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Classifying the Influential Individuals in Multi-Layer Social Networks

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ABSTRACT

Nowadays, social media is one of the popular modes of interaction and information diffusion. It is commonly found that the main source of information diffusion is done by some entities and such entities are also called as influencers. An influencer is an entity or individual who has the ability to influence others because of his/her relationship or connection with his/her audience. In this article, we propose a methodology to classify influencers from multi-layer social networks. A multi-layer social network is the same as a single layer social network depict that it includes multiple properties of a node and modeled them into multiple layers. The proposed methodology is a fusion of machine learning techniques (SVM, neural networks and so on) with centrality measures. We demonstrate the proposed algorithm on some real-life networks to validate the effectiveness of the approach in multi-layer systems.

KEYWORDS

Betweenness Centrality, Bottleneck Centrality, Centrality Measures, Multi-Layer Networks, Multiple Layers, Multiplex Network, Social Network, Trend Lines

INTRODUCTION

Social media is one of the fastest growing areas among users for communication and sharing information. It grows with an exponential rate due to advancement in technologies. For example, Twitter, Instagram, Facebook and so on are few social networking platforms where millions of users connected. Analysis of social networking platforms is one of the popular areas among researchers. The set of users and relationships between users are modeled in the form of a network, where each user is a node, and edge denotes the relationship (Breza & Chandrasekhar, 2019). Analyzing social network unveils diverse knowledge about users, their behavior and relationships (Newman, 2003). There exist several methods like centrality measures, community detection and so on, which helps in the analysis of such networks. The purpose of measuring centralities is to find the influential power of nodes in the system. There are several types of centrality measures like eigenvector, degree, betweenness and each having a different purpose, which we will discuss later in the next section.

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Community detection is identifying a set of nodes, which are highly connected compare to other nodes (Kuncheva & Montana, 2015).

Influential individuals are impactful users with loyal audiences, and other users tend to trust their recommendations. In social networks, Influential individuals could be highly connected and reachable nodes of the systems. For example, in social networking site Twitter, a user having a high number of followers could be marked influencer because they are trusted the source of information and their message is reachable to a large number of the audience (Watanabe & Kabashima, 2014; Mallipeddi, Kumar, Sriskandarajah, & Zhu, 2018).

Most of the existing research work for finding influential users from the social network is considering only one type of relationships between users, i.e., single layer networks are involved in the study whereas we are targeting to include multiple types of relationships between users, which is further modeled as multi-layer social networks (Domenico, Granell, Porter, & Arenas, 2018).

The primary purpose of finding such influential users is to achieve large cascades and full reachability. The high reachability is easily attaining in multi-layer systems because of the topology of the network. Identification of influential users is a crucial task, and in this paper, we propose a methodology to find such users from the multi-layer system by collaborating machine learning techniques with centrality measures and community detection (Sadri, Hasan, Ukkusuri, & Lopez, 2018).

Our proposed approach starts by computing the betweenness centrality, closeness centrality and degree centrality of each node of the multi-layer network. The purpose of finding centrality values is to check how much a node is central in the network. Next, we identify the communities in the system. Community detection helps us in the classification process when we introduce machine-learning algorithms for finding influential individuals from the system. The proposed model uses the influence capabilities of the target user and his/her friends to see how prone the friends are to getting influenced by the target user and user characteristics.

The significant benefactions of the paper are:

- We empirically try to find influential users in multi-layer networks;
- We propose a novel methodology to find influencers who can cascade information to a broad audience in a social network;
- We use some standard multi-layer network datasets for our study.

Paper Outline

In the next section, we discuss the work done in the related area of multi-layer networks, centralities and so on. In part 3, we talk our proposed approach for measuring the influential power of users, in section 4, we discuss the datasets, and at last, we enlighten the experiment results.

BACKGROUND

Influential Users in Social Networks

Measuring the influential power of a user in the social networks helps in digging out exciting findings from the systems, which are further used in many applications. For instance, influential users are a great source of information distribution. A theory related to influence is trust, and in social networks, it involves in advertisements, promotions and so on. Bacha and Zin (2018) and Cha, Haddadi, Benevenuto, and Gummadi (2010) finds the influential users from the Twitter dataset from the users having a large number of followers. Shin, Xu, and Kim (2008) give different definitions of influence and depending on the application it varies. Wadhwa and Bhatia (2015, 2016) proposed an algorithm for finding the radicalization in social networks using a Markov chain algorithm and implement the same on twitter datasets. Mittal and Bhatia (2018) proposed an algorithm based on