Natural Computing
Final Project Report
Studying the spread of misinformation with Spatial Modeling
(Group 11 & Group 13)

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1 Introduction

Misinformation has been a problem for a long time. With the increasing use of social media, this problem has only multiplied, and misinformation spreads faster and further than ever [5]. One of the more recent examples where misinformation showed its strong negative impact was the COVID-19 pandemic. Through social media, wrongful claims about the criticality of the virus or treatments were spread. Misinformation like the claim that drinking methanol would cure the virus lead to people risking their health and leading to lethal incidents. The consequences were at least 800 deaths, 5,876 hospitalizations and 60 cases of complete blindness [2].

Besides misinformation's role during the pandemic, Dr Tedros Adhanom Ghebreyesus, the Director-General of the World Health Organisation, saw another connection between viruses and misinformation. In 2020, at the end of an Ebola outbreak and the beginning of the COVID-19 outbreak, he held a speech at the Munich Security Conference stating that fake news spreads faster and easier than a virus but is just as dangerous. In his words, "we're not just fighting an epidemic; we're fighting an infodemic" [1]. This comparison between the spread of a virus and misinformation leads us to this project idea in which we will research the simulation of the spread of misinformation in a spatial model under different scenarios.

2 Research Questions:

- Q1 Does the spread of misinformation resemble the spread of a virus in a "normal" spatial model?
- Q2 How many static fact-checkers[1] are necessary to stop the spread of misinformation?
- Q3 How many dynamic fact-checkers[2] are necessary to stop the spread of misinformation?
- Q4 How do social network-like connections[3] influence the spread of misinformation in a spatial model?
- Q5 How do social network-like connections influence the strength of fact-checkers?

3 Method

Inspired by the SIR (Susceptible, Infected, Recovered) implementation of a spatial model in modelling the spread of a virus, we will implement a similar model using Python. We will initialize the grid with certain conditions, such as locations and the status of an agent at a position (informed, misinformed or uninformed). Next, we will construct a function that simulates the spread over time, which updates the grid each time it's called and iterate it on many iterations.

[1] random agents are confronted with factual information and have a certain degree of changing status

[2] in addition to footnote 1 when agents are confronted with misinformation, their status will not change, and they will also pass factual information back

[3] also spreads to agents outside direct neighbours

We will conduct several experiments based on our research questions by adding different numbers and types of fact-checkers and altering the spreading function to resemble social network-like connections and plan to run several experiments with different hyperparameters, such as grid size, infection points, recovery probability, and recovery speed.

We implemented the spread in a 5 x 100 x 100 grids field, where the first layer is the actual field used for plotting, the second layer is the field of probabilities in which a cell will be spread with misinformation, the third layer is the probabilities that a cell will be spread with proper information. The fourth and the last layers are the misinformed and properly informed iteration fields, containing the number of iterations ago the (mis)information was spread in that spot, respectively. Each pixel in the field is denoted as either 1 - coloured red for misinformed, 1 - coloured green for properly informed and 0 - coloured yellow for uninformed.

There are 6 types of spread, which are glide with only misinformation spread, random, glide with both misinformation and proper information spread, social media style, chess horse and direct neighbours spreading. The first spread means that an infected, misinformed cell will spread into the nearby 8 neighbour cells. However, the properties of the spread are not saved in the third layer. The second spread means that every two random neighbours in the field have an equal chance of being spread with (mis)information, where the proper information is initialized in a pixel if the number of iterations prior (in the 4th layer) is greater than a threshold of 7. The third spread is similar to the second spread but with the spread going to the eight nearby neighbours. The fourth type resembles the behaviour of social media, which randomly selects nearby locations within a 3x3 range. The fifth spread is the spreading of the knight pattern, which is the eight locations where a chess horse could move from the original position. Lastly, the last type of spread is similar to the second one, but only updating the information matrices, instead of spreading in the original field.

4 Related Works

There is not much work that has been done to investigate the spread of misinformation through spatial models. However, numerous papers focus on modelling the spread of a virus through spatial models, about the spread of misinformation and fact-checking.

In an article about the epidemic model of Cholera, the authors provide a brand-new deterministic model in their work to look at the spatiotemporal dynamics of cholera transmission. To represent the spatial movement of the hosts and pathogens, the model uses a reaction-convection-diffusion system. It also includes time-periodic parameters to explain the seasonality of disease transmission and bacterial growth rates [6].

There has been extensive research on the spread of misinformation already. One research found that true information takes six times longer to reach 1500 people than false information. Reaching a cascade depth of 10 takes true information 20 times as long as false information. Moreover, true information never diffuses beyond a depth of 10, yet false information reached a depth of 19 almost ten times as fast as true information reached a depth of 10 [5].

Stopping misinformation (fact-checking), like a virus with vaccinations, is part of our research questions. Mollalo researched the hesitancy for vaccination for COVID-19. Over 100.000 COVID cases can be attributed to vaccination hesitancy in August 2021 alone, which indicates that providing vaccines does not guarantee the same effectiveness as the vaccine itself [3]. Porter evaluated the effectiveness of fact-checking in various countries and concluded that, for all countries, the positive effect of fact-checking is larger than the negative effect (0.59 vs 0.07 on a 5-point scale), translating to 11.8% positive vs 1.4% negative [4] with a delay of around 2 weeks.

References

[1] Dr Tedros Adhanom Ghebreyesus. Who director-general speech at munich security conference. Published online: `https://www.who.int/director-general/speeches/detail/munich-security-conference`, Feb 2020.

[2] Md Saiful Islam, Tonmoy Sarkar, Sazzad Hossain Khan, Abu-Hena Mostofa Kamal, S. M. Murshid Hasan, Alamgir Kabir, Dalia Yeasmin, Mohammad Ariful Islam, Kamal Ibne Amin Chowdhury,

Kazi Selim Anwar, Abrar Ahmad Chughtai, and Holly Seale. Covid-19–related infodemic and its impact on public health: A global social media analysis. *The American Journal of Tropical Medicine and Hygiene*, 103(4):1621 – 1629, 2020.

[3] Abolfazl Mollalo and Moosa Tatar. Spatial modeling of covid-19 vaccine hesitancy in the united states. *International Journal of Environmental Research and Public Health*, 18(18), 2021.

[4] Ethan Porter and Thomas J. Wood. The global effectiveness of fact-checking: Evidence from simultaneous experiments in argentina, nigeria, south africa, and the united kingdom. *Proceedings of the National Academy of Sciences*, 118(37):e2104235118, sep 2021.

[5] Soroush Vosoughi, Deb Roy, and Sinan Aral. The spread of true and false news online. *Science*, 359(6380):1146–1151, 2018.

[6] Xueying Wang, Xiao-Qiang Zhao, and Jin Wang. A cholera epidemic model in a spatiotemporally heterogeneous environment. *Journal of Mathematical Analysis and Applications*, 468(2):893–912, 2018.