MATH 383L

Final Project

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Predicting the Spread of COVID-19 Using SEIR Model and Forward Euler

COVID-19 is one of the greatest challenges we face in this generation, and the development of computer-generated simulations can be an essential method to project its future effects on large groups and also help with possible future pandemics. The goal of our project was to capture this spread of disease, and predict the number of susceptible, exposed but not infected, infected, and recovered people within a population. We believe this method is a basic, yet vital way of expressing how disease can affect a population over time. In particular, our group was focused on the spread of COVID-19, which is not only a very relevant disease to analyze in today's world, but how it affects populations is changing rapidly with the discovery of vaccines and the development of immunity.

One of the biggest challenges we ran into while implementing the SEIR method was incorporating different environmental factors such as death rates, resusceptibility, aging, quarantining, and the effect of vaccines. Another factor that we aimed to consider but failed to incorporate was the introduction of new COVID variants, which we initially hoped to introduce after a certain time point, and ideally would see a new peak in the number of infected people in the population. The reason why this proposed project ended up being more complex than anticipated was that the introduction of a new strain would require the creation of new parameters and functions in order to simultaneously account for the effect of both strains. For

example, simply adding in a new infection after a certain point in time would fail to consider the past effects of the first variant, such as those who are still infected with the original virus and have not recovered, or those that are infected with both variants at the same time and how that would influence their recovery period. One other parameter that we did not consider was the death rate due to COVID-19. We understood that this was a big flaw in our model; however, when trying to take death into account, we discovered a dependency between death and recovery rate that should converge to a constant value. Thus, we noticed that we could not simply add a constant rate of death, as this might have overestimated how many people actually died due to disease and/or natural causes.

The numerical methods we used in our project were vector-valued forward Euler and an anonymous function. We used the vector-valued forward Euler to be able to compare and compute the number of susceptible, exposed but not infected, infected, and recovered people of COVID-19 in a population. We chose this method because it allows us to compare more than two functions simultaneously because the functions we used are all dependent on each other. Having the functions dependent on each other means they must be computed simultaneously or the result of each function will not work. Although forward Euler is notorious for not being accurate, with the modifications made to it allow it to be somewhat more accurate and compute the data to the needed values. We used forward Euler rather than a different, more accurate function because we wanted to incorporate class-learned code and we knew the code would work for our purposes, with a few modifications. The anonymous function allowed us to compute the initial susceptibility, exposed, infected, and reproduction of the virus. The anonymous function and forward Euler are used together with initial conditions to produce the needed data.

The initial conditions and parameters were determined over test. In other words, we tested different combinations for all the variables until the graph showed a realistic scenario of the COVID-19 spread. As we can see, not all people were exposed to the disease since there are still a suseptible population even after a long time. Moreover, since we were not able to input the death variable to the code, we added the death rate to the recovered rate as if part of the people who were part of the recovered population was, in fact, the dead population.