

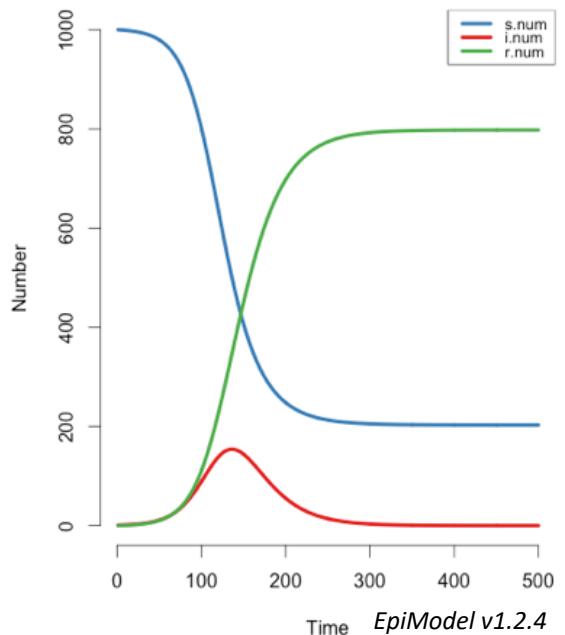


# How to Predict a Pandemic

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$$\frac{dS}{dt} = -\beta \frac{SI}{N}$$
$$\frac{dI}{dt} = \beta \frac{SI}{N} - \gamma I$$
$$\frac{dR}{dt} = \gamma I$$



# What is a disease?

## Noninfectious diseases

An illness caused by genetics,  
environmental factors, or  
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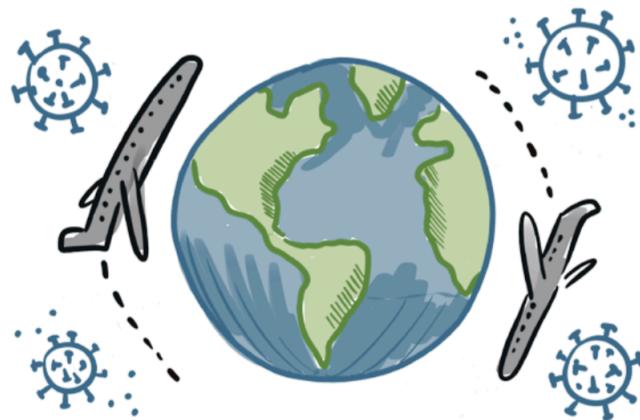


## Infectious diseases

An illness caused by a communicable (AKA contagious) pathogen that spreads through a population

