SOE 12: Focus Session: Opinion Formation and Voter Models

Time: Tuesday 14:00–15:45 Location: MA 001

SOE 12.1 Tue 14:00 MA 001

Person-situation debate revisited: Phase transitions with quenched and annealed disorders — •Katarzyna Sznajd-Weron and Arkadiusz Jedrzejewski — Department of Theoretical Physics, Faculty of Fundamental Problems of Technology, Wrocław University of Science and Technology, Wrocław, Poland

We study the q-voter model of opinion dynamics driven by stochastic noise arising from one out of two types of nonconformity: anticonformity or independence. We compare two approaches that were inspired by the famous psychological controversy known as the person-situation debate. We relate the person approach with the quenched disorder and the situation approach with the annealed disorder, and investigate how these two approaches influence order-disorder phase transitions observed in the q-voter model with noise. We show that under a quenched disorder, differences between models with independence and anticonformity are weaker and only quantitative. In contrast, annealing has a much more profound impact on the system and leads to qualitative differences between models on a macroscopic level. Furthermore, only under an annealed disorder may the discontinuous phase transitions appear.

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SOE 12.2 Tue 14:15 MA 001

Pair approximation for the q-voter model with independence on complex networks — •Arkadiusz Jedrzejewski — Department of Theoretical Physics, Faculty of Fundamental Problems of Technology, Wroclaw University of Science and Technology, Wroclaw, Poland

We investigate the q-voter model with stochastic noise arising from independence on complex networks. Using the pair approximation, we provide a mathematical description of its behavior. The analytical results are validated by carrying out Monte Carlo experiments. The pair approximation prediction exhibits substantial agreement with simulations, especially for networks with weak clustering and large average degree. Nonetheless, for the average degree close to q, some discrepancies originate.

In the work, we are mainly interested in the time evolution and stationary values of the up-spin concentration. It turns out that the qualitative behavior of a system on studied weakly clustered complex networks is similar as on a complete graph. However, the quantitative behavior depends on the average node degree of an underlying network. What is interesting is that networks which have very different arrangements of edges and node degree distributions lead to the same results when they have the same value of the average node degree. Moreover, we show that in the limiting case the prediction of pair approximation coincides with the mean-field theory.

SOE 12.3 Tue 14:30 MA 001

The biased-voter model — •Raul Toral[1], Maxi San Miguel[1], and Agnieszka Czaplicka[2] — [1]IFISC (CSIC-UIB), Palma de Mallorca, Spain — [2]BIFI, U. de Zaragoza, Spain

Most of the voter-model literature assumes that each one of the possible options are equivalent. In this work we focus in the situation where there is a bias. This situation has been considered previously as, for example, indicating the lack of asymmetry in the social preference for one or another language in a bilingual community. We introduce bias by letting a fraction of the agents to copy with a higher probability one of the two options. We address the question of how the ratio of the density of connections between biased nodes and unbiased nodes influences the behavior. It seems that a crucial role for reaching consensus are the degrees of biased and unbiased nodes, rather than the number of links between pairs of biased or unbiased nodes. Even if the majority of the nodes is biased but weakly connected, the probability to reach consensus cannot be larger than in a random network. On the other extreme case, when biased nodes form a well-organized minority, one obtains in some cases a higher probability to order for the preferred state. In the thermodynamic limit any non-zero value of the bias leads to preferred consensus, but when the network is finite, there is always a chance to order in the not preferred state. For a random network case we find that behavior of the system depends of the effective bias, which is the value of bias parameter multiplied by the number of biased nodes. When the topology is not random that scaling disappears. Our analytical results are supported by numerical simulations.

SOE 12.4 Tue 14:45 MA 001

Zealotry Effects on Opinion Dynamics in the Adaptive Voter Model — •Pascal Klamser[1,2,3], Marc Wiedermann[3,4], Jonathan F. Donges[3,5], and Reik V. Donner[3] — [1]Institute for Theoretical Biology, Department of Biology, Humboldt-Universität zu Berlin — [2]Bernstein Center for Computational Neuroscience, Humboldt-Universität zu Berlin — [3]Potsdam Institute for Climate Impact Research — [4]Department of Physics, Humboldt-Universität zu Berlin — [5]Stockholm Resilience Centre, Stockholm University

The adaptive voter model has been widely studied as a conceptual model for opinion formation processes on time-evolving social networks. Past studies on the effect of zealots, i.e., nodes whose opinon is fixed, only considered the voter model on a static network. Here, we extend the study of zealotry to the case of an adaptive network topology co-evolving with the state of the nodes. Numerical simulations reveal that below the fragmentation threshold a low density of zealots is sufficient to spread their opinion to the whole network. Beyond the transition point, zealots must exhibit an increased degree as compared to ordinary nodes for an efficient spreading of their opinion. The numerical findings are verified using a mean-field approximation. Our results imply that the spreading of the zealots' opinion in the adaptive voter model is strongly dependent on the link rewiring probability and the average degree of normal nodes in comparison with that of the zealots. In order to avoid a complete dominance of the zealots' opinion the remaining nodes can adjust the probability of rewiring and/or the number of connections with other nodes.

