Characterizing cluster synchronization phenomena in network dynamics

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Abstract

The field of dynamical systems studies how feature-rich phenomena arises from somewhat simple equations. The best example of this is the chaotic behavior found in the Lorenz equations. This phenomenology is enhanced if one considers dynamical systems whose underlying topology is non-trivial, i.e. systems whose interacting units are connected in a network-like fashion [1]. In these situations, it has been shown time and time again the relevance of the underlying network structure in the dynamical features appearing.

One of the main tasks in the theory of networked dynamical systems is characterizing the relation between the structural properties of the network and its synchronous state, i.e. whether the whole network can function in unison. The pinnacle of these studies was the Master Stability Function approach, which allowed a precise and quantitative characterization of this relation.

Over the last years, plenty of research has been poured on understanding a more complex phenomena: cluster synchronization, where groups of nodes are synchronous between themselves though not with respect to the rest of the network. Until very recently there was just numerical evidence and hints to when would this phenomena arise, however in [3] we provide a complete characterization of cluster synchronization, not only elucidating which groups of nodes will synchronize, but also at which values of the coupling strength will they do so.

References

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