Public Emergency Information Diffusion and Opinion Leader Mathematical Modeling Based on Sina Microblog

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Abstract Public emergency occur every day, the information diffusion of OSN (online social network) shows the characteristics of large capacity, a wide range of far-reaching effects. In order to analyze the role of opinion leader in OSN and the life cycle of Sina microblog information diffusion, public emergency information diffusion model and a new method grading opinion leader model are proposed. The simulation results show that the established public emergency information diffusion model can truly reflect the actual situation.

Keywords Public emergency; opinion headship; communication power; microblog lifecycle

1. Introduction

1.1. Background and Research Status

Microblog can be treated as an online social platform; each user can be regarded as a node. A number of nodes are interconnected to form the entire microblog network. In order to be more scientific and reasonably to analyze the microblog network structure and study the node properties, the researchers generally put the complex network theory, multi-network theory and social network analysis method as the basic support theory. Complex network is a branch of complexity theory, with complex structure, diverse nodes, varied network structure and other forms of expression, is a framework for the representation of complex systems. Multi-network theory refers to a network structure with multi-layer network, each node in the same network nodes, however there are some differences in the link attributes between different nodes. Social network analysis method regards the entire network as a number of nodes, each node has a certain linkage, the link within the network structure determines the information transmission path and its characteristics [1-3].

The scale of the network has been gradually expanded in current actual social network. As can be seen from Table 1, the number of users in several typical social networks both at home and abroad has exceeded one billion and continues to grow at a faster speed. As a result, researchers are only getting more accurate research on OSN (Online Social Network) information simulations in near real world environments. It has become one of the hot and difficult problems at home and abroad on how to build the large-scale network information diffusion simulation system [4-6].

The term of opinion leader was first proposed by the spread scholar Lazarsfield in the 1940s. Opinion leaders are "activists" who influence others. Which plays a medium role in the mass communication process. They will spread the information to the public when they access to information, so that the formation of two-level diffusion of information diffusion. In recent years, the emergence of microblog has changed the think-way of people, while microblog developed at a very rapid pace that people can not imagine [7-10]. The information diffusion in the social network presents many new features compared with the traditional media information diffusion, such as the user has created content, "points to points" mode of transmission, real-time transmission

and fastness. In the microblog, the analysis of opinion leaders have a lot of factors, such as the number of forwarded, the number of comments, the number of active days, the number of fans and so on. Using these factors, we can study the communication power of opinion leaders and propose diffusion mathematics models.

2. Public Emergency Information Diffusion and Mathematics Model

Unlike the computer virus propagation model(such as SIR model) and some other information dissemination mode in a multi-relationship online social network, network users usually adopt a proactive approach to the information diffusion and choose the appropriate type of friend relationship according to the preference of the information. According to the function of user nodes in the social network information diffusion model (as can be seen from Figure 1), the network user nodes can be divided into three types: diffusion node, interest node and no-interest node.
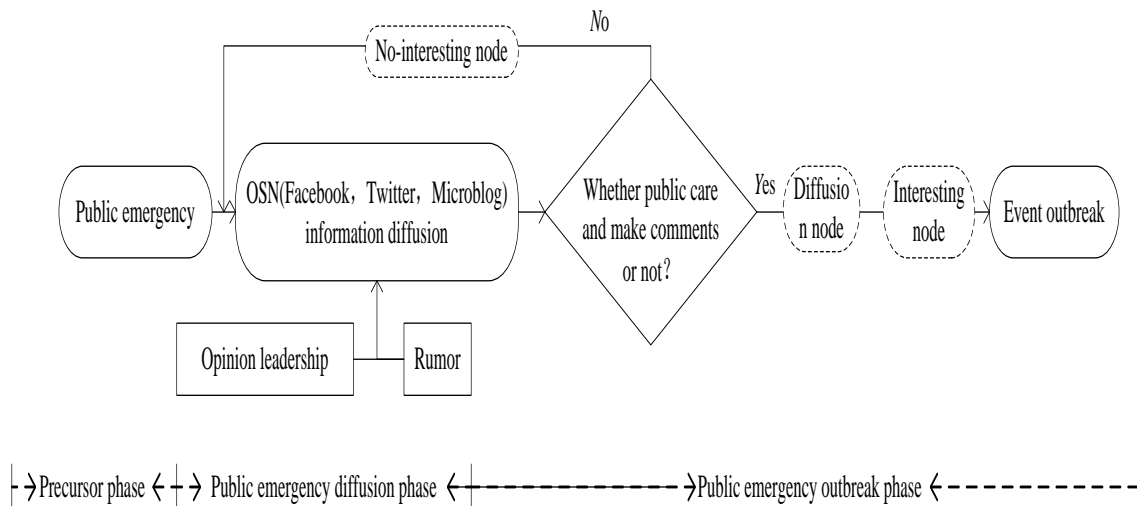

