

# Analysis on the differences in information dissemination laws between online and offline social networks

**Xinyang Wang**

Scholl of International Education, Hubei University of Economics, Wuhan, Hubei,  
430205, China

xwang4@aum.edu

**Abstract.** Social networks are ubiquitous, which has been one of the important topics of many scholars. With the rapid development of information technology in recent years, people's social platforms are not limited to offline, and online social networks have gradually become an indispensable part of our lives. However, there is still a lack of research on the differences between online and offline social networks. Therefore, this paper probes into the differences between online and offline social network information dissemination by collecting data from online and offline double-layer coupled networks, and comparing and analyzing the data. Research shows that there are some differences between online and offline social networks in the law of information dissemination, which will have a certain impact on real life. Therefore, three suggestions are put forward: 1. At the initial stage of promotion, there are few audience groups, so offline methods can be adopted. With the expansion of information dissemination scope, gradually turning to online promotion, the best promotion effect will be achieved at the fastest speed. 2. The speed and effect of information dissemination can't be ignored for people who have no value in social network information dissemination. 3. Based on the complexity of the public opinion information dissemination network, users need to constantly cultivate their ability to identify information, the management of major social platforms earnestly perform their regulatory responsibilities, and the relevant functional departments of the government gradually establish a public opinion guidance mechanism. If joint efforts can be formed, the public opinion prevention and control effect will be more significant.

**Keywords:** social network, information dissemination, online/offline network, contagion model, public opinion control

## 1. Introduction

### 1.1. Research background

Due to the fast development of computer networks and information technology, the spread of information not only depends on physical infrastructure networks, such as communication networks and transportation networks but also increasingly relies on online networks, such as online social networks [1]. In recent years, the applications of the online social network have been expanding, such as Instagram, Twitter, Wechat, and Microblog has become an important part of our daily life. People can obtain information, learn skills, and communicate and collaborate on these online social networks. People's

work and life have also entered a real-time online state. The user base of the social platform is huge, and all kinds of information spread rapidly in social networks, which endows information with timeliness and shortens the cost of information interaction between people. Compared with other social networks, online social networks are a large overlapping and interwoven diversity system, which also leads to more complex information interaction. These information interactions have a positive or negative impact on our political life, economic life, social life, and so on directly or indirectly. At the same time, users can't only obtain information from online social networks, offline social networks are also a channel, such as a friend sharing, advertising marketing, and offline promotional activities. This is a typical double-layer coupling network, in the online and offline two-layer coupling network, people can communicate with each other in real language when they can see each other, or through mobile terminals when they can't see each other. Therefore, the research on the differences in information dissemination laws of online and offline social networks is of great significance in promoting government governance, knowledge and culture dissemination, commercial activity promotion, and public opinion regulation.

### *1.2. Research Significance*

*1.2.1. Theoretical significance.* In studying the information communication and interaction mechanism of social networks in real life, the social relations of social networks are usually abstracted into complex networks, and various complex network theories and communication models are applied to multi-information interactive communication networks to explore the impact mechanism of information interaction and communication of social networks. In communication dynamics, it is very important to accurately measure nodes' propagation ability in complex networks, to implement the effective methods and to suppress the spread of diseases or accelerate the spread of information [2]. Based on the complex network and communication dynamics, research discusses the information communication model on the double-layer coupled network, explores the nature, characteristics, laws, and factors affecting information communication of social networks, perceives the evolution of information communication, and analyzes the differences of information communication laws between online and offline social networks.

*1.2.2. Practical significance.* Since the dissemination of information on online social platforms is decentralized, massive, and uncontrollable, it will vigorously promote the dissemination of false information, thus triggering a crisis of public opinion and rumors [3]. The research on the impact mechanism of multi-information interactive communication under the complex social network will help us to deepen our understanding of the law of information communication, help the public opinion supervision department fully understand the nature of information communication, obtain the guiding factors affecting information communication, predict the trend of information communication, and on this basis, and provide some feasible suggestions for the public opinion supervision department. This research will help the government and the relevant departments to regulate the spread of bad information, further, strengthen and improve the management of the social network environment, and promote the healthy and long-term development of social networks. In addition, identifying the most influential communication nodes in the real world is also conducive to promoting emerging products and helping enterprises improve economic efficiency. At the same time, it can also promote the spread of knowledge and culture in multiple fields and at multiple levels, carry forward social positive energy news information, and promote the good development of social ethos [4].

