Simulating Dystopian Worlds: A Sci-Fi Agent-based Modeling Anthology

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ABSTRACT

Science fiction is immensely popular, particularly over the last two decades where over half of the top domestic grossing movies of the 2010s were science fiction. Many scientists also share this enthusiasm for Sci-fi, including the authors, so why not apply various research techniques to different Sci-fi worlds? We want to create a Sci-fi computational community, where we can explore different worlds and understand how different phenomena emerge in these worlds. Sci-Fi Agent-based Modeling Anthology is an open-source and fully volunteer-based project; thus, we also hope to find new collaborators who can take on different stories with their unique approach. The participants explore their favorite science fiction stories with new mediums like agent-based modeling or even differential equations. We believe that this project will get the attention of a new audience and bring them into the science fiction genre. Here, we explore our favorite science fiction stories (i.e., Fahrenheit 451 and 1984) with new mediums and hope to bring them to a new audience. We hope that the application of computational complexity science to these Sci-fi dystopian worlds will help us to learn more about our own world, our own histories, or even future potential trajectories. For example, how easily could our society turn into a 1984 world or vice versa? These models give you a sense of control, where you can change the variables. Therefore, you are no longer passively watching science fiction, but you are actively engaging in it, you are changing it, seeking to understand something meaningful.

Introduction

Science fiction is immensely popular, particularly over the last two decades where over half of the top domestic grossing movies of the 2010s were science fiction[1]. Many scientists also share this enthusiasm for Sci-fi, including the authors, so why not apply various research techniques to different Sci-fi worlds? During our conversations between lectures at the Santa Fe Institute's Complex Systems Summer School (CSSS) 2019, we discovered our passion for science fiction stories and modeling. Therefore, we have decided to combine our two interests and launch on a trans-disciplinary project.

We want to create a Sci-fi computational community, where we can explore different worlds and understand how different phenomena emerge in these worlds. Sci-fi ABM is an open-source and fully volunteer-based project. The participants can explore their favorite science fiction stories with new mediums like agent-based modeling (ABM) or even differential equations. In this paper, we introduce two models by the authors, 1984[2] and Fahrenheit 451[3]. Nineteen Eighty-Four, written by George Orwell, is explored using differential equations. Fahrenheit 451 is explored through agent-based modeling. We believe this project simultaneously promotes science fiction literature and a new way to learn and explore agent-based modeling and differential equations.

Sci-fi Model Rationales

1984

The technology available to Big Brother and the state apparatus in 1984 is not too far from what we have today. However, the use of the technology in 1984 results in severe changes in human behaviour, such as the disappearance of empathy, memory, and trust. Most people are not under surveillance, but they decide to voluntarily spy for the state fearing that they might disappear otherwise. How did this world state happen (how can we save us from going to a 1984 world), and how can the situation change (how can we save the people of 1984)?