Figure 1: Information diffusion model

For a new information message, a diffusion node indicates that the node has received information from its neighbor node, and has the interest of spreading the information which received from the neighbor node. The interest node denotes that the node has not received the information from its neighbor node but it is interested in the information, and the interest node may become the diffusion node when received the information. If interest node is not interested in the information, the interest node will become the no-interest node after received the information. No-interest nodes expresses that it do not propagate information. Since public emergency information cannot be tested in real life. Therefore, the computer modeling and software simulation is the most effective way.

People of OSN in society can be treated as agents in computers. The interaction between people's opinions is modeled as agent's attributes and behaviors. Interactive rules are introduced in interaction process. It can determine whether the individual opinions can be changed and the extent of change by the rumor or opinion leader. Macro-public opinion phenomenon can often be observed from the group after repeated interaction of opinions. For a particular incident, the attitude of people is ambiguous at the beginning, it may be affected by the views of surrounding people, such as being influenced by rumors and being affected by opinion leaders, thus changing the original view. As shown in Figure 2, this method can effectively answer micro-individual opinions how to emerge macro public opinion.

In the dissemination of media, most people will form what kind of attitude, which is subject to the influence by others attitude. There are four features (such as attitude, conformity, credibility, authority) are related to information diffusion.
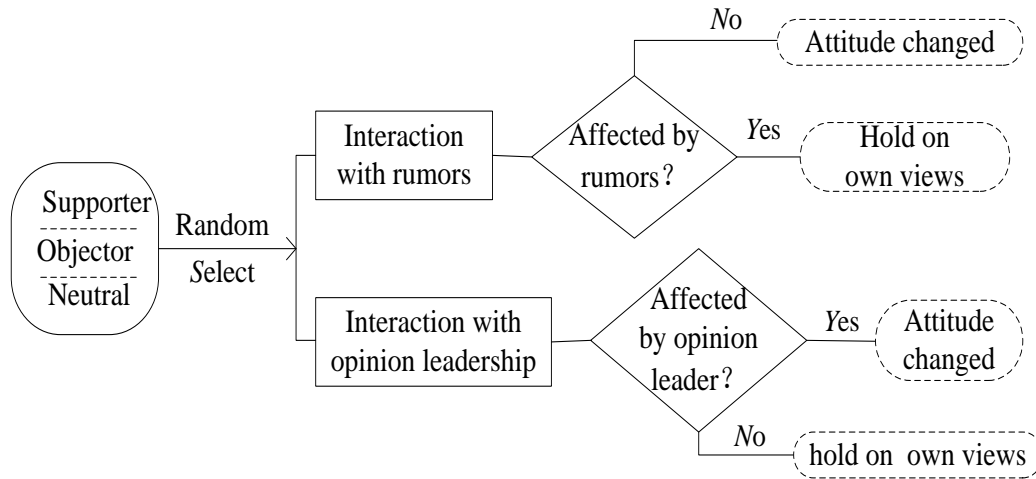
Figure 2: Information interaction model based on computer agent

People often hold three kinds of attitudes toward public emergency information: support, neutrality and opposition. In the real society, people's attitude is not clear at the beginning. Many people's attitudes have gradually shifted from ambiguity and swinging to clear and firm opinions because of media or interpersonal influence. In this paper, we take the real numbers in the interval (0,1) as the individual opinions, (0,0.33) denotes the objections, (0.33,0.67) means neutral, (0.67,1) indicates support.

During the period of the spreading and the outbreak of public emergency, there are mainly three types of subjects: people, rumor makers and opinion leaders. The properties of all kinds of subjects are shown in Table 1.