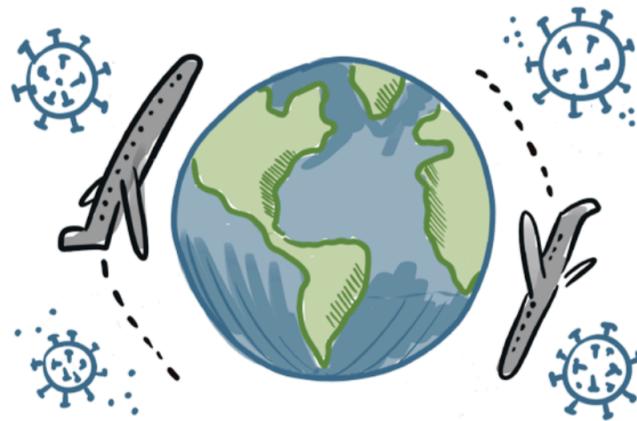


# What drives disease outbreaks and pandemics?

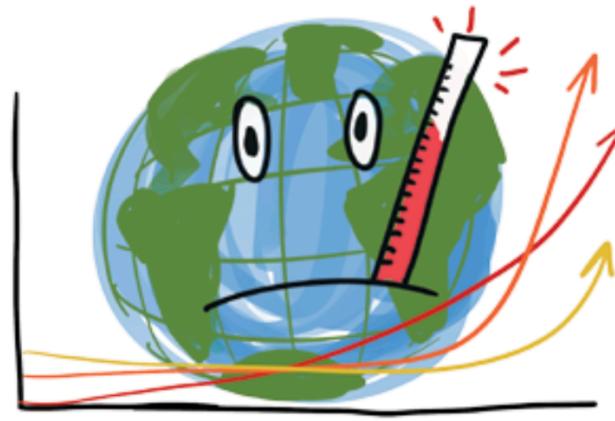


**Human movement**

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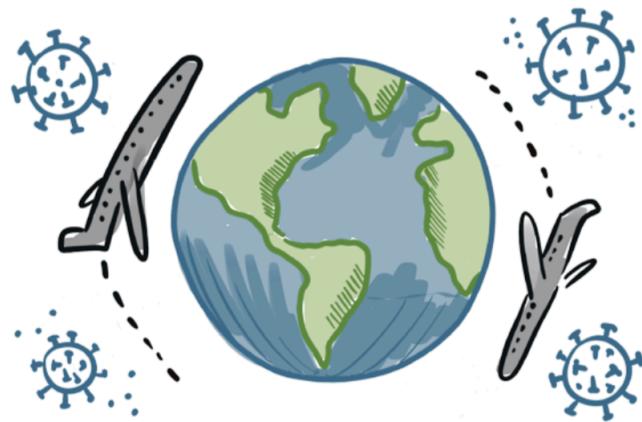


Human movement



Climate change

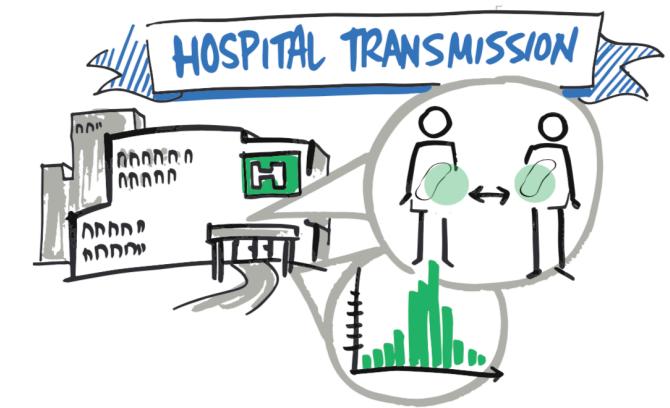
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Human movement

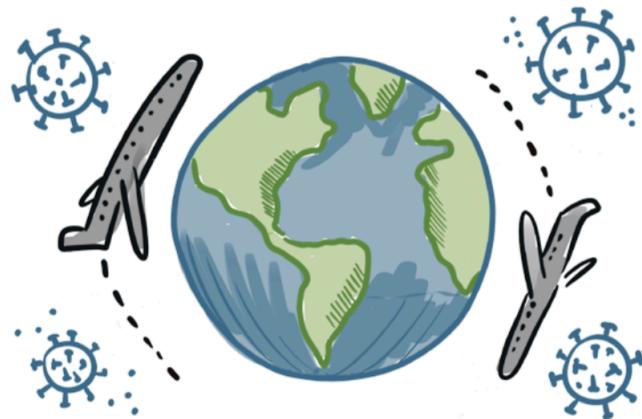


Climate change



Increased human contact

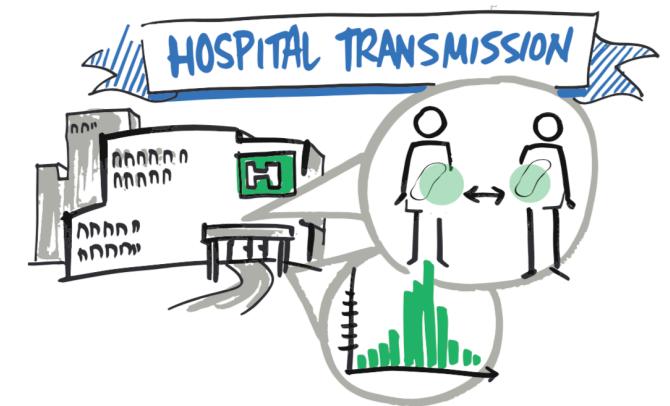
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Human movement



