How Information Diffuse in a Nomination Network?

Minghao Wang  
School of Communication  
Hong Kong Baptist University  
Hong Kong SAR, China  
wangminghao@hkbu.edu.hk

Keyu Xu  
School of Communication  
Hong Kong Baptist University  
Hong Kong SAR, China  
19456352@life.hkbu.edu.hk

Xiaohui Wang  
Department of Journalism  
Hong Kong Baptist University  
Hong Kong SAR, China  
v Vincentwx@hkbu.edu.hk

Paolo Mengoni, IEEE Member  
Department of Journalism  
Hong Kong Baptist University  
Hong Kong SAR, China  
p mengoni@hkbu.edu.hk

Abstract—During the special period of the COVID-19 outbreak, this project investigated the driving factors in different information diffusion modes (i.e., broadcasting mode, contagion mode) based on the nomination relations in a charitable social relay campaign on Sina Weibo. Specifically, we mapped a nomination social network and tracked the core communicators in both modes. Besides, we also observed the network from perspectives such as relationships between core communicators and modularity of the whole network. We extracted homophily factors and tested them on representative communities within the largest component of the network. We found that some core communicators distributed in a co-dependent way. At last, we presented several explanations to the phenomenon which can be explored in further research.

Index Terms—information diffusion, social network analysis, community detection, homophily analysis

I. INTRODUCTION

A. Background

Under the influence of the outbreak of COVID-19, Sina Weibo (a Twitter-like social media platform in China) launched a charitable campaign named #手写加油接力# (the “Nomination Campaign”) on February 3, 2020, aiming to encourage people to relay their blessing to Wuhan, China and to cheer for the workers who were fighting on the front line. The participants of this Nomination Campaign were asked to post a picture of their handwritten blessing words along with the hashtag, then nominate their friends using @. Those people who were nominated by others needed to pass on this relay. Half a month later, the Nomination Campaign had 4.17 billion views and more than 30 million engagements (data on February 18, 2020), which can be regarded as a successful viral campaign on Sina Weibo.

B. Related Works

The advent of social media has facilitated the study of information diffusion, user interaction [9] and user influence over social networks [13]. In many previous studies on social media and information diffusion, scholars mainly focused on retweet relations [14] [15] or follower relations [13] [5] to map and analyze the information diffusion network. Actually, nomination is also a common method to generate social map and analyze the information diffusion network. Actually, nomination networks are often used to study the homophily of intimate and small social relationships [1]. The study on the Ice Bucket Challenge, a campaign gained global recognition from digital audiences as one of the most successful disease-related viral campaigns using social media [7], also focused on the homophily of celebrities. Few studies have explored the different information diffusion modes (broadcasting and contagion) in the nomination network. Therefore, in this work we aim to explore the driving factors in different information diffusion modes by exploiting the social network based on the relationship of the senders and nominees in the Nomination Campaign.

Our research consists of two main parts: information diffusion mode of the Nomination Campaign and the related content of Key Opinion Leaders (also can be regarded as core communicators in this study). For Key Opinion Leaders (KOLs), we pay attention to the distribution of different attributes of this group and the structural mode of their collaboration.

C. Information Diffusion mode on Sina Weibo

Previous studies have explored the diffusion characteristics of cancer education information on Sina Weibo and found that information diffusion is driven by a mix of the broadcast and contagion mechanisms in the retweet network [14]. At the same time, “Out-degrees” and “in-degrees” can be regarded as the two key structural characteristics of advertisers on social media [19]. Similarly, for the Nomination Campaign, we raise the following research question:

RQ1: Whether the information diffusion mode of the Nomination Campaign is broadcasting or contagion?

