

handed out: June 23, 2020

handing in: July 2, 2020

presentation/discussion: July 3, 2020

Utopia's SEIRD (Susceptible-Exposed-Infected-Recovered-Deceased) model was developed with the current Covid-19 pandemic in mind. It is inspired by the well-known SEIR and SIRD epidemiology models, which are typically just formulated for well-mixed compartments, however. Their ideas are adapted here to form a CA-based spatial model of a contagious disease spread. The SEIRD model provides a variety of possibilities to investigate the spread of diseases within a spatially structured population of moving agents. We will take the opportunity to investigate some of these options in this and the following exercise sheets.

The main purpose of this exercise is to get a first understanding of the capabilities of the model, the processes it incorporates, their expected effects on each other, as well as the questions that could be addressed with it.

This model was just recently added to Utopia, so please make sure that you are using the latest version of the Utopia docker image by invoking `docker pull ccees/utopia:latest`.

You can find a detailed model description in the Utopia documentation¹. If not stated otherwise, you can keep the default model parameters. Note that some of the default plots may not succeed if the number of iterations is too small.

1. Understanding the SEIRD Model

present ☐

Read the SEIRD model documentation. Understand how the relevant parts of the model work, what they represent in the given context, and develop some intuition of the system's dynamics.

To do so, investigate the influence of movement by changing

- (a) the probability of a cell to move randomly (`p_move_randomly`)
- (b) whether cells `move_away_from_infected` cells.

Both will depend on the initial susceptible cell density provided by `p_susceptible`. Describe your expectations, show some results, and reflect on them.

2. Reproduction Number

present ☐

Perform a simulation run with default parameters for a sufficiently large amount of time. Then calculate and visualize the reproduction number R over time. Explain how you calculated it and reflect on possibly problematic properties. Interpret your results.

3. Choosing a Storyline

present ☐

With the understanding gained so far, develop a storyline using the SEIRD model that you would like to investigate. Investigating it will be your task next week. Elaborate on a question you would like to address and reflect on how to use the provided built-in capabilities of the SEIRD model. Which system behavior, pitfalls, or limitations would you expect?

Possible such storylines include lockdowns, vaccinations, spatially separated regions, superspreader events, the initial spread, long-term developments regarding a second wave, herd immunity and a possible loss of immunity, comparisons to the common flu.

Select and follow just one direction. Look at what inspires you and go explore. :)

Note that there is no coding required in this part.

¹https://hermes.iup.uni-heidelberg.de/utopia_doc/master/html/models/SEIRD.html