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Medical Preparedness
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The global pandemic, COVID-19, is wreaking havoc on the global medical infrastructure. The question we were tasked with answering was, how does the availability of medical resources (staffing, hospital beds, ventilators, masks, gowns, etc.) affect the propagation of COVID-19? In the world around us there is a social-distancing policy that is in place as well as hospitals concentrating their money towards fighting the pandemic. In this report we will take a look at three different scenarios; non-interacting states with no social distancing policy, interacting states with a social distancing policy with increased medical beds, and non-interacting states with one state having a social distancing policy.

We proposed a model for the medical preparedness that involved two states, the population size of each, the hospital capacity, and a social distancing policy. The model was:

$$\frac{d}{dt}NY_{infected} = T_{NJ} * NJ_{infected} + R_{NY} * NY_{infected} - \frac{1}{\tau_{NY}}NY_{infected} - D_{NY}NY_{infected}$$

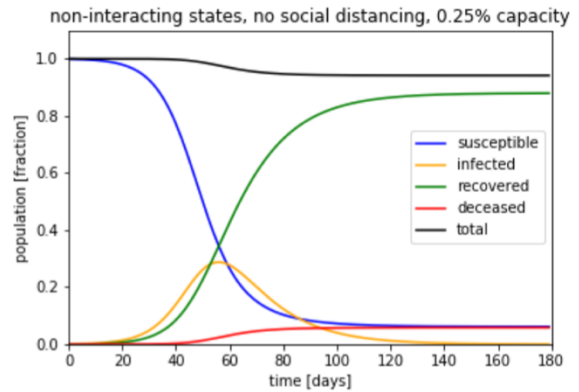
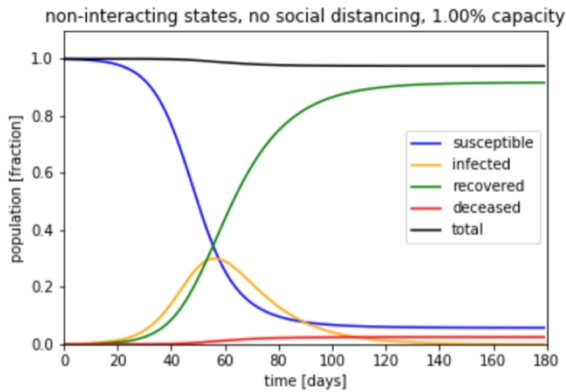
$$\frac{d}{dt}NJ_{infected} = T_{NY} * NY_{infected} + R_{NJ} * NJ_{infected} - \frac{1}{\tau_{NJ}}NJ_{infected} - D_{NJ}NJ_{infected}$$

This simply represents the change of infected people between New York and New Jersey. Between the two states, there can either be interaction or no interaction which determines people coming into contact with others. This is relevant especially to states, like New York and New Jersey, where people work in the city but live in another state. The population in this model was based off of New York and New Jersey where we had state one having 10 million people and state two having 1 million people. The hospital capacity was based on the number of beds available per a certain amount of people. If the number of beds increases this means that more people are able to receive good health care and this leads to less people dying. The social distancing policy is about people interacting with other people in their own state. If a social distancing policy is in place, we can assume that less people will be infected. So, Dr Edlund generated multiple graphs that demonstrated different scenarios.

The COVID-19 pandemic could be handled in different ways to eradicate the virus from Earth. The first scenario is what would happen if we had everyone go about their daily lives except for closing the borders of the states so there is no interaction.

State 1:
 Population = 10 million
 Hospital capacity = 1 bed per 100 people
 No social distancing policy

State 2:
 Population = 1 million
 Hospital capacity = 1 bed per 400 people
 No social distancing policy

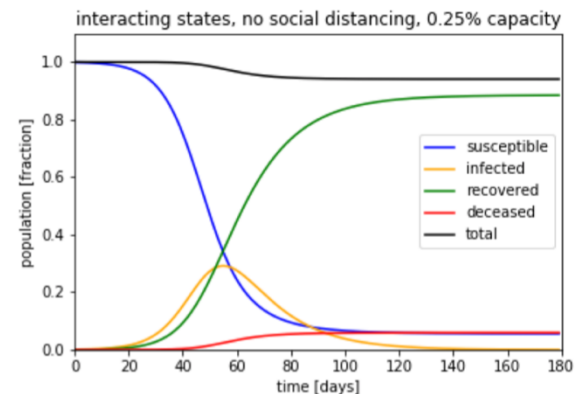
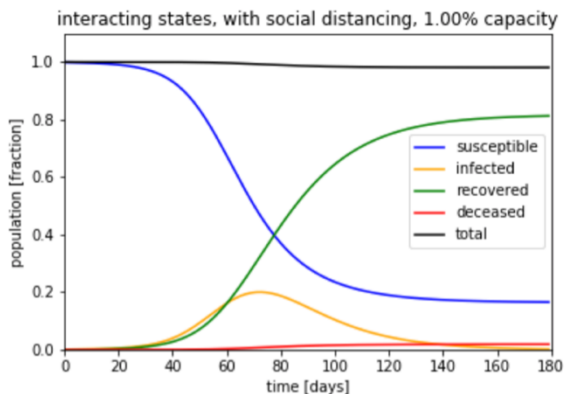