D. Key Opinion Leaders and Their Relationships on Sina Weibo

1) What is Key Opinion Leader: In literature, the definition of Key Opinion Leader (KOLs) differs when referring to the sociological and social media aspects. In this work, we mainly focus on the social media definition of the KOL, referred as someone that has acquired or developed his fame and notability through the Internet 1. In the context of social media, KOLs with different audience amounts have different names and features, such as Wang Hong and micro-celebrities. Wang Hong, i.e. 网红, are celebrities grown up from the Internet especially social media. They usually have a large number of audiences and act as an important role of Chinese digital economy. Micro-celebrities are usually ordinary persons who

1Wikipedia contributors. Internet celebrity — Wikipedia, the free encyclopedia, 2020. [Online; accessed 26-August-2020].
share their mini shows or opinions via mobile phones around a niche group. They don’t have many audiences compared to Wang Hong, but their audiences are much loyal and frequently interacted.

2) KOLs in this Nomination Campaign: During the outbreak of COVID-19 in 2020, online social activities not only be significant in social coordination but also played an important role in the establishment of motivation [18]. On the one hand, the 14-day quarantine period allows people to have more free time to participate in social media. Moreover, people are more attracted to celebrities, which strengthens their online social status [6]. Therefore, if celebrities are active during the outbreak, it will inspire people to increase the possibility of online socialization.

Meanwhile, the other groups, such as peer leaders, unverified, active, well-connected users and medical professionals with ICT experience, they all can play an active role in promoting Social Networking Sites (SNS) [11].

But in this Nomination Campaign, who are the promoters? To explore this problem, we have the following research question:

**RQ2**: Who strongly promoted the Nomination Campaign?

3) The Ways and Causes of KOLs Collaboration in the Nomination Campaign: Homophily refers to “a contact between similar people occurs at a higher rate than among dissimilar people” [8]. It will be easier to form ties based on homophily with the same geographic location or common hobbies between members [12]. A study on the online venue for international expats in Denmark shows that the group manifests itself as a community in terms of attachment to geographical location, degree of mutual responsibility of its members, recognition of communal history pieces, and normativity level [16]. In the previous related works on social media homophily, factors like people’s political views [4] or ethnicity, religion, age, country, and the reasons for joining specific social media platforms [2] are tested.

It seems to be a common phenomenon that users on social media spontaneously form a community for some reason. Since our research is based on Sina Weibo and the nodes in the network are basically entertainment stars, we decided to choose age, school, occupation, employer, the number of followers, and if they are verified as the factors to analyze the homophily. Then we will discuss:

**RQ3**: What makes Sina Weibo KOLs form communities of different sizes?

**II. METHODOLOGY**

A. Data Collection

We used the Python Web Crawler to extract the posts on Sina Weibo that contain the hashtag #手写加油接力#. The popularity of the Nomination Campaign has declined after half a month. Therefore, we selected a time period from February 3 to 18, 2020. All information about the posts have been collected into our dataset: number of retweets, number of comments, number of likes, content and pictures of posts, posting time and location. The senders’ personal profiles were also included: account name and gender, number of followers and followings. In consideration of the complexity of the ordinary accounts, we decided to only extract the verified account. Eventually, we obtained 13740 posts. In the process of data cleaning, firstly, we deleted duplicated rows and then we extracted all nominees from the text of posts that have “@” in it. Because there were many participators without nominating others in their posts and we deleted them. As a result, a total of 4532 posts were retained in the final dataset. Finally, only retained two columns, the sender name and corresponding nominees, as the source and target node for the visualization stage. The final dataset was imported into Gephi to generate the visualization of the network. It was a directed graph with 2256 nodes and 4310 unweighted edges.

B. Information Diffusion Mode of the Nomination Campaign

About the about the broadcasting mode, since the nodes with large out-degree are basically advertisement accounts, we decided to utilize in-degree together with timeline to examine the broadcasting mode. We first calculated the average in-degree in the network to illustrate the normal scale of diffusion. Then we selected the top 10 nodes with the highest in-degree, and extracted their 1-degree egocentric network. Meanwhile, we checked the time of their activities. So, if a node has a high in-degree and its activity is earlier than its neighbors, we regard this node is of the broadcasting mode.

