International Journal of Scientific Engineering and Science
Volume 6, Issue 4, pp. 38-40, 2022. ISSN (Online): 2456-7361

# Simulation Analysis of Information Diffusion in Scale Free Network for Considering Node Influence

Yulu Zhang[1], Qingsong Sun[2]
[1, 2]School of Computer and Information, Anqing Normal University, Anqing 246133, China

***Abstract***— *The influence of nodes in social networks has heterogeneity. Considering the reality that the greater the degree of users, the greater the influence of nodes, this paper constructs a forwarding probability function that affects unknown information nodes transfer to spreader nodes. The results show that compared with the uniform forwarding probability, the heterogeneity of node influence has a significant difference on the proportion of known information nodes, and the network size and other factors also have a significant impact on the final proportion of known information nodes.*

***Keywords***— *Node influence; scale free network; information diffusion*.

## I. Introduction

The forms of social networks are very common, such as Weibo and wechat, which can spread a lot of information, and may lead to some positive or negative effects. For example, the spread of positive information is conducive to social progress; the spread of negative information may damage the public interests, such as some rumors and some public panic buying behaviors in a short time, resulting in the instability of social and economic order.

Social network[1]Medium-Israel scale-free networks and small-world networks[2]In the scale-free network, most nodes in the network are connected to only a few nodes, and very few nodes are connected to a very many nodes. In reality, there are many such networks, such as WWW, scientific research cooperation network, Internet, social interpersonal network and so on.

Scholars at home and abroad have made some achievements in the research on information diffusion in social networks. Li Dong et al.[5] research the model of information diffusion, it is divided into two categories: theoretical diffusion model and information diffusion cascade, the research method and progress are compared and summarized, and its internal links are deeply analyzed, believing that it has extremely wide and important application value in controlling rumor spreading, recommending information, viral marketing and other aspects. Wei Zhang[4]by combining the network public opinion information diffusion in the individual state transfer characteristics of the SEIR network public opinion information diffusion model, better fit the network public opinion information diffusion in the process of different types of individual trend, shows that the network structure and initial diffusion state can significantly affect the network public opinion information diffusion. Kabir et al[5]combine with the basic SIR model, a new analytical framework for information diffusion is established—— a SIR epidemic model with conscious diffusion, and the epidemic awareness model is studied through analysis and evaluation, which helps people to restore health through conscious information diffusion.

Apart from this, Zhu et al.[6]study the effect of the evolution of the idea of information expression in the network on information diffusion, Zhao et al.[7] introducea memory mechanism to study the rumor propagation, Huang et al.[8]study the effects of random and target immunization strategies on preventing the spread of rumors are considered. Nekovee et al.[9] use mean field theory and interactive Markov chain to study the rumor propagation of homogeneous and inhomogeneous networks, we find that scale-free networks are more conducive to rumor propagation. Xiao Yunpeng et al.[10] consider two factors of the memory effect of group events and their interest in information are considered. Yi, et al.[11] consider the effect of user relationship strength on information diffusion is studied, Si et al.[12]consider the influence of the emotional feelings of information, Su et al.[13]in view of the incomplete reading information of some users, the data from Sina Weibo is proposed to verify the rationality of the proposed model.

From these existing studies, it can be found that most of the problems of information diffusion mainly learn from infectious disease models. These studies have not taken into account the influence of node influence factors on the range and speed of information diffusion in the network information. The number of followers at different nodes is different. For example, with the number of fans of different people on Weibo, star fans can reach millions or more, while ordinary people often have only dozens or even less fans. When stars release information, due to their large number of fans, it is highly likely to forward the information, and the information tends to spread faster and the scope will be wider. However, when ordinary people release information, because they have fewer fans, less attention, fewer people forwarding information, the speed of information diffusion is often relatively slow, and the scope of diffusion is also small. Therefore, it can be considered that the influence of nodes is an important factor affecting the speed and scope of information diffusion. It is of great significance to study the law of information diffusion in the social network by considering the node influence in the aspects of public opinion dissemination, information transmission and rumor diffusion. This paper proposes a hetero forwarding probability function considering the influence of user nodes in social networks to study the information diffusion problem in scale-free networks.

## II. MODEL

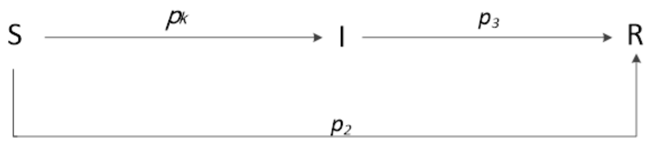



Fig. 1. Node state transition

The three types of nodes in the network are unknown information node S, diffusion information node I and known information node R. A schematic diagram of the state transitions between the three types of nodes is shown in Figure 1.