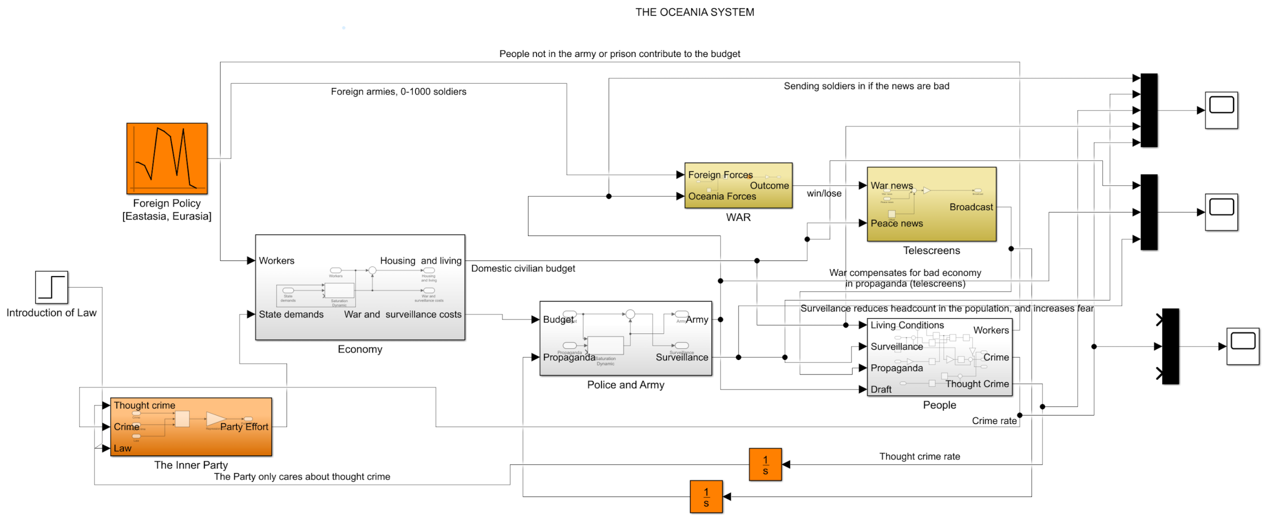

Figure 1. Orwell's 1984 as a system of nonlinear differential equations, represented graphically with block algebra. Negative and positive feedback loops connecting various elements of the society make the model complex.

Fahrenheit 451

Ray Bradbury reinvigorated one of the author's (Gillreath-Brown) love of reading when he was little and sparked his interest in science fiction. Fahrenheit 451 was specifically the book that did that. Since Gillreath-Brown is an archaeologist and history enthusiast, he was drawn into the world of Fahrenheit 451 because of the historical narratives that are interwoven into the book. The book really transported him into another world, and he connected with the main character, Guy Montag, at least in terms of the dissatisfaction with the harshness of society and Montag's appetite for knowledge.

Methods and Results

1984 Model

Setup

The 1984 model is not an ABM: it is a system of ordinary differential equations implemented in MATLAB's Simulink, conveniently splitting the system into subsystems corresponding to different areas of state organisation: economy, police & army, propaganda, and the people (Fig. 1). The only external input is the random number of soldiers deployed by the enemies in the distant war theatres: if it is greater than the number Oceania sends, then news from the warzone are bad. That is why the state aims to send an optimal number of soldiers to war, as good war news can compensate for bad economic news in the country—but sending too many soldiers out means less people in factories and the collapse of the economy altogether. This is one example of a loop in the system: other loops exist as well and complicate the mechanisms of Party's control over people. An example of a social experiment on this model is the introduction of law: instead of focusing surveillance on thoughtcrime, the state abruptly switches to the focus on "regular crime": while in the beginning the shift of suppression seems to decrease thoughtcrime, with time it explodes and rises to unprecedented levels: the revolution starts. This model is archived in the CoMSES Model Library.

Results

When we talk about politics, societal trends and dystopian futures, 1984 is the most common example. Everyone is afraid that we are either going towards Orwell's world of propaganda, surveillance, and lack of empathy—or convinced we are already living in such a world. This was the direct motivation for this experiment in psychohistory, as Asimov might call it: how does a democratic community transform into a 1984 society? If we knew it, then we could avoid it. How can the citizens already living in a 1984 world change it for the better? Instead of going for an agent-based model, we went for a system of differential equations, modelled here in a form of block algebra. All aspects of the society are connected in a big

