Vaccination

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Introduction

- Our model simulates disease spread based on the amount of people vaccinated in the population.
- The goal is to show that disease spread is slower when more people are vaccinated.

Entities

- Humans
  - Vaccinated
  - Not vaccinated, not infected
  - Not vaccinated, infected
- Humans move around randomly
- There is a chance for infected humans to infect uninfected humans.

What are we looking for?

- Rate of infection as determined by the proportion of vaccinated people
- Graph; Amount of each entity vs. time

Validation

- Kermack and McKendrick derived differential equations [Proc. R. Soc. A, 115, 772 (1927)]
- This is called the “SIR Model”

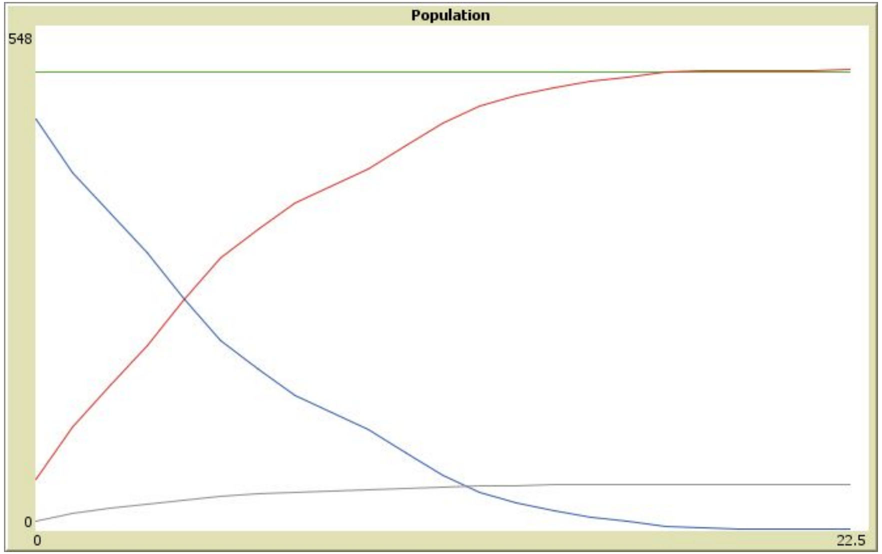
$$\frac{\mathrm{d}S}{\mathrm{d}t} = -\frac{\beta S I}{N},$$

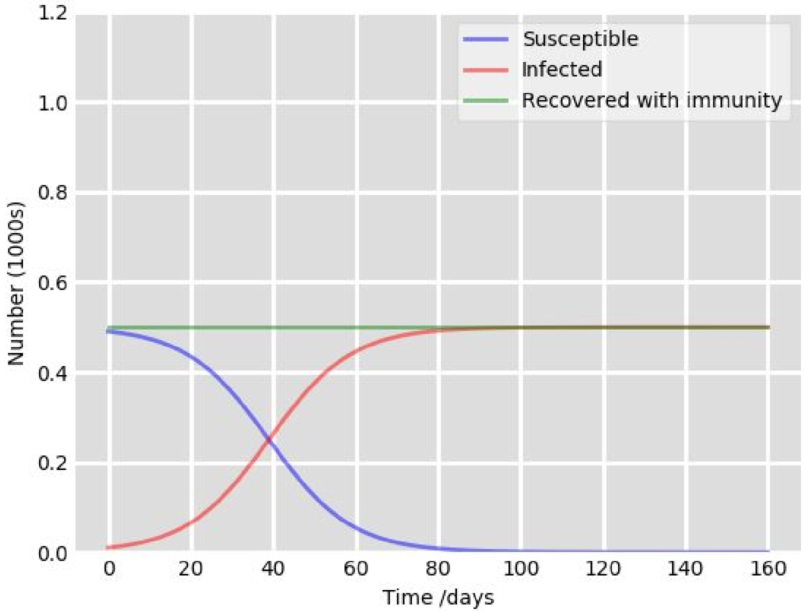
$$\frac{\mathrm{d}I}{\mathrm{d}t} = \frac{\beta S I}{N} - \gamma I,$$

