Mechanisms of knowledge diffusion in online social dynamics

Bosiljka Tadic

Department of Theoretical Physics, Jozef Stefan Institute, Ljubljana, Slovenia
Complexity Science Hub Vienna, Josefstaedter Strasse 39, Vienna, Austria
bosiljka.tadic@ijs.si

Similarly to physical and biological systems, diffusive processes are essential for the functioning of social systems, in particular, leading to collective behavior, which can be studied from extensive online empirical data. Some examples are the knowledge and innovation diffusion, spreading of news, opinions and diseases or outbreaks of emotion in online social networks. In contrast to physical systems, for example, studies of the domain wall dynamics in random media [1], social dynamics actors live on a graph whose structure evolves with the activity of actors. Moreover, human actors possess specific attributes that affect the diffusion process itself; they can be accounted for by different types of models that go beyond interactions that are standardly considered in physics. Specifically, the adequate approach [2,3] combines methods of statistical physics with agent-based models that are close to the empirical data (from which the action rules and statistical features for agents can be inferred) and graph theory analysis of the underlying social structure. First, we present this concept and define quantities that can be obtained from the online data and simulated by agent-based models.

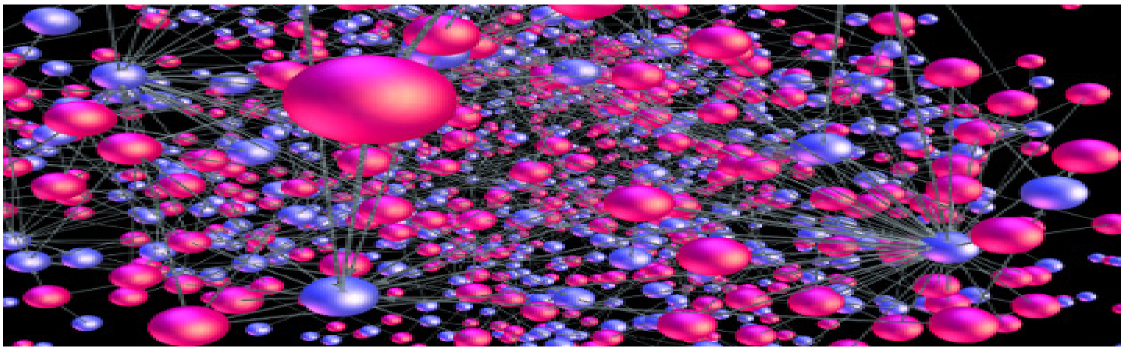

Figure 1: Segment of the bipartite network of users (blue) and questions (red nodes) from the studied Q&A data

We then discuss in more details the social processes of knowledge creation via online Questions & Answers, where the individual knowledge of actors (users, agents) is transferred to artifacts (questions or answers) and triggers more actions. We show how collective knowledge emerges through the mechanisms of self-organized criticality and co-evolution of the bipartite network, Fig., both in the empirical data from StackExchange/Mathematics and the appropriate agent-based model [4,5,6]. The activity time series are sampled for varied expertise of agents; their fractal features, avalanching and temporal correlations are determined and compared with those obtained from these empirical data.

References

[1] B. Tadic: *Dynamical implications of sample shape for avalanches in 2-dimensional random-field Ising model with saw-tooth domain wall*. Physica A **493**, 330-341 (2018).

[2] B. Tadic: *Self-organized criticality and emergent hyperbolic networks---blueprint for complexity in social dynamics*. European Journal of Physics **40**, 024002 (2019).

[3] B. Tadic, V. Gligorijevic, M. Mitrovic, M. Suvakov: *Co-evolutionary mechanisms of emotional bursts in online social dynamics and networks*. Entropy **15**(12), 5084-5120 (2013).

[4] M. Mitrovic, B. Tadic: *Dynamics of bloggers' communities: Bipartite networks from empirical data and agent-based modeling*. Physica A **4391**(21), 5264-5278 (2012).

[5] M. M. Dankulov, R. Melnik, B. Tadic: *The dynamics of meaningful social interactions and the emergence of collective knowledge*. Nature: Scientific Report **5**, 12197 (2015).

[6] B. Tadic, M. M. Dankulov, R. Melnik: *Mechanisms of self-organized criticality in social processes of knowledge creation*. Physical Review E **96**(3), 032307 (2017).

Bosiljka Tadic is a researcher at full professor rank at the Department of Theoretical Physics, Jozef Stefan Institute Ljubljana, and an external associate of the Complexity Science Hub Vienna. She has strong expertise in theoretical and numerical investigations of collective phenomena in various complex systems across the scales, from self-assembly of nano-structured materials to physics of the Internet and large-scale behaviour in online social dynamics. Her research combines methods of statistical physics and advanced mathematical techniques of graph theory with agent-based modelling and analysis of large datasets. In this context, her approach expands the ideas of modelling physical laboratory systems to account for the communicated contents (cognitive, emotional) in the online social dynamics, as the force driving these stochastic processes. Her other areas of expertise include modelling complex networks and the dynamics on them, self-organized criticality, and driven disordered systems and renormalization group theory of critical phenomena. As a PI, she recently completed two European projects in these fields (PATTERNS and CYBEREMOTIONS). She is an active member of the editorial board in some leading journals and international conferences in these fields of research. Apart from science life, her preferred activities include the Web design and writing poetry.