



Research on Work Strategies and Workflow of Social Bots

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Abstract. Social media is an important influence factor on public opinion. The application of social bots significantly influences the formation and changes in public opinion. This article analyses and concludes the workflow of social bots and divides workflow of social bots into three stages: Deployment, expansion of social network, and unleashing of influence. This article also analyzed the strategy of social bots in these steps. This article finds out that social bots can accelerate the spread of their influence in information cascades through a combination of different strategies. Besides, this article also analyzes the application of these strategies with some cases. This study reveals the working mechanism of social bots and lays a foundation for further analysis of the influence of social bots.

Keywords: social bots · social media · public opinion

1 Introduction

As social bots are becoming essential in forming public opinion on social media, scholars worldwide have set social bots as an essential topic for study. According to Nath and Iswary, social bots will be one of the most significant changes in social media [1]. Wang & Huang [2] also studied the act of social bots on Twitter through different methods. They found out that about 20 percent of accounts that actively comment on topics related to China are social bots. These bots also successfully influence the tendency of public opinion on these topics.

The massive use of social bots has also been discovered to be an essential influence on public opinion. For example, based on an analysis of the 2018 presidential election in the United States, Bessi & Ferrera [3] found that about 20% of accounts that actively communicate on topics related to the election are robots. Both Trump and Hillary massively used social bots to influence the cognition of voters. Bradshaw et al. [4] studied social media platforms of 28 countries and found that social bots have been massively deployed in social media platforms of some countries, like South Korea and Venezuela. Social bots in these countries upvote and retweet fake news on a large scale, which leads to a massive influence on human users and storms of fake news in public opinion.

However, there are still blanks in the study of social bots. Contemporary studies of social bots mostly focus on several specific steps in the work of social bots and the

identification of social bot accounts with machine learning or modeling based on analysis of these steps. For example, Shi et al. [5] investigated social bot activities during the COVID-19 pandemic. They found that social bots mainly retweet information unleashed by other sources, like media and human users. Social bots tend to retweet content and take a particular stance. Zhang et al. [6] proposed to analyze the influence spreading actions of social bots through group action and adapt communication theory to the analysis of social bots' actions. They discovered that the influence of social bots could be maximized when an echo chamber was constructed.

Thus, social bot controllers may execute a collective retweet and unleash information between organized social bot accounts. Because contemporary studies mainly focus on specific steps of social bots' workflow and need more comprehensive and detailed analysis, two aspects of their shortcomings need to be remedied.

To begin with, there is no analysis of which step of the whole workflow may amplify the effect of social bots, and the level of such amplification is also rarely studied. Second, the variation of workflow execution by social bots under various conditions is a current research gap.

In order to compensate for these two gaps in studies on the workings of social bots, this study comprehensively concluded and analyzed the whole workflow of social bots. Secondly, this article also discusses the effect of various steps taken by social bots under several possible circumstances.

2 Workflow of Social Bot Development

Based on analyze and conclude, this article divides the workflow of social bots into three stages: Deployment stage, social network expansion stage, and influence unleash step. In this chapter, these stages and the communication strategies that may be used in these steps are introduced respectively.

2.1 Deployment of Social Bots

Procedure of deployment stage: The first step in this stage is to create many social media accounts. In this step, the controller of social bots can use many ways to improve the efficiency of massive creation of accounts [7]. For example, the creator can use optical character recognition and machine learning to bypass the CAPTCHA system of social media; the controller can also use a botnet to cheat the infected social media account owners and make them open their accounts themselves; the APPs (applications) of social media can also be cracked. At the end of this step, the controller of social bots may use an online crawler to collect massive amounts of individual information about human users, like usernames, gender, interests, and photos. The controller uses this information to fill in the profile of bot accounts, which can make bot accounts more like accounts controlled by generic human users. After the creation of accounts, the creation of database and initial social network begins. See Fig. 1 for integrated workflow in deployment stage:

