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Research Article

Biostatistical Analysis on the "Information Cocoon Room" during the COVID-19 epidemic

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Abstract

This paper establishes a biostatistical model to describe the generation mechanism of neutral consensus and opinion polarization, explore the formation mechanism of "screaming effect", "echo chamber effect" and "information cocoon room", and discuss topic attractiveness, user activity, user The impact of factors such as psychology, interaction between different users, and platform recommendation algorithms on the formation of these phenomena.

Keywords: Echo Chamber Effect; Information Cocoon; Screaming Effect

Introduction

Introduce the Problem: The "screaming effect" is a well-known effect in psychology. For example, in a crowded public place, if someone suddenly screams hysterically, it can often quickly grab people's attention. "Echo chamber effect", or "stratosphere effect", proposed by psychologist Cass R. Sunsteinrefers to the fact that in a relatively closed media environment, some like-minded voices are repeated, even exaggerated and distorted [1], so that most people in the environment think that these voices are all the facts, unknowingly narrow their vision and understanding, and become self-sufficient and even paranoid.

The "screaming effect" and "echo chamber effect" easily lead to the formation of "information cocoons". The so-called "information cocoon" refers to the fact that people's own information needs are not comprehensive in information dissemination, and they only choose the information they want or make them happy. Over time, the information they come into contact with becomes more and more limited [2]. Confining oneself in a "cocoon room" like a silkworm cocoon, losing the ability to understand and access to other different information, and always seeing only what one thinks is correct.

Under the new information dissemination pattern, how to get rid of the "screaming effect" and "echo chamber effect" and get out of the "information cocoon room" is an urgent practical problem that needs to be solved at present. That is, how to act from the top-level design of information transmission, the fairness of recommendation algorithms, and the responsibility of the majority of network users to help the public to have a relatively accurate and clear understanding and judgment of news events and even social reality, and make a difference between mainstream awareness and personalized information [3]. Find a balance between the internet and make the network public opinion environment more rational and constructive.

Model Assumption

Basic Model Assumption

The model in this paper is based on the following reasonable assumptions:

1. When an ignorant person touches the propagation node, the probability of transforming into a propagation nodeis λ_1; the unknown node transforms into a wait-and-see node is λ_2; when the ignorant person encounters the information disseminator, it indicates that he already knows the information, so he can learn from the opposite The state of ignorance of the information turns into the state of knowledge, so $\lambda_1 + \lambda_2 = 1$ holds.
2. The probability that a wait-and-see state node will transform into a propagation node when it encounters a propagation node is μ_1, and the probability that a wait-and-see node will transform into a propagation node due to its own reasons is μ_2.
3. The onlooker exits without forwarding the message and becomes an immune person, with an exit probability of β.
4. The disseminator successfully forwards the message and quits, becoming a quitter, with a quit probability of γ.
5. The data provided in this article are true and reliable, and individual bad and missing data in this article have negligible impact on the results.
6. The people (nodes) in the information dissemination model mentioned in this article are all individuals in line with behavioral common sense, and there are no uncontrollable factors (such as mental illness, etc.).

Data Download

Reddits: Topics on the social networking site reddits contain content and comments on some topics (submissions) about abortion and gun control (Figure 1).

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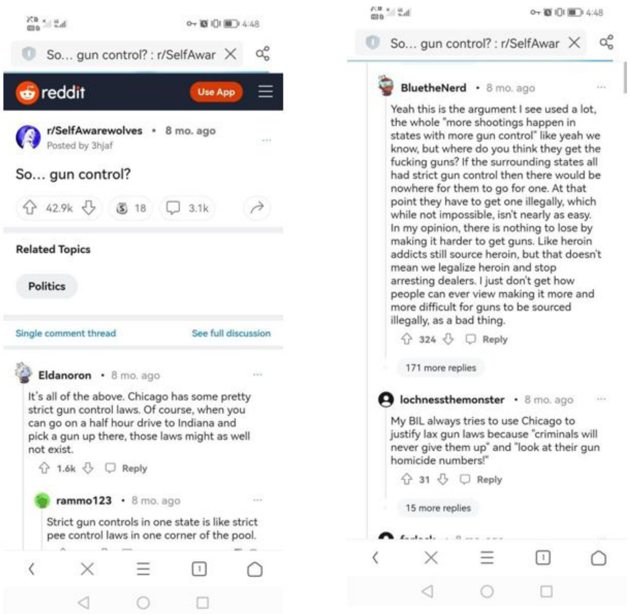


Figure 1: Abortion and gun control.

Weibo: Find comments about abortion, gun control in the topic section (Figure 2). Find report about abortion and gun control in the Articles section (Figure 3).

Figure 2: Abortion, gun control in the topic section.

