

Infection Simulation

HW4

Mike Yang

Basic Operations

Load CSV Graphs

Before a simulation, a user can load a csv population graph by selecting from menu File->Open menu item, opening a file chooser. CSV graph files are expected to be used.

The file is successfully loaded if the “Seed File” label shows the file path of the source file.

If the file is incorrectly formatted or doesn't exist, an information window will show up on the user screen showing the error. More information about the errors, read section “Errors”.

There are 4 sample CSV graph files given in the project subfolder src->main->resources. Each of them are from different sources and have different spread and population.

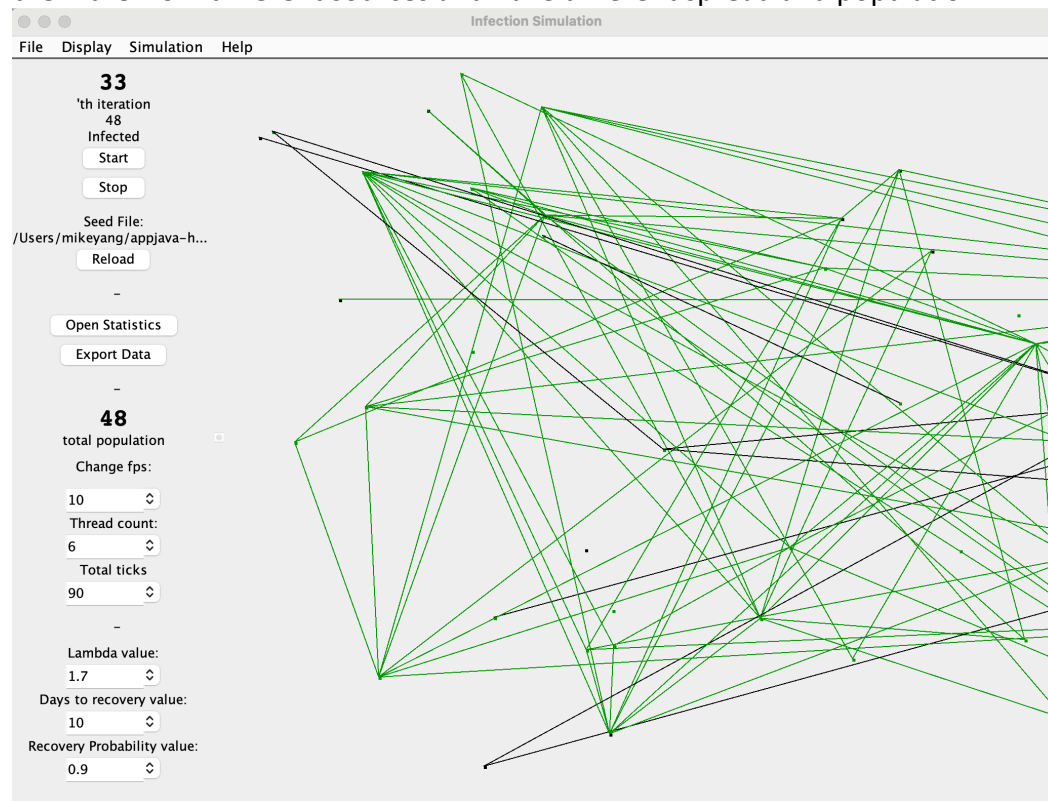


Figure 1, Infection Simulation UI

Start, Stop, and Reload

The user can start the simulation by clicking on the left-hand side menu button “Start”. The user might not see the graphs changing; that’s because there is not infection in the population yet.

For a simple infection simulation, the user can select from menu bar Simulation->Random Infect to randomly infection a subject from the population. After which the simulation can start to have infection spread.

To pause or stop the simulation, click on the left-hand side menu button “Stop”.

To reload the simulation, the user can click on the left-hand side menu button reload. Population data is reset. New subject positions are introduced after each reload.

