# Work and play: Disease spread, social behaviour and data collection in schools

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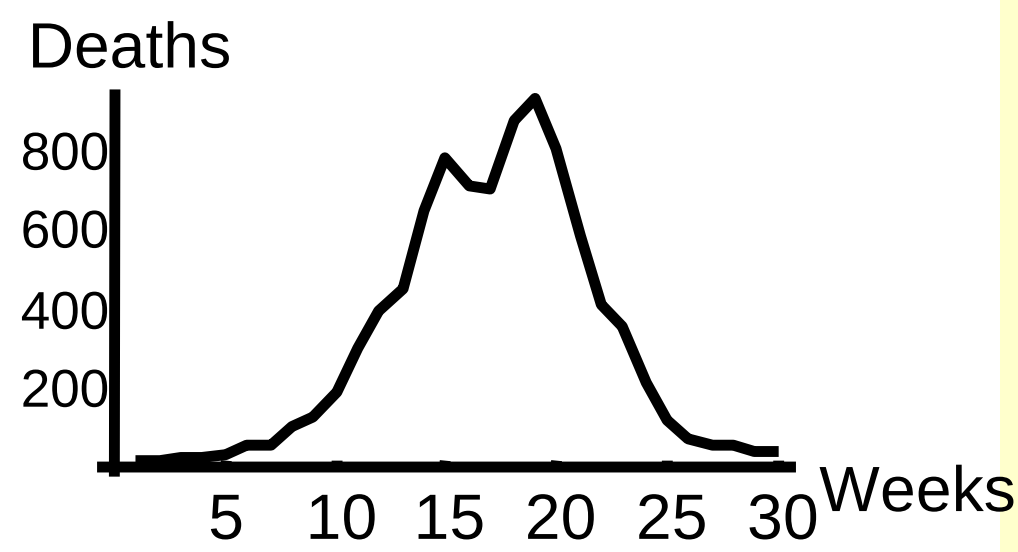
UNIVERSITY OF CAMBRIDGE

motivate videoconferences for schools

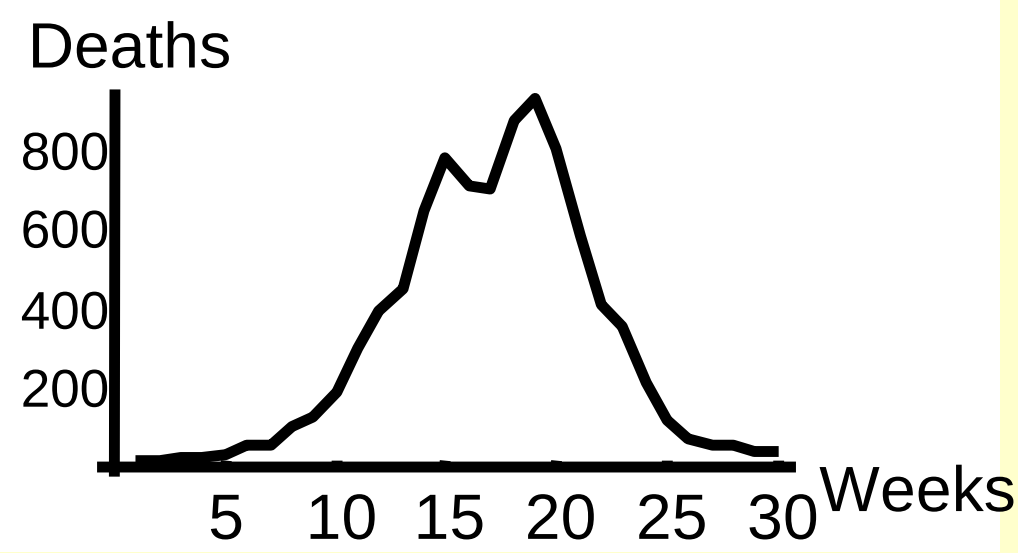
# Modelling the spread of diseases with mathematics

- Mathematicians try to find ways to model how diseases spread.
- The Standing Disease (an activity in the presentation Epidemics: Introduction) is a simple way to do this …



# Modelling the spread of diseases with mathematics

- Mathematicians try to find ways to model how diseases spread.
- The Standing Disease (an activity in the presentation Epidemics: Introduction) is a simple way to do this …
- … but it doesn't explain why after a rapid rise in infections there is a peak, and then the rate of infection starts to drop.



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What is $R_0$ for the Standing Disease?

