Rumor Diffusion through Social Media

Abstract

The growing adoption of social media increased the pace of spreading information significantly. This increase amplified the traditional problem of rumor propagation. The emergence of false rumors or “False News” caused substantial adverse consequences such as its effects on politics, the stock market, and health issues. Hence, lots of studies used different logics and methods, and explored this area to figure out this problem and finally proposed proper policies to deal with it. In this paper, in order to understand the underlying dynamics, I develop a system dynamics model based on current literature.

Keywords: False News, Rumor Propagation, Social Media, diffusion, System Thinking, Sharing Effect

INTRODUCTION

The increasing willingness of people to use social media made the flow of various types of information much simpler and rapid these days. People can generate as well as receive a vast variety of information from instructional to inspirational ones. News is one of the most popular and prevalent types of information affected by social media because of its pace dependent nature.

Although the rapid spread of news can be beneficial for many occasions like during mass emergencies (Kim and Hastak 2018), it can sometimes cause troubles. Generation and spread of uncertified rumors are traditional concerns; however, social media made it more widespread and accentuated its adverse effects. Hence, in this platform, everyone can generate uncertified content without much filtering, fact-checking or standard editorial judgment. (Allcott and Gentzkow 2017)

Software robots, known as bots, amplified the effects by generating the first spikes, and more than that by diffusing false news or rumors among people. Bots can make a part of information viral in the first seconds of its introduction by spreading it widely and targeting influential users with a considerable number of followers. After a substantial number of individuals bought it, then it is more likely for others to trust and believe what large groups of people agreed on. (Shao, Ciampaglia et al. 2018)

In sensitive circumstances, like during elections, false news generators start to fabricate misinformation, mostly with political or financial motives. (Graham 2017, Shu, Sliva et al. 2017, Guo and Vargo 2018) The rumor producers intend to deceive their targeted people by spreading it in an indistinguishable manner. They try to gain people’s attention and direct their actions in the way they planned to.

There are several proposed and implemented policies to cope with false news spread, predict and prevent its adverse effects. The evaluation and comparison of these policies and strategies needs a realistic transparent understanding of the structure that makes mentioned behavior.

Using simulation to develop a theory is a growing method unless it created lots of controversies about its usefulness. However, Davis et al declared that in specific conditions it can be extremely useful. (Davis, Eisenhardt et al. 2007) One of the most important factors is to build a model based on a “simple theory”. The simple theory is a theory in between of a complete well-developed theory and a blank no real theory. The simple theory consists of a basic rough idea that has an excellent potential to be enhanced and create original thoughts and insights to expand the basic idea.

Lots of researchers analyzed the social media platforms exhaustively and drew conclusions about false news spread. However, they have not reached a well-developed theory and most of them came up with simple theories. Therefore, there are huge potential to study this area, especially with simulation models. For example, Vosoughi et al declared that “Falsehood diffused significantly farther, faster, deeper, and more broadly than the truth.” This statement is a result of a study on more than ten years’ twitter stories (Vosoughi, Roy et al. 2018). It also asserted that novelty made people spread false news more than true news. All of these assertions should be studies structuraly over time to be validated.

In this paper, I used principles o system thinking and made a basic system dynamics model as a starting point to study the underlying mechanisms of rumor spread. This will pave the way for future researches from a systematic point of view.

Model

As it is mentioned earlier, uncontrolled generation and spread of rumors can cause huge negative consequences. The first step to reduce and eliminate these effects is to study the underlying mechanism. Lots of studies analyzed the generated data in social media platforms to find the correlations between different factors. But they usually did not consider all different factors together.

Here, I want to generate a comprehensive understanding of spread of rumors based on current literature. In fact, there are different layers to be considered, but I want to focus on spread of one single story as a micro level. Macro level studies can be done as future works.

In this study, I used the Vensim DSS 7.3.5. © software. The numbers are roughly estimated, and the results show the general trend.