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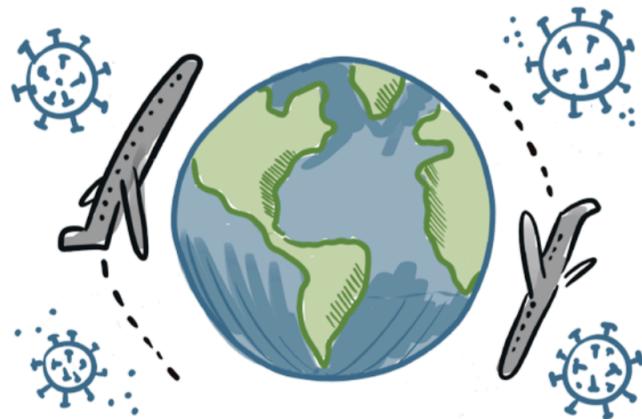


Increased human contact



Urbanization and habitat fragmentation

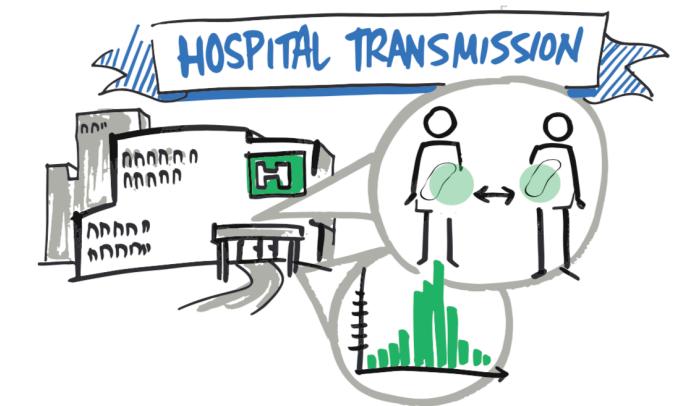
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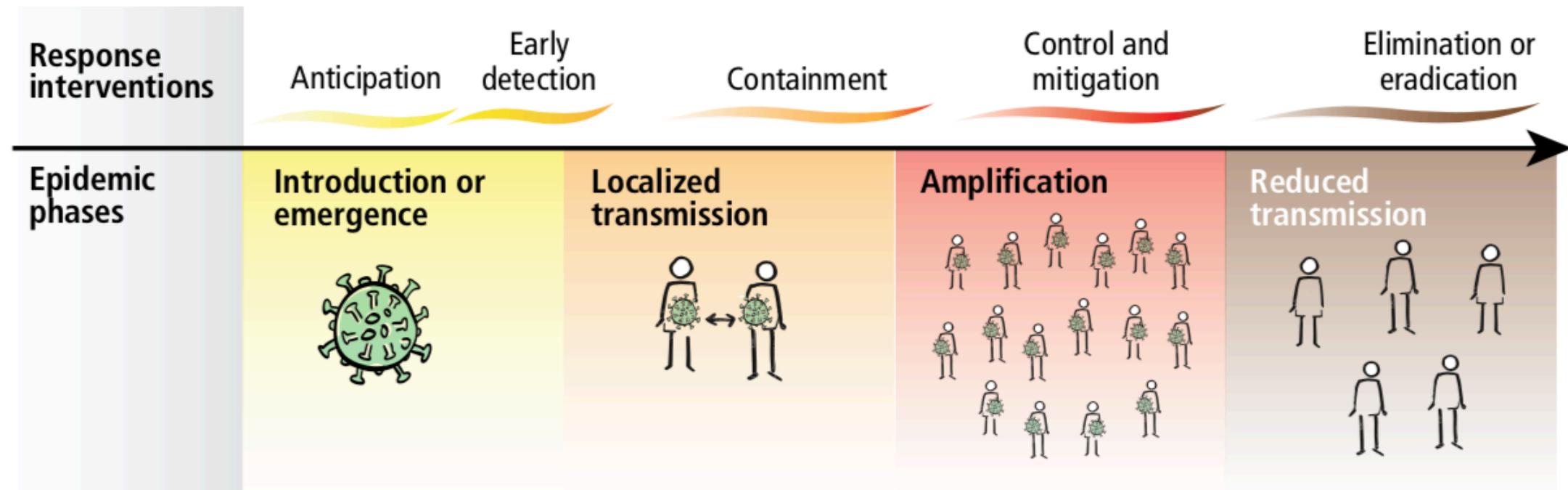