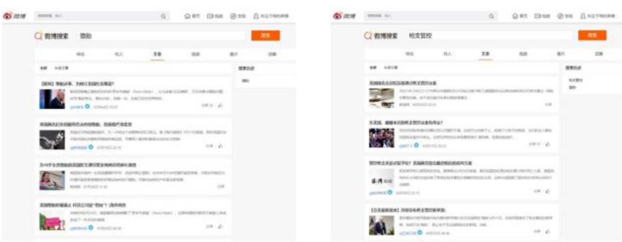
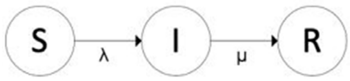


Figure 3: Abortion and gun control in the Articles section.

Quantitative description of information dissemination process

Classical SIR Model: The SIR model describes some diseases can be cured and never be infected again. Individuals in the SIR model are divided into three stages: susceptible stage S, infected stage I and immune stage R. Among them, the infected individual will be cured, and after being cured, he can gain immunity and will no longer be infected, and will not spread the virus to other individuals, so he will no longer participate in the spread of the virus. The transmission mechanism of the SIR model is as follows: Individuals in the susceptible state S who come into contact with individuals in the infection state I might be infected into the I state, and individuals in the infection state I will infect other individuals, and at the same time might be cured and recovered, and transform into an immune state R which will no longer be infected and spread the virus. As shown below.



Differential Equation of the SIR Model: where N is the total number of nodes in the network, t the number of nodes in the infected state in the time network is represented by S(t), the number of infected state nodes in the time network is represented by I(t). R(t) represents the number of R state nodes in the t time network, and λ is the infection rate, which represents the vulnerability of being infected when an infected S node touches an infected node I. μ is the cure rate, which indicates the probability that an infected node I is successfully cured.

The SIR model is more accurate than the SI and SIS models. Moreover, after a piece of information in social media is spread for a period of time, people will quit and stop spreading it, which is more in line with the characteristics of the SIR model. Therefore, it is relatively more appropriate to study information dissemination based on the SIR model.

Principle Analysis of Information Dissemination Model: The SIR model of infectious disease describes diseases for which one can never be infected if cured. Individuals in the SIR model are divided into three states: susceptible state S, infected state I and immune state R. The SIR model describes that the changes in the quantity of these three states are related to the infection rate, λ which represents the probability of being infected when the susceptible S node touches the infected state I node. μ is the cure rate, indicating the probability that the infected state I node is successfully cured. However, in information dissemination, users will choose their attitude towards information independently according to their own wishes, and this will is not static. It will be affected by the surrounding environment and the people around them, so the information dissemination model of this paper is revised based on the SIR model (Figure 4).

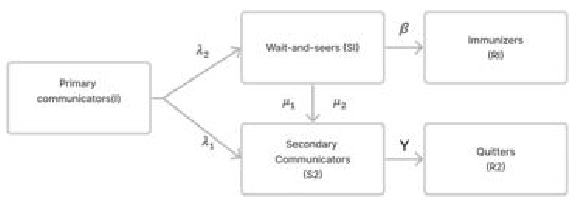


Figure 4: Analysis of Information Dissemination Model.

This paper adds an informed wait-and-see state on the basis of the SIR model. In the process of information dissemination, nodes in the unknown state have a certain probability of being infected by the propagation node to become a propagation node or a node in the wait-and-see state. Nodes in this state might be influenced by more people who spread this information and also spread this information, or just choose to quit directly to become immune. In the user's social media, if the user sees a piece of information shared by a friend, it may not arouse his interest, but if several friends share it, the information will naturally be valued by the user, and it is more likely for the user to share this message. When a piece of current news information is ignored by the onlookers, but when encountering the disseminator of this information, the user also wants to know more about this information, so he also chooses to forward it, and then becomes a quitter, thereby generating the "scream effect" in network information dissemination.

$$\begin{cases} \frac{dS(t)}{dt} = -\lambda I(t)S(t) \\ \frac{dI(t)}{dt} = \lambda I(t)S(t) - \mu I(t) \\ \frac{dR(t)}{dt} = \mu I(t) \\ S(t) + I(t) + R(t) = 1 \end{cases}$$

If the nodes in the wait-and-see state in the model do not choose to propagate, they will probably choose to quit over time and become immune, and the propagating nodes will also become quitters after propagation. However, the circumstances of these two withdrawals are not the same. The former withdraws without dissemination, while the latter withdraws after dissemination. For the study of information dissemination, not only the scope of dissemination, but also the effect of dissemination are also very important. The number of dropouts does not give a clear indication of users' attitudes towards information in the network. Compared with users who have not reposted, users who have reposted are more interested in this information. Therefore, in the model, we choose to separate the exit states of the two situations into those who have changed from the wait-and-see state and have not reposted immunity status, and the reposted exit status converted from the communication status. In this way, we can also intuitively see the user's participation in the process of disseminating information.

