Initial Plan

Agent-based Simulation of COVID-19 Transmission

CM3203 One Semester Individual Project - 40 Credits

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Project description

Back to the last-half year of 2019, a new type of coronavirus was spreading silently among people. By far, a report from John Elflein (2021) who is an expert in health and health care showed that about 103 million people were infected with COVID-19 in 210 countries and more than 2.2 million patients have died. Stopping the spread of the virus is now the top priority for countries around the world. However, studying what measures or factors can slow or stop transmission of the virus is difficult to observe on a large scale experiment with a short time and very hard to trace the path of virus transmission in a detailed way in real life. Moreover, the general public only knows about viruses in terms of these above figures, while these numbers cannot tell people how the virus spreads in the crowd.

This project, Agent-Based Simulation Of COVID-19 Transmission, then can be an alternative solution. it aims to use computer technology to simulate and visualise the occurrence of pandemics in a simple environment setting and explore the impact of some factors on the spread of the virus. Thus, providing a visual, clear and comprehensive perspective to observe how the COVID-19 spread.

In general, the problems that need to solved to achieve this system will be generated from two stages. The first stage is to construct a model depending on the rules analysed from virus spreading and the approach for modelling in this project is Agent-Based Modelling (ABM) which models a dynamic and complex system through the interaction of the autonomous agents in that system (Macal 2005). In this case, the agent in this project is the patient, for patients with a certain type of status such as health or infected, they are coded up with corresponding behaviour rules. Then iterating or looping this model, these agents will repeat their defined behavior in the system so that agents will interact with each other based on a simple environment to develop more complicated system behaviour. In the end, a pattern will be worked out to describe how the virus transmits. But of course, the actual implementation may need to considerate some elements such as infectivity (the possibility of a health people will be infected if he had contact with positive patients) to be close to the actual pattern in reality because not everyone who has been in contact with an infected person will be infected.

After completing the model, then comes with another stage which is visualization. It is the process to draw the agents with some geometry object in different colours to show how virus carriers infect healthy patients at each step of the model. Meanwhile, the visualisation also includes some components to allow to change the value of factors that we need to explore. For example, a slider to allow to change the capacity of the hospital in the system to see how it influences virus transmission .

It has to mention that both stages will be implemented under Mesa, which is a modular framework for building, analyzing and visualizing agent-based models(Project Mesa Team Revision 2016).

Project Aims and Objectives

The aim of this project is to use Mesa framework to deliver a system that can 1) simulate and 2) visualise how the COVID-19 spread in the crowd and then 3) look into how the different factors will affect the virus transmission.

Objectives:

0) Prepare

- Proficiency in the use of the Mesa framework
- Collect a list of rules of virus transmission in the reality

1) For stage: Modelling

- Different status of the agent has specific behaviour rules.
- The system has considered the contract frequency, infectivity, recover duration and other elements to make the model closer to the actual system in the reality.
- A simple environment which the agents walk around randomly is set (exploring multiple environments can be considered if there is time left).
- The agents can interact with each other automatically according to their own behaviour.
- The status will change if some behaviour rule acted. For example, an agent transforms from health status to infected status if it contacted with the agent who is in infected status.
- Different factors can be explored in this model.
- Model can simulate and give a reasonable pattern.

2) For stage: Visualisation

- Different types of status of agent represent with circles in different colours. For example, Infected(Red), Health(Black).
- The behaviours of the agent are visualised in the environment explicitly.
- Some sliders are set to decrease and increase the value of the factor.
- Visualising the changes of the virus spreading when different factors is added or the value of a factor is changed.

3) Others

- Evaluate the system and describe the weakness and strength of this system.

Work Plan

In my plan, the project will begin with the research and discussions with my supervisor how the system will be actual implemented. Then followed with the implementation of stage 1 and stage 2. Meanwhile, keeping taking notes during the implementation. After finishing the system, the system will be evaluated and then finally writing the final report. During these 12 weeks, there will be a supervisor meeting every week to monitor my progress.

Deliverables:

1. Initial plan
2. A system which realized the above objectives (codes
3. Final report

Timeline with milestones

The deliverable, milestones and special review meetings will be marked in the timeline.

- Week 1(1st Feb - 7th Feb)

- Research Mesa framework and other existing projects about virus transmission simulation.
- Discuss my implementation with the supervisor in the weekly meeting.

- Week 2 (8th Feb -14th Feb)

- **Submit the initial plan**

Milestone: The structure of the system is confirmed and the flowchart and phototype are sorted to show how the system works.

- Week 3 (15th Feb -21st Feb)

Stage 1

- According to the system flowchart and phototype, start to modelling
- Coding up the model to satisfy the first five objectives that are listed above.

- Week 4 (22nd Feb -28th Feb)

- Coding up the model to satisfy the left objectives that are listed above.

Milestone: The implementation of stage 1 finished.

-week 5 (29th Feb- 6th Mar)

- A review meeting with the supervisor to check if the existing model works well or need to do some changes or adjustments to the model where is not appropriate.
- If it works well, the improvement of the model can be considered.
- Summarize the notes for final report.

- Week 6 (7th Mar -13rd Mar)

Stage 2

- According to the system flowchart and phototype, start to visualization which is stage.
- Coding up the the system to satisfy the first two objectives that are listed above.

- Week 7 (14th Mar -20th Mar)

- Coding up the the system to satisfy the left two objectives that are listed above.

Milestone: The implementation of stage 2 finished.

-week 8 (21st Mar -27th Mar)

- **A review meeting** with supervisor to check if the existing system works well or need to do some changes or adjustments to the system which is not appropriate.
- If it works well, the improvement of the system can be considered.
- Summarize the notes for the finial report.

- Week 9 (19th Apr -25th Apr)

- A final test to the system with different arguments.
- Discuss the strengths and weaknesses of my solution with my supervisor in the weekly meeting.

Milestone: the evaluation of the system finished.

- Week 10-12 (26th Apr-14th May)

- Discuss with the supervisor the structure of the report.
- According to the nodes, start to write the final report.

11st May Milestone:

the final report finished.

13th May

- **Submit the final report.**
- **Submit the code of the system.**

About Ethics

For this project, the aim is to simulate and visualise how COVID-19 spreads in the crowd by using agent-based modelling. All the data is hypothetical such as the number of health individual which means this project will not involve human participation, for instance, interviews, observations, questionnaires, personal data, etc. (Cardiff University 2020). Also, it does not collaborate with others, so it does not need ethical approval.

Reference List

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