CASCADE DYNAMICS ON CLUSTERED NETWORK

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In real world systems, small initialized shocks are often propagated through a whole system. For example, the spread of rumors and the diffusion of norms and innovations are observed in social systems. These phenomena are called *information cascades*, during which individuals in a population exhibit collective behavior. To explain the mechanism causing information cascades, Watts proposed a network model(the Watts model) consisted of interacting individual agents, and showed that very large cascades are triggered by small initialized shocks in the model [1]. The Watts model is described as follows:

1. Take a network to be examined. The nodes and the edges correspond to individuals and relationships between them, respectively.
2. The state of each node is either active or inactive. As an initial state, we set a few nodes active randomly. These nodes are called *seeds*.
3. At each time step, each inactive node updates its state to be active if at least a fraction ϕ of its neighbors are active, otherwise it remains to be inactive.
4. Step 3 is iterated until no node changes its state. Then a cascade size ρ is defined as an active node fraction in the final state.

As shown in [1], the dynamics of cascades on a random graph is dependent on the structure of the underlying network. Particularly, sufficiently large size cascades, called *global cascades*, occur as a discontinuous phase transition in ρ with increasing ϕ. Gleeson [2] proposed a general analytical method by using the recursion relations to analyze the cascade dynamics for tree-like networks with arbitrary degree distributions.

Most networks well examined have locally tree-like structures, in which the effect of clustering structures can be ignored. Here, clustering means the presence of sets of three nodes, each of which connects to the others. As well known, many social networks are highly clustering — "two of your friends are likely to be friends of one another"

In this paper, we analyze the Watts model on a clustered network to find the effect of clustering on cascade dynamics. Our clustered network model is generated from a projection of a bipartite graph. We investigate information cascades on this network by numerical simulations and compare them with that on a non-clustered network with the same degree distribution. Our result indicates that global cascades occur more easily on a clustered network than on a non-clustered ones(Fig.1). Furthermore, we extend Gleeson's method [2] to estimate order parameter ρ analytically(Fig.2).

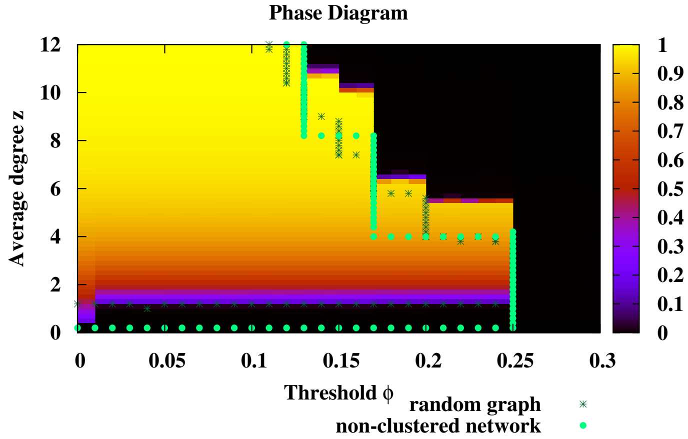

Figure 1: Color map of active node fraction ρ in a clustered network of average degree z and uniform threshold ϕ.

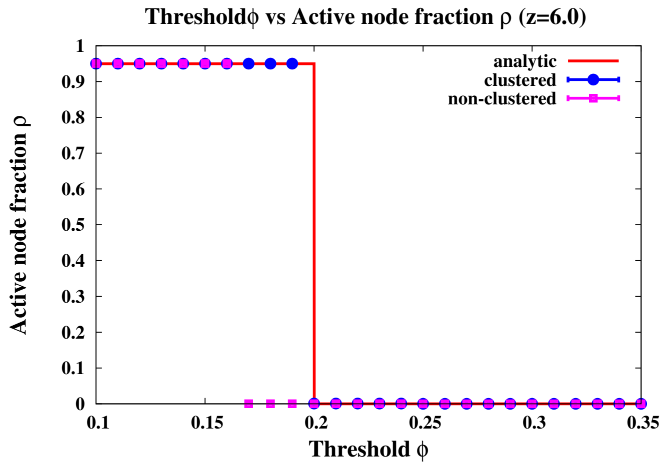

Figure 2: Active node fraction ρ as a function of ϕ obtained numerically on a clustered network(closed circles) and an non-clustered one(closed squares) at $z = 6.0$. Analytical result is also shown(lines).

Keywords
information cascades, social phenomena, complex networks, phase transition, simulation

References

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[2]J. P. Gleeson and D. J. Cahalane, Am. J. Phys. E **75** 056103(2007)