Construction of information dissemination model in this paper: N is the number of nodes in the entire network. I(t), S1(t), S2(t), R1(t), R2(t)represents the number of primary communicators, onlookers, secondary communicators, immunizers, and quitters in the network nodes at time t, and the I(t) + S1(t) + S2(t) + R1(t) + R2(t) = N holds. Set up the differential equations for the information propagation model, as shown below:

$$\begin{cases} \frac{dI(t)}{dt} = -\lambda_1 kI(t)S2(t) - \lambda_2 kI(t)S2(t) \\ \frac{dS1(t)}{dt} = \lambda_2 kI(t)S2(t) - (\mu_1 + \mu_2)kS1(t)S2(t) - [1 - (\mu_1 + \mu_2)k]\beta S1(t) \\ \frac{dS2(t)}{dt} = \lambda_1 kI(t)S2(t) + (\mu_1 + \mu_2)kS1(t)S2(t) - \gamma S2(t) \\ \frac{dR1(t)}{dt} = [1 - (\mu_1 + \mu_2)k]\beta S1(t) \\ \frac{dR2(t)}{dt} = \gamma S2(t) \end{cases}$$

Build a model to describe the generation mechanism of neutral consensus and opinion

Polarization: According to the principle analysis of the information dissemination model, we can know that:

Neutral consensus: In the first round of communication by the unknown, λ_2 parameter increase and the number of onlookers increases. Since everyone does not spread, the number of immune people increases, which affects the scope and influence of information dissemination. (Mostly on the sidelines➞immune)

Opinion polarization: Everyone only pays attention to what they want to pay attention to, which leads to an increase in parameter λ_1, an increase in the number of communicator. A decrease in parameter λ_2 and a decrease in the number of onlookers, which ultimately affects the results of information dissemination. Coupled with the influence of social platform recommendation algorithms, users the individual-centered moral judgment is dominant, and the degree of homogeneity and irrationality is relatively high. The comments were intense and the emotional catharsis was outstanding. (Most communicators ➞ quitters)

Symbiosis Network Analyses

Symbiosis network analysis is widely used to describe the interaction mechanism between microbial communities, and it is also applicable to the information dissemination mechanism in this paper [4]. A co-occurrence network is an undirected graph where nodes correspond to unique words in the vocabulary and edges correspond to how often words co-occur in documents. Visualize and extract information about relationships between words in a corpus of documents using co-occurrence networks. Specific steps are as follows:

1. Extract the text data in the file;
2. Tokenize the text, convert it to lowercase, and remove stopwords;
3. Create a word count matrix using the bag of words model;
4. Multiply the word count matrix by its transpose to calculate the total number of occurrences of words;
5. Use the graph function to convert the co-occurrence matrix into a network (Figure 5);
6. Use the plot function to visualize the network (Figure 6);
7. Use the neighbors function to find the neighbors of the word "XXX"
8. Visualize the co-occurrence of the word "XXX" by extracting a subgraph of its neighbors.

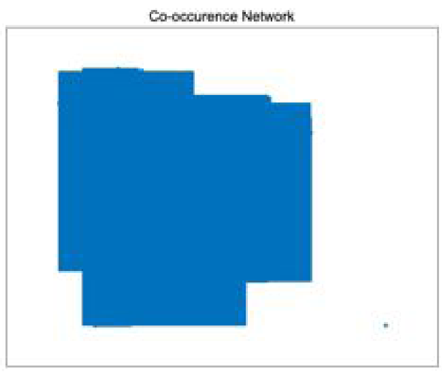


Figure 5: visualized symbiotic network (gun control).

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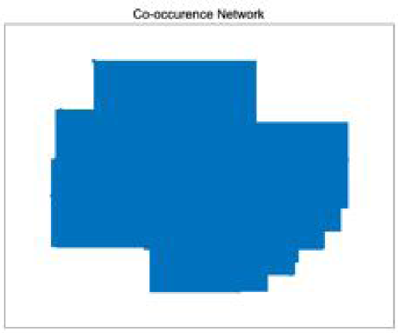

Figure 6: visualized symbiotic network (abortion).

Analysis of the results: Observing the symbiosis network figure 7 and figure 8, we can see that the word "police" presents the characteristics of opinion polarization in the text of the gun control report. Features of a neutral consensus.

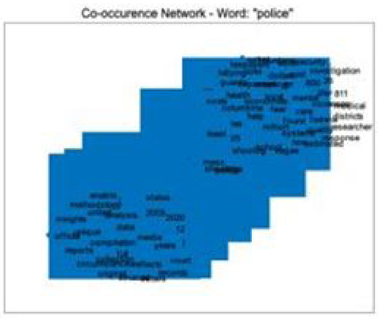

Figure 7: "police" neighbor visualization (gun control).

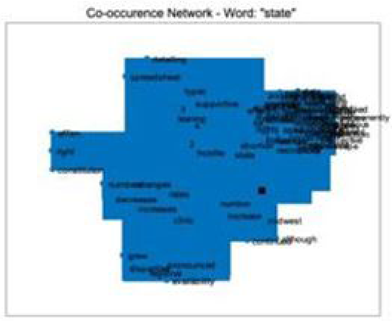

Figure 8: "state" neighbor visualization (abortion).

