Kinetic approximation of mean-field control problems

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Abstract

The modeling of government for dynamical multi-agent systems is in general cursed by both the number of agents populating the system and the dimensionality of the state space. Even though the first obstacle can be overcome through a mean-field formulation of the control problem, the feasibility of its solution is in general guaranteed only for agents living in low-dimensional spaces. To circumvent this difficulty, we approximate the solution from suboptimality, by means of an asymptotic Monte-Carlo method based on binary-type dynamics. Such method is associated to a Boltzmann-type dynamics, which is shown to be consistent with a mean-field control dynamics. This approach considerably lowers the numerical complexity from the initial formulation of the problem, which is now reduced to a collection of 2-agents sub-problems. Solving such binary interaction control problems has motivated further reliance on approximations, such as model predictive control, dynamic programming, and more recently gradient augmented supervised learning. We provide different numerical experiments assessing the proposed methodologies.