"Multi-agent system learning and control:

mean-field control and mean-field games"

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Abstract:

We present novel results on modeling and control of multi-agent dynamics. We focus in particular on two concepts:

- sparse control, i.e., steering a large group of interacting agents by influencing parsimoniously only few of them;

- mean-field control, i.e., the control of the mean-field equations describing the evolution of the probability distribution of a large population of agents.

We conclude the course with some complements related to mean-field games, and the problem of learning the interactions in multi-agent systems from the observation of realizations of the dynamics.

The course starts with basic results and it requires knowledge of relatively standard functional analysis (mainly basics of metric and Banach spaces and Bochner integration). The synopsis of the course follows:

- *Existence and uniqueness solutions of Caratheodory differential equations*
- *Examples of multi-agent dynamics*
- *Sparse stabilization and optimal control of multiagent dynamics*
- *Introduction to optimal control and first order optimality conditions*
- *Introduction to Gamma-convergence*
- *Existence and uniqueness of mean-field equations*
- *Sparse mean-field optimal control*
- *Mean-field Pontryagin maximum principle*
- *Mean-field games*
- *Learning of multi-agent systems.*