CUTTING THE CHEESE:
SIMULATING INFECTIOUS DISEASE SPREAD WITH FICTION

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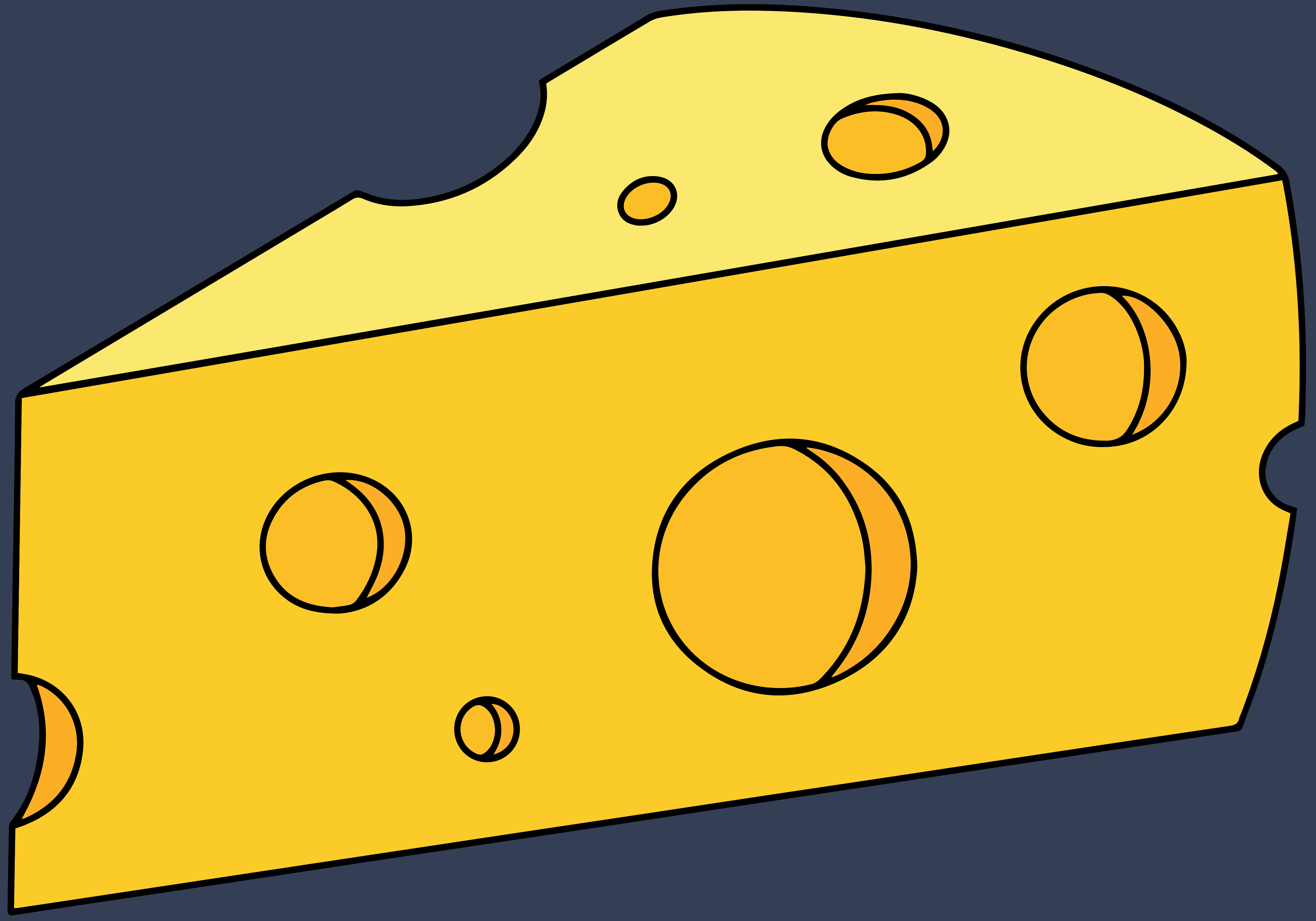
Math 382

OVERVIEW



BACKGROUND INFORMATION

THE RULES:

1. If a person with the cheese touch touches you, you have the cheese touch.
2. There is no limit to how long you can have the touch or how many times you get it, but you get rid of it once you touch another victim.
3. Any person can touch the cheese at any time and get the touch
4. A potential victim can have their fingers crossed when being given the cheese touch to block the infected person from passing it on
5. Moving away or consuming the cheese ends the round of the cheese touch

GUIDING QUESTION:

It is possible to model the spread of the infamous and made-up cheese touch in a way that mirrors a basic SIR model of disease?

MODEL ITERATIONS

PHASE 01

One person touches the cheese and can only spread it to one person who then has the cheese touch.

PHASE 02

One person begins, can only pass to one person, but a new infection of the disease added at a specific time interval.

