Distributed algorithms for interacting autonomous agents

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Abstract

This thesis is concerned with distributed algorithms for interacting autonomous agents. We reexamine a subclass of stochastic matrices, the Sarymsakov class of stochastic matrices and explore its relationship with other well-studied classes of stochastic matrices. The classical conditions for the convergence of products of stochastic matrices are reviewed and a new necessary and sufficient condition is established by making use of the Sarymsakov matrices. These results are applied to solve an asynchronous implementation problem of a distributed coordination algorithm that causes a group of agents to reach an agreement. By employing the structural balance theory from social networks study, we study distributed algorithms in the presence of positive and negative couplings. It is shown that the state of the system may finally polarize or converge to an agreed value of zero. Besides studying the system that may reach an agreement or polarize, we also identify three mechanisms that may lead to clustering behavior in distributed coupled networks. More insight is gained by jointly studying the controllability problem and the cluster synchronization problem of multi-agent systems. Those multi-agent networks that are uncontrollable in finite time tend to realize cluster synchronization as time goes to infinity. Furthermore, we investigate the clock synchronization problem in distributed networks with communication time delays and derive explicit expressions for the asymptotic synchronization errors.