$$\frac{\mathrm{d}R}{\mathrm{d}t} = \gamma I.$$

- **S(t)** are those susceptible but not yet infected with the disease;
- **I(t)** is the number of infectious individuals;
- **R(t)** are those individuals who have recovered from the disease and now have immunity to it.
- β = infection rate (arbitrary number; set to 0.2)
- ɣ = recovery rate (set to 0)

Validation



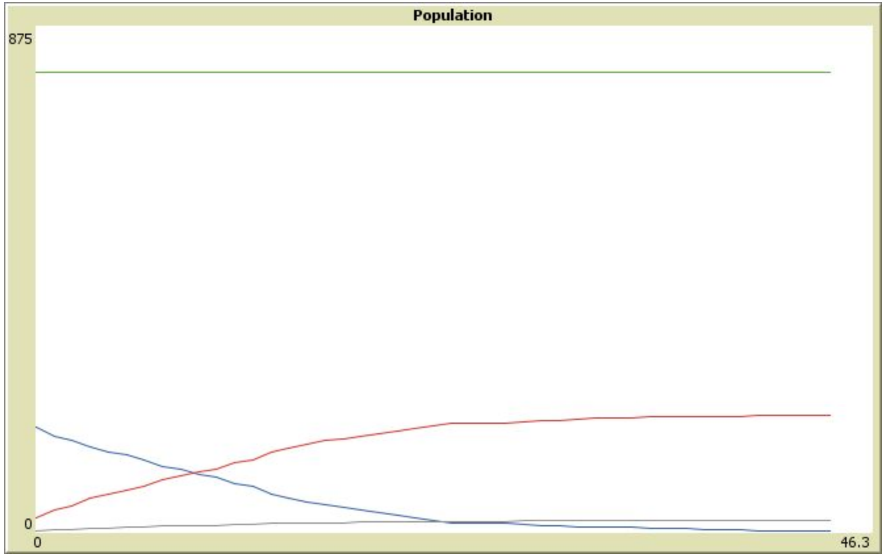


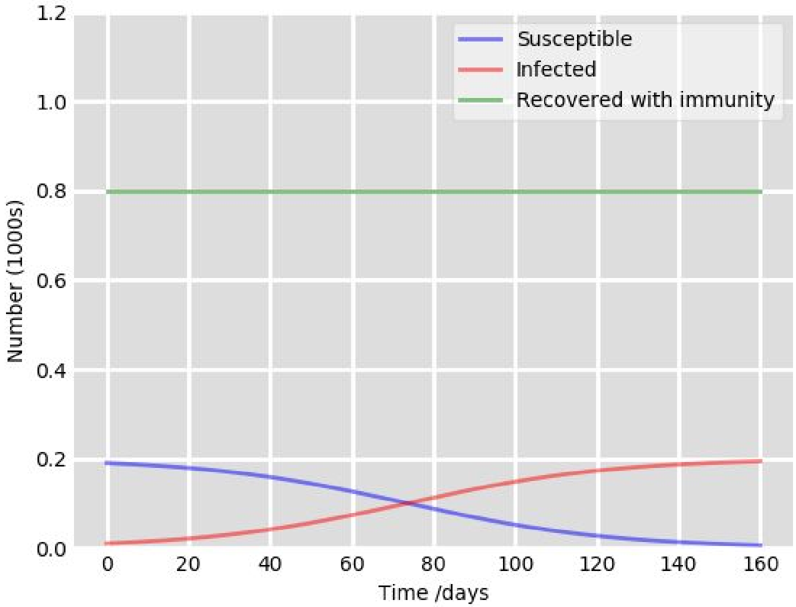
Our agent-based model implemented in NetLogo.