About the contagion mode, the eccentricity (i.e. the distance from a given starting node to the farthest node from it in the network) of nodes are compared with the diameter of the whole network. If the eccentricity is close to the diameter, we regard this node is of the contagion mode.

C. Promoters of the Nomination Campaign

Since we have calculated the key indicators of both modes (i.e. the in-degree and the eccentricity), we regard the top 10 nodes under each indicator are the promoters of the Nomination Campaign.

D. KOLs’ Community Analysis

We first arranged the nodes into different components using Gephi by their component ID, then we calculated the modularity class applying the algorithm proposed by Blondel, Guillaume, Lambiotte, and Lefebvre [3]. We selected the communities within the largest component and conducted portraits from 6 dimensions (i.e. age, school, occupation, employer, the number of followers and if they are verified) of those users and tried to extract some factors of their homophily.

E. Results

Figure 1 shows the whole network of the Nomination Campaign. It is a directed graph with 2256 nodes and 4310 edges. The network has 551 components and its density is 0.001. The average in-degree of the network is 1.584, and Figure 2 shows the top 10 in-degree nodes and their 1-degree egocentric network (the amount of neighbors are annotated below each chart). These 10 focal nodes have 54.400 nodes.
connected around them in average, with a standard deviation of 22.916. The timeline rank (i.e. the appearance rank of the focal nodes among the egocentric network in a decreasing time order) is shown in Table I. As we can see, most focal nodes appeared earlier than their neighbors ($M_{\text{timeline rank}} = 0.175$, $SD_{\text{timeline rank}} = 0.312$). So, we can prove there exists the broadcasting mode in the information diffusion of the Nomination Campaign.

Figure 3 shows the longest path in the network. Both the node size and color correspond to the eccentricity (i.e. bigger and darker nodes have larger eccentricity). The top 10 eccentricity are quite similar ($M = 21.800$, $SD = 0.632$). The diameter of the whole network is 23. So it can be proved that contagion mode is also obvious in the information diffusion of the Nomination Campaign.

Table II illustrates the top promoters of neither mode. There is no overlap between them, and the correlation between them is negative ($r = -0.518$), showing that the relationship between the two modes are fairly negative related. Actually, among the top 10 promoters in the broadcasting mode, a half of them are celebrity themselves, while among the top 10 promoters in the contagion mode, all of them are marketing accounts and fan clubs.

Figure 4 shows the communities within the largest component (contains 683 nodes, 30.275% of all nodes) of the whole network. There are mainly 7 communities within this component. We selected two representative communities to conduct portraits.

As shown in Figure 5, the first community we selected contains users namely “杨幂”, “Dear迪丽热巴”, “张云龙mnc” etc. Table III lists all individual users among this community (decreasingly sorted by the number of their followers). The
TABLE I
THE TIMELINE RANK OF TOP 10 IN-DEGREE NODES.

| name            | timeline rank |
|-----------------|---------------|
| RISE-姚琛       | 0.941         |
| 明星粉丝联盟    | 0.535         |
| 罗云熙Leo       | 0.037         |
| 微博明星        | 0.084         |
| 以啵之名助爱之城 | 0.018        |
| 微博书法        | 0.015         |
| 新浪娱乐        | 0.044         |
| 任嘉伦Allen     | 0.017         |
| 李一桐Q         | 0.022         |
| 谭松韵seven     | 0.042         |

TABLE II
THE TOP 10 PROMOTERS OF NEITHER MODE.

