

From trajectories to models: learning the stochastic dynamics of biological matter

Description: The dynamics of biological systems, from proteins to cells to organisms to ecosystems, is complex and stochastic. To decipher their physical laws, we need to bridge between experimental observations and theoretical modeling. Thanks to progress in microscopy and tracking, there is an abundance of experimental trajectories reflecting these dynamical laws. Inferring physical models from imperfect experimental data, however, is challenging and currently remains a bottleneck to data-driven biophysics. In this talk, I will present a set of tools developed to bridge this gap and permit robust and universal inference of stochastic dynamical models from experimental trajectories. These methods are rooted in an information-theoretical framework that quantifies how much can be inferred from trajectories that are short, partial and noisy. They permit the efficient inference of dynamical models for overdamped and underdamped Langevin systems, the identification of minimal models from large classes, and the reconstruction of trajectories from partial observations. I finally present early applications of these techniques, from cells and tissues to populations, as well as future research directions.