Causal-loop model

Figure 1 shows the causal loop diagram for this phenomenon. The main three parts are: “Viewing”, “Sharing” and “Accepting” or believing. These three together make a reinforcing loop (R1). Social validity as a part of human biases, makes people believe whatever large number of people shared, which makes he second reinforcing loop (R2). Social media platforms try to show people what they want to see by suggesting them the material that lots of people had positive impression on. They define a score to assign ranking to different material. This makes the third reinforcing loop, R3. People usually like to inform their friends by sharing virgin information. When lots of people saw a shared story, especially news, it is not logical to share it more. Hence, increasing the

number of views, reduces novelty and as a result, reduces sharing. The latter explain the balancing loop. (B1)

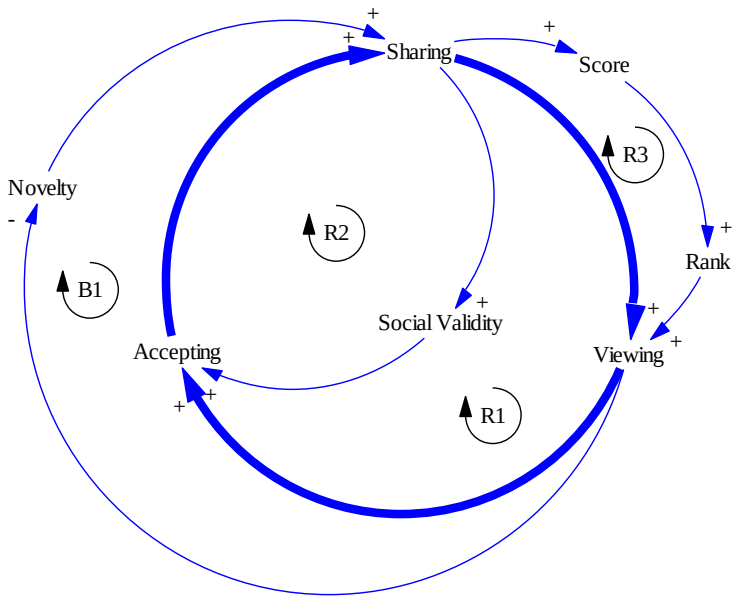

Figure 1. Causal Loop model

Stock and flow model

The stock and flow model, figure 2, I depicted the main structure. The main part of this model is inspired by classical bass-diffusion model (Bass, 1969, Sterman, 2000). The potential adopters (figure 2a) are the society members who are internet users. (a percentage of each country's population) and the adoption is translated in two steps: exposure and believing. Believing is considered as a function of compatibility with other evidence and the number of shares.