Green represents vaccinated, Blue for not vaccinated, and Red for infected.

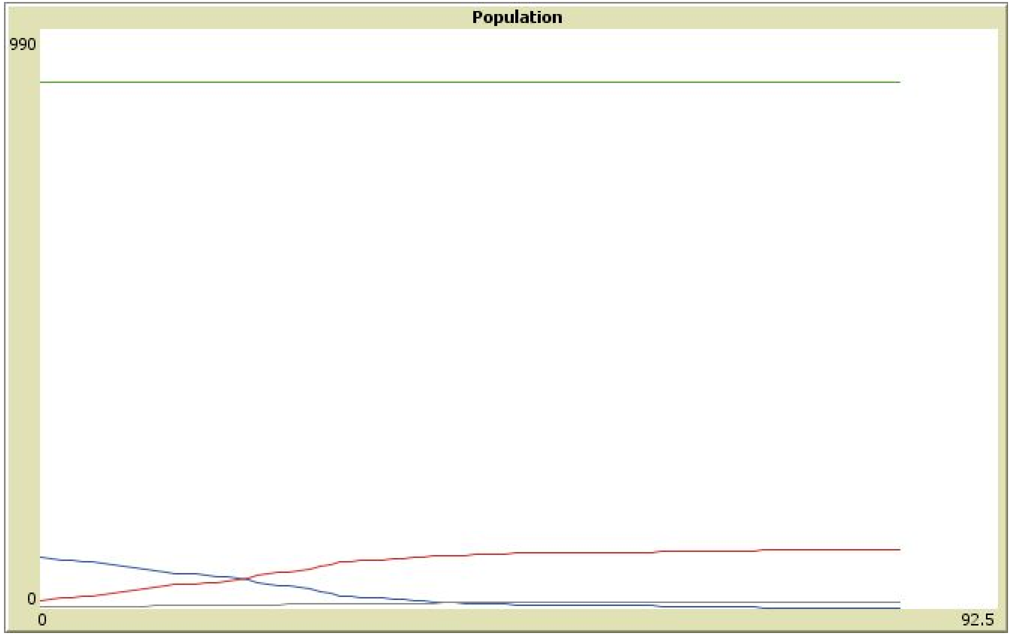
Kermack and McKendrick’s mathematical model implemented in SciPy

