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Competition Mechanism of False Information in Public Crisis based on Improved Lotka-Volterra competition model

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Abstract: In this paper, we analyzed the ecological characteristics of information diffusion networks, and incorporated it with Lotka-Volterra competition model. Based on this improved model we constructed ecosystems, competition and diffusion equation of false information in public crisis. Using this method, we studied how kinds of information decrease from n to only one by competing in information ecosystem and considered the reason why the false information is the most influential in the social network. The interesting conclusion is, if there are three types of information in ecosystem, when the information published by the official media and the information published by the unofficial media meet certain restrictions together, the official information may promote the diffusion of false information.

Keywords: Public crisis; False information; Lotka-Volterra model

1 Introduction

In digital, networked, high-tech era, the dissemination of information has become faster and faster, the way to diffuse is more diverse and convenient. Thus, the quick diffusion speed also has bad influence on information for the official media and grapevine media, controlling the information well is more and more difficult. When a public crisis occurs, truthfully reported information will appear as well as all kinds of false information. Scholar Liu Tuo [1] defines false information as: the so-called false information is a part of the truth even with the kernel of false, so people can accept and believe the false information easily. Though the information seems well-founded, its nature is strictly close to false, false information causes certain social blinded and harm. On March 11, 2011, the Fukushima nuclear leaked, a wide range of domestic “storm to buy iodized salt” occurred, the sales and the price of iodized salt increased in the geometric pace. There are many similar incidents, those incidents seriously affect people’s life. In society, when public crisis occur, relevant information can be true or false, many kinds of information in a complex dynamic social network compete with each other and controlling is also difficult, what kind of information can win is uncertain, so the information diffusion in public crises can cause unexpected results and huge losses.

Many scholars have conducted many related research about diffusion and effect of the false information. Liu Tuo introduced chaos theory to false information in public crisis, he used Matlab simulation modeling, and revealled laws of false information diffusion from the point of view of accepting probability [1,2]; Shayong Zhong, Zhongxian Shi et [3] studied the impact factors of false information diffusion in public crisis based on Agent simulation model, he also simulated how real information confront false information; Zhihong Li, Chen Yuan et [4, 5] studied the period characteristics of information diffusion Model and management strategies in sudden public crisis and information diffusion in network community, they also summarized a number of relevant theory from four levels space, structure, interaction and rule, these thory explained the meaning of network community and information diffusion mechanisms; Han Qiang [6] was busy with the study of dealing with rumor spread scientifically in public incident, he analyzed objective law of ways the rumors spread in, he also drew some suggestions to response to rumors scientifically;

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Chunye Wang [7] studied the relationship between rumor spread in public emergencies and government information disclosure, he found that disclosure of government information can make people get to know more about the truth; Weizhu Zhu [8] established information diffusion model in crisis, he also analyzed the information diffusion process, period character. Initially Lotka-Volterra ecological model is mainly used to study changes in the growth number of eco-population [14,15,16,17] But with the development of cross-disciplinary and diverse, Lotka-Volterra model is gradually being applied to stock market investment, to the development mechanism of the service in management sector, to the mechanism of knowledge creation and to the mechanism of innovation diffusion, etc [9,10,11,12,13].

Most scholars only summarized existing research theories on information diffusion, used simulation model to find laws of false information diffusion, analyzed the factors and indicators of information diffusion, period characteristics when diffuse, presented recommendations to government to control information. But few studies are based on Lotka-Volterra model to research false information. In this article, we innovatively use Lotka-Volterra model to reveals the number of population coming , going and the periodic cycle phenomenon, we explore the formation and diffusion mechanism of false information in a phased manner .

