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Roles of Ties in Spreading

Ai-Xiang Cui, Zimo Yang, Tao Zhou

(Submitted on 31 Mar 2012)

Background: Controlling global epidemics in the real world and accelerating information propagation in the artificial world are of great significance, which have activated an upsurge in the studies on networked spreading dynamics. Lots of efforts have been made to understand the impacts of macroscopic statistics (e.g., degree distribution and average distance) and mesoscopic structures (e.g., communities and rich clubs) on spreading processes while the microscopic elements are less concerned. In particular, roles of ties are not yet clear to the academic community.
Methodology/Principle Findings: Every edges is stamped by its strength that is defined solely based on the local topology. According to a weighted susceptible-infected-susceptible model, the steady-state infected density and spreading speed are respectively optimized by adjusting the relationship between edge's strength and spreading ability. Experiments on six real networks show that the infected density is increased when strong ties are favored in the spreading, while the speed is enhanced when weak ties are favored. Significance of these findings is further demonstrated by comparing with a null model.
Conclusions/Significance: Experimental results indicate that strong and weak ties play distinguishable roles in spreading dynamics: the former enlarge the infected density while the latter fasten the process. The proposed method provides a quantitative way to reveal the qualitatively different roles of ties, which could find applications in analyzing many networked dynamical processes with multiple performance indices, such as synchronizability and converging time in synchronization and throughput and delivering time in transportation.

Comments:	8 pages, 4 figures, 1 table
Subjects:	**Physics and Society (physics.soc-ph)**; Social and Information Networks (cs.SI)
Cite as:	**arXiv:1204.0100 [physics.soc-ph]**
	(or **arXiv:1204.0100v1 [physics.soc-ph]** for this version)

Submission history

From: Tao Zhou [view email]
[v1] Sat, 31 Mar 2012 13:38:35 GMT (113kb)