

Agent Technology Practical - Final Report

Fake News: Modelling the Influence of Fact-Checked News Media on the Spread of Misinformation

Name 1: Lawrence Fulton, student number 1: s3599523

Name 2: Darren Rawlings, student number 2: s3612309

Name 3: Tim Chandler, student number 3: s3173593

Name 4: Bogdan Chelu, student number 4: s3355926

Final project group: C34

1 Introduction

1.1 Subject

Misinformation, can take many forms such as conspiracy theories, propaganda, malicious hoaxes, and deliberate attempts to present a false narrative. It may be spread by those aware of the falsity of the information with the intention to deceive, or unwittingly by those who believe it to be true, unaware that the information is actually false.

Early examples of misinformation include pasquinades, witty verses recited in the piazzas of fourteenth century Rome, used to smear political rivals (Darnton, 2017). Today, however, we do not need to gossip in the piazza, we live in a highly connected world. Communication can happen over great distances and over a number of different mediums. We have access to telephones, email, social media, and a plethora of messaging apps, all used to spread misinformation.

Whilst individuals may struggle to fact check every utterance, and those deliberately deceiving would not want to, large news organisations have the ability, and in some countries the legal obligation to fact check the news they are reporting. In the Netherlands NOS Nieuws, the news service from the Dutch public broadcaster, is trusted by 81% of those surveyed (Newman, Fletcher, Schulz, Andi, & Nielsen, 2020). Whereas, in the same report, the USA's most trusted individual brand is the BBC News, a British news organisation with international news channels, with 56% trust. Newman et al suggest the increasingly partisan nature of the US news as a reason for this strange occurrence, with one person surveyed stating: *"I'm tired of hearing fake news from the dishonest left socialist commie traitors!!!"*.

1.2 New idea

Models of the spread of gossip and misinformation often use SIR (Susceptible, Infectious, Recovered) models and based on ideas developed by Ross (1916) to model the spread of diseases. When combined with the concepts developed by Latané as part of Social Impact Theory (Latané, 1981), which models impact based on strength, immediacy, and number of sources, creates a powerful tool for modelling.

Existing models, however, tend to focus on the spread of misinformation only by individuals, ignoring the more broad global influence of modern news media as we have seen in some cases these can be highly trusted and are often viewed by large numbers of people. If fact checked a trusted news media could inhibit the spread of misinformation. This report will therefore model the influence of fact-checked news media on the spread of misinformation. Our hypothesis being if the news media is trusted by enough people and always factual, then it will inhibit the spread of misinformation.

2 Methods

2.1 Conceptual model

The model was created to model the beliefs of individual people. Rather than distinct states that the SIR model creates, the model has a strength of belief, which allows for the concept of belief, but without the requirement for absolute certainty. A level of belief that either a conversation with a friend may alter, or a trusted news source may reduce.

The model consists of a population of agents, who represent people, who at the start either do or do not believe in a piece of misinformation. These agents will be linked to other nodes who will act as friends, with the number of these links determined by the average number of friends. The distance between two friends will determine the trust they place in each other, rather than a simulation of actual distance. A person trusts the information of somebody they are close to rather than a friend further away. Some people who trust in a news media will also link to an agent that represents news media, for this link the distance is not a factor.

A single agent will act as a fact-check news media, as such will always report the truth. This news media agent will be connected to all those agents that trust the news media.

The full list of features integrated in to this model is outlined in table 2.

2.2 Implementation details

The model was implemented in NetLogo. In which we created two types (breeds) of agents (turtles), these were **people** (singular: **people**), representing the population who may or may not believe the misinformation; and **sources** (singular **source**), representing the news sources. These are placed in a 61 by 61 world.

2.2.1 Setup

A single news **source** was used in this model and placed centrally. Although, distance does not matter for links to the news source it becomes easier to see visually.

The **people** were distributed randomly across the world avoiding the edges by limiting their positions to 95% of the maximum values `setxy (random-xcor * 0.95) (random-ycor * 0.95)`. Links are then formed to other people, this is done individually by selecting a **person** at random and having them form an link to the nearest other **person** with whom they do not already have a link with, until $(\text{average-friends} * \text{number-of-people}) / 2$ links are formed. Initially all people are set to have **belief** = 0. A number of **people**, determined by **percent-misinformed** are then randomly selected and have their **belief** set to 100.

