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MSDS 460 Final Project: Agent-Based Disease Simulation

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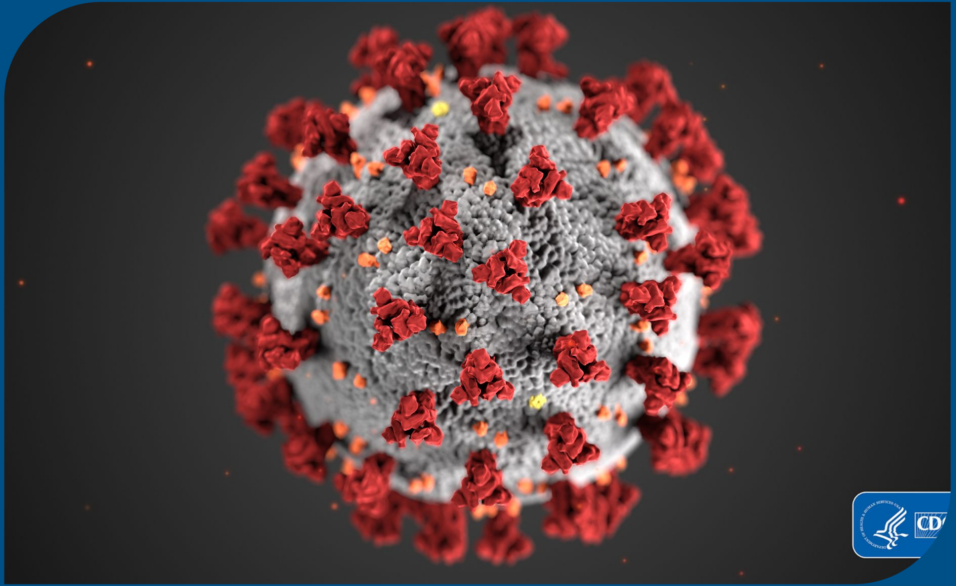


Agenda

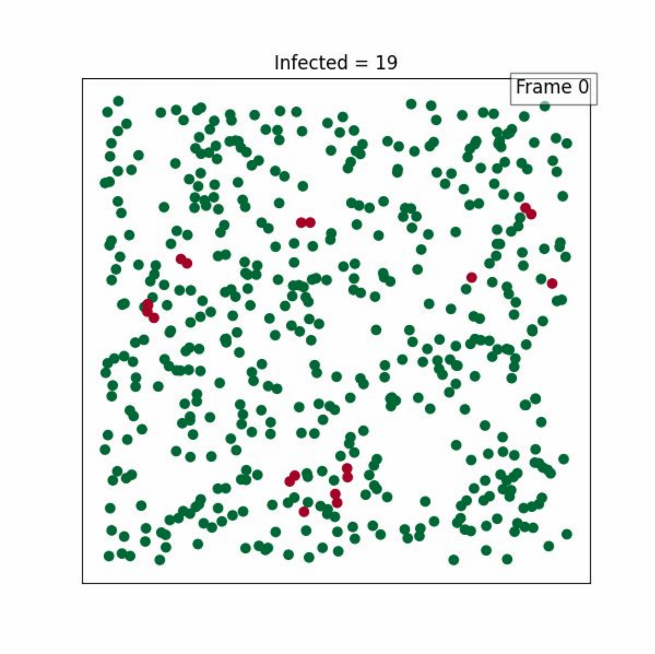
1. Project Overview and History
2. Simulation Design
3. Insights & Findings
4. Future Direction and Conclusion

Simulating the Spread of Disease

Objective: Be able to simulate the spread of a disease within a closed community under different scenarios.

Goals: Understand how disease characteristics and aspects of a population affect a population outcome.

Methodology: Use Python to create an agent-based simulation and create a dashboard of interactivity.



Historical/ Industry Context

- **Epidemiology** the study and analysis of the distribution (who, when, and where), patterns and determinants of health and disease conditions in a defined population, and application of this knowledge to prevent diseases.
- First recorded use of statistics in this field was in 1662 with the great plague
- Invention of computers in the 1950s allowed for more complex simulations to happen involving more variables
- Utilized extensively during COVID-19 pandemic for forecasting infection and death rates.

1. **Simulate disease spread using an agent-based model.**
2. **Understand effects of vaccination, isolation, and transmission likelihood.**
3. **Inform policies for future pandemic responses.**

Models each individual separately (agents).

Captures variability in behavior and outcomes.

Agent States

Uninfected

The agent does not currently have the disease but can get it.

Infected

The agent has the disease. Once the agent has the disease, a counter is started that determined how long the agent will have the disease for.

Immune

These agents have been infected but their infection counter has expired. The moment they are no longer infected, they are immune for a determined number of events meaning they cannot spread the disease and they cannot be infected.

Adjustable Parameters

Number of Agents

This represents the total starting number of agents being simulated. As the total number of agents increases, the likelihood of agents making contact with each other increases. As a result, this variable can be directly related to the population density of the environment.

Agents Infected

This is the number of agents that are infected from the onset of the simulation.

Agent Resistance

This parameter controls how contagious the disease is. A higher resistance level means healthy agents are less likely to contract the disease if they come into contact with an infected agent.

Proximity Threshold

This defines the maximum distance within which agents are considered to have made contact. A lower proximity threshold reduces the likelihood of interactions, while a higher threshold increases potential exposure.

Step Size and Number of Timesteps

Determines how far agents move in each iteration of the simulation and the total duration of the simulation. Larger step sizes lead to faster movement and potentially more interactions between agents, while a greater number of timesteps allows for longer observation of disease spread and population dynamics.

Simulation Demo

Insights and Future Direction

- Simulation demonstrates how the effect of a disease on a population
- Opportunities for improvement:
    - Fatality Rates
    - Individualized factors – vaccinations
    - Non-random movement
    - Isolation effects
- Practical Value: Opportunities for policy creation; disease research