Numerical Analysis and Scientific Computing Seminar

A mean-field games laboratory for generative modeling

Benjamin Zhang
University of Massachusetts Amherst

Abstract: We demonstrate the versatility of mean-field games (MFGs) as a mathematical framework for explaining, enhancing, and designing generative models. We establish connections between MFGs and major classes of flow and diffusion-based generative models by deriving continuous-time normalizing flows, score-based models, and Wasserstein gradient flows through different choices of particle dynamics and cost functions. Furthermore, we study the mathematical structure and properties of each generative model by examining their associated MFG's optimality condition, which consist of a set of coupled forward-backward nonlinear partial differential equations. The optimality conditions of MFGs also allow us to introduce HJB regularizers for enhanced training of a broad class of generative models. We present this framework as an MFG laboratory which serves as a platform for revealing new avenues of experimentation and invention of generative models.

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