SOCIAL NETWORKS, COGNITIVE BIASES AND FAKE NEWS: CAN A SIMPLE COMPUTER MODEL EXPLAIN A COMPLEX PHENOMENON?

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Abstract: *Misinformation spread by individuals sharing fake news can cause problems in social, economic and democratic systems. The World Economic Forum considers the viral spread of misinformation online to be one of the main threats to our society. While the reasons why people spread misinformation likely haven't changed in the last millennia, the rise of Internet powered social networks has allowed news to spread rapidly among millions of users, and gave rise to new phenomena such as echo chambers. The question we ask in this paper is whether we can model the dissemination of fake news and the emerging phenomena using relatively simple rules in an agent-based model. We present the current state of research in the field of fake news, the agent-based modelling methodology, and the current state of our model development.*

Keywords*: Fake news, Disinformation, Cognitive bias, Emergent phenomena, Social networks, Agent-based modelling, Social psychology.*

INTRODUCTION

The viral spread of digital misinformation has become so severe that the World Economic Forum (Tedeneke, 2018) considers it among the main threats to human society. There is worldwide concern over false news and the possibility that it can influence political, economic, and social well-being (Törnberg, 2018). The scale and rapidity of sharing fake news and misinformation are having an impact on democratic processes. False news can drive the misallocation of resources during terror attacks and natural disasters, the misalignment of business investments, and can misinform elections (Vosoughi, Roy, & Aral, 2018)

The spreading of fake news in social networks is a complex social phenomenon. Unfortunately, the study of large-scale social systems is hampered by its subject – in contrast with modelling of problems typically examined in natural sciences, social science problems are much harder to analyse and model, as they involve real human beings. Consequently, it is nearly impossible to build coherent theories that would account for all empirical observations and which all scientists would agree on.

Currently, there is a lack of models explaining the behaviour of individuals spreading fake news, as the past research has been mostly focused on statistical analysis of the spread of individual articles or posts via sharing (retweeting) in social networks. The analysis of large datasets (e.g. 500 million tweets in (Yang & Leskovec, 2010)) can improve our understanding of the macro phenomena via the development of statistical models, which can provide a reference point for the validation of novel micro models of processes behind the current fake

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news phenomena. Such micro models would allow us to develop and test new theories explaining and predicting the fake news phenomena using individual-level rules.

Agent based modelling (ABM) is currently the methodology of choice for the construction of micro models aiming to model the interaction of individual humans. In ABM, the focus is on individual agents, their decision processes, their interaction with other agents, and the effects of that interaction on decision processes. Differences between individuals can be introduced relatively easily, as ABM models operate on the micro abstraction level, with individuals represented as discrete agents. The aim of this paper is therefore to present the current state of research in the field of fake news, ABM methodology, and the current state of our model development.

LITERATURE REVIEW

Social media platforms are often used as effective tools for constructive communication, but they also help disseminate false news (Tedeneke, 2018). Known examples of fake news disrupting democratic processes include the 2016 US presidential elections (Bovet & Makse, 2019), the UK Brexit referendum (Himma-Kadakas, 2017), 2019 European elections (Marianna Spring and Lucy Webster, 2019), and the 2018 Brazil election (Paraguassu, 2020; Trevisani & Seetharaman, 2018).

The paradigm of direct production of uncurated content and its uncritical consumption on online social media fosters the formation of homogeneous communities (echo-chambers) around specific worldviews, and has been demonstrated as a breeding ground for the creation and diffusion of fake news (Zollo et al., 2015). It seems that fake news become rife in times of crisis, as people seek simple explanations for complex truths and scapegoats, as evident in the ongoing Covid-19 pandemic (Hartley & Vu, 2020; Orso, Federici, Copetti, Vetrugno, & Bove, 2020). Furthermore, fake news 'factories' and 'troll farms' seem to have become a common weapon in psychological warfare used by state actors as well as a tool to generate web traffic and thus profit (Gorrell et al., 2019; Linvill & Warren, 2018) (Linvill & Warren, 2018).

