Infectious Disease Spread

Padraic Flood[1] Aoife Hill[1] Damian O'Connor[3] Bram Siebert[1]
Andrew Whelan[2]

[1]NUI Galway [2]Dublin IT [3]University of Limerick

Mentors: Dr. Petri Piiroinen, Richard Burke and Eoghan Staunton

June 16, 2016

NUI Galway
OÉ Gaillimh

University of Limerick
Ollscoil Luimnigh

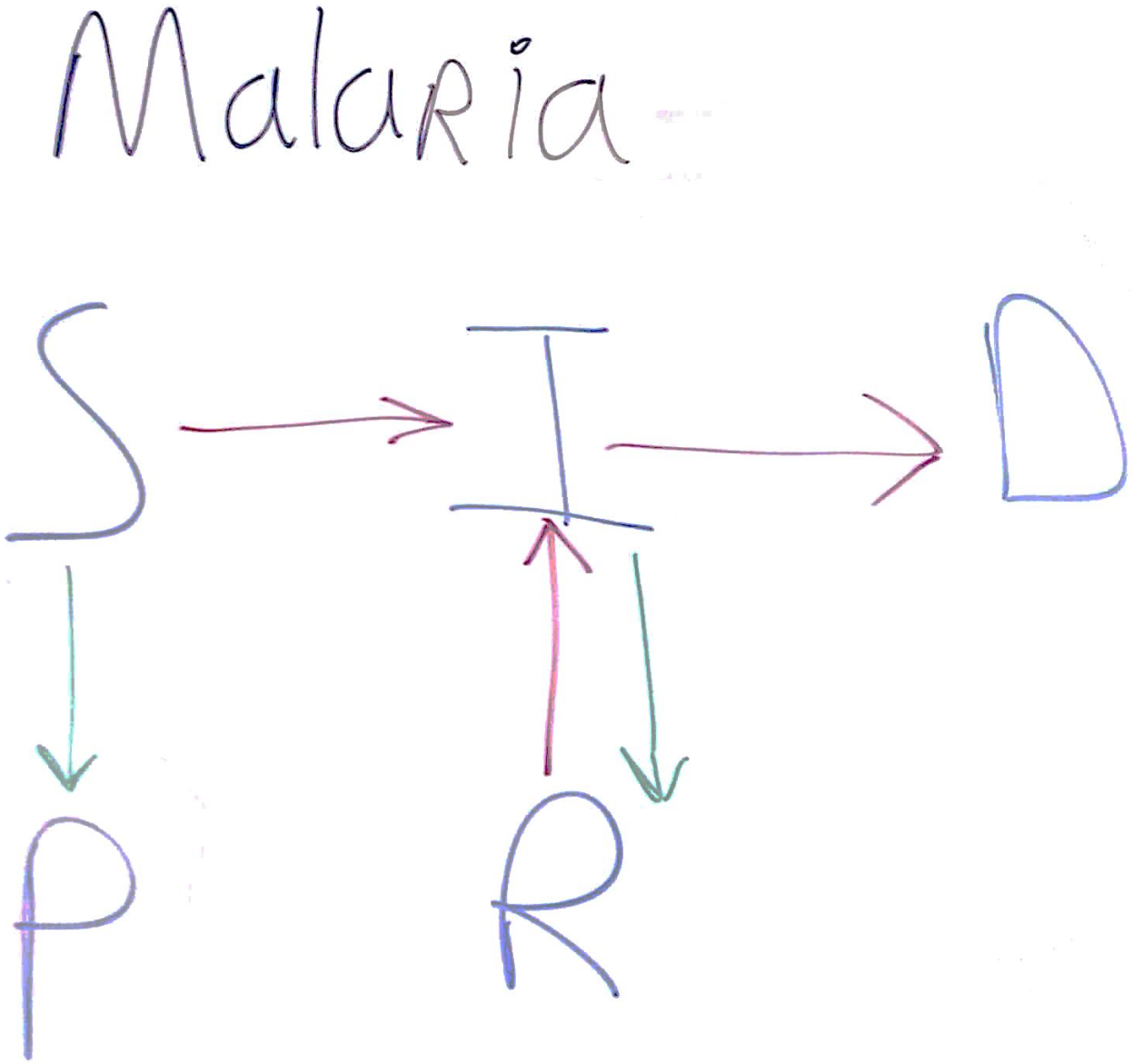
