Monitoring COVID-19 Infections

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PSTAT 197A

Introduction and Motivation

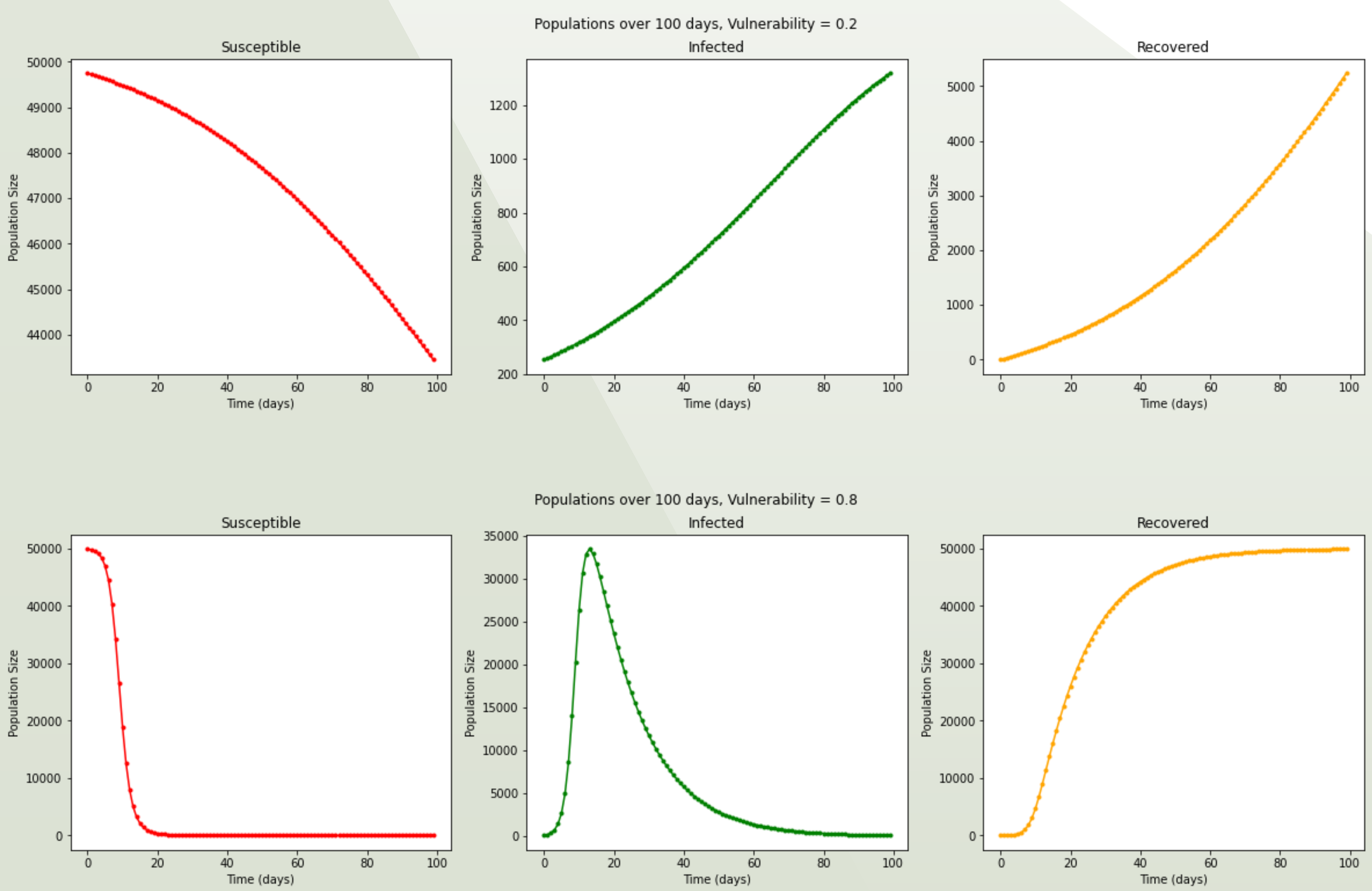
This quarter we investigated methods of modeling the spread of COVID-19. We were interested in:

1. Modeling flow patterns of COVID-19 to see how the virus affects different demographic groups (project part 1)
2. Discovering fair ways to allocate resources to minimize spread of COVID-19 (project part 2)

Part 1

Goal: model flow patterns of COVID-19 to see how the virus affects different demographic groups