Humans are biased in perceiving and understanding a semantic content. A person can verify grammatical correctness of a sentence faster if the subject matches his pre-existing opinion and can understand a sentence faster based on hierarchical structure of the content in brain (Collins & Quillian, 1969; Gilead, Sela, & Maril, 2018). In addition, an individual weakness, such as lack of analytical thinking, can result in significant inaccuracy in generating content and detecting fake content distributed in social networks (Pennycook & Rand, 2017). A recent study has shown that humans are extremely naive in distinguishing content generated by other humans from those by bots (Shao et al., 2017).

While all persons potentially succumb to cognitive biases, regardless of their political persuasion (Pelly, 2017; Tait, 2017), there is evidence that the political bias and demographic factors significantly influence individuals response to fake news and thus their dissemination of fake news (Bovet & Makse, 2019; Guess, Nyhan, & Reifler, 2018; Poynter Institute, 2018; Silverman & Alexander, 2016) (Tait, 2017; Silverman and Lawrence, 2016; Hern, 2018; Guess et al., 2018; Poynter Institute, 2018). The polls conducted during Brexit also show a stronger response to pro-Brexit propaganda, which focused on the immigration issues (“take control of our borders”) in districts with an older age profile, lower proportions of residents educated to the equivalent of a degree, lower median earnings and lower proportions employed in highly skilled occupations (Gunther, Nisbet, & Beck, 2018; Waldherr & Wijermans, 2013). Work of

Goyanes and Lavin (Goyanes & Lavin, 2018) further sheds light on the demographic factors and situational predictors that influence the probability to share political fake news through social media platforms.

METHODOLOGY

Agent based modelling in social psychology

The key properties of the multi-agent approach according to Smith and Conrey (Smith & Conrey, 2007) are as follows. First, agents are autonomous. Second, agents are interdependent. Third, agents in these models follow extremely simple rules. One frequent goal of ABM is to identify the simplest and best supported assumptions about individual agent behaviour (such as the motive to seek the most attractive partner) that will generate the overall pattern or outcome of interest. Agent-based models can be used to study the sensitivity of a system to path dependence, and to explore perturbations to social organization at various stages of group processes (Smaldino, Calanchini, & Pickett, 2015). While the concept of agent-based modelling is easy to grasp, defining an agent-based model is not an easy task. Common mistakes in ABM based research include the integration of too many features and the choice of the parameters. The results of models are often criticized for being either trivial (too much abstraction) or, on the other hand, too complex (insufficient abstraction) and therefore probably wrong because of their surprising results (Waldherr & Wijermans, 2013). Getting the level of abstraction right is therefore of paramount importance. It goes without saying that the modeller must have a good understanding of the problem or system that is being modelled, but a less obvious requirement for selecting the appropriate level of abstraction is a well-defined hypothesis. The hypothesis defines the goals of modelling and thus informs the selection of model variables, their level of detail (=abstraction) and the scenarios to be simulated.

Experiments in social psychology have to navigate the thin line between an experimental setup that mimics real-world situations at the risk of complicating later data analysis, and an over-controlled environment trying to eliminate all potentially interfering variables. In ABMs, we can create the experimental environment containing the exact amount of detail needed. However, a strong bias towards simplicity should be adopted, as overly complicated models are more difficult to analyse, and the number of model parameters can be prohibitive due to the dimensionality of the space of possible parameter settings, which can become too large to be searched efficiently (Eberlen, Scholz, & Gagliolo, 2017). Conte and Paolucci (Conte & Paolucci, 2014) offer a similar view, and advise that model designer should strive to create a model system that captures the aspects of the real-world system in which she is interested, with enough complexity to create a credible analogy between the model and real world systems, but otherwise as simple as possible so as to maximize generalizability and minimize obscuring artefacts.

