Computer Systems Project Proposal

An Epidemic Model in NetLogo

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1. Problem Statement.

   My project looks to use System Dynamics to provide a simple, yet realistic look at how changing numerous variables of an epidemic or its environment changes the end result of the epidemic (in terms of deaths and duration of the disease.)

2. Purpose.
   - The purpose of this project is to implement system dynamics in a NetLogo environment for the purpose of creating a simple yet relatively realistic model of a population plagued by a disease. I will explore how different characteristics of a virus or a population's response to a virus affect the magnitude and length of an epidemic. This topic is a good one to explore in the TJHSST Computer Systems Lab as it is intertwined with a scientific topic, one which is appropriate to research at a high school for science and technology. The results from my project can be used to determine how a population can best respond to an epidemic, as well as how strong of an epidemic the human population can survive.
3. Scope of Study. Describe the overall bounds of the work that will be involved, e.g., the research or data that will be required, and the relationships and variables that will need to be programmed, and the expected results
   - In the papers I read on epidemic modeling before beginning my coding, I was distressed to find complicated differential and parametric equations which I did not comprehend. I realize that my model will not be truly accurate, as I do not have the mathematical knowledge needed to reflect the complexities of a virus. I hope by using System Dynamics that I can create a complete and simple model that, while is not as complicated as other models, can still be realistic enough to draw valid conclusions on a virus. I want to develop a model that can shift populations between unaffected, infected, quarantined, and death accurately and in a logical manner. I will work in a way that will allow me to have a simple working model every few weeks, with each model adding a new variable or complexity into the greater picture. This should help me avoid "biting off too much that I can chew", per se.

4. Background and review of current literature/research in this area.
   - There have been numerous epidemic models created by researchers, with many of their algorithms and results published in journals. However, I never found any model that used System Dynamics, as they all chose a more complex approach to modeling, whether it be by using parametric equations or other upper-level math. However, the basic principles of the models I have looked into should be the same. (i.e. an

epidemic can only spread from infected individuals to non-infected individuals, quarantined individuals cannot infect others, etc.) I did come across a System Dynamics tutorial on a "virtual high school" site which briefly discussed creating an epidemic model. I plan on using some of the basics of its models as a basis for my own, more complicated model.

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5. Procedure and Methodology
    - First I plan on creating a simple System Dynamics Model where people get sick, spread the disease, and die. I then will attempt to add a quarantined stock between deaths and infections. Then I will add the possibility of recovering from the disease when infected, as no epidemic kills 100% of those who come down with the virus. I hope to later add a way to track "awareness" of the disease, so when a virus is more widespread, quarantine measures are more effective and quicker. I will do all my coding in NetLogo, and probably will end up writing some code in the non System Dynamics procedures box to supplement the System Dynamics portion. I will use sliders to allow for easy changes to variables and will track the changes of all the population variables in the ticks vs. stock value window. I plan on researching actual populations and infection rates so I can compare my model to a case study, such as that of historically deadly influenza outbreaks.
6. Expected Results & Value to Others
    - I hope to be able to use comparisons of runtime graphs to highlight the differences changes in variables make on the effect of the course of an epidemic. My results will likely be more qualitative than quantitative, unless I find time at the end of the year to implement advanced mathematical concepts, such as derivative graphs to pinpoint the exact times a virus was the most deadly and when it began to decline in potency. I hope my runtime graphs will allow users to comprehend the effects of changing characteristics of a virus or the response to a virus without forcing them to work too hard to make conclusions.