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Mean field games and related topics
Special Session A1

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Mean field games are a recent and active area of research which presents new challenging mathematical questions, from analytical, probabilistic, and numerical sides. They originated from the seminal works of Lasry and Lions, and, simultaneously, Huang, Malhamé and Caines, in 2006.

This class of models is very popular not only in the mathematical community, but also in economics, engineering, life and social sciences, since they are widely used for applications; to mention a few, they include models of oil production, volatility formation, crowd motion, energy consumption, social networks, bitcoin mining.

Mean field games represent limit models for symmetric non-cooperative N-player games, as the number of players tends to infinity. On the other hand, mean field control problems, also called optimal control of McKean-Vlasov dynamics, represent limit models for cooperative N-player games. Systems with a large number of interacting agents, both cooperative or non-cooperative, arise in several physical, social and economic models, but finding explicitly the equilibria, or even numerically, is typically an intractable problem when N is large, due to the curse of dimensionality. For this reason, limit models have been introduced: letting $N = \infty$, instead of finite, may restore some tractability of the model and thus permits to understand the qualitative behavior of the multitude of players. One of the main object of study in mean field games is nowadays the master equation, which is a PDE stated on the infinite dimensional Wasserstein space of probability measures. The master equation encapsulates all the features of the mean field game and represents the value of the game for any initial distribution. Its counterpart for mean field control problems is a Hamilton-Jacobi-Bellman equation in the Wasserstein space.

The aim of this special session is to gather together the big community of researchers working on mean field games in Italy and in the United States. Possible topics of the presentations will be the following: existence and uniqueness of equilibria, under various forms of dynamics and costs (optimal stopping, correlated equilibria, jumps, ...); well-posedness of the master equation; convergence of the N-player game towards a suitable mean field game; asymptotics: fluctuations, large deviations, long time behavior; numerical methods, also based on machine learning techniques; applications to economics and finance, with a particular focus on energy transition.

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