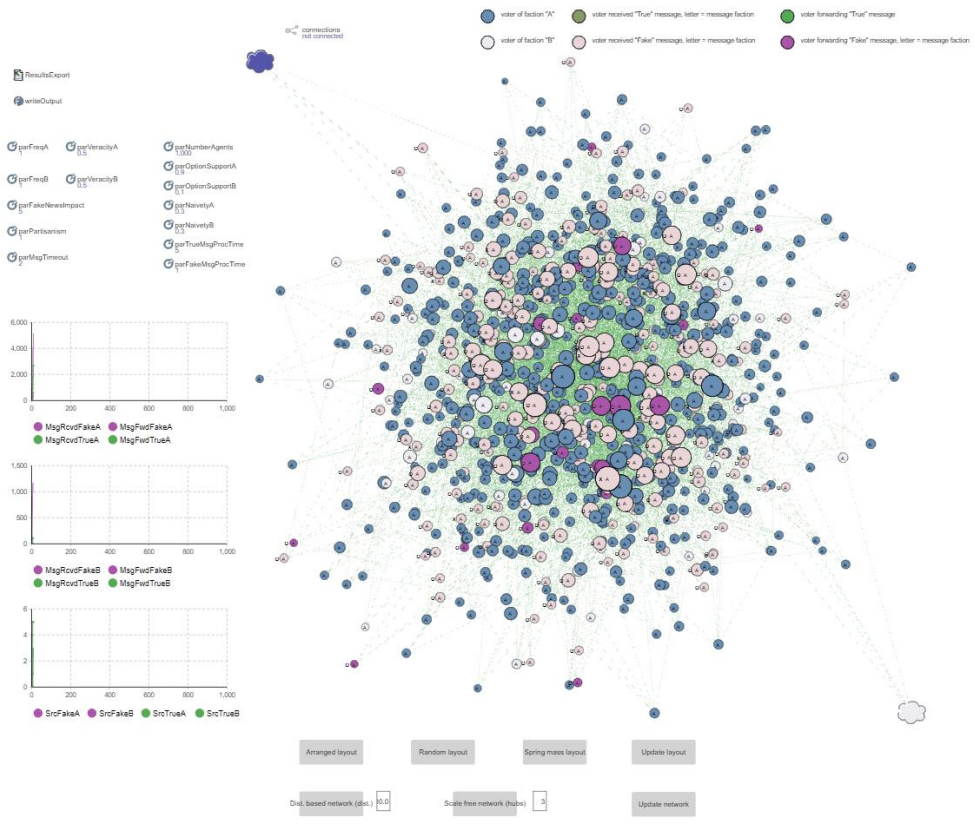
CURRENT STATE OF RESEARCH

While the development of a complex human actor model may be unfeasible due to the complexities of human psyche, we aim to model the fake news dissemination processes with sufficient accuracy by leaning on a main premise of complex adaptive systems research and agent based modelling (ABM) in social systems: complex phenomena emerges from the interplay of a large number of autonomous actors employing a set of simple rules. An individual will be modelled from the aspect of an agent in the news dissemination process, and its decision-making model is to integrate representations of the relevant cognitive biases.

The current version of the model allows us to adjust the number of individual agents, and adjust the parameters governing the behaviour of the "news consumer" agents and several sources of legitimate and fake news (messages). Agent parameters include political partisanism (propensity to forward authentic messages supporting the favoured faction), naivety (likelihood to accept a false message as authentic), ration of fake/authentic messages and frequency of message generation per news source, processing time for fake and authentic news per agent, and the impact of a false message (affecting likelihood for it to be forwarded).

