Lab exercises

Set-up instructions

- Copy and paste these lines into your Console, then hit "Enter":

```
install.packages("shiny")
install.packages("EpiModel")
EpiModel::epiweb("dcm")
```

- Under "Disease Type", select "SIR"

- Leave all parameter values as they are, but spend a few minutes to make sure you understand what each parameter is. "Act rate" is what we've called the "contact rate".

Lab part 1:

1. Adjust the parameters so that you get a *beta* value of 0.13. At day 50, how many people are in each compartment (S, I, and R)? Are these numbers logical?

632, 369, 0

2. Now change the recovery rate to 0.04 while leaving all the other parameters the same. What are the number of people in each compartment at day 50? (hint: summary tab, set "Time Step" to 50) What is the R_0 for this system? How many total people were infected by the end of the time period (day 500)?

897, 70, 33
3.25
956

3. How many people would have to be vaccinated at the start of this simulation in order for the disease to never take hold - i.e. for each person to infected less than 1 other person. Hint, two classes ago you were given the formula that the *effective* reproductive number (R) can be determined by: R = R0 – (p • R0), where p = the proportion immune.

Solving for p gives us p = 0.69, so 69% of the total population (N) need to be immunized. In a SIR model, this would have th effect of putting 69% of N into the R group at the beginning of the simulation.

4. Simulate a situation where there are enough vaccinated individuals. How many total people were infected during the course of the simulation? Why is this number not 0 if we have indeed achieved herd immunity (hard question)?

16 people. It's not 0 because the program does not "know" that people are indivisible. In other words, we have not specified in this program how to deal with fractions of people, and this becomes important when operating with low infection counts.

5. If you had to advise a policy maker purchasing vaccines based on this model - how many vaccines would you recommend they buy? Remember, for every vaccine purchased, that's less money that could be used elsewhere in the healthcare system. What variables do you consider (including variables we have not mentioned so far in the lab)

No correct answer. Just keep in mind the uncertainty of the input parameters will affect any quantitative result. We have not accounted for any uncertainty, so it is difficult to give a specific number of vaccines based on this model.
Some example considerations include: vaccine cost, efficacy of the vaccine, severity of outcomes associated with the disease, frequency and severity of vaccine side effects, many more....

Lab Part 2

6. *Together as a class* First, let's get comfortable with the Poisson distribution. Go to your RStudio window and the "Console" section. Type in `rpois(1, 0.13*1000*(1/1001)`. This simulates 1 "draw" from a poisson distribution. Now try again but with `hist(rpois(10000, 0.13*1000*(1/1001)))`. This gives a histogram of 10,000 "draws".

7. Run `EpiModel::epiweb("icm")`, set the number of simulations to 1. Set up the model for question 2 and run the simulation at least 5 times. What do you notice?

The results vary, sometimes by over 100 ppl

8. Estimate the probability of an outbreak occurring by running this model 10 times.

Results will vary - I saw an outbreak in 80% of the simulations when I ran it 10 times.

9. Answer question 4 using this stochastic model - how do the results compare, why is this?

Results will vary, but most the the time you will see fewer total infections than we saw with the mechanistic model. For example, I see 304, 0, 697 in each compartment at day 500.

10. Based on your findings from question 8, how would you respond to a hospital manager that wants to know if we should prepare for an outbreak or not?

Need to consider:

- How severe the outcomes are. If it's a mild disease, risk of no preparation is different than if it's a disease like Ebola.
- How expensive preparations are - what would the money be used for otherwise.
- What the confidence interval is on our predictions - this will be depend on how confident we are in our parameter values, and how the system responds in a sensitivity analysis.