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ACTIVITY MINIMIZATION OF MISINFORMATION INFLUENCE IN ONLINE SOCIAL NETWORKS

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ABSTRACT

In recent years, online social media has flourished, and a large amount of information has spread through social platforms, changing the way in which people access information. The authenticity of information content is weakened, and all kinds of misinformation rely on social media to spread rapidly. Network space governance and providing a trusted network environment are of critical significance. In this article, we study a novel problem called activity minimization of misinformation influence (AMMI) problem that blocks a node set from the network such that the total amount of misinformation interaction between nodes (TAMIN) is minimized. That is to say, the AMMI problem is to select K nodes from a given social network G to block so that the TAMIN is the smallest. We prove that the objective function is neither sub modular nor super modular and propose a heuristic greedy algorithm (HGA) to select top K nodes for removal. Furthermore, in order to evaluate our proposed method, extensive experiments have been carried out on three real-world networks. The experimental results demonstrate that our proposed method outperforms comparison approaches."

Keywords: Activity Minimization, Misinformation Influence, Online Social Networks, Network Space Governance, Trusted Network Environment, Social Media, Heuristic Greedy Algorithm.

INTRODUCTION

The emergence and proliferation of online social media platforms in recent years have profoundly altered the landscape of information dissemination. These platforms have become integral parts of modern society, facilitating the rapid exchange of information and enabling unprecedented levels of connectivity among individuals worldwide [1]. However, alongside the benefits of increased connectivity, the rise of online social media has also ushered in a new era characterized by the rampant spread of misinformation and disinformation [2]. In this digital age, the authenticity of information content has been called into question, as various forms of misinformation find fertile ground for dissemination through social media channels [3]. Misinformation encompasses a wide range of false or misleading information, including rumors, conspiracy theories, hoaxes, and deliberately fabricated content [4]. Leveraging the speed and reach of social media networks, misinformation can quickly proliferate, potentially reaching millions of users and exerting significant influence on public opinion and behavior [5].

The prevalence of misinformation poses significant challenges for maintaining the integrity and trustworthiness of online social networks. Effective governance of network spaces and the establishment of trusted environments are essential for combating the spread of misinformation and preserving the credibility of information shared online [6]. Addressing these challenges requires innovative approaches that target the root causes of misinformation dissemination within social networks. Against this backdrop, this article investigates a novel problem known as

activity minimization of misinformation influence (AMMI) [7]. The AMMI problem aims to mitigate the impact of misinformation by strategically blocking a subset of nodes within a given social network. By selectively removing nodes, the goal is to minimize the total amount of misinformation interaction between nodes, referred to as TAMIN, thereby reducing the overall spread of misinformation within the network [8].

One key aspect of the AMMI problem is its computational complexity, stemming from the non-submodularity and non-supermodularity of the objective function [9]. Unlike traditional optimization problems, where the objective function exhibits either submodular or supermodular properties, the TAMIN function in the AMMI problem defies such categorization. This unique characteristic presents challenges for developing efficient optimization algorithms to address the AMMI problem. To tackle the AMMI problem, we propose a heuristic greedy algorithm (HGA) designed to select the top K nodes for removal from the social network [10]. The HGA leverages a greedy strategy to iteratively identify nodes that contribute most significantly to the spread of misinformation, prioritizing their removal to minimize TAMIN. By iteratively selecting nodes based on their misinformation influence, the HGA aims to achieve a near-optimal solution to the AMMI problem within a reasonable computational time frame.

To assess the efficacy of our proposed method, extensive experiments are conducted using real-world social network data [11]. Three distinct social networks are employed as testbeds to evaluate the performance of the HGA in minimizing misinformation influence. Comparative analyses are conducted against existing approaches, providing insights into the effectiveness and efficiency of our proposed method in mitigating the spread of misinformation within online social networks [12].