Table 1: Number of online social network sites users

Subject	people	rumor makers	opinion leaders
Property	Attitude	Attitude	Attitude
	Conformity	Credibility	Credibility
	Credibility		Authority

The interaction rules between agents can reflect the various factors that influence the change of agent's opinion. $P_i(t)$ denotes the subject. $C_i(t)$ is the credibility of subject i. τ is interaction threshold($\tau=0.34$). At the time t, if we have $|P_i(t)-P_j(t)| < \tau$,it can be indicated that there are less difference between the subject i and subject j. When $C_j(t) > C_i(t)$, it can be denoted that subject j can affect subject i .The state transfer equation of subject i at time $t+1$ can be expressed as follows

$$P_i(t+1)=P_i(t)+\{P_j(t) - P_i(t)\}\cdot a_i(t) \tag{1}$$

$$C_i(t+1)=C_i(t)+\{C_j(t) - C_i(t)\}\cdot a_i(t) \tag{2}$$

Where, $a_i(t)$ represents the probability that the subject i can be affected by subject j .Such as the probability of rumor impact on the attitude of the public, and the public is proportional to conformity, and is inversely proportion to the credibility of popular information. It is directly proportional to rumors provocative. The impact probability of opinion leaders on followers is proportional to their conformity, and it is inversely proportion to the credibility of the public and directly proportional to the credibility of opinion leaders and it is proportional to the authority of opinion leaders.

If $|P_i(t)-P_j(t)| > \tau$ .It can be indicated that there is much difference of opinion on the subject. Subject i will not change his attitude. The state transfer equation can be described as

$$P_i(t+1)=P_i(t) \tag{3}$$

$$C_i(t+1)=C_i(t) \tag{4}$$

The communication power formula of the opinion leader can be calculated as.

$$F_{propagation} = w_1 V_{fans} + w_2 V_{forward} + w_3 V_{activity} \tag{5}$$

3. Influence factors of opinion leaders

Sina microblog which has more than 3 million fans of the users is defined as the opinion leader, ignoring the transmission of certain specific conditions, temporarily the number of fans less than 300 million users do not act as the leader of the diffusion of its efforts to ignore. First of all, take from the microblog list of fans to obtain the number of fans more than 3 million of 1870 users are analyzed. The number of fans of these opinion leaders is sorted and sorted by quantity, and how many people can see how many of these opinion leaders have released microloggings. Second, the list of opinion leaders will be concerned about the list of attention in the list of attention is extracted from the number of opinion leaders, the results can be analyzed in the opinion leader after the release of information, how many opinion leaders can see, see more people, the greater the probability of forming multi-level propagation. Two factors have important implications for the multi-level communication of opinion leaders.
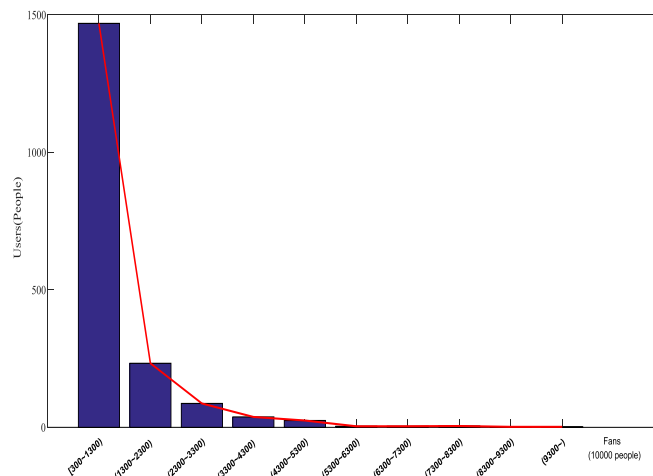

Figure 3: Sina microblog celebrity fans distribution map

As can be seen from the Figure 3.The majority fans of the opinion leaders are between 3 million and 33 million, there are less opinion leaders which more than 33 million fans. The next step is to analyze the number of opinion leaders (10% of the total number of people is less than 1 which is set with 1) by 10% of opinion leaders from the ten classified opinion leaders according to the number of fans.
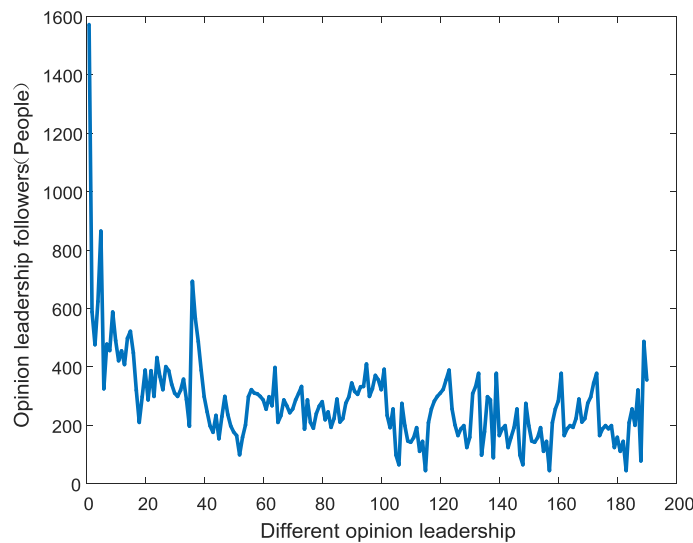

Figure 4: The number of opinion leaders in the list

Figure 4 shows that the number of opinion leaders concerned by these opinion leaders ranged from 45 to 1572, with the maximum and the minimum being the two extremes. The average number of opinion leaders of the 190 opinion leaders was 277. After the information is released, it is possible to be forwarded by the opinion leaders or forwarded by opinion leaders, which can then be forwarded by the opinion leaders to form a multi-stage forwarding, which maximizes the diffusion of information.