Basic SIR Model

S - Susceptible
I - Infected
R - Recovered

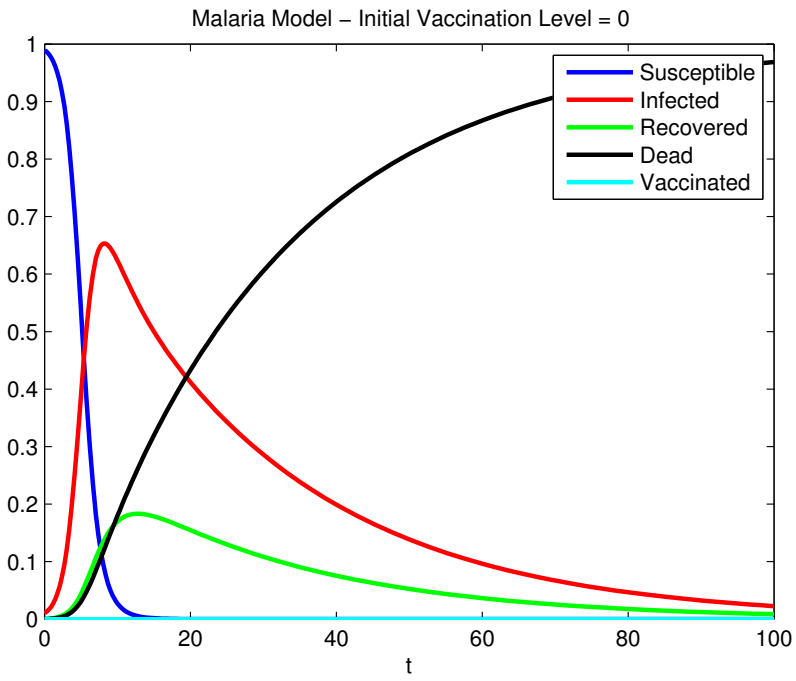
$$\frac{dS}{dt} = -\alpha SI$$
$$\frac{dI}{dt} = \alpha SI - \beta I$$
$$\frac{dR}{dt} = \beta I$$
$$N = S + I + R = 1$$

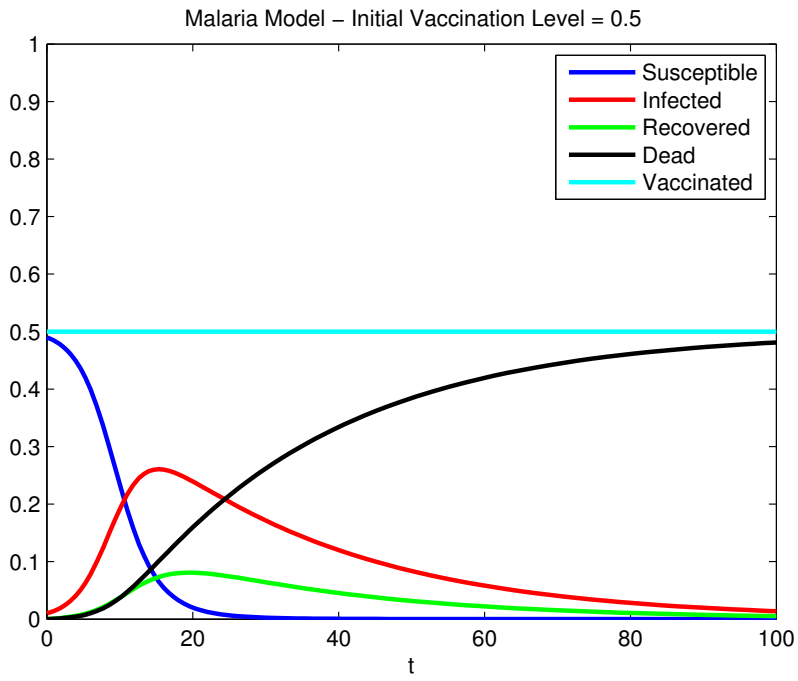
$\alpha =$ Infection rate
$\beta =$ Recovery rate

