The Effect of the Number of Quarantine Officers and Vaccination on Changes in Death Rate in an Outbreak of Smallpox
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Abstract

This project is intended to determine the effects of quarantine officers and immunization on the death rate of a given population of agents in which an outbreak of Variola occurs in a closed world scenario where agents are allowed to move randomly.
The agent movement will be affected by the quarantine officers who would direct them to safety or to an immunization site, determined by the officer as whichever has the greater value and practicality based on the location of the agents at the time.
This can be used to help realize the maximum effectivity of quarantine officers and vaccination on a closed population in order to reduce the death rate of the population in which the outbreak takes place.

1 Introduction

1.1 Actual Situation

While smallpox has been eradicated, reserves remain in case of an outbreak to use as a vaccine. If Variola Major was released on a population, many fatalities would result if effective measures were not taken.

1.2 Objectives

The purpose of the project is to use a sugarscape based modeling system in Python in order to determine the effect of quarantine officers directing or leading agents to safety and/or immunization of a population on the overall death rate of the population.

2 Background

An understanding of the disease of smallpox is needed in order to better represent the effects of the virus on infected agents, with examination of other projects with respect to quarantine regarding a generic illness, vaccination regarding a generic illness, and the modeling of virus transmissions between agents. These reports are to be used to better represent the effects of the quarantine officers on the population, ideal immunization rates, and the spread of the disease among agents.

2.1 Related Work

Much research has been done in the field of epidemiology, focusing on the containment of a disease. Several government programs have made advances on simulating the effect of vaccinations, but few projects dealt with the integration of quarantine and vaccinations; therefore this project will address that issue.

2.2 Rationale

This research will specify a disease, smallpox, or all forms of the Variola virus, and the effect or containment officers and vaccination to determine the ratio for maximum effect for the fewest officers to minimize the effect of a large-scale attack by spreading resources over a large area. The project makes the assumption that there are limited resources for vaccination and containment.

3 Procedure and Methodology

Python will be used in the final project where NetLogo was used to obtain a basic understanding of the intended result of the project. Testing will be done with regard to statistics for previous outbreaks of smallpox and recorded death rates with regard to variables in these outbreaks. Immunization will also be implemented with similar tests.

3.1 Construction of Program

1. Create a Sugarscape-based model to display a closed world of agents that can become infected, die, recover, or become immune.

2. Some agents are quarantine officers and instruct agents on the direction to travel in order to get them to safety or to a vaccination point. Quarantine officers cannot become infected.

3. Agents have a basic understanding of the world around them and can move in a direction where less danger is apparent; movement is influenced by others, but maintains a random element for simulation purposes.

4. Agents, when infected, progress through several phases of the disease:

    (a) When first infected, the agents are not infectious, and show no signs of infection, therefore, other agents do not respond to them in a negative way.

(b) As the disease progresses, it takes a form, whether ordinary, malignant, hemmorhaging, or modified, and each form affects the agent differently.

(c) Over time, the agent will either die or recover. If the agent recovers, it may become immune, or be left with a weakened immune system.

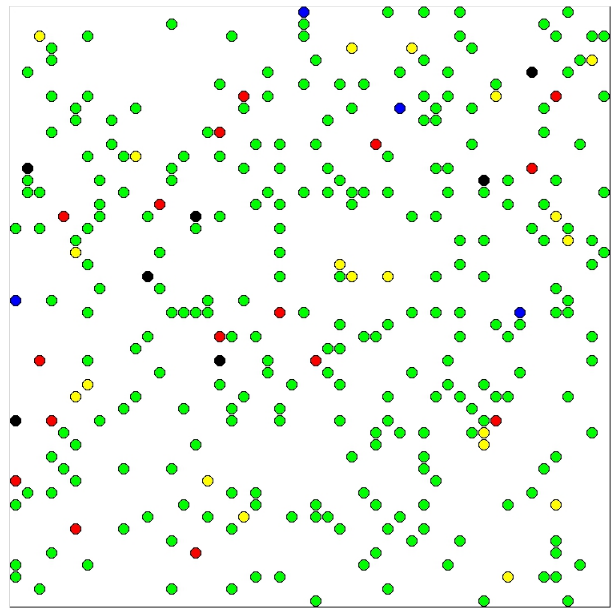
(d) If the agent dies at any point, it is removed from the world.

5. Agents directed towards an immunization location will become immune after three days, the typical response period after innoculation.

6. The program will show an output of infected, fatality rate, and number of immunizations over time given the number of quarantine officers and immunization locations, in order to determine the maximum cost-benefit scenario to simulate a large-scale outbreak where resources to contain the epidemic are limited.

4 Expected Results and Value to Others

This project can be expected to provide an understanding of the use of quarantine if an outbreak of smallpox were to occur in



a real- world scenario and provide examples for the greatest efficiency by determining the ideal quarantine officer/general population ratios in different situations, spreading out the manpower of the officers over a higher range to save the greatest number of lives.

These statistics will be explained in a chart comparing the number of quarantine officers with vaccination rates with the number of fatalities and other statistics.

5 Recommendations

References

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