Data Table and Statistics

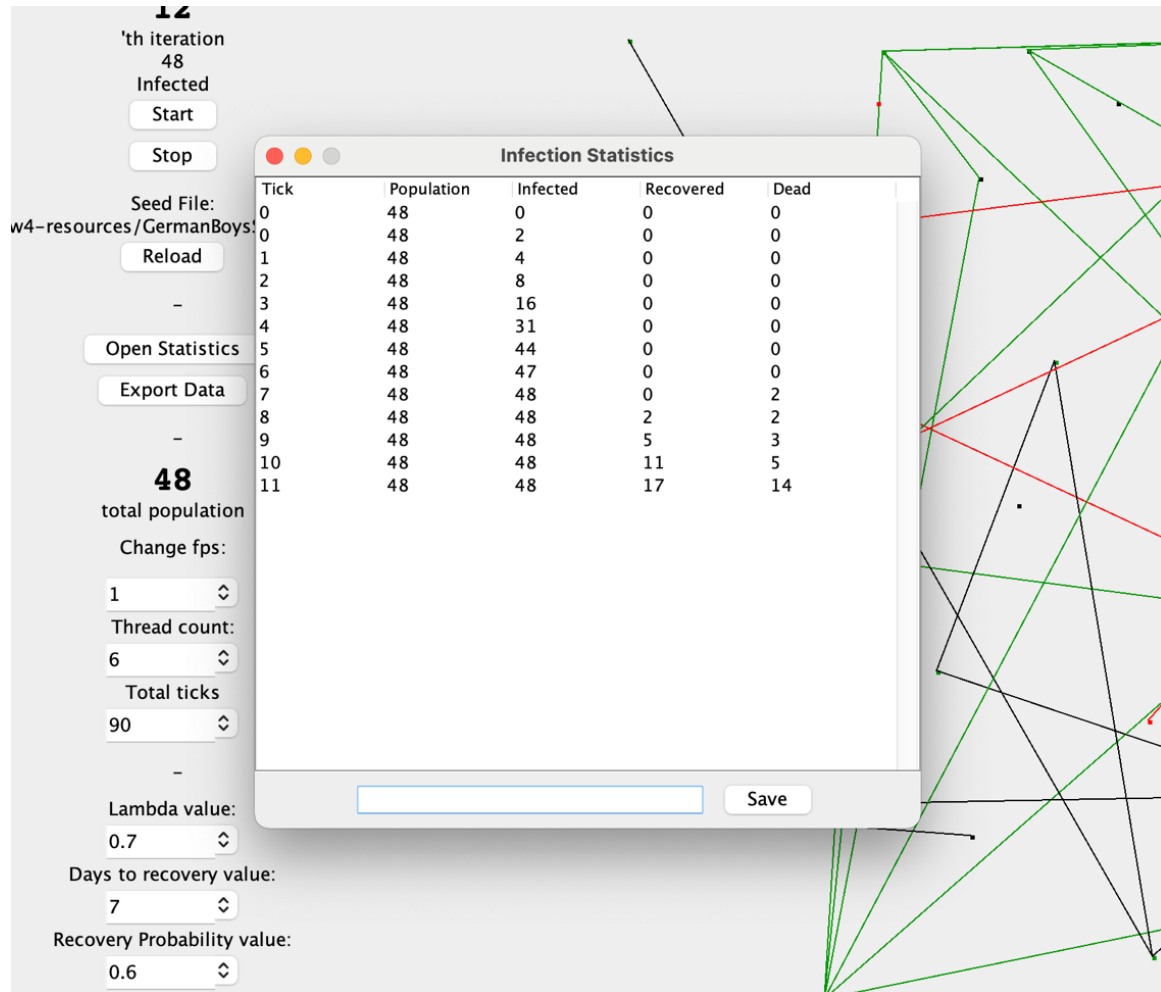


Figure 2, data window showing current running statistics.

The user can open a separate data table alone-side the main graph window. Click on the left-hand side menu button “Open Statistics” a separate window will show up on the screen.

The table contains fields “Tick”, “Population”, “Infected”, “Recovered”, and “Dead”. All data are updated live while the simulation is running.

Export Simulation Data

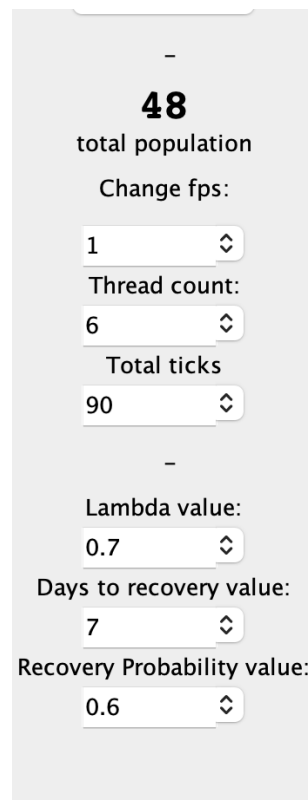
The data collected from the current running simulation can be done by clicking on the left-hand side menu button “Export Data”. A file chooser window will open, the user should enter a desired file name to save the data as a file.

