

Soft Rumor Control in Mobile Instant Messengers

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Abstract— Mobile Instant Messengers (MIMs) are vastly used for communication and information sharing in recent years. However, interesting features of these applications such as group-based communication and broadcasting in channels cause rumors also to be spread in MIM networks more quickly than ordinary social networks. Although there are lots of works on modeling, analysis, and controlling rumor dissemination in social networks, the mentioned features of MIMs are not almost considered. In this paper we propose a new model for soft rumor control in MIMs that considers rumor propagation in groups and channels. By soft rumor control we mean measures for enhancing the people's knowledge and awareness against the rumor to persuade them avoiding rumor dissemination. We suggest two soft rumor control mechanisms including a provenance based decision making process and making anti-rumor campaigns. In the first mechanism, in order to improve the ability of users to take proper actions against rumors, they are equipped with rumor provenance information including the level of trust to rumor spreader, reputation of the source of rumor and the degree of credibility of the rumor. In the second mechanism, some MIM users who have more serious concerns about the rumor effects try making an anti-rumor campaign to fight spreading the rumor. The proposed model is formalized as an extended Partially Observable Markov Decision Process (POMDP) to capture the dynamics of rumor propagation and the control mechanisms. To evaluate the proposed model, we conduct a number of extensive agent-based simulation experiments on a synthesized MIM network that show the effectiveness of the proposed mechanisms to control rumor propagation. We also conduct interesting sensitivity analysis to see the effects of different model parameters on the dynamics of the rumor propagation with control mechanisms. The proposed model helps MIM developers to provide facilities to control rumor by collective wisdom. Furthermore, it helps people, NGOs, political parties, and so on to improve their rumor fighting strategies by making properly designed anti-rumor campaigns.

Index Terms— Rumor propagation, Mobile instant messenger, Social communication network, Trust, Soft rumor control

I. INTRODUCTION

NOWADAYS rumor propagation is considered as a cyberspace soft threat against individuals, organizations, governments, and even the whole society. The evolution of mobile technology and the emergence of smartphones and Mobile Instant Messengers (MIMs) have provided very convenient ways that allow millions of people to propagate rumor as a form of unverified information using various media such as messages, photos, audios and videos. MIMs provide one-to-one, one-to-many, some-to-many and many-to-many communication modes. Group-based communication and broadcasting in channels are features of MIMs such as WhatsApp, Viber, WeChat, and Telegram. These features provide platforms for propagating information to people who had never contact with the sender. This type of communication leads to creation of a so called Social Communication Network (SCN) in which not only users and their contact lists, but also groups and channels are involved [1]. It has been shown that in such networks, the rumor propagation process is highly influenced by group and channel structures [2].

Works on rumor analysis and fighting rumors as parts of cyberspace soft security are in progress to propose models and practical measures for minimizing the rumor influence on societies. Although there are lots of works in this regard, to the best of our knowledge none of them consider elements of the MIM networks including their SCN. Most of the previous works, model rumor spreading in traditional social networks which do not cover social communications between users, groups and channels in MIM systems. This is while due to their broadcasting features, MIMs are going toward playing their roles more as social media rather than social networking and hence the challenges of rumor propagation in these systems are terrible [2]. Moreover, most of the previous works in modeling rumor propagation and control use analytical approach for analysis of the dynamics of rumor propagation. Hence, to avoid complexity, they consider the behavior of the system at macro level i.e. in a coarse grained manner. This is while, rumor spreading is a decision making process which is made by users and hence should be modeled at micro level to represent detailed user-related parameters and social behavioral differences between users.

Commented [1]: تبیین مسئله به صورت کلی و آماده سازی زمینه ورود به بحث.

تبیین مسئله به صورت دقیق تر از طریق اشاره به ادبیات موضوع و کارهای مرتبط، باید نشان دهیم مسئله خاص مد نظر ما در ادبیات موضوع هست ولی هنوز حل نشده یا ابعادی از آن حل نشده باقی مانده. در این بخش دقیقاً مشخص می کنیم که هدف ما حل چه مسئله ای است. دقت کنید این بخش در چکیده مختصر است. مفصل تر آن در "مقدمه" و خیلی مفصل تر آن در بخش "مرور کارهای مرتبط" می آید. نحوه ورود به بحث و جمع بندی در بخش کارهای مرتبط باید دقیقاً با ساختار و نحوه ارائه بحث در مقدمه و چکیده سنخیت داشته باشد.

تبیین راه حل ارائه شده. ابتدا راه حل به صورت کلی بیان می شود و سپس جزئیات بیشتری از آن توضیح داده می شود. در اینجا باید به خوبی نشان دهیم که مسئله قبلی که تبیین شد را چگونه حل کرده ایم.

توصیف نحوه ارزیابی کار انجام شده و اشاره به نتایج حاصل شده.

توصیف اهمیت، کاربرد و نقش روش ارائه شده در حل مسائل علمی، صنعت، جامعه و ...