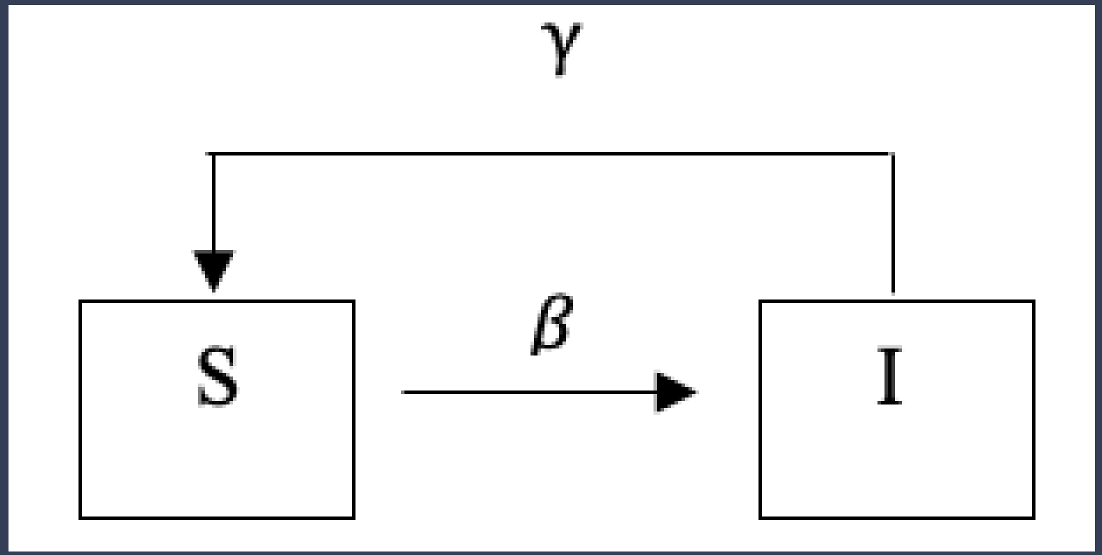
PHASE 03

Infected person can spread the disease to as many people as possible, however, a person is only infectious for three hours.

PHASE 04

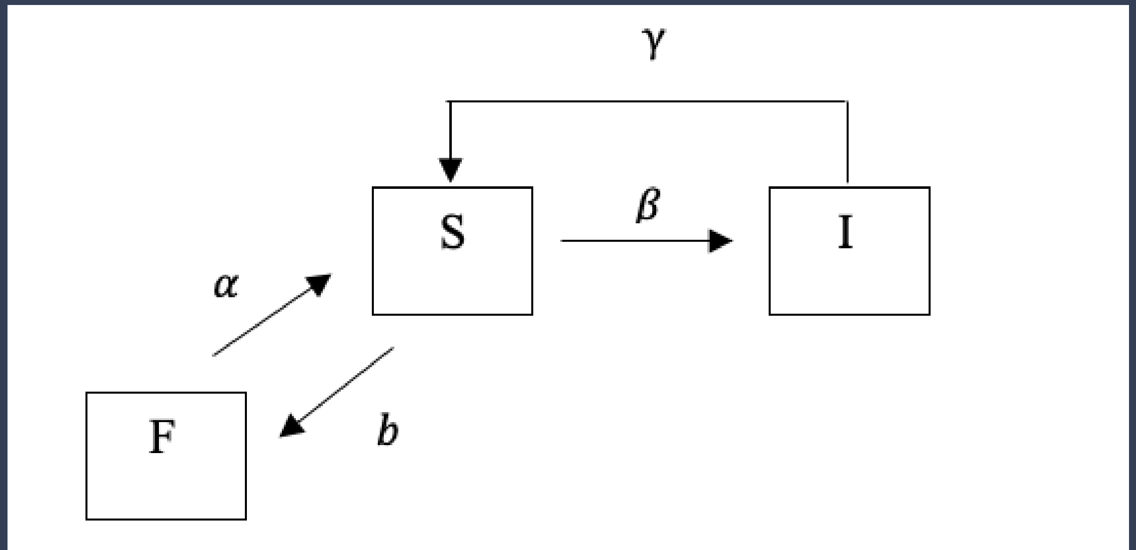
Infected person can spread the disease to as many people as possible, and an infection is added every three hours, however, a person is only infectious for three hours. **finger-cross

SCHEMATICS AND EQUATIONS



$$\begin{cases} S' = -\beta S + \gamma I \\ I' = \beta S - \gamma I \end{cases}$$

- βS represents the susceptible becoming infected
- γI represents the infected population re-entering the susceptible population
- S’ and I’ are in terms of ppl/t