Approach: we used a modified version of the SIR equations to model the spread of COVID-19. Our model takes into account different social vulnerability and comorbidity risk compartments within the population



$$\frac{dS_{v,c}}{dt} = -\frac{\beta_{v,c} \cdot S_{v,c} \cdot I}{N}$$

$$\frac{dI_c}{dt} = -\sum_v \frac{dS_{v,c}}{dt} - \gamma \cdot I_c$$

$$\frac{dR}{dt} = \gamma \cdot I$$

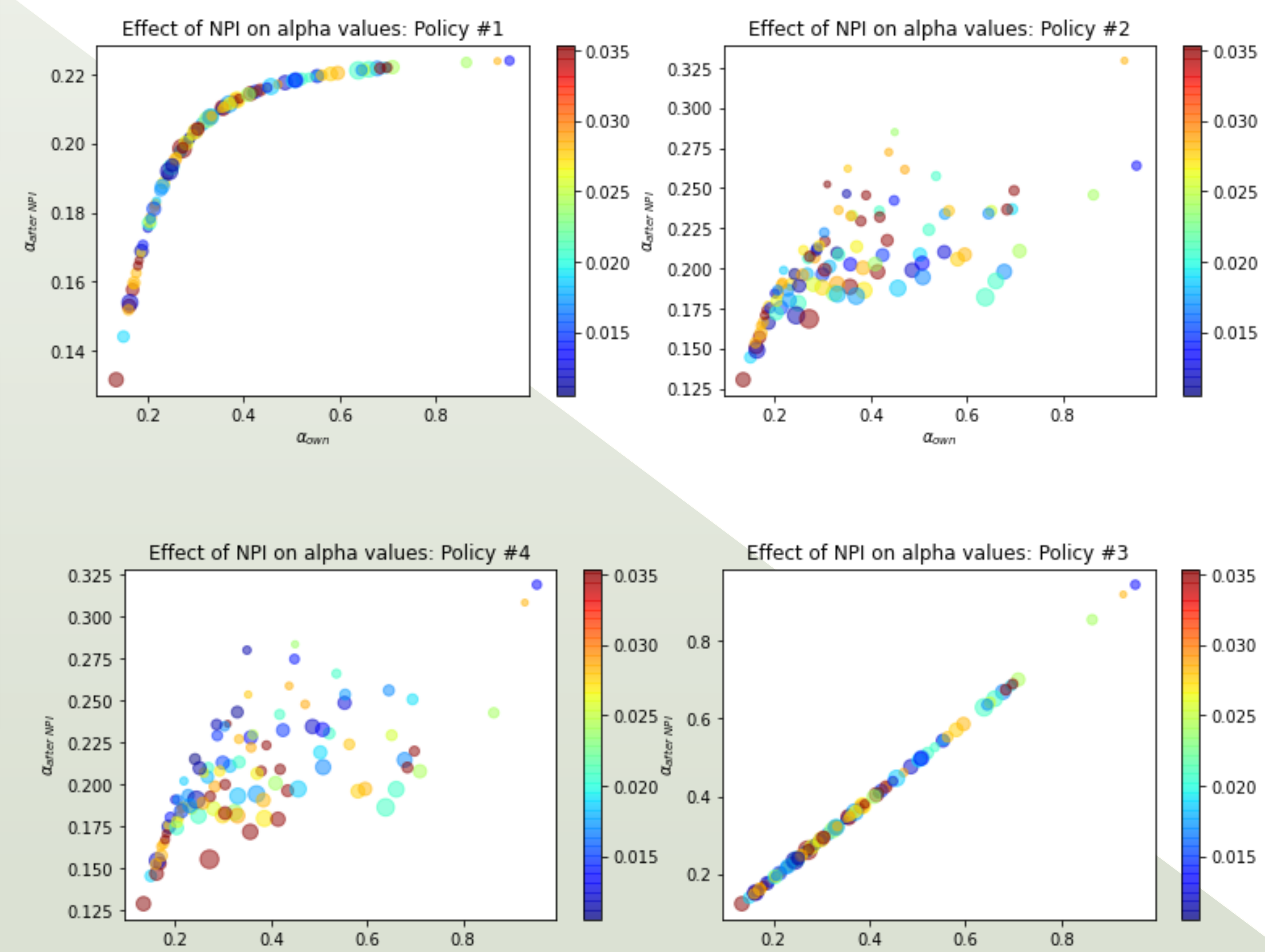
Part 2

Goal: analyze precautionary response & budget allocation fairness on different populations

Approach: we used minimization of MSE to find α. We then implemented 4 policies to allocate the $1,000,000 NPI budget.

$$\alpha = g(x) = \frac{1}{log_2(2 \cdot 10^{-3}x + 2)}$$

$$x = g^{-1}(\alpha) = \frac{2^{1/\alpha} - 2}{2 \cdot 10^{-3}}$$



Future Work

- Proof of concept use cases with previous outbreaks given a limited amount of data (e.g. SARS)
- A more positive outlook: Extrapolating programming tools used here for Marketing purposes (e.g. How long does it take for brand awareness to spread? Can a popular product be tracked in terms of 'uptick' in sales and consumer behavior?

Summary

* Visualized the dynamics of COVID-19 through the lens of Social Vulnerability & Comorbidity
* Expectations:
  - Infection Curve & Viral Load Density Curve flatten when Infection Rate decreased, i.e. "flatten the curve"
  - Varying effects of NPIs on α
* Obstacles:
  - Exploring "Individual Fairness" vs. "Group Fairness"
  - Measuring "Fairness" (Open-Ended)
  - Implementation & Interpretation of Results
    - Optimization
    - Grid Search
    - Node Breakdown

Coordination

- Use of Google Colab to simultaneously work on the project
- Scheduled meetings to discuss best ways to approach each part and to delegate tasks
- Open communication through group text message

References

Visuals

- Icon used from Google Colab
- Icons for Slides and Docs (Google)