Urbanization and habitat fragmentation



Spillover from animals

### Epidemic phases and response interventions



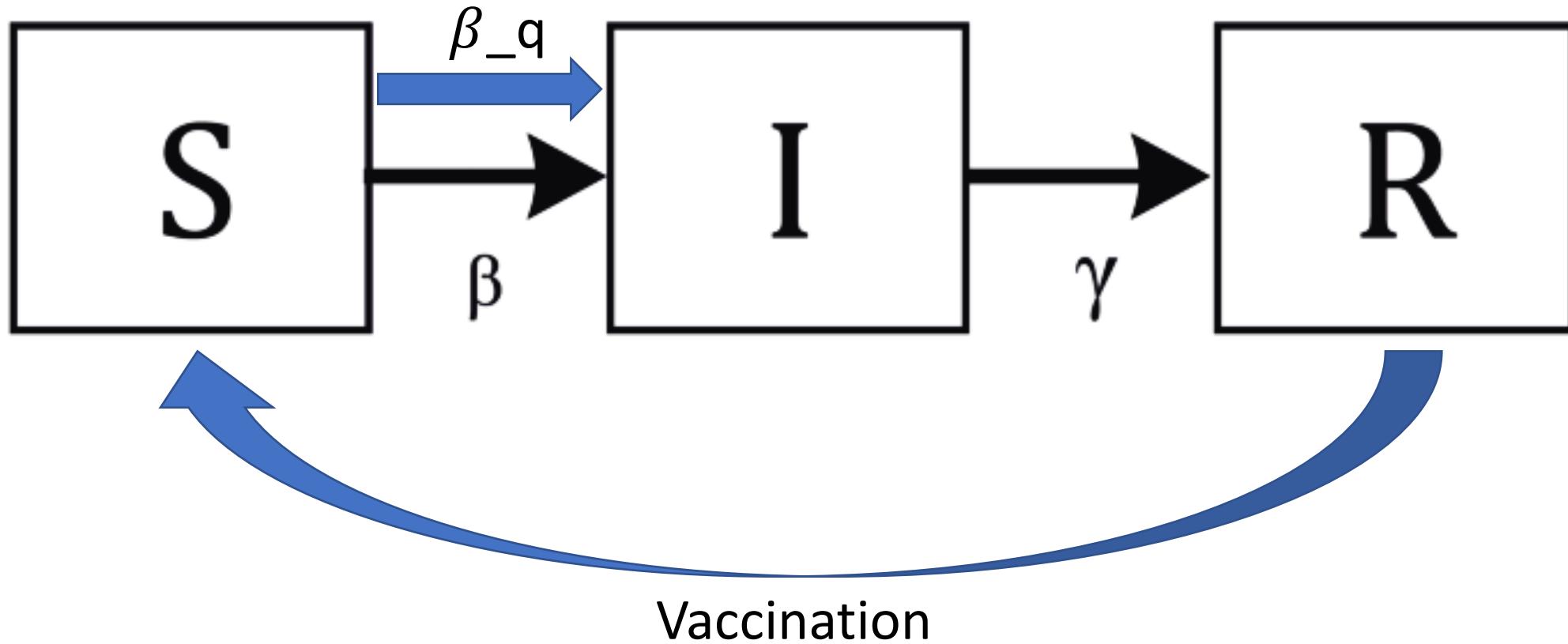
# Epidemic! The Handshake Game

This game will help demonstrate how epidemiologists utilize mathematics to describe the spread of a pathogen.