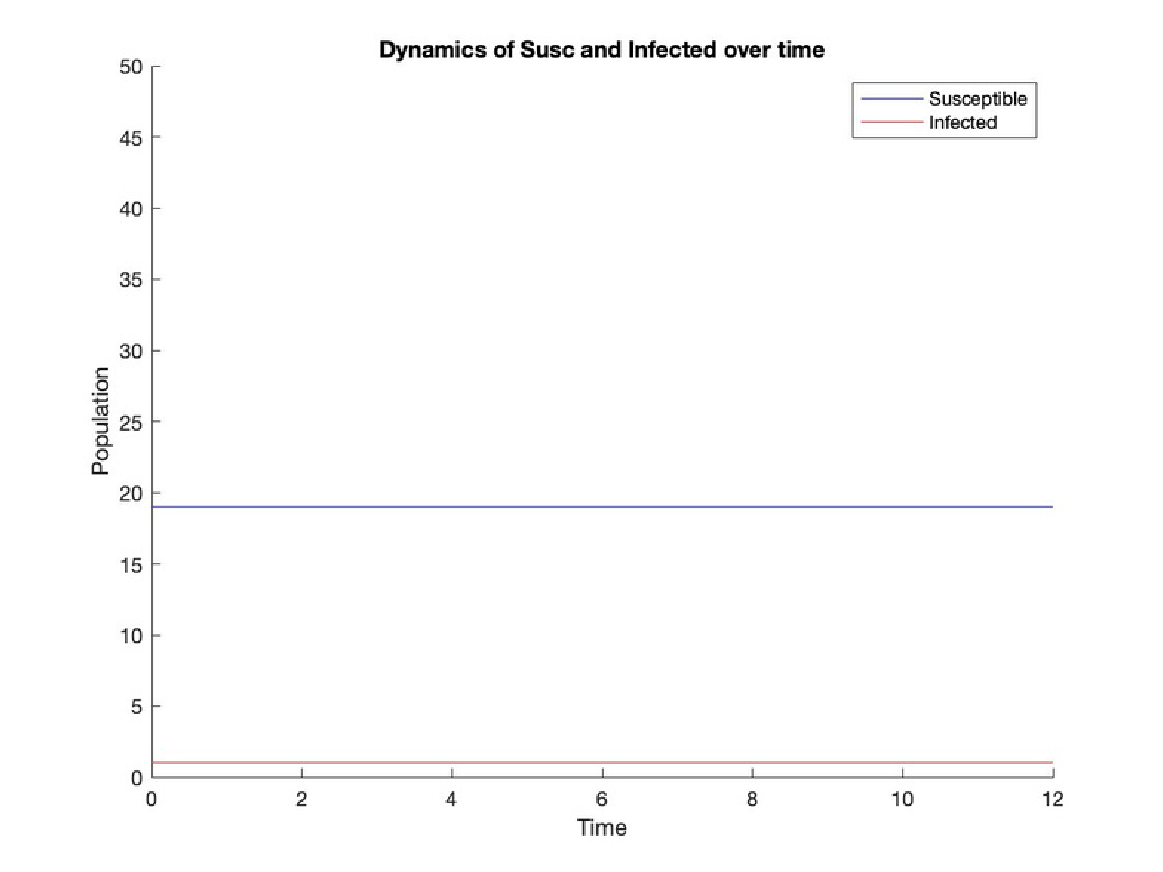
$$\begin{cases} S' = -\beta S + \gamma I + aF - bS \\ I' = \beta S - \gamma I \\ F' = bS - aF \end{cases}$$

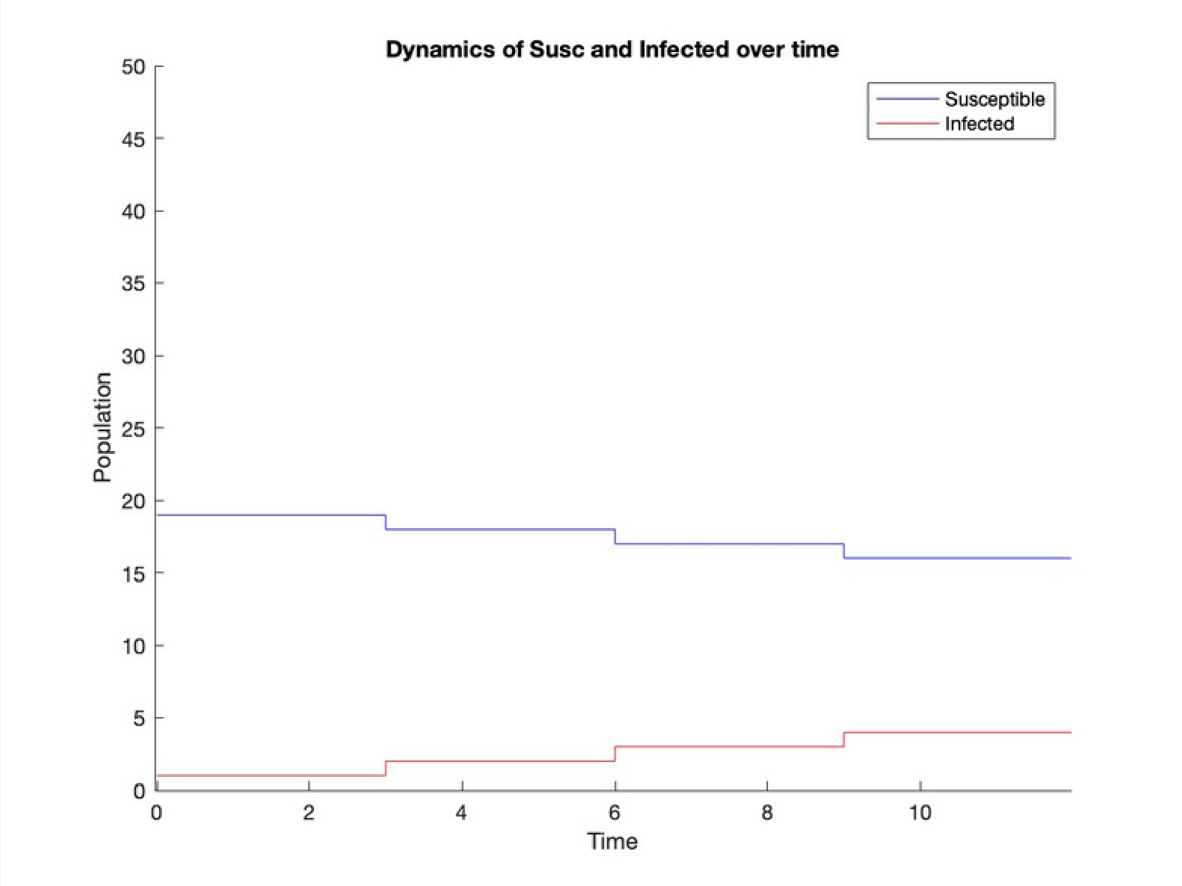
- βS represents the susceptible becoming infected
- γI represents the infected population re-entering the susceptible population
- bS is the susceptible population entering the fingers-crossed population
- aF is the fingers crossed population becoming susceptible to infection