Exploring the formation mechanism of "screaming effect", "echo chamber effect" and "information cocoon"

In the dissemination of information, users will independently choose their attitude towards information according to their own wishes, and this will is not static, it will be affected by the surrounding environment and the people around them. It is precisely because of the mechanism of neutral consensus and opinion polarization that people pay different attention to certain issues (such as different views on gun control and abortion) [5].

The formation mechanism of "echo chamber effect": In a relatively closed media environment, some voices with similar opinions are repeated, even exaggerated and distorted, so that most people in it think that these voices are all the facts, unknowingly narrow their vision and understanding, and become self-styled or even paranoid polarization. Users will favor information that fits their worldview, ignore differing viewpoints, and form an "echo chamber" with other users who share the same viewpoint [6].

The formation mechanism of "screaming effect": The media creates contradictions. With the polarization of opinions, social contradictions deepen, and more and more fuses that can detonate public emotions at any time are produced in the society. In addition, the media promotes and distorts the truth, and the public has long been in the "echo chamber effect" lost the ability to judge, and become perceptual, lack of analytical ability, often can be attracted by information, and lose independent judgment. The desire to forward information increases, and with the continuous growth of the number of forwarders, the number of forwarders shows an exponential growth, that is, the "screaming effect" in the dissemination of network information is produced.

The formation mechanism of "information cocoon room": People forward messages to each other, the media monitors user information and the government guides public opinion, and accurately pushes information to users. Over time, their views on a certain event continue to deepen, and their attitudes are shifting towards the trend of opinion polarization. People only pay attention to information that they are interested in and want to see [7].

Result

The influence of factors such as the attractiveness of discussion topics, user activity, user psychology, interaction between different users, and platform recommendation algorithms on the formation of these phenomena

Simulation and Analysis of Information Dissemination Model: Use MATLAB software to solve the information dissemination model. Analyze the attractiveness of the topic to and number of primary communicators, wait-to-seers, secondary communicators, immunizers, and quitters. The change of activity of users, user psychology, interaction between different users, and platform recommendation algorithm over time is shown in figure 9 below.

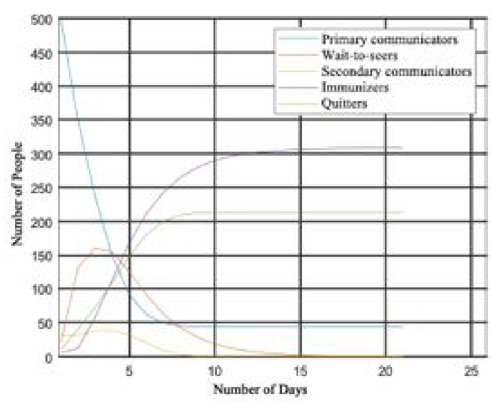

Figure 9: Trend diagram of the number of nodes in each state.

It can be seen from figure 9 that the number of primary communicators decreases continuously in the process of information dissemination, and decreases rapidly around the interval of t=2~5. In the steady state, only a small part of the number of primary communicators remains. The number of secondary communicators increases with the passage of time in the process of information dissemination, and the number reaches the maximum at t= 2~3. The number of secondary communicators first increases and then decreases with the passage of time in the information dissemination process, and reaches the maximum at t=4, and then decreases to 0. As the number of primary communicators in the network decreases, the number of secondary communicators increases, and they are inversely proportional to each other. The more secondary communicators, then primary communicators decline faster. Among the onlookers, due to contact with secondary communicators or their own reasons, some become secondary communicators, and some choose to quit transmission and become immune. However, as time goes by, the number of secondary communicators decreases, which can be seen as people's curiosity and attention gradually decreasethat after a period of time. No one among the user's friends is still spreading this information, or the onlookers are not interested in this information, so the onlookers choose not to repost this message, and instead withdraw and become immune.

In addition, it can be seen that there are still a very small number of unknown nodes at the end, and the information is basically uploaded throughout the entire network. Since the information is forwarded, the communicators who have forwarded the information become quitters. The number of quitters who have forwarded the information is similar to the number of immunized people who have not forwarded it. The number of people participating in the spread accounts for about half. When the entire process of information dissemination is over, the numbers of the four types of people in the network, namely, waiters, sub-spreaders, quitters, and immunizers, all reach a stable value, and remain unchanged at about t=10.

Simulation and analysis of the transmission rate λ_1 of primary communicators: The initial transmission rate λ_1 can be understood as: the degree of attention people pay to the received information. The greater the degree of attention, the greater the probability of forwarding information, and vice versa. λ_1 interpreted as the probability of an unknown state node being transformed into a propagation node when it touches a propagation node, expressed as the user's activity; λ_2 interpreted as the probability of an unknown state node being transformed into a propagation node when it contacts a propagation node, expressed as the attractiveness of the topic, $\lambda_1 + \lambda_2 = 1$.

