Modeling the Benefits of Pandemic Interventions

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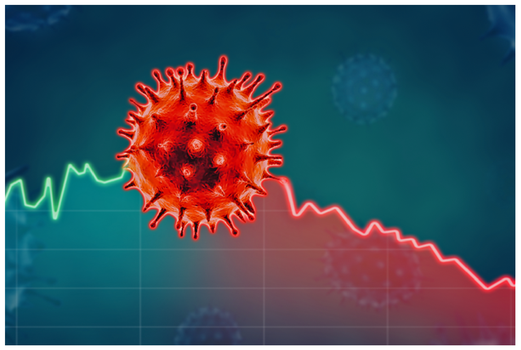
Objectives

This project aims to look at how different disease interventions can help in different ways:

- Examine any trend when giving vaccines between two different groups in order to limit total infections.
- Find the optimal threshold for when to send everyone into quarantine to flatten the curve.
- Look at the effects of contact tracing on causing large outbreaks.

Introduction

This research is important because of all the current real world applications it has. In recent times the Covid-19 pandemic is a great example of how this research helps people stay healthy.



During this outbreak the CDC came up with many ways to avoid getting sick including:

- Keeping up to date with vaccines.
- Avoiding contact with others who you know are sick.
- Staying home when not feeling good. [1]

The CDC gave even more suggestions besides the ones above like wearing masks and staying at least 6ft apart from one another but this project examines the issues above to see some of their real world impacts.

Model

This project uses a Suseptable, Infected, Recovered (SIR) model to examine different things.

Figure 1:SIR Representation

Simulation

Throughout all of the simulations we used a compete graph as pictured below.

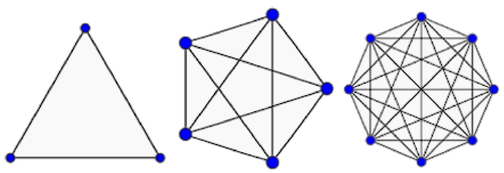


Figure 2:Complete Graph Examples

Using this complete graph we made 3 simulations for real world scenarios:

- Vaccines:
  - Goal: See if there were any interesting trends between total infections and vaccines given to both groups.
  - Action: Varied the percent of vaccines given to both of the groups.
- Mass Quarantine:
  - Goal: See how we can flatten the curve with timing when we go into isolation.
  - Action: Varied the threshold for when isolation occurs.
- Contact Tracing:
  - Goal: See what infection rate caused a large outbreak.
  - Action: Varied the infection rate to see when it became a large outbreak.

Results

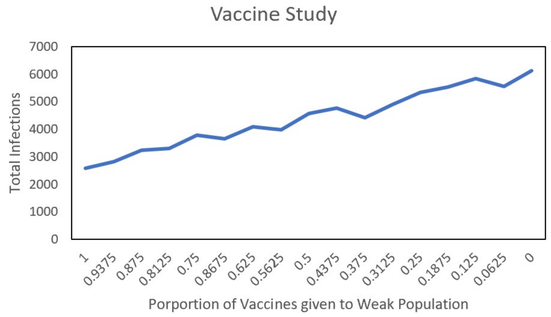


Figure 3:Vaccine Simulation Results

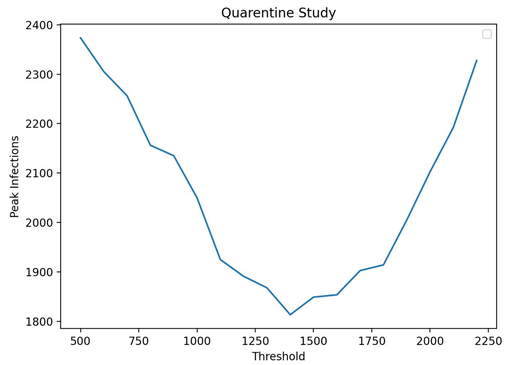


Figure 4:Mass Quarantine Simulation Results

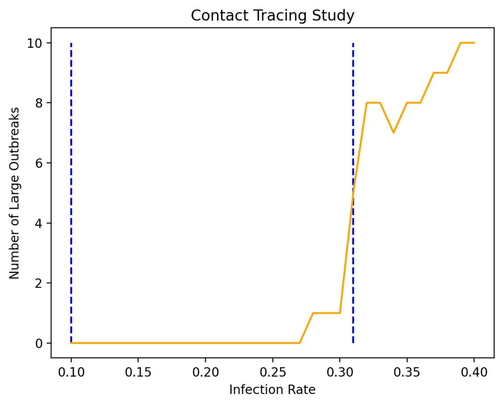


Figure 5:Contact Tracing Simulation Results

Conclusion

From these different methods we can see how to limit the spread or flatten the curve so people can live healthier lives. Some of the main takeaways from this project are:

- Vaccines:
  - Show us that there is a trade off for vaccinating normal and weak people.

If the cost of finding the weak people exceeds this trade-off then it would be more advantageous to vaccinate the normal people.

- Mass Quarantine:
  - With only 1 quarantine we have to set the threshold in the right spot to be able to flatten the curve.

If the threshold is set too low or too high then the outbreak still happens.

- Contact Tracing:
  - With proper contact tracing we can have a higher rate of infection before the outbreak becomes large.

In the simulations we can see that an infection rate around .31 caused large outbreaks with contact tracing where as if there was none a rate of .1 or larger would have caused these large outbreaks.

References

[1] Centers for Disease Control and Prevention. How to protect yourself and others. https://www.cdc.gov/coronavirus/2019-ncov/prevent-getting-sick/prevention.html, January 2023.

Acknowledgements

Dr. Matthew Wascher
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