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Grouping Games: Finding Clusters in Graphs, Digraphs and Hypergraphs

Clustering refers to the process of extracting maximally coherent groups from a set of objects using pairwise, or high-order, similarities. Traditional approaches to this problem are based on the idea of partitioning the input data into a predetermined number of classes, thereby obtaining the clusters as a by-product of the partitioning process. In this talk, I'll provide a brief review of recent work done in my group which offers a radically different view of the problem. In contrast to the classical approach, in fact, we attempt to provide a meaningful formalization of the notion of a cluster and we show that game theory offers an attractive and unexplored perspective that serves well our purpose. To this end, we formulate the clustering problem in terms of a non-cooperative “clustering game” and show that a natural notion of a cluster turns out to be equivalent to a classical (evolutionary) game theoretic equilibrium concept. We prove that the problem of finding the equilibria of our clustering game is equivalent to locally optimizing a polynomial function over the standard simplex, and we provide a discrete-time dynamics to perform this optimization, based on the Baum-Eagon inequality. The proposed grouping framework, which has already found applications in a variety of application fields, including computer vision, bioinformatics, security and video surveillance, etc., is general and can be applied to weighted graphs, digraphs and hypergraphs alike.