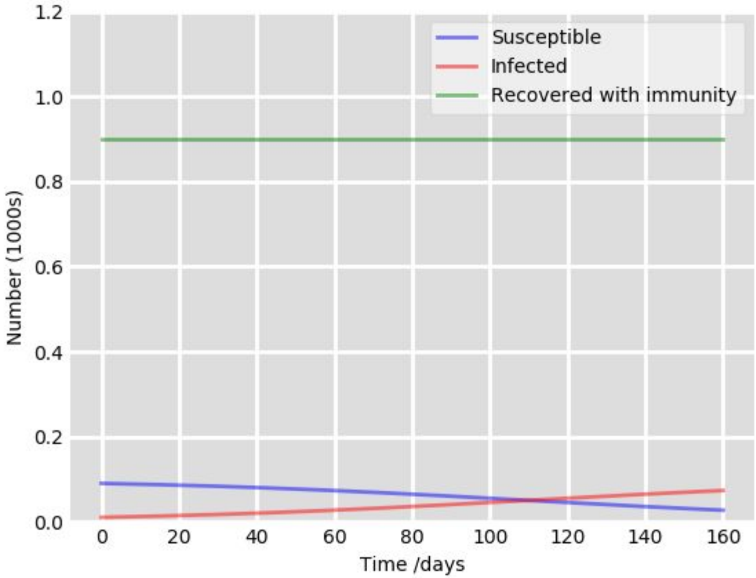
Validation


Population
875
0
0
46.3

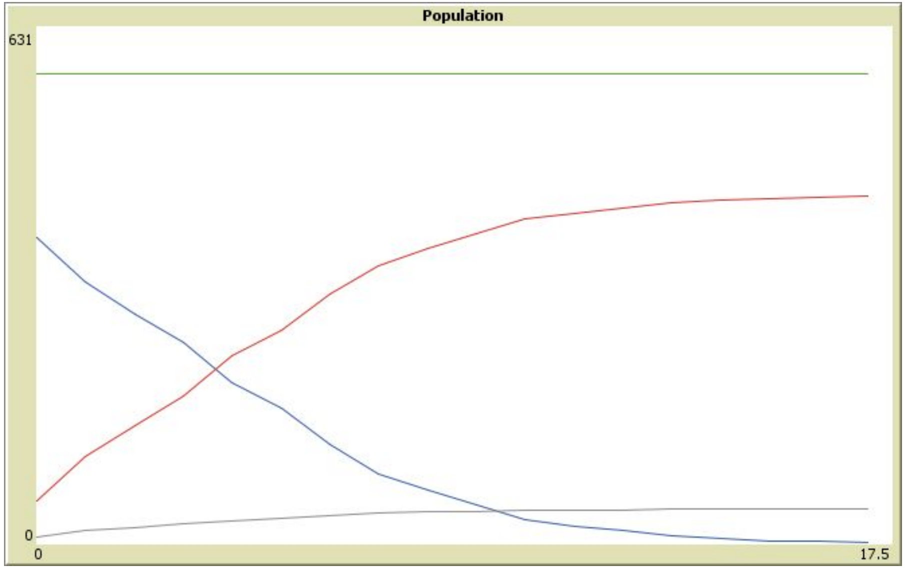

Susceptible
Infected
Recovered with immunity
Number (1000s)
Time /days
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0
20
40
60
80
100
120
140
160

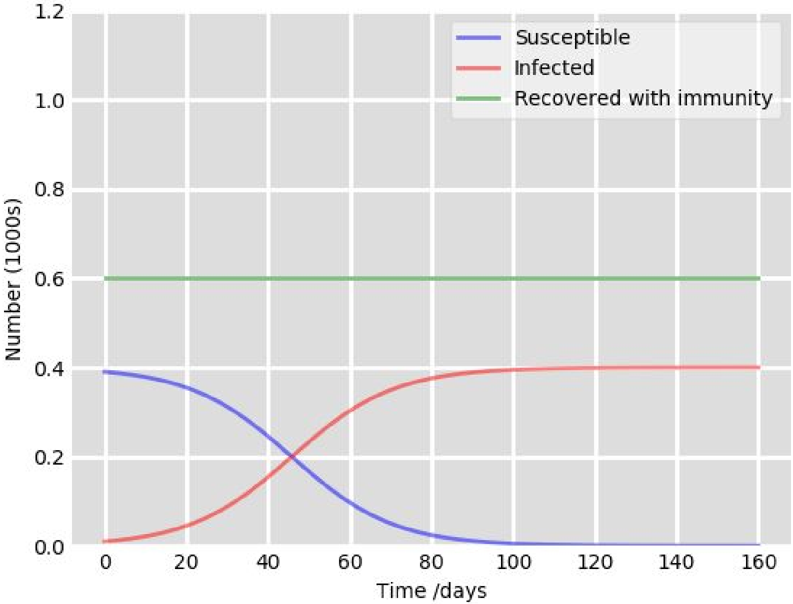
Validation


Population
990
0
0
92.5


1.2
1.0
0.8
0.6
0.4
0.2
0.0
Number (1000s)
0
20
40
60
80
100
120
140
160
Time /days
Susceptible
Infected
Recovered with immunity

Validation


Population
631
0
0
17.5


Susceptible
Infected
Recovered with immunity
Number (1000s)
Time /days
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0
20
40
60
80
100
120
140
160

Recommendations

- More entities aside from infected, non-infected, and vaccinated humans
- Opportunity for infected individuals to be cured and become immune
- Try validating with other models