Fast and accurate detection of spread source in large complex networks

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Spread over complex networks has become a ubiquitous process with wide applications. Locating spread sources is important, e.g. finding the patient one in epidemics, or a rumor source in social networks. The authors of [1] introduced an algorithm (PTVA) to solve the important case of this problem in which a limited set of nodes act as observers and report times at which the spread reached them. PTVA uses all observers to find a solution. Here we propose a new approach in which observers with low quality information (i.e. with large spread encounter times) are ignored and potential sources are selected based on the likelihood gradient from high quality observers. The original complexity of PTVA is $O(N^{\alpha})$, where $\alpha \in (3, 4)$ depends on the network topology and number of observers. Our Gradient Maximum Likelihood Algorithm (GMLA) reduces this complexity to $O(N^2 \log(N))$. Extensive numerical tests performed on synthetic scale-free networks demonstrate that GMLA yields higher quality localization results than PTVA does. Counterintuitively, increasing the number of nearest observing nodes over some critical value decreases the quality of localization results in GMLA.

The work was partially supported as RENOIR Project by the European Union Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement No 691152 and by Ministry of Science and Higher Education (Poland), grant Nos. 34/H2020/2016, 329025/PnH /2016. and National Science Centre, Poland Grant No. 2015/19/B/ST6/02612.

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