

A study of the influence of different opinion leaders on the evolution of followers' views in social e-commerce networks

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Abstract—In the recently emerged social e-commerce platforms, online opinion leaders play a crucial role. Based on the finite trust model in opinion dynamics and combined with the actual situation of social e-commerce platforms and research literature, this paper divides opinion leaders into ‘Big-V’ type opinion leaders and authoritative opinion leaders, and divides followers into ordinary followers and fans, and constructs different opinion leaders in social e-commerce networks based on bounded trust and self-confidence degrees - the follower opinion evolution model. The influence of different opinion leaders on the evolution of followers' views is explored through multi-agent simulation. It is found that opinion leaders play an important role in the aggregation of views, and the breadth of follower coverage of ‘Big-V’ type opinion leaders makes them more influential and able to gain more strong supporters than authority-type opinion leaders.

Keywords—opinion dynamics theory, social e-commerce, opinion leaders, multi-agent emulation

I. INTRODUCTION

In the current e-commerce industry, users mostly need to check the historical reviews about the product before purchasing it, but the false recommendations and massive redundant recommendations seriously affects the effectiveness and accuracy of users' access to recommendations [1]. Nowadays, with the integration and development of e-commerce and social networks, professional social networking platforms for product sharing, evaluation and communication have started to emerge and become important channels for users to exchange views and proliferate products (e.g. Weibo, Xiaohongshu, Facebook, etc.). In these sites, users can establish online social relationships to share product information or reviews, and can also ask product-related questions to network members. Compared to traditional e-commerce platforms, the establishment of perceived trust by consumers here relies more on recommendations from others in the form of user-generated content [2]. In this process, we can find individuals who can exert influence on the opinions, decisions and actions of most other consumers, i.e., online opinion leaders, who play a crucial role in social e-commerce networks. Therefore research on the influence of online opinion leaders on groups has also received extensive attention. Qing et al [3] studied the influence of online opinion leaders' mobilization methods on Internet users' online cluster behavior participation in the context of product harm crisis. Liu Li et al [4] used an empirical research method to test the influence of opinion leaders on college students' participation in tourism virtual

community behavior by constructing a conceptual model. Tobon[5] looks at the role of opinion leader's electronic word of mouth as well as the effect of its valence and product type on the decision to buy or not buy from a realistic experimental online store design.

In social e-commerce platforms, the relationships between individuals interacting and influencing each other constitute a social network. In recent years, the development of statistical physics, multi-agent models and complex networks has provided researchers with tools for quantitative analysis or numerical simulation of large-scale social networks. Among them, dynamic simulations of perspectives using opinion dynamics models can better reflect the process and mechanism of perspective evolution [6]. At the same time, in order to more detail the change of individual opinions in social networks, more and more scholars focus on microscopic opinion dynamics models based on multi-agent system. Tingyu Li et al [7] constructed an opinion dynamics model with the addition of media influence variables to study the key role of media in the evolution of opinions; Giacomo[8] consider the modeling of opinion dynamics over time dependent large scale networks.

In this paper, we take social e-commerce platform as a background, construct a social network in line with its characteristics, set up different types of opinion leaders and followers based on literature studies and realistic situations. Then we introduce a bounded trust model of opinion dynamics (Hegselmann-Krause model) and improve it. Through multi-agent simulation, we further explore the impact of different types of opinions leaders on followers in social e-commerce backgrounds. A theoretical basis is provided for companies to design appropriate marketing tools and opinion guidance for their brands and products, and feasible measures are proposed.

II. THE CONSTRUCTION OF A SOCIAL E-COMMERCE NETWORK

The metrics of mainstream social networks from Stanford University's publicly available social network dataset show that mainstream social network, such as Facebook, Twitter, etc, have both small-world properties and scale-free properties. In order to evolve the model on a network structure similar to real social networks, we need to select a network with both scale-free and small clustering properties, referring to the network construction approach of Gong Yi Li [9], the process of constructing the network, the generative edge algorithm fuses preferential connections and neighborhood connections. Preferential connection means that new node will be prioritized to

establish a connection with a large influence in the network; the neighborhood connection refers to the node, which is preferentially generated from the node from the near. The improved network model generate edges with a preferential connection with a certain probability to the new join node (set this probability of p) and according to the probability of $1-p$ in the neighborhood connection way. Assuming $p = 0.7$ for preferential connectivity and $1-p = 0.3$ for neighborhood connectivity, the model evolved to a number of nodes of 1000 is shown in Fig.1. The average clustering coefficient of the improved network is 0.5021. From Stanford University public SNAP data sources, the average cluster coefficient of Twitter social network is 0.5653^[10]. It can be seen that the improvement results are in line with the actual situation.

