Coevolving complex networks in the model of social interactions

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In the 90s Robert Axelrod have proposed the canonical model of social interactions [1] explaining one of possible important mechanisms of dissemination of culture. He have found that depending on initial conditions the system can end up in one of two states: ordered with global culture or disordered with many small subcultures. The dynamics of this model captures complexities of real interactions between people, but the square lattice which was considered is far from satisfying reflection of real-world social networks.

Others have studied Axelrod's model deeper [2], also on complex networks [3] and it turned out that the structure can have fundamental influence on the behavior of the system. Maxi San Miguel et. al. [4] made the next step by exploring the model of social interactions on coevolving random networks and finding two phase transitions with interesting properties. Unfortunately social networks are as far from randomness as from regularity.

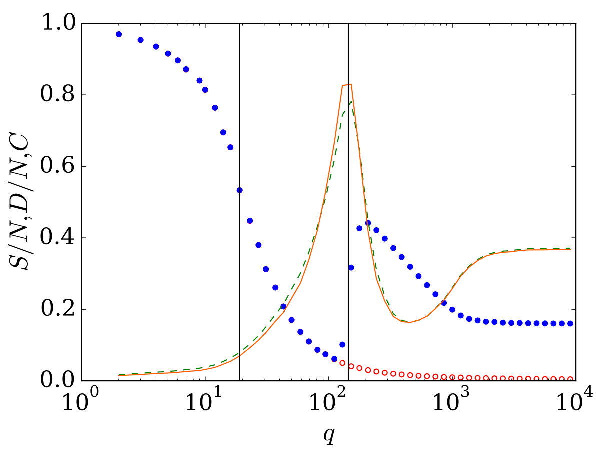

Figure 1: Average relative size of the largest network component (full blue circles) and largest domain (empty red circles), global (solid orange line) and average local (dashed green line) clustering coefficient in the stationary configuration vs parameter q, for $N = 500$, averaged over 400 realizations, for the model with preferential attachment. Vertical lines are placed at transition points, which are respectively $q_c = 19$ and $q^* = 144$.

In our work [5] we introduce four extensions with different mechanisms of edge rewiring. The models are intended to catch two kinds of interactions - preferential attachment, which can be observed in scientists or actors collaborations, and local rewiring, which can be observed in friendship formation in everyday relations. Numerical simulations show that proposed dynamics can lead to the power-law distribution of nodes degree and high value of the clustering coefficient, while still retaining the small-world effect in three models. All models are characterized by two phase transitions of a different nature (see Fig. 1). In case of local rewiring we obtain order-disorder discontinuous phase transition even in the thermodynamic limit, while in case of long-distance switching discontinuity disappears in the thermodynamic limit, leaving one continuous phase transition. In addition, we discover a new and universal characteristic of the second transition point - an abrupt increase of the clustering coefficient, due to formation of many small complete subgraphs inside the network.

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