# The Spread of Information on Real World Networks
## Final report on project PIEF-GA-2009-255115

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The role of social networks in various aspects of social life has been brought forward during the last decade, mainly due to the widespread development of the Internet. The Internet is nowadays the backbone of human communication at a global scale and, among other things, it serves as the platform on which many social networks are built. The freedom and the speed of communication over the Internet are the two key factors that have led to the rapid growth of social networks as well as to the increasing influence of them on parts of social life such as the political and economic life.

This has brought into the foreground a number of questions regarding the mechanisms through which beliefs and ideas are spread over a social network. The study of these questions requires the analysis of a number of aspects of social networks. Firstly, it requires knowledge about the structural characteristics of these networks. It turns out that features such as the number of individuals with a certain number of acquaintances or the fact that friends of a certain individual are quite likely to be friends of each other are crucial. Secondly, it requires a reasonable model about how individuals are influenced by their social environment.

Regarding the first requirement, during the last decade there has been a number of models whose purpose is to describe some of the observed structural features of social networks. In this project, we focus on models that capture the so-called *degree distribution* of the social network. This parameter counts essentially how many individuals have a certain number of acquaintances in the social network. Experimental observations have shown that the degree distribution of a social network typically follows a *power law*. That is, the fraction of individuals with $k$ acquaintances scales like $k^{-\beta}$, where the parameter $\beta$ has been observed to be between 2 and 3.

As far as the second requirement is concerned, this project assumes that each individual has a threshold and if the number of acquaintances that have adopted a new belief is at least as large as this threshold, then the individual also adopts the new belief. For example, if this threshold is equal to 3 and at least 3 friends of an individual have bought an *iPhone*, then the individual may also decide to buy one. Such a rule captures the fact that many social trends are *spread by imitation*. The threshold itself is a parameter that determines the degree to which an individual is influenced by its social environment. In this project, we have studied not only such models but also models where dissemination occurs actively.

In [1], we study such a mechanism where each individual who holds some beliefs chooses one of its acquaintances and shares them with her/him or if it does not, then selects one of

its acquaintances and probes her/him over their beliefs. We show that when the underlying network has a power law degree distribution with $\beta$ between 2 and 3, as it has been observed in many real social networks, then a belief that is initially held by one individual can be spread to most of the network in a very small number of steps.

In [2], we study the evolution of imitation mechanisms on such networks. There, we find that it is enough to have initially a very small number of individuals who have adopted a new belief in order for the spread-by-imitation mechanism to disseminate it to a large part of the network. We shed some light on the role of individuals with a very high number of acquaintances. It turns out that these act as *hubs* during the spread of the new belief over the network. These form a very dense core of the network and if a few of them adopt the new belief, then this is enough to pass it to other such individuals and altogether to a large part of the network.

The latter observation can lead to the design of efficient strategies for the rapid spread of rumours or commercial products on groups of people. It shows that it is not necessary to have a large scale "advertisement" campaign, but it is enough to identify "popular" individuals and inform only those about a new product or a new trend in order to successfully spread this over a large part of the group. Thus, targeted advertisement strategies, which in principle might be less costly, are enough to secure a relatively widespread dissemination.

## References


[1] N. Fountoulakis, K. Panagiotou and T. Sauerwald, Ultra-fast rumor spreading in models of real-world networks, submitted.

[2] H. Amini and N. Fountoulakis, What I tell you three times is true: bootstrap percolation in small worlds, manuscript in preparation.