2 The formation mechanism of false information based on the Lotka-Volterra model

2.1 The formation mechanism of false information in public crisis

General information diffuses mainly through formal channels, such as news, newspapers, Internet and other media. But a number of informal ways can not be ignored. “Oral communication”, and infection like “viral” also transmit wrong messages though complex social networks. Information generats in public crisis and is disseminated by communicators though complicated social network but it is likely to magnify to distortion. The mainly reason is the interference of false information in the network. The process of information from creation to the diffusion can be seen as an ecosystem, so in this information ecosystem, there are a variety of false information subsystems “to compete” to achieve the purpose to proliferate. The ecosystem is a system with a certain range and space, and in this system there are a plenty of populations. After analysis, the information ecosystem is same with a general ecosystem. First, both have more subjectivities than one. The eco-system consists of multiple species, and information ingredients are composed of multiple subsystems. Second, both internal subjects have linkages. In eco-system the relationship among multiple species consists of competition, predation and cooperation and there are similar relationships among information subjectivities. Third, both are restrained by resource. In ecosystem different populations has to compete to found different food chains because resources are limited. To diffuse in social networks, information ingredients has to grab for resources among the main subjects because the number of the information carrier and recipient are limited, the influence and the individual psychological effects of the information carrier and recipient are different. So ultimately reliable mainstream information becomes the main trend or false information is the winner.

2.2 The LotkaVolterra model in ecosystem

In 1930s, American scholars Lortka and Italian scholars Volterra established Lotka-Volterra model, it initially is based on two populations predator and prey: Suppose a ecosystem including two populations predator and prey, predators can survive rely on prey, the system has no exchange with the outside world population .They established a mathematical model describing this system, based on this, the later scholars study the general form of Lotka-volterra model.

$$\begin{cases} \frac{dx_1}{dt} = x_1(\alpha_1 + \beta_1 x_1 + \gamma_1 x_2), \\ \frac{dx_2}{dt} = x_2(\alpha_2 + \beta_2 x_1 + \gamma_2 x_2), \end{cases} \tag{1}$$

which $\alpha_i, \beta_i, \gamma_i$ are constants, β_1 and γ_2 respectively reflects the density effect of the two groups, known as action coefficient within populations, γ_1 and β_2 reflects the interrelated factors between the two groups, called action coefficient between populations, α_1 and α_2 respectively represent the natural growth rate of the two groups. $\beta_i < 0$ represents limit resource in the population. $\gamma_i > 0 (< 0)$ means that the interaction between populations lead to their rate of change positive (negative). Depending on the parameters of model, we can analyze the different relationship between populations, for example, when $\gamma_1 > 0$ and $\gamma_2 > 0$, the relationship between the two is cooperative and mutually beneficial; When $\gamma_1 < 0$ and $\gamma_2 < 0$ the relationship is competitive; When $\gamma_1 < 0$ and $\gamma_2 > 0$, the relationship is prey.

Ahmad [15,16], Zeaman [14] studied other competitive models further, they used the similar defined variables, $x_i(t)$ means population density of the l_{th} group at t, N_i means the intrinsic population growth rate; M_{ij} means mutual action coefficient between population i and j, which is known as species contributing factor. In particular, Chinese and foreign scholars conducted research in-depth on periodic, stability and asymptotic lines about the autonomous ecosystem Lotka-volterra, n

kinds of populations are competing in this system, we can know from literatures [15,16,17] system is as follows:

$$\frac{dx_i(t)}{dt} = x_i(t)\left(N_i - \sum_{j=1}^{n} M_{ij}x_j\right), \quad (2)$$
$$M_{ij} > 0, M_{ii} > 0, i, j = 1, 2, \cdots, n$$

2.3 Based on ecosystem constructing formation mechanism of false information in public crisis

Lotka-volterra model represents an ecological phenomenon, but in nature, in addition to predator-prey relationship in the form of outside surface, the model can also describe the parasitized relationship between parasite and host. Similarly, different types of information can be assumed as different subsystems, each representing a population, mutual "confrontation" between reliable information and kinds of false information in populations. Because of this, we not only study competitive model between true and false information, but also research more realistic situations of competition among the various false information to analyze the diffusion mechanism of false information.

To understand the information ecosystem Lotka-volterra models better, we view the groups in complex social network as the carrier, and define information group i as the l_{th} kind information received by groups. Intrinsic population growth of Information group i means growth number of population receiving information i, the interaction between information group i and j refers to the changes of the number of people receiving information i instead of j. The growth rate represents the growth of the recipients of information i, but indicators of different communicators' influence and psychological effects are different, which can be reflected by growth rate and interaction indices. Changes of various recipient groups can be affected by interaction within groups, as well as among the groups.