After creating accounts, the controllers may use network crawlers and machine learning to build up the interaction and feedback capabilities of social bots when communicating with human users. According to Wang et al. [8], the controllers use network crawlers

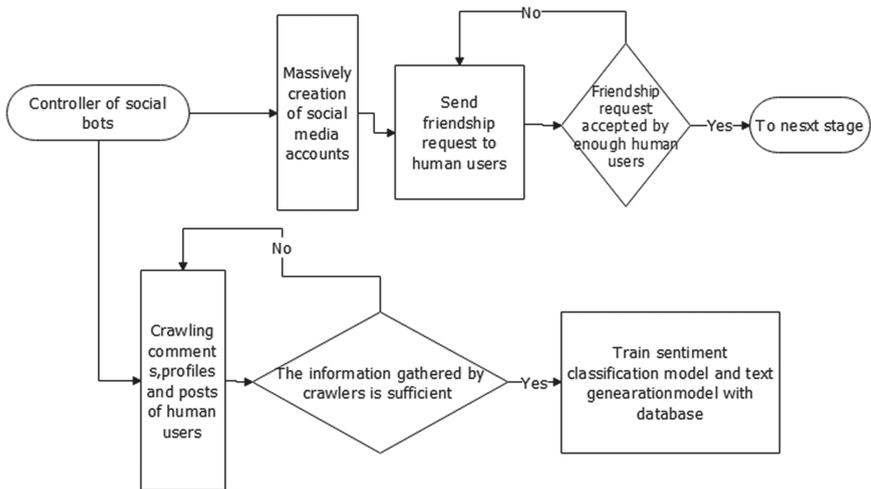


Fig. 1. The Deployment stage in workflow of social bots

to collect four types of information about human users: social network information, profile information, posts, and comments. The information gathered by a network crawler would be saved in a database. Based on the database, the controller trains a sentiment classifier to distinguish positive and negative comments. The controller also uses the database to train a text generation model, which can give the social bots the capability to generate comments with a specific tendency.

The final step of deploying social bots is to construct a social network for the bots. According to Bilge [9], human users are less willing to accept friendship requests sent from forged users than human users. Human users would accept about 60% of friendship requests from forged users.

A possible strategy of social bots in this strategy is to construct a “profile setting” on social media through the social media account homepage profile. Several characteristics may make social bots more likely to attract and influence human. According to studies [10], setting gender as female and using photos of real humans can increase the possibility of attracting human users. However, such an increase is slight because, as for human users, the gender setting of friends on social media may not be the same as their gender in the real world. It can be set casually, so it would not require additional attention from human users. Similarly, using photos of real humans in profiles may not lead to an increase in social network construction efficiency.

Increasing the frequency of sending friendship requests may increase the efficiency of the deployment stage because it helps to construct social networks, which means an increased possibility of being noticed by more human users. Meanwhile, send friendship requests only to users who consistently act on the specific topics. This strategy may increase the efficiency of the influence unleash stage, thus increasing the overall efficiency of workflow, because it may result in more active feedback from human users. The effect may be obvious when it is activated, retweeted, or commented on to unleash influence.

2.2 Social Network Expansion of Social Bots

Procedure of social network expansion stage: The second stage in social bots' workflow is expanding the social network. See Fig. 2 for integrated workflow of this stage:

The ultimate purpose of this stage is to maximize the number of users in the social network of bots. These users should be interested in the topic that the social bots will influence in the third stage. Firstly, after the deployment of social bots, they would be activated at a specific, preset time. After it is activated, the social bots automatically search for the preset keywords in all posts, comments, and retweets posted by their friends on social media. These friends are selected from the social network inferred in the deployment stage, they mostly post or retweet information related to the preset topic of social bots. After gathering information from friends, the social bots re-rank all messages according to the descending order of posting time, ensuring the social bots can give timely feedback to the most recent related message. The social bots filter messages with a keyword filtration model. Thus, social bots can select information related to preset topics. If the information containing the keyword is a retweeted message, then the social bots send friendship requests to the original poster of this message. This stage ends when the social bot meets the upper limit of friend quantity on social media platforms.

