WHAT WOULD A MOCK ZOMBIE INFECTION OUTBREAK LOOK LIKE?

Infectious Disease, Host-Parasite, or Predator-Prey Model

Adriana Kraig, Pure Mathematics and Psychology
Mentor: Dr. Ryan S. Szypowski
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Background

- The concept of the Zombie has grown significantly in 21st century popular culture. Films, videogames, and novels continuously address the question of "How would humanity fare in a zombie apocalypse?"
- The zombie virus is generally, and for all purposes of this model, an infectious disease. Infectious diseases are those that are passed from individual to individual with the primary risk factor being the current number of infectious cases within the population. Furthermore, the zombie virus is spread only through direct transmission of the microparasites. The most likely models in this type of epidemic are models of infectious disease models.
- In 1927, mathematicians W.O. Kermack and A.G. McKendrick made a model that attempted to explain the rapid fluctuations in the number of infected individuals within a population. The three components that make of the total population in a simple SIR model are: susceptible individuals, S(t), infected individuals, I(t), and removed individuals, R(t).
- The only way an individual can leave the susceptible population is to become infected. Likewise, one becomes a removed individual (dead or cured) to leave the infected population. The β and the γ are the rates involved with susceptibility and removal from the population.

Method

- **Participants**

A group of 283 Cal Poly Pomona students played a week-long game of Humans vs Zombies on a volunteer basis . Students came from 10 different colleges within the university in representative percentages.

Participants were clearly identified at all times, based on a visible uniform of an orange bandana.

*Human and Zombie Bandana Position

- **Game**

The game began with one "Zombie", whose only goal was to spread the disease across as many other players as possible.

Every time a "Zombie" would tag a "Human", the actions would be logged into a computer counter. The counter would record the time of death, the number of Human players, the number of Zombie players and the number of Corpses .

The game was set up such that individuals in play still carried through with their everyday activities such as class, jobs, and campus activities.

Model

- The game was run such that the total population of players, N, at any time was equal to:

$$N = H(t) + Z(t) + D(t)$$

- the flow across the populations was:

$$H \rightarrow Z \rightarrow D$$

- The population throughout the game can best be modeled using the simple SIR model with the added a "Zuicide" term of 20:

$$\frac{dH}{dt} = -\beta HZ - 20$$

$$\frac{dZ}{dt} = \beta HZ - \gamma Z + 20$$

$$\frac{dD}{dt} = \gamma Z$$

- β is found to be .0004 (the contact rates and transmission probability.)
- γ is found to be .2353 (the removal rate)

There is a root mean error of 223.0435 (or about 1.1864 per hour across the 188 hours)

Raw Data

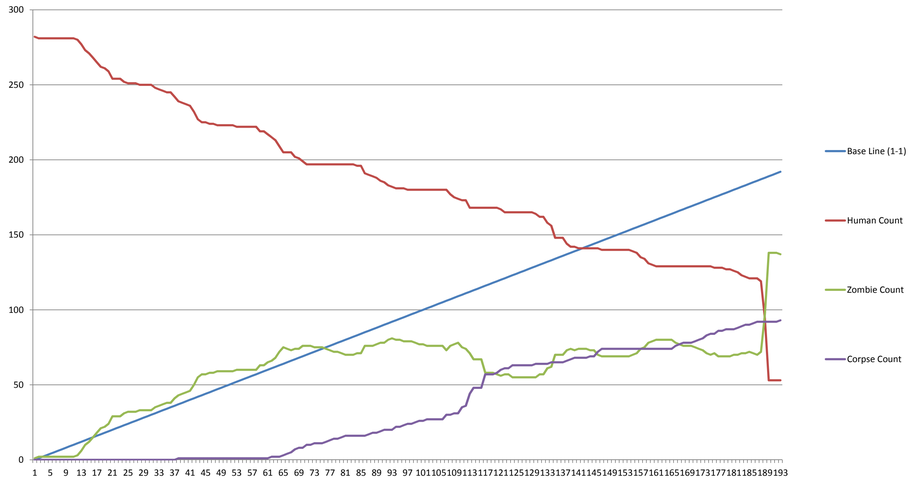

Figure 1: Raw Data of Population Count versus the Number of Hours in Play

Optimized Data

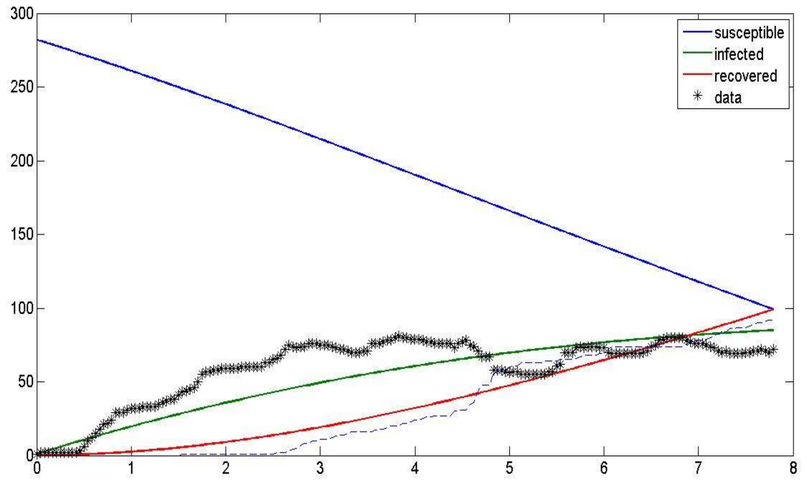

Figure 2: Model of Simulated Population Count versus the Number of Hours in Play

Conclusion

- In the optimization of the model, the coefficient constants were found. The "transmission coefficient," β, was .0004. This describes the rate of encounters among individuals, together with the probability of infection. The rate is rather small due to the fact that it considers the "Zombie" hunting and capturing efficiency rates, as well as, the "Human" hiding and defending efficiency rates.
- The "removal coefficient," γ was .2353. This describes the rate an infected individual becomes deceased. Within the game, this coefficient considers the "Zombie" hunting and capturing efficiency rates, and the "Human" death rate. This is very consistent with the way the game is run.
- To fit the data, a term needed to be added to account for the learning of Human individuals. There was a added "learning" term to the "Zombie" population of 20 individuals. The 20 individuals are also subtracted from the "Human" population to account for population equilibrium. This term accounts for the few "Human" individuals in each game who initially "Zuicide", or who willing switch roles to a zombie, for the fun of it. As the game progresses, the individuals who are more serious about survival become harder to hunt and are no longer likely to commit this form of suicide.

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