Epidemic Modeling in NetLogo

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Abstract

Even with today's modern scientific and medical breakthroughs, there exists the threat of a widespread epidemic. Could the Avian Flu wreck havoc on the human population like the Spanish Influenza nearly a century ago? By creating a model that uses system dynamics, one may determine how widespread a given epidemic would be by experimenting with variables corresponding to preconceived epidemic and environmental behaviors and characteristics.

Keywords: Model, epidemic, virus, disease, system dynamics

1 Introduction

Historically speaking, the worst catastrophes in terms of deaths have been natural. Terrible epidemics have reoccurred over and over again. More people died in the Spanish Influenza of 1918 than in World War I. With recent worries about mutating avian influenza strains, it is more imprtant now than ever to prepare for the worst. How does a population best behave to minimize the death count from a dangerous epidemic? What type of characteristics does a virus have to truly make it among the worst epidemics ever seen. Such questions can be answered by creating a model of an epidemic with variables corresponding to the different reactions of a population and the characterisitcs of a virus. I hope to use System Dynamics to make a simple, yet useful model that realistically traces the affect of a virus on a population over a specified period of time. By changing variables and seeing how the shape of the graph differs between runs, one can determine how much an impact numerous factors have on the duration and severity of an epidemic.

2 Background

If an epidemic were to occur, there would be two types of factors that would affect its duration and severity. There would be the variables corresponding to how a population reacted (in terms of quarantine and the probability of transmission) and characteristics unique to the disease, such as its severity and its genetic make up (which then decides what percentage of thepopulation has a natural immunity.) By experimenting with these values, one can find out how one variable affects the overall behavior of the situation (i.e. a delay in establishing a quarantine would likely prolong the duration of the epidemic and its severity.)

By programming in NetLogo, one can take advantage of a unique programming approach known as System Dynamics. Rather than typing out loops and methods, one simply defines populations (“stocks”), changes between populations (“flows), and variables, all “linked” together to produce a constant flow of populations ever “tick” (the unit of time NetLogo uses.) This simpler approach can be useful in explaining the model to someone not literate in traditional coding languages such as C or Java, and also allows one to easily expand on the model by adding flows on top of an existing model without having to define or change a new variable in multiple loops.

In scientific journals, parametric and complicated differential epidemic models are frequently published, but no system dynamic model was found. Thus my model must be analyzed without being able to compare it to a vetted model. My model seems to run in a somewhat logical manner, as seen by the snapshot of a 35 tick runtime in Figure 1. Initially a great deal of the population gets sick, but no one dies for the first five ticks, as the program defines duration_of_infection to be 5. On the fifth day, however, people are either quarantined or die. By t=10, a cure is found and gradually the population climbs back to a level similar to its initial level. However, some problems do exist, as some of the population levels are exaggerated, including “Deaths” and the rapid climb of the variable “Alive_Folk” after a cure is found. The problems should be easy to address and once they are fixed the systems dynamics model will be made more complicated and realistic .

3 Developmental Sections

So far all I have coded is a simple flow between the following stocks: unaffected, infected, quarantined, and deaths. The diagram of my System Dynamics is seen below. I have nothnig else to really add at the time, but I hope to expand the model further and perhaps modify the relationships between stocks.

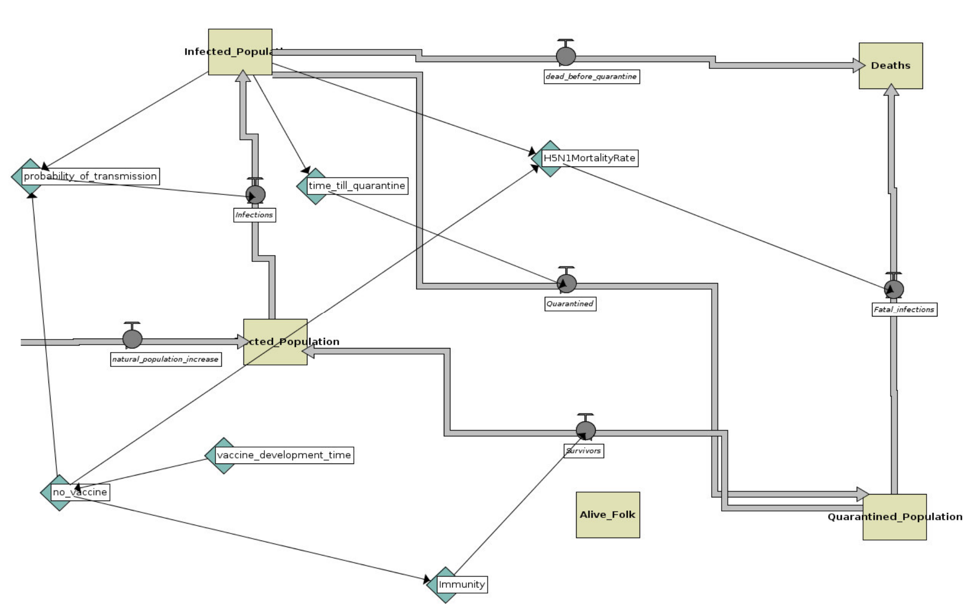

Figure 2. System dynamics flow diagram

3 Results

My model is not yet functional enough to provide meaningful , numerical results. Will have some next quarter.