| promoter           | mode          |
|--------------------|---------------|
| RISE-姚琛          | broadcasting  |
| 明星粉丝联盟       | broadcasting  |
| 罗云熙Leo          | broadcasting  |
| 微博明星           | broadcasting  |
| 以啵之名助爱之城  | broadcasting  |
| 微博书法           | broadcasting  |
| 新浪娱乐           | broadcasting  |
| 任嘉伦Allen        | broadcasting  |
| 李一桐Q            | broadcasting  |
| 谭松韵seven        | broadcasting  |
| 林一网宜站         | contagion     |
| 路人甲_张云雷个站  | contagion     |
| 汪苏清官方后援会  | contagion     |
| 林一超话小管家1号 | contagion     |
| 兔子小姐是个哲学家| contagion     |
| 绵绵绵呀           | contagion     |
| 林一反黑站         | contagion     |
| Boogie_王子异全球粉丝后援会 | contagion     |
| 张嘉倪官方后援会  | contagion     |
| 我是小刘同学      | contagion     |

most obvious homophily factor is that they are all belong to the same employer (i.e. 嘉行传媒). And they are all quite young and from the same generation, with an average age of 30.250 (SD age = 3.945). And they all graduated from the most accomplished performing school in China. The are all extremely popular on Sina Weibo, with 27933891.750 followers in average.

The second community we selected is shown in Figure 6 and Table IV. Quite different from the first one, they all belong to different employers (some of their employers are not available from the internet, only broker’s contact). And their ages are of quite large deviation (the youngest one, namely 赵今麦, is underage). They are from quite different schools as well. The average number of their followers is 26342852.500, almost the same as the first community. No obvious homophily factors were found in this community.

III. DISCUSSION

In this study, we aimed to discover the information diffusion modes of the Nomination Campaign on Sina Weibo. By calculating in-degree, we discovered that information disseminates in a broadcasting mode and we also verified that there was a virus-like spreading mode in the network by calculating
chains. One proposed interpretation is that the marketing crew in a relay chain and stars from other exclusive relay marketing accounts interacts with both stars from the same to several star relay groups. For example, a fixed group of groups. One group of marketing accounts is corresponding to one star relay groups. The phenomenon is interesting and offers further research insights by analyzing more connections between fixed star groups and marketing accounts in more scenarios.

Besides, we also observed the relationships between different KOLs based on the network structure. KOLs in the broadcasting mode received in-degree edges from both fan clubs and marketing accounts. Fan club groups always distributed around their idols to support them in the network. Compared to fan clubs, marketing accounts didn’t have such significant preference. However, our analysis shows that there are also specific marketing account groups lying around specific star groups in the network. In details, there are two kinds of distributions.

The first is based on one group to one group. One group of marketing accounts is corresponding to one star relay groups. For example, the marketing accounts lying around “杨幂-迪丽热巴” corporation community only points to members in the community. The suggested interpretation is that there might be in cooperation or marketing accounts aiming to obtain more attention from the public.

The second distribution is based on one group to many groups. One group of marketing accounts is corresponding to several star relay groups. For example, a fixed group of marketing accounts interacts with both stars from the same crew in a relay chain and stars from other exclusive relay chains. One proposed interpretation is that the marketing accounts might want to obtain more public attention. Another possibility could be that this is a marketing strategy used by stars. The phenomenon is interesting and offers further research insights by analyzing more connections between fixed star groups and marketing accounts in more scenarios.

What’s more, we also analysed the connection between different communities by observing the modularity which indicated the dense connection within communities and sparser connections between communities. [10] In our network, modularity is 0.892 which indicates a very dense interactions during the event. However, combining indicators of 1848 strongly connected components and 568 communities, we found that a great amount of small size of components were included in the same group by the algorithm [3], which revealed that many users in the event relayed and enjoyed in a limited circle.

### IV. Conclusion

Our research focused on a charitable social media relay campaign during the most struggling period of COVID-19 pandemic. We studied the information diffusion mode in the campaign, and conducted a series of analysis about KOLs. It gives ideas for the development and communication of such activities in the future. Find the corresponding KOL, attract more attention and participation, and transfer love and positive energy would be effective the communication effects that are supposed to be achieved.

Future works will include the comparison with other relay events also in different settings from the public welfare here analysed. Moreover, we will analyse if the effects discovered on Sina Weibo is applicable to other social media outlets.
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