The specific meaning of each variable is defined as follows

$x_i(t)$ represents the number of recipient at the time of i in social network;

$\frac{dx_i(t)}{dt}$ represents the change rate of recipient at the time of i;

B_i is the intrinsic growth index of information i recipient (determined by the sensitivity of the information and the psychological effect and influence of the infected individual);

A_{ij} is interaction index that the recipient of information i influence the recipient of information j;

A_{ii} is interaction index among the recipient of information i;

Assumption 1: The development of information populations depends on competition of communicators resources in social network, their presence can inhibit the growth of other populations, namely $A_{ij} > 0$ (inhibition within populations); But the more the number of recipient is ,the greater growth rate is promoted, this competitive relationship is different with the general Lotka-volterra ecosystem model, that is $A_{ii} > 0$ (reciprocity within group), showing a positive effect.

Assumption 2: A period of time is divided into aliquots countless infinitesimal, which can be considered infinite. After the unexpected occurs, a small amount of information diffuses in a variety of social networks, the attitude of government agencies and official media towards the event is very cautious, efficiency to deal with the event is affected, diffusion speed can be easily lagged. In a short time, a variety of false information is generally mixed with reliable information in a non-dominant state, they compete with each other to diffuse.

Taking the special nature of competition among information populations into account, we can define Lotka-volterra model of information ecosystem as follows:

$$\frac{dx_i(t)}{dt} = x_i(t)\left(B_i + A_{ii}x_i - \sum_{j=1, j\neq i}^{n} A_{ij}x_j\right), \quad (3)$$
$$A_{ij} > 0, A_{ii} > 0, i, j = 1, 2, \cdots, n$$

3 Analyzing competitive process of false information diffusion in ecosystem

Though competitive process of information diffusion ,we draw when n kinds of information diffuse in social networks, one kind information can survive after competition, we also find various conditions the ultimately survival information must meet in the process of reducing.

In ecosystem (3), when $dx_i(t)/dt = 0$, we define the system as stable at the moment of t, that is

$$x_j(t) = 0 \quad (4)$$

or

$$B_i = \sum_{j=1, j\neq i}^{n} A_{ij}x_j - A_{ii}x_i, i, j = 1, 2, \cdots, n \quad (5)$$

We can know from (5), its essence is the case of finding the answers of a non-homogeneous linear equations. In hypothesis, $(A_{n\times n})$ is Coefficient matrix of x_n, and the augmented matrix is $(A_{n\times n} : B_n)$, B_n is N-dimensional column vector, $r(A)$ represents the rank in linear algebra.

Lemma 1 All non-homogeneous linear equations such as $Ax = b$ are n order matrix. Its necessary and sufficient condition for solvability is $r(A) = r(Ab)$, when $r(A) = r(Ab) = r = n$, equations have the unique solution. When $r(A) = r(Ab) = r < n$, equations have many solutions. When $r(A) \neq r(Ab)$, equations have no solutions.

Theorem 1 For system (3), when $r(A_{n\times n}) \neq r(A_{n\times n} : B_n)$, we can know $x_i = 0, (i = 1, 2, \cdots, n)$ or $x_n = 0$; when $r(A_{n\times n}) = r(A_{n\times n} : B_n) = r = n$, x_i has the unique key; when $r(A_{n\times n}) = r(A_{n\times n} : B_n) = r < n$, there are r nonzero components within n at least.

Proof: In the system (3), when l components are zero $(l \leq n)$, $x_{n-l+1}, \cdots, x_n$ are taken as zero, and others as nonzero, then (5) is in respect of a group of equations, and $r(A_{(n-l)\times(n-l)}) \leq n-l$. First considering (5), we deal with it by main element Gauss elimination method, augmented matrix form is as follow

$$(A:B)^{(1)} = \begin{pmatrix} -A_{11}^{(1)} & A_{12}^{(1)} & \cdots & A_{1,n-1}^{(1)} & B_1^{(1)} \\ A_{21}^{(1)} & -A_{22}^{(1)} & \cdots & A_{2,n-1}^{(1)} & B_2^{(1)} \\ A_{31}^{(1)} & A_{32}^{(1)} & \cdots & A_{3,n-1}^{(1)} & B_3^{(1)} \\ \vdots & \vdots & \ddots & \vdots & \vdots \\ A_{n-l,1}^{(1)} & A_{n-l,2}^{(1)} & \cdots & -A_{n-l,n-l}^{(1)} & B_{n-l}^{(1)} \end{pmatrix}.$$

