Course: A gentle introduction to combinatorial stochastic processes (with applications to Finance and Economics)

Lecturer: Enrico Scalas, Department of Statistical Sciences, Sapienza University of Rome.

Textbook: U. Garibaldi, E. Scalas, Finitary Probabilistic Methods in Econophysics, Cambridge University Press, 2010.

Outline:

The theme of this course is the allocation of n objects (or elements) into g categories (or classes), discussed from several viewpoints. We shall start from descriptions of the world as facts (taking place or not), and events as propositions (true or not) about facts (taking place or not). Not everything in the world is known, and what remains is a set of possibilities. For this reason, events can be probabilized and probability theory plays a fundamental, but often underestimated, role in our scientific theories. Indeed, it turns out that problems in economics and finance can be formulated and solved using these methods.

Syllabus: The following topics will be addressed

Individual and statistical descriptions

The Pólya urn process

The Ehrenfest–Brillouin model

Applications to stylized models in economics and finance

The Zipf–Simon–Yule process

Course: Some applications of Mean Field Games to Economics

Lecturer: Daria Ghilli, Department of Economics and Management, University of Pavia, Italy.

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 concerns 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.

The theory of Mean Field Games (MFGs hereafter) is a powerful framework for analysing 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 have 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 analyse 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.

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.