CITS4403 Project

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Background

Problem statement

This project seeks to simulate and analysis the ways rumours and information are spread. A rumor can be defined as “a proposition for the belief of a topical reference disseminated without official verification”.

Importance

Studying the spread of rumours and information in the digital world is extremely vital due to the immense influence and power of social media. According to the research paper “The disaster of misinformation”(Muhammed T S and Mathew SK, 2022), one of the examples of the harm of spreading disinformation(intentially spreading wrong information) is the surge in fake news linking the virus outbreak to a particular religious group during the initial stage of COVID-19 in India. It eventually translated into physical violence and discriminatory treatment against members of the community in some of the Indian states. Moreover, the spread of misinformation and disinformation has been on the rise, which means their impact is only going to grow larger.

Overview

This report is an simple investigation on how rumor and information are spread in general. For the model selection agent based model is selected due to its flexibility and complexity compare to cellular automata. The results of the simulations show that although we can predict some characteristics(e.g. More indifferent agents than other types of agents) of the process/result based on certain factors(e.g. Decay of believer/skeptic over time), a lot of times the simulations are quite unpredictable and really demonstrate the emergent characteristics of agent based models.

Model description

Selected Model - Agent Based Model

In this project, we employ Agent-Based Models (ABMs) to study the propagation of rumors. ABM is a computational approach where social agents operate as evolving, autonomous entities. Unlike cellular automata (CA), where agents occupy fixed coordinates, ABMs allow agents to move freely. This flexibility makes ABM suitable for our case study, capturing the dynamic interactions of individuals on social media platforms. Past

researchers (Moreno et al., 2004; Zhao et al., 2013; Zhao et al., 2012) predominantly used differential equations and the SIR model, assuming homogeneity in rumor spread. However, the nature of rumor dissemination is dictated by individual behaviors and interactions. Recognizing this heterogeneity is pivotal to understand complex social behaviors, even though both homogeneous and heterogeneous recognitions are valuable in rumor studies. Given our focus on heterogeneity, we've adopted agent-based modeling, drawing inspiration from the Social Impact Theory(Latané, 1981).

Assumptions and rules of the model

Due to the enormous complexity of this research topic. There are a lot of assumptions made to narrow down the project to be more simplistic and easier to understand.

Assumptions:

- Social Impact Theory (SIT): The interaction of the agent(s) (Person) are based on the Social Impact Theory (SIT), which seeks to explain how social influence causes changes in behaviour, attitudes and beliefs of individuals as a result of their interaction with others. STI scores are random in this simulation.
- Decline in Spreading: The probability of spreading the rumor decrease over time or successive steps since the enthusiasm or newness of information might diminish, affecting the likelihood of sharing. There is a chance that believer/skeptic will become indifferent over time.
- Exposure Reinforcement: Repeated exposure to the same information will impact agents' choice. The more the agent has heard the rumor the more likely the agent is going to be active(believer/skeptic)
- There are only 3 response when an agent had heard the rumor, either become indifferent or believe(and spread the rumor) or become skeptical.
- There are no external social forces that affects the spread of rumor besides the ones stated in the simulation
- The initial location of the rumor being spread doesn't matter
- There are 4 types of rumor - fear, wish, wedge-driving and anticipatory
- Assume the only difference between spreading rumor in real life and spreading rumor on Internet is the neighbor area.
- Skeptics wouldn't try to spread the rumor, only believers would

Rules:

- If an agent's SIT score is greater than its neighbor's, then the rumor will be spread.
- Every step

- The agent(s) interact with the rumor, the rumor's attribute(credibility, urgency, impact and complexity) and the agent's attribute affects the way the agent interact/spread with its neighbors
- If the agent is a believer/skeptic, it may become indifferent
- If the agent can spread to its neighbor(s) (greater STI score), the neighbor will either become indifferent, believe or skeptic based on the probability weights.
- After interactions, believers and skeptics have a chance to become indifferent