In order to study the influence of the transmission rate λ_1 of the primary communicator on the propagation process, keep other parameters unchanged, k=0.01, $\lambda_2 = 1 - \lambda_1 = 0.8$, $\mu_1 = \mu_2 = 0.175$, $\beta = 0.35$. Change the transmission probability of the primary communicator λ_1 to 0.15 and 0.3 respectively, and calculate the propagation process through MATLAB. Figure 10 shows the trend of the number of primary communicators, onlookers, secondary communicators, immunizers, and quitters over time under different transmission rates.

The maximum value and time data of each state node are shown in Tables 1 & 2.

Result Analysis: From the above comparison, it can be seen that changing the probability of forwarding λ_1 (the probability of waiting and watching λ_2) when the initial communicator sees the information has a great impact on communication. This probability can also be seen as the activity of the user (the attraction of the topic). The larger the λ_1, the greater the intensity of information dissemination, and more people will receive the information, resulting in greater secondary dissemination.

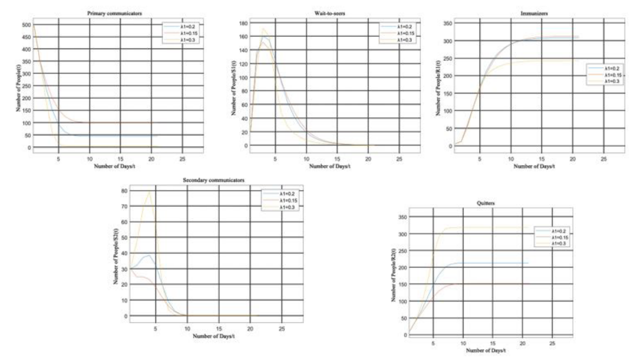

Figure 10: The impact of the transmission rate of primary communicators λ_1 on the five types of people in the information network

Transmission Rate λ_1	S1(t)	S2(t)	R1(t)	R2(t)
$\lambda_1 = 0.15$	3	1	21	14
$\lambda_1 = 0.2$	3	4	21	13
$\lambda_1 = 0.3$	3	4	21	12

Table 1: The maximum value reached by each state nod under different λ_1

Transmission Rate λ_1	S1(t)	S2(t)	R1(t)	R2(t)
$\lambda_1 = 0.15$	151	30	A	152
$\lambda_1 = 0.2$	160	39	308	212
$\lambda_1 = 0.3$	172	80	243	318

Table 2: The time taken for each state node to reach the maximum value under different λ_1

Therefore, in order for a message to spread more widely, it is very important whether the message will make people want to forward it when it is seen. If it is news and entertainment news, whether the content is interesting is naturally the most important point related to whether people want to repost it. For merchants, many merchants adopt reposting lottery, which undoubtedly increases the probability of people reposting when they see the information. It is indeed a simple and effective way to promote their product information. As far as the media is concerned, digging out breaking news, deliberately inciting and exaggerating public sentiment, creates a wave of public opinion, that is, increases the exposure rate of information, increases the probability of people forwarding information, and thus causes the "screaming effect".

Simulation and analysis of the propagation rate μ_1 and μ_2 of the observer: The transmission rate of the waiters can be defined as the probability that people forward information due to the influence of friends or their own reasons. The onlookers decide not to forward the information when they receive the information at the beginning, but they may forward it because they see the forwarding of their friends or because they slowly accept the information, and then change their minds and forward it.

μ_1: The probability that a wait-and-see state node will transform into a propagation node when it encounters a propagation node, that is, the mutual influence between different users: friend influence.

μ_2: The probability that a wait-and-see state node is transformed into a propagation node due to its own reasons, that is, the mutual influence between different users: its own reasons.

Keeping other parameters unchanged, change the probability of the onlooker $\mu_1 = \mu_2 = 0.175$ to $\mu_1 = \mu_2 = 0.125$, $\mu_1 = \mu_2 = 0.25$ respectively. The propagation process is calculated by MATLAB. Figure 11 shows the trend of the number of primary communicators, onlookers, secondary communicators, immunizers, and quitters over time under different transmission rates. The maximum value and time data of each state node are as follows shown in Tables 3 & 4.

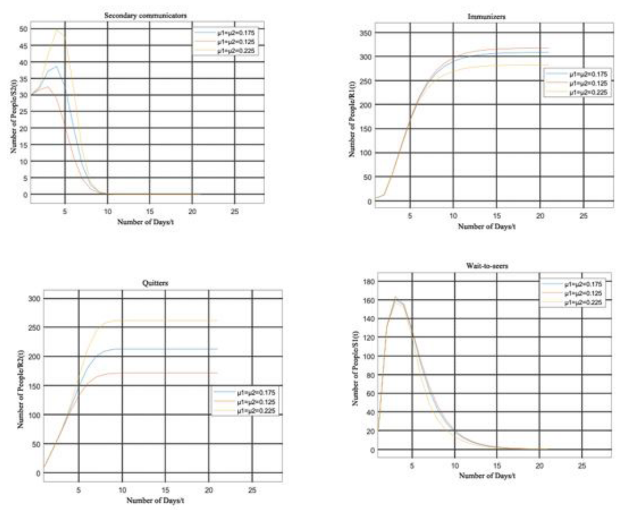

Figure 11: The influence of the transmission rate of the observers μ_1 and μ_2 on the five types of people in the information network.