The data can also be exported by clicking on the “Save” button from a data table window. All data collected are exported as a CSV file. The file can be analyzed by any tools or profiling software that can read a CSV file.

Simulation

Infection Force

Infection force is named lambda value in this program. A user can change the infection force of a simulation by clicking on the left-hand side menu box and enter a desired value.



The screenshot shows a configuration menu with the following settings:

- total population: 48
- Change fps: 1
- Thread count: 6
- Total ticks: 90
- Lambda value: 0.7
- Days to recovery value: 7
- Recovery Probability value: 0.6

Figure 3, Simulation configuration menu

The value is defined for any real number greater than 0.

Infection force is defined as “the force of infection as the number of susceptible neighbors of currently infected nodes that become infected in the next tick divided by the number of currently infected nodes” from the course website. The higher the value, the faster the spread of infection, and vice versa.

Recovery/Death Probability and Speed

An infected subject in a simulation will be recovered or dead after a period with a certain probability.

A user can change the period an infected has to wait to recover or be dead by editing the left-hand side menu box labeled “Days to recovery value”.

The period value is defined for any integer number greater than or equal to 1.

A user can change the probability of recovery by editing the left-hand side box labeled “Recovery Probability value”.

The probability value is defined for any real number greater than or equal to 0.

Initial Infection Spread Models

The simulation gives three ways to introduce the initial infection into the population.

Random infect

To use this model, select menu item Simulation->Random Infect. This model will randomly choose a subject from the current population to infect.

This model applies to multiple subjects by selecting the module multiple times.

Greater Than Model

To use this model, select menu item Simulation->Greater Than Infect. This model will infect any subject that has more neighbors than the “Days to Recovery value”. A user can customize what population to infect by also changing the “Days to Recovery value”.

This model will not infect more than the subjects that meet the condition.

Spread Infect

To use this model, select menu item Simulation->Spread Infect. This model will randomly choose a subject and spread randomly throughout the graph 7 times.

This model can be applied multiple times.

