A level-set approach to the control of state-constrained McKean-Vlasov equations: application to renewable energy storage and portfolio selection

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We consider the control of McKean-Vlasov dynamics (or mean-field control) with probabilistic state constraints. We rely on a level-set approach which provides a representation of the constrained problem in terms of an unconstrained one with exact penalization and running maximum or integral cost. The method is then extended to the common noise setting. Our work extends [1] and [2] to a mean-field setting.

The reformulation as an unconstrained problem is particularly suitable for the numerical resolution of the problem, that is achieved from an extension of a machine learning algorithm from [3]. A first application concerns the storage of renewable electricity in the presence of mean-field price impact and another one focuses on a mean-variance portfolio selection problem with probabilistic constraints on the wealth. We also illustrate our approach for a direct numerical resolution of the primal Markowitz continuous-time problem without relying on duality.

[1] O. Bokanowski, A. Picarelli, H. Zidani. *Dynamic programming and error estimates for stochastic control problems with maximum cost.* Appl Math Optim, **(71)**, 125–163, 2015.

[2] O. Bokanowski, A. Picarelli, H. Zidani. *State-constrained stochastic optimal control problems via reachability approach.* SIAM Journal on Control and Optimization, **54(5)**, 2568–2593, 2016.

[3] R. Carmona, M. Laurière. *Convergence analysis of machine learning algorithms for the numerical solution of mean-field control and games : II the finite horizon case.* arXiv :1908.01613, to appear in The Annals of Applied Probability, 2022.

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