ASSUMPTIONS FOR FIRST TWO ITERATIONS:

- 20 people in the population at all times
- The timespan of the disease is 12 hours
- Parameters:
  - Beta is the rate at which infections occur
  - Gamma is the recovery rate of infected individuals
  - both are fixed, assuming the population equilibriums
- Initial Conditions:
  - one person infected with the cheese touch
  - nineteen susceptible individuals

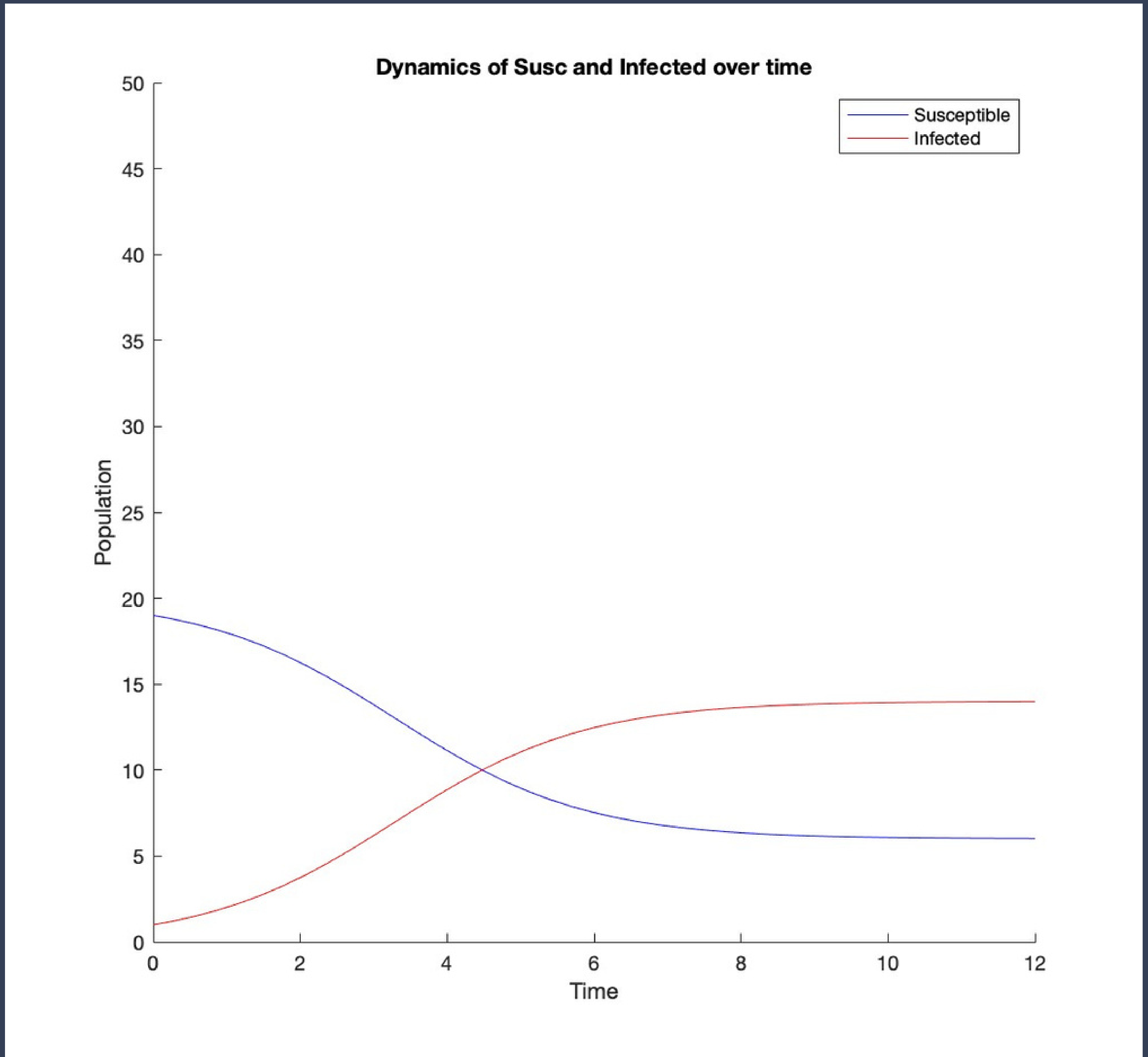