SOE 12.5 Tue 15:00 MA 001

Opinion dynamics on social networks in an age of digital transformation — •Kilian B. Zimmerer[1,2], Wolfram Barfuss[1,3], and Jonathan F. Donges[1,4] — [1]Potsdam Institute for Climate Impact Research, Telegrafenberg A31, D-14473 Potsdam, Germany — [2]Department of Physics and Astronomy, University of Heidelberg, Im Neuenheimer Feld 226, D-69120 Heidelberg, Germany — [3]Department of Physics, Humboldt University, Newtonstr. 15, D-12489 Berlin, Germany — [4]Stockholm Resilience Centre, Stockholm University, Kräftriket 2B, 114 19 Stockholm, Sweden

Increased connectivity due to digitization has led to interaction patterns which enable individuals to broadcast information in ways similar to traditional mass media. Thus, the role of mass media to act as a gatekeeper by disseminating only information that is both relevant and sufficiently proven is weakened. A frequently discussed consequence is the apparent emergence of echo chambers in which misinformation is believed to be true. The dynamics causing their emergence, as well as adaptive policies avoiding social networks dominated by misinformation must be better understood. Therefore, the impact of increasing connectivity on a multiplex network model of continuous opinions is studied in this work.

SOE 12.6 Tue 15:15 MA 001

Opinion dynamics in a model with multiple issues — •Sven Banisch and Eckehard Olbrich — Max Planck Institute for Mathematics in the Sciences, Inselstrasse 22, D-04103 Leipzig, Germany

Arguments in a discussion often address different aspects of the issue at stake. But, some of these aspects are also relevant for other issues, which induces correlations between opinions on different issues. Those correlations could originate from factual interdependencies between the considered processes in the world, but they give also rise to ideologies and group identities which can induce further dependencies on their part. Many of the classical models of opinion dynamics studied in sociophysics are not able to address these issues. Drawing upon expectancy-value models in attitude research and the theory of conceptual spaces we developed a multi-level representation of opinions which allows to study of opinion dynamics on multiple interrelated issues. The model is based on three different ingredients: (1) interacting agents align their views regarding the significance of

different argumentative domains; (2) different (partially overlapping) sets of these domains are associated with different political issues and an agent's attitude is a function of the importance assigned to the argument domains and their evaluative relevance for the issues; and (3) agents preferentially interact with other agents that hold similar attitudes. We show under which conditions these combined processes give rise to polarization and discuss the role of correlations of attitudes towards multiple political issues in this context.

SOE 12.7 Tue 15:30 MA 001

Cooperation dynamics reflecting social dilemmas and social conformity in multiplex structured networks — •Yui Murayama[1], Ohashi Hirotada[1], and Kaj-Kolja Kleineberg[2] — [1]Dept. Systems Innovation, The University of Tokyo, 7-3-1 Hongo,Bunkyo-ku, Tokyo, Japan — [2]Computational Social Science, ETH Zurich, Clausiusstrasse 50, CH-8092,Zurich, Switzerland

Solving many important economical or environmental challenges require large-scale cooperation. Cooperation is surprisingly common even in situations where defection seems the logical choice. Individual behavior, however, is not only determined by the strategic interactions, but also by social influence. Our interest is in how cooperation evolves among networked agents who make decision in dilemmatic situations and what are conditions attaining full cooperation.

We employ two-layer networks; one layer corresponds to strategic interactions and the other layer represents social conformity. In strategic interactions layer, agents play prisoner's dilemma or public goods games. In the social conformity layer, agents change their behavior playing voter games or majority votes with their neighbors. Each layer comprises the same set of nodes but has different link structure.

We identify under which conditions cooperation thrives and when the system becomes stuck in a state with distinct groups of cooperators and defectors. Finally, we propose measures that promote full cooperation and hence successfully overcome the persistence of defectors.