In this stage, the main purpose of social bots may be to draw more attention to social media. According to Danisch et al. [11], the social bots may build a reticular structure in their social network, which contains various social bots' content. This reticular structure of social bots enables social bots to retweet each other and form an information cascade. Furthermore, social bots can create a centralized structure, which can help with the creation of new opinion leaders via social bots. Zhao et al. [12] analyzed the public opinion intervention of social bots on Twitter, found a social bot account created in February 2022 became an opinion leader with 53,000 fans. The research team analyzed

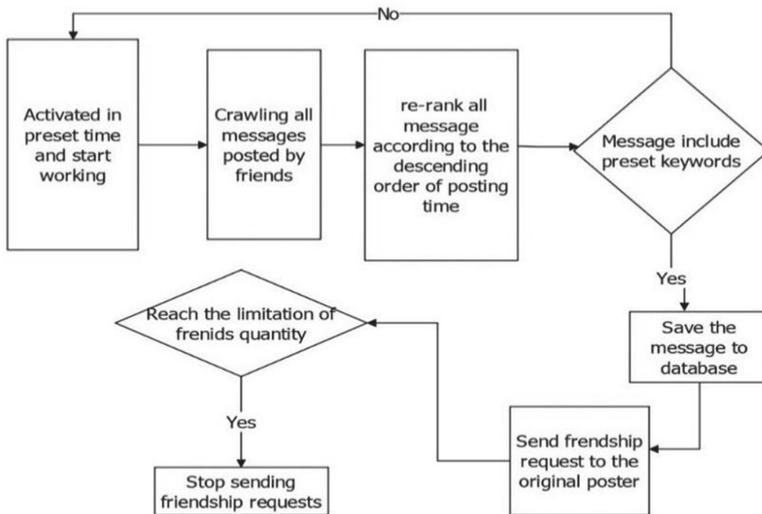


Fig. 2. The Social network expansion stage in workflow of social bots

the retweets of its most popular posts and found that almost half of the friends that frequently retweet the popular posts of this opinion leader are social bots in a centralized structure of a social network composed of robots.

Meanwhile, social bots may also build up a close social media community that simply includes specific information sources and human users in specific stances. Social bots can influence public opinion by spreading the posts in this community. For example, Hagen and his research partners [13] analyzed the prevalence, behavior, and influence of political, and social bots in a Twitter network related to the 2016 election in the United States. They found out that in specific social media communities, like “far-right” communities, many members in communities are social bots. These bots connect to minority human users in the community and amplify their opinions. Meanwhile, the social bots also obscure the sources and human users that do not take a far-right stance, which may lead to the humans in the close social networks keeping their stance more steadily and increasing the strength of the social community.

2.3 Influence Release Stage of Social Bots

In this stage, social bots influence public opinion by generating comments, retweeting, and posting information. In this stage, social bots mainly accomplish their mission through two types of actions: actions that change the structure of their social network, also referred to as SS actions (Social Structure actions); actions that influence other users through retweeting, “like” and commenting posts, also known as SI actions (Social Interaction actions). In this stage, the social bots begin with identifying the sentiment and stance of content posted by other content through the sentiment identification model trained in the first stage. The social bots would focus on the contents corresponding to the preset sentiment of the sentiment identification model. This process can help social bots confirm the object of an interaction. According to related studies, at this stage, social bots may retweet content to users with the same stance, and bots may also intentionally retweet content to users with opposite stances to trigger an opinion conflict, which may draw more attention from human users [8].

After confirmation of interactive objects, the social bots may apply the database to generate contents. See Fig. 3 for the integrated procedure in this stage, including confirmation of objects and generation of contents:

The social bots use a text generation model trained in stage I to generate comments and posts with specific stances to interactive objects. Besides, social bots also rank interactive objects according to their importance in social media communities and interact with high-influence objects first [14, 15].

