

Math 229, Spring 2024

Project: Insights into managing a pandemic from the SIR model

In this project you will investigate epidemic management strategies that take into account high- and low-risk populations. Suppose that the population consists of two groups: a small high-risk group, and a large low-risk group. Risk level refers to group members' chances of dying from the disease, *not* their chances of catching the disease or of passing it on. For example, with COVID-19, a healthy small child in the low-risk group is at extremely low risk of dying from the disease, but just as likely to contract it if exposed and just as likely to pass it along if they encounter a susceptible person as anyone else. Within each risk group, there are susceptible, infected, and recovered groups. The two groups interact with each other, allowing for susceptible individuals from one group to be infected by contact with infected individuals from the other group.

Here are two possible disease management strategies:

- Plan A: Members of the low-risk group do more basic and less inconvenient things – wash hands, wear a mask, stay home if sick, etc. Members of the high-risk group do this as well as stronger forms of social distancing – work from home, avoid close contact with others, avoid large gatherings, etc.
- Plan B: Members of both groups practice basic hygiene plus stronger forms of social distancing, as much as possible.

Devise a modified SIR model in which you can test these two plans. Your model should account for two groups, as well as the interaction between them, and you should be able to use the model to test the two different plans. Are there circumstances in which Plan A works better? Are there circumstances in which Plan B works better? By the way, what does 'better' mean in this situation? You will need to decide how best to judge the success of a containment plan. This could take account of health outcomes, effect on the healthcare system, economic and social disruption, or any other factors you think are relevant.

In your writeup, please include the following:

1. A full and careful description of your model/models.
2. A full description of how they can be modified to show the progress of the disease under Plans A and B.
3. The results your model predicts for the progression of the disease through both groups under the different plans, and maybe for different scenarios of how infectious the disease is.
4. A discussion of which plan is better in which sorts of scenarios. What would your recommendations be for the next pandemic?