COMPUTER SCIENCE

AWS & JHU Delineo Joint Project:
Modeling Spread of Infectious Disease Using Spatial Simulation on AWS & Delineo Disease Modeling Project

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Design Day 2023

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Introduction

- Spatial simulations on AWS give us insights into aggregate population movement patterns. SimSpace Weaver is a service that allows scalable spatial simulations.
- DMP from Delineo is a software that provides insight into the spread of diseases within a city or an urban environment.
- In particular, DMP is able to use demographic information, pre-existing conditions and the distribution of people across facilities to compute the rate of spread of infectious diseases using a Wells-Riley model.

Objectives

- DMP currently uses approximate ML models for predicting the flow of people from one facility to another. The model operates at the level of granularity of individual facilities in contrast to individual people.
- The objective of this project is to augment current DMP analysis by including spatial movement information of individual entities on AWS, and observe if it improves prediction accuracy in comparison to real-world data.

Materials and Methods

- We run multiple concurrent spatial simulations coupled to DMP disease modeling codes to perform what-if scenario analysis to understand epidemiological spread of disease.

Results

- For the models presented here, we ran spatial simulations on AWS EC2 instances with 10,000 entities as singular partitions. SimSpace Weaver would allow for scaling to hundreds of thousands of entities as part of future work.