Infected, Recovered, Dead and the Population

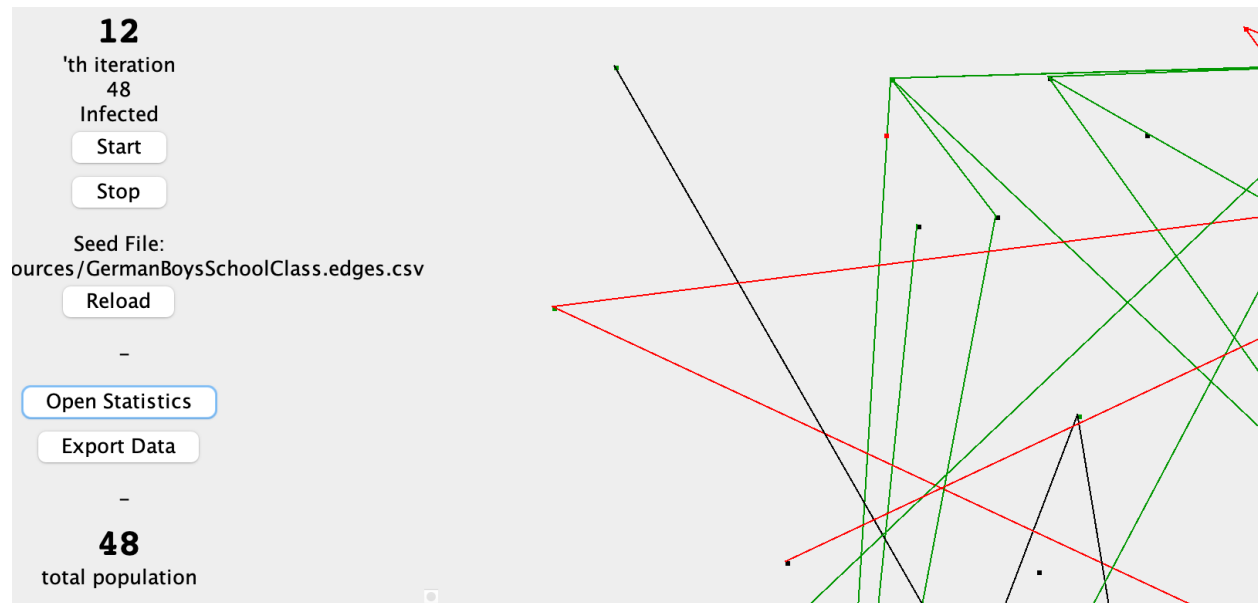


Figure 4, total population is the bottom left label, infected in labeled infected on the upper left. Infected subject have red lines spread out, and it will be green if the subject recovered and black if the subject died, yellow if unaffected yet.

The basic data about the current running simulation is shown in the UI as different colored lines for infection spread, and numbers in the left-hand side menu.

The infection number increase as the more and more subjects are infected. The number label is in the upper left labeled “Infected”.

The total population is shown in the figure above in the bottom left labeled “total population”. This number reflects the number of total subjects in the simulation. It might change as a new file is loaded.

After the simulation started to run, the graph representation will show spread of the simulation infection.

Yellow lines are subjects that have no outgoing or incoming infection (susceptible); this can be turned off by going to the menu Display->Toggle Un-infected lines. Red lines show the spread of outgoing or incoming infections from subjects' neighbors. The lines will change to green if the subject is recovered and black if the subject died.

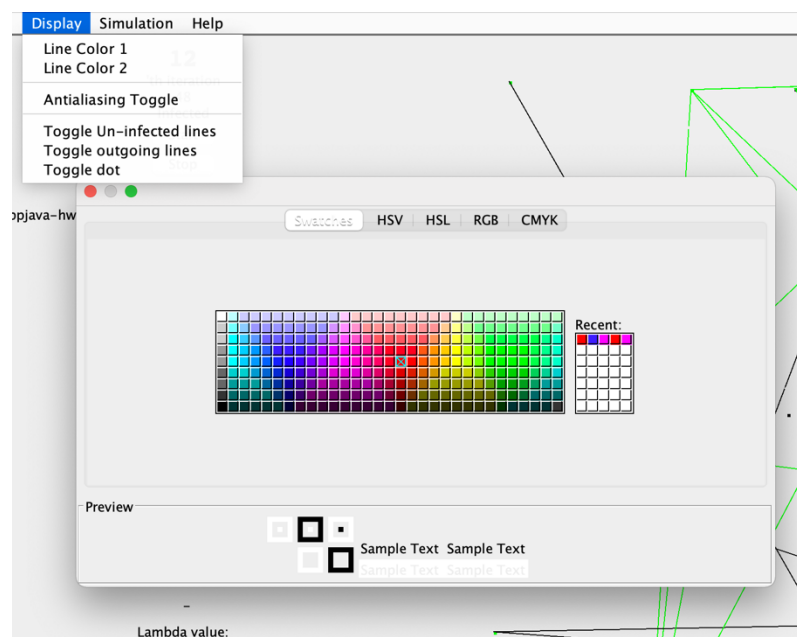
Set Iteration Count

The simulation can run as long as the iteration count is higher than the current iteration number. To change this value for the preferred iterations, edit the left-hand side box labeled "Total Ticks".

The value is defined for any integer number greater than 0.

Computation and Display

Figure 5, color chooser



Colors

The user can change the color of infection and recovery spread.

To change the color, go to menu Display->Line Color#.

The color selections are applied immediately as the selections are made.

Incoming or Outgoing Infection Lines

The user can toggle on/off the outgoing lines by choosing the menu Display->Un-Infected Lines.

The outgoing lines are lines that will be shown if the infection a subject is infected and it has neighbors; any connection that subject has will be colored to the respective color.

The incoming lines are lines will be shown if an infection happened, caused by another subject, and that connection will be colored by the respective color.

Disable Unaffected Subjects, and Dots

To toggle on/off the unaffected subjects, click on menu Display->Toggle Un-infected Lines.

To toggle on/off the dots showing the subjects, click on menu Display->Toggle Dots.

These options are preferred to see a clearer graph spread. One should turn them off they have a big spread graph.

The default options are all turned on.

Antialiasing

Antialiasing helps with smoother picture. Choose menu option Display->Toggle Antialiasing.

Antialiasing is turned on by default.

