Neural networks for deterministic control problems with state constraints

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We propose a scheme [1] based on deep neural networks in order to approximate the value function solution of some deterministic optimal control problem in presence of state constraints. We consider a reformulation of the problem into a front propagation problem in presence of state constraints - or obstacles. In this framework, the negative region of the value function encodes the reachable set of the considered problem, taking into account the possible state constraints. Convergence results will be given, as well as numerical examples, showing the potential of the method. The numerical results are surprinsingly good with respect to what can be expected from neural network approximations, and we will discuss the gap between the theoretical bounds and the numerical behavior of the proposed scheme. Comparison with other approaches (such as Huré et al. [2], or Sirignano et al. [3]) will be also given in order to motivate our choice of neural network approximations.

[1] O. Bokanowski, A. Prost, X. Warin. *Neural network approximations for deterministic control problems with state constraints*, Work in progress, 2022.

[2] C. Huré, H. Pham, A. Bachouch, N. Langrené. *Deep neural networks algorithms for stochastic control problems on finite horizon : convergence analysis.* SIAM J. Numer. Anal., **59(1)**, 525–557, 2021.

[3] J. Sirignano, K. Spiliopoulos. *Dgm : A deep learning algorithm for solving partial differential equations.* Journal of computational physics, **375**, 1339–1364, 2018.

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