KINETICS OF SOCIAL CONTAGION [1,2]

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Big Data, full records of online services provide unprecedented possibilities in the empirical study of complex social contagion processes like innovation or rumor spreading [3]. One of the observations is that the time scale of the processes can change enormously. Models have to take into account the influence of peers, which, as shown by Watts in a simple model [4], can lead under some circumstances to fast, cascading phenomena. The Watts model on a connected graph provides a phase diagram as a function of the average degree z and the critical threshold ratio ϕ of adopting neighbors with a closed region, where global cascades can develop. The phase boundary can be calculated from a static, percolation type argument and represents second and first order transitions. Motivated by empirical observations from large scale communication service data [2,3] we generalized the Watts model in two ways. First, we introduced blocked nodes with density r for peers, who never adopt; second we assumed that even without peer pressure, just due to external influences, nodes can become spontaneous adopters with rate p. The first case is a straightforward extension and can be treated similarly to the original Watts model resulting in a three-dimensional phase diagram. In the second case the model gets intrinsically dynamic and can be handled by generalization of the efficient technique of approximate master equations [5]. For $r = 0$ and $p > 0$ finally all nodes adopt and the time dependence of the process is reminiscent to the approach of the ground state in a physics system. In this picture introducing blocked nodes corresponds to quenched disorder. For fixed z and ϕ we observe a transition from bimodal size distribution of induced clusters of adopters to a unimodal one at a given $t_\times < r^*$, where r^* is the critical value of the density of blocked nodes, where the system of susceptible nodes gets fragmented. The theoretical results are in good agreement with numerical simulations and can be used to interpret empirical observations on spreading of innovations of internet services [2].

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