2.2.2 Go

During each tick three steps happen:

1. **People talk to neighbours**, here each person ‘talks’ to other people they had a link with. This process allows the people to spread the information, this spread of information results in an update of belief for both sides of the link. For this the distance between the two nodes has to be evaluated by mirroring the distances so that closer distances have a larger weight (1), then the values get normalised such that they add up to 1 (2), then this array of normalised and mirrored values will be multiplied with the actual beliefs of the neighbour nodes (3). A slight radicalisation of % per tick is implemented in (4) which is based on social psychology theory (Borum, 2011). Finally, the own belief will be updated based on the own prior belief, the influenceable value and the new ‘outer-impact’ value (5). $distance_i$ are the distances between the current person and the linked person and $belief_i$ are the beliefs of these neighbours.

$$mirror_n = \sum_m distance_m - distance_n \quad (1)$$

$$friends - impact_n = \frac{mirror_n}{\sum_m mirror_m} \quad (2)$$

$$outer - impact = \sum_n (friends - impact_n * belief_n) \quad (3)$$

$$radical - outer - impact = (outer - impact - 50) * 0.05 + outer - impact \quad (4)$$

$$B_{post} = B_{prior} * (1 - I_{own}) + I_{own} * radical - outer - impact \quad (5)$$

2. **People receive the fact-checked news**, here all people who are connected to the fact checked news will get their beliefs reduced by 10%. This can be seen in the following update function.

$$belief_{post} = belief_{prior} * 0.9 \quad (6)$$

3. **People adjust their position**, becoming closer to like minded people. Each person will face each connected neighbours sequentially, once this is done the distance it should move is determined from the difference in belief between the people. For this first the difference in belief between a person and his neighbour is calculated and scaled (7), once this is done it will travel towards the neighbour if the difference is smaller than 0.5 else travel away from the neighbour (8). In case that the distance is too close to the neighbour prior to the travel the person will increase the distance so that a minimum distance of 2 patches is maintained.

$$difference = |(belief_{cur} - belief_{neighbour})/100| \quad (7)$$

$$travel - distance = 0.5 - difference \quad (8)$$

2.3 Experiments and analyses

To test the model, the experiment was run over 6 categories, representing the broad trust in the news media at different scales: no trust (0%), South Korean levels of trust (21%), USA levels of trust (29%), a middle value between the highest and lowest countries (38.5%), Dutch levels of trust (52%), and Finnish levels of trust (56%). This level of trust is therefore our independent variable. Our dependent variable is the number of people after 100 ticks that believe (defined as belief greater than 50) in the misinformation. All other variables are held constant. Full details are shown in table 1.

Experiment	Trust in media	Population	Average Friends	Percent misinformed
No trust	0%	500	15	50%
South Korea	21%	500	15	50%
USA	29%	500	15	50%
Middle value	38.5%	500	15	50%
Netherlands	52%	500	15	50%
Finland	56%	500	15	50%

Table 1: Full list of variables per experiment

Each experiment was run 100 times giving a total of 600 data points.

Feature	Purpose	Values	Notes
Number of People	The size of the sample used to model the population	500	If this is too small it creates an overly interconnected society which impacts on the results.
Mean number of friends	This is the number of people the average person is connected with	15	This is the result of the research of Dunbar, Arnaboldi, Conti, and Passarella (2015).
Percentage of people who are misinformed	This initial belief of the population of a new fact.	50%	Belief in a fact can be influenced by a number of factors. In order to simplify the model and not make any direct inference on the nature of misinformation, we choose 50% to represent an entirely new piece of misinformation given to a population.
Percentage of people who trust in the news	Trusting the news allows it to influence peoples beliefs	0% 21% 29% 38.5% 52% 56%	These represents the following: no trust, South Korean, USA, a middle value, Dutch, and Finnish, levels of trust the news media (Newman et al., 2020)
Distance	The distance between two friends represents the trust they have in each other	Not a pre-defined value	People are distributed across a 61 by 61 grid and initial connected to those nearest themselves using the average number of friends
Belief in misinformation	The strength of belief in the misinformation with 0 representing absolute certainty in its falsehood, to 100 where the person is absolutely convinced it is true. Any value above 50 represents belief in the misinformation to some degree.	0 to 100	Initially people will either believe in the misinformation (100) or not (0), these values will change over time to reflect the changing of beliefs.
Influenceable	This value represents a strength in the persons convictions, regardless of the belief in the information. A person with a high value (close to 1) is less likely to change their mind, and more likely to convince others. Conversely, a person with a low value (close to 0) is more likely to change their mind, and less likely to convince others.	0 to 1	A randomly linear assignment on the range [0, 1]
Moderating influence of news	The constant factor with which the news media alters an individuals (who trusts them) belief	0.9	This constant was chosen after testing, but is worthy of future research.
Radicalisation factor	The constant which amplifies the belief of a member of a cluster	0.05	This creates mimics the echo chambers found in social groups (Cinelli, De Francisci Morales, Galeazzi, Quattrociocchi, & Starnini, 2021) and (Borum, 2011).