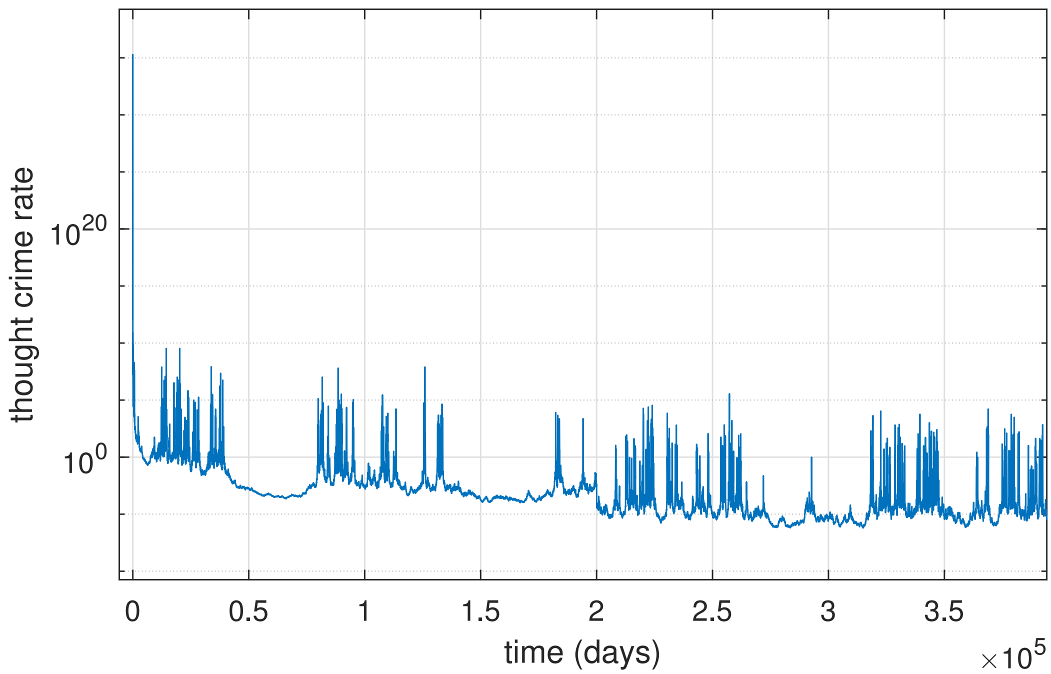

Figure 2. The change in thoughtcrime rates over time.

loop: more money in the army budget might improve the war performance and help the propaganda, compensating for the bad news at home. However, investing in the army also means increased draft, which in turn means less workers and less contribution to the budget. It also means less money for improving the life of Oceania's citizens, and hence can raise the levels of crime and thoughtcrime. That in turn will trigger more investment in surveillance. This creates deliberate and accidental loops, both positive and negative. Running different simulations on this model, including external events as triggers or just letting it evolve on its own allows us to monitor all these variables, and nonlinear effects that arise: a sudden spike in thoughtcrime the government cannot react properly to? That is revolution!

The model itself is a set of subsystems connected with input-output pairs. A random generator of enemy soldiers euphemistically named Foreign Policy feeds into the subsystem of war where based on the number of soldiers Oceania sends into battle, number of enemy soldiers, an element of chance and historical record, battle results become propaganda fodder for the masses. However, you cannot make the whole news broadcast about the war, you must talk about domestic affairs as well, which usually means cutting chocolate rations. Add the war news to the peace news, amplify it and send it out to the masses! People will process that, together with the surveillance the state puts on them, living conditions they experience, and military service enforced by the government. All that affects the levels of crime and thoughtcrime in the population, as well as the size of the working population. The crime rates go back to the Ruling Party as indicators for their demand on increase or decrease in surveillance. Another input could be an actual legal system being put in place, just for the sake of an experiment.

The economy does the budget planning based on the workforce and the demands from the Party. The Money Party asks for and gets the priority in budget allocation; the rest goes to the domestic budget for improving the infrastructure and distribution of goods. The police and the army split the priority budget based on the state of the nation, as assessed by the propaganda. The Army gets the priority and drafts new soldiers if necessary, while all the rest goes on to surveillance. So, the loop goes and goes! It is interesting to examine, for example, the level of thoughtcrime in this system as we run it, as seen in Fig. 2. In the beginning, there are big spikes in thoughtcrime—these could easily lead to successful revolutions. However, as time passes, the system is much more stable, and the probability of big unrest decreases. So, if we wake up in a 1984 world, then we must act immediately. An ABM take on 1984 would be interesting

