

# Simulation of the Spread of a Virus Using Agent Based Modeling

Matt Wade

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## **Abstract**

My goal is to make an agent based modeling simulation that shows the spread of a cold through a school. It will start with an amount of infected students and healthy students received as inputs and will show how much the virus spreads or possibly recedes over time.

## **1 Introduction**

My program will answer the question as to how quickly and fully different types of sicknesses will be able to spread through the population of a school once introduced.

This will show how likely it is for a disease to be spread by a set amount of sick people coming to school with the sickness. This will show if the danger of infecting others is actually a valid excuse not to come to school or if you should come to school unless you actually don't feel like you will be able to do work.

I expect my program to show how many people are infected with a virus after any amount of time given an input of how many people there are and how many are infected at the start. It will display the number of infected people and the period that the agents are in at the moment in the display window plus possibly some other information such as the ratio of infected to healthy people, the total number of people that have been infected (including those that have gotten healthy after being infected), and other similar results.

When finished the program will display values for the number of agents are sick, healthy, total agents, total infections, and total recoveries. It will

also have a display showing the locations of all of the agents and their status (healthy or sick). Eventually it will be able to have different diseases which have different recovery times and infection rates. I will use research data for all of the stats relating to the different diseases such as the recovery time and the infection rates based on real values for different diseases.

If I finish all of this early I could move on to possibly exploring different methods of contracting the diseases. At the moment viruses are all passed through close contact with a sick agent, but I could add diseases passed through contact with where a sick person had recently touched such as a doorknob or a keyboard.

## 2 Background

I have been researching different examples of agent based modeling using MASON through the MASON website and the book Growing Artificial Societies which specifically discusses the Sugarscape model. A model similar to mine is part of the demo models for MASON which describes the spread of a virus through a workplace. In this example the agents become immune to the virus once they become healthy, they stay sick for a set amount of time, and move to work and come back home without moving to other places. They are infected through close contact with sick agents just like in my program and this program only has one type of disease unlike mine will when finished. I will attempt to make my model more realistic in most of these areas by using actual data. There are also many papers documenting the usefulness of computer models and simulations in science such as Tutorial on Agent-Based Modeling and Simulation by Cayzer and Sullivan, and Modelling Danger and Anergy in Artificial Immune Systems by Macal and North, which is another paper documenting the use of a computer model in analyzing the human immune system. **References:** Macal, C., and North, M. (2005). Tutorial on Agent-Based Modeling and Simulation; Cayzer, S., and Sullivan, J. Modelling Danger and Anergy in Artificial Immune Systems.; Macal, C., and North, M. (2005). Tutorial on Agent-Based Modeling and Simulation Part 2: How to Model with Agents.; Epstein, J. (1996). Growing Artificial Societies: Social Science from the Bottom Up. Brookings Institution Press.

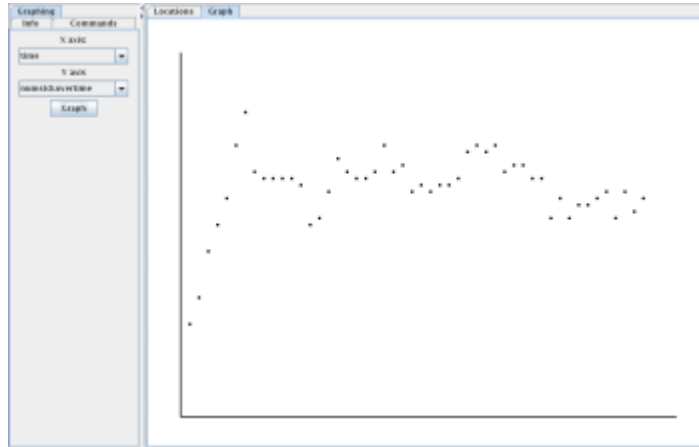


Figure 1: Graphing

### 3 Development

My program has three main classes. An Agent class which defines what values an Agent will store and how to construct it. A class that creates the GUI. And the most complicated of the three, the Model class which is where all of the calculations occur. In the Model class there is an arraylist containing all of the Agents in the simulation. With these Agents the class has to define a `step()` function which moves the simulation forward. This function has to update the locations of all of the agents, check to see if any of them get infected, and check to see if any recover from being sick. First it goes through the list of Agents and moves them all to the next location in their schedule. In order to check for any new infections it goes through the entire list of Agents finding each sick Agent. Whenever it finds a sick Agent it finds any healthy Agents in the same location and checks a randomly generated number against the sick Agent's infectiousness value. If the random number is lower then the healthy Agent is switched to sick and the method continues on through the rest of the list. To check if any Agents recover from sickness it goes through the list checking the recoverytime value and if it equals zero the Agent is switched to healthy. The GUI class contains another important function, the ability to graph data gathered through the simulation. In the Model class I added new arraylists to retain information over time for all of the main variables (number of sick agents, number of

healthy agents, infections per step, etc.). Whenever the graphing method is called the Model class gets information from two drop down menus as to which arraylists are going to be the x and y axis variables and sends them to the graph class. The graph class then takes these variables and goes through the arraylist graphing a scatterplot of the data.

## 4 Results

My program will answer the question as to how quickly and fully different types of sicknesses will be able to spread through the population of a school once introduced. This will show how likely it is for a disease to be spread by a set amount of sick people coming to school with the sickness. This will show if the danger of infecting others is actually a valid excuse not to come to school or if you should come to school unless you actually don't feel like you will be able to do work. At the moment my program is pretty much in its final state in terms of the actual simulation. All of the methods relating to the simulation, such as `step()`, `checkinfection()`, or `checkrecovery()`, are all completed and working as they should. This means that the results I am getting right now are pretty much the same results I will have when the whole project is completed except for any analysis tools that I plan to add to the program, such as a picture showing the locations of all of the Agents, and a graph that shows the number of sick and healthy Agents over time. As of now though, it will give you data on the number of sick and healthy agents, the total number of infections and recoveries, the number of steps taken, and the locations of all the agents.

## References

- [1] Macal, C., and North, M. (2005). Tutorial on Agent-Based Modeling and Simulation
- [2] Cayzer, S., and Sullivan, J. Modelling Danger and Anergy in Artificial Immune Systems.
- [3] Macal, C., and North, M. (2005). Tutorial on Agent-Based Modeling and Simulation Part 2: How to Model with Agents.

- [4] Epstein, J. (1996). *Growing Artificial Societies: Social Science from the Bottom Up*. Brookings Institution Press.