In the first stage, the social bots may increase the frequency of friendship requests; social bots may also simply send requests to users active in topics related to the preset topic. In the second stage, social bots may build a reticular structure or a closed structure. In the third stage, social bots may massively retweet information with the same hashtag or post much irrelevant information to mislead public opinion of public disagree with the preset opinion. Social bots also try to use the SS strategy to become opinion leaders or try to influence opinion leaders by inferring them in comments.

Hashtags are an essential function of social media. It allows users to concentrate different types of content, like text, videos, and photos, on a specific subject. Users can

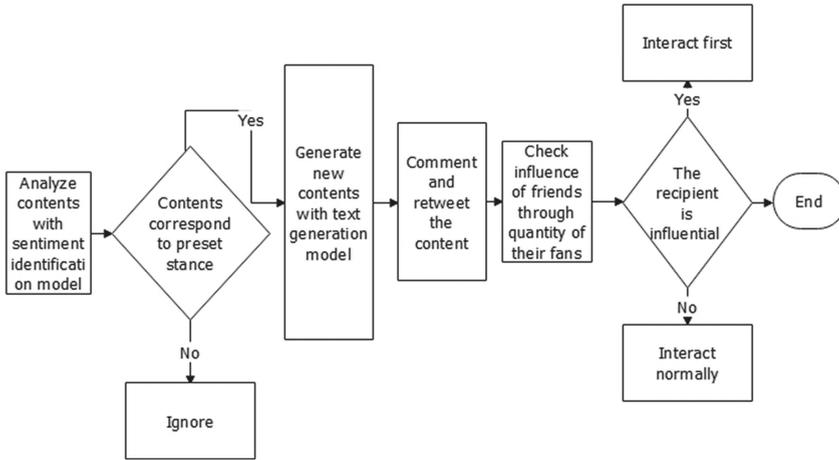


Fig. 3. The influence release stage of social bots

focus on the content by retweeting it with the same hashtag. Social bots can use hashtag campaigns in this stage to influence public opinion on specific topics. On the one hand, social bots may massively retweet content under the same hashtags; on the other hand, social bots may “boycott hashtags,” which means they will massively post irrelevant content to mislead users who disagree with the preset opinion of social bots.

Besides, social bots may strategically use SS action to place themselves as the center of public opinion. Social bots may become opinion leaders or influence opinion leaders to form an information cascade and amplify the spread of information. Social bots may also try to influence opinion leaders by referring to influential users.

In conclusion, the workflow of social bots includes three stages: deployment, expansion of social networks, and release of influence. In the first step, controllers massively create accounts, train sentiment evaluation and text generation models, and give bots an initial social network. In the second step, social bots are activated and crawl information related to preset keywords. Social bots can identify users who may be interested in the preset topic at this stage. This stage comes to an end after social bots maximize their social network. In the third stage, social bots use a sentiment identification model to identify contents corresponding to preset stances and use a text generation model to comment on these contents. Social bots also rank users based on the number of followers they have and retweet comments to influential users in order to influence them.

3 Analysis of Social Bots Strategies Under Two Circumstances

3.1 Classification of Competitive Public Opinion Agendas

According to studies [16] and [17], the internet cannot obtain limitless expression of individuals. Space for expressing opinions and stances in social media is limited. As a result, the essence of public opinion development is a competition of expression between opposing groups. The importance, Fuzziness, and controversiality of public opinion may