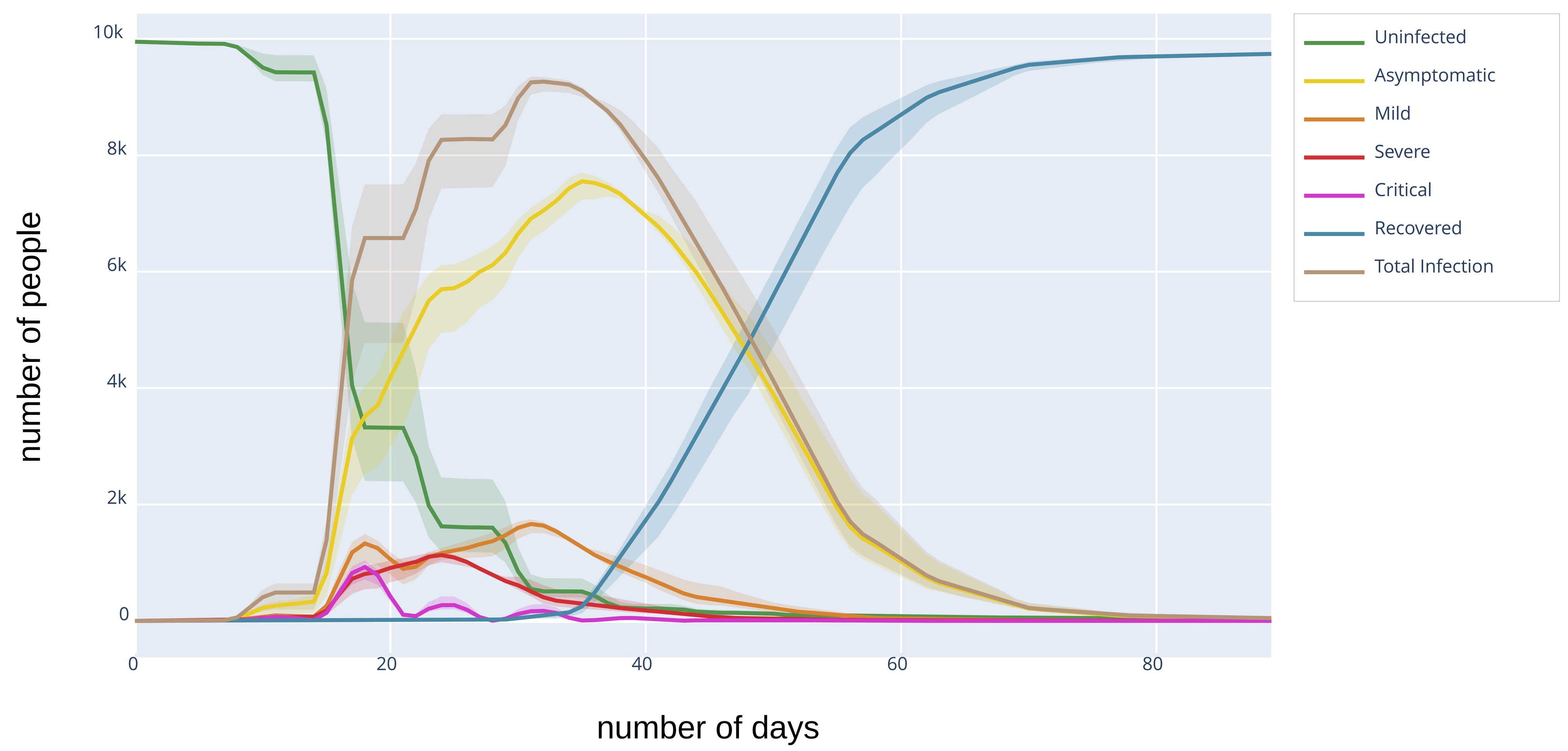

Figure 1 – Probabilistic forecast envelopes of different disease stages statistics in the population with different initializations

- Figure 1 shows four random initializations to derive potential outcomes for a given city structure. We visualize the spatial spread of disease Figure 2 across 4 timesteps. The QR code beside links to the full video.