Table 2: Key model features

3 Results

3.1 Example model run

Figure 1 shows the sample run using the United States of America preset (trust: 29%, population: 500, average friends: 15, percent misinformed: 50%) after 100 ticks. It represents a characteristic output from the model. A visual representation of the agents can be seen in the back box.

There are several interesting things to note here. First despite the random distribution of agents at the start, they are now organised in to distinct clusters. This is the result of the `do-layout` function, which is called on every tick and draws like-minded people together (as discussed in section 2.2.2. Secondly, the closer from a relatively even colour (representing belief). These two match what we expect and see in the real world as like-minded people gather and from echo chambers.

A final thing to note from the visual representation is the degree of connections to the news media agent often is a good indicator as to whether a cluster is likely to be misinformed. Clusters that have a higher degree of connection experience the moderating influence of the fact-checked news, becoming paler indicating a greater disbelief in the misinformation.

The external behaviour that results is that with a greater degree of trust in fact checked news the more connections to it there exist in the population the higher the likelihood of the clusters having several connections to the news. As the news (through the `send-news` function) moderates peoples beliefs (`set belief belief * reduction-through-news` with `reduction-through-news` set at 0.9). This results in a greater number of people not believing the misinformation.

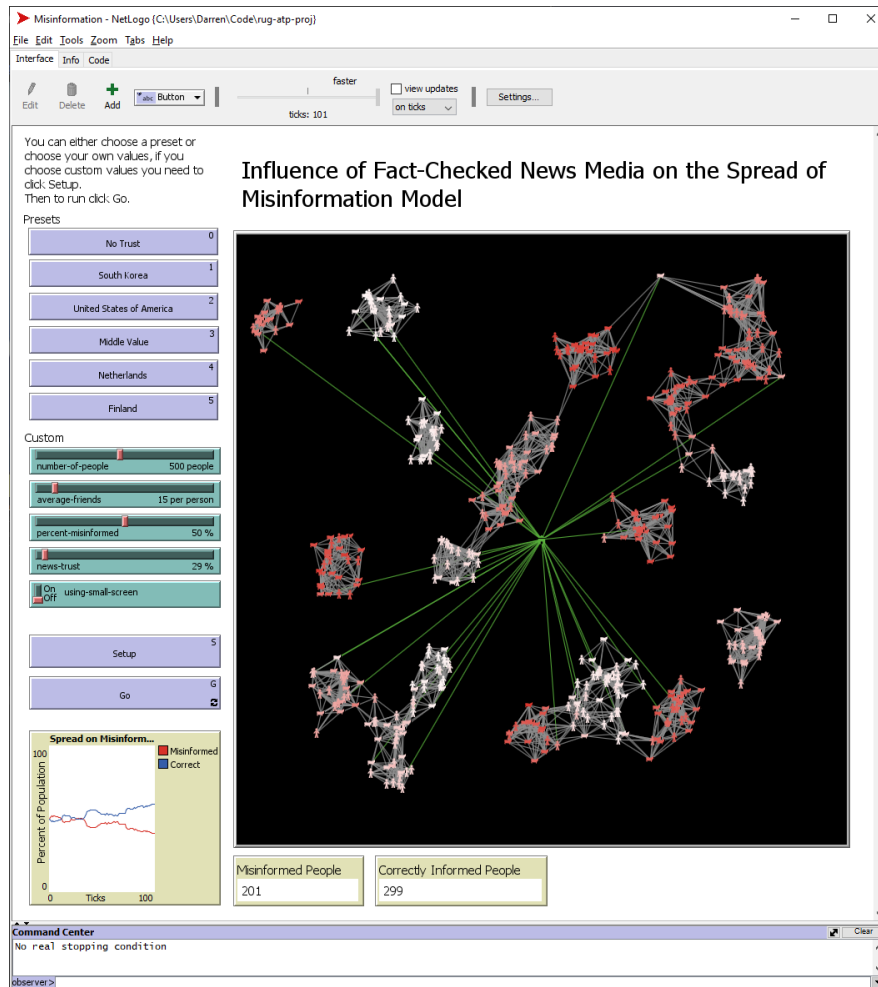


Figure 1: Example model run

3.2 Other results

As a prelude to performing a statistical test, a box-and-whiskers plot can provide interesting visual insight in to the data and confirm that the preconditions of the desired test are satisfied. Due to the nature of the data a box-and-whiskers plot provides this (figure 2).