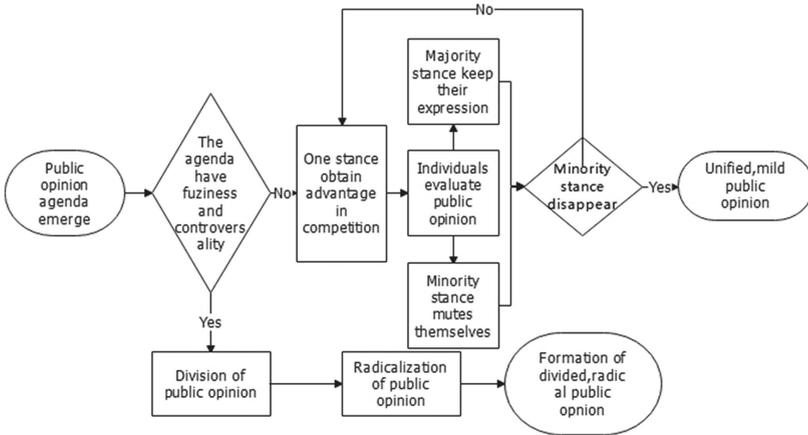


Fig. 4. The formation of public opinion

influence the process of public opinion agenda development. Because such agendas tend to influence the public’s interests or daily life, their importance leads to an increase in interaction frequency. See Fig. 4 for the formation of public opinion:

The Fuzziness of agenda may influence its controversiality, increase of controversiality means the quantity and accuracy of information about public opinion agenda is insufficient, thus increasing the controversiality of the agenda.

The third influence factor on the public opinion agenda is controversiality. With the increase in controversiality, the probability of antagonism between different groups would increase. Thus, public opinion may be divided and radicalized. Under such circumstances, participants who hold conflicting views may repeatedly strengthen their own views, and ultimately leads to radicalization and division of public opinion. Otherwise, because of the spiral of the silent effect, supporters of the minority stance in public opinion may feel the stress of disadvantage and gradually become silent.

3.2 Evaluation of Social Bots’ Strategies in Three Stages Under Different Public Opinion Circumstances

In the deployment stage, the strategy of social bots may be to build up the profiles of accounts, increase the frequency of sending friendship requests, and intentionally send requests to actors that are active under topics related to preset topics. These strategies are more effective in a unified and mild public opinion situation because a unified situation means friendship requests from social bots are more likely to be passed by human users supporting different opinions. However, such strategies may need to be more effective in a divided and radical public opinion. According to research on the 2016 US presidential election [18], communicating with accounts holding opposing views in a radical and divided public opinion environment promotes the process of division and radicalization. Thus, these strategies cannot influence users to disagree with the preset opinions of social bots.

In the social network expansion stage, social bots may build up a closed social network. The majority of this network is bots, and a minority of this network is human users. The social bots may selectively cover information sources that do not correspond to the social bots' preset stance. In the circumstance of a divided and radical public opinion environment, this strategy probably forms an echo chamber, and this strategy can also strengthen the stability of the echo chamber.

However, under the circumstance of open and unified public opinion circumstance, the efficiency of a closed social network may be lower than that of an open, reticulate social network. In an open, reticulate social network, social bots have a better chance of influencing opinion leaders and the general public. Besides, an open social network can exaggerate its influence on the public by forming an information cascade through retweet actions between social bots.

In the influence release stage, social bots may execute hashtag campaigns, including retweeting information with specific hashtags and massively posting irrelevant information in the hashtag of opposite opinions. The hashtag campaign may be effective in circumstances of divided and radical public opinion circumstances because it can not only misdirect the communication of supporters of opposite opinions but also stop them from receiving information related to preset opinions. As a result, opinions supported by social bots may gain more space for expression on social media.

The social bots may also try to set themselves as the center of social networks, which may be more effective in an open public opinion environment than a divided environment because opinion leaders in an open environment may have the opportunity to gain more fans and influence.

4 Analysis of Social Bots' Application Scenarios

The application of social bots includes various scenarios, including forming up echo chambers, expanding influence of hotspot and competitive opinion expression. In this part, the application of social bots under these scenarios would be analyzed. See Table 1 for the effects of social bots' strategies under various scenarios:

4.1 Echo Chamber

Studies have proved that users with similar interests and content preferences tend to form a homogeneous cluster intentionally or unintentionally on social media called an "echo chamber." Social bots can play a significant role in an echo chamber. When bots actively post content and imitate human users, it shows no apparent difference in perceptions of credibility between humans and bots. Thus, it can increase the audience of some sources. As illustrated in the previous paragraphs, social bots selectively support some sources because the expression on social media is limited, and selective source access leads to the formation of an echo chamber.

