

COMP90083 COMPUTATIONAL MODELLING & SIMULATION

Assignment 1, 2022

Released: Monday 8 August, 2022

Due: 23:59, Sunday 28 August, 2022

In this assignment, you will use NetLogo to create an agent-based model (ABM) of a complex observed phenomenon: the spread of an infection (such as COVID-19) through a population. Deliverables include a functional NetLogo model of the system, a description of the model using the ODD protocol (Overview, Design concepts, Details), and a brief report describing an investigation conducted using the model.

The objectives of this assignment are to gain experience in: (1) using NetLogo to implement/extend an ABM; (2) using the ODD protocol to describe an ABM; and (3) using an ABM to answer a question of scientific or policy interest.

Background

Outbreaks of infectious diseases such as influenza, Ebola and COVID-19 impose large health and economic costs upon societies. Models play an important role in responding to these outbreaks, helping to develop insight into their dynamics, and informing the public health response.

An important driver of the ongoing COVID-19 pandemic is the evolution of new variant strains. Over the last two and a half years, the original wild-type strain has been replaced by the Alpha, Delta and Omicron variants. The emergence of these new strains poses challenges for control due to immune escape (ie, protection gained from vaccination or prior infection by a different strain may be less effective), and increased transmissibility (ie, spreading more easily) and/or severity (ie, making infected people sicker).

Clearly, the basic SIR model we have discussed in class—which assumes that all infections are identical, and that immunity is permanent, among other things—will be too simple to answer questions involving multiple variants. Your task in this assignment is to extend the simple SIR model to answer a question involving multiple variants.

Note that you are *not* expected to become an expert in COVID-19 epidemiology or immunology, and to develop an extremely realistic model using empirical data. Rather, you should focus on the challenges outlined above (or any other challenge that you identify by reading or thinking about this scenario) and develop a simple model to explore that challenge from a theoretical perspective.

Your tasks

Your tasks are:

1. to **propose a question** (relevant to science or policy) that cannot be satisfactorily answered by the SIR model;
2. to **extend an existing model** of disease transmission¹ such that it can be used to address the question ;
3. to **design and execute one or more experiments** with your model in order to address the question you proposed;
4. to **report your findings**, in the format (a) a description of your model using the ODD protocol, and (b) a brief report discussing your question, experiments and results

¹If you wish, you are welcome to develop your own model from scratch; however, this is not required.

Approach

- Start by familiarising yourself with the basic SIR model in NetLogo. One implementation to start with is Curricular Models → epiDEM → epiDEM Basic. Another possibility is Biology → Virus, although note that this model already includes demography (death and birth of new people) and waning immunity.
- Read a couple of the recommended papers and choose a question. Keep your question simple! Note that your question does not have to be *novel*—you may choose a question that is already discussed in one of the readings.
- Determine how you need to modify the SIR model in order to answer your question: Do you need to change the disease model? Do you need to change the population structure or attributes?
- Decide what experiments you need to run—which scenarios you need to compare—in order to answer your question.

Procedure and assessment

- This assignment is to be completed *individually*. You are welcome to discuss question and model ideas with the teaching team and with other students; however, remember that all submitted work should be your own individual work, and you should not share code or writing.
- Late submissions will incur a penalty of 2 marks for every day (or part thereof) after the deadline. If there is a valid reason that you require an extension, email it well before the due date to discuss this.
- You should submit your assignment via Canvas LMS. Please upload:
 1. Your NetLogo model file;
 2. A document containing your ODD description (max 2 pages);
 3. A document containing your model report (maximum 1,200 words, excluding figure captions and references); see below for a suggested format.All three files should contain your name and student number.
- I have addressed a couple of common questions below. If you have further questions, I encourage use of the Ed Discussion Board.
- This project counts for 20% of your total marks in this subject. Marks will be awarded according to the following criteria:

Criterion	Description	Marks
Question	The question proposed is clearly articulated, feasible, interesting and relevant.	2 marks
Model description	The model is comprehensively described, making appropriate use of the ODD protocol. The design of the model is well matched to the research question.	6 marks
Model implementation	The NetLogo code is well structured, readable, and is well commented and explained. The model interface is clear and intuitive.	6 marks
Model report	The experiments conducted are clearly described and address the question. The results of the experiment are appropriately represented in figures and/or tables. The results are interpreted and an answer to the question is provided.	6 marks
Total		20 marks

Frequently Asked Questions

How realistic does my question need to be?

As noted, I do not expect you to become epidemiologists, nor to conduct extensive research as part of this project (though I have added a couple of papers via Readings Online to provide some general background that I *do* suggest reading!). So long as your question is broadly “on topic” and can be addressed via an extended SIR model, you are free to be creative.

How complex do my question and model extension have to be?

I suggest aiming for a simple question: remember that you only have 1,200 words to describe your question, results and interpretation. The model extension should, at a minimum, require the addition of at least one new process (ie, behaviour) to the basic model, with any associated changes to entities and state variables this requires.

How should my report be structured?

A suggested structure for your report is as follows:

- **Title:** a descriptive title for your report.
- **Background:** a brief motivation for the project, providing information the reader needs in order to understand your question.
- **Question:** the question you are addressing with your model.
- **Experimental design:** a brief description of the scenarios you will run and the outputs you will measure, sufficient to enable someone to reproduce your results.
- **Results:** one or two figures or tables summarising the results obtained from your experiments.
- **Discussion:** interpret your results and describe how they provide an answer your question; discuss any interesting observations.

Normally, a report with this format would have a description of the **model** between the **question** and **experimental design**; however, you do *not* need to include a model description in this report, as it will be described in the separate ODD description.