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Edition IV

Maneesh Sahani

Professor and Director,
Gatsby Computational Neuroscience Unit,
University College London, UK
Smt. Sudha Murty Chair Professor

12 Jan | 14:00 - 15:30
13 Jan | 14:00 - 15:30

Talk 1: Visualising population dynamics: GPFA and extensions

Abstract: Individual neurons in the mammalian neocortex do not act alone. Instead, they are embedded within densely interconnected networks, and it is the collective dynamics of these networks which forms the substrate for the rich computational repertoire of the forebrain. Empirical access to these dynamics has historically been challenging, relying on inference either from isolated recordings of individual neurons or from aggregate measures such as local field potentials. Fortunately, the advent of large-scale multiple-neuron recording methods opens the possibility of characterising dynamics directly at the network scale.

I will discuss a family of analytic tools based on Gaussian-Process Factor Analysis, a technique we first introduced in 2009. In particular, I will survey recent updates that incorporate point-process models, time warping, irreversibility and non-linear manifold models into the framework, extending its potential applicability greatly.

Talk 2: The dynamics of robustness in motor cortical circuits

Abstract: The rich repertoire of skilled mammalian behavior is the product of neural circuits that generate robust and flexible patterns of activity distributed across populations of neurons. Although decades of associative studies have linked many behaviors to specific patterns of population activity, association alone cannot reveal the dynamical mechanisms that shape those patterns. Here, we consider the dynamics of primate motor cortex perturbed by optogenetic and electrical microstimulation during reaching behavior. We develop a novel analytic approach that relates measured activity to theoretically tractable, dynamical models of excitatory and inhibitory

neurons. This computational model captures the dynamical effects of these perturbations and demonstrates that motor cortical activity during reaching is shaped by a self-contained, low-dimensional dynamical system, acting within a subspace that is oriented so as to be robust to strong non-normal amplification within cortical circuits. The results resolve long-standing questions about the dynamical structure of cortical activity associated with movement, and illuminate the dynamical perturbation experiments needed to understand how neural circuits throughout the brain generate complex behavior.

Brief Bio: *Maneesh Sahani is Professor of Theoretical Neuroscience and Machine Learning, and Director of the Gatsby Computational Neuroscience Unit at University College London (UCL). Graduating with a B.S. in physics from Caltech, he stayed to earn his Ph.D. in the Computation and Neural Systems program, supervised by Richard Andersen and John Hopfield. After postdoctoral work at the Gatsby Unit and the University of California, San Francisco, he joined the faculty at Gatsby in 2004, becoming Director in 2017. His work spans the interface of the fields of machine learning and neuroscience, with particular emphasis on the computations underlying inference and control under uncertainty, in perceptual and motor cortical systems. He has helped to pioneer analytic methods which seek to characterize and visualize the dynamical computational processes that underlie the measured joint activity of populations of neurons. Much of his work explores methods for approximate inference in Bayesian models and decision problems, which he develops in the context of machine learning theory and applications as well as biological theory.*