

Title	ループ強化に基づく逆優先選択とメッセージ伝搬法の情報拡散や攻撃耐性に対する強固な効果
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A common topological structure, known as scale-free (SF), is observed in many social, technological, and biological networks. SF networks have efficient short paths between nodes but are highly vulnerable to intentional attacks targeting hubs with high degrees. This combination of efficient paths and extreme vulnerability creates a double-edged sword. Additionally, SF networks can be generated using a preferential attachment rule, such as the Barabasi and Albert (BA) model, where new nodes are linked to existing nodes with a probability proportional to their degree.

Due to the presence of hub nodes, many researchers believe that these hub nodes possess stronger dissemination capabilities, often referred to as influential nodes. Identifying influential nodes as seeds in real networks is an important problem with wide-ranging applications. However, conventional heuristic methods do not account for the overlap phenomenon. To address this issue and prevent overlapping of spreading, we propose a new method that combines statistical physics approaches and multi-hop coverage. We also introduce a faster epidemic model that eliminates the need for stochastic behavior averaging. Computer simulations demonstrate that our method outperforms conventional methods in terms of stronger spreading power per seed.

Furthermore, Self-organization of robust and efficient networks is important for the future designs of communication or transportation systems, because both characteristics are not coexisting in many real networks. As one of the candidates for the coexisting, the optimal robustness of onion-like structure with positive degree-degree correlations has recently been found, and it can be generated by incrementally growing methods based on a pair of random and intermediation attachments with the minimum degree selection. We introduce a continuous interpolation by a parameter  $\beta \leq 0$  between random and the minimum degree attachments to investigate the reason why the minimum degree selection is important. However, we find that the special case of the minimum degree attachment can generate highly robust networks but with low efficiency as a chain structure. Furthermore, we consider two intermediation models modified with the inverse preferential attachment for investigating the effect of distance on the emergence of robust onion-like structure. The inverse preferential attachments in a class of mixed attachment and two intermediation models are effective for the emergence of robust onion-like structure. However, a small amount of random attachment is necessary for the network efficiency, when  $\beta$  is large enough. Such attachment models indicate a prospective direction to the future growth of our network infrastructures.

Keywords:

Network science, Self-organization, Minimum degree attachment, Influence maximum problem, Statistical physics approach