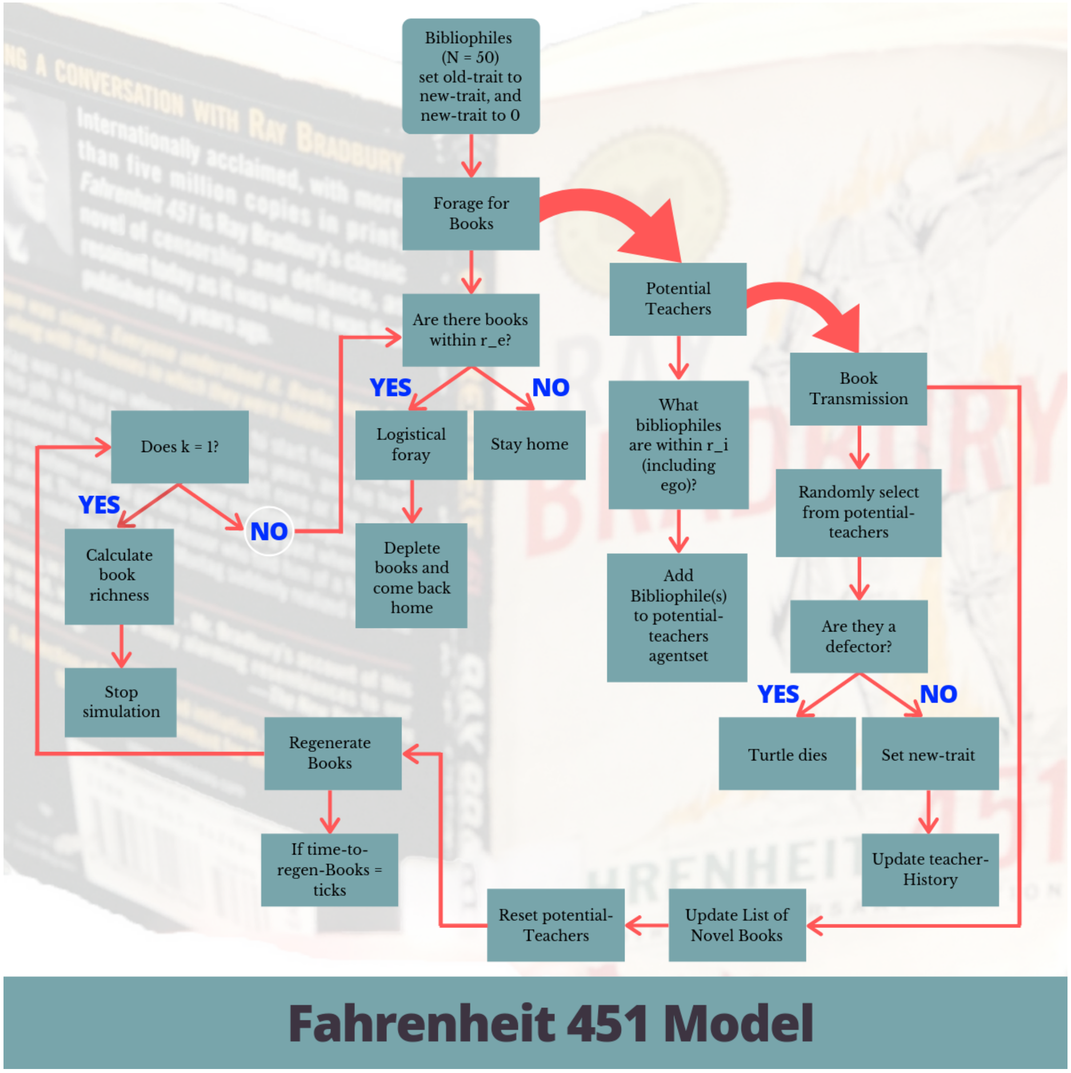

Figure 3. The Fahrenheit 451 conceptual model.

as well. In particular, it could answer questions about the lack of empathy in the 1984 world and the lack of trust (fear of fellow citizens spying). The dynamics observed in this systems model of 1984 are rich thanks to multiple loops in the model, but also the existence of integrators. Thus, there is a lot of memory in the system, especially in the crime loops, so that cumulative values of crime are relevant for the state of the system, not just the instantaneous ones. However, there is one catch. Orwell insists on the manipulation of memory as an important part of Big Brother's rule, so it is questionable whether it is justified to include all those integrators in the dynamics. If it is not, then we can still state an important conclusion—preserving an ability to remember events from the past helps in keeping dictators away!