### *1.3. Research status*

In recent years, various social platforms and new media have emerged in an endless stream and flourished, making complex networks a research hotspot and attracting the attention of many researchers. From the social relationship between a few people to the ubiquitous social network, the complex network has been closely linked with our life. The research of complex network information dissemination is usually regarded as a complex system composed of a variety of interrelated factors and has the function of information dissemination [5]. The analysis of information transmission models started in the field

of infectious disease transmission models. At present, the most commonly used infectious disease transmission models include the SI model, SIR model, SIS model, etc. Building an accurate information propagation model can generally describe the propagation process and flow direction of information in the network, and can also predict the propagation trend and path of information to a certain extent. Although the transmission process of information in different social networks is different, its transmission dynamics, transmission laws, and other characteristics are similar. The analysis of various studies found that the current research on social networks is mostly focused on single-layer social networks, such as online social networks or offline social networks. However, in real life, information transmission is generally carried out in online and offline interactive social networks, and the overlap between online social networks and offline social networks is a common phenomenon. Online and offline social networks are a typical double-layer coupled network model. At present, the research on online and offline double-layer coupled social networks has just started [6].

## **2. Overview of related theories**

### *2.1. Introduction to complex networks*

A complex network is a network composed of many connections between nodes. Combined with graph theory, a complex network is a network topology with many nodes and intricate edges. Any complex system is composed of many edges and nodes. Nodes represent different individuals in the system, and edges represent the relationships between individuals [7]. Complex networks widely exist in our daily life, such as transportation networks, metabolic networks, food networks, and social networks. At present, the complex network theory mainly includes the geometric properties of the network, the properties of the network model, the evolution mechanism of the network, the propagation dynamics mechanism, disease prediction, and other issues.

### *2.2. Theory of propagation dynamics*

The main purpose of studying the complex network structure and its evolution process is to understand its dynamic process and study its propagation dynamics. At present, the types of communication dynamics in social networks are mainly divided into disease transmission and information transmission, which correspond to two different network structures, namely contact network and communication network. However, the communication models are not different in general, but in the aspect of information transmission, information has the characteristics of timeliness and repeatability in the network [8].

### *2.3. Principle of social network concept*

The social network is also a kind of complex network. A social network refers to the network structure built between people through hobbies, real friends, or others [9]. Social networks are based on real interpersonal networks, including nodes, relationships, communities, and groups. Nodes in social networks can represent individuals, objects, and so on. The relationship between nodes can be cooperation, preferences, and so on. The difference between community and group is that a community is an original social network, which reflects the distribution of network members and other unique attributes of the network, and the group is established for a certain purpose.

### *2.4. Concept of network public opinion*

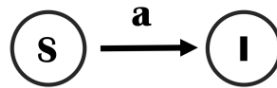
The public opinion refers to the sum total of various emotions, opinions, and attitudes generated by individuals and social groups around the occurrence, development, and change of social events within a certain time and space. In recent years, the number of various social network platforms has been increasing, providing a new communication channel for the general public. Every user of online social networks can become a news producer and disseminator [10], and the possibility of online public opinion happening at any time. Internet public opinion is a way for the public to express their views, emotions,

and attitudes towards social events through the Internet platform, which usually has a certain impact on the development of social events.

### 3. Pattern category

#### 3.1. SI model

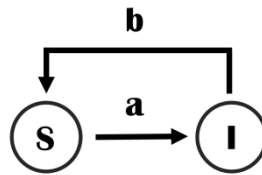
The SI model is the earliest and most basic type of infectious disease model, which is used to simulate infectious diseases that cannot be cured completely and will not produce antibodies once infected. The model has two types of populations: susceptible state population S (Susceptible) and infected state population I (Infective). Susceptible state population S represents the uninfected and non-immune people, that is, people who have not been exposed to information. Infected state population I represents people who are infected and can infect, that is, people who have begun to spread information. As shown in Figure 1, the susceptible state S will receive information with probability  $a$  and become infected state I.



**Figure 1.** SI model diagram.

#### 3.2. SIS model

In the real world, individuals cannot remain infected all the time, so scholars further propose the SIS model as Figure 2. Based on the SI model, the infected state I (Infective) has a certain probability  $b$  to be re-transformed into the susceptible state S (Susceptible) after recovery and may be transformed into the state again.  $a$  represents the infection probability, and  $b$  represents the recovery probability. When  $a > b$ , the infectious disease spreads rapidly. When  $a \leq b$ , the infectious process is relatively stable and controllable [11].



**Figure 2.** SIS model diagram.

#### 3.3. SIR model

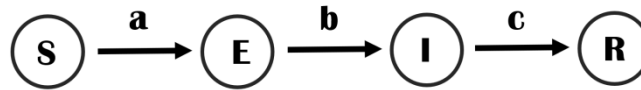
The SIR model is used to simulate the infectious diseases that can be cured after infection, and the immune system will be obtained after cure, without secondary infection. The model has three populations: susceptible population S (Susceptible), infectious population I (Infective), and immune population R (Recovered). Immune population R represents people who have recovered and have immunity and will not be re-infected. The SIR model is an improvement on SIS. When susceptibility state S with probability  $a$  becomes infection state I, there is the probability  $b$  will become immune state R, and there is no possibility of being infected again. The conversion process is shown in Figure 3. Additionally, when the infection state I gradually changes to the immune state R, the system state has a stable trend, and the susceptible population in the system gradually disappears.