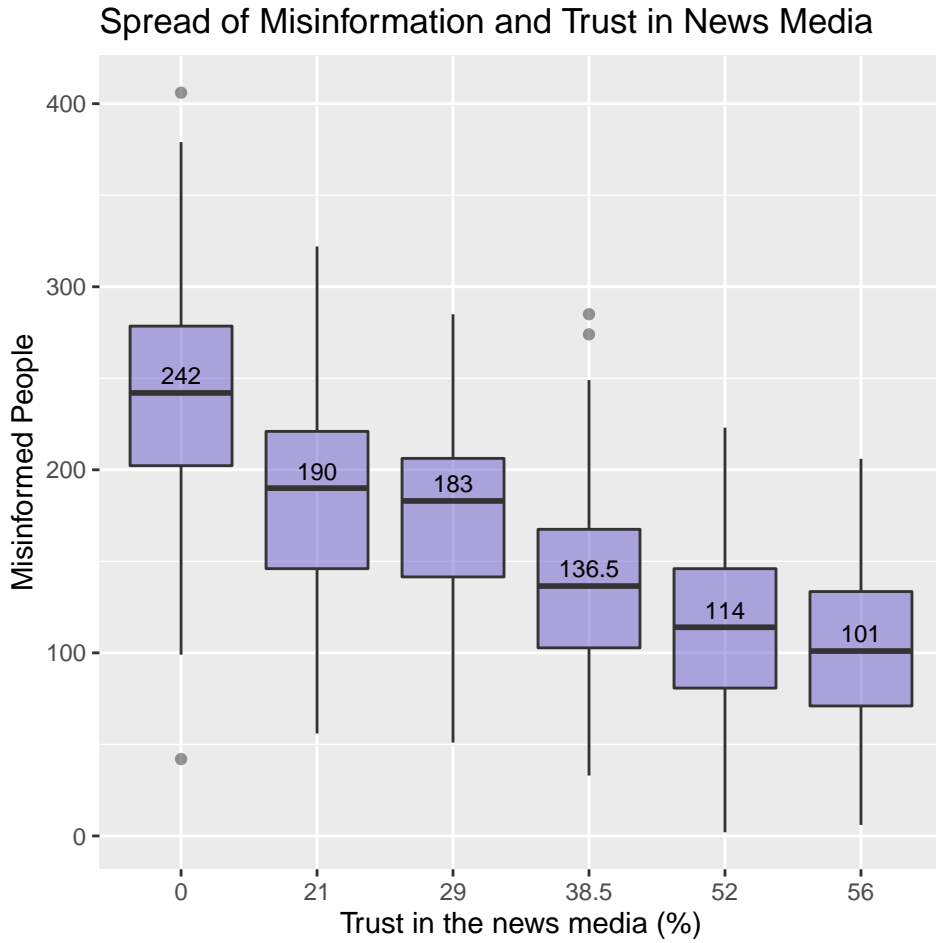


Figure 2: The level of trust in news expressed as a percentage, plotted against the number of misinformed people

As can be seen in figure 2 the samples appear normally distributed, and have a homogeneity of variance. Furthermore, as each run was unconnected with other runs we also satisfy the independence requirement of ANOVA.