Iterating as the following rules:

$$\begin{cases} A_{ij}^{(k+1)} = A_{ij}^{(k)}, B_i^{(k+1)} = B_i^{(k)}, \quad j \leq k, j \leq n-l \\ A_{ij}^{(k+1)} = A_{ij}^{(k)} - (A_{ik}^{(k)} / -A_{kk}^{(k)}) A_{kj} * (k), \\ \qquad k+1 \leq i \leq n-l, k+1 \leq j \leq n-l \\ B_i^{(k+1)} = B_{ij}^{(k)} - (A_{ik}^{(k)} / -A_{kk}^{(k)}) A_{kj} * (k), \\ \qquad k+1 \leq i \leq n-l, k+1 \leq j \leq n-l \\ A_{ij}^{(k+1)} = 0, \quad 1 \leq j \leq k \leq i \leq n-l \end{cases}$$

The i step sequence master formula of $(A_{n-l,n-l})$ is $\delta_i (i = 1, 2, \cdots, n-l)$, $\delta_i = \prod A_{ii}^{(i)} \neq 0$.

We can know from the theorem above, for the system (3) after satisfying a number of constraints, there will be some kinds of information weakening to perish. We analyze the progress that the population i compete, diffuse and gradually perish in the social network under different conditions, but what kinds of population information perished and how to confirm need further discussion.

Here we introduce the Lotka-volterra competition model. Biwen Li, Xianwu Zeng [17] and other scholars in the field of bio-mathematical has strictly proved competition relationship of Lotka-volterra model among N populations and drawn important conclusions .We can use the conclusions in this study, citing as follows:

Lemma 2 [17] If system (2) satisfy the condition

$$N_i > 0, 1 < i, j < n, (h_1) N_i > \sum_{j=1, j\neq i}^{r} M_{ij} \frac{N_j}{M_{jj}}, i = 1, 2, \cdots, r;$$

$$(h_2) N_m < \sum_{j=1}^{r} M_{mj} x_j^*, m = r+1, r+2, \cdots, n;$$

And $x_j^* = (x_1, x_2, \cdots, x_r)$ is a positive solution to linear algebra system $b_i = \sum_{j=1}^{r} M_{ij} x_j, i = 1, 2, \cdots, r$, if there are $n-r$ positive constants $M_{r+1}, \cdots, M_r$, which can make

$$\max\left\{ \left(\sum_{j=r+1}^{r} M_{ij} M_j\right) \left(N_i - \sum_{j=1, i\neq j}^{r} M_{ij} \frac{N_j}{M_{jj}}\right)^{-1}, i = 1, \cdots, r \right\}$$
$$\leq \max\left\{ M_m M_{mm} \left(\sum_{j=1}^{r} M_{mj} \frac{N_j}{M_{jj}}\right)^{-1}, m = r+1, \cdots, n \right\},$$

the key to system is $x_i(t) \to x_i, i = 1, \cdots, r$; $x_m(t) \to 0, m = r = 1, n$, if $t \to \infty$.

We analogy the system 3 as competing models of n various groups in original ecological system

Theorem 2: If (3) satisfies the condition:

$$(H_1) B_i > \sum_{j=1, j\neq i}^{r} A_{ij} \frac{B_j}{-A_{jj}}, i = 1, 2, \cdots, r,$$

$$(H_2) B_k < \sum_{j=1}^{r} A_{kj} x_j^*, k = r = 1, r+2, \cdots, n.$$

And $x_j^* = (x_1, x_2, \cdots, x_r)$ is a positive solution to linear algebra system $b_i = \sum_{j=1}^{r} M_{ij} x_j, i = 1, 2, \cdots, r$ (In order to protect the positive solution, take $r \geq 2$); there are $(n-r)$ positive constants $A_{r+1}, \cdots, A_r$, which can make

$$\max\left\{ \left(\sum_{j=r+1}^{r} A_{ij} A_j\right) \left(B_i - \sum_{j=1, i\neq j}^{r} A_{ij} \frac{B_j}{-A_{jj}}\right)^{-1}, i = 1, \cdots, r \right\}$$
$$\leq \max\left\{ A_k(-A_{kk}) \left(\sum_{j=1}^{r} A_{kj} \frac{A_j}{-A_{jj}}\right)^{-1}, k = r+1, \cdots, n \right\},$$

So the key to system (3) is $x_i(t) \to x_i, i = 1, \cdots, r$; $x_k(t) \to 0, k = r+1, \cdots, n$ if $t \to \infty$.