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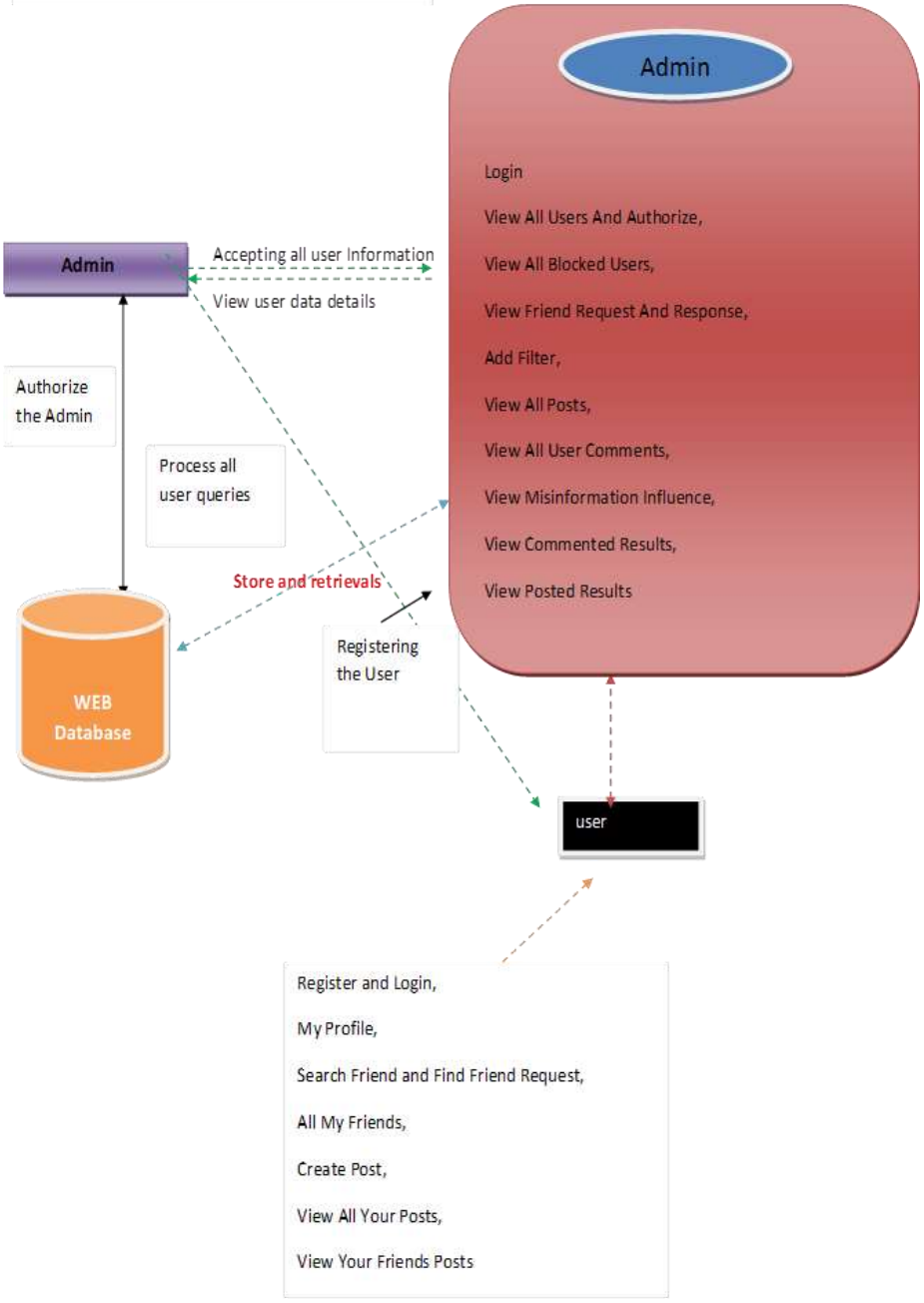