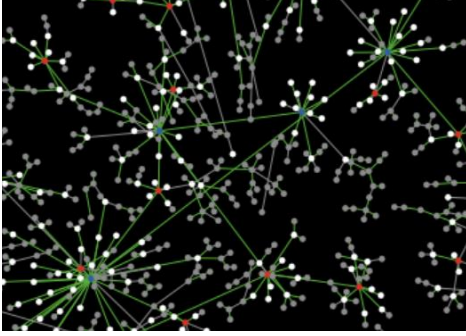


Figure 1. Simulation of the evolution of real social networks

III. MODELING

A. Opinion leader and follower settings

The traditional literature divides crowds into two broad categories: opinion leaders and followers, they differ in their adherence to their views, and the views of opinion leaders can influence the views of followers^[11]. Zhu^[12] considers the difference in the acceptance and communication of the viewpoint, it will be refined as a fan and ordinary follower, and the filaments are subdivided into a fanatic hot fans and ordinary fans. However, few studies have considered the diversity of opinion leaders and the differences in their influence. Therefore, this paper considers the characteristics of social e-commerce networks and the diversity of opinion leaders. We refer to Shao Peng^[13] to define three special types of users who influence the evolution of group views, and subdivides opinion leaders into authoritative opinion leaders and 'Big -V' type opinion leaders (Hereinafter referred to as V opinion leader). Authoritative opinion leaders have a high degree of expertise in a certain field and are able to provide objective and authoritative advice to consumers on social e-commerce platforms, such as scholars, experts. And by posting information with expertise over time, these users have built up a high level of trust in the network. In turn, they themselves have a smaller trust threshold and do not easily change and update their opinions. V opinion leaders are those who have a strong influence and a large number of social links in social commerce platforms, which are crucial for product adoption and spreading. They generally harvest followers and influence their purchase decisions through emotional, subjective and interesting information postings. They themselves have a low trust threshold and are influenced by other opinion leaders.

The followers in the social e-commerce network are set as general followers as well as fans. The number of fanatic fans on this platform is small as most of the consumers on this platform seek sharing and advice on product purchase, so it is not set in this paper. Fans in this model are followers of opinion leaders who are more easily persuaded by opinion leaders, usually show super interest and enthusiasm for the product, and are more active in product proliferation. Ordinary followers, on the other hand, are consumers who do not follow opinion leaders, who are more easily persuaded by those around them, and show no interest in product diffusion.

According to the above definition and previous studies on the structure of social network opinion leaders^[14], "medium V" users have stronger opinion guiding power and stronger professionalism, which is equivalent to the authoritative opinion leaders in this paper, while "medium V" users have fewer followers and lower influence compared with "big V" users. Therefore, in the network where opinion leaders exist simultaneously, the top 1% of nodes with the highest degree value are set as V opinion leaders, and the nodes with degree values between the top 2% and 5% are set as authoritative opinion leaders.

B. A model for the evolution of different opinion leader-follower views based on bounded trust and confidence levels

In this paper, we choose to introduce the HK model of "confidence factor". The "confidence factor" is the individual's self-confidence and belief that the vast majority of people do not completely lose their views in a clash of views, but retain them to some extent.

Set up the network with N individuals, among which there are N_0 opinion leaders, N_1 regular followers, and N_2 fans. Among the N_0 opinion leaders, the number of authoritative opinion leaders is Y_1 and the number of V opinion leaders is Y_2 . When the opinions at time t of all individuals are denoted by $x_i(t)$, for $i = 1, \dots, N$. The completely positive and completely negative opinions are, respectively, defined by $x_i(t) = 1$ or -1 . Assume that the initial viewpoint $X(0)$ of all individuals conforms to a uniform distribution of $[-1, 1]$.

If a fan has a total number of neighbors j of m , with the number of followers m_1 , the number of authoritative opinion leaders m_2 and the number of V opinion leaders m_3 , then its opinion update rule is:

$$x_i(t+1) = \alpha_i \frac{1}{m_1^A} \sum_{j=m_1+1}^{m_1+m_2} a_{ij}(t)x_j(t) + \beta_i \frac{1}{m_1^V} \sum_{j=m_1+m_2+1}^{m_1+m_2+m_3} a_{ij}(t)x_j(t) + (1-\alpha_i-\beta_i-\gamma_i) \frac{1}{m_1^F} \sum_{j=1}^{m_1} a_{ij}(t)x_j(t) + \gamma_i x_i(t) \quad (1)$$

where, $i=1, 2, \dots, N_2$, $a_{ij} = \begin{cases} 1, & \text{if } |x_i(t) - x_j(t)| \leq \varepsilon_i \\ 0, & \text{if } |x_i(t) - x_j(t)| > \varepsilon_i \end{cases}$

