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Topic of Research : Infection Source Detection in Complex Networks

Finding

Brief Overview

Infection source detection deals with the localization or detection of the sourceof a diffusionor infection process in a given complex network. Given the diverserange of the applications of the problem, it has attracted researchers from variousfields, like computer science, biological science, electrical engineering, network science,etc. While there has been extensive work done on this problem over the past 10years or so, the problem still poses various interesting challenges. For example, theimpact of infection models on the generation of an infection graph and subsequently, oninfection source detection, has not been explored exhaustively. Besides, graph factorsinfluencing infection source detection methods are also not explored thoroughly. Moreimportantly, researchers generally tend to ignore certain indicators of infection source,i.e., non-infected surrounding neighbors of an infected node in a complex network.Another important facet, i.e., the impact of classical graph centrality measures oninfection source detection, has largely been ignored in connection to the problem.Besides, researchers generally tend to evaluate their source detection methods usingsimulations, i.e., in a controlled environment, and the evaluation of such methods usingrealworld infection networks has not been examined so far. In addition, there is a lackof real-world infection networks datasets on which source detection methods could beevaluated.In this thesis, the problem of infection source detection has been tackled keepingin view the above-mentioned problems and challenges.

Outcome of the Research

In this thesis, a thorough investigation of thesechallenges has been conducted and come up with appropriate solutions. A summarizedview of the studies conducted in this thesis is presented below:

- An extensive analysis of the different infection models (SIR, SIS, SIR/S, SIRS)has been performed w.r.t. to their capability to generate information cascade/infection graphs. The properties of infection graphs produced by thesemodels have also been deeply analyzed. Besides, another model called SIR/Smodel is proposed to let a node have a chance to recover from an infection orbecome susceptible to infection again.

- An exhaustive analysis of the impact of various graph factors on infection sourcedetection has been performed. The factors which have been used are infectionprobability, infection size, graph topology and graph density.

- The thesis also successfully exploits the benefits of non-infected neighbors surroundinginfected nodes in an infection network to detect single sources of infectionand proposed two novel algorithms, i.e., EPA (Exoneration and Prominencebased Age) and EPA-LW (Lightweight), for the same. A large scale evaluationhas been performed to test the efficacy of these novel algorithms.

- The work on single source detection algorithm has been extended to supportinfection source detection in multiple source detection scenario and two novelmulti-source detection algorithms called EPA K-Means and EPA SSI (SuccessiveSource Identification) have been proposed.

- The classical graph centrality measures in connection to infection source detectionproblem have been revisited and a source detection technique based on thesemeasures has been proposed. Besides, a theoretical justification of the effect ofdensity on source detection is also provided using k-regular trees.

- Real-world rumor infection networks datasets, namely Cov19-RN and Use20-RNbased on COVID-19 and US Elections 2020 misinformations, have been constructedand infection source detection techniques are tested on these datasets.Besides, another variant of EPA called EPA-NP (No Penalty) has been proposedfor source detection in small real-world networks.

- A probabilitic model for COVID-19 infection network estimation has also beenproposed.