CREST - GENES
Cours doctoraux 2023 – 2024

EVOLUTIONARY GAME THEORY

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SCHEDULE	Mondays	11:th December 2023 18:th December 2023	From 13:00 to 16:00	2033
	Thursdays	7th December 2023 14th December 2023	From 13:00 to 16:00	2033

Aims and objectives

The aim of this course is to introduce participants to concepts and results in evolutionary game theory of relevance for economics.

Evolutionary game theory was pioneered by John Maynard Smith and George Price in an article in Nature in 1973. Inspired by non-cooperative game theory, they suggested a solution concept for evolutionary biology, namely, evolutionary stability of strategies. That approach, which generalizes Darwin's natural selection paradigm from "perfect competition" to "imperfect competition" in the survival of the fittest, has spurred a large literature not only in biology but also in many behavioral and social sciences including economics.

In his 1950 Ph.D. thesis (in mathematics at Princeton university), John Nash proposed two interpretations of his equilibrium concept, one rationalistic (or epistemic) and one population-statistical (or evolutionary). Instead of imagining that the interaction in question takes place exactly once under common knowledge between perfectly rational individuals, as in the rationalistic interpretation, the population-statistical interpretation is that the interaction takes place recurrently in random matchings between boundedly rational individuals from large populations, one population for each player role in the game. This interpretation is very close to that made in evolutionary game theory, and it turns out that it has behavioral implications for Nash equilibrium and beyond.

This course will introduce the participants to such concepts as evolutionary and neutral stability of strategies, the single-population replicator dynamic, deterministic and stochastic multi-population dynamics, and approaches to preference evolution, that is, models in which individuals act rationally given their preferences, but preferences evolve in the population according to how well individuals with those preferences do in the interactions at hand. Key results in this broad literature will be presented and discussed, in particular, their implications for rational behavior and for point- and set-valued solution concepts in non-cooperative game theory. Time allowing, we will also briefly discuss pre-play communication, language, social conventions and norms.

Course outline

1. Introduction (3hrs).
    - History of thought in economics and evolutionary biology
    - The notions of evolutionary stability of (pure or mixed) strategies in symmetric games
    - Relations to Nash equilibrium, proper equilibrium, and backward induction in games
    - The single-population replicator dynamic in symmetric games, and relations to evolutionary stability
2. Multi-population dynamics (4hrs).
    - The Taylor multi-population replicator dynamics in arbitrary finite games
    - Generalized multi-population dynamics
    - Implications for dominated strategies, rationalizability, Nash equilibrium and beyond
    - Stochastic multi-population dynamic processes: a law of large numbers, exit times and visitation rates, relations to the deterministic mean-field equations
    - Preliminary experimental results: “Game lab”
3. Preference evolution (4hrs).
    - History of thought
    - Evolutionarily stable preferences under complete information: “The strength of family ties”
    - Evolutionarily stable preferences under incomplete information: “Homo moralis”
    - Stochastic population genetics: “Genes, guns, and culture”
    - Experimental evidence: “the Zürich experiment”
    - Implications for economic theory and economic policy
4. Extensions and avenues for further research (1hrs)
    - Theory
    - Experiments
    - Policy

Pre-requisites

Knowledge of microeconomic theory, non-cooperative game theory and mathematics at the level of advanced master courses, or first-year Ph.D. courses, in economics.

Literature

The lectures will focus on a small selection from the reference given below. The main text for the first part of the course is my MIT Press book Evolutionary Game Theory (reference item 56). Participants are recommended to familiarize themselves in advance with themes and approaches in evolutionary game theory, for example by reading abstracts and introductions to a few articles that seem interesting, by looking up sources and discussions on the internet, and by buying or borrowing one or two of the books.

1. Alger, I., and J. Weibull (2010): “Kinship, incentives and evolution”, *American Economic Review* 100, 1725-1758.
2. Alger, I., and J. Weibull (2013): "Homo moralis---preference evolution under incomplete information and assortative matching", *Econometrica* 81, 2269-2302.
3. Alger, I., and J. Weibull (2016): "Evolution and Kantian morality", *Games and Economic Behavior* 98: 56-67.
4. Alger, I., J. Weibull and L. Lehmann (2020): “The evolution of preferences in structured populations: genes, guns, and culture”, *Journal of Economic Theory* 185.
5. Axelrod, R. (1984): *The Evolution of Cooperation*. New York: Basic Books.

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