The greater the degree of the diffusion information node, the greater the influence, the more likely it is to make the unknown information node in the network become the diffusion node, given a function

$$p_k = \left(\frac{k}{N-1}\right)^{\frac{1}{\theta}} \qquad (1)$$

In the upper equation, $p_{k\,23}$The diffusion information node with degree k affects the probability that the unknown information node becomes the diffusion information node, and N is the number of network nodes, which is a constant.

The information diffusion rules are as follows:

（1） Initially, there is only one diffusion node I in the network, and all the other nodes are unknown information node S.

（2） The unknown information node S receives the information sent by the diffusion information node I with degree k to $p_k$ The probability of becoming a diffusion node I or with $p_2$The probability of becoming a node, the R.

（3） Diffusion node I with a probability $p_3$No longer forwarding the information to become a node R.

## III. SIMULATION AND ANALYSIS EXPERIMENT

Assuming the number of scale-free network nodes N=4000, the network average degree <k> =6, the duration of information diffusion is t=30, =5, $p_2$=0.2, $p_3$=0.6, Take the mean of the Matlab simulation experiment results repeated 100 times without changing the parameters. The effects of the above factors on the diffusion results were considered.

### *3.1 Proportion of nodes over time*

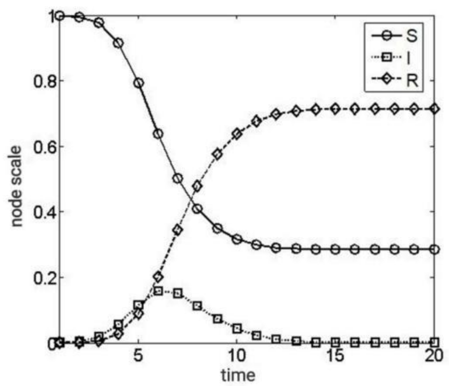


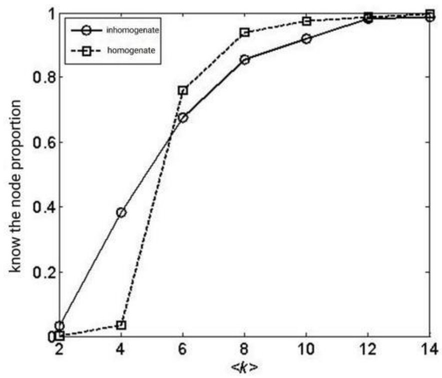

Fig. 2. Trend of node proportions

Figure 2 is the trend of the proportion of three nodes over time. It can be seen from the figure that the proportion of unknown information node S and knowing node R is basically opposite until the stability; the proportion of forwarding node I has a significant increase and a peak and then decrease, and the proportion of node I is stable at the 13th time unit in the figure.

### *3.2 The effect of forwarding probability on knowing the proportion of nodes*

In Figure 3, the influence of the forwarding probability and the network average degree on the proportion of known information nodes is shown without the other parameters changing. The inhomogeneity of the probability of an unknown information node becoming a forwarding node is closer to reality. All unknown information nodes in the network have the same probability of forwarding node and enter formula (1) with k=6 to calculate the uniform forwarding probability; the forwarding probability of the unknown information node in the network is affected by the degree of the forwarding node connected to it. As can be seen from Figure 3, when the average network is less than 6, the forwarding probability of ununiform is greater than the proportion of information nodes; but when the average network is greater than 6, the forwarding probability of uniform makes the proportion of information nodes in the final network.

Fig. 3. Effect of the forwarding probability on the proportion of node R




### *3.3 Network scale*

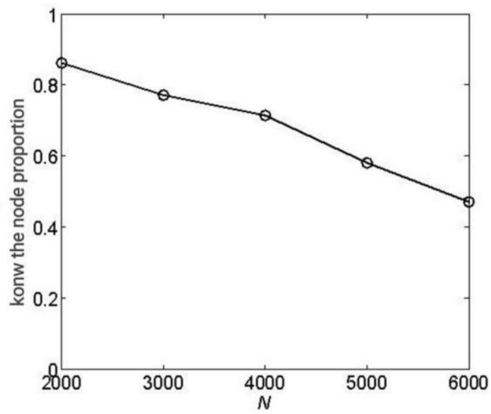



Fig. 4. Effect of network size on knowing the proportion of informative nodes

The network size increased from 2000 to 6000, and finally knew that the proportion of information nodes was in a trend against the network size. In the absence of a change in the network average degree, the network average path increases, which reduces the possibility that the unknown information nodes are affected by the forwarding information nodes, which may cause the proportion of known information nodes in the whole network to decrease, but the number of known information nodes gradually increases.