Initial configuration and the parameter choices for the model

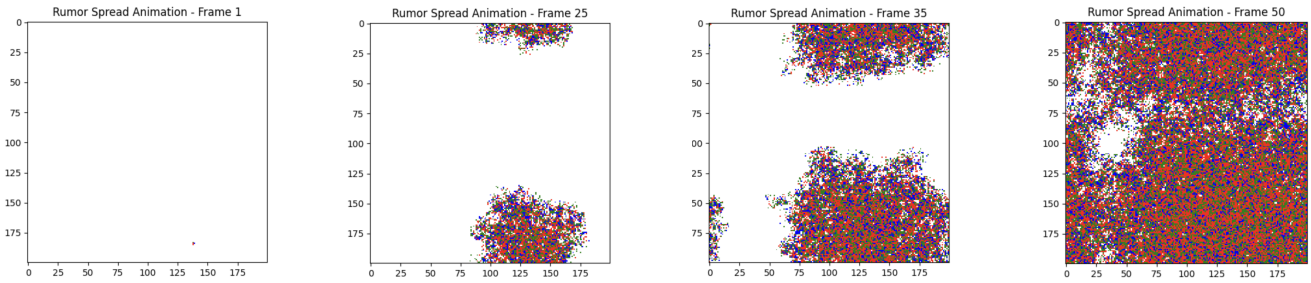
There are four initial rumor configurations: fear, wish, wedge-driving, and anticipatory, with fear as the default. Each configuration presents varying levels of credibility, urgency, impact, and complexity. Complexity determines the spread likelihood, credibility influences the believer-to-skeptic ratio, urgency dictates how believers/skeptics transition to indifference, and impact determines how the indifferent become believers or skeptics.

Four adjustable parameters significantly affect the simulation:

1. News/Internet: Expands the rumor's spread area.
2. Decay: Converts believers/skeptics to indifferent after sharing the rumor with immediate neighbors.
3. Tribalism: If an agent hears a rumor and reacts, nearby uninformed agents might react similarly.
4. Pushback: If an informed agent encounters skepticism, they might turn skeptic too.

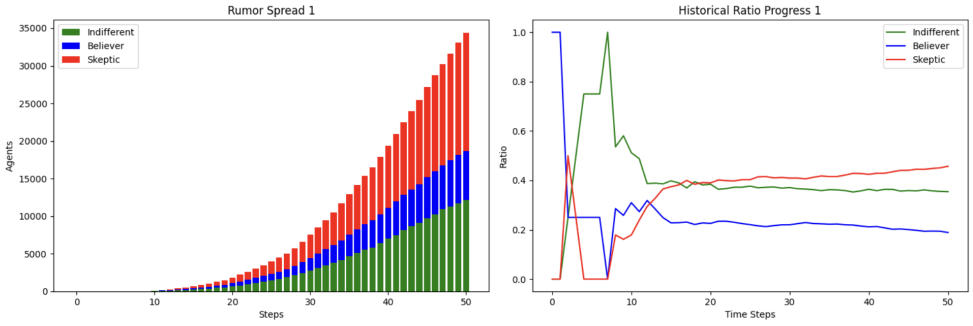
Result

Results visualization and discussion



Simulation frames(default settings)

The default initial configuration(fear type rumor) is shown above alongside with the final result of the simulation(after 50 steps) and all the parameters were turned off in this simulation.



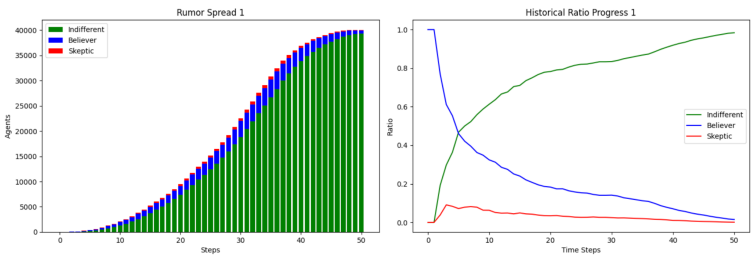
Simulation statistics(default settings)

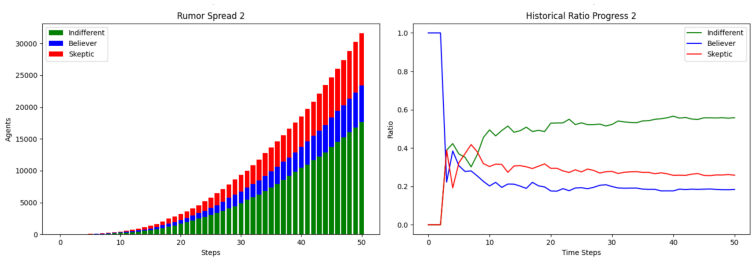
An obvious trend that displayed is that the number of agents who had heard the rumor grows exponentially as the steps increase. The ratio of different types of agent also stabalized after a certain period. By looking at the simulation frames, we can also notice that the rumor grows, agents that have just heard the rumor tend to believe it (more blue agents on the edges) rather then to be indifferent or skeptic.