Malaria

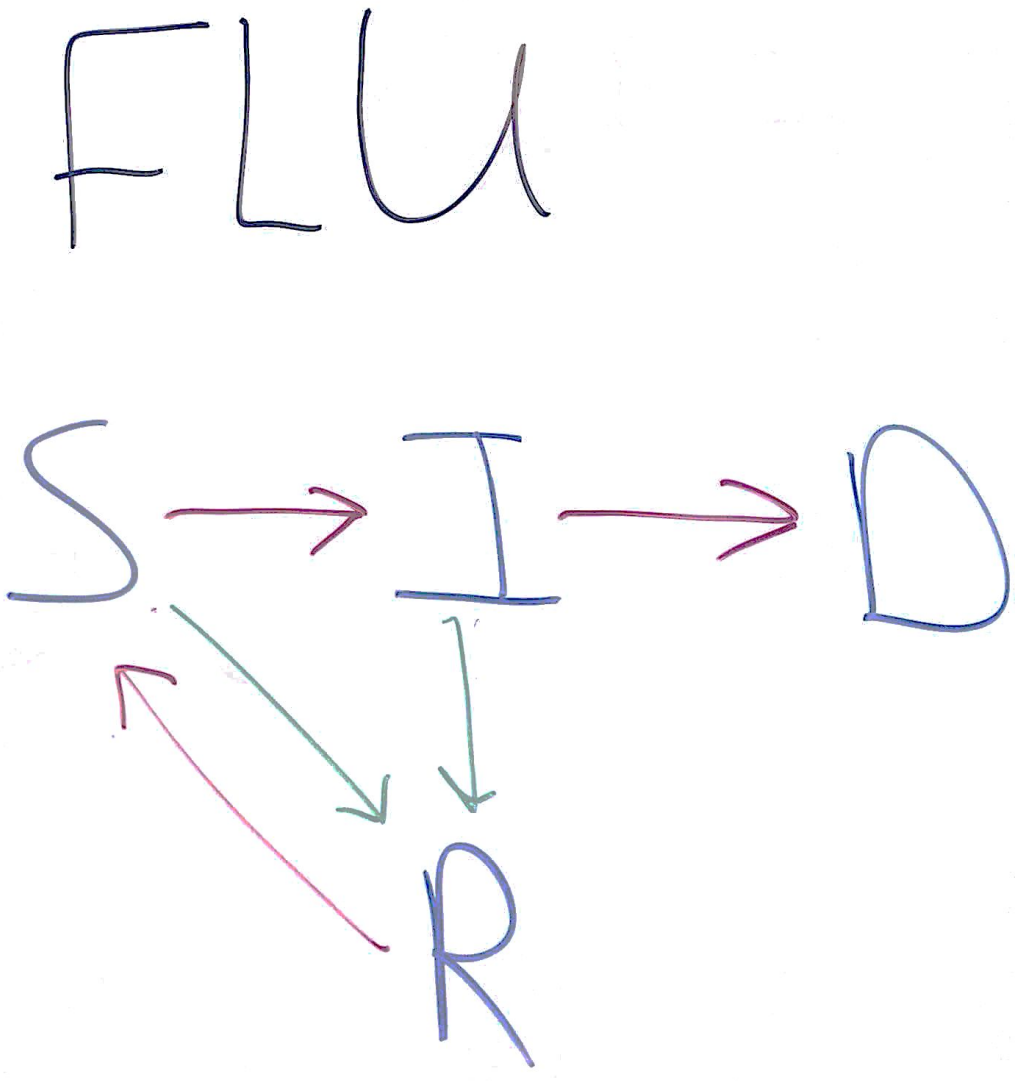


Malaria

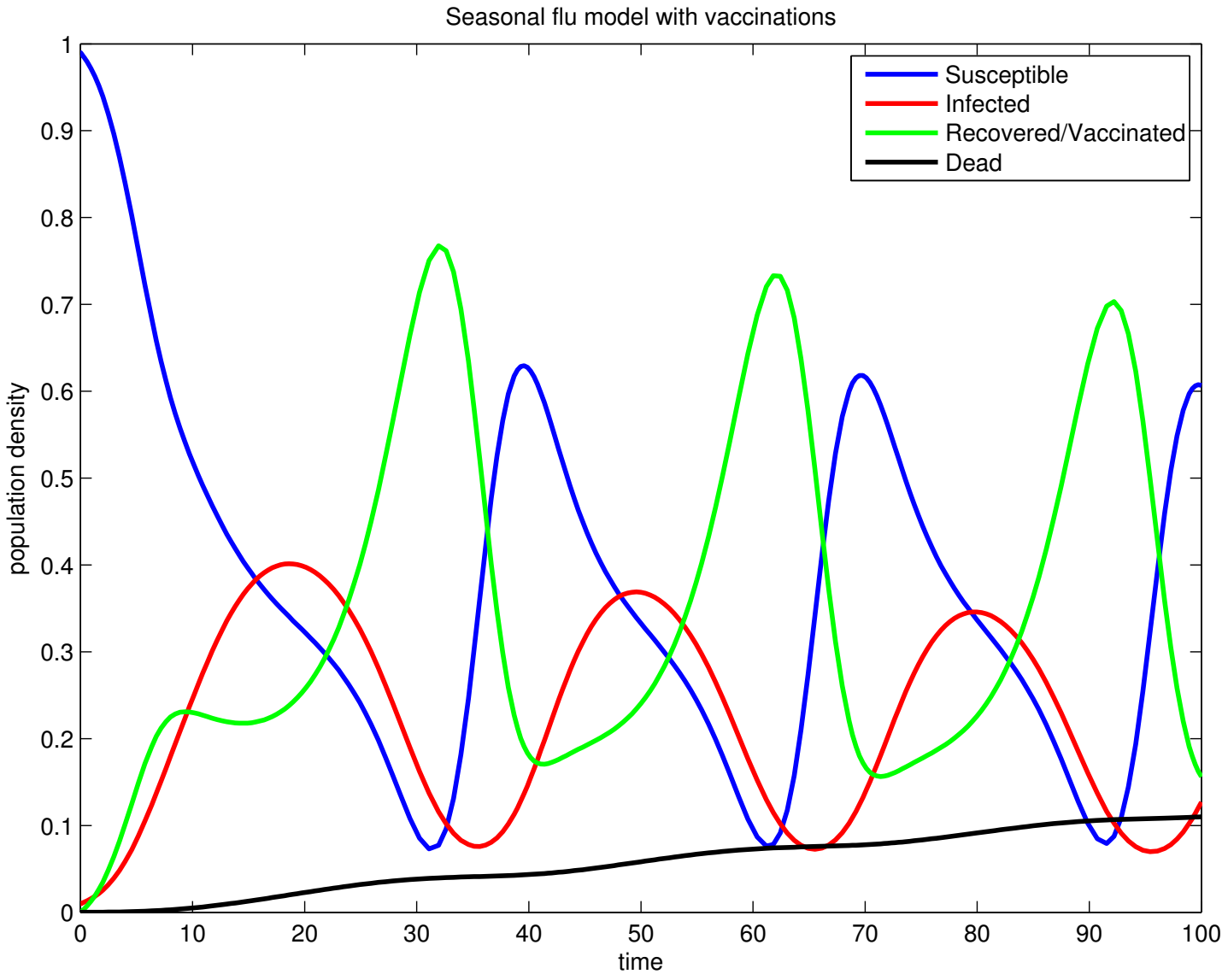

Malaria Model – Initial Vaccination Level = 0
Susceptible
Infected
Recovered
Dead
Vaccinated
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
20
40
60
80
100
t


Malaria Model – Initial Vaccination Level = 0.5
Susceptible
Infected
Recovered
Dead
Vaccinated
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
20
40
60
80
100
t

