Seminar 2023

Math

Mean-field limit and gradient flows for non-exchangeable multi-agent systems

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과학관 225호

Abstract: In this talk I will discuss on a recent derivation of the mean-field limit for multi-agent systems on a large class of sparse graphs. More specifically, the case of non-exchangeable multi-agent systems consisting of non-identical agents is addressed, where the heterogeneous distribution of connectivities in the network is known to have critical effects on the collective dynamics. As a result, we obtain a Vlasov equation for the continuum of agents, which still captures the heterogeneous distribution of weights at the macroscopic scale in terms of the so-called extended graphons. Our method of proof does not only involve PDEs and stochastic analysis, but also graph theory through a novel concept of limits of sparse graphs (extended graphons) for the structure of the network, which can be regarded as a new non-trivial extension of the seminal works by L. Lovasz and B. Szegedy for dense graph limits. Our proof allows removing some of the main restrictive hypotheses in the previous literature on the connectivities between agents (dense graphs) and the cooperation between them (symmetric interactions). If time allows, I will also discuss on a recent gradient flow formulation, which is valid for a variety of kinetic equations with heterogeneities arising in collective dynamics, in particular the above class of Vlasov equations over graphons. Our approach is based on the study of the so-called fibered Wasserstein space, which we show it exhibits similar features to the classical Wasserstein space, and we are able to extend Otto calculus and the well-known theory of gradient flows on metric spaces by Ambrosio, Gigli, Savaré to treat systems with heterogeneous variables.

This is based on joint works with P.-E. Jabin (Penn State University), J. Soler (University of Granada) and J. Peszek (University of Warsaw).

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