Applied Mathematics Seminar

University College Cork, Ireland
Coláiste na hOllscoile Corcaigh

Alessio Cardillo

Department of Computer Science and Mathematics
University Rovira i Virgili, Tarragona, Spain

A coevolutionary model combining game theory and synchronization: the evolutionary Kuramoto Dilemma

The synchronization of coupled oscillating systems has received considerable attention from the scientific community given its wide range of applications. The pattern of interactions among the oscillators – usually encoded as a network/graph – plays a crucial role in the onset of the synchronized state and, over the years, several studies have investigated the emergence of synchronization in populations of oscillators arranged on a network.

Despite the amount of studies made hitherto, such approaches assume that the variation of the state for an oscillator, which is required to attain synchronization, is costless. Yet, it seems reasonable to assume that the alteration of an oscillator's state involves some cost. The introduction of such cost leads to the formulation of a dichotomous scenario: an oscillator may decide to pay the cost necessary to alter its state making it more similar to that of the others or, alternatively, keep it unaltered waiting for the others to adjust their states to its own one. The former behavior can be viewed as an act of cooperation, whereas the latter as one of defection. Both behaviors constitute the basic action profiles of an evolutionary game.

Complex networks play a key role also in the emergence of cooperation and, in particular, the presence of hubs in scale-free networks bolsters such phenomenon. Thus, it is worth investigating the mechanisms responsible for the onset of synchronization in populations of networked oscillators where they decide whether to cooperate, by synchronizing their states with those of their neighbors, or not. Such scenario leads to a coevolutionary approach intertwining together synchronization and game theory dynamics. Coevolutionary approaches constitutes the natural extension of actual models, allowing a better description/understanding of complex systems. In this talk, I will present a coevolutionary model based on the combination of Kuramoto oscillators playing an evolutionary game. Specifically, the emergence of cooperation and synchronization is studied in three different topologies, namely: Erdős-Rényi random graphs, Random Geometric Graphs, and Barabási-Albert scale-free networks.

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University College Cork · Western Road · Cork · T12 XF62