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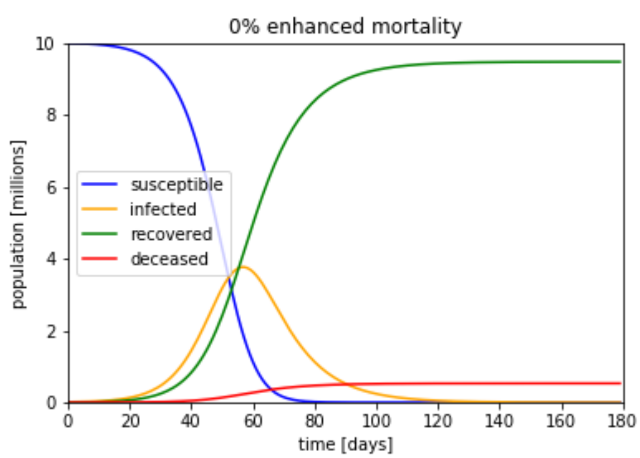
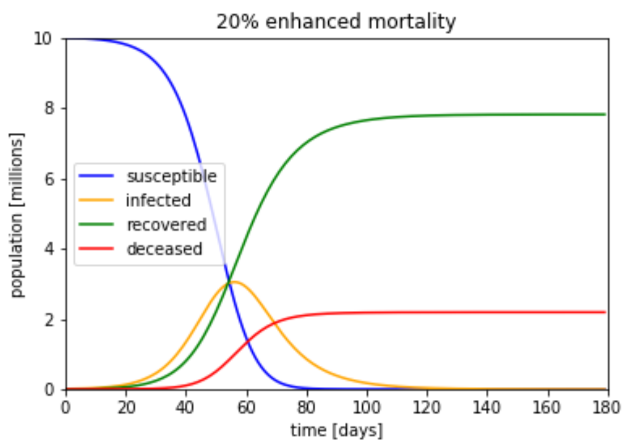
PHY 203: Collaboration Project

Social Distancing and Quarantine decreases the spread of COVID-19. Generally, people tend to gather in large groups in close proximity to each other. Typically, people tend to have a lot of close contact with other people, which makes the spread of a virus much more rapid. Implementing a social distancing policy or a quarantine policy slows the spread, allowing medical workers to gain more control or the virus.

We have developed a few different models which represent different cases, each having some factor changed. There were factors that we did not take into consideration that could improve our model. We have chosen a population of 10 million people for our model. The change in our susceptible population is influenced by the change in the infected population. The change in the infected population is influenced by the change in the recovered population and the deceased population. The recovered population depends on some recovery time and the deceased population is dependent on the death rate. Our first model is a base case in which we implement no policy and the death rate is constant. Our next model is a case in which we implement no policy, but the death rate is enhanced by 20%. We have a model in which we implement a social distancing policy, and the death rate is enhanced by 5%. Finally, we have our last model in which we implement a shelter at home, or quarantine policy and the death rate is enhanced by 5%. We have chosen an R_0 value to be 3, this represents the number of people one person infects.

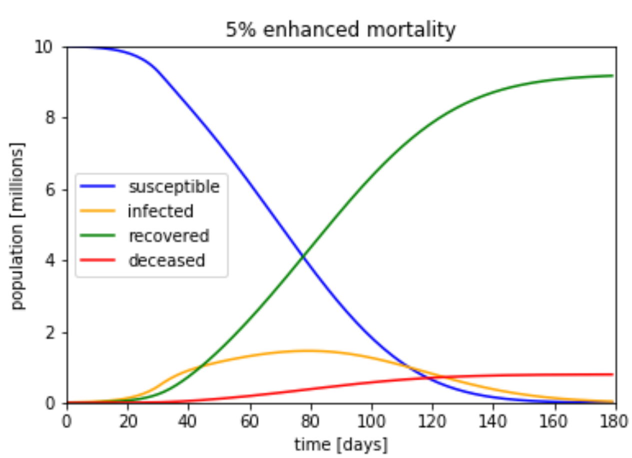


For our base case, we had a Do-Nothing Policy. Everyone can go about their daily lives as if nothing is wrong. Let's say we take no action to limit the spread, so over time, everyone gets infected at some point, leaving no one susceptible to getting the virus. After about 100 days, no one is left susceptible to getting the virus because everyone has gotten it, and after 130 days, we can say no one is infected with the virus. For our base case, the death rate stayed constant, meaning it was not affected by any factors, such as the number of hospitalizations versus the capacity of the hospitals, or the age distribution of the population. Out of the 10 million people in our model, 9.47 million people recovered from the virus and 0.53 million people died from the virus, so 94.7% of the population recovered, and 5.3% of the population died. This case is not realistic because the death rate would not stay constant if 10 million people ended up getting sick over the course of 100 days. Not everyone would be hospitalized for it, but the number of hospitalizations would be relatively high so the quality of health care they would receive would be low, increasing the death rate. Another factor not considered in this case is the increased risk of doctors and nurses getting sick, they would be out of work for a couple weeks which lowers the capacity of hospitals, thus increasing the death rate.

