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Parameterized Approximability of Maximizing the Spread of Influence in Networks[☆]

Cristina Bazgan^{a,d}, Morgan Chopin^b, André Nichterlein^c, Florian Sikora^a

^a*PSL, Université Paris-Dauphine, LAMSADE UMR 7243, France.*

{bazgan,florian.sikora}@lamsade.dauphine.fr

^b*Institut für Optimierung und Operations Research, Universität Ulm, Germany.*

morgan.chopin@uni-ulm.de

^c*Institut für Softwaretechnik und Theoretische Informatik, TU Berlin, Germany.*

andre.nichterlein@tu-berlin.de

^d*Institut Universitaire de France*

Abstract

In this paper, we consider the problem of maximizing the spread of influence through a social network. Given a graph with a threshold value $\text{thr}(v)$ attached to each vertex v , the spread of influence is modeled as follows: A vertex v becomes “active” (influenced) if at least $\text{thr}(v)$ of its neighbors are active. In the corresponding optimization problem the objective is then to find a fixed number k of vertices to activate such that the number of activated vertices at the end of the propagation process is maximum. We show that this problem is strongly inapproximable in time $f(k) \cdot n^{O(1)}$, for some function f , even for very restrictive thresholds. In the case that the threshold of each vertex equals its degree, we prove that the problem is inapproximable in polynomial time and it becomes $r(n)$ -approximable in time $f(k) \cdot n^{O(1)}$, for some function f , for any strictly increasing function r . Moreover, we show that the decision version parameterized by k is W[1]-hard but becomes fixed-parameter tractable on bounded degree graphs.

Keywords: Parameterized Complexity, Approximation, Parameterized Approximation, Target Set Selection, Dynamic Monopolies, Spread of Information, Viral Marketing

1. Introduction

Optimization problems that involve a diffusion process in a graph are well studied [23, 17, 10, 1, 14, 9, 4, 24, 3]. Such problems share the common property that, according to a specified *propagation rule*, a chosen subset of vertices activates all or a fixed fraction of the vertices, where initially all but the chosen vertices are inactive. Such optimization problems model the spread of influence or information in social networks via word-of-mouth recommendations, of diseases in populations, or of faults in distributed computing [23, 17, 14]. One representative problem that appears in this context is the *influence maximization* problem introduced by Kempe *et al.* [17]. Given a directed graph, the task is to choose a fixed number of vertices such that the number of activated vertices at the end of the propagation process is maximized.

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