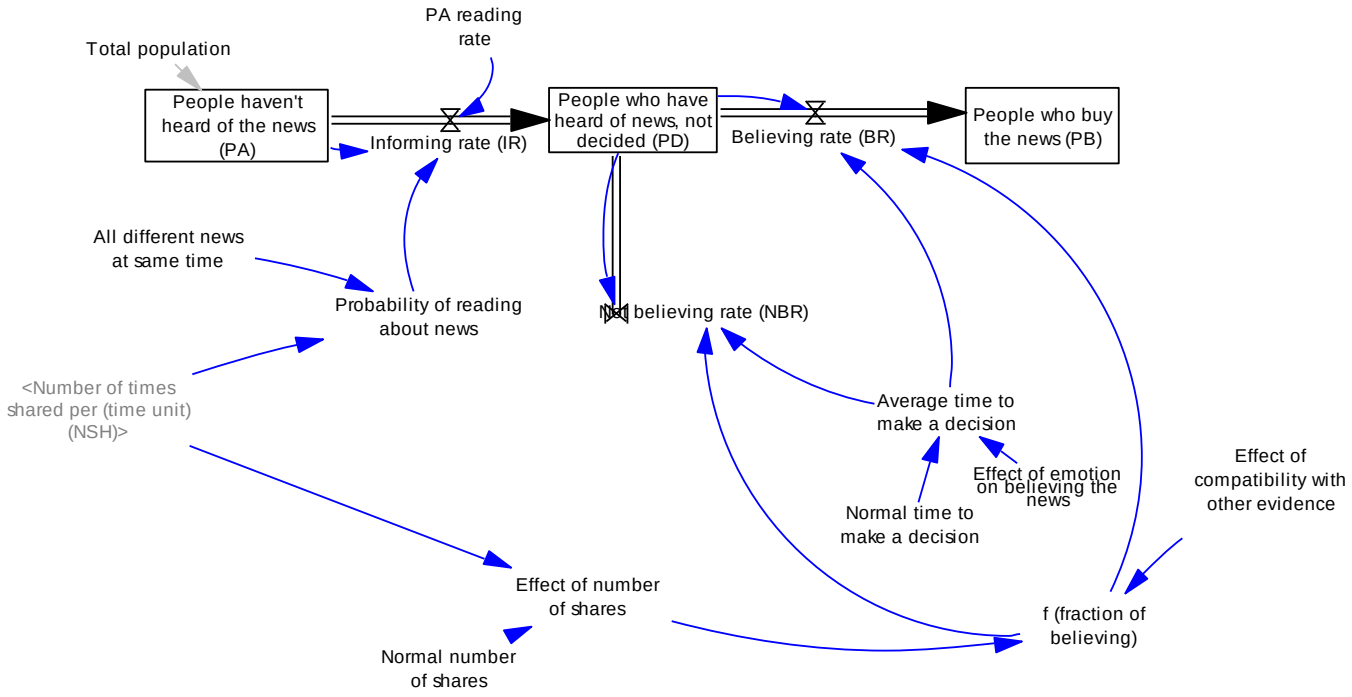

Figure 2. a) Stock-Flow model of rumor spread

Figure 2 b shows the stock for number of re-shares. Believing rate, effects of novelty and effects o introduction are the determinants of sharing rate.

The details are combined in a single variable for now. For example, the effect of bots, can be considered as a part of initiators strength that affects the total number of re-shares.

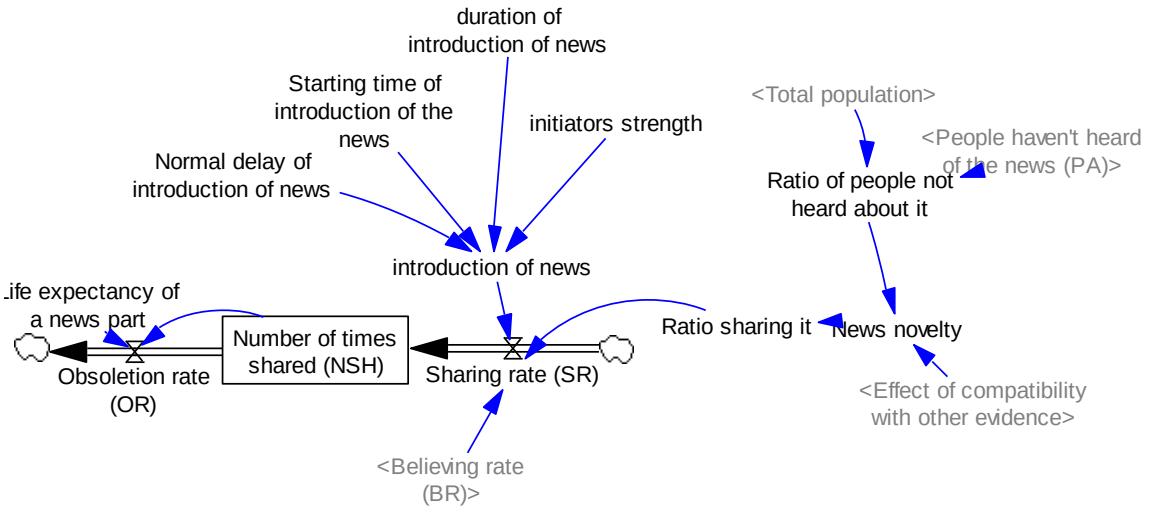

Figure 2. b) Stock-Flow model of rumor spread

Results:

The complete set of formulas and units of parameters are provided in appendix part, table 1. The simulation results of exact same numbers (base run) are shown in figure 3. The results of the basic run are completely like the results of every diffusion model result. It is also consistent with the intuition and the behavior of each story published in social media platforms. The next step is to check the effects of each variables. The model should be calibrated using a typical story data. Then experimentation, which is the most important part of the simulation-based theory development can be implemented.

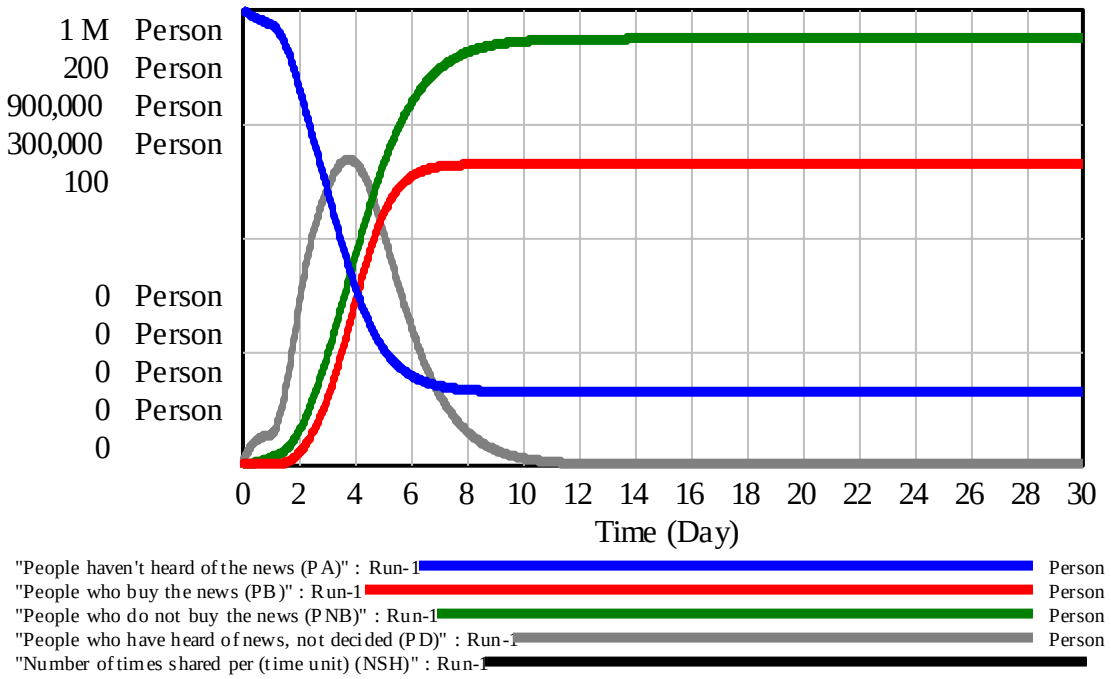

Figure 3) Basic run results (graph of several variables over time)

DISCUSSION AND CONCLUSIONS

This paper provides differential equation modeling of the phenomenon of spread of rumors. I used systems thinking and system dynamics to figure out the underlying structure that generate the known behavior. Different policies can be applied and compared in more developed model

REFERENCES

Allcott, H. and M. Gentzkow (2017). "Social media and fake news in the 2016 election." Journal of Economic Perspectives **31**(2): 211-236.

Davis, J. P., et al. (2007). "Developing theory through simulation methods." **32**(2): 480-499.