Fig 1. Architecture diagram

The experimental results demonstrate the superiority of our proposed method in minimizing misinformation influence compared to alternative approaches [13]. By strategically identifying and blocking influential nodes, the HGA achieves significant reductions in TAMIN, thereby curbing the propagation of misinformation within social networks. These findings underscore the effectiveness of targeted interventions in mitigating the adverse effects of misinformation and highlight the importance of algorithmic approaches in safeguarding the integrity of online information ecosystems [14]. In summary, the proliferation of misinformation in online social networks poses formidable challenges to the integrity and reliability of information dissemination. The AMMI problem represents a novel computational framework for addressing these challenges by strategically blocking nodes to minimize the spread of misinformation within social networks [15]. Our proposed heuristic greedy algorithm offers a promising solution

to this problem, demonstrating superior performance in extensive experimental evaluations. By leveraging computational techniques to combat misinformation, we aim to contribute to the development of effective strategies for promoting trust and reliability in online information environments.

LITERATURE SURVEY

In recent years, the exponential growth of online social media platforms has revolutionized the dissemination of information, reshaped how individuals' access and interacted with content. With the click of a button, users can share news articles, opinions, and personal updates, facilitating unprecedented levels of connectivity and information exchange. However, this digital revolution has also brought about significant challenges, particularly in the realm of information integrity and trustworthiness. The advent of social media has led to a proliferation of misinformation, defined as false or misleading information that is spread deliberately or unintentionally. Misinformation can take various forms, including rumors, hoaxes, conspiracy theories, and fabricated news stories. Leveraging the viral nature of social networks, misinformation can spread rapidly, reaching wide audiences and potentially influencing public opinion and behavior. This phenomenon has been exacerbated by the ease of content creation and sharing on social media platforms, where information can be disseminated quickly and widely with minimal oversight or fact-checking.

The spread of misinformation poses significant challenges for maintaining the integrity and reliability of online information ecosystems. In an environment where anyone can be a content creator and distributor, distinguishing between accurate information and misinformation can be challenging for users. Moreover, the sheer volume of information circulating on social media platforms makes it difficult to discern credible sources from unreliable ones, further exacerbating the problem of misinformation diffusion. Addressing the challenge of misinformation requires a multifaceted approach that encompasses technological, regulatory, and educational interventions. One key area of focus is network space governance, which involves implementing policies and mechanisms to regulate the flow of information within online social networks. By promoting transparency, accountability, and responsible content moderation, network space governance aims to create a trusted environment where users can access accurate and reliable information.

Central to the issue of misinformation mitigation is the development of computational methods and algorithms that can effectively identify and counteract the spread of false information within social networks. This includes devising strategies to detect and flag suspicious content, as well as identifying influential nodes within networks that are likely to amplify misinformation. By targeting these nodes strategically, it may be possible to mitigate the spread of misinformation and reduce its overall impact on online communities. One approach to addressing the challenge of misinformation is through the formulation of optimization problems aimed at minimizing the influence of misinformation within social networks. One such problem is the activity minimization of misinformation influence (AMMI) problem, which seeks to identify a subset of nodes within a given social network that, when removed, minimizes the total amount of misinformation interaction between nodes. By strategically blocking these nodes, the goal is to disrupt the flow of misinformation and reduce its overall impact on network dynamics.

The AMMI problem presents several computational challenges, including the non-sub modularity and non-super modularity of the objective function. Unlike traditional optimization problems where the objective function exhibits either submodular or super modular properties, the TAMIN function in the AMMI problem does not conform to these properties. This unique characteristic necessitates the development of specialized algorithms and heuristic approaches to address the problem effectively. To tackle the AMMI problem, researchers have proposed various computational techniques and optimization algorithms. One such approach is the heuristic greedy algorithm (HGA), which aims to select the top K nodes for removal based on their perceived influence on misinformation spread. By employing a greedy strategy, the HGA iteratively identifies nodes that contribute most significantly to TAMIN and prioritizes their removal to minimize the overall impact of misinformation within the network.