$$R0 = \frac{N\beta}{\gamma}$$





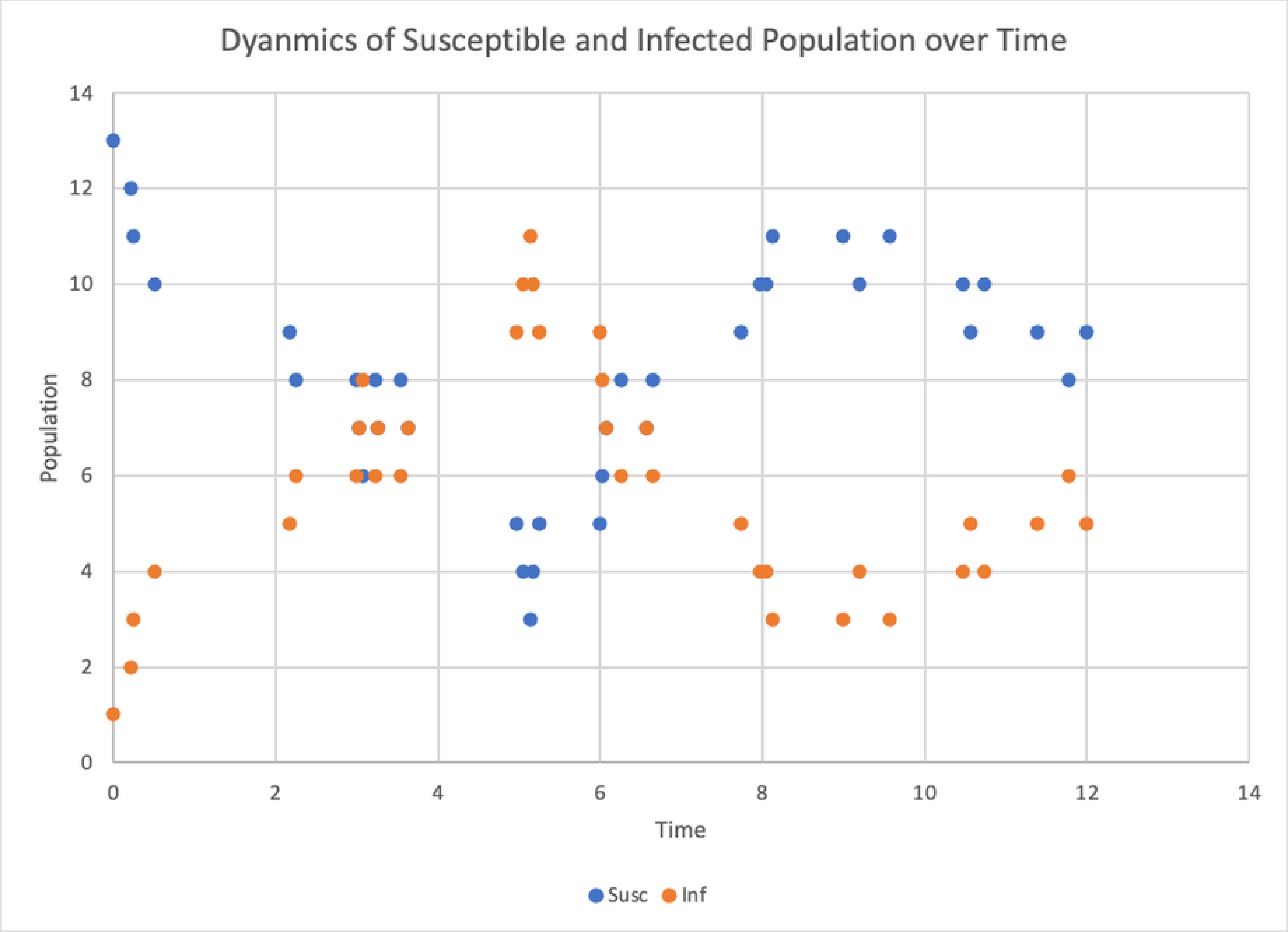
ITERATION THREE:

- More than one person can become infected at a time, same rules apply.
- Used Next Generation Matrix Model Method to create an R0 that expresses how infectious the disease is and relates the beta and gamma coefficients
- Setting the steady states to 6 and 14 and then calculating the corresponding beta and gamma values

