PHSX815_Project1:
Affects of Introducing a Trial Serum to Combat/Cure the Rakghoul Plague (based on a plague in Star Wars)

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1 Introduction

On the city-planet, Taris, a horrible plague has begun ravaging through the city's underworld, turning many of the lower class citizens (who inhabit the underworld) into blood-thirsty monsters, we are calling Rakghouls; thus, we are calling this plague the Rakghoul Plague.

There are many unknowns surrounding the plague: we are not sure how it was introduced, but we have been able to take several samples from captured Rakghouls, which we hope will be crucial in developing an anti-plague serum to cure those infected before they are fully turned.

We also have collected data on the weekly rate of Rakghoul infection spread over the last 200 weeks. This will be useful for comparing to simulated infection spread after the serum is introduced.

This report is organized as follows: Sec. 2 explains the differences in several trial serums my team is working on, and a description of the computer simulation developed to simulate these possibilities is provided in Sec. 3, with an analysis of the outputs included in Sec. 4. Finally, conclusions are presented in Sec. 5.

2 Discussion of Possible Trial Serums and Infection Rate Simulation

As mentioned above. The goal of this project is to simulate the spread of the "Rakghoul Plague" given a population which has been inoculated with 2 different trial serums, whose goal is to cure those who have already been infected and prevent the plague from spreading to new victims. I also want to compare the simulated post serum data to the gathered plagued infection rate data, to see if there is a notable difference after introducing the cure/serum to the population. There will be two different serums which will be compared to the plague data. The first serum is an anti-bacterial designed to cleanse the body of the Rakghoul bacteria. The second serum, introduces a dormant form of the plague bacteria into the blood stream, which will trigger an immune-response to the bacteria.

3 Code and Experimental Simulation

This code used to simulate the serum data and analyse is made from three separate codes. I have a random class which contains the code with the definitions of the distributions. The distribution used in this experiment is a "log-normal" distribution or "skew-normal" distribution. This distribution was chosen as it is often used to simulated disease spread, which is the goal of this project.

The "log-normal" distribution, X, takes a random variable, R, generated according to a normal distribution, and transforms it using an exponential function:

$$X = e^{\mu + R\sigma}$$

where μ and σ are parameters related to the actual mean and standard deviation of the log-normal distribution, mux and $sigx$. I, however, want the distribution to take the variables mux and $sigx$, so transformations are needed to convert from μ and σ to mux and $sigx$. These are the following:

$$\mu = \ln\left(\frac{mux^2}{\sqrt{mux^2 + sigx^2}}\right) \tag{1}$$

$$\sigma = \sqrt{\ln\left(1 + \frac{mux^2}{sigx^2}\right)} \tag{2}$$

Substituting in equations 1 and 2, gives me $X(mux, sigx)$, which is the distribution I used to generate my random numbers in the main code. The DataGen code generates a list of N random numbers according to my log-normal distribution, and writes the list to a .txt file. The Analysis code reads my file, then unpacks and creates a list of these numbers and makes a histogram displaying the data.

4 Output Analysis

In Figure 1, the infection data (New infections per week) for the Rakghoul Plague (in green), is compared to the simulated infection data after introducing two different test Serums to cure the plague. Serum 1 is represented in blue and Serum 2 is represented in red. From the data, we see over that 200 weeks for which we collected data, the plague began infecting very quickly; and, during it's peak week, it infected 1,750,000 citizens. The plague also totaled 10,000,000 infections over the 200 weeks.

To gauge the effectiveness of the serums, we are primarily examining the peak number of infections in any given week, as well as the total number infected overall, and how fast the infection dies off. The simulated data tells us the following: with serum 1 (blue), the plague infected a total of 6,500,000, and peaked at about 870,000 infections. With Serum 2, the plague peaked at about 400,000 infections, and totaled 5,000,000 infections. As far as plague die off rates go: the plague data died off around week 125 with no cure; with Serum 1, it died off around week 100; and, with Serum 2, the plague was almost completely eradicated by week 75. Based off of these simulations, and the plague data, Serum 2 has both the lowest peak infection for any given week, the lowest total infections, and the quickest die off rate. This leads to the conclusion that Serum 2 is indeed effective at curing and reducing the plague, and more so than Serum 1.

5 Conclusion

To conclude, with the Rakghoul plague turning many of the citizens of Taris into blood-thirsty Rakghouls, it has become imperative to develop a cure to to reduce infection rates, and stop those infected from fully turning before it's too late. Two such cures, we are calling Anti-Rakghoul Serum 1 and 2, were created for testing. From our simulated infection spread data, it was found that Serum 2 effectively reduced the total infected population by 50%, and killed off the plague about 40% faster, than if there was no cure.

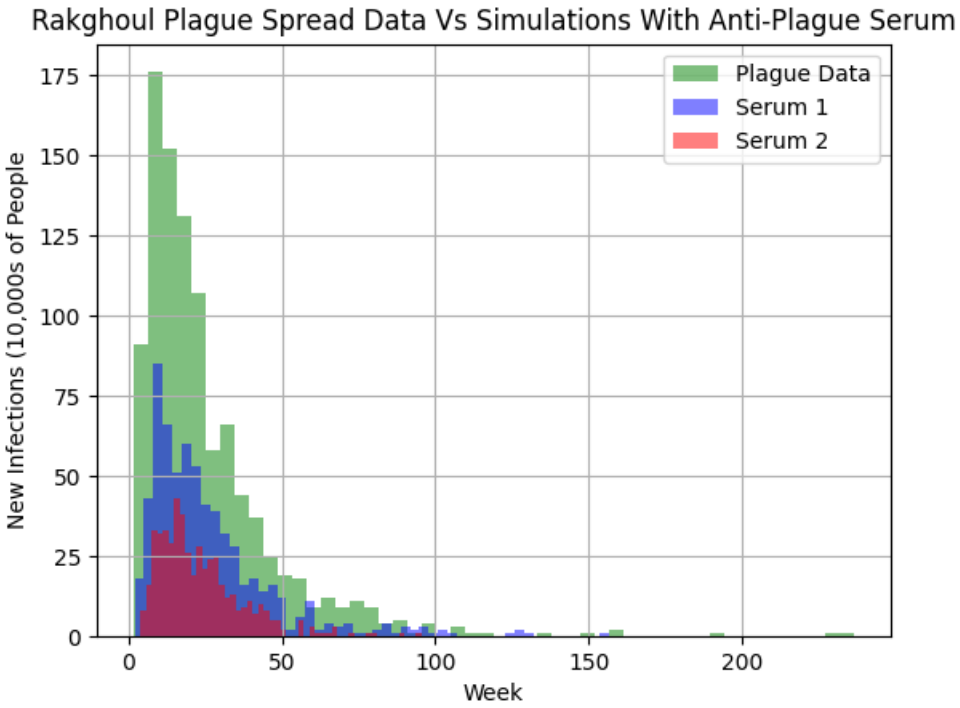

Figure 1: Histogram showing the new infection cases for the Rakghoul plague per week (green), and comparing to the infection simulations for Serum 1 and 2 (blue and red).

References

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