Research on the Mechanism of Public Opinion Dissemination in Social Networks Based on Opinion Dynamics

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Abstract

[Objective/Significance] We extend the continuous opinion dynamics model with the SEIR model and systematically study the opinion dynamics process in opinion dissemination in the social network environment, which has certain theoretical value and practical significance for controlling the law of opinion dissemination and improving the opinion guidance strategy. [Methodology/Procedure] With the help of SEIR model, we construct an opinion dynamics model considering the process of subject state transfer in complex networks, and use simulation experiments to simulate the opinion dissemination process and analyze the influence of convergence coefficient and trust threshold on the process. [Results/Conclusions] The process of public opinion spreading in social networks has an obvious life cycle; both the convergence coefficient and trust threshold can significantly affect the convergence speed of group opinion and the final group stable point opinion, and the decrease of trust threshold can effectively suppress the spreading speed and outbreak scale of public opinion.

Keywords

public opinion dissemination; social network public opinion; group opinion dynamics; continuous opinion dynamics model; SEIR model

1.Introduction

The rapid development of the Internet has led to the increasing importance of online governance, and public opinion governance has become an important aspect of government work. Opinions, as an expression of individual ideas, opinions and attitudes, are widely present in daily life and thus are used extensively in the study of public opinion dynamics. Studying the propagation process of public opinion in social networks from the perspective of the dynamics process of opinions, while considering the state transfer of social subjects, and analyzing the propagation mechanism and influencing factors of public opinion in social networks, can provide a decision basis for the government to effectively detect and identify public opinion and choose appropriate means to control and guide public opinion, which is of great significance to the Internet network governance.

As a carrier of individuals' opinions and attitudes, opinions are widely used to describe individual states in social behavior. Qinyue Zhou proposed a two-part propagation opinion dynamics model based on the DeGroot model, introduced self-adherence to measure individuals' adherence to initial opinions, and proposed a new weight calculation method [1]. Fei Xiong proposed an opinion model with topic interaction to reveal the heterogeneous behavior of opinion dynamics in different scenarios, and found that multiple topics can facilitate opinion interaction as well as the process of opinion dynamics and, at the same time, can weaken the influence of network topology[2]. Yucheng Dong developed a consensus building process in opinion dynamics based on conceptual leadership by analyzing the structure of social networks where all agents can form consensus[3]. Xi Chen added two phenomena, bias assimilation and backfire effect, to the basic opinion dynamics model to study the dynamics process of individual opinions in a network environment under conditions that are not based on known facts[4].

A large number of studies have found that the transmission mechanism of the contagion model is

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consistent with the process of public opinion transmission in social networks, therefore, the online public opinion transmission model based on the contagion model has become one of the mainstream research directions in the study of the transmission mechanism of online public opinion. Sahafizadeh E investigates the influence of group communication on the dynamics of rumor spreading process in mobile social networks by extending the SIR model, and finds that group size is the main influencing factor on the speed of spreading public opinion information in group communication [5]. Hosni, AIE proposed that with the popularity of online social networks, an increasing number of social network addictions have arisen, and verified through an extended SIR model that Internet users who are obsessed with the Internet spread public opinion information more easily [6]. Jiang constructed a SPNR model based on an infectious disease model to investigate the spread and reversal of rumors on microblogs about unexpected events, and the experiments showed that the timing of the government's announcement of the truth about the event had an important effect on the spread of rumors [8].

At present, scholars at home and abroad study the opinion dynamics process mainly focusing on the opinion dynamics rules and dynamics environment, and few studies consider the influence of individual state transfer on the dynamics process. On the basis of the contagion model, many scholars have improved the model by designing subject state and transfer rules, designing dynamic transfer rates, and introducing complex networks to construct network individual state transfer rules.

Therefore, this paper studies the development law of social network public opinion from the following two new perspectives.

I. Combining the epidemic model with the opinion dynamics model, a social network public opinion dissemination model based on complex networks is constructed.

II. Analyze the impact of convergence coefficient and trust threshold on the public opinion transmission process, and propose corresponding public opinion response strategies.