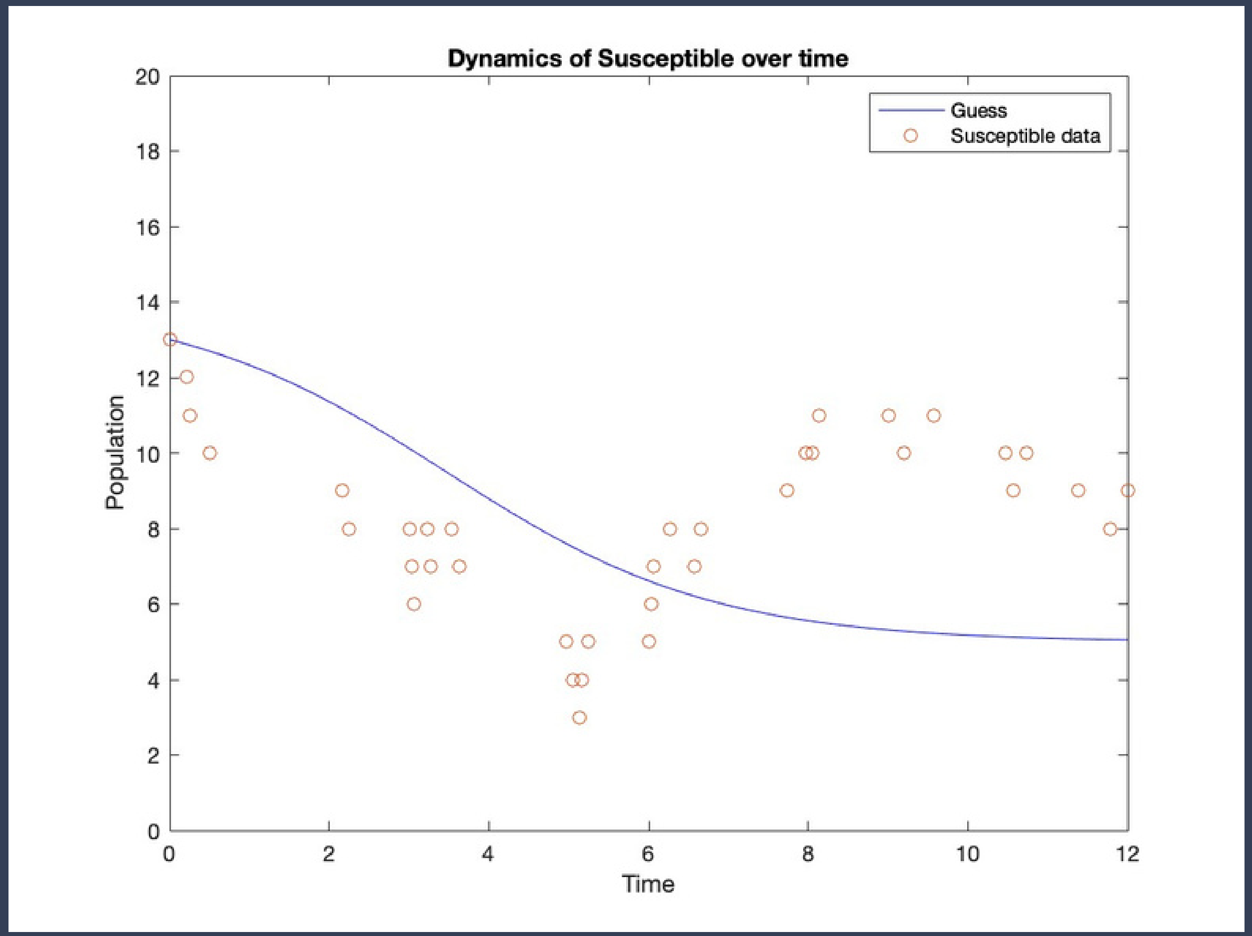


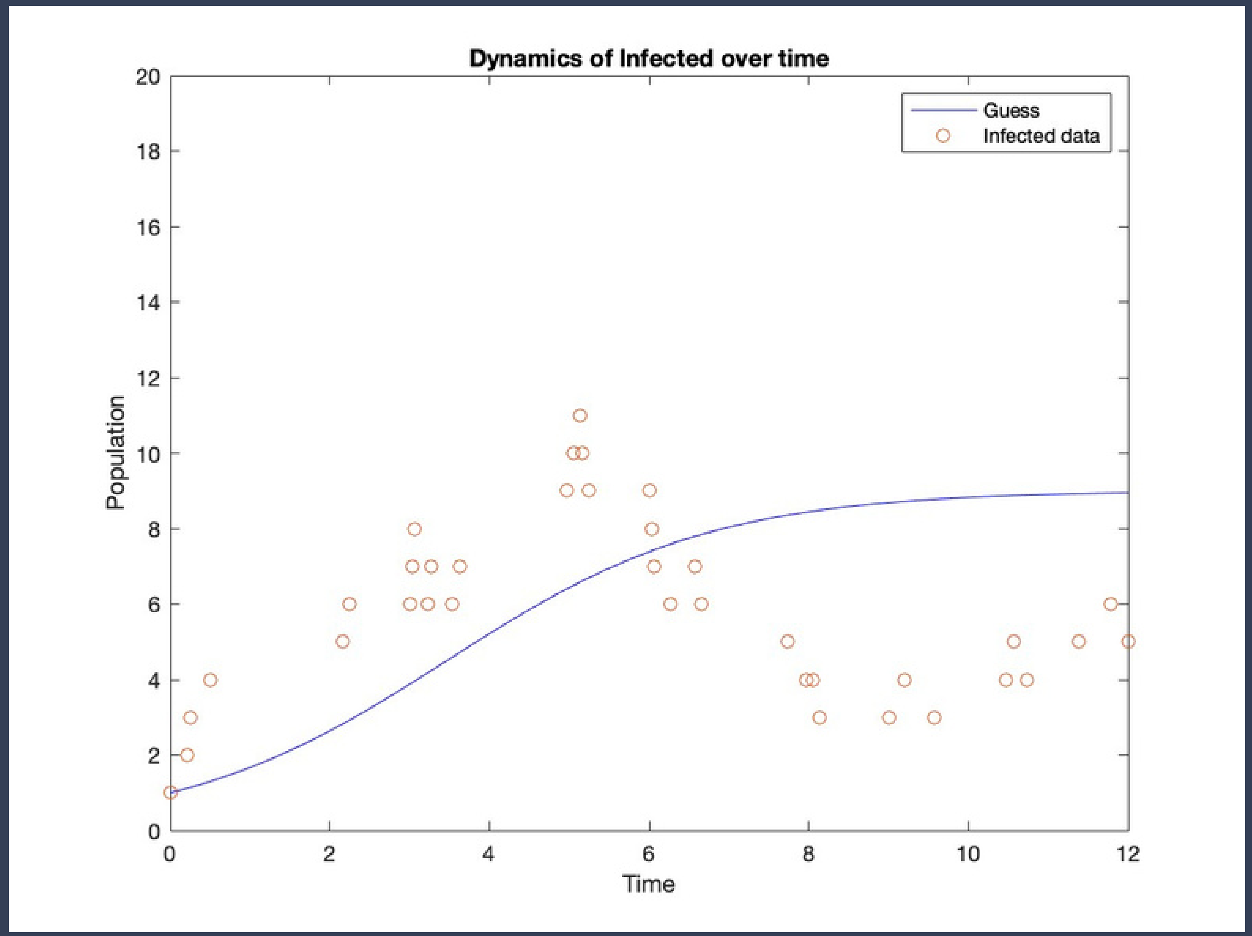
ITERATION FOUR (THE DATA):

