

Lecture 1

Game-Theoretic Methods in Machine Learning

The development of game theory in the early 1940's by John von Neumann was a reaction against the then dominant view that problems in economic theory can be formulated using standard methods from optimization theory. Indeed, most realworld economic problems typically involve conflicting interactions among decision-making agents that cannot be adequately captured by a single (global) objective function, thereby requiring a different, more sophisticated treatment. Accordingly, the main point made by game theorists is to shift the emphasis from optimality criteria to equilibrium conditions. As it provides an abstract theoretically-founded framework to elegantly model complex scenarios, game theory has found a variety of applications not only in economics and, more generally, social sciences but also in different fields of engineering and information technologies. In particular, in the past there have been various attempts aimed at formulating problems in machine learning and related areas from a game-theoretic perspective and, with the recent development of algorithmic game theory, the interest in these communities around this topic is growing at a fast pace. The goal of these lectures is to offer an introduction to the basic concepts of game theory and to provide an overview of recent work on the use of game-theoretic models in some classical machine learning problems. Applications in areas such as computer vision and natural language processing will be discussed. I shall assume no pre-existing knowledge of game theory by the audience, thereby making the lectures self-contained and understandable by a non-expert.