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Social influences in opinion dynamics: The role of conformity

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HIGHLIGHTS

- We analyze the role of conformity in opinion dynamics.
- Conformity strongly affects opinion dynamics.
- Conformist agents play the role of stabilizers in fully-connected networks.
- It is better to behave as a nonconformist agent in small-world networks.
- It is better to behave as a conformist agent in scale-free networks.

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ABSTRACT

We study the effects of social influences in opinion dynamics. In particular, we define a simple model, based on the majority rule voting, in order to consider the role of conformity. Conformity is a central issue in social psychology as it represents one of people's behaviors that emerges as a result of their interactions. The proposed model represents agents, arranged in a network and provided with an individual behavior, that change opinion in function of those of their neighbors. In particular, agents can behave as conformists or as nonconformists. In the former case, agents change opinion in accordance with the majority of their social circle (i.e., their neighbors); in the latter case, they do the opposite, i.e., they take the minority opinion. Moreover, we investigate the nonconformity both on a global and on a local perspective, i.e., in relation to the whole population and to the social circle of each nonconformist agent, respectively. We perform a computational study of the proposed model, with the aim to observe if and how the conformity affects the related outcomes. Moreover, we want to investigate whether it is possible to achieve some kind of equilibrium, or of order, during the evolution of the system. Results highlight that the amount of nonconformist agents in the population plays a central role in these dynamics. In particular, conformist agents play the role of stabilizers in fully-connected networks, whereas the opposite happens in complex networks. Furthermore, by analyzing complex topologies of the agent network, we found that in the presence of radical nonconformist agents the topology of the system has a prominent role; otherwise it does not matter since we observed that a conformist behavior is almost always more convenient. Finally, we analyze the results of the model by considering that agents can change also their behavior over time, i.e., conformists can become nonconformists and vice versa.
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1. Introduction

During last years opinion dynamics [1,2] have been investigated by several authors. Just to cite a few, Galam introduced many sociophysics models [3–5] as, for instance, a spin model for studying the dynamics of majority rules [6] that, later on,

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has been further developed by Krapivsky and Redner [7], Holme and Newman analyzed the opinion spreading in terms of a nonequilibrium phase transition [8], and Bianconi and collaborators proposed a model to consider the role of social networks in these dynamics [9]. The voter model [10] represents one of the most famous models of opinion dynamics. Usually, this model considers a set of interacting agents, provided with a state that represents their opinion. In so doing, it is possible to perform computational studies to analyze the evolution toward consensus in the presence of different opinions. Agent-based models allow to study interesting phenomena in opinion dynamics (see for instance [11–13]) or, more in general, in social dynamics [14–16]. We put our attention on the majority rule voting [5] from a socio-psychological perspective [17]. Social psychology provides fundamental theories to study interactions among individuals in social contexts, for instance see Ref. [18]. In this work, we analyze the role of conformity, an important behavior of individuals [17] that emerges as a result of their interactions, by a simple model based on the majority rule voting. In the proposed model, we consider a system with only two opinions (i.e., two possible states) and we provide agents with an individual behavior; in particular, they can be conformists or nonconformists (i.e., contrarians). Conformist agents take the opinion of the majority of their neighbors, whereas the nonconformist agents do the opposite. As discussed in Ref. [19], the contrarian effects have an important role in the voter model (see also [20–22]) and they can also explain complex phenomena in real electoral dynamics. We analyze the nonconformity under two different hypotheses, i.e., a local nonconformity and a global nonconformity. The former is a behavior related only to the social circle of each agent, but not to the whole population. This concept means that a nonconformist agent takes the minority opinion of its social circle (i.e., its neighbors), but it prefers to have the same opinion of majority of the population. Instead, the global nonconformity is more radical, as it assumes that nonconformist agents aim to have an opinion contrarian also to that of the majority of the population. We perform a computational study of the proposed model by considering different conditions, as the topology of the agent network and the density of nonconformist agents in the population. Moreover, we analyze the system by allowing agents to change behavior over time. In particular, at each time step, agents decide whether to be conformists or nonconformists, depending on the comparison between their state and that of the majority of the population, and to their current behavior. The main result is that conformity is an important behavior in these dynamics as it strongly affects the outcomes of the proposed model. Furthermore, we found important differences between the outcomes achieved by varying the topology of the agent network if a radical nonconformity is considered; otherwise, with different topologies, the outcomes are always very similar. The remainder of the paper is organized as follows: Section 2 introduces the model for studying the role of conformity. Section 3 shows results of numerical simulations. Eventually, Section 4 ends the paper.

2. Conformists versus non-conformists

We introduce a simple model of opinion dynamics where agents interact over a network. Agents have an opinion, mapped to a state $s = \pm 1$ (i.e., there are two possible opinions) and, in addition, they are provided with an individual behavior. In particular, an agent can be conformist or nonconformist. Conformist agents modify their state (i.e., opinion) according to the majority of their neighbors, whereas nonconformist ones do the opposite, i.e., they take the minority opinion. Therefore, conformist agents change state over time as follows:

$$s_i(t+1) = \begin{cases} +1 & \text{if } \sum_{j=1}^{n^i} s_j(t) > 0 \\ -1 & \text{if } \sum_{j=1}^{n^i} s_j(t) < 0 \\ s_i(t) & \text{if } \sum_{j=1}^{n^i} s_j(t) = 0 \end{cases} \tag{1}$$

with $s_i(t)$ state of the ith agent at time t, n^i number of neighbors of the ith agent and $s_j(t)$ state of the jth agent, linked with the ith agent. On the other hand, nonconformist agents follow an opposite rule for changing their state:

$$s_i(t+1) = \begin{cases} +1 & \text{if } \sum_{j=1}^{n^i} s_j(t) < 0 \\ -1 & \text{if } \sum_{j=1}^{n^i} s_j(t) > 0 \\ s_i(t) & \text{if } \sum_{j=1}^{n^i} s_j(t) = 0. \end{cases} \tag{2}$$

In so doing, at each time step, agents compute the new state depending on their behavior and on the opinion of their social circle. Fig. 1 shows an example of the proposed model. Furthermore, agents achieve a score computed by comparing their

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