Transmission Rate μ_1 and μ_2	S1(t)	S2(t)	R1(t)	R2(t)
$\mu_1 = \mu_2 = 0.125$	163	32	318	171
$\mu_1 = \mu_2 = 0.175$	160	39	308	213
$\mu_1 = \mu_2 = 0.225$	157	50	282	261

Table 3: The maximum value reached by each state node under different μ_1 and μ_2

Analysis of the results: It can be seen that the effect of changing the transmission rate of the onlookers is not as obvious as that of changing the transmission rate of the initial communicators. Although the number of retweeters varies greatly, it can be seen from the change curve of unknown nodes that changing the spread rate of wait-and-seers has significantly less impact on the spread speed and spread range. If you want to change the speed and scope of information dissemination, changing the transmission rate of the waiters is not as good as changing the transmission rate of the unknown, but its impact on the number of reposts cannot be ignored.

Transmission Rate μ_1 and μ_2	S1(t)	S2(t)	R1(t)	R2(t)
$\mu_1 = \mu_2 = 0.125$	3	3	21	14
$\mu_1 = \mu_2 = 0.175$	3	4	21	13
$\mu_1 = \mu_2 = 0.225$	3	4	21	12

Table 4: The time taken for each state node to reach the maximum value under μ_1 and μ_2.

Simulation and Analysis of the Exit Rate β of Wait-and-seers: The exit rate β of the onlookers is the probability that users will completely lose interest in the information after receiving it, and the higher the value, the faster the onlookers will make the decision to quit the communication. β the probability that a wait-and-see state node becomes an immune node without reposting, that is, the user's psychology: the degree of disinterest in the topic.

In order to study the influence of the exit rate β of the onlooker on the propagation process, keep other parameters unchanged, k =0.01, $\lambda_2 = 1 - \lambda_1 = 0.8$, $\mu_1 = \mu_2 = 0.175$, change the exit rate β of the onlooker to 0.15 and 0.55 respectively, and calculate the propagation process through MATLAB, as shown in figure 12. Tables 5 & 6 show the trend of the number of primary communicators, onlookers, secondary communicators, immunizers, and quitters over time under different transmission rates, and the maximum value and time data of each status node.

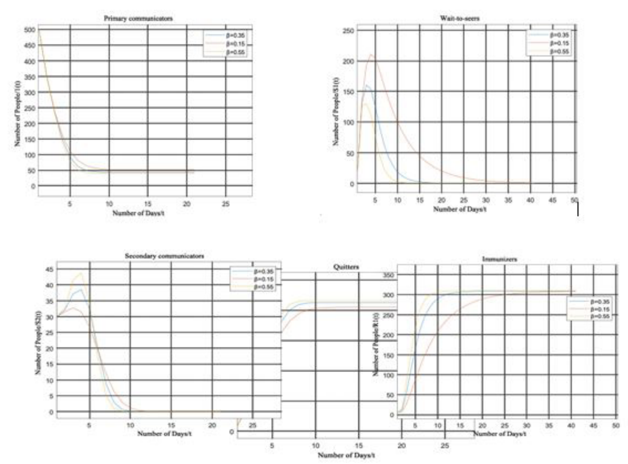

Figure 12: The impact of the exit rate β of the spectators on the five types of people in the information network

Analysis of the results: With the increase of the withdrawal rate of wait-and-see, the number of immunized people who forwarded slightly increased, but the number of quitters after forwarding was slightly obvious. Due to the increase in the exit rate, the time for users to wait and see is shorter, and the number of users who lose patience and change their minds and choose to forward information is lower, resulting in a decrease in the forwarding rate of information and a worsening effect of information dissemination.

Exit Rate β	S1(t)	S2(t)	R1(t)	R2(t)
β = 0.15	4	3	38	12
β = 0.35	3	4	24	10
β = 0.55	3	4	14	9

Table 5: The maximum value reached by each state node under different β.

Exit Rate β	S1(t)	S2(t)	R1(t)	R2(t)
β = 0.15	211	33	308	205
β = 0.35	160	39	309	213
β = 0.55	130	44	310	216

Table 6: The time taken for each state node to reach the maximum value under different β.

Simulation and Analysis of Network Average Degree k: The degree k of node i refers to the number of edges directly connected to node i, and the average degree refers to the average degree of all nodes in the network. k is the probability that a node touches a propagation node, which is used to represent the precise push of user information, that is, the platform recommendation algorithm.

In order to study the influence of network average degree k on the propagation process, keep other parameters unchanged, $\lambda_2 = 1 - \lambda_1 = 0.8$, $\mu_1 = \mu_2 = 0.175$, change the network average degree k to 0.006 and 0.012 respectively, and calculate the propagation process through MATLAB. Figure 13 shows the primary communicators, Tables 7 & 8 show the trend of the number of onlookers, secondary communicators, immunizers, and quitters over time, and the maximum value and time data of each status node.