Thread Count

This simulation is multi-threaded, which will greatly decrease the time it takes to gather data for the given data. To change the amount of threads running the simulation, edit the left-hand side menu box labeled "Thread Count".

The simulation has been tested with thread value from 1 to 150 threads. It is safe to choose any value your CPU can support. Any value higher than $2 * \text{CPU_core_count}$ might result in larger number of processes preemption including other open processes running on the user computer.

The thread count is defined for any integer value greater than 0.

Frame Time

Frame time is the time it takes for one iteration to update the next. Frame rate is the number of iterations per second. You can change the frame rate of the simulation by editing the left-hand side box labeled "fps".

The frame rate of a simulation might be slowed due to high number of populations the simulation need to resolve; thus, the fps is likely to be the maximum frame rate.

This value is defined for any integer value greater than 0.

Configuration File and Settings

```
1  sim_thread_count@6
2  sim_total_ticks@90
3  sim_k_count@7
4  sim_k_prob@0.6
5  sim_lambda@0.7
6  sim_fps@1
7  graph_uninfected_lines@false
8  graph_antialias@true
9  graph_show_dot@true
10 graph_outgoing_lines@true
```

Figure 6, automatically saved and loaded configuration files.

Configuration files

The user's configuration is loaded at start-up of the program. If no valid configuration files are found, the program will fall back to default.

The configuration file is generated automatically when the programing quits. It is saved out side of the root directory of this program, and named "config.conf".

A user can edit the value in any order, or delete any configuration they see fit. The program will only read the listed configuration options.

Configuration Options

These are the supported configuration options:

- "sim_thread_count@6", thread count of the simulations; defined for positive integer values after the symbol "@".
- "sim_total_ticks@90", total tick that the simulations will run; defined for any positive integer after the symbol "@".
- "sim_k_count@7", days to recovery; defined for any positive integer after the symbol "@".

- “sim_k_prob@0.6”, probability of recovery; defined for any positive real number smaller than 1 after the symbol “@”.
- “sim_lambda@0.7”, force of infection; defined for any positive real number after the symbol “@”.
- “sim_fps@1”, frame rate; defined for any positive integer after the symbol “@”.
- “graph_uninfected_lines@false”, unaffected lines toggle; defined for “true” or “false” after the symbol “@”.
- “graph_antialias@true”, antialiasing toggle; defined for “true” or “false” after the symbol “@”.
- “graph_show_dot@true”, dot toggle; defined for “true” or “false” after the symbol “@”.
- “graph_outgoing_lines@true”, incoming or outgoing lines toggle, defined for “true” or “false” after the symbol “@”.

Errors

The following list is a list of possible errors for the simulation. The user will see a window pop-up displaying these messages if any errors happen to occur during the execution of the program.

1. “Unable to export, file path or file name faults”:
The export data file format extension is incorrect. Add the correct extension “.csv”.
2. “Simulation stopped. Tick count reached ”
Simulation limit reached before stopping. More of an alert than an error. The user doesn’t need to do anything.
3. “Thread joining failure, skipping; no need to elevate.”
A thread is previously killed or orphaned. The program evaluated that the simulation doesn’t need to stop, and no data is lost. The user can try to decrease the thread count.
4. “File readLine fails, data not added.”
The input file format is incorrect. the user need to open a different file that contain correct CSV formatted data.
5. “File loading fails, fix it.”
The input file doesn’t exist or corrupted. This should never happen if the user just choose the files from the chooser. This might happen if the user uses a mechanical hard drive instead of a solid-state drive. This is 2021, the user should drop CS and go learn Management or something.
6. “File cannot parse, parse_cvs received null”
Memory corruption. Cannot be fixed. Rerun the program. Never seen this happen.
7. “File not found or simulation format false!”
The file chosen might contain incorrectly formatted or inconsistent data that cannot be parsed by the program
8. “Unable to export, file path or file name faults”
The user chose a directory that they don’t have access to or the file name cannot be understood. Change the file directory or the file name.

9. "Export failure"
No data is available for export. See section "basic operation" for how to generate data.
10. "Overwriting configuration file"
The program stuck at exit. Force quit the program. Never happened.
11. "Writing configuration file in"
Program stuck at startup. Force quit the program and rerun.
12. "No correct configuration files"
configuration file format incorrect. See section "Configuration and Saves"
13. "Color undefined"
The input color is not define. Use the GUI color chooser.