$m_i^A = \sum_{j=m_1+1}^{m_1+m_2} a_{ij}(t)$, $m_i^V = \sum_{j=m_1+m_2+1}^{m_1+m_2+m_3} a_{ij}(t)$, $m_i^F = \sum_{j=1}^{m_1} a_{ij}(t)$ denote the number of authoritative opinion leaders, V opinion leaders, and followers in individual i 's neighborhood that are within the confidence level, respectively. Coefficients α_i, β_i denote the confidence

level of individual i in authoritative opinion leaders and V opinion leaders, respectively. Due to the different traits of the two, setting $\alpha_i > \beta_i$, indicates that individual fans trust authoritative opinion leaders more. Also set $m_2 < m_3$, since V opinion leaders have more followers and wider influence, then correspondingly fans can receive more messages from V opinion leaders. Coefficient γ_i indicates the confidence coefficient of an individual. The larger it is the less it is influenced by the outside world and the more it trusts its own judgment.

The opinion updates of ordinary followers are less influenced by opinion leaders than ordinary fans. Assuming that the total number of neighbors j is m , where m consists of fans and regular followers whose opinion update rule is:

$$x_i(t+1) = (1-\gamma_i) \frac{1}{m_i^F} \sum_{j=1}^m a_{ij}(t)x_j(t) + \gamma_i x_i(t) \quad (2)$$

where $i=1,2,\dots,N_2$, the means of a_{ij} , γ_i are consistent with the above.

The views of authoritative opinion leaders are not influenced by other opinion leaders and followers, but are derived from their own knowledge and experience and from research findings that are more authoritative than their own, and the rules for updating their views are:

$$x_i(t+1) = \gamma_i x_i(t) \quad (3)$$

where $i=1,2,\dots,Y_2$, $\gamma_i \in [0.8,1]$ indicates that authoritative opinion leaders will have to revise their views appropriately based on the latest professional information.

The opinion of a V opinion leader is not influenced by followers, but will be influenced by opinion leaders in the neighborhood. Suppose the total number of neighbors of j is m , among which those who are followers are m_1 , those who are authoritative opinion leaders are m_2 , and those who are V opinion leaders are m_3 whose opinion update rule is:

$$x_i(t+1) = \alpha_i \frac{1}{m_i^A} \sum_{j=m_1+1}^{m_1+m_2} a_{ij}(t)x_j(t) + \beta_i \frac{1}{m_i^V} \sum_{j=m_1+m_2+1}^{m_1+m_2+m_3} a_{ij}(t)x_j(t) + \gamma_i x_i(t) \quad (4)$$

where, $i=1,2,\dots,Y_2$, the means of a_{ij} , β_i are consistent with the above.

In this model, V opinion leaders take their confidence level to a consistent level of 0.25. According to the literature, there is no confidence level for authoritative opinion leaders, and the confidence level for followers fits a uniform distribution of $[0,1]$ and hold the individual opinion values constant when all individual neighbors are outside their confidence levels. Denote the set of neighbors $N_i(t)$ that are within the i -confidence level, i.e., $x_i(t+1) = x_i(t)$ when $N_i(t)$ is null.

IV. SIMULATION AND PARAMETER SETTING

Using netlogo software, we construct a network and add the above-mentioned opinion update rules and set the output of the line graph. Based on previous research, this paper investigates the evolution of public opinion when

there are two competing products and the opinion leaders hold different opinions, thus studying the influence of different types of opinion leaders.

A. Evolution of views when different types of opinion leaders support different competing products

Set the opinion of the V opinion leader to 1, the opinion of the authoritative opinion leader to -1, and set the confidence of the opinion leader $\gamma=1$, confidence level $\epsilon=1$ to indicate that different types of opinion leaders firmly support different competing products respectively, and the opinion leaders' views do not change during the evolution. The evolution of the views of fans and ordinary followers is shown in Fig 2, Fig 3.

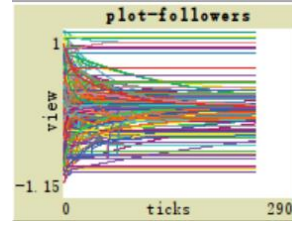


Figure 2

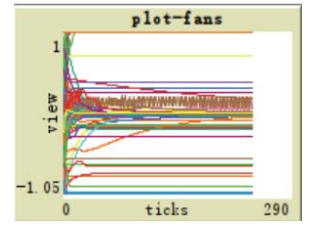


Figure 3

From Fig 2 and Fig 3, we can see that both ordinary followers and fans are influenced by opinion leaders. Fans' viewpoint polymerization effect is better, ordinary followers' viewpoint more dispersed. Most followers tend to be close to neutral views, while a small number of views are maintained by extreme individuals. In addition, the influence of opinion leaders can spread from fans to ordinary followers. By comparing the number of fans with extreme views in the fan evolution chart, we can see that the number of opinion supporters of V opinion leaders is higher after the evolution.

