**CBS 810 Infectious disease modeling**

**Assignment 4**

Instructions:

* This assignment is due on Friday Nov 6th 2015.
* Please submit your work by email ([schen31@ncsu.edu](mailto:clanzas@utk.edu)).

Estimate the basic reproduction number of the following model using the next generation matrix. Show all the steps and provide an interpretation for the elements of the next generation matrix *G* and the basic reproduction number.

The model has four compartments: Susceptible, Infectious, Carrier, and Recovered. Susceptible individuals can be infected by either infectious individuals or carriers.



Estimating R0 using the next generation matrix

Step 1: Identify the classes that have gains or losses of infectors

* The infectious and carrier classes, both contribute to transmission.

Step 2: Calculate the full disease-free equilibrium

* I, C, and R = 0, so S = N
* X0 = {S\* = , I\* = 0, C\* = 0, R\* = 0}

Step 3: List the gain and loss terms for each class (gains = increase of infectors)

* Gains in I:
* Gains in C: 0
* Losses in I:
* Losses in C:
  + The net loss to C is the losses minus the gains of that class, with the gains a function of the probability (or rate) at which the infectious enter the carrier vs. recovered class (the term).

Step 4: Create a matrix of gain terms for each class and evaluate at the disease-free equilibrium

Step 5: Create a matrix of loss terms for each class and evaluate at the disease-free equilibrium

Step 6: Invert matrix V to get V-1

Step 7: Evaluate matrix G = FV-1

* The elements of G are the rates of transition between classes. Assigning to correspond with the above matrix locations, *a* is the transition from susceptible to infectious, *b* is the loss of infectious, *c* is the transition rate from carriers to infectious, and *d* is the loss of carriers.

Step 8: Find R0 as the dominant eigenvalue of G

Since D = 0 the dominant eigenvalue of matrix G is T, which is therefore R0 (the expected average number of new infections caused by a single initially infected individual introduced into a completely susceptible population during that individual’s infectious period, i.e. when disease transmission can happen).