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Emergence and spread of extremist opinions

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HIGHLIGHTS

- A model to study the dynamic evolution of collective opinions is proposed.
- The controversy between distinctively different opinions is incorporated.
- People's willingness to express their opinions is introduced.
- Extremism prevails at a critical uncertainty when people interact with inner opinions.
- Extremism can be avoided if the centrists have a sufficiently large influence scope.

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ABSTRACT

Understanding the emergence and diffusion of extreme opinions becomes important to our globalized society. In this study, we propose a social judgment based opinion (SJBO) dynamics model, which incorporates both the compromise between similar opinions and the repulsion between discrepant opinions, to study the occurrence and spread of extremism in two different scenarios. The first concerns a situation in which individuals interact with each other through their inner opinions, while the second involves a case that each individual updates his inner opinion and choice via observing his neighbor's choice. The simulation results show that, in the first scenario, a critical uncertainty level is present, at which the size of extremists can be maximized. Increasing or decreasing the uncertainty level from the critical value can diminish or even eliminate the extremists. In the second scenario, high uncertainty level tends to promote the development of extremists. However, the extremism can be contained or even avoided if the influence scope of silencers is large enough. In both scenarios, a large level of tolerance can help to reduce extremists as well.

1. Introduction

Rapid advances in information technologies have greatly facilitated communication, discussion, and information dissemination among individuals. All of these factors accelerate the formation and spread of public opinions and sometimes extreme opinions. In this globalized society, extremism poses a huge impact on people's lives and some extremists may feel justified to commit violent actions [1,2]. Therefore, a deep understanding of the emergence and spread of extremism is of particular importance, both from a practical and a political point of view.

Opinion dynamics, as a subfield of Sociophysics proposed by Galam et al. [3,4], provides an effective way to model the evolution and spread of opinions in a multi-agent system in which each agent represents an individual. The agents initially

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hold diverse opinions, and then update their opinions under the influence of other agents by following some predefined rules. The effects of update rules on the collective behavior are generally explored via statistical physics [3]. In terms of the domain of initial opinions, the opinion models can be classified into three groups: (1) discrete opinion models; (2) continuous opinion models; and (3) continuous opinions and discrete actions (CODA) model [5].

In the discrete opinion models, each agent carries one of a finite number of different opinions. The discrete opinion models are suitable for describing some practical scenarios that people are confronted with a limited number of choices, frequently two opposite binary points of view (e.g., yes or no, support or opposition, accept or reject). The significant representatives of discrete opinion models include voter model [6,7], Sznajd model [8–10], and majority rule model [11–13]. In the voter model, each agent is randomly chosen to adopt the opinion of one of his neighbors, whereas in the Sznajd model two agents with the same opinion persuade their neighbors to accept their opinion. The agents in the majority rule model update their opinions by following local majority rule. The discrete opinion models have been generalized and improved to study the influences of social network structures [14], contrarian agents [15], opinion leaders [16], personal emotion [17], extremists [18] on the dynamic evolution of public opinions. Although the discrete opinion models are justified to represent the situations where binary choices are a good description of a problem, they are not well suited to reveal the emergence of extremism in the system since no strength is associated with the discrete opinions [2,5]. The usually adopted way to study the extremism is through introducing inflexible agents in the system [19].

Continuous opinion models, on the other hand, allow agents to change their opinions within a continuous opinion domain (e.g., $[0, 1]$). In many situations, for example evaluating a new product, people's opinions usually vary continuously from one side to the other side instead of being just two extremes. Continuous opinion reflects the individual's strength of supporting or opposing a choice, and thus quantifies the desire for a specified choice. The continuous opinion models mainly consist of Deffuant model [20,21] and Hegselmann–Krause (HK) model [22,23], which are all developed using the concept of bounded confidence. This means that agents interact with each other only if the difference in their opinions is smaller than a threshold. In the Deffuant model, agents meet in random pairwise to update their opinions, whereas in the HK model each agent moves his opinion to the average opinion of all agents whose opinions lie in his coverage of confidence. The continuous opinion models and their extensions have been used to study the effects of different social networks [24,25], extremists [24–26], and heterogeneous agents [27] on the opinion evolution. However, continuous opinion models encounter challenges in revealing the emergence of real extreme opinions [2] because it is impossible for an opinion to become stronger than the strongest one in the initial conditions [28]. To study the propagation of extremism in the system, the extreme opinions must be artificially introduced in the initial conditions of the models.

The CODA model [5,29,30] differentiates the inner continuous opinions from the observable binary choices. In this model, the inner opinion is expressed by a probability that an individual believes one of the two alternatives is the best. The agent in the CODA model observes the choices of his neighbors, and then updates his inner opinion and choice according to a set of Bayesian rules [2,5]. The emergence of extremism has been successfully captured in the CODA model as a consequence of the dynamic evolution of opinions [2,28]. In the CODA model, the emergence of extremism is due to the repeated validation of an agent's choice by his neighbors with the same choice [5]. In fact, the extremism may also evolve from the interaction between discrepant opinions even if the opinions are continuous [31]. For example, recent studies on Polish Internet forums showed that some online discussions, especially when they are associated with political issues, usually develop into fierce quarrels, provocation, and invective [32]. Moreover, since each agent in the CODA model can only perceive the choices of other agents without knowing their inner opinions, the CODA model may fail to capture the dynamic evolution of opinions in the case that people tend to share their inner opinions with others to seek certain mutual understanding and compromise.

It is noteworthy that the agents in the discrete opinion models and the CODA model must express their choices. However, in some cases, people tend to keep silent when they are not very sure about their opinions or they are not willing to take the loss resulted from declaring their choices [33]. The loss could be monetary costs such as using communication media, psychological costs such as being blamed by peers and society, or even physical costs such as being arrested or killed in some extreme cases [34–37]. Therefore, to acquire a more comprehensive understanding of the dynamic evolution of opinions, particularly the formation of extremism, people's willingness to express their choices should be considered.

As discussed above, although the extremism has been investigated in several studies, the controversy between discrepant opinions has scarcely been incorporated in the continuous opinion models. The discrete opinion models and the CODA model, on the other hand, fail to consider the effect of individuals' willingness to express their opinions or choices. Therefore, a model that can both capture the emergence of extremism evolved from different causes and take individuals' willingness to express their opinions into consideration is obviously more useful for understanding extremists.

In this paper, a novel opinion model named social judgment based opinion (SJBO) model is proposed to study the formation and spread of extremism in a multi-agent system. The continuous opinion in this model characterizes the inner thought of an agent, whereas the discrete choice represents his decision for an issue. The SJBO model incorporates both the compromise between similar opinions and the repulsion between discrepant opinions. Each agent in the SJBO model updates his opinion and choice via interacting with other agents' opinions or choices. The agent in the SJBO model can also keep silent if his support to either choice is not sufficiently strong. It will be shown that the proposed model cannot only reveal the emergence and propagation of extremism but also provide a straightforward measure for the strength of extremist opinions.

This paper is organized as follows. Section 2 elaborates on the development of the SJBO model. The emergence and spread of extreme opinions in two different scenarios are discussed in Section 3. Finally, Section 4 concludes the paper.