2.Model

2.1.Improved Finite trust model

The Weisbuch-Deffuant model considers the opinion interaction between two individuals, and only one individual in the group can be randomly selected at a time, without considering the joint action of multiple individuals, and without considering the social relationship between individuals; the Hegselmann-Krause model forms a new opinion of an individual by weighting the opinions of the individual in the neighborhood, but the individual completely abandons his original opinion, which is not consistent with the realistic opinion interaction process. Therefore, the two models are combined and improved to obtain a limited trust model applicable to the opinion dynamics of social networks.

Assuming that the population size of the group is N and remains unchanged, at time t, an individual i is randomly selected, whose opinion value is $x_i(t)$(x_i∈[-1,1]), and the opinion of the neighborhood individual on its social network is marked as $\{x_1(t),x_2(t)\ldots x_n(t)\}$, a trust threshold ε∈[0,2]is given and is constant, and the convergence coefficient μ∈[0,1] of a group opinion is given, which has

$$x_i(t+1)=x_i(t)+\mu(\sum_{j=1}^{n}c_{ij}a_{ij}x_j(t)-x_i(t)) \tag{1}$$

Where, c_{ij} indicates whether the opinion gap between individual i and j is greater than the trust threshold ε, and there is

$$c_{ij}=\begin{cases}0 \quad , \quad |x_i(t)-x_j(t)|>\varepsilon \\ 1 \quad , \quad |x_i(t)-x_j(t)|\le\varepsilon\end{cases} \tag{2}$$

a_{ij} is the weight value assigned to individual j by individual i, representing the weight of individual i's influence on individual j, including

$$\sum_{j=1}^{n}a_{ij}=1 \tag{3}$$

The opinion transfer rule of the individual obtained from this model is: select an individual in the group, use the trust threshold to screen out the neighborhood individuals who can interact with the individual's opinion, and weight the opinions of these neighborhood individuals to obtain a virtual individual. The individual and the virtual individual will evolve their opinions with the given convergence coefficient to obtain the new opinion of the individual. The individual's opinion transfer rule is shown in Fig. 1.

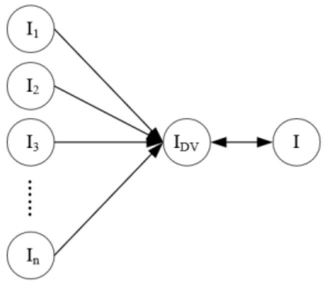

Fig. 1 Individual's opinion transfer rule

This model first considers the resultant opinion formed by multi neighborhood individuals, and then interacts the resultant opinion with the individual opinion to obtain the individual's final opinion. At the same time, the interval of opinion value is set as [-1,1], which is consistent with the positive and negative opinions that appear in the evolution of real online public opinion.

2.2.Improved SEIR model considering opinion dynamics and correlation

The traditional SEIR model does not take into account the differences between disseminators, that is, the disseminator' own opinion on public opinion events. According to the opinion dissemination dynamics, everyone has their own opinion on hot issues, and each subject changes their opinions according to certain rules and their current opinions, so that the whole population eventually becomes consensus, polarization and other states.

For initial disseminators, they hold a strong polar opinion on public opinion information. For the unknown, they have a relatively neutral initial opinion on public opinion events, accept the opinions of the surrounding disseminators who are close to their own opinions, and become a disseminator; Become immune when receiving opinions from others with too large difference from their own opinions; Otherwise, become the insider. For insiders, because they have preliminary knowledge of public opinion events, they will modify the probability of transformation into disseminators and immune persons to a certain extent according to the opinion polarity of the first public opinion information received. For the disseminators, they have a relatively polar opinion of public opinion, and output their opinions to their nearest nodes. At the same time, when they continue to receive the opinions of the disseminators around them that are too different from their own opinions, they stick to or change their opinions until their interests decline and they choose to forget and become immune. For those who are immune, they are immune to public opinion events and no longer pay attention to public opinion events.

In the process of public opinion information dissemination, different subjects have different degrees of relevance, and their trust and acceptance of public opinion information of different dissemination subjects are also different. The closer the relationship between subjects is, the easier the public opinion information is to be trusted and accepted; On the contrary, public opinion information is more likely to be ignored. At the same time, when the dissemination subject continuously receives similar opinions in the process of communication, the higher the degree of acceptance of public opinion information, the easier it becomes a disseminator, showing a herd mentality. Moreover, due to the first cause effect, when an unknown person first contacts the opinion of a disseminator and becomes an insider, if the difference between the disseminators' opinion and his own is less than the threshold of his own opinion, he will be more likely to have a sense of identity with the disseminator, and he will be more likely to become a disseminator the next time he contacts a similar opinion (correspondingly, the probability of directly becoming an immune person is reduced); On the contrary, it will have an aversion to public opinion information and inhibit itself from becoming a disseminator (accordingly, the probability of directly becoming an immune person increases).