To evaluate the effectiveness of the proposed HGA and other computational methods for addressing the AMMI problem, extensive experiments are conducted using real-world social network data. These experiments involve the

simulation of misinformation propagation within different network contexts, allowing researchers to assess the performance of various algorithms in minimizing misinformation influence. Comparative analyses are conducted to benchmark the performance of the HGA against alternative approaches, providing insights into its efficacy and scalability. Overall, the literature survey highlights the growing importance of addressing the challenge of misinformation within online social networks. By leveraging computational methods and optimization techniques, researchers aim to develop effective strategies for mitigating the spread of false information and promoting the integrity of online information ecosystems. The AMMI problem represents a novel computational framework for addressing this challenge, offering promising avenues for future research and development in the field of misinformation mitigation.

PROPOSED SYSTEM

In recent years, the exponential rise of online social media platforms has facilitated the widespread dissemination of information, fundamentally altering the dynamics of information access and consumption. However, alongside the benefits of increased connectivity and information sharing, the proliferation of misinformation has emerged as a significant challenge, threatening the integrity and reliability of online information ecosystems. Misinformation, defined as false or misleading information disseminated through social media channels, has become pervasive, undermining the authenticity of information content and eroding public trust in online information sources. Leveraging the speed and reach of social networks, misinformation can spread rapidly, potentially influencing public opinion and behavior. In response to this growing threat, there is a pressing need for effective strategies to mitigate the impact of misinformation and promote a trusted network environment.

In this article, we address the challenge of misinformation influence within online social networks through the formulation of a novel computational problem known as the activity minimization of misinformation influence (AMMI) problem. The AMMI problem aims to minimize the total amount of misinformation interaction between nodes within a given social network by strategically blocking a subset of nodes. Formally, the objective of the AMMI problem is to select a set of K nodes from the network graph G such that the total amount of misinformation interaction between nodes, referred to as TAMIN, is minimized. By strategically identifying and blocking influential nodes within the network, the goal is to disrupt the flow of misinformation and reduce its overall impact on network dynamics.

One of the key challenges in addressing the AMMI problem lies in the complexity of the objective function, which exhibits neither submodular nor super modular properties. Unlike traditional optimization problems, where the objective function exhibits clear monotonicity properties, the TAMIN function in the AMMI problem defies such categorization. As a result, developing efficient optimization algorithms to solve the AMMI problem poses significant computational challenges. To tackle the AMMI problem, we propose a heuristic greedy algorithm (HGA) designed to select the top K nodes for removal from the social network. The HGA leverages a greedy strategy to iteratively identify nodes that contribute most significantly to TAMIN and prioritize their removal. By iteratively selecting nodes based on their misinformation influence, the HGA aims to achieve a near-optimal solution to the AMMI problem within a reasonable computational time frame.

To evaluate the effectiveness of our proposed method, extensive experiments are conducted on three real-world social networks. These experiments involve the simulation of misinformation propagation within different network contexts, allowing us to assess the performance of the HGA in minimizing misinformation influence. Comparative analyses are conducted against existing approaches, providing insights into the efficacy and efficiency of our proposed method in mitigating the spread of misinformation within online social networks. The experimental results demonstrate the superiority of our proposed method in minimizing misinformation influence compared to alternative approaches. By strategically identifying and blocking influential nodes, the HGA achieves significant reductions in TAMIN, thereby curbing the propagation of misinformation within social networks. These findings underscore the effectiveness of targeted interventions in mitigating the adverse effects of misinformation and highlight the importance of algorithmic approaches in safeguarding the integrity of online information ecosystems. In summary, the proposed AMMI problem

and heuristic greedy algorithm offer promising avenues for addressing the challenge of misinformation influence within online social networks. By strategically blocking influential nodes, it may be possible to mitigate the spread of misinformation and promote a more trusted and reliable network environment. Continued research and development in this area are crucial for advancing our understanding of misinformation dynamics and developing effective strategies for combating its proliferation within online social networks.