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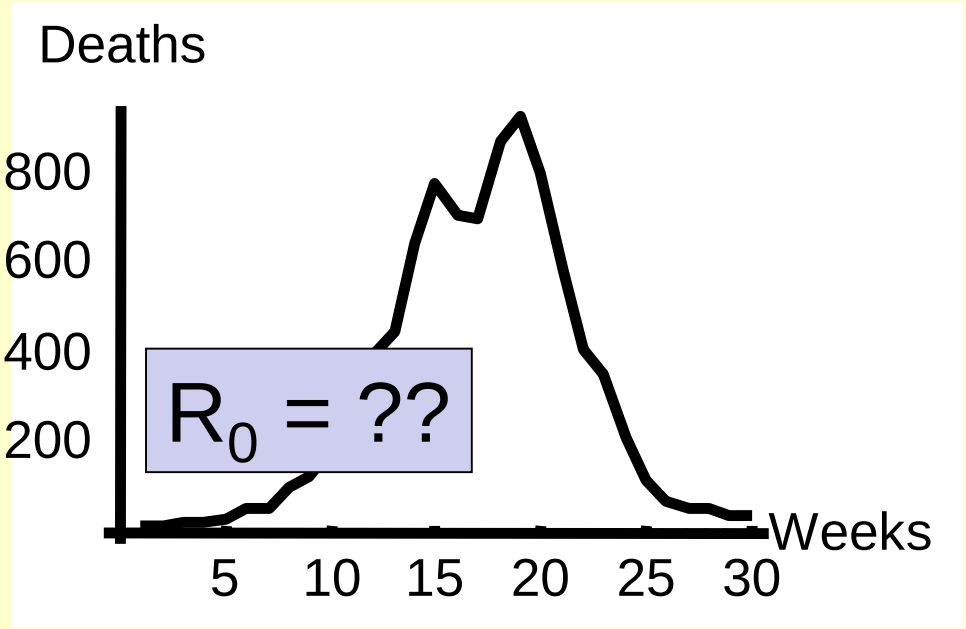

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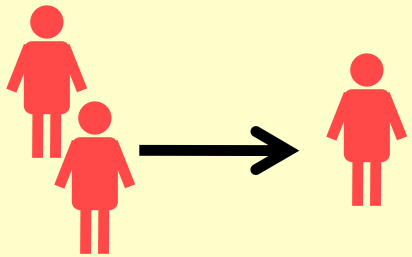

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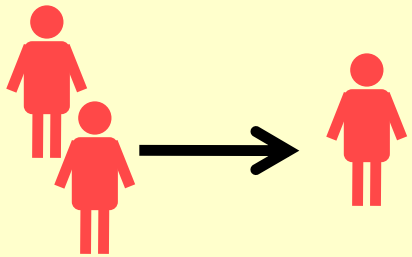

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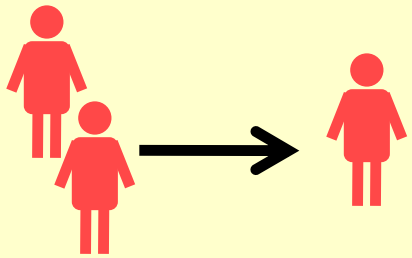

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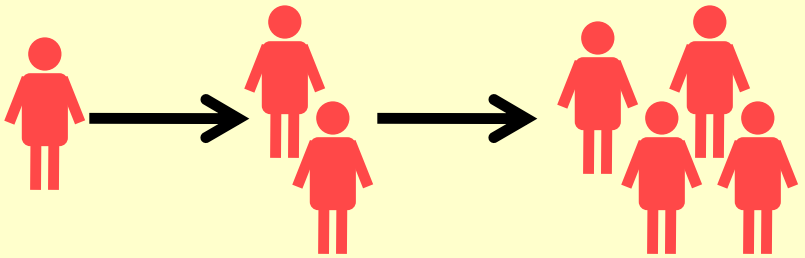
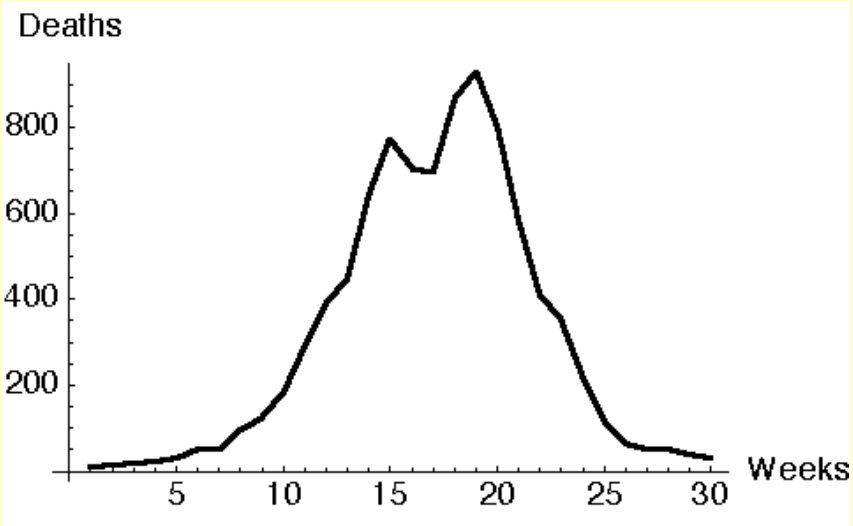


