A New Model for Social Networks

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Abstract

In a digital age, social networks help people communicate one another in their daily life. Maximizing the spread of influence among people through a social network is thus important. In recent years, many studies have been conducted on this topic, and many good solutions are proposed. In this article, firstly, based on the papers that I read, I will conclude a solution that is proposed by others, a traditional model - Linear Threshold Model. Secondly, I will propose a solution that I have conducted for a long time - Independent Cascade Model. I also explain what a social network is, and briefly introduce some background information. In order to put forward to my own solution, I will introduce existing research results, because they are the root of my solution. At last, I will conclude what my paper is about, what contribution I have made to this field.

Keywords: Social networks, Spread of influence, Linear Threshold Model, Independent Cascade Model

Introduction

My research question is how to maximize the spread of influence through a social network. Firstly, we should know that what a social network is. A social network is the graph of relationships and interactions within a group of individuals - play a fundamental role as a medium for the spread of information, ideas, and influence among its members [1]. In recent years, social networks are playing a more and more important role in people's daily life. At the same time, people are also more dependent on social networks, like sending message, calling friends, scanning news and so on.

I can take Twitter as an example, Twitter, a microblogging service less than three years old, commands more than 41 million users as of July 2009 and is growing fast [2]. If we want to understand the extent to which such ideas are adopted, it can be important to understand how the dynamics of adoption are likely to unfold within the underlying social networks: the extent to which people are likely to be affected by decisions of their friends and colleagues, or the extent to which "word-of-mouth" effects will take hold [3]. Such network diffusion processes have a long history of study in the social sciences. Word of mouth is the passing of information from person to person by oral communication, which could be as simple as telling someone the time of day. Storytelling is a common form of word-of-mouth communication where one person tells others a story about a real event or something made up. Oral tradition is cultural material and traditions transmitted by word of mouth through successive generations. Storytelling and oral tradition are forms of word of mouth that play

important roles in folklore and mythology.

Because of social networks' importance, many researchers are putting much energy on this field, there are many good solutions to solve this problem, among the good solutions, the Linear Threshold Model (LTM) is a simple and good one. LTM is such a process whose approach is based on the use of node-specific thresholds. Many models of this flavor have since been investigated, LTM lies at the core of most subsequent generalizations [4].

Because of my tutor, my learning direction is social networks, so I have researched the spread of influence through a social network for a long time. I propose another model, it is called Independent Cascade Model, although this model has been proposed by other people, however, they do not use this model to solve something on social networks. I find that this model can be applied on social networks well. In the following section, I will talk about this model in detail.

Objectives

This paper aims to maximize the spread of influence through a social network. In order to solve this problem, I propose a model - Independent Cascade Model. What I contribute to this field is as follows:

(a) Although there have been many papers studying social networks, as for the topic of maximizing the spread of influence, few people use the Independent Cascade Model. So what I research make some certain contribution on social networks.
(b) I have read some papers about this topic. I find that this field has much to be researched. It proves that this is a new field and I have much to do.

In the following section, I will talk about the Independent Cascade Model in detail.

Methodology

What is an Independent Cascade Model? It occurs when a person observes the actions of others and then — despite possible contradictions in his/her own private information signals — engages in the same acts. A cascade develops, then, when people "abandon their own information in favor of inferences based on earlier people's actions". Information cascades provide an explanation for how such situations can occur, how likely they are to cascade incorrect information or actions, how such behavior may arise and desist rapidly, and how effective attempts to originate a cascade tend to be under different conditions. By explaining all of these things, the original Independent Cascade Model sought to improve on previous models that were unable to explain cascades of irrational behavior, a cascade's fragility, or the short-lived nature of certain cascades.

In this paper, I apply the Independent Cascade Model on social networks. In considering operational models for the spread of an idea or innovation through a social network G, represented by a directed graph, we will speak of each individual node as being either active (an adopter of the innovation) or inactive. We will focus on settings, guided by the motivation discussed above, in which each node's tendency to become active increases monotonically as more of its neighbors become active. Also, we will focus for now on the progressive case in which nodes can switch from being inactive to being active, but do not switch in the other direction. It turns out that this assumption can easily be lifted later. Thus, the process will look roughly as follows from the perspective of an initially inactive node v: as time unfolds, more and more of v's neighbors become active; at some point, this may cause v to become active, and v's decision may in turn trigger further decisions by nodes to which v is connected.

The following part is the steps that show how the Independent Cascade Model works. We start with an initial set of active nodes A_0, and the process unfolds in discrete steps according to the following randomized rule. When node *v* first becomes active in step *t*, it is given a single chance to activate each currently inactive neighbor *w*; it succeeds with a probability $P_{w,v}$ — a parameter of the system — independently of the history thus far. (If *w* has multiple newly activated neighbors, their attempts are sequenced in an arbitrary order.) If *v* succeeds, then *w* will become active in step *t*+1; but whether or not *v* succeeds, it cannot make any further attempts to activate *w* in subsequent rounds. Again, the process runs until no more activation is possible.

Here there is a claim: A node *x* ends up active if and only if there is a path from some node in A to *x* consisting entirely of live edges. So every node is not only independent but also related. This is a dynamic cascade model compared with a static Linear Threshold Model.

Novelty

Independent Cascade Model has been used in other fields before. However, it has not been applied to social networks. I apply this model in such a field, and find that this model can solve this problem well. With the popularity of social networks, there are also many other solutions being proposed, the Linear Threshold Model is one of them. This is a simple and good model to solve social networks. However, it is a static method. Nowadays social networks have good topology and model, a static model is not enough to solve such social networks. Independent Cascade Model is a dynamic model and can adjust modern social networks well. Of course, I know there is much to improve in the future. I will continue it as my direction.

Conclusion and Significance

In this paper, in order to maximize the spread of influence through a social network, I have proposed a novel model - Independent Cascade Model. The Independent Cascade Model is the most basic and widely-studied diffusion model, but of course many extensions can be considered. Compared with the recent papers, this model is novel and effective. For example, Linear Threshold Model is a static model, thus it is not suitable for the rapidly developing social networks. The independent Cascade Model can adjust to this condition well. However, because time is not enough, there is much space to improve, I will continue my study in the future.

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