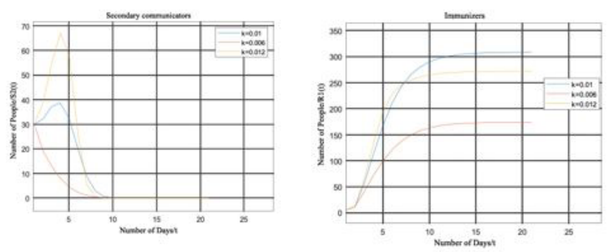

Figure 13: The impact of network average degree on the five types of people in the information network.

Analysis of the results: the greater the network average degree k is, the rapid decrease in the number of primary communicators, the increase in the number of secondary communicators, the increase in the number of quitters after information dissemination and forwarding, the greater the power and influence of information dissemination, and the number of untouched in the network The number of ignorants of the information becomes smaller and smaller until all users in the network are exposed to the information and the dissemination of information ceases.

Summary of the Experiment

From the perspective of comprehensively changing the influence of the three kinds of probabilities and the average degree of the network on the spread, changing the spread probability of the primary communicator λ_1 and λ_2 is the most obvious in terms of the speed and

Network Average Degree $_k$	S1(t)	S2(t)	R1(t)	R2(t)
k = 0.006	3	1	18	9
k = 0.01	3	4	17	10
k = 0.012	3	4	17	9

Table 7: The maximum value reached by each state node under different $_k$

Network Average Degree ^{k}	S1(t)	S2(t)	R1(t)	R2(t)
k = 0.006	89	30	174	89
k = 0.01	160	39	308	213
k = 0.012	194	67	272	291

Table 8: The time taken for each state node to reach the maximum value under different.

scope of the spread and the effect of the spread (that is, the impact of the number of reposts). Changing the propagation probability μ_1 and μ_2 of the waiter has little effect on the propagation speed, while changing the exit probability β of the waiter has little effect on the propagation speed. Changing the average degree k of the network affects the speed and scope of the entire information dissemination. It can be seen that the most effective way to change the dissemination situation is to change the propagation probability λ_1 and λ_2 and the network average degree k of the primary communicator, that is, when the user first sees the information. Possibility of forwarding and accurate push of users (platform recommendation algorithm).

For the improvement of network average degree k, further analysis, that is, the precise push of users, makes users in a relatively closed media environment, and some voices with similar opinions are repeated, even exaggerated and distorted, making most people think that these voices It is all the facts, unknowingly narrowing one's vision and understanding, becoming complacent and even paranoid, resulting in the "echo chamber effect" in the dissemination of network information.

At 15:00 on April 19th, the owner of the Tesla climbed onto the roof and shouted that the brakes had failed. At this time, the public opinion reached its first peak, with more than 3,600 negative sentiments, and only 1,623 positive and 1,425 neutral sentiments. , Public opinion is biased towards Tesla owners, accusing Tesla of disrespecting consumers for dumping the pot. From 5:00 pm on April 19th to the diffusion period on April 20th, both positive and negative emotions increase. On April 20th, car roof defenders were detained and notified. At this time, public opinion reached a new round of climax.

People's Daily, CCTV News and other influential mainstream official media successively spoke out, digging into the cause of the situation, and multiple departments issued statements in response. At the same time, Sina Technology, Toutiao News and self-media accounts actively participated in the discussion of the situation. Driven by these media, netizens closely followed the situation and expressed their views, further promoting the fermentation of public opinion. At this time, there were more than 6,000 negative sentiments, and positive and neutral sentiments accounted for less than half of the negative sentiments. Tesla was criticized. By April 21, Tesla apologized, and at this time the mood of public opinion eased, and public opinion turned from condemnation of Tesla to discussions on the cause of the situation and how to solve it.

The attractiveness of the topic of the Tesla owner's rights protection incident (which tends to a neutral consensus) the negative sentiment accounts for more than 3600, positive and neutral. There are only 1623 and 1425 sentiments respectively. Experts are scored by Delphi method (the interval is 0-1, which is equivalent to normalization processing). In the processing of scoring, considering that positive emotions and neutral emotions are extremely large indicators, while negative emotions are extremely small indicators, so negative emotions need to be positively processed in the AHP. The formula for positive processing used in this paper is (5). There are 6648 data in total.

$$\mathbf{z} = \mathbf{max} - \mathbf{z}$$

From the figure, it can be seen that the public opinion transmission curve fluctuates according to time. By replacing the abnormal points of the curve, this article will get the average value of the curve is used as the source of data. As can be seen from the figure, the total number of user activity data is 1246. Since activity is a qualitative quantity, it is converted into quantitative data by means of expert scoring. Score the experts (the interval is 0-1, which is equivalent to normalization). For the interaction between users, it is mainly based on the main views of the main rights protection event.

