Karlstad Applied Analysis Seminar (2024)

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19 Nov 2024

Deep Learning for Stackelberg Mean Field Games via Single-Level Reformulation

Abstract

We propose a single-level numerical approach to solve Stackelberg mean field game (MFG) problems. In Stackelberg MFG, an infinite population of agents play a non-cooperative game and choose their controls to optimize their individual objectives while interacting with the principal and other agents through the population distribution. The principal can influence the mean field Nash equilibrium at the population level through policies, and she optimizes her own objective, which depends on the population distribution. This leads to a bi-level problem between the principal and mean field of agents that cannot be solved using traditional methods for MFGs. We propose a reformulation of this problem as a single-level mean field optimal control problem through a penalization approach, and we prove convergence of the reformulated problem to the original problem. We propose a machine learning method based on (feed-forward and recurrent) neural networks and illustrate it with several examples from the literature. Joint work with Gokce Dayanikli.