This model shows that 30% of the people will be infected at a given time (yellow) approximately two months since the first case. This is the important piece of information that we are looking at because a huge spike in infected people potentially means not enough room in hospitals for everyone. With no social distancing, the virus is able to be spread easily through contact thus the sharp increase in infected people. The negative for this model is that around 10% of people will die (red) because of the virus. A positive is that about 90% of people will be infected and recovered (green) within three months of the virus arriving to the area and hence be immune to the same strand for the rest of their lives.

The next model is about what would happen if the states interacted but New York had a social distancing policy.

State 1:
 Population = 10 million
 Hospital capacity = 1 bed per 100 people
 With social distancing policy

State 2:
 Population = 1 million
 Hospital capacity = 1 bed per 400 people
 No social distancing policy

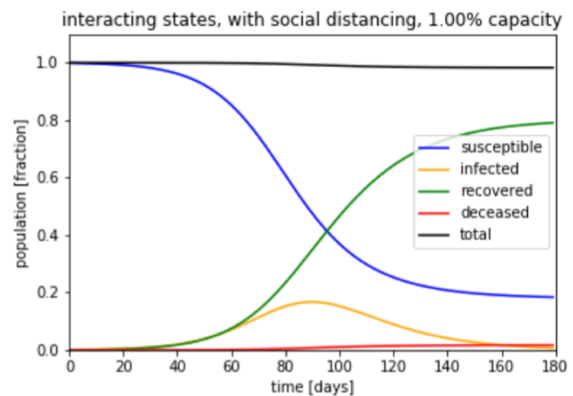
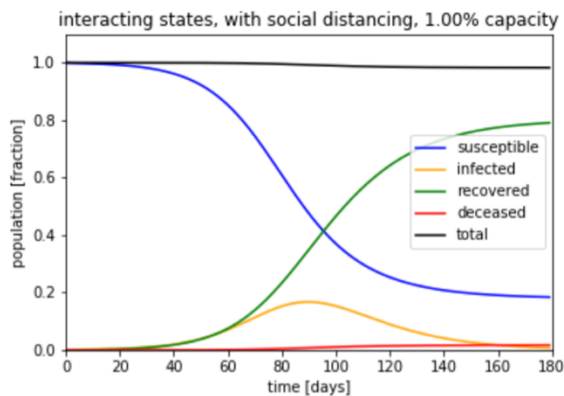


The important value (yellow) has greatly reduced in New York from 30% in the last model to 20% in this model, but the curve lasts 2 months longer than New Jersey. New Jersey still has the spike of infected people at 30% but most people are immune to the virus after 3 months. This model clearly shows that social distancing works to reduce the amount of people sick at a

specific time. So, this model was looking at the difference in New York and what happens if social distancing is used. A negative to this model is that only 80% of people are immune to the virus if it appears again, which means that there may have to be another social distancing policy. A positive is that only 5% of people died instead of 10%. The takeaway from this is that social distancing works and it lessens the amount of people in need of hospital beds at one time. Finally, we have what would happen if we had states that could interact, but everyone was practicing social distancing as well as increasing the hospital capacity for New Jersey.

State 1:
 Population = 10 million
 Hospital capacity = 1 bed per 100 people
 With social distancing policy

State 2:
 Population = 1 million
 Hospital capacity = 1 bed per 100 people
 With social distancing policy



This model shows us that the important peak infected (yellow) is now below 20% which is good for hospitals so they do not overflow with people at one time. The negative of this model is that people have to social distance for 6 months and hospital staff are also working for the same amount of time. The positive is that less than 5% of people die and hospitals will hopefully be able to handle the total amount of people infected.

The important message from this information is that social distancing and increasing the number of beds in the hospital help to decrease the peak amount of people that are infected at a single time. There are two ways that a virus could be handled by states or nations, one is to change nothing so that the virus infects people in a short amount of time and then they are immune to it, or the second is to practice social distancing so that the virus infects people over a long amount of time and the hospitals are not overflowing with people. This model is a good start into the representation of what could happen, but it is merely an approximation. I believe that there are other factors that we did not include, such as people practicing good hygiene. This is a simple model as to not confuse any of us so that we could visually see what would happen if certain elements are changed. For example, I am a little skeptical about the susceptible population leveling off which would indicate that some people are immune without ever having the virus. But for an approximation, I believe that this model is somewhat accurate. For our medical preparedness question, I believe the best option would be to practice social distancing so that the hospitals are not overrun.