Graham, R. (2017). "Google and advertising: digital capitalism in the context of Post-Fordism, the reification of language, and the rise of fake news." Palgrave Communications **3**(1): 45.

Guo, L. and C. Vargo (2018). ""Fake News" and Emerging Online Media Ecosystem: An Integrated Intermedia Agenda-Setting Analysis of the 2016 US Presidential Election." Communication Research: 0093650218777177.

Kim, J. and M. J. I. J. o. I. M. Hastak (2018). "Social network analysis: Characteristics of online social networks after a disaster." **38**(1): 86-96.

Shao, C., et al. (2018). "The spread of low-credibility content by social bots." **9**(1): 4787.

Shu, K., et al. (2017). "Fake news detection on social media: A data mining perspective." **19**(1): 22-36.

Vosoughi, S., et al. (2018). "The spread of true and false news online." Science **359**(6380): 1146-1151.

APPENDIX I

Table 1. Model parameters formulas and units (In stock variables, the second item in parenthesis is the initial value of the integral)

Formulations and comments	Units
(PA)"= INTEG (-"Informing rate (IR)", Total population) The stock of people haven't heard of the news	Person
"People who have heard of news, not decided (PD)" = INTEG ("Informing rate (IR)"-"Believing rate (BR)"-"Not believing rate (NBR)",0)	Person

"People who buy the news (PB)"= INTEG ("Believing rate (BR)",0)	
	Person
"People who do not buy the news (PNB)"= INTEG ("Not believing rate (NBR)",1)	
Number of times shared (NSH)	Count
INTEG ("Sharing rate (SR)"-"Obsoletion rate (OR)", 1)	
Informing rate (IR)	Person/Day
PA reading rate*"People haven't heard of the news (PA)"*Probability of reading about news	
Believing rate (BR)	Person/Day
People who have heard of news, not decided (PD)"/Average time to make a decision)*"f (fraction of believing)	
Not believing rate (NBR)	Person/Day
"People who have heard of news, not decided (PD)"/Average time to make a decision) *(1-"f (fraction of believing)"	
	Count/Day
"Obsoletion rate (OR)"="Number of times shared per (time unit) (NSH)"/Life expectancy of a news part	
	Count
All different news at same time=100	
	Day
Average time to make a decision=Normal time to make a decision*Effect of emotion on believing the news	

Day [0,30,0.5] duration of introduction of news=1
Dimensionless Effect of compatibility with other evidence=1
Dimensionless Effect of emotion on believing the news=1
Dimensionless Effect of number of shares="Number of times shared per (time unit) (NSH)"/Normal number of shares
Dimensionless "f (fraction of believing)"=0.5*Effect of compatibility with other evidence*Effect of number of shares
Count/Day [0,10,1] initiators strength=6
Count/Day [0,1,1] introduction of news= PULSE (Starting time of introduction of the news, duration of introduction of news)*initiators strength/Normal delay of introduction of news
Day Life expectancy of a news part=1
Dimensionless

News novelty=Ratio of people not heard about it/Effect of compatibility with other evidence
Day
Normal delay of introduction of news=1
Count
Normal number of shares=20000
Day
Normal time to make a decision=1
Count/Person
number of shares=1
1/Day
PA reading rate=5
Dimensionless
Probability of reading about news="Number of times shared per (time unit) (NSH)"/All different news at same time
Dimensionless
Ratio believing it="People who buy the news (PB)"/ ("People who buy the news (PB)"+"People who do not buy the news (PNB)")
Dimensionless
Ratio of people not heard about it="People haven't heard of the news (PA)"/Total population
Dimensionless

Ratio sharing it=0.5*News novelty

Count/Day

"Sharing rate (SR)"= ("Believing rate (BR)"*Ratio sharing it +introduction of news*number of shares)

Dimensionless

[0,30,1]

Starting time of introduction of the news=1

TIME STEP = 0.03125

Units: Day

Person

Total population=1e+06