There is a statistically significant different between the number of people that are misinformed at the different levels trust at of as determined by one-way ANOVA $F(5, 594) = 105.4, p < .001$. The results of this test can be seen in full in figure 3.

```
##           Df  Sum Sq Mean Sq F value Pr(>F)
## news_trust    5 1353255  270651   105.4 <2e-16 ***
## Residuals   594 1525362    2568
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Figure 3: Results of the ANOVA test

4 Discussion

The results from our project show a significant relation between a populations trust in a primary news outlet and the likelihood of them being taken in by misinformation. Confirming our hypothesis that the modelled influence of a fact-checked news media on the spread of misinformation, clearly shows the ability of the news media to inhibit the spread of this misinformation.

As can be seen in Figure 2 the results show a fairly steady downwards trend in the resulting number of misinformed individuals as the level of trust increases. This suggests that there is not a “tipping point” at which the erosion of trust leads to an outbreak of misinformation, but rather that it is a steady slope, where incremental change leads to incremental results.

4.1 Potential Problems

Our project was limited in some regards, only showing a broad overview of the dissemination of misinformation.

One obvious weakness of our study is the rather low population size. In order to run the model multiple times, and keep the analysis of the results feasible, we restricted the population to 500 people per run. Of course, more accurate results would be obtained with participants in the order of millions (i.e. the average population of a country), however that would have been too costly in computing time to be viable for this project.

Another limitation lies in the assumptions that were made. We assumed one single, universal news media outlet for a population. This was used to allow us to test the trust in news media as a whole against the resulting spread of misinformation without interference from other variables. We believe that the inclusion of multiple media sources could lead to a similar result, with larger communities that include preferred media outlets as well as neighbours.

Additionally, some variables hold assumed values. The extend to which beliefs become ingrained per tick was determined through experimentation. It could be informative to run an experiment varying this whilst other values remain constant.

Finally, our simulation uses an infallible news media. The assumption being that it is fact checked and relays only the truth. This is not true to life as few outlets can claim to have never made mistakes.

4.2 Future Research

We believe that this project could serve as a foundation for more specific research within the topic of misinformation. This could be approached in a number of ways, focusing on different aspects of the topic.

As mentioned in the potential problems, an extension of the news media, allowing for different outlets with different levels of trust, or levels of accuracy. To further extend this, outlets could be included that intentionally broadcast misinformation. It would be interesting to observe the formation of communities around such outlets, and how they change when there are more, or fewer, accurate media entities.

4.3 Conclusion

This has been an interesting project to tackle. Misinformation and conspiracy theories are an ever present spectre in the modern world. Whilst they are by no means a new occurrence, the rate at which they spread and the impacts they can have are an ever present concern. It has impacted elections (Swire, Berinsky, Lewandowsky, & Ecker, 2017) and threatens vaccination roll-outs (Kata, 2010).

The agent based approach worked well for this project, and despite the limitations of our model, we believe that the results were both interesting and relevant to the real world.

5 Division of labour

5.1 Group member 1: Lawrence Fulton

Lawrence contributed to all items of the project, specifically the planning, code, documentation, and presentation. His largest contribution was to completing the Netlogo model.

5.2 Group member 2: Darren Rawlings

Darren contributed to all items of the project, specifically the planning, code, documentation, and presentation. His largest contributions were found in the initial Netlogo model setup, and in the Introduction and Methods section.

5.3 Group member 3: Tim Chandler

Tim contributed to all items of the project, specifically the planning, code, documentation, and presentation. His largest contributions were to presentation and the video production along with the discussion section.

5.4 Group member 4: Bogdan Chelu

Bogdan contributed to all items of the project, specifically the planning, code, documentation, and presentation. His largest contribution was to the results section.

References

- Borum, R. (2011). Radicalization into violent extremism i: A review of social science theories. *Journal of strategic security*, 4(4), 7–36.
- Cinelli, M., De Francisci Morales, G., Galeazzi, A., Quattrociocchi, W., & Starnini, M. (2021). The echo chamber effect on social media. *Proceedings of the National Academy of Sciences*, 118(9).
- Darnton, R. (2017). The true history of fake news. *New York Review of Books, NYR Daily*. Retrieved 2021-03-20, from <http://www.nybooks.com/daily/2017/02/13/the-true-history-of-fake-news/>
- Dunbar, R. I., Arnaboldi, V., Conti, M., & Passarella, A. (2015). The structure of online social networks mirrors those in the offline world. *Social networks*, 43, 39–47.
- Kata, A. (2010). A postmodern pandora’s box: anti-vaccination misinformation on the internet. *Vaccine*, 28(7), 1709–1716.
- Latané, B. (1981). The psychology of social impact. *American psychologist*, 36(4), 343.
- Newman, N., Fletcher, R., Schulz, A., Andi, S., & Nielsen, R. K. (2020). Reuters institute digital news report 2020. *Reuters Institute for the Study of Journalism*.
- Ross, R. (1916). An application of the theory of probabilities to the study of a priori pathometry.—part i. *Proceedings of the Royal Society of London. Series A, Containing papers of a mathematical and physical character*, 92(638), 204–230.
- Swire, B., Berinsky, A. J., Lewandowsky, S., & Ecker, U. K. (2017). Processing political misinformation: comprehending the trump phenomenon. *Royal Society open science*, 4(3), 160802.