Contribution ID: **2** Type: **not specified**

A Less Artificial Intelligence

Friday 27 September 2024 09:00 (45 minutes)

"You, your joys and sorrows, your memories and ambitions, your sense of personal identity and free will, are in fact no more than the behavior of a vast assembly of nerve cells and their associated molecules."Francis Crick's words encapsulate a core challenge in neuroscience: cracking the neural code. This challenge has been hindered by two major limitations: (1) our ability to record activity from large neuronal populations at single-cell resolution under the complex, variable conditions in which brains evolve to survive and thrive, and 2) our capacity to model the relationships between stimuli, behaviors, neural activity, and internal brain states, given the complexity of the natural world.

Recent technological advances have begun to overcome these obstacles. High-throughput recording technologies, such as multi-photon imaging and multi-electrode arrays, now enable large-scale recordings, sometimes approaching one million neurons. Simultaneously, cutting-edge machine learning (ML), artificial intelligence (AI), and the availability of large-scale GPU clusters now provide the power to analyze this complex, high-dimensional data and build multi-modal foundation models that relate stimuli, neural activity, behavior, and internal brain states. These models can serve as digital twins of the brain, enabling limitless in silico experiments to test theories and generate hypotheses that are impossible to achieve in biological brains due to technical limitations.

I will discuss our progress in designing large-scale physiology experiments, leveraging these technologies and brain data to build foundation models and digital twins, which allow us to run in silico experiments to test theories and generate hypotheses. Applying mechanistic interpretability tools developed for artificial neural networks—techniques designed to make AI neural network systems more interpretable and transparent—we can uncover mechanisms and principles of neural representation in the digital twin. We then use our "Inception Loop"approach to validate these principles in real brains through closed-loop experiments—bridging the gap between computational models and biological reality to uncover new insights into brain function. Finally, I will describe our efforts to answer the long-standing question of the relationship between function and structure using the MICrONS functional-connectomics dataset (https://www.microns-explorer.org). This dataset of paired functional and connectonomic data from around 70,000 neurons can provide unprecedented insight into the elegant inner workings of biological neural networks.

Presenter: TOLIAS, Andreas (Stanford University)

Session Classification: Multiscale Models in Neuroscience (Chair: Hermann Cuntz)