Physica A 391 (2012) 1729–1734

Contents lists available at SciVerse ScienceDirect

Physica A

journal homepage: www.elsevier.com/locate/physa

Effects of mass media on opinion spreading in the Sznajd sociophysics model

Nuno Crokidakis

Instituto de Física - Universidade Federal Fluminense, Av. Litorânea, s/n, 24210-340 Niterói - Rio de Janeiro, Brazil

ARTICLE INFO

Article history:
Received 14 March 2011
Received in revised form 13 May 2011
Available online 25 November 2011

Keywords:
Social dynamics
Phase transition
Computer simulation
Sociophysics

ABSTRACT

In this work we consider the influence of mass media in the dynamics of the two-dimensional Sznajd model. This influence acts as an external field, and it is introduced in the model by means of a probability p of the agents to follow the media opinion. We performed Monte Carlo simulations on square lattices with different sizes, and our numerical results suggest a change on the critical behavior of the model, with the absence of the usual phase transition for $p >\sim 0.18$. Another effect of the probability p is to decrease the average relaxation times τ, that are log-normally distributed, as in the standard model. In addition, the τ values depend on the lattice size L in a power-law form, $\tau \sim L^{\alpha}$, where the power-law exponent depends on the probability p.

1. Introduction

Social dynamics have been studied through statistical physics techniques in the last twenty years. Among the studied problems, we can cite models of cultural [1], language [2] and opinion dynamics [3–5] (for a recent review, see Ref. [6]). These kinds of models are interesting to physicists because they present order–disorder transitions, scaling and universality, among other typical features of physical systems [6].

One of the most studied models of opinion dynamics in the last years is the Sznajd model [5,7]. The original Sznajd model [5] consists of a chain of sites with periodic boundary conditions where each site (individual opinion) could have two possible states (opinions) represented in the model by Ising spins ("yes" or "no"). A pair of parallel spins on sites i and $i+1$ forces its two neighbors, $i-1$ and $i+2$, to have the same orientation (opinion), while for an antiparallel pair $(i, i+1)$, the left neighbor $(i-1)$ takes the opinion of the spin $i+1$ and the right neighbor $(i+2)$ takes the opinion of the spin i. In this first formulation of the model two types of steady states are always reached: complete consensus (ferromagnetic state) or stalemate (anti-ferromagnetic state), in which every site has an opinion that is different from the opinion of its neighbors. However, the transient displays an interesting behavior, as pointed by Stauffer et al. [8].

A more interesting situation was studied in Ref. [8], where the model was defined on a $L \times L$ square lattice. The authors in Ref. [8] considered not a pair of neighbors, but a 2×2 plaquette with four neighbors. Considering that each plaquette convince its eight neighbors if all four center spins are parallel, and that the initial density of up spins is $d = 0.5$, the authors found that the system reaches the fixed points with all up or all down spins with equal probability. For $d < 0.5$ (> 0.5) the system goes to a ferromagnetic state with all spins down (up) in all samples, which characterizes a phase transition at $d = 0.5$ in the limit of large L. This phase transition separates two distinct states of the system: for $d < 0.5$ the system never reaches full-consensus states with all spins up, whereas for $d > 0.5$ the consensus is always reached. Other formulations of the two-dimensional model, considering for example memory [9], reputation [10], diffusion of agents [11] or a random dilution of the lattice [12], also present similar phase transitions.

E-mail address: nuno@if.uff.br.

0378-4371/$ – see front matter
doi:10.1016/j.physa.2011.11.038

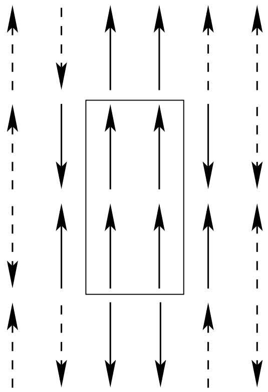

Fig. 1. Schematic representation of a plaquette (spins inside the rectangle) and its eight neighbors (full-line spins). Notice that the other agents (dotted-line spins) do not participate in the dynamics.

The utility of the Sznajd model goes beyond the basic description of a community [7]. It was applied, for example, to politics. In 1999, Costa-Filho et al. [13] showed that distribution of votes per candidate for the 1998 elections in Brazil follow a power law with exponent ~ -1.0. Based on the Sznajd model, two models with more than two opinions were proposed, considering the dynamics on square and cubic regular lattices, and also in complex Barabási networks [14]. The authors successfully reproduced the distribution of the number of candidates according the number of votes they received in Brazilian elections [15–17]. The Sznajd model was also applied to marketing, where it was considered advertising and a competition of two different products, and to finance, where the authors found a good agreement between some characteristics of the price trajectories (like returns, for example) and the simulations [7]. It was also claimed that some other characteristics of Sznajd-like models may also be present in real social systems, like the power-law relationship between the time need to reach the fixed point (the complete consensus), called the relaxation time, and the system size [11].

However, we can observe that the above-mentioned works did not take into account the effects of an external field in this phase transition. In a real community, external effects may be, for example, the mass-media influence. It is well-known that, in real life, the mass media (television, radio, ...) has a great influence in the population, and people tend to keep or change their opinions on any question according to that influence. These effects were considered in some social models, specially in the Axelrod model of cultural diversity [18–23], and interesting results were found. Thus, in this work we consider the effects of mass media in the opinion dynamics of the Sznajd sociophysics model. This influence is introduced in the model by means of a probability p of the agents to follow the media opinion. We performed Monte Carlo (MC) simulations for different lattice sizes, and our results suggest that the system undergoes a phase transition, as well as in the original Sznajd model, for values of the probability $p <\sim 0.18$, and that the relaxation times are log-normally distributed. In addition, the average relaxation times τ depend on the lattice size L in a power-law form $\tau \sim L^{\alpha}$, where α is a function of p.

This work is organized as follows. In Section 2 we present the microscopic rules that define the model. The numerical results are discussed in Section 3, and our conclusions are presented in Section 4.

2. Model

We have considered the Sznajd model defined on a square lattice with linear size L and periodic boundary conditions. The lattice sites were numbered by one index i, $i = 1, 2, \ldots, N$, where $N = L^2$ is the total number of agents in the population. We assign an Ising variable to each site, $s_i = \pm 1$, representing the two possible opinions of each agent. At each time step, the following three microscopic rules control our model (see the schematic representation of Fig. 1):

(1) We *randomly* choose a 2×2 plaquette of four neighbors.
(2) If all four center spins are parallel, the eight nearest neighbors are persuaded to follow the plaquette orientation.
(3) If not all four center spins are parallel, we consider the influence of mass media: each one of the eight neighbors follows, *independently* of the others, the media opinion with probability p.

Notice that we update the agents' states in a random sequential order (asynchronous updating). After the above three steps, we count one MC step in our model. In addition, we will consider that the mass media is favorable to the opinion $+1$, i.e., in the above-mentioned rule (3), each neighbor (independently of the others) will change his opinion to $+1$ with probability p if he was not persuaded by the plaquette agents (i.e., if not all four plaquettes' spins are parallel). In other words, we will take into account that the influence of a group of agents is stronger than the influence of media. In fact, we can imagine that in the real world people tend to be more influenced by friends, relatives and colleagues (represented in the model by the plaquettes' agents), among others, in comparison with the influence of the media (represented in the model by the probability p). Notice that for $p = 0$ we recover the standard Sznajd model defined on the square lattice [8].