Some applications of Mean Field Games to Economics

The theory of Mean Field Games (MFGs hereafter) is a powerful framework for analyzing scenarios in which a large number of forward-looking players interact through the distributions of their state. MFG theory is strongly connected to the study of Nash equilibria in N-player games for large N (number of the agents), a central topic in many applications, which yet presents significant challenges. Since its birth (2006), this powerful mathematical toolbox has been employed in several fields of application, as macroeconomics, engineering, finance, crowd motion, social networks, machine learning and many others. In the first lectures we will give motivations to study MFGs and explain how this theory arises from economics and from game theory. Then some time will be devoted to explain the mathematical toolbox of MFGs and how it arises from the N-players game when N tends to infinity. The main part of the course is devoted to analyze some applications and specific examples of MFGs in economics which are listed in the following syllabus.

In some cases, we will explicitly solve the MFG by computing the solution.

Textbooks: i) Notes by F. Gozzi and S. Federico "Dynamics Optimization in Economics and Finance"of the course held in San Miniato in September 2024 available on the website (..). These notes concern the optimal control preliminaries to the course. The content of these notes will not be addressed during the course; ii) the specific notes for the course will be provided by the lecturer; iii) "Mean Field Games and Applications"by O. Guéant, J.-M. Lasry, P.-L. Lions available on the web; iv) for a first glimpse on Mean Field Game the website https://www.science4all.org/article/mean-field-games/ is advised.

Syllabus:

Introduction to Mean Field Games and preliminaries to Mean Field Games: N players games, Nash equilibria and limit as N grows

A first toy model: when does the meeting start?

Mean field games model of growth and Pareto distribution of salaries

A Mean Field Game applied to economics: production of an exhaustible resource

Mean Field games in environmental economics: consumption deteriorating local environmental quality and influence of the global environmental quality in the utility

Mean Field Games in macroeconomics: the Aiyagari-Bewley-Huggett (ABH) heterogeneous agent model, and the ABH model with common noise ("Krusell-Smith")

Mean Field Games in infinite dimension: a production output planning problem with delay in the control variable and a vintage capital model