A community-based collective influence algorithm for immunizing networks

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Keyword: Community structure, complex networks, immunization algorithm, percolation

Abstract

A practical approach to protecting networks against epidemic processes such as spreading of infectious diseases and contagion of bank defaults is to immunize some influential nodes beforehand to fragment the network into small components. Because determining the optimal order to immunize nodes is NP-hard, various heuristic algorithms have been proposed to efficiently fragment networks. Morone and Makse [1] recently proposed a highly efficient algorithm, called the CI algorithm, which outperforms various existing algorithms with a reasonable computational cost. In fact, the CI algorithm is based on the assumption that networks have locally treelike structure, compromising the fact that many empirical networks have clusters and community structure.

In the present study [2], we develop an immunization algorithm, called the community-based CI algorithm (abbreviated as CbCI), by exploiting the community structure of networks. The CbCI algorithm prioritizes the node whose influence in terms of the non-backtracking matrix is large in the coarse-grained, but not original, network. Our algorithm works more efficiently than the Morone-Makse's CI algorithm and other existing algorithms, such as [3], for model and empirical networks. We find that the CbCI algorithm is particularly efficient when it uses a community detection algorithm that partitions networks into relatively many and evenly sized communities, such as the Infomap or the Walktrap method.

References

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