Based on the above analysis of the dissemination subject and dissemination rules, the structure and dissemination process of SEIR model are improved and designed.

2.2.1.Model Assumptions

Hypothesis 1: On the basis of the epidemic model, a social network public opinion dissemination model based on opinion dynamics and relevance is established: the subjects are divided into those who do not know the public opinion information, that is, the unknown (*S* state); The subject who knows public opinion information but does not disseminate it, namely the insider (*E* state); The subject of public opinion information dissemination, namely the disseminator (*I* state); The subject who knows but does not disseminate public opinion information is the immune person (*R* state).

Hypothesis 2: There is *N* nodes representing the user in the social network, and there are no newly added or removed nodes, and the relationship between nodes remains unchanged. The interaction of all nodes occurs at the same time, that is, the node status is updated synchronously. At the same time, individuals will receive information from individuals in all fields, that is, there is no information loss.

Hypothesis 3: The rules of dissemination behavior are: (1) When an unknown person first contacts the information spread by the disseminator, the unknown person becomes the disseminator with the infection rate β according to the correlation degree with the disseminator and the disseminator 's opinion value, or is not interested in becoming an immune person with a given direct immunity rate α, otherwise he becomes an informed person. (2) When the informant receives the opinion of the transmitter, the infection rate is corrected for the difference in view of the first contact, converting to a transmitter with the infection rate $(1+b)\beta$ or to an immune with the direct immunity rate $(1-b)\alpha$. (3) When the disseminator receives the opinions of the surrounding disseminators, if the opinions are similar to their own, then the opinions will evolve; If the difference between the opinion and the self is too large or the polarity of the opinion is constantly weakened, it will generate aversion until it loses interest in dissemination. It will become an immune person with immunity rate γ and will not express opinions on public opinion.

Hypothesis 4: There is a close and distant relationship between the dissemination subjects of the social network platform and the offline dissemination network, that is, the higher the degree of association between users, the higher the degree of trust in the dissemination information, which will promote the spread of information in the network. Therefore, the definition of infection rate and immunity rate includes the design of the degree of association, that is, the design of the edge weight of the social network.

2.2.2.Model state transition rules

The proportions of unknowns, insiders, disseminators and immunizers are $S(t)$, $E(t)$, $I(t)$ and $R(t)$, β_1 and β_2 are infection rates, δ is latency rate (for individuals, there is $\delta=1-\alpha_1-\beta_2$), γ is immunity rate, α_1 and α_2 is direct immunity rate, and b is correction coefficient. The state transition rules of individuals are shown in Fig. 2.

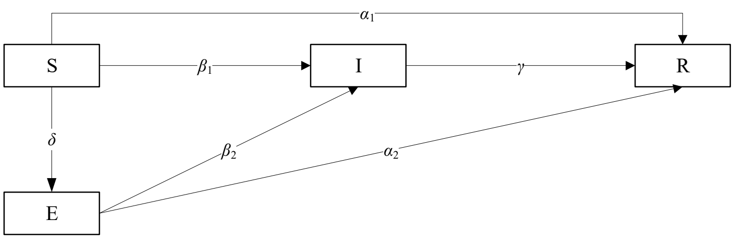

Fig. 2 Improved SEIR model

2.2.3.Improved SEIR model

$$\begin{cases} \frac{dS}{dt} = A - \beta_1 SI - \delta SI - \alpha_1 S \\ \frac{dE}{dt} = \delta SI - \beta_2 EI - \alpha_2 E \\ \frac{dI}{dt} = \beta_1 SI + \beta_2 EI - \gamma I \\ \frac{dR}{dt} = \gamma I + \alpha_1 S + \alpha_2 E \\ S + E + I + R = 1 \end{cases} \tag{4}$$

2.2.4.Design of infection rate, immunity rate and correction coefficient

A node selected from the network is marked as *m*, its opinion value is marked as *x*, and its status is marked as *s* (if the node status is disseminator, *s*=1; otherwise, *s*=0). The nodes that have a connection relationship with node *m* are marked as $\{m_1, m_2...m_n\}$. Accordingly, the opinion value of these nodes is marked as $\{x_1, x_2...x_n\}$, and the correlation degree (i.e. the edge weight value) between *m* and $\{m_1, m_2...m_n\}$ is recorded as $\{w_1, w_2...w_n\}$.

