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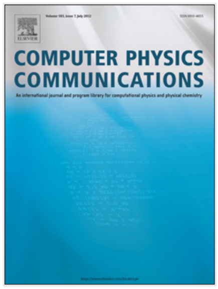

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Opinion percolation in structured population

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In a recent work [Shao *et al* 2009 Phys. Rev. Lett. **108** 018701], a nonconsensus opinion (NCO) model was proposed, where two opinions can stably coexist by forming clusters of agents holding the same opinion. The NCO model on lattices and several complex networks displays a phase transition behavior, which is characterized by a large spanning cluster of nodes holding the same opinion appears when the initial fraction of nodes holding this opinion is above a certain critical value. In the NCO model, each agent will convert to its opposite opinion if there are more than half of agents holding the opposite opinion in its neighborhood. In this paper, we generalize the NCO model by assuming that each agent will change its opinion if the fraction of agents holding the opposite opinion in its neighborhood exceeds a threshold T ($T \geq 0.5$). We call this generalized model as the NCOT model. We apply the NCOT model on different network structures and study the formation of opinion clusters. We find that the NCOT model on lattices displays a continuous phase transition. For random graphs and scale-free networks, the NCOT model shows a discontinuous phase transition when the threshold is small and the average degree of the network is large, while in other cases the NCOT model displays a continuous phase transition.

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Keywords: complex networks; opinion; percolation

I. INTRODUCTION

The dynamics of opinion sharing and competing has become an active topic of recent research in statistical physics [1]. One of the most successful methodologies used in opinion dynamics is agent-based modeling [1]. The idea is to construct the computational devices (known as agents with some properties) and then simulate them in parallel to model the real phenomena. In physics this technique can be traced back to Monte Carlo (MC) simulations [2]. Beyond relevance as physics models, the ferromagnetic Ising model [3–5], the XY model [6] and the Potts model [7, 8] can be seen as agent-based models for opinion dynamics. Other versions of opinion models have also been proposed, such as the Sznajd model [9], the majority rule model [10–12], the voter model [13, 14], and the social impact model [15]. Some models display a disorder-order transition [16–25], from a regime in which opinions are arbitrarily diverse to one in which most individuals hold the same opinion. Other models focus the emergence of a global consensus, in which all agents finally share the same opinion [26–36].

It has been known that the formation of opinion clusters plays an important role in opinion dynamics [37–40]. An opinion cluster is defined as a connected component (subgraph) fully occupied by nodes holding the same opinion. Recently, Shao et $al.$ proposed a nonconsensus opinion (NCO) model [41] in which each node adopts the majority opinion in its neighborhood at each time step. It was found that a large spanning cluster of nodes holding the same opinion appears when the initial fraction of nodes holding this opinion exceeds a certain threshold [41, 43]. Motivated by the NCO model, Li et $al.$ proposed an inflexible contrarian opinion (ICO) model in which some agents never change their original opinion but may influence the opinions of others [44]. It was found that the threshold above which a large spanning cluster appears is increased with the fraction of inflexible contrarians.

In both the NCO and ICO models, an agent will adopt the opinion that is held by more than half of neighbors. However, in many real-life situations, a quorum far larger than one half is necessary to pass a resolution. For example, a referendum to recall the president of the United States requires the support of two-thirds of the senators. Based on the above reasons, in this paper we generalize the NCO model by assuming that an agent will change its opinion when the fraction of agents holding the opposite opinion in its neighborhood exceeds a threshold $T \geq 0.5$. We call this generalized model as the NCOT model. When the threshold $T = 0.5$, the NCOT model recovers to the NCO model. When $T = 1$, the NCOT model becomes the standard percolation without opinion dynamics. Both the NCO and ICO models focus on the critical value for finite-size networks. By the standard finite-size scaling approach, we have obtained a critical point at which the phase transition takes place in the limit of infinite network size. It is interesting to find that, continuous or discontinuous phase transitions can arise in the NCOT model, depending on the value of T and the network structure.

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