Social network heterogeneity promotes depolarization of multidimensional opinions

Keywords: Social networks, opinion dynamics, social science, consensus, polarization

Extended Abstract

Understanding the mechanisms to mitigate opinion polarization in our society is crucial to minimizing social division and ultimately strengthening democracy. Due to the challenge of collecting long-term reliable empirical data, researchers have been mostly focused on a theoretical understanding of the process of opinion depolarization. To this aim, realistic yet simple models prove valuable, especially when multiple topics are discussed at the same time, which may result in entangled opinion dynamics [1].

In this paper, we propose the multidimensional social compass model, based on two competing key ingredients: DeGroot learning [2], driven by the social influence exerted across multiple topics, and the preference of individuals to maintain their initial opinions [3]. The interplay between these two mechanisms triggers a phase transition from polarization to consensus, determined by a threshold value of social influence.

We analytically study the nature of the depolarization transition and its threshold, depending on the number of topics discussed, the possible correlations between initial opinions, the topology of the underlying social networks, and the correlations between the initial opinion distribution and the network's structure. Theoretical predictions are validated by running numerical simulations on both synthetic and real social networks. We rely on several simplifying assumptions to explore different scenarios, such as a mean-field approximation for high dimension or orthogonal initial orientations.

We uncover an upper critical dimension ($D_c = 5$ topics) for uncorrelated initial opinions, distinguishing between discontinuous and continuous phase transitions (see Figure 1). For the simplest $D = 2$ case and correlated initial opinions, we found that the depolarization threshold can vanish if the underlying connectivity is heterogeneous, as predicted by perturbation theory. Such an effect is due to the presence of hubs, which promote consensus in the population. We test this hypothesis by designing a rewiring algorithm that increases the structural heterogeneity of the underlying network, showing that the depolarization threshold decreases. Finally, we demonstrate that if hubs share the same initial opinion, the depolarization dynamics is significantly hindered.

Our findings contribute to understanding the mechanisms to mitigate polarization in real-world scenarios, suggesting which settings can promote the depolarization process. The presence of very popular individuals on online social networks and the alignment of their opinions, in particular, may play a pivotal role in the multidimensional depolarization dynamics.

References

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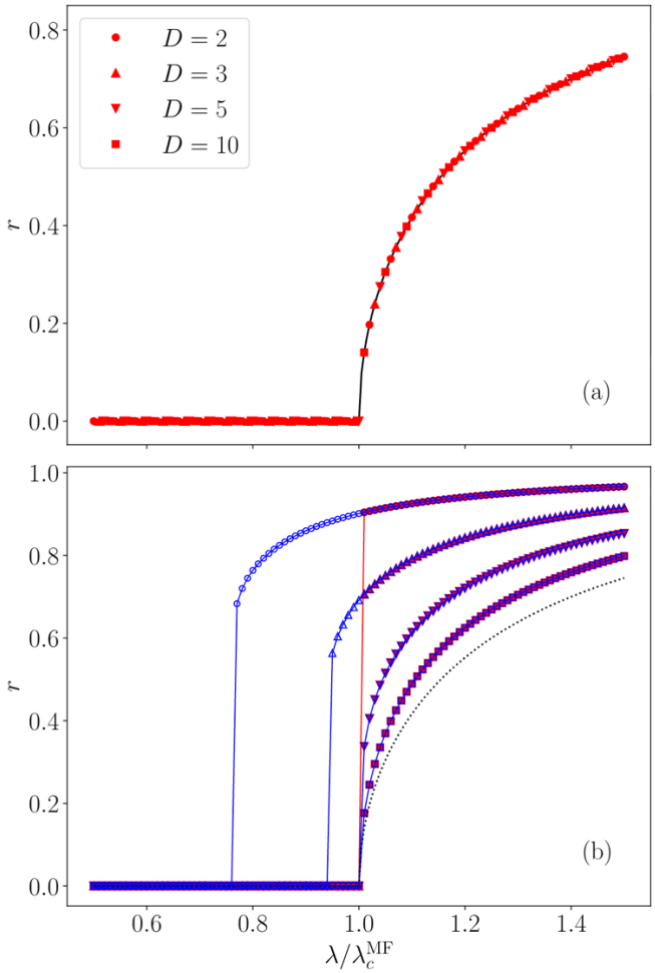

Figure 1. **Multidimensional depolarization dynamics at the mean-field level**. Scalar order parameter r as a function of the rescaled social influence λ/λ_{MF} for correlated (a) and uncorrelated (b) initial opinions. Different dimensions D considered, system size $N = 3\times10^6$. Conviction is fixed constant, $\rho=1$. Points (solid lines) represent numerical simulations (theoretical predictions). For uncorrelated opinions, backward continuation (blue) is plotted in empty symbols. Curves of forward continuation (red) for different D collapse for $\lambda<\lambda_{MF}$, while they are identical to backward continuations for $\lambda > \lambda_{MF}$. Dashed line (black) represents the solution for $D \to \infty$, which coincides with the one for correlated opinions.