Suppose a variable *c* is used to judge whether the difference of opinion between *m* and m_1 is greater than the trust threshold *ε*, there is

$$c_j = \begin{cases} -1 \quad , \quad |x_i(t) - x_j(t)| > \varepsilon \\ 1 \quad , \quad |x_i(t) - x_j(t)| \le \varepsilon \end{cases} \tag{5}$$

Suppose that a node *m* is an unknown person, and all the individuals in its field are disseminators. They all have the same opinion (i.e. $x_1=x_2=...=x_n=x$) as node *m*, and their correlation degree is the maximum correlation degree (i.e. $w_1=w_2=...=w_n=W$). According to the conformity effect and identity psychology of psychology, this node must become a disseminator carrying this opinion. It is defined that at this time, an individual in the field has the maximum positive influence *p_flu_MAX=Wnε* on this individual. Accordingly, the maximum negative influence is *n_flu_MAX=Wn(2-ε)*.

Suppose that the difference between the opinions of individual m_i (disseminators) and *m* (unknown) in a field is less than the trust threshold. When the difference is smaller, the individual is more likely to identify with m_i's opinions, trust its opinion and promote it to become a disseminator. At this time, the positive influence of m_i on *m* is *p_flu*=$w_i(\varepsilon-|x_i-x|)$. It is assumed that the difference between m_i and *m* is greater than the trust threshold. When the difference is larger, the individual is more likely to have antipathy to m_i's opinions and gradually lose interest in public opinion, inhibiting him from becoming a disseminators. At this time, the negative influence of m_i on *m* is *n_flu*=$w_i(|x_i-x|-\varepsilon)$. Thus, in a complete opinion interaction process, the positive influence received by individual *m* is

$$p\_flu\_sum = \sum_{i=1}^{n} \frac{c_j + 1}{2} s_i w_i (\varepsilon - |x_i - x|) \tag{6}$$

Accordingly, the negative influence received by individual *m* is

$$n\_flu\_sum = \sum_{i=1}^{n} \frac{1 - c_j}{2} s_i w_i (|x_i - x| - \varepsilon) \tag{7}$$

Thus,

$$\begin{cases} \beta_1 = \frac{p\_flu\_sum}{p\_flu\_MAX}\left(1 - \frac{n\_flu\_sum}{n\_flu\_MAX}\right) \\ \gamma = \frac{n\_flu\_sum}{n\_flu\_MAX}\left(1 - \frac{p\_flu\_sum}{p\_flu\_MAX}\right) / x + \alpha_1 \\ b = \frac{p\_flu\_sum - n\_flu\_sum}{2Wn} \\ \beta_2 = (1+b)\beta_1 \\ \alpha_2 = (1-b)\alpha_1 \end{cases} \tag{8}$$

3.Experiments & Results

3.1.Simulation experiment design

In order to verify the rationality of the model and the improvement of parameters such as transfer rate, this paper uses MATLAB to construct an initial weighted BA network of $N=300, m_0=5, m=5$ with simulated data, defines the edge weights as discrete values from 1 to 10 conforming to a uniform distribution, representing the degree of association between nodes, randomly selects 2 nodes as initial infectors (the initial infectors are selected any according to the degree of nodes for merit selection, the initial opinion of 1 node is value is -1 and the other node's initial opinion value is +1), and the rest of the nodes are unknowns (the initial opinions of the unknowns are generated using the rule of obeying the normal distribution of $\mu=0$ to simulate the differential initial opinions in reality). The model is simulated and validated by averaging $D=200$ simulation experiments. In order to analyze the influence of trust threshold and convergence coefficient on the model, different parameter schemes are set in this paper for comparison experiments, and the corresponding simulation experiment parameters are set as shown in Table 1.