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Rumor in social networks can be controlled with either soft or hard rumor control strategies. A hard rumor control strategy considers depriving actions such as removing rumor spreader users or blocking the rumor messages. In a soft rumor control strategy on the other hand, the goal is to enhance the people's knowledge and awareness to prevent rumor dissemination via persuading users to personally decide not to propagate rumors.

In this paper we propose a new model for rumor propagation and soft rumor control in MIMs that considers message propagation in groups and channels as well as the user decision making process in micro level. We suggest two soft rumor control mechanisms including a provenance based decision making process and making anti-rumor campaigns. In the provenance mechanism in order to improve the ability of users to take proper actions against rumors, they are equipped with rumor provenance information by the MIM system. Rumor provenance is additional information that is received along with the rumor by the user and provides him/her with an important context for assessing rumors. Rumor provenance information influences the users' decisions and their actions against the rumor. A rumor provenance includes the computed values for credibility of the received message, the reputations of the message source, and the trust of the message senders. In fact we propose a message rating system that helps users to identify rumor messages for making better decisions about forwarding or stopping rumors using the rumor provenance information. Users who disseminate rumors (messages with low rates) lose their reputation and low reputation consequently reduces the credibility of the rumor propagated by the user. This brings us a self-control system for reducing the propagation rate of the rumor in the SCN of an MIM system. In the second mechanism i.e. the anti-rumor campaigns, some MIM users who have more serious concerns about the rumor effects for any reason try making an anti-rumor campaign to fight spreading the rumor. An anti-rumor campaign is an overlaid network of certain MIM users for combating rumors via raising the people awareness. Anti-rumor as an important form of information for fighting against rumor can be created, enriched and rapidly disseminated via an anti-rumor campaign with different users to prevent rumor spreading. Indeed, an anti-rumor campaign facilitates interactions among the members of the campaign who in turn may belong to different groups and channels to increase the speed of detecting and sharing new rumors and to create and propagate anti-rumors. Each user in the campaign who receives a rumor, shares it to the campaign and the other users in the campaign interact with each other and try to generate the corresponding anti-rumor and empower it to propagate.

We use an extension of Partially Observable Markov Decision Process (POMDP) as a mathematical model to capture the dynamics of rumor propagation and to represent the considered soft rumor control mechanisms on this dynamical system. POMDP is an abstract mathematical model which can be applied in various domains where a sequential decision-making with considering utilities of sequences of actions is required. We propose an extension of POMDP which is suitable for modeling the stochastic multi-agent systems including the impact of agents on each other. The system is assumed to be

decentralized and each agent has his/her own POMDP model while maintains his/her belief about the other agents and his/her actions. This way POMDP provides formal facilities to model refinement of the beliefs of an agent about other agents and their actions.

To evaluate the proposed model, we conduct a number of extensive agent-based simulation experiments to show the effectiveness of the proposed mechanisms in controlling the rumor propagation. We perform a number of Monte Carlo simulations on a synthesized network based on our previously proposed SCN generation algorithms [1]. We also conduct sensitivity analysis to show the effects of different model parameters on the dynamics of the rumor propagation and control mechanisms. The results of experiments show that the provenance based rumor control mechanism can significantly control rumor propagation in MIM networks. As the system face with newer rumors, the control parameters are updated over the time and the rumor provenance information greatly effects on users' decisions to control the rumor propagation. Using the provenance mechanism not only significantly reduces the size of rumor propagated in the network, but also it effectively decreases the time to reach the steady state of the rumor propagation.

Additionally, the results indicate that anti-rumor campaign can reduce the size of the propagated rumor and increase the speed of stopping rumor propagation in MIM network. However, the effectiveness of anti-rumor campaign depends on its structural parameters. It is shown that the SCN degree is a highly influencing structural parameter to control rumor in anti-rumor campaign mechanism. The results also reveal that anti-rumor campaign with diffused users (i.e. with diverse memberships in groups and channels) are more effective in rumor control than those with closely connected users.

We believe that the proposed model in this paper can be applied to provide effective facilities for soft rumor control inside the MIM applications. It helps MIM system developers to provide users with facilities for supporting rumor provenance information. Moreover, government organizations, companies, NGOs, political parties, and users who have concerns about the trust of social lives and try to reduce rumor diffusion in the society can use the results of this work to improve their rumor fighting strategies by creating properly designed anti-rumor campaigns.

The rest of the paper is organized as follows: Section II reviews the related work. In Section III we introduce some preliminaries, in section IV we introduce our proposed model for rumor propagation and control. Simulation experiments and analysis results of the model are explained in Section V. The proposed soft rumor control mechanisms are compared with hard rumor control in section VI, and finally we evaluate the proposed model in Section VII.

II. RELATED WORK

There exist lots of works that employ information diffusion models for modeling and analysis of the rumor spreading dynamics in social networks. Information diffusion means flowing a piece of information from an individual to other ones