FCP – Simulating COVID-19

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1 Introduction

The group's aim for this project was to create an adaptable model that allows the evolution of a COVID-19 epidemic to be accurately represented by displaying the results visually for simple interpretation. The code is based around Oscar Benjamin's Covid-19 simulator[1]. However, this group has changed large parts of the existing code base. For example, adding a range of new functions and a set of variable inputs displayed by an interact-able GUI (Graphical User Interface).

2 Code

The code makes it possible to alter various factors which influence the outcome of the model. These factors can be varied in the GUI and include: the population size, which is the square of the dimension input; the duration of the program, measured in days; the number of initial cases of COVID-19; and the average length of time a person will be infected with the virus etc. Furthermore, it is also possible to change the probabilities of each age group becoming infected, recovering and dying.

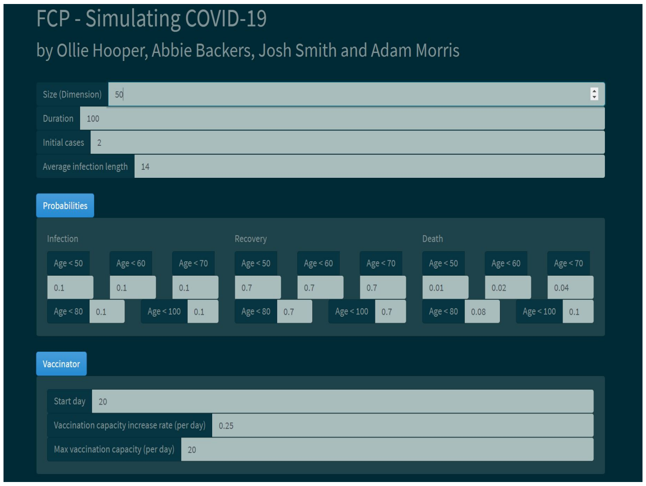
The GUI also contains four preventative measures: lockdown, social-distancing, improved treatment and ventilators. These can be enabled to see how they would impact the spread of COVID-19 in the simulation. In the GUI, each measure can be changed to model different scenarios. The measures can be manually changed to take effect over a time period correlating to a start and end day; the multiplier can take any value. For the lockdown and social distancing measure's, this multiplier mitigates the rate of spread. Whereas for the improved treatment and ventilators measure's, this multiplier lowers the death probability of each person who becomes infected.

The combination of these factors and measures enable the model to be applied to populations in different environment's, such as a first world country or a third world country, where the economic statuses may differ, restricting possible measure's governments could take.

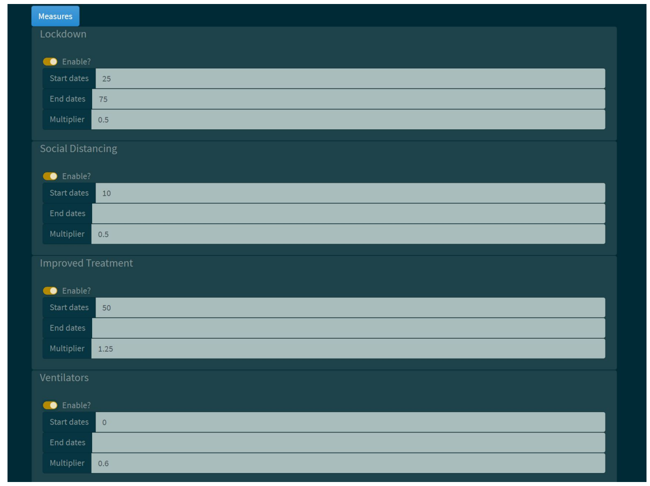
[1] [Oscar's code]

3 Animations

All of the figures used in this report are our own and are generated using the following inputs in the GUI. The inputs for the statuses - dependant on age - are generated from real-life UK statistics of from the COVID-19 crisis. [2] The values and animations presented and discussed in this report are generated from the following set of inputs to the GUI.



Factors used in examples



Measures used in examples

3.1 Grid Animation

The grid animation displays an evolving diagram for each day. Each frame represents a single day in which people can exist in a selection of 5 states: susceptible, infected, recovered, dead or vaccinated. For visual purposes each one of these states is represented by a different colour: yellow, red, blue, black and green respectively. The age of each individual person is also represented by the shade - the darker the colour the older the person. The grid operates such that any infected person only has the potential to infect the surrounding eight people (imagine a 3x3 matrix) of which the chance of infecting someone is determined by a probability. This helps to better simulate real life where someone can only become infected with coronavirus having come into contact with someone else who is infected. Naturally, only susceptible individuals have the potential to be infected.

