Central Building

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