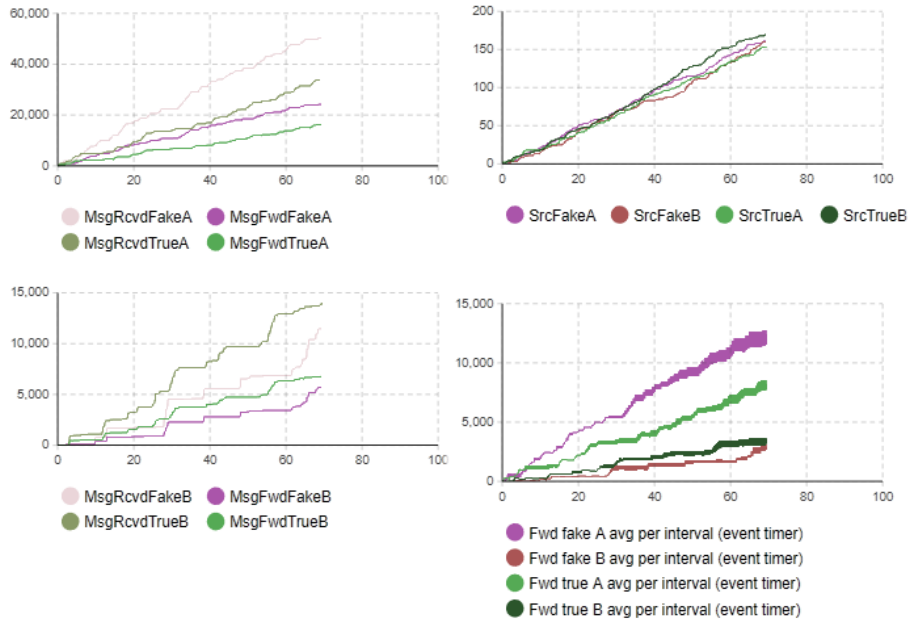
The model also allows us to adjust network type and layout during a simulation run. Available network layouts include arranged, random, and spring-weight, and network types distance-based and scale-free (Barabási & Bonabeau, 2003). The simulation interface with animation of agent communication is shown in Figure 1, while Figure 2 shows that nonlinear behaviour can appear even in the relatively simple current version of the model. News consumer agents are represented as circles and are divided among two factions (political options) A and B. There are two news source agents, represented as cloud icons, and each news source generates messages supporting a single faction. Colours are used to represent the political factions, state of agents (receiving/forwarding messages) and the authenticity of messages received or forwarded. Agent size is adjusted to indicate the number of their connections (links to other agents). Simulation experiment interface is shown on Figure 1. The current value of experiment parameters is shown in the top left, while the charts display the dynamics in the model, such as number of legitimate and fake messages received and forwarded by news consumer agents of factions A and B and the rate of message forwarding per adjustable time period. The agents, their state, network layout and connections are shown on the right.

Figure 1. Simulation interface within the current model prototype



The charts in Figure 2 display the linear increase of the cumulative number of received and forwarded messages, with visible aberrations appearing between agent factions despite the equal number of agents per faction and the same values of agent parameters. This indicates that even a relatively simple model, containing only linear dependencies between variables can produce unpredictable, nonlinear and even counterintuitive behaviour under the right circumstances, such as network congestion.

Figure 2. Observed nonlinear behaviour within the current model prototype



We must note that the experiment results do not yet correspond to real world data, as the model is still under development and not yet calibrated with empirical data. The model's value in current state is in generating insight and new ideas for its further development.

CONCLUSION

The current version of the fake news dissemination model allows use to vary the agent behaviour parameters, news generation and processing parameters as well as agent network type and layout in order to examine the influence of these parameters on the dynamics of message diffusion as well as visualize the diffusion of messages through the network. We have so far noticed that the increased frequency of messages can produce non-linear behaviour through network congestion. The development of the model prototype will utilize the findings from previous studies and literature review. Calibration, verification and validation of the model will be carried out using the rules identified through secondary sources and available databases of social network (e.g. Twitter, Facebook) and news website data. Originality and innovation of the planned simulation model is in the focus on the mechanisms at the level of individuals, which result in complex social dynamics present in the fake news phenomenon. We will use ABM to model and test new theories based on existing fake news research. The fake news phenomenon is a very relevant area of research, with a major potential scientific and applied impact. As the subject of our research is interdisciplinary, we are looking to cooperate with researchers from the field of network analysis, psychology and social psychology.

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