Understanding and Modeling Behavioral Mechanisms in Social Diffusion*

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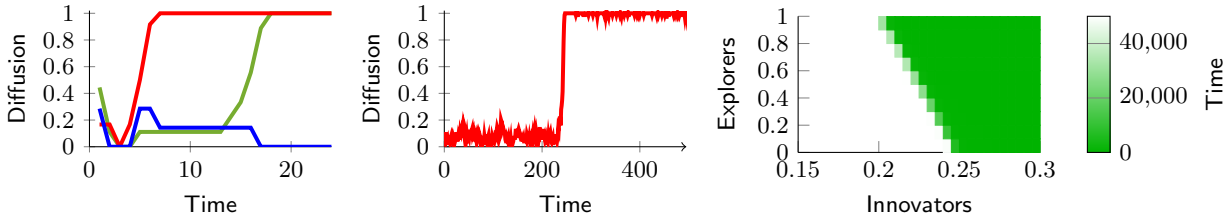
Social diffusion is a key phenomenon in human societies. Evolutionary game theory has been widely used to model it, allowing to capture and study salient features of diffusion dynamics[1,2]. However, unlike other kinds of diffusion processes, e.g., epidemics outbreaks, social diffusion involves human decision making, which is characterized by complex behavioral mechanisms, including *inertia* and *trend-seeking*. The former refers to the inclination of individuals to be consistent with their previous choices[3], and the latter to their tendency to be influenced by dynamic trends of changes in the decisions made by the population[4]. These mechanisms should not be neglected in the design of a realistic agent-based model to study social diffusion.

Motivated by these reasons, we have designed and conducted a multi-round online experiment (partially inspired by the work of Centola et al.[5]) to unveil the role of these two mechanisms in shaping social diffusion. Our experimental data highlights some key features of social diffusion, consistent with real-world empirical data and in agreement with social-psychological literature. Specifically, at the macroscopic (societal) level, we observed that diffusion may not always occur and, even if it does, the take-off time (i.e., the time to reach a tipping point) may be strongly delayed due to the presence of inertia. However, if a tipping point is reached, then the innovation explosively diffuses in a short amount of time, due to the trend-seeking mechanism (see Fig.1(a)). At the microscopic (individual) level, we observed a moderate and heterogeneous switching activity due to the participant population having heterogeneous susceptibility to the two behavioral mechanisms, where a fraction of the participants, called explorers, is more affected by trends.

Building on standard coordination games on networks[1,2], we have proposed a novel evolutionary game theoretic model for social diffusion that explicitly incorporates terms in the payoff accounting for inertia and trend-seeking[6]. After parametrizing the model using the empirical data from our experiments, we performed an extensive campaign of Monte Carlo simulations. The main objective of our simulations was not only to verify that the model was able to capture the salient features of social diffusion observed (see Fig. 1(b)), but also to extend the analysis far beyond the practical experimental limitations, allowing for the elucidating of the effect of inertia and trend-seeking on large-scale populations and over arbitrary networks of interactions. Some of these results are shown in Fig.1(c).



(a) (b) (c)

Figure 1: Panel (a) displays the trajectories of three experimental trials. Panel (b) shows a sample path of our model on a large network, exhibiting the diffusion features observed in the experiment and in real-world social diffusion. Panel (c) shows the delay in the take-off time, depending on the proportion of explorers and innovators (those that initiate the diffusion) in the population. If a critical mass (determined by innovators and, in second instance, by explorers) is reached, fast diffusion is always observed while, if such a critical mass is not reached, take-off time blows up, effectively hindering social diffusion, as observed in the blue curve in (a).

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