Proof: comparing information ecosystem competition model (3) with the original ecosystem n species competitive systems (2), Variable relationship is as follows: $A_{ii} = -M_{ii}$, $A_{ij} = M_{ij}$, $B_i = N_i$, there in no other essential changes. Substituting it to Lemma 1, $(h_1) = (H_1), (h_2) = (H_2), (h_3) = (H_3)$, completing the proof.

Theorem 2 and Lemma 2 shows, no matter M_{ii} is positive or negative, information ecological systems (5) can get positive solutions. This can also be learned from the point that the nature of the non-homogeneous linear equations is independent of positive and negative of coefficient matrix.

After competition among n species in information diffusion in a moment we can know from theorem 2, n will gradually decrease after satisfying a number of conditions, in this case we consider $n = 3$. To simplify the problem, we assume that: in public crises practical information can be broadly grouped into three categories, x_1 on behalf somewhat true information, x_2 on behalf of somewhat false information, as well as x_3 represent the information released more officially at a certain moment, which impact the diffusion of the information x_1, x_2.

Based on this, the model of $n=3$ is very meaningful, and its three-dimensional information ecological competition model based on (3) is as follow:

$$\begin{cases} \frac{dx_1(t)}{dt} = x_1(t)(B_1 + A_{11}x_1 - A_{12}x_2 - A_{13}x_3) \\ \frac{dx_2(t)}{dt} = x_2(t)(B_2 + A_{21}x_1 - A_{22}x_2 - A_{23}x_3) \\ \frac{dx_3(t)}{dt} = x_1(t)(B_3 + A_{31}x_1 - A_{32}x_2 - A_{33}x_3) \end{cases} \quad (6)$$

Theorem 3 Assume that the system (6) satisfies the following conditions, (i) $B_1 > A_{12}\frac{B_2}{-A_{22}}, B_2 > A_{21}\frac{B_1}{-A_{11}}$; (ii) $B_3 < A_{31}x_1^* + A_{32}x_2^*$; (iii)

$$\frac{A_{33}A_{12} + A_{32}A_{13}}{A_{33}A_{11} + A_{31}A_{13}} < \frac{B_1A_{22}}{B_2A_{11}} < \frac{A_{33}A_{22} - A_{23}A_{32}}{A_{31}A_{23} - A_{33}A_{21}},$$

$A_{12}A_{21} - A_{22}A_{11} > 0$. In which

$$x_1^* = \frac{A_{12}B_2 + A_{22}B_1}{A_{12}A_{21} - A_{22}A_{11}}, x_2^* = \frac{A_{11}B_2 + A_{21}B_1}{A_{12}A_{21} - A_{22}A_{11}}.$$

Any positive solution to system (6) is $x_1 \to x_1^*, x_2 \to x_2^*, x_3 \to 0$, when $t \to \infty$.

Proof: we take $r=2$, and (i) and (ii) contains the conditions that (H_1) and (H_2) are right. (iii) show that

$$\frac{A_{33}A_{12} + A_{32}A_{13}}{A_{33}A_{11} + A_{31}A_{13}} < \frac{B_1A_{22}}{B_2A_{11}} \Rightarrow \\ \frac{A_{13}}{B_1 + B_2\frac{A_{12}}{A_{22}}} < A_{33}\left(A_{31}\frac{B_1}{A_{11}} + A_{32}\frac{B_2}{A_{22}}\right)^{-1}$$

$$\frac{B_1A_{22}}{B_2A_{11}} < \frac{A_{33}A_{22} - A_{23}A_{32}}{A_{31}A_{23} - A_{33}A_{21}} \Rightarrow \\ \frac{A_{23}}{B_2 + B_1\frac{A_{21}}{A_{11}}} < A_{33}\left(A_{31}\frac{B_1}{A_{11}} + A_{32}\frac{B_2}{A_{22}}\right)^{-1}$$

So the condition H_3 is right. According to Theorem 2, theorem 3 is right. QED (Note: The existing results can not deduced theorem 3).