# Discussion

So we can understand the **start** of an outbreak, but what happens **next**?

- Why does the number of cases peak and then decrease?
- Is there no one left to infect?
- Has the disease changed its nature?



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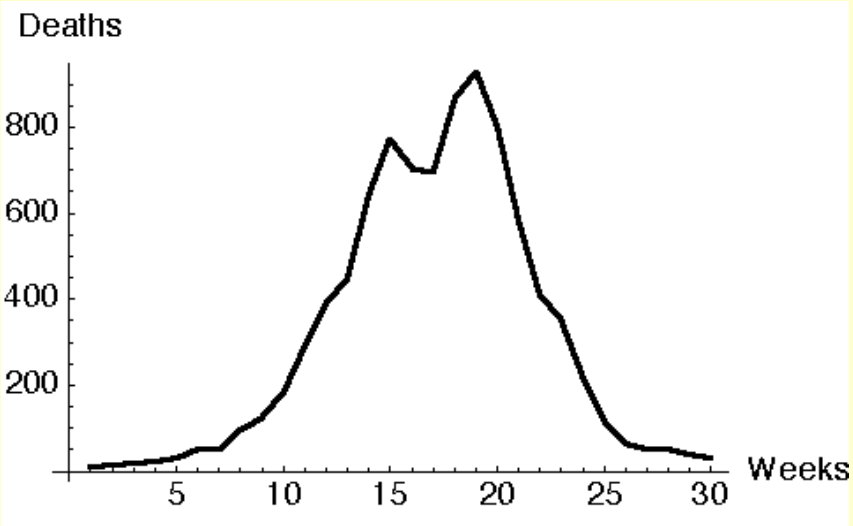
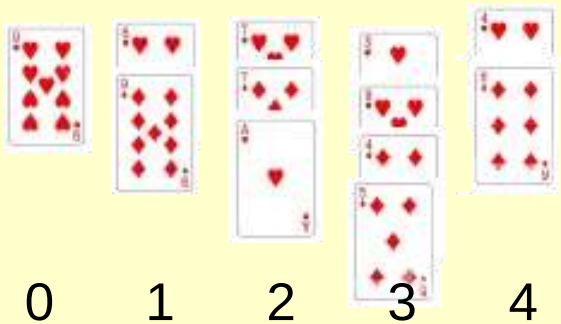
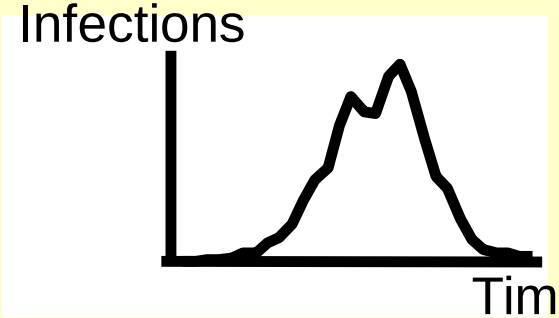