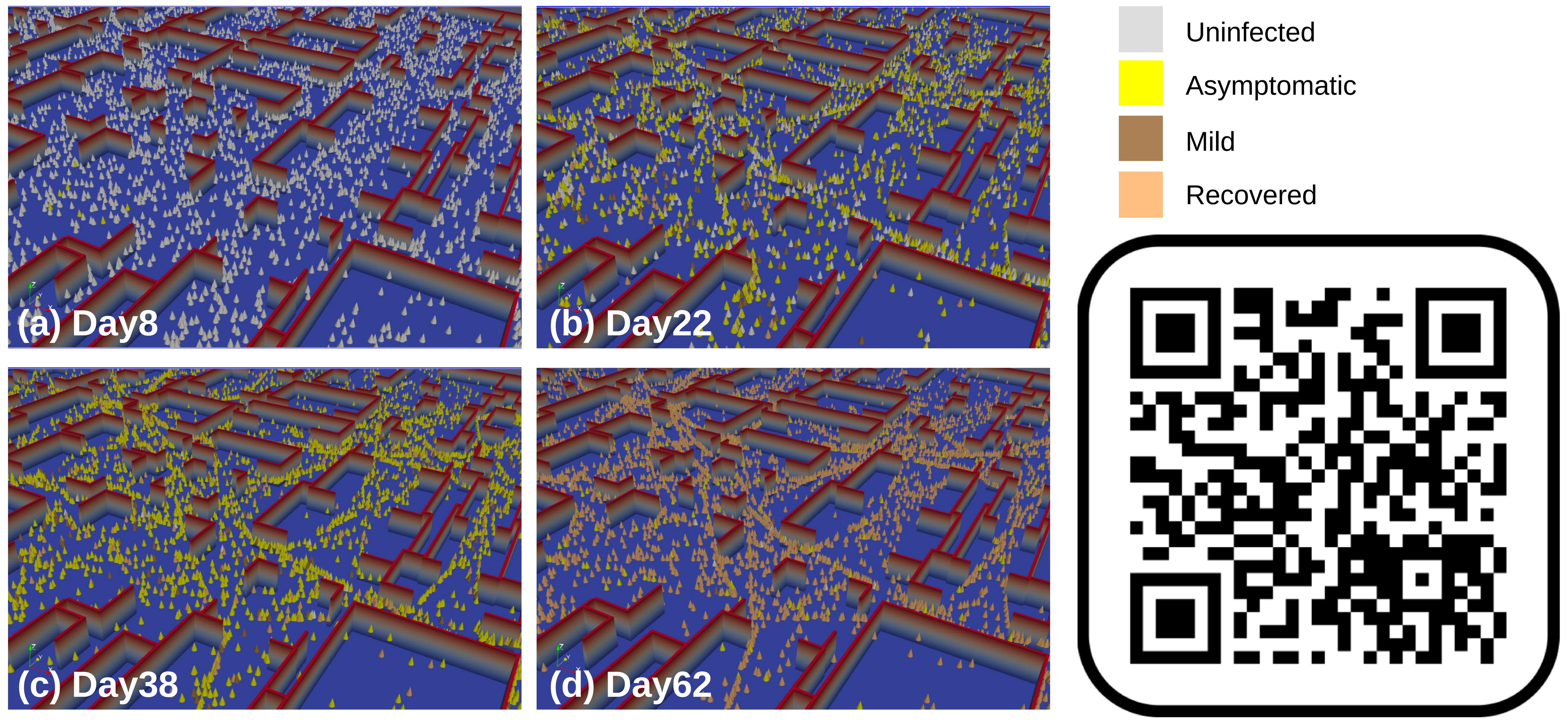

Figure 2 – The spatial distribution of simulated entities and disease state

Figure 3

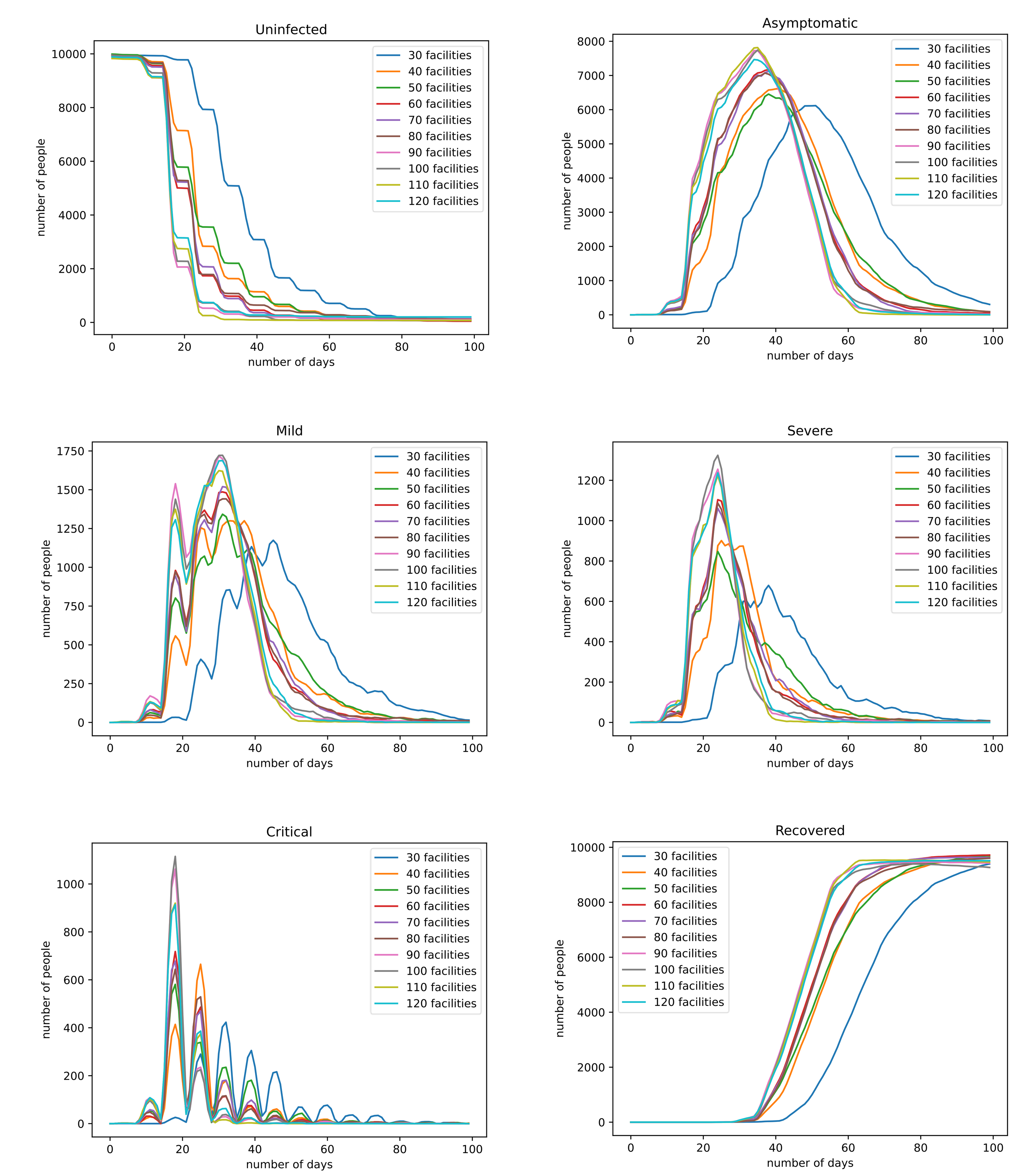

Figure 4 – Different infectious states for different number of facilities

- The propagation given different numbers of facilities are also tested to simulate the various possible real world city situations.

Conclusion

- We have demonstrated that spatial simulations provide meaningful insight into how population movement and infrastructure influence epidemiological modeling.
- Future work involves scaling the simulations to millions of people within realistic cities and running thousands of concurrent scenarios.