If the coefficient of x_3 released by official media as well as x_1, x_2 the two types of true and false information satisfy constraints conditions from Theorem 3, we get a more interesting conclusion from Theorem 3 that the information released by official media may also promote the diffusion of the false information. That convergence of x_3 promote the diffusion of x_1 and x_2.

In the example, at the last stage of the diffusion of information in public crisis the number of kinds of information eliminates to two from three .In social network two kinds of relative opposites information generally formed, in the system (3) two-dimensional competition model system for $n=2$ occur.

$$\begin{cases} \frac{dx_1(t)}{dt} = x_1(t)(B_1 + A_{11}x_1 - A_{12}x_2) \\ \frac{dx_2(t)}{dt} = x_2(t)(B_2 - A_{21}x_1 + A_{22}x_2) \end{cases} \quad (7)$$

After a time t, $dx_1(t) = 0$ and $dx_2(t) = 0$, four steady states may appear in system (7).They are E(0,0), F($\frac{B_1}{-A_{11}}$,0), M(0,$\frac{B_2}{-A_{22}}$) and N(x_1^*, x_2^*). As is shown in Figure 1 and Figure 2.

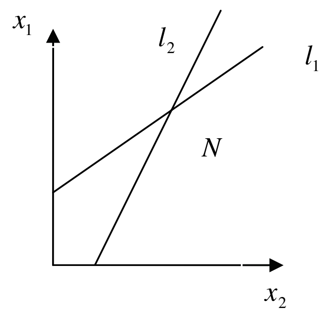

Fig. 1

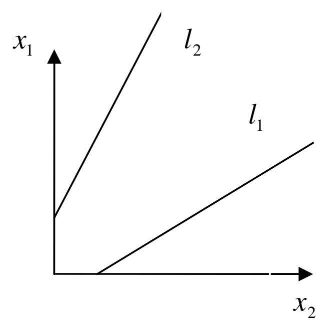

Fig. 2

(1) When system (7) satisfy the condition $A_{11}A_{12} - A_{21}A_{12} < 0$, as is shown in Figure 1, on l_1 the right to N is the intersection point of l_1 and l_2, that is $\frac{dx_1(t)}{dt} > 0$; and the left is $\frac{dx_1(t)}{dt} < 0$. Similarly, on l_2 the right to N is the intersection point of l_1 and l_2, that is $\frac{dx_1(t)}{dt} > 0$; and the left is $\frac{dx_1(t)}{dt} < 0$. When $t \to \infty$, all points in quadrant convergence to N, which is consistent with Theorem 3.

(2) when the system (7) satisfy the condition $A_{11}A_{22} - A_{21}A_{12} > 0$, as is shown in Figure 2, l_1 and l_2 have no intersection point. As is analyzed in follow:

Theorem 4 When the system (7) satisfy the condition $a = A_{12}(A_{11}A_{22} - A_{21}A_{12}) > 0$, $b = A_{12}(A_{21}B_1 + A_{11}B_2)$,

$c = A_{21}(B_2^2 - B_1^2)$ and when $\triangle = \sqrt{b^2 - 4ac}$, we can get $x_2 \to 0$.

Proof: We can know from the system (7), if $x_1 \neq 0$, we can get $x_1 = \frac{A_{12}}{A_{11}}x_2 - \frac{B_1}{A_{11}}$ and $x_1x_2 = \frac{B_2}{A_{21}}x_2 + \frac{A_{22}}{A_{21}}x_2^2$. Substituting them to equation and we can get

$$A_{12}(A_{11}A_{22} - A_{21}A_{12})x_2^2 + A_{12}(A_{21}B_1 + A_{11}B_2)x_2 + A_{21}(B_2^2 - B_1^2) = 0$$

When $\triangle = 0$, that is $(A_{12}(A_{21}B_1 + A_{11}B_2))^2 - 4A_{12}(A_{11}A_{22} - A_{21}A_{12})A_{21}(B_2^2 - B_1^2) = 0$, $x_2 = 0$ QED.

The theorem states that information diffusion in this particular scenario, eventually only x_1 can diffuse, and x_2 demise. We can know at the final state of false information diffusion in public crisis, only information x_1 is accepted in the social network population groups.