**Make a mathematical model to explore what is happening …**

# 26-Card Epidemic

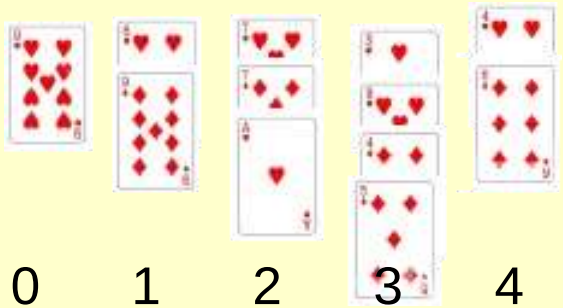
1. Put the 26 black cards down in a pile face up.
2. Put the 26 red cards in a pile face down – this is your population.
3. Pick one card from this population and put it facing up on the table – this is the first infection (step 0).
4. It will be red, so replace it with a black card – this represents that person, now recovered and back in the general population.
5. Shuffle the population cards, and put two cards face up on the table. These are the new infections (step 1).
6. Put any black cards back into the population pack – these people are now immune, so won't get the infection again. Replenish the population pack with black cards to replace the red ones you've put down.
7. Repeat items 5 and 6 until you pick only black cards. This is the end of the epidemic, when there are no new infections.
8. Plot a graph to show how many new infections there are at each step.
9. Look at the shape of your graph. Does it look at all similar to the one on the right below?



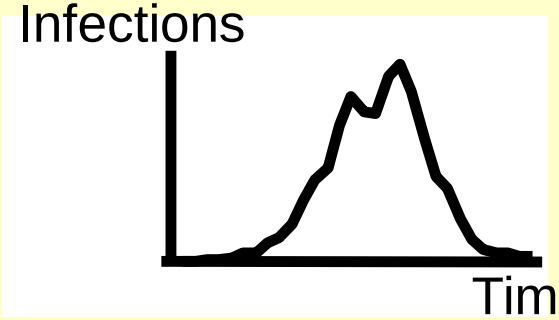



# 26-Card Epidemic

- What is the significance of keeping the population at 26?
- Any patterns?
  - initial steps
  - overall shape of graph
  - duration
  - variability
- What is the probability that no one new is infected at step 2?
- How might things change if:
  - more than one person is infected at the start
  - you have more cards
  - each infected person infects 3 or 4 people rather than 2
- Is this a realistic model?
- How could you improve it?



Step 0 1 2 3 4



# Model

Everyone starts here:
not yet infected

**Susceptible**

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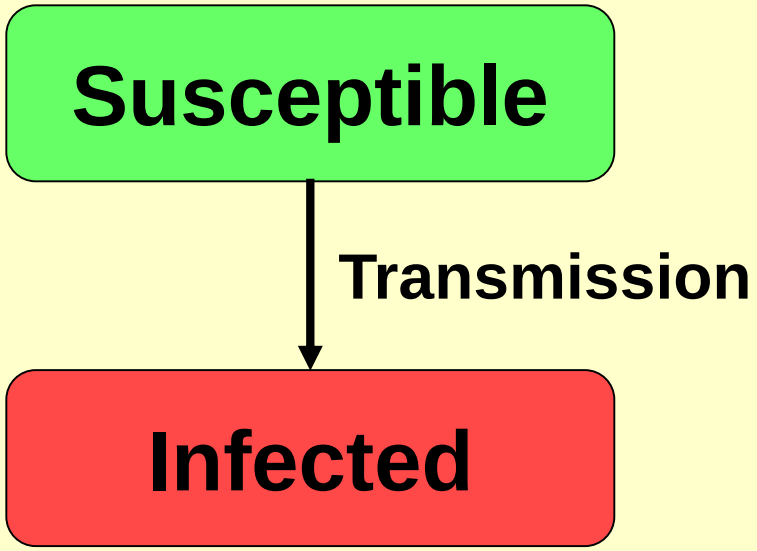


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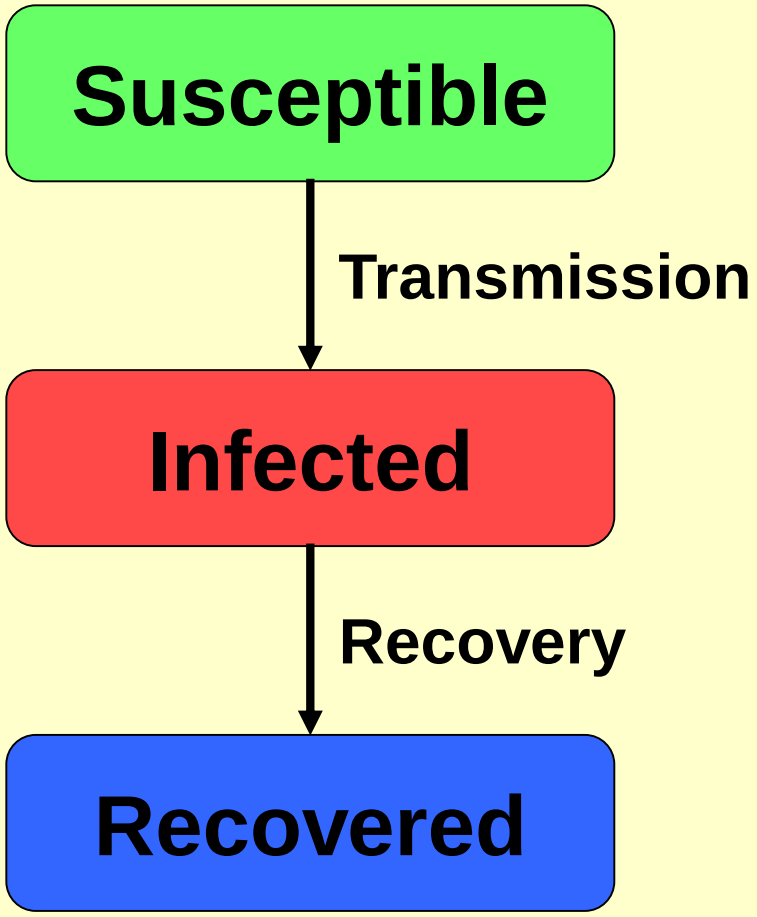