**Figure 3.** SIR model diagram.

#### 3.4. SEIR model

Many existing infectious diseases have a certain incubation period, so dividing network nodes into susceptible, infectious, and immune persons may not accurately describe the transmission process of such infectious diseases [12]. The SEIR model has four populations: S (Susceptible), E (Exposed), I (Infective), and R (Recovered). The susceptible population S will be converted into the latent population E with the probability of a, the latent population E will be converted into the transmission population I with a probability of b, and the transmission population I will be converted into the immune population R with a probability of c. Its propagation state is shown in Figure 4.

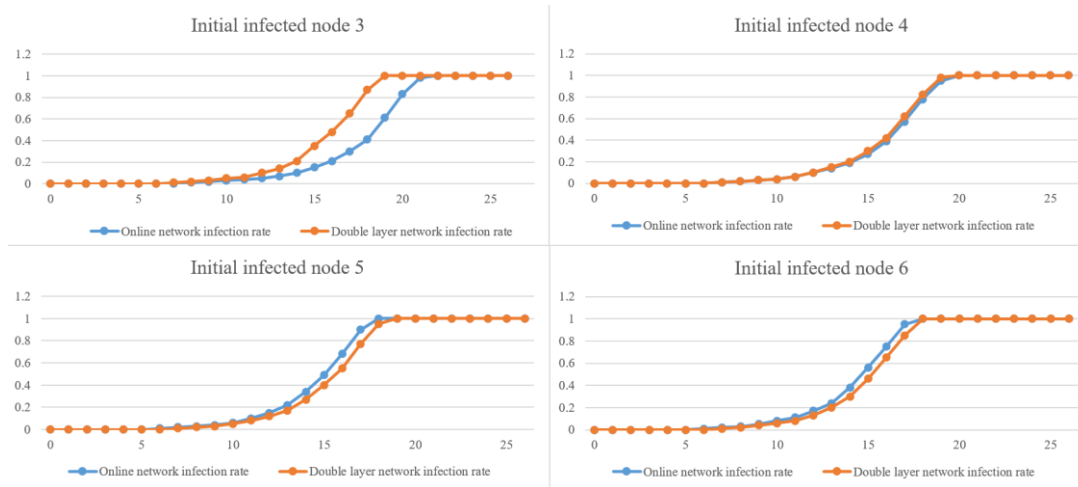


**Figure 4.** SEIR model diagram.

## 4. Results and analysis

### 4.1. Comparative analysis of information dissemination process

There are obvious differences in topology structure and information transmission process between single-layer online social networks and two-layer coupled social networks. As shown in Figure 5, in the case of setting the same node that does not receive information, change the number of initially infected nodes is changed to conduct a comparative experiment on the information transmission process, and form two different curves of the network information transmission range over time are formed. As can be seen from the figure, when the number of initial infected nodes is small, such as 3 and 4. A two-layer coupled social network will reach a fully infected state earlier than a single-layer social network. With the number of initially infected nodes increasing, the whole infection process of double-layer coupled social networks and single-layer social networks will almost overlap at a node. After that, the single-layer social networks of infected nodes will reach the whole infection status earlier than the double-layer social networks.

