Boğaziçi
MATH COLLOQUIUM

Optimization, Games and Evolution

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Abstract:

We start with a brief discussion about the main ideas standing behind optimization methods. These methods can be roughly divided into gradient-based algorithms (such as gradient descent) and gradient-free methods (stochastic search, evolutionary algorithms, genetic algorithms).

The second part of the talk is devoted to evolutionary games. *Evolutionary Game Theory* (EGT) is a subdiscipline of Game Theory, that has been founded in 1970's by Maynard Smith and others, inspired by Darwin's theory of evolution. Although EGT has been founded with a view on biological applications, later it gained various interpretations and attracted interest from Sociology, Cognitive Science and even Philosophy and Law. Indeed, the evolution is not exclusively biological concept, one might talk about, say, cultural evolution, or evolution of moral norms.

We will explain that evolutionary dynamics can be viewed as a process of collective learning, implementing optimization algorithms on statistical manifolds (i.e. on spaces of probability distributions). In other words, the population that evolves tends to learn an optimal probability distribution. We will tackle the following questions:

a) What the population tends to minimize in the course of an evolutionary game?

b) How individuals within the population contribute to this collective goal, by following their simple behavioral rules?

Finally, we will very briefly mention potential applications of these paradigms and models in fields of Artificial Intelligence and Machine Learning.

Key words: replicator equations, Information Geometry, Fisher information metric, Kullback-Leibler divergence, Natural Evolution Strategies, Reinforcement Learning

Date : Wednesday, November 16, 2022
Time: 13:30
Place: TB 130, Boğaziçi University