Assignment: Spread of the disease

The aim of the assignment is to create a game inspired by the spread of the epidemic. Each additional assignment will expand the functionality of the previous one. Firstly, we will describe the game as a whole (for a better idea) and then divide it into two or three assignments.

The game should simulate the spread of a contagious disease in the population. The game ends in two cases, the population is cured or succumbs to the disease. The player can intervene in the spread of the disease with various tools (which accelerate or slow down the spread). At the beginning of the game, the player can choose the type of disease whose spread he wants to simulate, the method of calculating the spread and the initial state of the population. The method of calculating the spread of the disease can be selected. The so-called a simple SIR model and a SIR model that also takes into account the vaccination of the population. During the game, the player can activate or deactivate tools to slow/accelerate the spread of the disease. After each time iteration (eg after each hour or day), the health status of the population is recalculated and the player's interaction is waited for. It can change the course of the game by activating or deactivating the retarders.

According to the **simple SIR model,** there are three groups of people:

- (S) susceptible: a group of people who can be infected by an infectious person. These then become infectious,
- (I) infectious: a group of people who have been infected and therefore can spread the infection,
- (R) recovered: a group of people who have developed immunity (are vaccinated, overcome the infection and thus have become immune or have died) and therefore cannot be infected or infect others.

Spread parameters:

- transmission rate between S and I group (β),
- transmission rate between I and R group (γ),
- reproduction number (R0).

β parameter:

The β parameter represents the rate of transmission of the infection to the susceptible person. This is the average number of contacts of one infected person (I) with susceptible people (S) per unit of time.

The parameter γ:

The parameter γ represents the measure of how many people from group I are cured or die (they can no longer spread the infection) per unit of time.

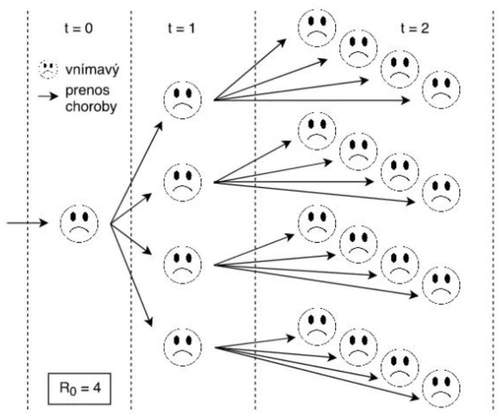
Parameter R0:

Reproductive number (R0) - expresses the average number of infected persons who are infected by one infectious person in a fully susceptible population. A fully susceptible population is one that is 100% likely to become infected from an infectious person (because it is not vaccinated or has no anti-infection antibodies). It can always be calculated from the parameters β and γ and can serve as an indicator for the end of the simulation.

$R_0 = \frac{\beta}{\gamma}$.

The parameter acquires positive values in the field of real numbers:

- if R0 <1, the disease does not spread (humanity has won over the disease),
- if R0> 1, the disease spreads and an epidemic occurs. The higher the R0, the less controllable the spread of the disease.



The second model we can choose is **the SIR that takes into account vaccination.** This is, in contrast to the simple SIR model, extended by another parameter f. This parameter represents the size of the population (percentage) that is vaccinated, ie. cannot be infected. The vaccine is expected to be 100% effective. The calculation of the population S, I, R will, therefore, be performed according to different formulas than in the simple SIR model.

We can control the ways in which the disease spreads through various measures or, more generally, by events. We have a group of events that slow down the spread of the disease and that speed up the spread of the disease. Among slowers include (in this game) a ban on gatherings at public events, the closure of schools, and the isolation of the country from the outside world. Propagation accelerators include natural disaster (various types) and, of course, deactivation of slowers. These events change the parameters β and γ in the way you define. For simplicity, just multiply the parameter (s) by a constant.

Resources

For more details on calculating the spread of the disease, use the Internet or eg:

http://www.public.asu.edu/~hnesse/classes/sir.html (Visualization of the course of the spread of the disease)

http://www.iam.fmph. uniba.sk/studium/efm/diplomovky/2018/dzugasova/diplomovka.pdf (A good source of information about the SIR model with a good explanation of the formulas) https://en.wikipedia.org/wiki/Compartmental_models_in_epidemiology (Also a good description of the SIR model)

Assignment 1 [5b]

Within the assignment 1, you must design a data structure for the disease spread model. When designing classes, place great emphasis on adherence to OOP principles (read the study materials carefully on the subject website). Try to design classes so that you minimize duplicate code and that the design is ready for expansion of functionality, e.g. a new event will be added to check the speed of the spread, save the state of the game, a new model of the spread, etc. At a minimum, classes representing the disease, classes representing the spread of the disease, game engine (classes controlling the progress of the game), user interface, classes representing events in the game (eg accelerators/slowers of the spread of the disease, infection of new people, death) are required.

Evaluation

The assignment is rated 5 points. The main emphasis is on compliance with the object-oriented approach and the principles associated with it, inter alia:

- appropriate naming of classes and methods in a single language (uppercase initial class names, lowercase method names), ideally in English,
- appropriate use of access modifiers (public, private, protected) to restrict access to methods and attributes,
- use inheritance and polymorphism,
- do not use nested classes,
- do not use static methods (not required in the specification),
- properly divide the code into packages.

Method of submitting the assignment

The assignment is transmitted to AIS. The entire zipped project (ZIP) is uploaded. You can use the built-in IntelliJ function (File > Export to Zip file ...) to unpack. The deadline for submission is set for 26.4.2020 23:59.Ł