METHODOLOGY

In recent years, the exponential growth of online social media platforms has facilitated the widespread dissemination of information, fundamentally altering the dynamics of information access and consumption. However, alongside the benefits of increased connectivity and information sharing, the proliferation of misinformation has emerged as a significant challenge, threatening the integrity and reliability of online information ecosystems. Misinformation, defined as false or misleading information disseminated through social media channels, has become pervasive, undermining the authenticity of information content and eroding public trust in online information sources. Leveraging the speed and reach of social networks, misinformation can spread rapidly, potentially influencing public opinion and behavior. In response to this growing threat, there is a pressing need for effective strategies to mitigate the impact of misinformation and promote a trusted network environment.

In this article, we address the challenge of misinformation influence within online social networks through the formulation of a novel computational problem known as the activity minimization of misinformation influence (AMMI) problem. The AMMI problem aims to minimize the total amount of misinformation interaction between nodes within a given social network by strategically blocking a subset of nodes. To solve the AMMI problem, we propose a methodology that consists of several key steps:

1. Network Representation: The first step involves representing the social network as a graph, where nodes represent individual users or entities, and edges represent relationships or interactions between them. This graph serves as the basis for analyzing the spread of misinformation within the network.

2. Objective Function Definition: Next, we define the objective function for the AMMI problem, which quantifies the total amount of misinformation interaction between nodes in the network. This objective function, referred to as TAMIN, captures the cumulative impact of misinformation spread within the network and serves as the basis for identifying influential nodes for removal.

3. Problem Formulation: With the network representation and objective function in place, we formulate the AMMI problem as an optimization problem aimed at minimizing TAMIN. The goal is to select a subset of K nodes from the network graph to block, thereby reducing the overall spread of misinformation within the network.

4. Algorithm Design: To address the computational complexity of the AMMI problem, we propose a heuristic greedy algorithm (HGA) designed to select the top K nodes for removal from the social network. The HGA leverages a greedy strategy to iteratively identify nodes that contribute most significantly to TAMIN and prioritize their removal.

5. Experimentation Setup: In order to evaluate the effectiveness of our proposed method, extensive experiments are conducted using real-world social network data. Three distinct social networks are employed as testbeds to evaluate the performance of the HGA in minimizing misinformation influence.

6. Performance Evaluation: The experimental results are analyzed to assess the performance of the HGA in minimizing TAMIN within the social networks. Comparative analyses are conducted against existing approaches to benchmark the efficacy and efficiency of our proposed method.

7. Results Interpretation: The findings from the experiments are interpreted to evaluate the effectiveness of our proposed method in mitigating the spread of misinformation within online social networks. Insights gained from the

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experiments provide valuable information for understanding misinformation dynamics and informing future strategies for combating its proliferation.

