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Sampling rare trajectories using stochastic bridges

UNIT OF EXCELLENCE MARÍA DE MAEZTU



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Introduction

The most uncommonly occurring events in stochastic systems are often the most consequential. Instances where this unlikely-yet-important combination occurs include fade-outs of epidemics, the extinction of species in ecology, the dynamics of biological switches, large fluctuations in chemical reactions and the detection or prediction of rare natural disasters such as earthquakes, storms or heavy rains. The broad range of these applications justifies the considerable recent effort expended on developing sampling algorithms for rare events in models of stochastic phenomena.

We present a new method that constructs an ensemble of stochastic trajectories that are constrained to have fixed start and end points (so-called stochastic bridges). We then show that by carefully choosing a set of such bridges and assigning an appropriate statistical weight to each bridge, one can focus more processing power on the rare events of a target stochastic process while faithfully preserving the statistics of these rare trajectories [1].



We developed a method to draw stochastic bridges for arbitrary Markov processes and show its applicability to sample rare trajectories.

- The Quasi-stationary approximation eases the implementation for continuous-time processes and opens a way for analytical treatment.
- Our stochastic transition paths give information about the regimes in which the WKB approximations are useful.
- This method can be extended to generate stochastic trajectories constrained to pass through more than two desired points.
- The main conclusion of this poster is that you should read the full article :^)!

[1] Aguilar, Javier, et al. "Sampling rare trajectories using stochastic bridges." arXiv preprint arXiv:2112.08252 (2021).



