Accepted Manuscript

Dynamic node immunization for restraint of harmful information diffusion in social networks

Dingda Yang, Xiangwen Liao, Huawei Shen, Xueqi Cheng, Guolong Chen

PII: S0378-4371(18)30227-9
DOI: https://doi.org/10.1016/j.physa.2018.02.128
Reference: PHYSA 19248

To appear in: *Physica A*

Received date : 31 August 2017
Revised date : 22 December 2017

Please cite this article as: D. Yang, X. Liao, H. Shen, X. Cheng, G. Chen, Dynamic node immunization for restraint of harmful information diffusion in social networks, *Physica A* (2018), https://doi.org/10.1016/j.physa.2018.02.128

Dynamic Node Immunization for Restraint of Harmful Information Diffusion in Social Networks

Dingda Yang[a,d], Xiangwen Liao[b,d,*], Huawei Shen[c,e], Xueqi Cheng[c,e], Guolong Chen[a,d]

[a]*College of Physics and Information Engineering, Fuzhou University, Fuzhou 350116, China*
[b]*College of Mathematics and Computer Science, Fuzhou University, Fuzhou 350116, China*
[c]*University of Chinese Academy of Sciences, Beijing, 100049, China*
[d]*Fujian Provincial Key Laboratory of Network Computing and Intelligent Information Processing, Fuzhou University, Fuzhou 350116, China*
[e]*CAS Key Laboratory of Network Data Science and Technology, Institute of Computing Technology, Chinese Academy of Sciences, Beijing 100190, China*

Abstract

To restrain the spread of harmful information is crucial for the healthy and sustainable development of social networks. We address the problem of restraining the spread of harmful information by immunizing nodes in the networks. Previous works have developed methods based on the network topology or studied how to immunize nodes in the presence of initial infected nodes. These static methods, in which nodes are immunized at once, may have poor performance in the certain situation due to the dynamics of diffusion. To tackle this problem, we introduce a new dynamic immunization problem of immunizing nodes during the process of the diffusion in this paper. We formulate the problem and propose a novel heuristic algorithm by dealing with two sub-problems: 1) how to select a node to achieve the best immunization effect at the present time? 2) whether the selected node should be immunized right now? Finally, we demonstrate the effectiveness of our algorithm through extensive experiments on various real datasets.

Keywords: Social Network; Harmful Information diffusion; Dynamic Immunization; Heuristic Algorithm

1. Introduction

Social networks have become one of the important platforms for opinion expression and information communication. We benefit from the spread of ideas, news, innovation, etc. However, we also suffer from the spread of misinformation [1, 2], negative opinions [3] and rumors [4]. Such undesirable information, collectively referred as harmful information in this paper, even spreads more rapidly and frequently than beneficial information [5]. Harmful information potentially causes political panic and even leads to serious economic consequences. For instance, the rumor of "Barack Obama was injured" on April 23rd, 2013 in Twitter dragged stock index down sharply [6]. As another example, stimulated by the event of "explosion of Samsung mobile phone", the spread of negative information in social networks brought massive troubles to the Samsung Corporation. In order to reduce the influence, it is crucial to study an effective method to limit the spread of the harmful information.

The research community has recently addressed the above problem by finding an optimal set of nodes to immunize, so that the spread of harmful information at the end of diffusion is minimum. We call it *influence minimization* problem, or *network immunization* problem, which is converse to the classic influence maximization problem [7]. Existing methods for this problem can be roughly divided into two classes. The first class focuses on the network topology. These strategies, e.g., targeted immunization [8] and acquaintance immunization [9], are pervasive and have been successfully applied in controlling of infectious diseases. However, the immunization is prior to the emergence of the harmful information in the network, and consequently it is far from the optimal restraint of harmful information. The second class of methods study how to immunize nodes with the knowledge of

*Corresponding author. liaoxw@fzu.edu.cn (X. Liao)