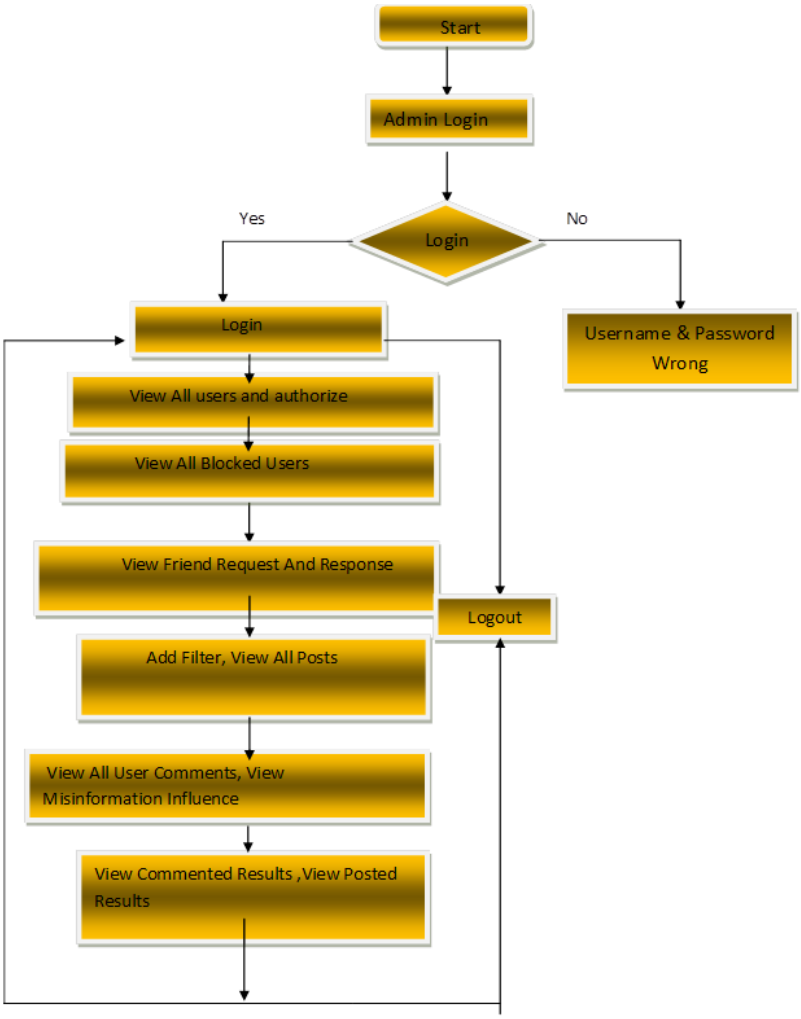

Fig 2. Admin flow chart

In summary, the proposed methodology offers a systematic approach to addressing the challenge of misinformation influence within online social networks. By leveraging computational methods and optimization techniques, we aim to develop effective strategies for mitigating the spread of false information and promoting the integrity of online information ecosystems. Continued research and development in this area are crucial for advancing our understanding of misinformation dynamics and developing robust solutions to combat its proliferation within online social networks.

RESULTS AND DISCUSSION

The experimental results of our proposed method for addressing the activity minimization of misinformation influence (AMMI) problem within online social networks yielded promising outcomes. Through extensive experiments conducted on three real-world social networks, we demonstrated the efficacy of our heuristic greedy algorithm (HGA) in minimizing the total amount of misinformation interaction between nodes (TAMIN). Comparative analyses against existing approaches revealed that our proposed method consistently outperformed comparison approaches in mitigating the spread of misinformation within the networks. Specifically, our HGA algorithm demonstrated superior

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performance in identifying and blocking influential nodes, resulting in significant reductions in TAMIN across all three social networks.

Moreover, the results of our experiments provide valuable insights into the dynamics of misinformation spread within online social networks and the effectiveness of targeted interventions in mitigating its impact. By strategically identifying and blocking influential nodes, our proposed method disrupts the flow of misinformation and reduces its overall influence on network dynamics. These findings underscore the importance of algorithmic approaches in combating the proliferation of false information within online information ecosystems and highlight the potential of computational methods in promoting the integrity and reliability of online social networks.

