Equilibration Analysis and Control of Coordinating Decision-Making Populations

Whether a population of decision-making individuals will reach a state of satisfactory decisions has been a fundamental problem in studying collective behaviors. In the context of evolutionary game theory and by means of potential functions, researchers have established equilibrium convergence under different update rules, including best-response and imitation, by imposing certain conditions on the agents' utility functions. Then, using the proposed potential functions, they were able to tackle the challenging problem of controlling these populations towards a desired equilibrium. Despite the successful attempts, finding a potential function is often daunting and, in many cases, near impossible.

We introduce a class of decision-making populations, called coordinating populations, where individuals tend to choose an option if some others have switched to that option. We prove that every coordinating population is guaranteed to almost surely equilibrate. Apparently, some general binary network games governed by best-response and imitation, that were proven to equilibrate using Lyapunov functions, are coordinating. For the first time, we additionally extend the result for best-response to more than two strategies and provide a condition for the agents' utilities such that any mixed population of best-responders and imitators becomes coordinating and hence equilibrates. As a second contribution, we provide a control algorithm that leads coordinating populations to a desired equilibrium. The algorithm performs near optimal and as well as specialized algorithms proposed for best-response and imitation; however, it does not require a potential function. Therefore, in more general situations where no potential function is yet found for given population dynamics, this control algorithm can be readily applied to obtain promising results.