# Susceptible-Infected-Recovered Model



# Susceptible-Infected-Recovered-Quarantined-Vaccinated Model



# Discussion

- What was the best choice, vaccination or quarantine?
- What would happen if everyone chose to be vaccinated?
- Was quarantining effective? Is it always possible to quarantine?

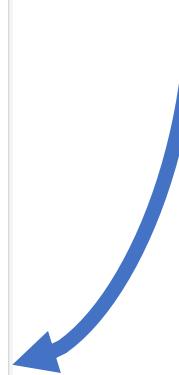
<https://www.r-project.org/>

To run code, highlight and press command-return

## Script



```
epidemic_handshake_game.R
1 #=====
2 # Epidemic! The Handshake Game
3 #=====
4
5 # Here you will have the chance to run the basic susceptible-infected-recovered
6 # model that we first discussed in the handshake game. We will also show how to
7 # plot these results so you can visualize them. If you're up for an additional
8 # challenge, you will also be able to adapt code to try out different infection
9 # scenarios.
10
11 # Lastly, we will go through how to run the susceptible-infected-recovered model
12 # with quarantine and vaccinated added into the model.
13
14 #=====
15 # Load packages
16 #=====
17
18 ## Differential equations library
19 require(deSolve)
20
21
22 #=====
23 # Basic SIR Model
24 #=====
25
26 ## Create an SIR function
27 sir <- function(time, state, params) {
28   with(as.list(c(state, params)), {
29     dS <- -beta * S * I
30     dI <- beta * S * I - gamma * I
31     dR <- gamma * I
32
33     return(list(c(dS, dI, dR)))
34   })
35 }
36
37
38 ### Set parameters
39 ## Proportion in each compartment: Susceptible 0.999999, Infected 0.000001, Recovered 0
40 init <- c(S = 1 - 1e-6, I = 1e-6, R = 0.0)
41
42
43 ## beta: infection parameter; gamma: recovery parameter
44 params <- c(beta = 1.5, gamma = 1 / 8)
45
```



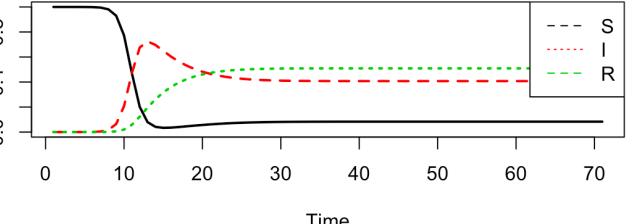
Project: (None)

Console Terminal Jobs

```
> ## beta: infection parameter; gamma: recovery parameter
> params_sirs <- c(beta = 1.5, gamma = 1 / 8, waning_immunity = 0.1)
>
> ## Time frame
> times_sirs <- seq(0, 70, by = 1)
>
> ## Solve using ode (General Solver for Ordinary Differential Equations)
> out_sirs <- ode(
+   y = init_sirs,
+   times = times_sirs,
+   func = sirs,
+   parms = params_sirs
+ )
> # SOME PLOTTING
> matplot(
+   out_sirs[, 2:4],
+   typ = 'l',
+   lwd = 2,
+   xlab = 'Time',
+   ylab = 'Proportion'
+ )
> legend('topright',
+        c('S', 'I', 'R'),
+        col = 1:3,
+        lty = 2:3)
> |
```