The "backfire effect" would be used by the social bots to build an echo chamber. According to the use and gratifications theory, the reason why people use media is to meet a certain psychological need rather than acquire knowledge. Because persuasion and denial may endanger people's psychological needs, they may become more insistent

Table 1. Social bots' activities and effects in different scenarios

Application scenario	Activities of social bots	Effect of bot activities
Echo chamber	Selectively support some sources and mute other sources Use backfire effect, support human users at first and intentionally provide opposite opinion	Forming up and strengthen echo chamber
Forming up of a new hotspot agenda	Post and retweet news with negative sentiment and polarized news	Trigger wide spread of news
Comparative opinion expression	Activate opinion leader accounts Mention opinion leaders in posts and retweets Collectively retweet posts from one specific social bots account	Generate new opinion leaders or make more existed opinion leaders attend the competition of opinion expression

on their own point of view. Thus, another strategy of social bots in constructing echo chambers is: to agree with the opinion of the public, attract followers, and then release the opposite opinion. Thus, the audience that accessed the opposite view conversely amplified their original view. Thus, when the social bots stop posting the opposite view, the construction and stabilization of the echo chamber will be achieved. For example, Bauman and his research team [19] modeled and analyzed echo chambers' formation in American politics' social media communities. The research team uses social bots to provide information to human users who support the Democratic and Republican Party, respectively. Nevertheless, the information that social bots supplied was opposite to the audience's political tendency. As a result, the research team discovered the formation of an echo chamber and the polarization of the audience on both sides.

4.2 Forming Up of a New Hotspot Agenda

The formation of a new agenda heavily relies on the emotion of related news. Polarized news and news with negative sentiments are more likely to promote the spread of the agenda.

Thus, in order to spread news, social bots may intentionally select negative and polarizing news and retweet it in order to accelerate the agenda's influence spread. According to studies on Twitter [20], the sentiments of human users and social bots have a high degree of similarity; social bots frequently post and retweet information with apparent "fear" and "anger" sentiments. These sentiments can strongly influence the sentiment of human users, the sentimental changes of human users are so strongly influenced by social bots that researchers can forecast the sentimental changes of humans

through the quantity of information released by social bots with negative sentiments. The most influential sentiment is “fear.”

4.3 Comparative Opinion Expression

According to a comparative modeling study of social bots and humans, although social bots have faster information posting and retweeting speeds than human users, the most decisive factor in competitive opinion expression is the tendency of opinion leaders. Thus, in the comparative opinion expression scenario, social bots’ primary strategy is accessing more opinion leaders.

Besides, social bots also produce opinion leaders automatically to generate influence [13]. On the one hand, social bots frequently mention existing opinion leaders in retweets and comments to entice opinion leaders. Meanwhile, the social bots may execute a combined action, retweeting posts from specific social bot accounts to make this account attractive and persuasive for human users.

An example of this scenario is the opinion conflict related to the Russia-Ukraine conflict on Twitter. In the opinion expression competition related to the Russia-Ukraine conflict, many opinion leader social bots were activated to engage in the competition [13]. The deployment time of these accounts can be dated back to 2007. On the one hand, these accounts release information related to the conflict with high frequency. On the other hand, because many social bots need a deeper, identical connection with Russia-Ukraine to make their content more convincing, these bots changed their profiles and camouflaged their accounts as politicians’ accounts.

5 Summary

In order to analyze the workflow of social bots, this article makes an in-depth study and analysis of social bots and divides the workflow of social bots into three stages. Besides, this article concludes with probable strategies of social bots in each stage. Finally, this article evaluates the efficiency of these strategies under different public opinion circumstances. Based on the strategies and workflow of social robots, the impact of social robots on public opinion will be the focus of future research.

Acknowledgments. This paper is supported by the key project of the 13th Five-Year Plan of the China Education Technology Association. The project name is “Innovation education of artificial intelligence robot technology (project No. [2017] QY119)”.

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