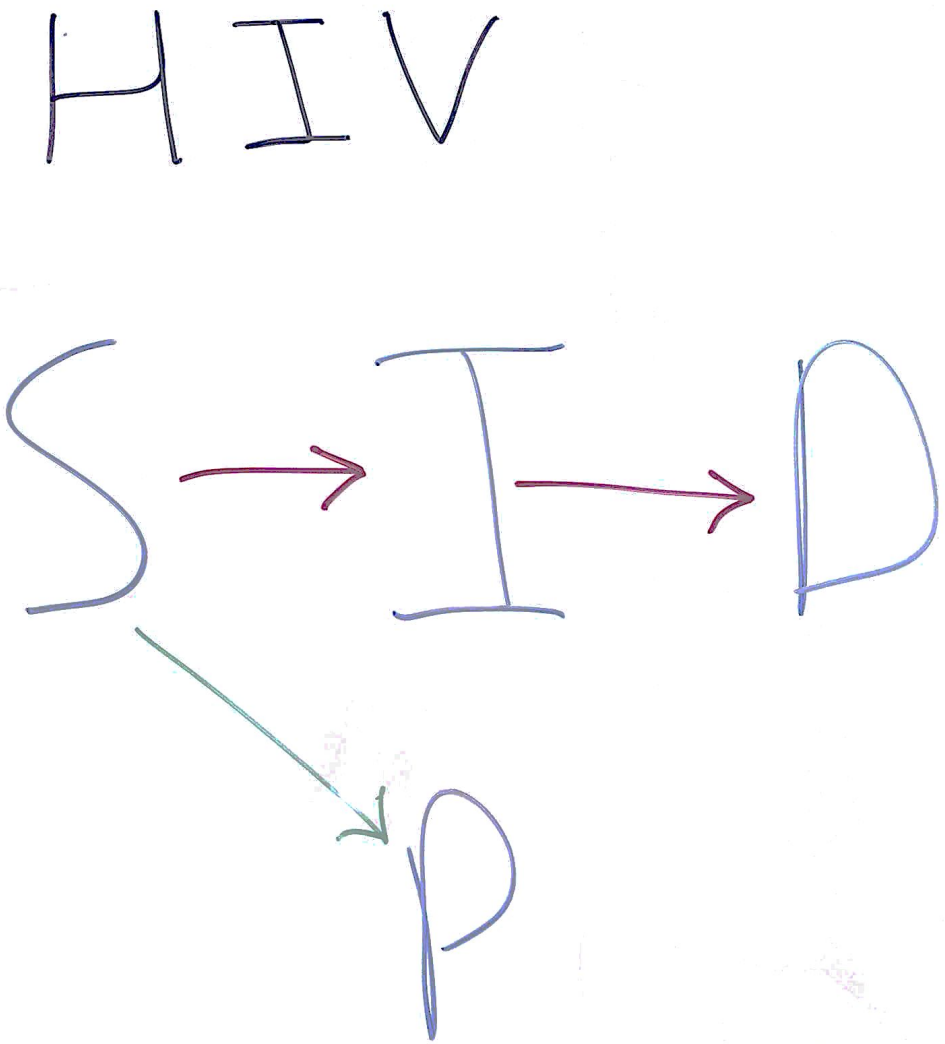
Seasonal Flu



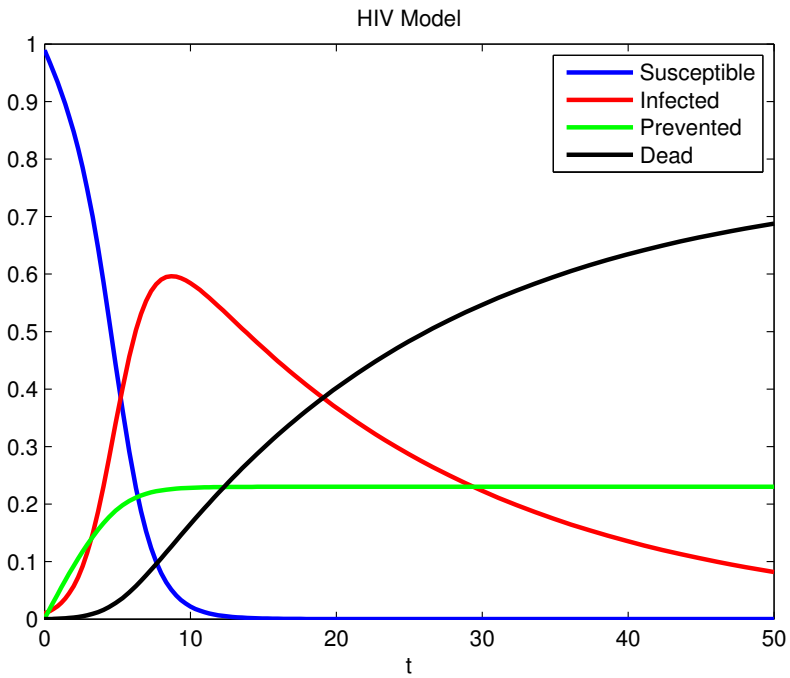
Seasonal Flu

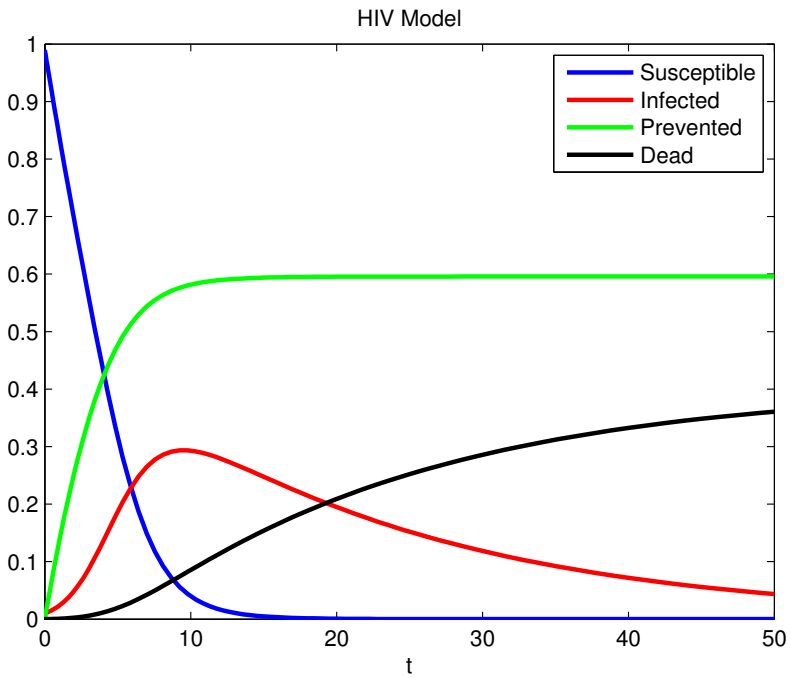


HIV



HIV


HIV Model
Susceptible
Infected
Prevented
Dead
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
10
20
30
40
50
t


HIV Model
Susceptible
Infected
Prevented
Dead
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
10
20
30
40
50
t

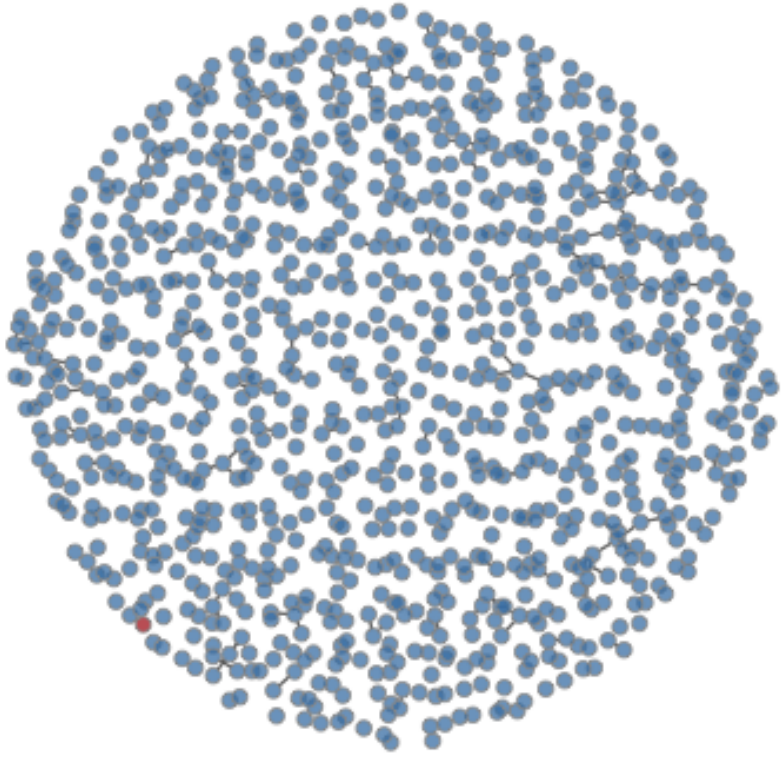
Critical Point for Vaccination Rate

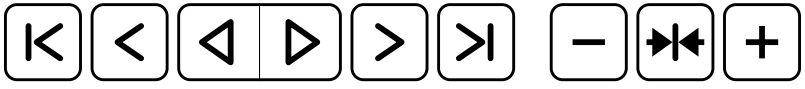
- Performed qualitative analysis
- Discovered stability for simpler models
- for SIR, an epidemic occurs if

$$\frac{\alpha}{\beta} > 1$$

- $\beta =$ Recovery rate
- $\alpha =$ Infection rate
- Vaccination rate does not affect the behaviour of an epidemic.
- Vaccination rate does affect the scale of an epidemic

Contact Network





Open Questions

- Studying more diseases
- Model using stochastic differential equations
- Develop network approach
- Perform a cost benefit analysis on various prevention methods