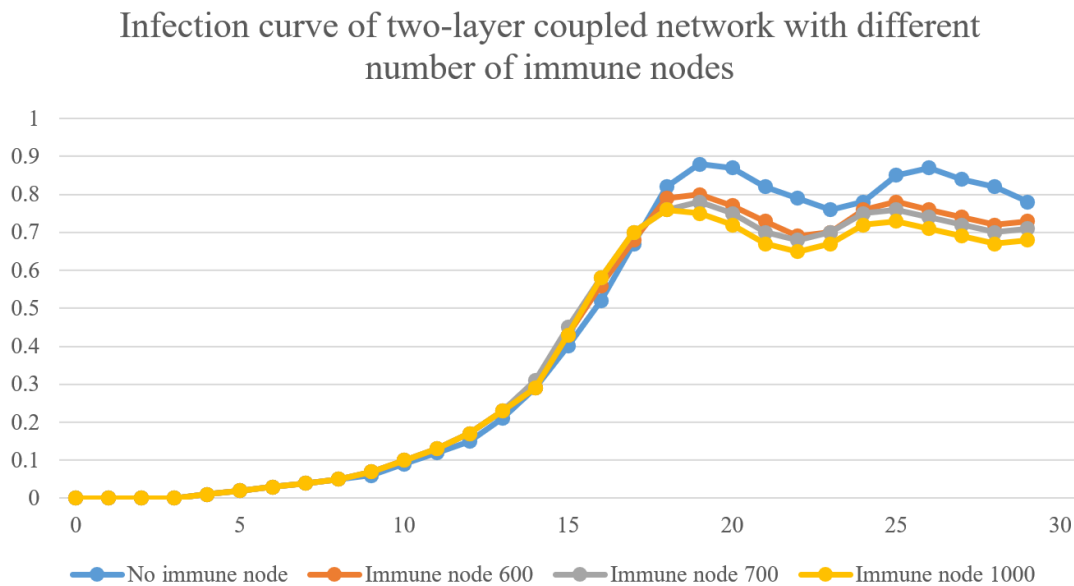


**Figure 5.** Comparison of propagation process of uninfected nodes [13].

Nodes in a two-layer social network are moving, while nodes in a single-layer online social network are not moving. Each initially infected node in a single-layer social network randomly selects a node for infection, while each initially infected node in a two-layer social network discovers uninfected nodes through continuous movement. At this time, the efficiency of a single-layer social network infecting a node will be higher than that of a two-layer social network. From this result, it can be inferred that in real life, when the government carries out knowledge and culture communication, the company carries out commercial product promotion, and individuals carry out the advertising information promotion. Offline promotion can be carried out when the initial audience is small. As the number of people who know this information increases, the scope of information dissemination can gradually shift to online promotion, which will achieve the best promotion effect at the fastest speed.

#### 4.2. Comparative analysis of immune nodes

In the model, an immune node is a person who has no value for the dissemination of social network information, but its existence will also have some impact on the social network infection process. If the infected node finds an immune node in the process of continuous movement, the infected node will ignore this immune node. Here we mainly explore the impact of the different numbers of immune nodes on the infection process of the double-layer coupling network. On the premise that the initial number of uninfected nodes, the number of infected nodes and the self-healing time are the same, this experiment adopts different numbers of immune nodes to establish the curve of infection rate of two-layer coupled network with time.



**Figure 6.** Infection curve of two-layer coupled network with different number of immune nodes [13].

It can be seen from the Figure 6 that the network without immune nodes and the network with immune nodes will reach the peak in a period, and then there will be fluctuations smaller than the peak. In addition, the infection rate curves of the immune node network and the non-immune node have the same trend, the infection rate extreme value of the immune node network is lower than the infection rate extreme value of the non-immune node network. Before reaching the peak, the infection rate curve value of the network with immune nodes is slightly higher than that of the network without immune nodes. After reaching the peak, the infection rate curve of the network with immune nodes is significantly lower than that of the network without immune nodes. Through the above experiments, it can be found that the existence of immune nodes in a double-layer coupled social network can accelerate the speed of information transmission, but the effect of information transmission may become worse after reaching a certain speed. In online and offline social networks, attention should be paid to the number of people who are worthless for the transmission of social network information, and their possible impact should not be ignored.

#### 4.3. Suggestions on prevention and control of online public opinion

The research found that the time, purpose, and way of online users using online social platforms are completely different, and there are huge differences between different individuals. Most of the active people on the Internet are young people, they prefer to express their views on social hot events on the Internet. First of all, as the main body of online public opinion dissemination, the users must have a sense of self-discipline and social responsibility in the process of surfing the Internet, constantly cultivate the ability to identify information, and jointly create a civilized Internet environment. Users with high traffic and influence can attract a large number of ordinary users to follow, and can even speed up the dissemination of information and expand the scope of information dissemination. Therefore, they should abide by the constraints of ethical norms in the process of surfing the Internet, and be cautious in their words and deeds when speaking about hot events, to set a good example for others. Secondly, the management of major social platforms must actively fulfill their supervisory responsibilities, build social platform behavior codes, control and clarify false information or negative information promptly, and guide the dissemination of information on online social platforms. Finally, the relevant government departments can use the official media resources to release positive energy messages, interact directly with netizens on various social platforms, further improve information disclosure and feedback channels, obtain a real online public opinion, and gradually establish a public opinion guidance mechanism.

## 5. Conclusion

The social network has always been a research direction attracting much attention, and the research results of the social network have been applied to all aspects of real life. The topic of this paper is the information dissemination of online and offline social networks based on complex networks. This research explores the differences in its laws based on the infectious disease model and puts forward suggestions for practical problems by applying them to real life. Social networks in real life consist of online social networks and offline social networks. The research found that online and offline social networks can play a positive role in promoting government governance, knowledge and culture dissemination, Optimizing business activities, and regulation of public opinion. The research results are presented in the fourth part. However, the models and methods involved in this paper still have some shortcomings, and there is still room for optimization, which is worthy of further exploration in future scientific research.

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