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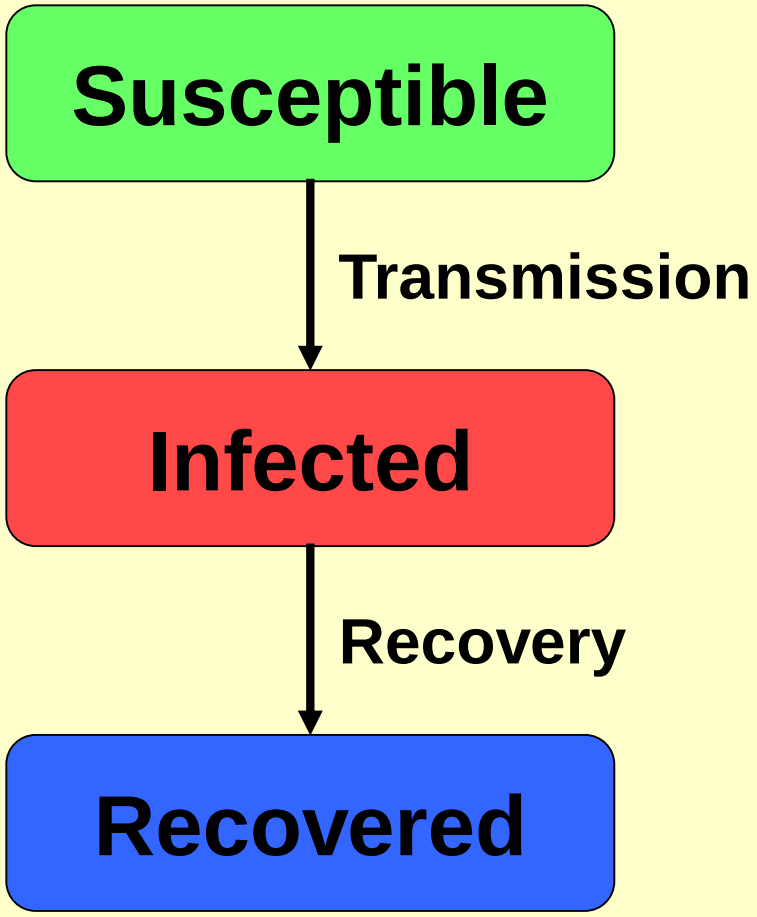


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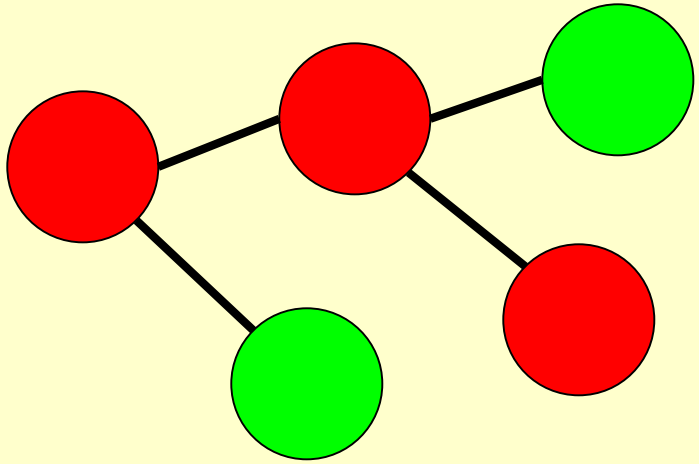
Need to make assumptions about how people mix together.