Through the standard normalization of the data of 12 views, 21,564 pieces of data are obtained. For the platform recommendation algorithm, it is mainly based on the key communicators of public opinion. It can be seen from the figure that public opinion is mainly spread through 10 aspects, and the key communicators can indirectly explain the platform recommendation. Algorithm, perform standard normalization processing on the above 10 data, and obtain 896 pieces of data.

Since it is necessary to evaluate the four indicators of topic attractiveness, user activity, user interaction and platform recommendation algorithm, a standardized matrix needs to be constructed, so that the minimum data volume of these four indicators is used as the evaluation indicator, which is 896 items, evenly shave the data exceeding the evaluation index. Therefore, there are a total of 4 evaluation objects and 896 evaluation indicators in this evaluation. Due to the forward processing of the above data, the forward matrix is:

$$X = \begin{bmatrix} x_{1,1} & x_{1,2} & \cdots & x_{1,896} \\ x_{2,1} & x_{2,2} & \cdots & x_{2,896} \\ x_{3,1} & x_{3,2} & \cdots & x_{3,896} \\ x_{4,1} & x_{4,2} & \cdots & x_{4,896} \end{bmatrix}$$

Due to the problem of dimensionality in the data, the data needs to be standardized. Then, the standardized matrix is recorded as Z, each element in Z:

$$Z = x_{ij} \Big/ \sqrt{\sum_{i=1}^{n} x_{ij}^2}$$

Define maximum:

$$Z^+ = (Z_1^+, Z_2^+, \ldots Z_m^+) = (\max\{z_{11}, z_{21}, \ldots, z_{n1}\}, \max\{z_{12}, z_{22}, \ldots, z_{n2}\}, \ldots, \max\{z_{1m}, z_{2m}, \ldots, z_{nm}\})$$

Define minimum:

$$Z^+ = (Z_1^-, Z_2^-, \ldots Z_m^-) = (\min\{z_{11}, z_{21}, \ldots, z_{n1}\}, \min\{z_{12}, z_{22}, \ldots, z_{n2}\}, \ldots, \min\{z_{1m}, z_{2m}, \ldots, z_{nm}\})$$

Define the distance between the i-th evaluation object and the maximum value:

$$D_i^+ = \sqrt{\sum_{j=1}^{m} (Z_j^+ - z_{ij})^2}$$

Define the distance between the i-th evaluation object and the minimum value:

$$D_i^- = \sqrt{\sum_{j=1}^{m} (Z_j^- - z_{ij})^2}$$

Calculate the unnormalized score of the i-th evaluation object:

$$S_i = \frac{D_i^-}{D_i^+ + D_i^-}$$

Normalize the scores:

$$p_{ij} = z_{ij} \Big/ \sqrt{\sum_{i=1}^{n} z_{ij}^2}$$

Calculate the information entropy of each indicator, and calculate the information utility value, and normalize to obtain the entropy weight of each indicator. For the j-th indicator, the calculation formula of its information entropy is:

$$e_j = -\frac{1}{\ln n} \sum_{i=1}^{n} p_{ij} \ln(p_{ij}) (j = 1, 2, \ldots, m)$$

As shown in Table 9, the platform recommendation algorithm has the greatest impact on the «information cocoon room», while the user's activity has the least impact on the «information cocoonroom». Figure 14 shows the main idea of modeling.

	Topic Attractiveness	User Activity	User Interaction	Platform Recommendation Algorithm
Weights	0.25	0.15	0.15	0.45
Score	0.56	0.46	0.48	0.63
Ranking	2	4	3	1

Table 9: Relevant data obtained by entropy weight method

Figure 14: The main idea of modeling.

Conflict of interest

We have no conflict of interests to disclose and the manuscript has been read and approved by all named authors.

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References

1. Cinelli M, Morales GDF, Galeazzi A, Quattrociocchi W, Starnini M (2021) The Echo Chamber Effect on Social Media. Proceedings of the National Academy of Sciences 118: e2023301118.

2. Gossart C (2014) Can digital technologies threaten democracy by creating information cocoons?. Transforming politics and policy in the digital age IGI Global: 145-154.

3. Liu W, Zhou W (2022) Research on Solving Path of Negative Effect of "Information Cocoon Room" in Emergency. Discrete Dynamics in Nature and Society 2022: 1–12.

4. Wang D, Qian Y (2021) Echo Chamber Effect in Rumor Rebuttal Discussions About COVID-19 in China: Social Media Content and Network Analysis Study. Journal of Medical Internet Research 23: e27009.

5. Starnini M, Cota W, Ferreira SC, Satorras RP (2019) Quantifying Echo Chamber Effects in Information Spreading over Political Communication Networks. EPJ Data Science 8: 1–13.

6. Guess A, Lyons B, Nyhan B, Reifler J (2018) Avoiding the echo chamber about echo chambers. Knight Foundation 2: 1-25.

7. Peng H, Liu C (2021) Breaking the Information Cocoon: When Do People Actively Seek Conflicting Information?. Proceedings of the Association for Information Science and Technology 58: 801-803.