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The role of persuasion power on the consensus formation

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HIGHLIGHTS

- An opinion dynamics model where each individual is identified by two parameters, namely, opinion and persuasion is introduced.
- The persuasion parameter is taken as an acceptability measure of the proposed arguments.
- The model has been applied to the Scottish referendum opinion poles data since 2011.

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ABSTRACT

An opinion dynamics model which is based on a version of two dimensional Sznajd model is introduced. According to this model the dynamics is governed by the interactions between four agents which live on the corners of a plaquette and their neighbors. The distinctive feature of the model is that each individual is identified by two parameters, namely, opinion and persuasion ability. The united group may persuade the individuals living at the neighboring sites according to both the number and their persuasion ability. This form of the model is used to discuss opinion dynamics processes in societies where a campaign is conducted by the principle being united and putting forward arguments which are commonly accepted by the members of the society. It is seen that persuasion parameter plays the major role in the societies where a minority opinion gains ground to be the major opinion of the society. The model has been applied to the Scottish referendum opinion poles data since 2011. The model in its simplicity, predicts that the arguments of the minority opinion ("YES" votes) are more appealing despite the observed win of the "NO" votes. This result may be due to the abundance of the "NO" opinion supporters at the beginning of the campaign.

1. Introduction

Modeling opinion formation is important for both to understand social phenomena and to predict the effects of social elements during the time evolution of social events. Despite its importance, mathematical modeling of social phenomena only recently became possible by using the techniques imported from statistical physics and hence a new area of research has emerged under the general name of sociophysics. The break through in sociophysics came with the observation that in social phenomena, similar to that of statistical mechanics, systems can be formulated in terms of local interactions of the constituents, but the macroscopic changes are the result of collective phenomena rather than the effects of the individual entities. Modeling the social systems in terms of locally interacting constituents together with the techniques imported from statistical physics, and large computer resources made it possible to make ever more realistic models of social events with some prediction power [1].

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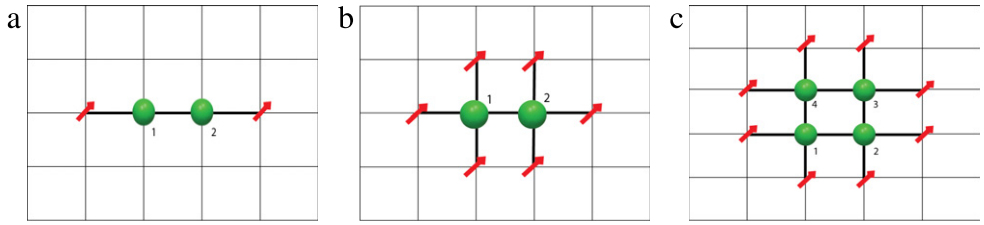

Fig. 1. Basic rules for SM (USDF) in one and two dimensional systems.

The very first models are very simple but equally powerful for describing the social interactions. One of the most acknowledged model of social interactions is Schelling model of segregation [2]. Since then many models on the specific area of dynamics of opinion formation, the Voter model [3–6] is one of the first opinion formation models. Similarly, opinion formation models the majority rule [7,8] and the bounded confidence [9] models are widely considered as representative of many real social phenomena. The interactions between the individuals in these models can be classified in two basic types: In the first type a randomly chosen individual interact with one of its neighbor. In the second, randomly chosen individual changes opinion under the influence of its surrounding neighbors. In this sense Sznajd-Weron model [10–12] has unique feature. Sznajd-Weron model assumes that when a group of individuals unite, they may influence their surrounding neighbors. The Sznajd model [10] is another sociophysics model which considers opinion as Ising type variables. In the original version of this model, which assumes a chain of individuals, a pair of neighboring sites sharing the same opinion may influence the opinions of their nearest neighbors [10,11,13].

The aim of this work is to introduce an opinion formation model in which individuals living on a 2-dimensional regular lattice are identified by two variables, a binary opinion value and a persuasion parameter. The persuasion parameter is directly related with the acceptability of an opinion by the community. In the proposed model opinion formation dynamics is based on a modified Sznajd-Weron type interactions: A group of individuals unite to convert the neighbors of opposite opinion according to a majority rule. This model can be used to study both equally divided societies and societies with some minority supporting one of the opinions.

Sznajd-Weron model [10] (SM) has attracted much attention since it is a model of binary spins with an update mechanism which is unique of its kind. The crucial difference of this model from the previously introduced models of opinion formation or from Ising model of statistical mechanics is that the information flows outward: If two neighboring sites share the same value, they unite and influence the surrounding neighbors. This update mechanism has close resemblance with the trade union idea, hence the model originally called USDF after the slogan "United we Stand, Divided we Fall". SM has been studied as a model of statistical mechanics [14–16].

As far as the phase transitions are concerned, the one dimensional SM shows smooth dependence on the initial conditions. As one type of opinion supporters increase, the winning possibility increases. For two dimensional case, a phase transition was observed as the effect of initial conditions on the time evolution of the system [11].

Apart from the theoretical investigations modified versions of SM has found many applications in marketing, finance, and politics [17].

The most successful application of SM is on the politics. Predictions on Brazilian and Indian elections has been possible by introducing more than two opinion states together with probabilistic external influences of the candidates on the individuals [18–20].

Marketing is an other area of research that SM has found applications. Here in this field, advertisement has been considered as an external field. Initial market distribution, Neighbor–neighbor interactions and advertisement are the modifications to the SM [21–23].

Attempts to extend simple one dimensional SM to two dimensional square lattices necessarily require some modifications or new assumptions which will extend the original model. On a square lattice, four individuals living at the sites which form smallest closed 2×2 surface (plaquette), Fig. 1 are chosen instead of a pair of individuals of one dimensional case. At this point there exist two major interaction algorithms [17].

- If four neighbors living at the corners of a 2×2 square, are sharing the same opinion, they persuade all 8 nearest neighbors to share the same opinion.
- If the chosen pairs living on the sides of the plaquette share the same opinion, they persuade their neighbors to follow orientation of the pair. This process is repeated for all possible nearest neighbor pairs of the chosen plaquette.

The two dimensional version of the Sznajd-Weron model has been extensively studied on simple square lattice [11,13,24–26], on triangular lattice [27], on three-dimensional cubic lattice [19] and also on the dilute [12] systems.

These rules leads to complete consensus as steady state. Moreover, a phase transition is observed—initial densities below 1/2 of up-spins lead to all spins down and densities above 1/2 to all spins up for large enough systems [11].

The proposed model is based on modified Sznajd-Weron type interaction with individuals carrying both opinion and persuasion values. Two new concepts are introduced in this model which to our opinion make the opinion dynamics studies more realistic.