Fahrenheit 451 Model

Setup

We began development on the Fahrenheit 451 model by thinking about how we as individuals would interact in that world, what information would we want to know to stop the dystopian trajectory. So, we became curious of how surveillance and defectors in the world could affect bibliophiles, of which we would want to be a part of. So, relying on previous ABM experience, we began constructing a conceptual model of how bibliophile agents would interact in this world. Fahrenheit 451 is an ABM in NetLogo[4], which is used to understand the world of Fahrenheit 451 and particularly how long and under what conditions bibliophiles may or may not persist in the world (Fig. 3). The agents in the model represent bibliophiles. The population is set by the global variable N, which is meant to represent a subdivided population. In the model, it is assumed that each bibliophile will gather books at approximately the same rate. This is a spatially explicit model. Each bibliophile will keep their old books (or old traits), which is derived from the experienced generation, and new books (or new traits), which shows the naïve generation. Each time step will consist of the naïve bibliophile trying to gather new books (or traits) within their effective foraging radius (r_e). Each bibliophile begins with a number of books, which in this case is just a number and is set in the beginning according to the turtle identification number. Each agent also keeps a list of agents (potential-teachers) that are within their interaction radius (r_i), including themselves (or ego).

Additionally, they will find out whether their potential teacher, or someone that they could learn a book from, is a defector, or someone that could report them to firemen. The agent's potential teacher list remains as nobody until it is generated in each time step and the potential teachers are added. The list is also used in book transmission and is reset in each time step. Each agent also keeps track of who and the number of times that they have been taught by a specific agent (teacher-history). The list keeps track of who ego has learned from in each time step throughout the simulation. Further, the list keeps track of how many times ego has learned from each bibliophile; so, it is cumulative for one entire simulation. Each agent also has a variable that calculates the number of unique groups that the agent has learned from (teacherRichness), or which is the number of groups that each group has learned from over the course of a simulation. Finally, if a bibliophile comes within a given buffer of a red patch, where a fireman would be, then they die. We are ultimately interested in how bibliophiles can persist in the world of Fahrenheit 451. The Fahrenheit 451 agent-based model is currently still in progress. However, the model will be posted on Sci-Fi Agent-based Modeling Anthology when it is completed.

Discussion

Although we have spent time interacting in the Fahrenheit 451 world, we are still left pondering: at what point for our modern world, how much surveillance increase and people defecting does it take before we flip into a world where something like books would be illegal/managed? Furthermore, by defecting, we partially mean that people are blindly following with little regard for questioning, discovering complexity, disregarding science, and so on. So, we plan to continue to explore the Fahrenheit 451 world to understand if there is a way to stop the flip into dystopia.

Conclusion

Although we are using computational complexity science to understand these dystopian Sci-fi worlds, somebody else could use their own unique story and methods to explore the stories in a completely different way. We hope that the application of computational complexity science to these Sci-fi dystopian worlds will help us to learn more about our own world, our own histories, or even future potential trajectories. We believe that this project will get the attention of a new audience and bring them into both classic and new Sci-fi explorations. We also hope to find new collaborators who can take on different Sci-fi stories using their unique approach.

References

1. Dirks, T. All-time (domestic) box-office hits and top films by decade and year (2019).

2. Orwell, G. *1984* (Tandem Library, 1950), centennial. edn.

3. Bradbury, R. *Fahrenheit 451* (Ballantine Books, New York, 1979).

4. Wilensky, U. Netlogo. http://ccl.northwestern.edu/netlogo/, Center for Connected Learning and Computer-Based Modeling, Northwestern University, Evanston, IL (1999).

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713567. The 1984 model is archived in the CoMSES Model Library. This material was also presented in a virtual conference, CoMSES 2019, which you can access at Simulating Dystopian Worlds: A Sci-Fi Agent-based Modeling Anthology.