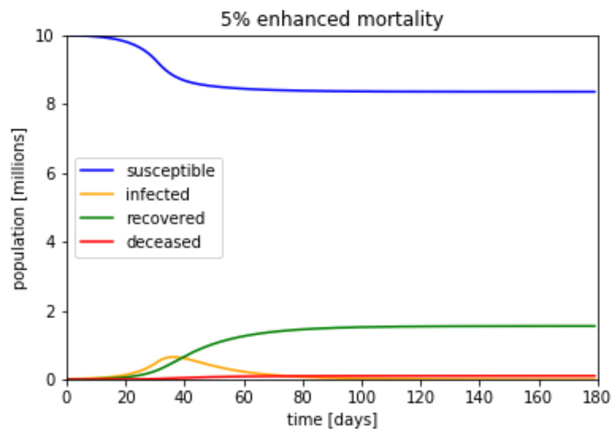


If we continue to do nothing to limit the contact with people, the number of cases of COVID-19 will skyrocket. This increases the number of hospitalizations. The more people who get infected, the less people who are susceptible to contracting the virus. Although, not everyone requires hospitalizations, there will be more people requiring hospitalization with the increased numbers of infected people. With more infected people being hospitalize, the risk of medical workers getting sick increases, putting them out of work, and lowering the capacity of the hospitals because with less doctors or nurses, they can't take care of as many patients. The quality of care people receive will also decline. So, with the lower quality of care, the lower hospital capacity and the increased hospitalizations, the mortality rate is enhanced. This model shows that the mortality is enhanced by 20%. After about 100 days, everyone has been infected, and after about 130 days, no one is infected. This model leaves 0 people susceptible to getting infected, it shows 7.81 million people of the 10 million people recovered, which means 2.19 million people died after contracting COVID-19. So, after doing nothing to limit the spread, we have modeled that about 78.1% of the population recovered, but it resulted in 21.9% of the population dying. This death rate is a little high for what I think the reality would be if we did nothing, but I think it would be somewhere in between this model and the first model.

Obviously the first two models are not accurate, the first model showed that the death rate would remain constant, and the second model assumed that the death rate was enhanced by 20%, which is an assumption, still unknown.



So, we come to our social distancing policy. We have assumed the morbidity enhancement is 5%. Social distancing means no large gatherings, and you should stay 6 feet away from each other. People can still go about their everyday lives, just keep their distance from each other. The social distancing policy slows the spread of COVID-19, making it easier for hospitals to manage the patients and ensure that they receive proper care. Our R-value is initially 3 but after 30 days, it drops to 1.5, meaning that the number of people one person infects is cut in half. So, the spread of COVID-19 over the first 30 days is a more rapid than the spread after the first 30 days. In this model, the whole population gets sick, but it is over a longer period of time than the do-nothing policy. Extending the amount of time it takes for everyone to get sick decreases the death rate because it can be controlled better. According to this model, 0 people are left susceptible after about180 days, 0.04 million people are still infected after about 1180 days, 9.16 million people recovered, and 0.80 million people died. So, 91.6% of the population recovered and 8% of the population died. There are still other factors that need to be taken into consideration to improve this representation, so it is not entirely accurate. The social distancing policy allows the virus to run its course, but not overwhelm the hospitals all at once.



If we implement a shelter at home policy, where everyone is restricted to their home and can only leave for essential items such as groceries, the number of infected people drops. Initially, our R-value is 3, meaning that the number of people each person infects is 3people, but after 30 days, it decreases to 0.3. This shelter at home policy decreases the number of people getting infected and slows the spread. According to our model, after about 40 days, no one is getting sick. Since the spread is slowed down, hospitals are not overwhelmed and therefore patients are able to receive the best care, which lowers the death rate. Our model also leaves 83.5% of the population still susceptible, since only 16.5% of the population got infected, 15.5% recovered and 1% of the population died from the virus. Although it may sound great, leaving 83.5% of the population still susceptible to getting sick means its only a matter of time before there is another outbreak, and we will be restricted to our home all over again.

By implementing a social distancing policy or a shelter at home policy, the spread of COVID-19 will be slowed. Slowing the spread of the virus decreases the hospitalizations, thus increasing the quality of care those who are hospitalized receive. Having a higher quality of care increases the chances of survival. It is clear that some sort of policy to slow the spread should be in place. Looking at our model, we can see that by putting in place a shelter at home policy, the spread slows much faster, and the outbreak ends much sooner. But does it really end there? If you look at how many people are left susceptible, 83.5% of the population did not get infected, so as long as COVID-19 acts like other viruses, (once you get it, you can't get it again), 83.5% of the population is still susceptible to getting the virus. I think the shelter at home policy is not the way to go because it is only a matter of time before there is another outbreak. Even though with social distancing, according to our model, the outbreak lasts longer, but over the course of the outbreak, everyone gets infected at some point, leaving no one susceptible to getting the virus. The social distancing policy allows the virus to run its course at a slower rate and based on our model, there won't be another outbreak. Obviously, our model can be improved because there are still several factors that we did not take into consideration in our specific model. Factors that were not taken into consideration that may make the model more accurate include: Age Distribution of the population, or the overall health of the population. A younger, healthier population will most likely have a lower death rate, while an older, less healthy population might have a higher death rate. A younger population may spread the virus faster because younger people tend to be more social.