- Game begins at t = 0 by randomly selecting one person to start with cheese touch
- Allowed to touch and infect as many people as possible
- Each person is infectious for a time of exactly three hours.
- At t=3, t=6, and t=9, will select another random person to become patient zero and be infected with the cheese touch.
- After the three hours of infection, an individual re-enters the susceptible population
- Each person will report exactly when they were infected for each infection (if infected more than once).
- The game will end at t=12 hours.



RESULTS


Dynamics of Susceptible over time
Guess
Susceptible data
Population
Time


Dynamics of Infected over time
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Infected data
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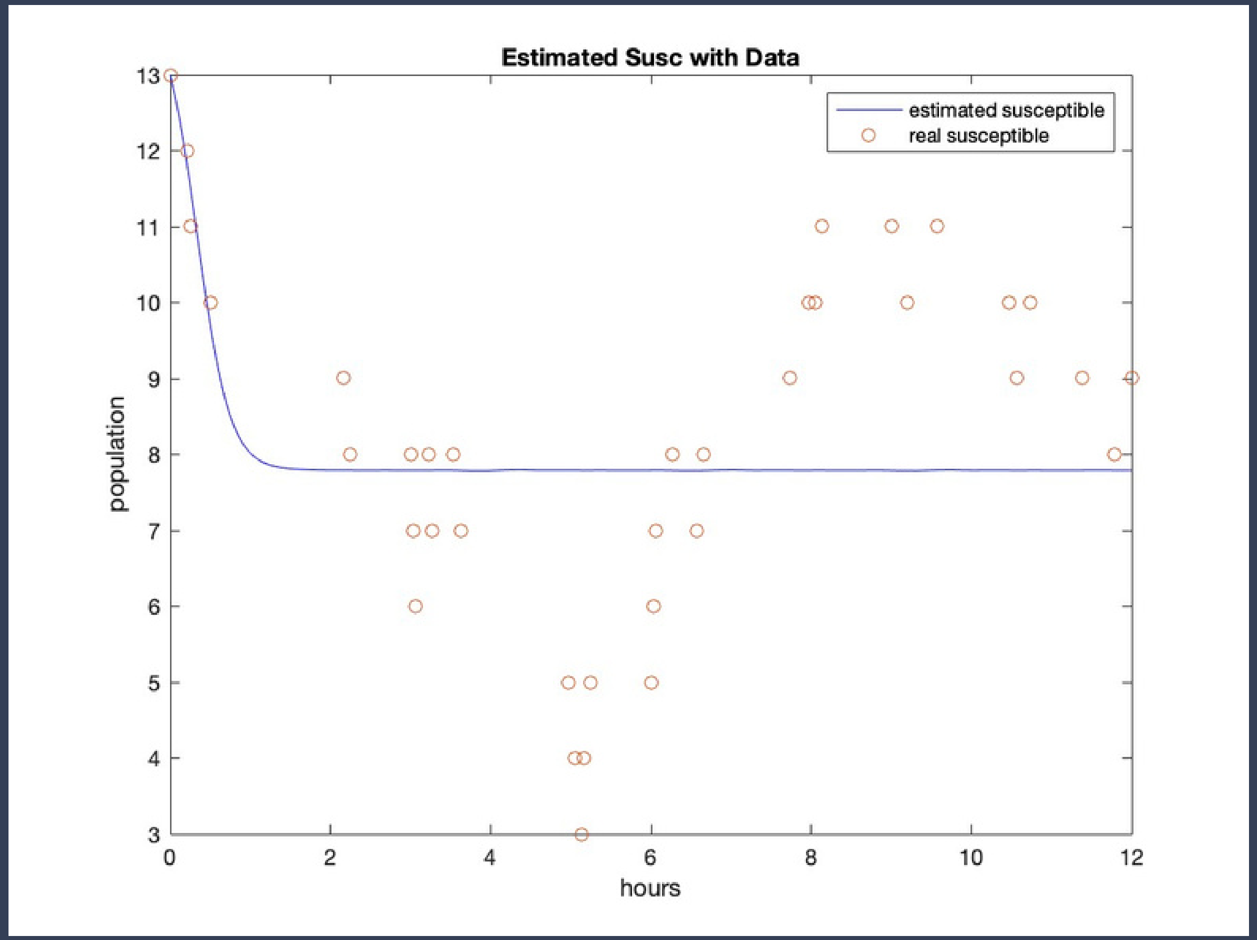
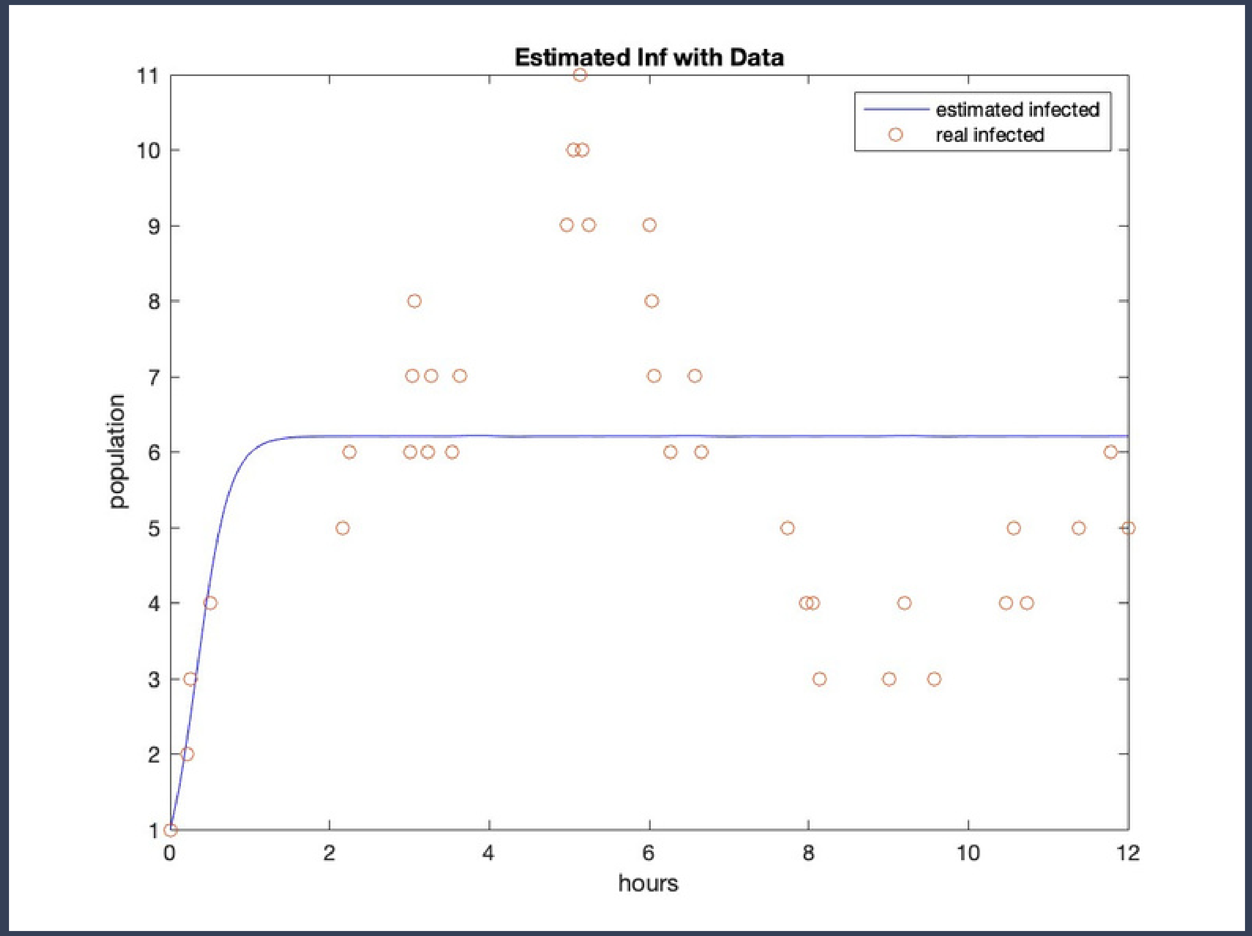
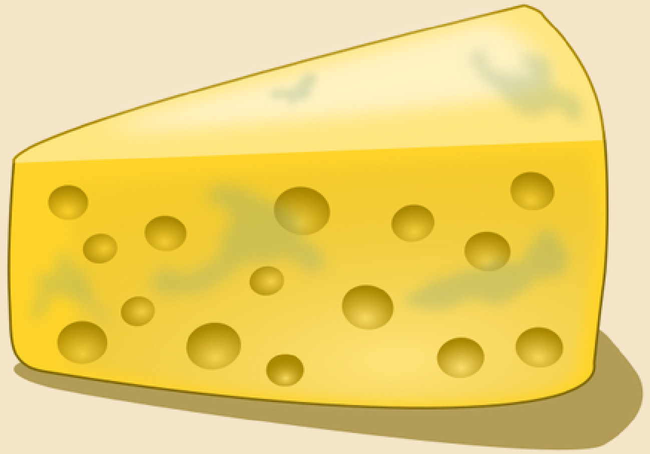

Estimated Susc with Data
estimated susceptible
real susceptible
population
hours


Estimated Inf with Data
estimated infected
real infected
population
hours

CONCLUSIONS

- This model does not really fit the cheese touch design, mostly because the cheese touch does not act like any infectious disease
- The R0 values is not really accurately measuring how infectious the disease is
  - currently it is changing when an additional person is infected in iteration 2, but it should be constant across the timeframe because each individual is not becoming more infectious
  - hope to rectify this in later iterations because mostly due to the strange dynamics
- May need a more controlled environment for the data collection



FUTURE WORK

- Gather data running the same simulation, but this time including the cheese touch rule
- Calculate the R0 values for this and compare to previous iterations
- Investigate each individual data point (players in the game) and calculate their R0 value to get a more accurate representation of how infectious the disease is

THANK YOU

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Math 382 Presentation