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Amir Ali Ahmadi
Operations Research and Financial Engineering
Princeton University

Learning Dynamical Systems with Side Information

In several safety-critical applications, one has to learn the behavior of an unknown dynamical system from noisy observations of a very limited number of trajectories. For example, to autonomously land an airplane that has just gone through engine failure, limited time is available to learn the modified dynamics of the plane before appropriate control action can be taken. Similarly, when a new infectious disease breaks out, few observations are initially available to understand the dynamics of contagion.

In situations of this type where data is limited, it is essential to exploit "side information -e.g. physical laws or contextual knowledge--to assist the task of learning. We present a mathematical formalism of the problem of learning a dynamical system with side information, where side information can mean a concrete collection of local or global properties of the dynamical system. We show that sum of squares optimization is particularly suited for learning a dynamical system that best agrees with the observations and respects the side information.

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