### *3.4 Probability $p_2$ influence*

When probability $p_2$ at less than 0.5, more and more unknown information nodes become known information nodes, but when greater than 0.5, they have little impact on the proportion of known information nodes in the whole network. Probably due to the $p_2$When large, the proportion of unknown information nodes affected as forwarding nodes is relatively small, resulting in a small proportion of forwarding nodes in the network, which has a small influence on the proportion of known information nodes in the whole network.

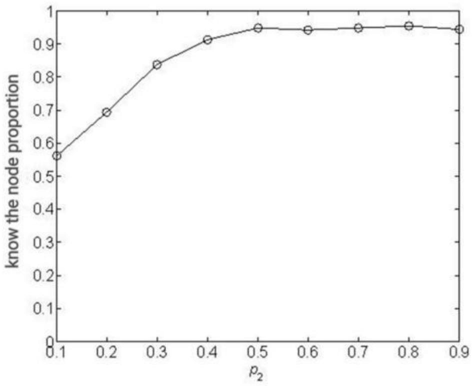



Fig. 5. Probability $p_2$ Effect on knowing the proportion of nodes

## IV. CONCLUSION

This paper considers the differences in the influence of forwarding nodes in the actual network, and unknown information nodes are affected by different forwarding nodes. The higher the assumption degree, the greater the influence of the forwarding node, and the heterogeneous forwarding probability is constructed. Through simulation research, it is found that heterogeneous forwarding probability and uniform forwarding probability have obvious differences on the proportion of known information nodes in the network, and other factors such as network size also have a certain impact on the proportion of nodes that finally know the information in the network.

Whether the unknown information node becomes the forwarding information node is not only affected by the influence of the forwarding node. It may also affect its personal content preferences, content form, reading behavior and many other factors that are not considered in this paper. It is worth trying to add these factors to analyze their influence on the proportion of known information nodes.

## REFERENCES

[1] Xu Ke, Zhang Sai, Chen Hao and so on.Measurement and analysis of the online social networks [J].Journal of Computer Science, 2014,37 (1): 165-188.
[2] Watts D J, Strogatz S H.Collective dynamics of 'small-world' networks[J].Nature,1998,393 (6684):440-442.
[3] Li Dong, Xu Zhiming, Li Sheng, et al.Information diffusion in online social networks [J].Journal of Computer Science, 2014,37 (1): 189-206.
[4] Wei Zhang.Research on SEIR Network Public Opinion Information Spread Model Based on Near Neighborhood Response [J].Journal of Information Resource Management, 2018,8 (4): 67-77.
[5] Kabir K, Kuga K, Tanimoto J.Analysis of SIR epidemic model with information spreading of awareness [J].Chaos, Solitons & Fractals, 2019,119:118-125.
[6] Zhu H M, Kong Y H,Wei J, Ma J.Effect of users' opinion evolution on information diffusion in online social networks.Physica A.2018, 492:2034–2045
[7] Zhao L J,Wang J J,Chen Y C,Wang Q, Cheng J J, Cui H X.SIHR rumor spreading model in social networks .Physica A.2012, 391(7): 2444-2453
[8] Huang J Y, Jin X G.Preventing rumor spreading on small-world networks.Journal of Systems Science and Complexity.2011, 24(3): 449-456
[9] Nekovee M, Moreno Y, Bianconi G, Marsili M.Theory of rumour spreading in complex social networks.Physica A.2007, 374(1): 457-470
[10] Xiao Yunpeng, Li Songyang, Liu Yanbing.A model of information propagation dynamics based on social influence and mean-field theory.Journal of Physics.2017，66 (3):030501
[11] Yi Y X, Zhang Z F, Gan C Q.The effect of social tie on information diffusion in complex networks.Physica A.2018,509: 783-794
[12] Si X M, Wang W D,Ma Y.Role of propagation thresholds in sentiment-based model of opinion evolution with information diffusion.Physica A.2016, 451: 549–559
[13] Su Q, Huang J J, Zhao X D.An information propagation model considering incomplete reading behavior in microblog.Physica A.2015,419: 55–63