Files Plots Packages Help Viewer

Proportion

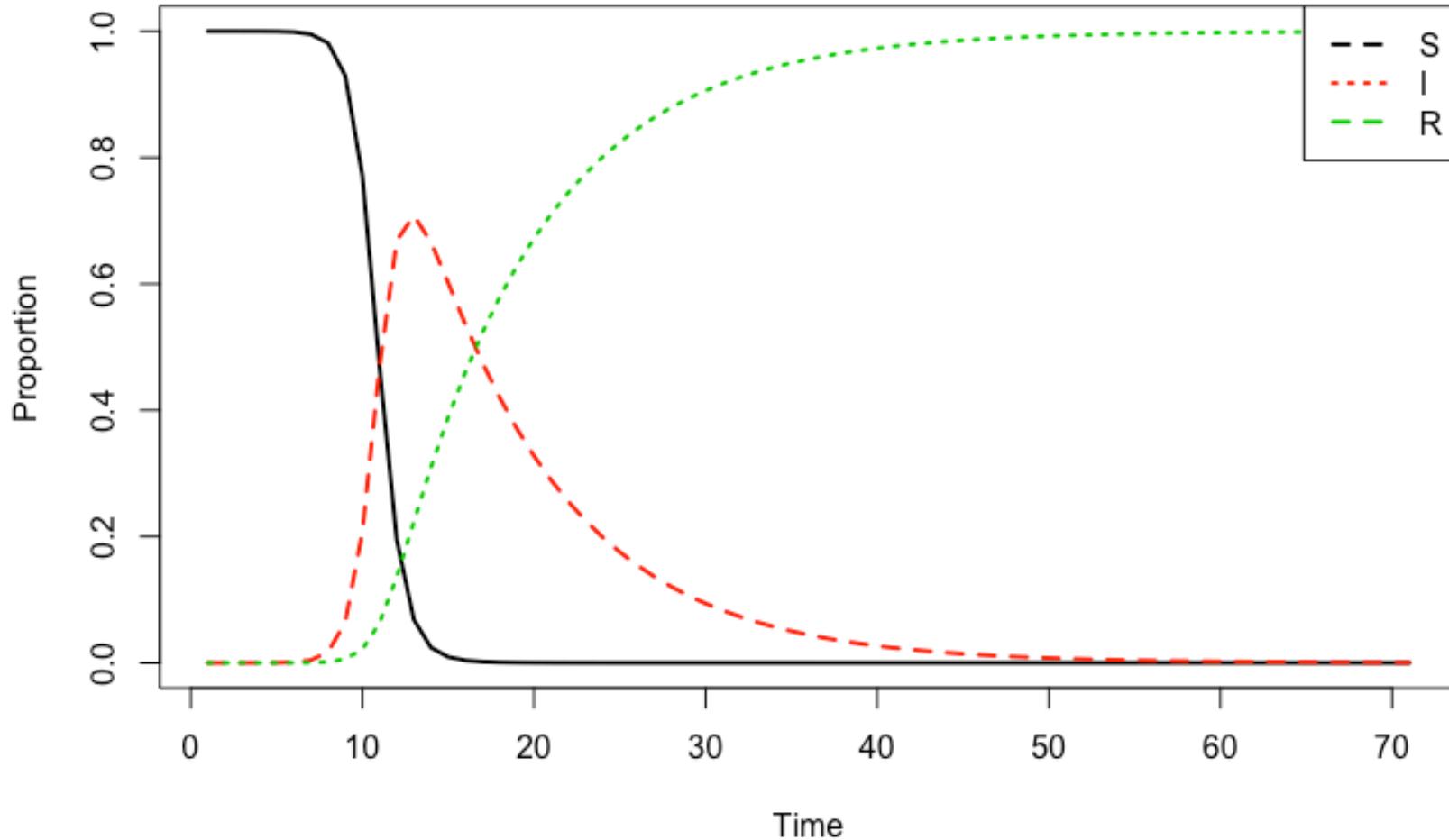


Time

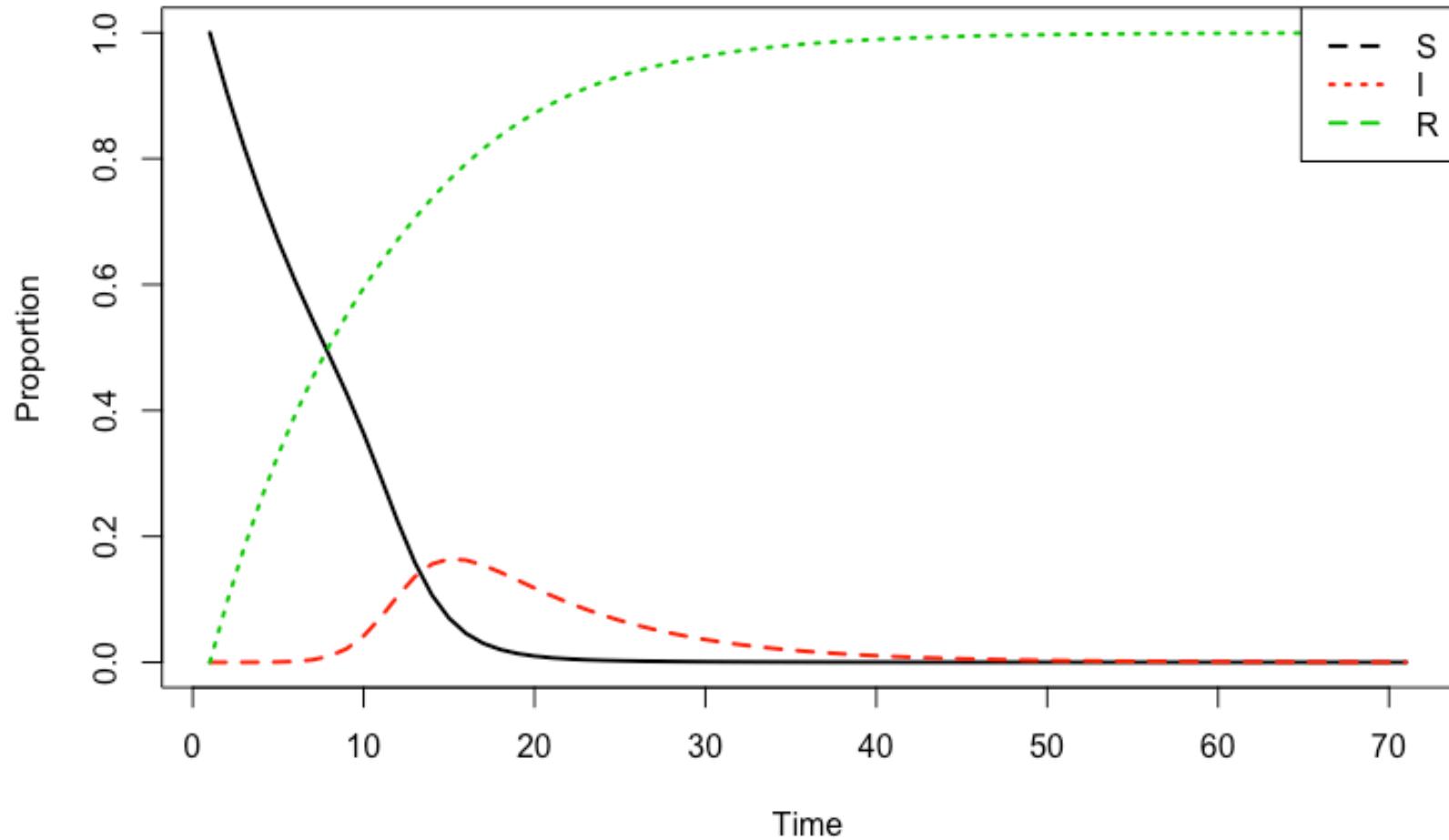
## Console

- 1) Open R app
- 2) Open file called 'epidemic\_handshake\_game.R' from R app

# SIR Results



# SIRS Results



# Our contact information



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