No-exclaves percolation on networks

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Percolation problems have played pivotal role in shaping and deepening our understanding of various physical, biological, computational and societal problems from mathematics and statistical physics to complex systems and network science. The subject of our study is the so-called no-exclaves percolation (NExP) model on networks. Our model is a modification of the NEP model proposed by Sheinman *et al* in 2015 defined on Euclidean lattices to make it applicable to networks. It changes the state of the un-occupied nodes which are trapped by completely surrounding occupied nodes into occupied. As a result, a new kind of cluster, that we call the NExP cluster forms. An NExP cluster can give account of, for example, providing the size of the isolated group by quarantine measure against outbreak of infectious disease on networked population. Here we solve the NExP problems both on the regular tree (Bethe lattice) by deriving self-consistency equations for the order parameter and susceptibility, and on the random graphs by setting up generating function equations incorporating the exclave clusters. On one hand, the NExP transition on networks occurs at a lower critical density p_c than ordinary random percolation and the fully-percolated phase is attained at a different, higher density p^*. On the other, at the transition, the obtained critical exponents correspond to those of ordinary random perolcation. Our results highlight the nontrivial role of no-exclaves rule, revealing for instance that the hidden impact of a disease outbreak could be much more severe than estimated just by prevalence alone.