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A mathematical attempt to understand, analyze and predict the behavior of COVID-19 virus using SIR model

Coronavirus disease, or COVID-19, is an infectious disease caused by a newly discovered coronavirus[1], first identified in Wuhan, China, in December 2019[2], and declared as a pandemic in March 11, 2020. Up to this date, November 26 2020, 12.9M cases have been identified as COVID patients in the United States and 60.6M worldwide[3]. This makes the epidemiology of COVID-19 an interesting topic for further investigation.

The goal of this project is to model COVID-19 outbreak using the materials covered in class by parametrization of the simple SIR model [4], and then study different scenarios using the generated model. Answering the following questions will be our main focus for this project:

How successful SIR is both locally and globally, in modeling data since the beginning up to this point? Indeed, there will be some inconsistencies between the reported data and our predictions. We try to answer why the model can be successful at some time intervals, locally, but not during the whole interval since the outbreak until now, Globally.

After generating our SIR Model, we try to study different scenarios including the effects of lockdown and vaccine both alone and together . We also aim to find steady states of each scenario, if there is one, and analyze the stability of each of these steady states.

One scenario that we find particularly interesting is the introduction of vaccines. We are at a critical point at the day of writing this proposal, and there are two great vaccine candidates that are in phase three of clinical trials. We try to answer, how this can affect the behaviour of the outbreak, and more importantly, if there is an optimal vaccination rate. In addition we want to see if we can predict when we can go back to our normal lifestyle and compare our results with the predictions that are already made about this point.

Answering all these inquiries requires implementation of a broad range of topics discussed during the semester, and our final goal is to infer some real world conclusions from our results using our simplified model.

[1]- https://www.who.int/health-topics/coronavirus#tab=tab_1
[2]- https://www.cdc.gov/coronavirus/2019-ncov/cdcresponse/about-COVID-19.html
[3]- https://www.nytimes.com/interactive/2020/us/coronavirus-us-cases.html
[4]- Adekola, Hafeez Aderinsayo, et al. “Mathematical Modeling for Infectious Viral Disease: The COVID 19 Perspective.” *Journal of Public Affairs*, 2020, doi:10.1002/pa.2306.

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