Table 1 Model parameter setting schemes

schemes	convergence coefficient μ	trust threshold ε	Notes
	0.05	1	Change convergence coefficient μ
Group 1	0.25	1	
	0.45	1	
	0.25	0.75	Change trust threshold ε
Group 2	0.25	1	
	0.25	1.25	

3.2.Results

3.2.1.Analysis of the process of public opinion dissemination

Numerous studies have shown that the dissemination process of online public opinion has a complete life cycle, and the simulation experiment of this study also verifies this characteristic, as shown in Fig. 3(a). Meanwhile, the overall opinion aggregation process of disseminators is described with the help of the average opinion change curve of disseminators in the dissemination process (because all parameters of this experiment are set symmetrically, only the average opinion change curve of positive disseminators is shown in Fig. 3(b)). Accordingly, this study divides the opinion dissemination process into four stages.

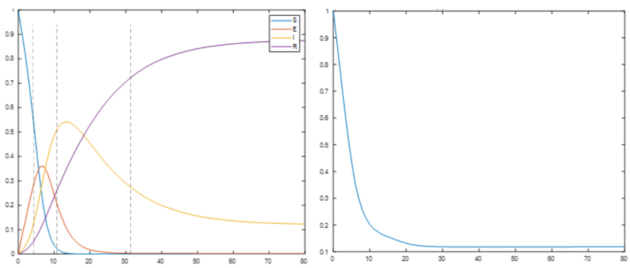

Fig. 3 (a) Node density variation curve and (b) positive mean opinion variation curve (μ=0.25&ε=1)

Stage 1 Import stage. In this stage, because the gap between the views of the unknowns and the initial disseminators is too large, most individuals learn about the public opinion information but hold a wait-and-see attitude and choose to be informed rather than disseminate the public opinion, and the number of informed individuals in the system increases rapidly at a rate greater than the growth of disseminators, while the growth of disseminators gradually accelerates as the opinions of individual disseminators are rapidly concentrated.

Stage 2 Outbreak stage. As the difference between the opinions of disseminators and unknowns decreases, unknowns and informants continuously receive similar opinions and turn into disseminators as the main feature of this stage. In this stage, the number of informed persons reaches its peak, and then, due to the clustering of opinions, informed persons are rapidly transformed into disseminators and public opinion information spreads rapidly, attracting more uninformed persons to accept views and spread public opinion information around them when they are first exposed to public opinion information.

Stage 3 Maturity stage. Due to the slowdown of the aggregation of disseminators' opinions and the extremely low number of uninformed and informed individuals in the system, the interaction of disseminators ' views becomes the main feature of this stage. In this stage, disseminators receive gradually less differentiated views, repeatedly receive similar views, and their own viewpoint polarity weakens, leading disseminators to slowly lose interest in public opinion and become immune to public opinion information. For the whole dissemination system, the rate of decline in the number of disseminators slowly slows down, and the rate of increase in the number of immunizers slows down accordingly.

Stage 4 Fading stage. In this stage, the number of unknowns and informants tends to be close to zero, the individual views of disseminators are highly homogeneous and extremely weak, the influence of domain individuals on disseminators decreases significantly, and the direct immunity rate becomes the main influencing factor for the decrease in the number of disseminators in this stage.

3.2.2.Analysis of the influence of convergence coefficient μ

By comparing Fig. 3(a), Fig. 4(a) and Fig. 5(a), it can be seen that the change in the convergence coefficient did not have a significant effect on the process of changing the number of individuals of each type in the propagation process. However, comparing Fig. 3(b), Fig. 4(b) and Fig. 5(b), it can be found that the change in the convergence coefficient has a significant effect on the process of opinion dynamics of the group, and as the convergence coefficient increases, the average opinion of the disseminators slows down and the final average opinion of the disseminators stabilizes at a higher level.

The reason for this phenomenon is that when the convergence coefficient increases, on the one hand, unknowns and informants converge faster to the opinions of neighboring disseminators, and the rate of transformation into disseminators increases and they carry more polarized views; however, due to the higher view polarity of disseminators, their ability to infect neighboring individuals decreases accordingly, resulting in longer opinion convergence cycles and ultimately higher stable views. On the other hand, the high viewpoint polarity when individuals transform into disseminators leads to an increase in the number of neighboring individuals holding mutually exclusive views and an increase in the immunity rate of neighboring. The combined effect of both was not observed in the density change curves for each type of individual.