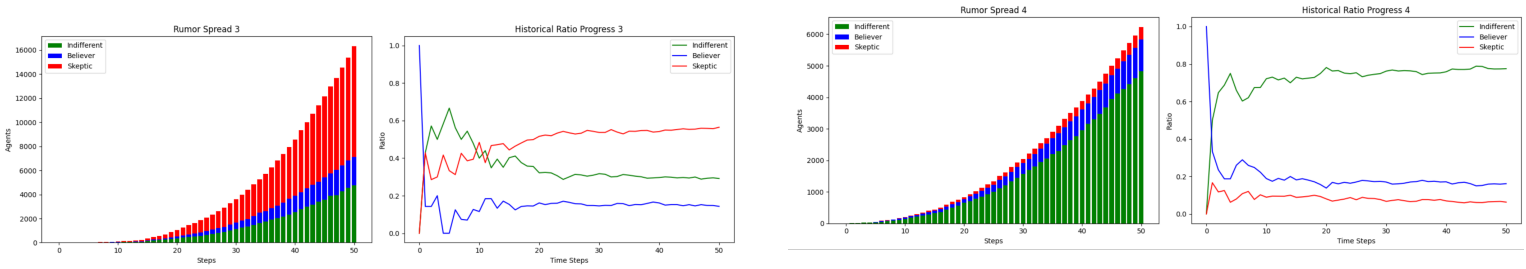
Different parameter comparison and analysis

There were 4 simulations performed, each with a different sets of parameters and initial configurations shown in the table below.

	Parameters/Features			
Initial configurations	News/Internet	Decay	Tribalism	Pushback
Fear (1)	1	1	1	1
Wish (2)	1	0	1	1
Wedge-driving (3)	1	0	0	1
Anticipatory (4)	1	0	0	0







Results using different parameters

For the first simulation with a fear-type rumor, a vast majority remain indifferent due to the decay parameter turning agents indifferent post interaction with all neighbors. This simulation shows the quickest spread. In the second simulation, with reduced decay and a wish-type rumor, fewer agents are indifferent but more are skeptical, likely due to pushback and tribalism factors. The spread ratios stabilize as the simulation progresses. The third simulation with a wedge-driving rumor indicates an increase in skeptics when only pushback and internet factors are active. Meanwhile, the fourth using an anticipatory rumor reveals a slower spread similar to the first, with only the internet factor active.

Comparing the first and second sets, decay parameters significantly influence the number of indifferent agents. Initial rumor configurations, such as fear vs. wish type, affect the spread ratios and the stability of these ratios over time. Visualization results indicate that parameters like decay and rumor type greatly influence the spread and agent reactions.

Conclusion

Overall the simulations' result can be partly predicted based on the initial configuration and parameters used. Most of the spread of the rumor occur in exponential rate in the simulation. The proportion/ratio of the agents also reflect the parameters used. Although the model has put into consideration about some rumor/agent features(e.g. Exposure reinforcement), it may not reflect real life situation due to the immense complexity of the nature of the problem. For example even among fear type rumor there will be a lot of variations and the way it will be spread will be different according to the variations.

In the future, pre-existing examples might be used to contrast to the model's simulation in order to test how grounded the model actual is and also simulate some edge cases. Investigation into decision-making in situations where managing rumors is also crucial. This could involve discussing strategies for rumor control and mitigation.

Reference

1. Muhammed T S, Mathew SK. (2022) "The disaster of misinformation: a review of research in social media." International Journal of Data Science and Analysis, 13(4), 271-285. DOI: 10.1007/s41060-022-00311-6.
2. Moreno, Y., Nekovee, M., Pacheco, A.F. (2004) "Dynamics of rumor spreading in complex networks." Physical Review E, 69, 066130.
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5. Latané, B. (1981) "The psychology of social impact." American Psychologist, 36, 343.