CS:4980 Computational Epidemiology, Spring 2020

Reading Response 2, Due in class on Thu, Feb 20

Notes: (a) Your submissions will be evaluated for correctness *and* clarity. Correctness is of course crucial, but how clearly you communicate your ideas is also quite important. Organize your thoughts first, write in full sentences, avoid grammatical and spelling errors, and follow standard rules of style for technical writing. (b) Unless you have a documented accommodation, no late submissions are permitted. You will receive no points for your submission if your submission is not turned in at the beginning of class on the due date.

These questions are based on the posted reading "Nowcasting and forecasting the potential domestic and international spread of the 2019-nCoV outbreak originating in Wuhan, China: a modelling study", by Wu, Leung, and Leung, *The Lancet*, Jan 31 2020.

1. On Page 4, the paper describes the equations of an SEIR model. You may recall that the SEIR model is a close relative of the SIR model in which, in addition to the compartments S, I, and R, there is an *Exposed* compartment in which an individual is infected, but not yet infectious. Earlier (on the bottom of Page 3 and top of Page 4) the authors discuss data they obtain on travel to and from Wuhan. In the compartmental models we discussed in class, there was no notion of travel from location to location. Explain how the authors incorporate the notion of travel into their compartmental SEIR model.

2. Let me restate the equation for the susceptible compartment on Page 4 in slightly more familiar language:

$$\mathbb{E}[S(t+1)] = S(t) - \frac{S(t)}{N}\left(\frac{R_0}{D_I}I(t) + z(t)\right) + L_{I,W} + L_{C,W}(t) - \left(\frac{L_{W,I}}{N} + \frac{L_{W,C}(t)}{N}\right)S(t).$$

   Now let us try to make sense of this equation by considering the different terms in the righthand side of this equation.

   (a) After slight readjustment, the first term is

   $$-S(t)\cdot\frac{R_0}{D_I}\cdot\frac{I(t)}{N}.$$

   Since this is a negative term it represents people leaving the S compartment. Explain this term. Remember that in the SIR model $R_0 = \beta/\gamma$. Also recall that $1/\gamma$ is the mean infected period in the SIR model.

   (b) After slight readjustment, the second term (also negative) is

   $$-S(t)\cdot\frac{z(t)}{N}.$$

   Here $z(t)$ denotes the *zoonotic force of infection* at time t. As you know from your previous reading, "zoonotic" refers to the spread of pathogen from animals to humans. Based on this explanation and the mathematical form of the above term, explain this term.

   (c) The next two terms $L_{I,W}$ and $L_{C,W}(t)$ are positive and so they represent people entering the S compartment. Explain these terms. While you are at it, also explain why $L_{C,W}(t)$ is a function of t, but $L_{I,W}$ is not.

   (d) The last two terms are negative. Explain these two terms and also make sure to explain why they seem to differ in form from the two positive terms in (c).