4 The Conclusion

The government and relevant personnel are often passive to deal with the harm caused by the false information in public crisis, because they know little diffusion mechanisms. The current literature about the diffusion mechanism of false information in public crisis is rare, we study the competitive process of kind of information defeating N kinds of information, and we mainly want to know how false information in public crisis becomes "a single large" in the social network.

According to the analysis about information ecosystem characteristics, we introduce the biodynamic Lotka-Volterra model and study the diffusion mechanism of false information in public crisis. First, supply something new to the Lotka-Volterra competition model, and innovatively consider intraspecific reciprocal and species competition mode. Second, Theorems 1 and 2, respectively, from the macro and micro perspective indicate the false information diffusion tendency from n to 1 in public crisis when the false informatiion respectively meet the conditions. Theorem 3 is as a special form of Theorem 2 under certain conditions. When $n = 3$, the information published by government media sometimes facilitated the false information diffusion. Theorem 4 can be drawn what special conditions should meet if one kind information wants to defeat others.

However, to simplify the problem, we assume that the information will not be renewable after the demise, and the information diffusion is in the form of ordinary differential equations, but the actual problem is more complex, sometimes delayed or partial differential nonlinear equations is closer to reality. In addition, how to measure variables in the model is difficult, they are identified by the various indicators of the crowd in critical nodes in complicated social networks. These can be the directions for further research

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References

[1] Liu Tuo False information in public crisis and crisis management characteristics [J] Journal of Information 2008 (12): 155-157.
[2] Fu Yu Wei, Liu Tuo ,Zhu Fagen. Chaotic simulation of false information diffusion in public crisis [J] Journal of Information .2007 (12): 7-9.
[3] Sha Yongzhong, Shi Zhongxian. Chaotic simulation of diffusion affecting factors false information in public crisis. Library and Information Service. Volume 56, No. 5 March 2012.
[4] Li Zhihong, etc. Period Characteristic and management measures of the information dissemination mode in sudden public crisis Vol.51, No.10, October, 2007 Library and Information Service.
[5] Chen Yuan. Ni Maria. Zou Jing. Dissemination of information related to the online community Theory Book intelligence. Total No. 122 March 2008.
[6] Han Qiang. Scientific research to deal with rumors diffusion in public crisis Chinese administration. Spotlight 2008 Section 7 Article 277 total.
[7] Wang Chunye. Rumors diffusion and government information disclosure in public crisis POLITICAL Article 2 April 2009.
[8] Zhu Weizhu. In digital age features of crisis information dissemination mode and management measures modern intelligence in February 2009 Volume 29, Issue 2.
[9] Bian Yuetang, HeJianmin, Zhuang Yaming. The research based on Lotka-Volterra model on development mechanism of producer services Soft Science Technology and Economic January 2011 Volume 25 Section 1 (Total 133).
[10] PSO in two groups of cooperative based on Lotka-Volterra model Control and Decision 2010.07 Volume 25 11.
[11] Wang Min. Based on Lotka-Volterra model the research on shareholder symbiotic population. Statistics and Decision 2013 Section 9 Total No. 381.
[12] Huang Weiqiang Yao shuang. ZhuangXin-tian Multi-agent-based simulation of the innovation diffusion based on complex social network. Volume 31, Issue 2 February 2013 study of science.
[13] Zhong Qi. Qi Wei Zhang Yue. Social crisis information diffusion model base on Lotka Volterra system under the System Engineering Theory and Practice Volume 32, No. 1 l March 2012.
[14] Zeeman M L . Extinetion in Competitive Lotka-VOlterra systems. Pro, Amer, Math, Soc, 1995,123:8796.
[15] Ahmad S, Lazer A C.One Speeies Extinetioninan Autonomous Competiton Model. Proeeedings of The World Congresson Nonlinear Analysis,1994.

[16] Ahmad S. On the Nonautonomous Lotka-VOlterra systems Competition Equations. Pro , Amer , Math .Soc. 1993,lt7:199-205.
[17] LI Bi-Wen Yu Shengli Lotka–Volterra model some new results of autonomous systems with populations competing Journal of Applied Mathematics, 2004 Vol 27 No. 3.

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