

Dynamic Quarantine Model for Rumor Propagation Control in Online Social Networks

Dipti Rashmi ^a, Dr. Binod Kumar ^b, Dr. Buddhadeo Mahato ^{c,*}

^a Department of Computer Applications, Annada College, Hazaribag, India

^b Department of Computer Applications, AISECT University, Hazaribag, India

^c Department of Mathematics, University College of Engineering and Technology, Hazaribag, India

Abstract

Spreading rumors is a common social interaction that is harmful to both society and individual lives. It is vital and significant to research how rumors propagate and are managed in online social networks. In this study, we explore how individuals respond to rumors in different ways based on their levels of understanding and personalities. We use the phrases susceptible(S) - infected (I) - quarantine (Q)-recovered(R) to group all human populations in social networks. Differential equations are used to describe how rumors spread in social networks. Then, using the Jacobian matrix and Next Generation matrix, the spreading threshold of the SIQR model in social networks is determined. Next, the stability and existence of the equilibria are examined. It has been determined that the rumor-free equilibrium E_0 is unstable if basic reproduction number $R_0 > 1$, indicating that fresh rumors are spreading across the population, and locally asymptotically stable if basic reproduction number $R_0 < 1$. Lastly, numerical simulations of the dynamic model are performed on the system to verify the analytical results.

Keywords: Epidemic model, Equilibrium point, Reproduction number, Stability, Online Social Networks.

1. Introduction

Rumors, like infectious diseases, propagate through social networks, influencing public perceptions, behaviors, and ultimately, the outcomes of epidemic situations. This statement underscores the complexity of infectious disease dynamics, which is crucial to understanding the context within which rumor propagation occurs during epidemic events. It highlights the interconnectedness of various factors that shape the spread of both pathogens and rumors, setting the stage for the development of mathematical models that capture these intricate dynamics. The dynamics of behaviour transmission in online social networks provide important new understandings of the mechanics behind digital ecosystems information diffusion [1]-[4]. Centola [5] investigated how social influence functions in online communities through a number of creative experiments, offering a fundamental framework for comprehending the propagation of rumors and false information in social networks. Musa [6] provided insight into the dynamics of information diffusion and behavioural contagion, which are pertinent to understanding how rumors propagate within the context of epidemic events. Emphasizing the critical role of network structure in shaping the spread of epidemic diseases, highlighting the significance of individual connections and network topology, it underscores the

importance of considering network-based models in understanding and predicting epidemic dynamics, which can also inform the spread of rumors within social networks during epidemic events [7]-[11].

Social network theory, which emphasizes the significance of interpersonal interactions in influencing information dispersion, completely changed the study of rumor transmission. According to Granovetter's (1973) "strength of weak ties" theory [12], for example, people with a variety of social connections are essential in the propagation of rumors within various social circles. Network-based models of rumor dissemination, which take into account the dynamics of information flow, the topology of social networks, and the strength of relationships between individuals, were made possible by this viewpoint [13]-[14].

The first models of rumor transmission were frequently influenced by epidemiological models, which depict the transmission of contagious diseases across populations. Individuals are divided into three categories according to the traditional SIR (Susceptible-Infectious-Recovered) paradigm, which was first presented by Kermack and McKendrick [15] in 1927: susceptible, infectious, and recovered. In order to quantify the dynamics of information distribution and assess intervention efforts, this framework has been modified to simulate the propagation of rumors, where people move between states of ignorance, belief, and denial. Through differential equations, the SIR model elucidates the progression of an outbreak and the impact of interventions such as quarantine and vaccination. Existing methods for rumor detection have focused on text content, user profiles, and propagation patterns.

Yuan [16] introduced a global-local attention network (GLAN) for rumor detection that encodes both local semantic and global structural information. Zhu [17] proposed a delayed SIR epidemic-like rumor propagation model that considers forced silence functions, time delays, and network topology in both homogeneous and heterogeneous networks. Additionally, Hosni [18] extended the classical SIR model by incorporating the role of addicted individuals in the spreading process, showing a significant influence of online social network addiction on rumor propagation. Different models have been proposed to contain rumor spread in social networks. In the context of rumor source detection, Jin [19] provided an overview of various diffusion models and source estimators used in online social networks. They highlighted the importance of diffusion models in modeling rumor propagation and discussed different schemes for source