Mean field models, propagation of chaos and applications

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Timetable: 24 hours, first lecture on April 21, 2016, 15:00 (dates already fixed, see the calendar), Torre Archimede, Room 2BC/30.

Course requirements: The course assumes the knowledge of measure theory and basic probability. The necessary notions of stochastic analysis will be briefly introduced in the first part of the course.

Examination and grading: Oral exam.

SSD: MAT/06 Probability and Mathematical Statistics

Aim:
The purpose is to introduce a class of dynamic models of many interacting components and derive their macroscopic behavior, i.e. the limit as the number of components tends to infinity. These models, characterized by the invariance with respect to permutations of the components and originally introduced as "toy models" in Statistical Physics, have been intensively studied in the last decades for their applications to social and biological sciences. In particular, these models have been used in the study of large-scale socio-economic phenomena and of multicellular systems, e.g. networks of neurons. Moreover, the recent theories of mean-field control and games are built on these dynamics.

Course contents:

1. *INTRODUCTORY NOTIONS.* Basic results on stochastic differential equations, including models with discontinuous trajectories. Weak convergence of stochastic processes.
2. *PROPAGATION OF CHAOS.* Chaotic probabilities and propagation of chaos. The coupling approach. The martingale approach.
3. *APPLICATIONS.* Models of interacting agents. Neuronal networks. Control of mean-field systems.