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Pseudo paths toward minimum energy states in network dynamics

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Abstract

The dynamics of networks forming on Heider balance theory moves towards lower tension states. The condition derived from this theory enforces agents to reevaluate and modify their interactions to achieve equilibrium. These possible changes in networks topology can be considered as various paths that guide systems to minimum energy states. Based on this theory the final destination of a system could reside on a local minimum energy, "jammed state", or the global minimum energy, balanced states. The question we would like to address is whether jammed states just pop up? Or there exist some pseudo paths that bound a system toward a jammed state. We introduce an indicator to suspect the location of a jammed state based on the Inverse Participation Ratio method (IPR). We provide a margin before a local minimum where the number of possible paths dramatically drastically decreases. This is a condition that proves adequate for ending up on a jammed states.
keywords: Network dynamics, Balance theory, Jammed state, Participation

Introduction

A society consists of a collection of members and their relationships that influence each other. According to the balance theory the societies evolve towards a lower stress status [1–3], where the individuals affect each other either by gossip [4] or viral [5]. The dynamics of our network is based on flipping the links as long as the energy of the network decreases. It is worth noting that in the early stages of the dynamics, the possibility of lowering the energy by flipping the links is high. But in the vicinity of a minimum energy level, local or global, less links allow tending towards lower energy. This is in a sense that less links exist that by flipping them the energy level decreases. As the number of available links towards the minimum energy decreases, a guiding path like a cone seems to appear. This is the pseudo path towards the minimum energy [1–3]. This rule deforms the topology of societies, eventually gaining stability [6]. Now how could one gain a physical insight on the structure and dynamics of such systems? the answer owes its existence to the concept of Hamiltonian. As such, a smart technique that could be implemented to deal with such issues is to relate a Hamiltonian to the system and study its evolution [7]. Although the Hamiltonian equations provide a platform for issuing statements on the tendency of societies towards lower energy states [6, 8], but due to the number of possible paths, the Hamiltonian could not give us a clear picture of the next steps. In the present study since we will be dealing with the sociability of the members in a society, we implement the Heider balance theory [1]. The decrease of energy in these societies would eventually lead to local or global minimum energy states named as the jammed states or balanced states [3, 6]. The query that we try to answer here is whether there is an indicator to uncover hidden pseudo-deterministic paths towards local minimum energy states or jammed states in social networks?