PHENIX SEMINAR

Matching method for first passage observables and diffusion sensitivities of Langevin dynamics

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9th September 2024, 16h00

In this talk, I will discuss two ongoing research projects whose common thread is dynamical analysis of stochastic systems. The first part **1.** will focus on developping matching methods to reconcile discrepencies between experimentally measured first passage observables and continuous modelling; in a second part **2.** I will discuss response theory for out-of-equilibrium systems, for which the fluctuation-dissipation theorem do es not hold. More precisely

1. Because of limited time resolution in tracking instruments, time series are typical realisations of discrete time stochastic dynamics. In turn, any experimental estimation of relevant first passage observables, such as mean exit times or commitor functions, cannot be directly mapped on a continuous stochastic model without parameter fitting. Starting from the one dimensional commitor function for discrete time and continuous space random walks, we show how to make the link with limiting continuous processes while safeguarding important specific discrete behavior. We then show how this one dimensional commitor is the single key to properly characterizing the limiting behavior of general first passage observables across various dimensions and geometries.

2. Analyzing the response properties of systems subject to perturbations provides useful insights on the structural properties of the system, and is of paramount importance in identifying phase transitions. For equilibrium Langevin systems, the fluctuation-dissipation theorem (FDT) relates response to spontaneous fluctuations, such that sensitivity analysis can be carried out without actually perturbing the system. Out of equilibrium, the FDT does not hold; however we construct general non-equilibrium response estimators that allow sensitivity analysis for both stationnary (NESS) and non stationnary systems. This estimator is based on the instantaneous score $\nabla \log \rho_t$ of the system, a by-now classical object in machine learning, that can be estimated from system snapshots.