[2][Statista. 2021. Coronavirus cases in England by age and gender 2020 Statista]

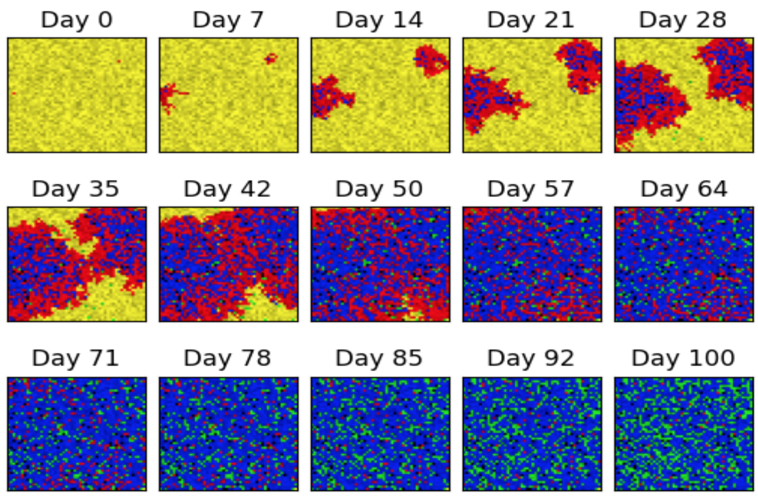


Figure 1: This image shows the screenshots of the grid animation at various days of the pandemic.

3.2 Line Animation

The line simulation shows the 5 states that the people in the simulation are assigned based on their age. The five states are susceptible, infected, recovered, dead and vaccinated. These states are represented in the line animation by different colours as indicated by the key shown below in Figure 2. The x-axis represents the number of days that the user inputted in the GUI; in this particular plot the input was 100 days. The y-axis represents the percentage of the population that are assigned these states. For example, on day one every person in the simulation is assumed to be susceptible, however this percentage varies in response to people become infected, recovering, getting vaccinated or dying. The likelihood of any susceptible person in the simulation recovering, dying or being vaccinated is determined by probabilities depending on their age.

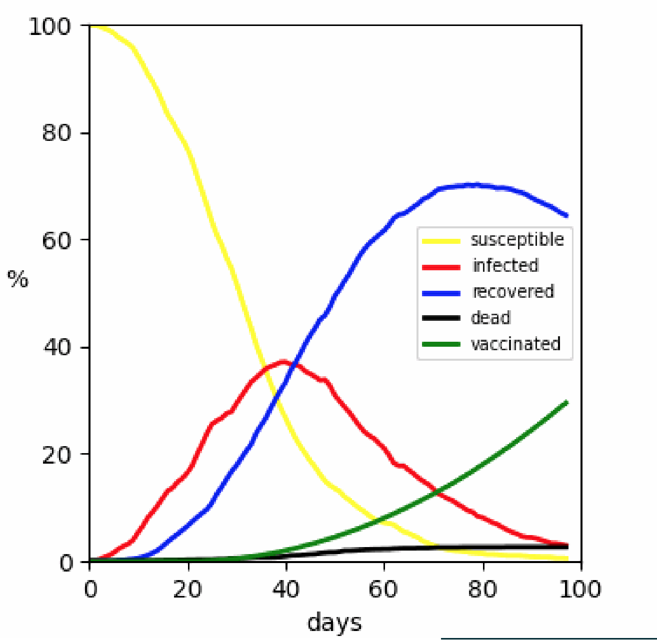


Figure 2: This image shows a screenshot of the line animation at roughy 97 days into the simulation.

3.3 Age Distribution

The code also generates a histogram displaying the age distribution of the infected population. The x axis represents age (in years) whilst the y axis is the number of people. Very early on in the project the group realised the age range of a population greatly affects the behaviour of a COVID-19 epidemic. For example, younger ages tend to be less severely affected with a lower chance of death and faster recovery. For this reason, we deemed it important to include the population demographic, enabling the user to investigate this point further.

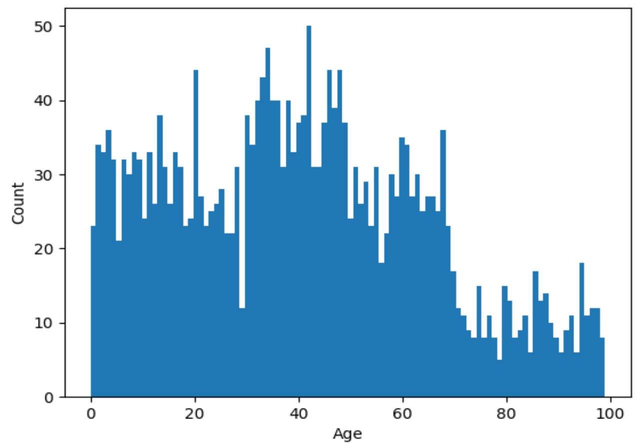


Figure 3: Age distribution histogram for example values defined in section3

4 Conclusion

Our project has performed as initially intended. It generates a variety of graphical data that represents a COVID-19 epidemic. It also contains variables that are easily altered by the user. The code is also robust with reusable functions. On the other hand, the animations are not generated very quickly, parts of the code could therefore be restructured to increase its efficiency. Given more time, the group would have liked to implement the idea of multiple different populations interacting with each other, this corresponds to real life where cities or even countries would be interacting. This could be done by having multiple grids capable of communicating with each other. In conclusion however, our project is a success.

References

[Statista. 2021. Coronavirus cases in England by age and gender 2020 Statista] Available at:
https://www.statista.com/statistics/1115083/coronavirus-cases-in-england-by-age-and-gender

[Oscar's code] Available at:
https://engmaths.github.io/emat10006/assignment/