The above experiments show that although higher convergence coefficients do not significantly affect the changes in the number of individuals of each type in the process of public opinion dissemination, they imply higher topic attention, which brings about higher opinion polarity of individuals in the end, and when similar or derived topics occur, these individuals will carry out the role of disseminators at a faster rate, leading to faster and larger outbreaks of public opinion. Therefore, by controlling the topic hotness in time and reducing the convergence coefficient, we can effectively prevent the emergence of derivative and secondary public opinions.

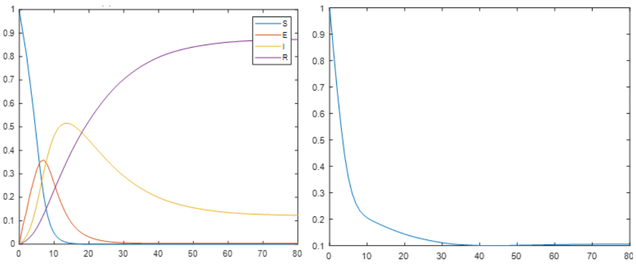

Fig. 4 (a) Node density variation curve and (b) positive mean opinion variation curve (μ=0.05&ε=1)

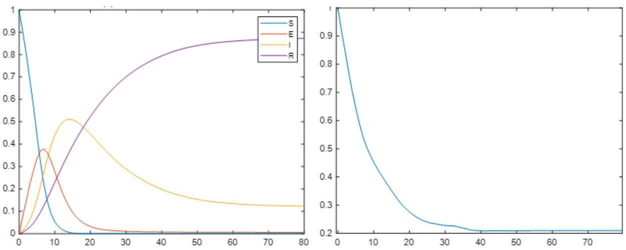

Fig. 5 (a) Node density variation curve and (b) positive mean opinion variation curve (μ=0.45&ε=1)

3.2.3.Analysis of the influence of trust threshold *ε*

By comparing Fig. 3(a), Fig. 6(a) and Fig. 7(a), it can be seen that as the trust threshold increases, the growth of disseminators and informants accelerates and the number of disseminators reaches a higher peak, which means that the outbreak stage of public opinion is advanced and the scale of dissemination of public opinion becomes wider; meanwhile, when the trust threshold decreases to a certain level, a small number of individuals who are not disseminated eventually exist in the system. Comparing Fig. 3(b), Fig. 6(b) and Fig. 7(b), we can find that the increase of the trust threshold accelerates the decrease of the average opinion of positive communicators and reduces the stable average opinion of communicators to a lower level.

The reason for the above phenomenon is that, as the trust threshold increases, individuals can receive more acceptable opinions and receive fewer unacceptable views, which makes individuals believe that their opinions are favored by more individuals and have a stronger incentive to become disseminators, resulting in a faster increase in the number of disseminators in the whole system; similarly, individual disseminators receive more opinions that are different from their views due to a larger trust threshold, and are more likely to receive opinions that are opposite to their own polarity. The individual communicators are more likely to receive opinions that are opposite to their own polarity due to a larger trust threshold, leading to a faster convergence of their own opinions to a compromise opinion and eventually stabilizing at a lower view.

The above experiments show that as the trust threshold increases, individual Internet users are more willing to spread and promote the development of public opinion because they receive more favorable opinions, and public opinion sweeps through the whole Internet user group at a faster speed, leading to a larger scale of public opinion outbreak. Therefore, by reducing the trust threshold and narrowing the distance between individuals' opinions, the speed and scale of public opinion dissemination can be effectively reduced.

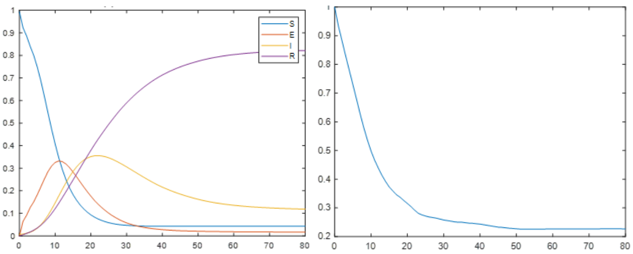

Fig. 6 (a) Node density variation curve and (b) positive mean opinion variation curve (μ=0.25&ε=0.75)

