

## **A Single-Level Deep Learning Approach to Stackelberg Mean Field Games**

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In this talk, we introduce the Stackelberg mean field games to approximate the continuous-time, dynamic, and stochastic game between a principal and a large number of agents. Then, we discuss how to rewrite this intrinsically bi-level problem as a single-level problem to propose an efficient numerical solution based on neural networks and Monte Carlo simulation. In the model, the agents in the population play a non-cooperative game and choose their controls to optimize their individual objectives by interacting with the principal and the other agents in the population through the population distribution. The principal can influence the resulting mean field Nash equilibrium through incentives to optimize her own objective. These models can be used to model different real-life problems, such as regulating the systemic risk in the banking sector or mitigating an epidemic. After analyzing the game using a probabilistic approach, we rewrite this intrinsically bi-level problem as a single-level problem and propose a deep learning approach to solve the Stackelberg mean field game. After providing theoretical convergence results, we will present different applications.