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INFERENCE OF FOKKER-PLANCK EQUATIONS FOR THE DYNAMICS OF POPULATIONS

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ABSTRACT

The population dynamics of a wide range of systems from human agents to biological cells evolve in response to internal rules. One common approach to them is via Markov Decision Processes, which address these problems by considering agents that take actions following a probabilistic policy function to make transitions between states. Also included in this framework is the notion of a reward function that the agents maximize by choosing an optimal policy. Such a description can be arrived at by algorithms of inverse reinforcement learning, which, however depend on the specification of the transition probability function. While the transition function may be constructed empirically, it may miss important mechanistic information and not generalize well. This has led to interest in obtaining the transition function by first inferring a partial differential equation--typically one that has the form of an optimal transport problem--from the data [1]. When applied to real data that is multi-modal, represents high-dimensional probability densities, and furthermore is sparse, the optimal transport form may be difficult to learn. Here, recent advances in learning complex, push-forward maps of distributions assume importance. They allow the identification of optimal transport forms underlying non-Gaussian distributions. Furthermore, with the Fokker-Planck equation, they also allow the inference of the potential and diffusivity in parametric form. This is of special interest in the setting of cell dynamics where the potential field can arise from chemokine gradients and diffusivity models the random migration of cells. We will discuss recent advances in the inference of high-dimensional Fokker-Planck equations for this class of problems.

REFERENCES

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