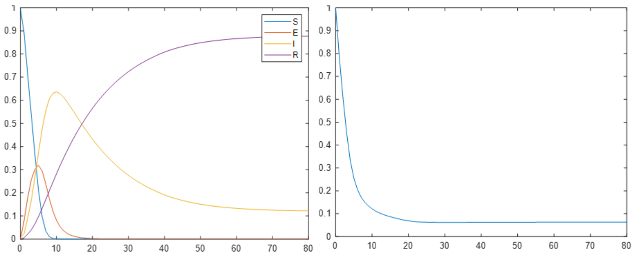

Fig. 7 (a) Node density variation curve and (b) positive mean opinion variation curve (μ=0.25&ε=1.25)

4.Conclusion

Online public opinion on social platforms is characterized by strong openness, rapid development and difficulty in control. In order to help the government better control the law of public opinion evolution, this study mainly starts from the following aspects: firstly, the simulation complex network is constructed by analyzing the structural characteristics of social networks; secondly, the DW model is fused with the HK model to propose an improved continuous opinion dynamics model applicable to the structural characteristics of social networks; then, the opinion dynamics process is used as the entry point to construct the subject state transfer with the help of the SEIR model; Finally, the public opinion dissemination model is obtained by taking the opinion evolution process as the entry point and constructing the subject state transfer process with the help of SEIR model; finally, the opinion propagation model is used to conduct simulation experiments on the evolution of social network opinion and the experimental results are analyzed parametrically.

It has been discovered that that online public opinion has an obvious cycle. Starting from the introduction of public opinion by a few individuals, individuals in the network continuously receive public opinion information and disseminate their own opinions through the promotion of super nodes such as media and opinion leaders, and public opinion rapidly enters the outbreak stage, and the number of individuals who are not disseminating in the system rapidly decreases until they die out, and then, disseminators interact with each other frequently and their opinions gradually converge. When the views of individual disseminators reach a high level of agreement, the disseminators gradually lose interest in public opinion and withdraw from the communication system because the surrounding individuals are highly consistent with their own opinions. Meanwhile, as the convergence coefficient increases, the final stable opinion of disseminators improves; with the increase of trust threshold, public opinion will explode at a faster rate in a larger area. Therefore, we argues that during the outbreak period of online public opinion, the government can lower the convergence coefficient by controlling the hotness of topics and lower the trust threshold by reducing the openness of the online environment and promoting the formation of a more cohesive "small circle" society, so as to reduce the spread speed and outbreak scale of public opinion, and reduce the number of derivative and secondary public opinions.

There are also the following shortcomings in our study: in the actual online opinion dissemination process, different identity subjects, such as ordinary Internet users, opinion leaders, and media, are involved. The interaction of opinions among different subjects varies, which has a significant impact on the opinion dynamics process and life cycle of public opinion. In addition, we finds that adjusting the convergence coefficient has no significant effect on the opinion dissemination cycle under the influence of multiple roles; therefore, the multiple roles in this phenomenon will be explored in depth in the subsequent study.

5.References

[1] ZHOU Q, WU Z, ALTALHI A H, et al. A two-step communication opinion dynamics model with self-persistence and influence index for social networks based on the DeGroot model[J]. Information Sciences, 2020,519: 363-381.

[2] XIONG F, LIU Y, WANG L, et al. Analysis and application of opinion model with multiple topic interactions[J]. Chaos: An Interdisciplinary Journal of Nonlinear Science, 2017,27(8): 83113.

[3] DONG Y, DING Z, MARTÍNEZ L, et al. Managing consensus based on leadership in opinion

dynamics[J]. Information Sciences, 2017,397-398: 187-205.
[4] CHEN X, TSAPARAS P, LIJFFIJT J, et al. Opinion dynamics with backfire effect and biased assimilation[J]. PLoS One, 2021,16(9): e256922.
[5] SAHAFIZADEH E, TORK LADANI B. The impact of group propagation on rumor spreading in mobile social networks[J]. Physica A: Statistical Mechanics and its Applications, 2018,506: 412-423.
[6] HOSNI A I E, LI K, AHMAD S. Analysis of the impact of online social networks addiction on the propagation of rumors[J]. Physica A: Statistical Mechanics and its Applications, 2020,542: 123456.
[7] JIANG G, LI S, LI M. Dynamic rumor spreading of public opinion reversal on Weibo based on a two-stage SPNR model[J]. Physica A: Statistical Mechanics and its Applications, 2020,558: 125005.
[8] ZHANG Y, FENG Y, YANG R. Network public opinion propagation model based on the influence of media and interpersonal communication[J]. International Journal of Modern Physics B, 2019,33(32): 1950393.