4. Simulation Analysis

Randomly selected from the data collection of hot search microblog which randomly selected three forwarding more topics, first of all the leaders of the number of fans and the degree of activity simulation analysis, followed by the respondents from the time to find opinion leaders, and calculate the spread of opinion leaders Force, in the calculation of the transmission power of the factors are collected nearly a year of data, and finally the real data and proposed model simulation analysis.

As for a certain public emergency, such as "a big earthquake". When the value of rumor attitude is (0,0.33) between the random number. The interaction between the subject and the rumor is shown in Figure 5. It can be seen from Figure 8 that the number of people has increased over time who affected by rumors.
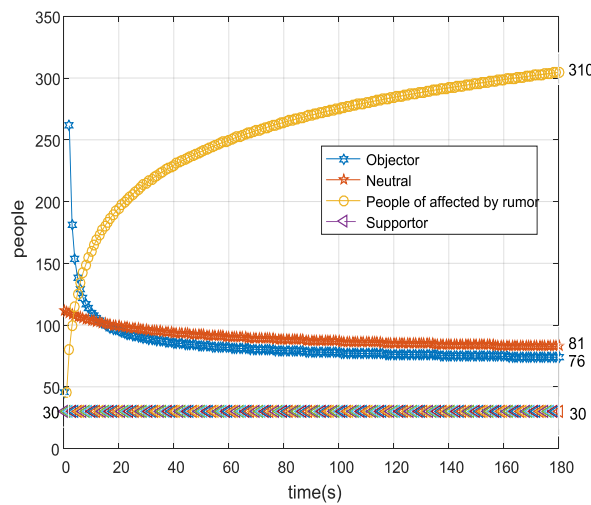

Figure 5: Different kind people affected by rumors

For the three groups of parameters, the number of fans and the number of factors to analyze the number of fans directly affect the information can see the flow of information, and the higher the degree of activity will lead to more people continue to pay attention to this opinion leader.
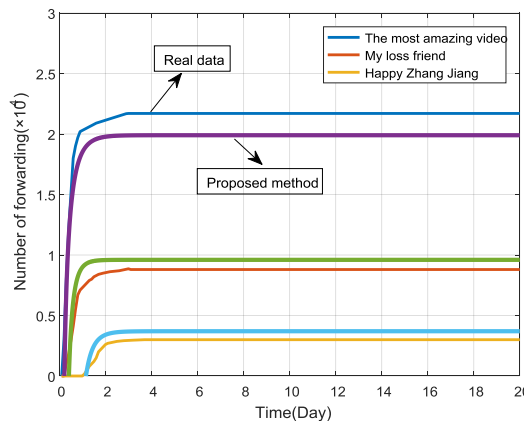

Figure 6: The second lifecycle of microblog

In Figure 6, its release form is not forward for the second topic of microblog, but the way to the original microblog direct reference to others microblog, release the form is equivalent to forwarding. In this did not find the relevant level of opinion leaders, so in the twenty-three four in the extraction of opinion leaders to analyze, and finally calculate the error in the micro-data and the actual simulation of the error of the average value of 13.7%. The error is also due to microblog randomness. It can be found in the neglect of randomness, the views of the leaders caused by the more extreme, the relative error will be higher. Found that the original microblog was cited a total of 60,000 of the total amount of forwarding, from the extraction of the three opinion leaders which have 33,500 of the forwarding, more than half of the total forwarding volume.

7. Conclusions

After the weight of the opinion leaders is calculated, the communication leaders are classified according to the numerical value of the transmission power, and the propaganda effect of the opinion leaders at all levels in the microblog social network communication is analyzed. And carries on the mathematical modeling using the Bessel function for the hierarchical opinion leader communication process, carries on the contrast simulation analysis according to the model and the real data, and analyzes the error existing in the model, and the role of the opinion leader in the communication process. The simulation results show that the proposed model is effective and accurate to analyze the microblog life cycle, and the error is low.

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