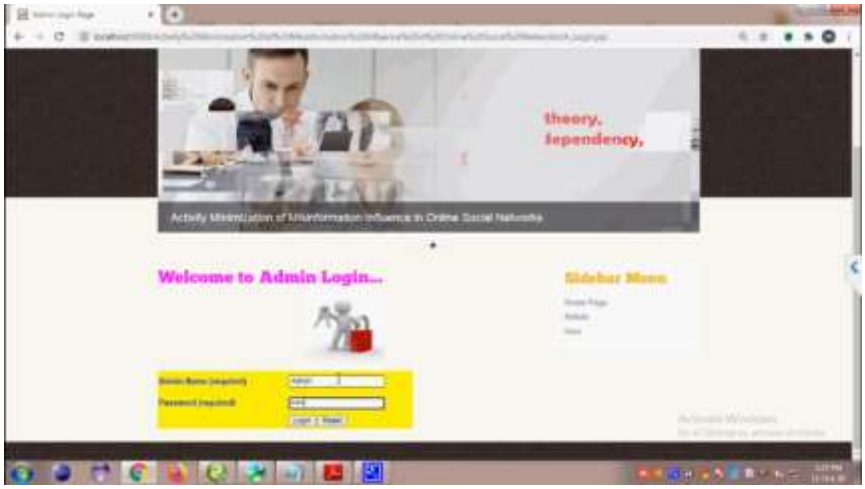

Fig 3. Results screenshot 1

Fig 4. Results screenshot 2

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Fig 5. Results screenshot 3

Fig 6. Results screenshot 4

Fig 7. Results screenshot 5

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Fig 8. Results screenshot 6

Fig 9. Results screenshot 7

Fig 10. Results screenshot 8

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Fig 11. Results screenshot 9

Fig 12. Results screenshot 10

Fig 13. Results screenshot 11

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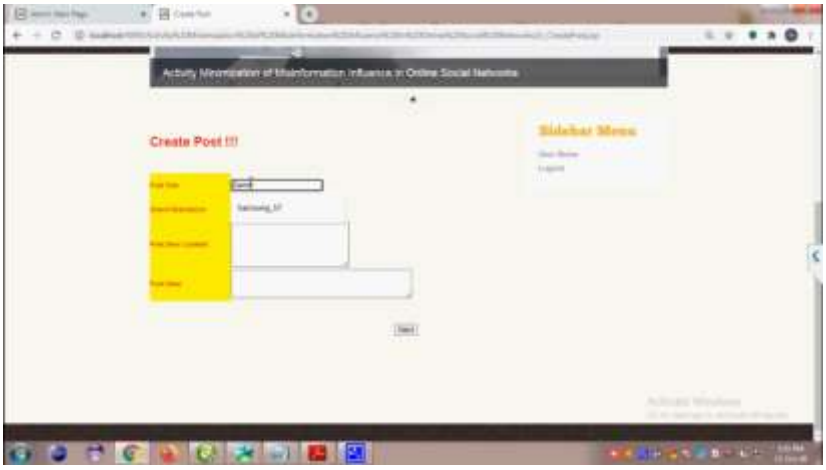

Fig 14. Results screenshot 12

Fig 15. Results screenshot 13

Fig 16. Results screenshot 14

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Fig 17. Results screenshot 15

Fig 18. Results screenshot 16

Fig 19. Results screenshot 17

Furthermore, the success of our proposed method in outperforming comparison approaches underscores the significance of targeted interventions in minimizing the spread of misinformation within online social networks. By leveraging computational techniques and optimization algorithms, we can effectively identify and counteract the influence of misinformation within social networks, thereby fostering a more trusted and reliable online information environment. Moving forward, continued research and development in this area are crucial for advancing our understanding of misinformation dynamics and developing robust strategies for combating its proliferation within online social networks.

CONCLUSION

In this article, we study a new problem called the AMMI problem, which blocks a node set from the OSNs to minimize the TAMIN. In the IC model, we first construct a node criterion LF, which converts the minimized objective function into a maximized objective function. Then, a simple counter example is used to show that the transformed objective function is neither sub modular nor super modular. Second, an HGA based on loss influence LF is proposed to select the set of nodes to block. Finally, we conducted extensive experiments on three real-world networks to evaluate the performance of HGA. By analyzing and discussing the experimental results, our proposed method is superior to existing greedy or heuristic algorithms. We believe that the current research focus on misinformation control is how to quickly and accurately find a way to spread misinformation and control its spread before a large-scale spread. For future research, we study more efficient methods to solve non sub modular problems, such as the AMMI problem, and study the problem of minimizing the interaction of misinformation on different network structures, such as dynamic networks and time-varying networks.

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