# The Network Disease



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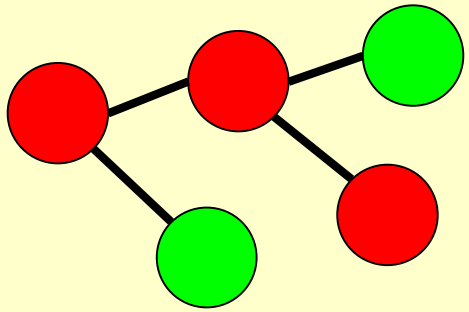
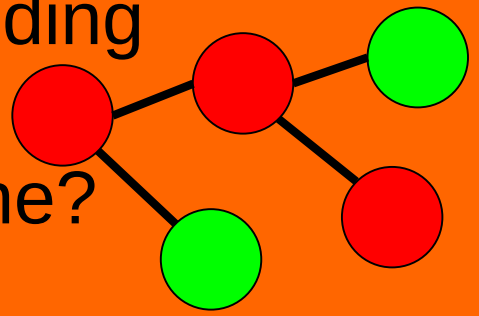


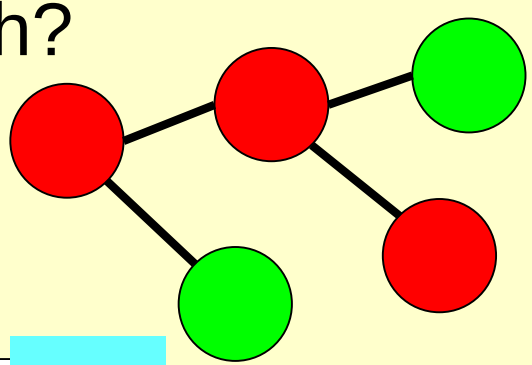
- Like the Standing Disease but:
  - before starting, everyone writes down the names of two other people in the room.
- The first case picks the two they've written down to infect.
- The next generation stands up and *each* pick their two… and so on.

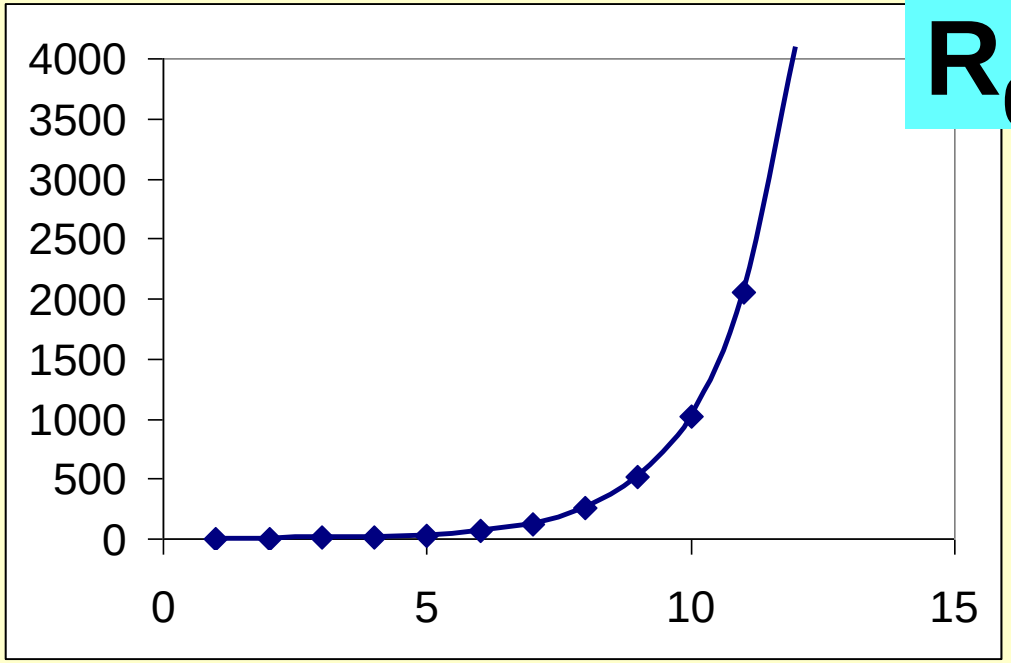
- How is this different from the standing disease?
- How many steps to infect everyone?



# Challenge the models

- Are they realistic enough?
- What else might be important?






$R_0$