Epidemics:
Modelling with mathematics

26-Card Disease

You will need (per student, pair or small group):

- a pack of playing cards (no jokers)

The activity:

- Sort your cards into 26 red and 26 black cards (the number and the suit don't matter).
- Red cards represent people who are susceptible or have the disease.
- Black cards represent people who have had the disease, or have been vaccinated against it, and are now immune.
- Put the black cards in a pile, face up.
- The red cards are your population - it must always have 26 cards in it. Hold them in your hands, so you can't see the faces of the cards.

Step 0: take the top card off the population pack, and place it face up on the table (left-hand card above). This is the first case of the infection. Put a black card into the population pack to replace the card you have just removed. This represents the infected person recovering and hence being immune.

Step 1: without looking at the population cards, shuffle them, and take the top two cards. Put them face up on the table, next to the first case of the infection (middle pair of cards above). If they are both red, they represent two new infections.

If either is black, that represents an immune person being in contact with the disease - they cannot become ill, so just put the black card back into the population pile. Replace the red cards in the population pack with the same number of cards from the black pile.

Step 2: again without looking at the population cards, shuffle them, and place on the table double the number of red cards you took out last time. Then continue as in Step 2. The photo above shows an example of the first three steps, with one black card among the four cards placed on the table at this stage.

The black card needs to be put back into the population cards, as this person is immune, and the three red cards replaced with three cards from the black pile

Step 3 and subsequent steps: as in Step 2. In the example above, 6 cards would be laid out from the population pack for Step 3.

Continue until you only pick black cards - the epidemic has ended once there are no new infections.

Record the progress of the epidemic on a graph.

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26-Card Disease as a model:

- Run several epidemics, recording them with graphs.
- How do the graphs compare?
- What does it mean for the population that we keep it at size 26?
- How realistic is this model? How does it compare with others you've investigated?

Changing the model

How would it change things if:

- the initial infection was 2 people instead of 1?
- you had more cards?
- each infected person passed on the disease to a different number of people?

How would you change the model to make it more realistic?

Extension questions

- What patterns do you see in your graphs? You might compare how variable the graphs are, what the initial stages of the epidemics look like, the overall shape of the graph, and the duration of the epidemic. You could also compare them with the graphs in Models of Epidemics - interpreting the graphs. How good is the 26-Card Disease model?
- (Hard!)

  Step 0 is the first infected person. What is the probability that the epidemic terminates at Step 1? How about at Step 2?