B. Evolution of views when a certain type of opinion leader supports a competing product

This part of the simulation sets the opinion value of V opinion leaders to 1, and the opinion value of authoritative opinion leaders obeys uniform distribution and tends to be neutral, that is, the self-confidence of authoritative opinion leaders is set $\gamma=0.8$. This means that the confidence level of the authoritative opinion leader is set to 1, which means that the V opinion leader supports a product, while the authoritative opinion leader is in a wait-and-see state. The evolution of the opinions of fans and ordinary followers is shown in Fig 4 and Fig 5.

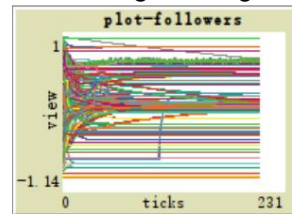


Figure 4

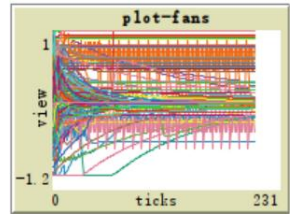


Figure 5

From the figure, we can see that followers are roughly divided into two opinions, neutral and positive point views, but there will be up and down floats. Comparing with the simulation diagram in Part I, when opinion leaders are close enough to their fans' views or have been in contact with them for long enough, they can strongly influence

them; however, it is not yet possible to see which type of opinion leader is at work.

In order to better study the influence of the two opinion leaders, the opinion value of the authoritative opinion leader is set to 1, and the opinion value of the V opinion leader follows a uniform distribution and tends to be neutral, i.e., the confidence of the V opinion leader is set to $\gamma=0.8$. This indicates that the authoritative opinion leaders support a competing product, while the V opinion leaders are in a wait-and-see situation. The evolution of the opinions of fans and ordinary followers is shown in Fig 6 and Fig 7.

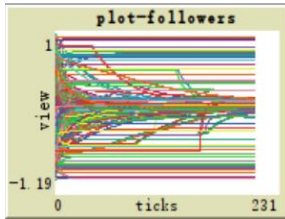


Figure 6

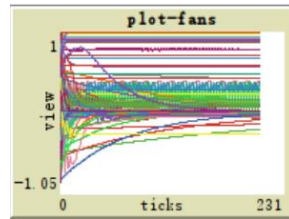


Figure 7

The main difference between the evolution diagram of this case and the previous case is that there are no two more distinct clusters of opinions, only in neutral view attachment aggregation. This comparison shows that V opinion leaders are more influential than authoritative opinion leaders in attracting followers with strong support tendencies or extreme views. Combined with the e-commerce scenario, if a company attracts strongly supportive followers accordingly, it may first consider enlisting the support of V opinion leaders.

V. CONCLUSIONS AND MANAGERIAL IMPLICATIONS

This paper extends the HK model in continuous opinion dynamics by combining today's popular social e-commerce scenarios, constructs a social e-commerce network with both small-world and scale-free properties, and combines the classification types of opinion leaders and follower with the HK model to form different opinion leader-follower viewpoint evolution models based on bounded trust and assertiveness. In addition, integrating e-commerce into opinion dynamics extends the study of opinion dynamics by examining the presence of rival contenders in the network, and the situation of contender supporters. It is found that when two opinion leaders have opposing views on the platform, most of the individual views will be guided to neutral views and some strong supporters will be lost, which is detrimental to the development of competing products; in the case where one side supports the view and the other side holds a neutral view, the V opinion leader with a strong supportive view is more able to attract followers with strong supportive tendencies or extreme views, making the group divided into two parts with different opinions; when the authoritative opinion leader holds a strongly supportive view, the aggregation of group views is not effective, and most individuals tend to have a neutral view.

In real social e-commerce scenarios, opinion leaders can powerfully influence followers when their opinions are close enough to those of their followers, or when they have

been in contact for long enough. When there are opposing competing products, in order to retain and gain more strongly supportive followers one should actively communicate with opinion leaders with opposing views to try to make them eliminate their bad opinions about the product and give priority to gaining the support of V opinion leaders, whose breadth of fan coverage makes them more influential. Exploring the sources of influence of different opinion leaders and constructing simulation networks from real social network data can be considered in future studies.

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