



Complex Networks

Homework 4

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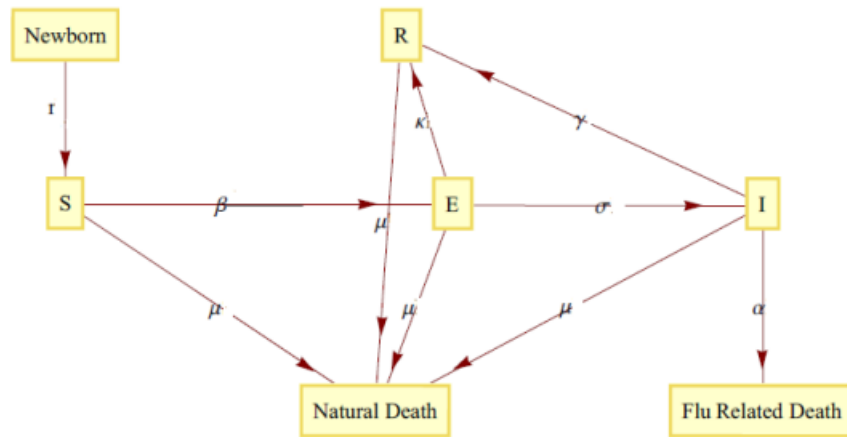
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1 Exercise 1

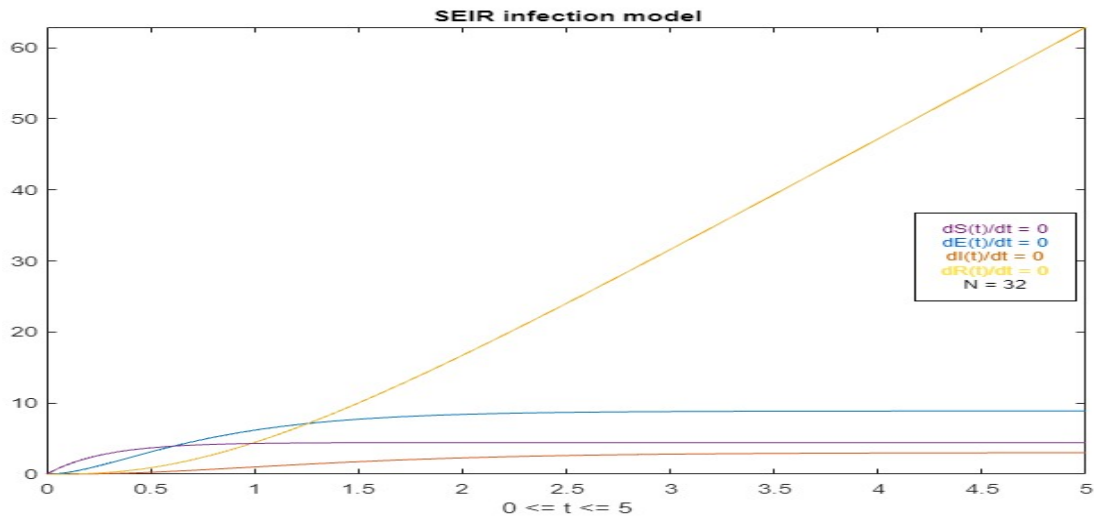
1.1 SEIR infection model Graph

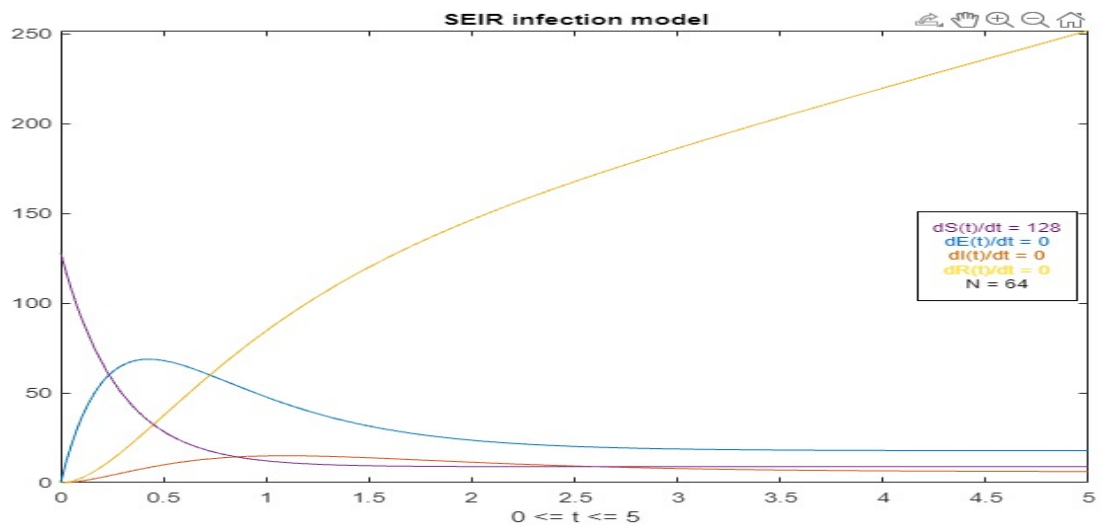
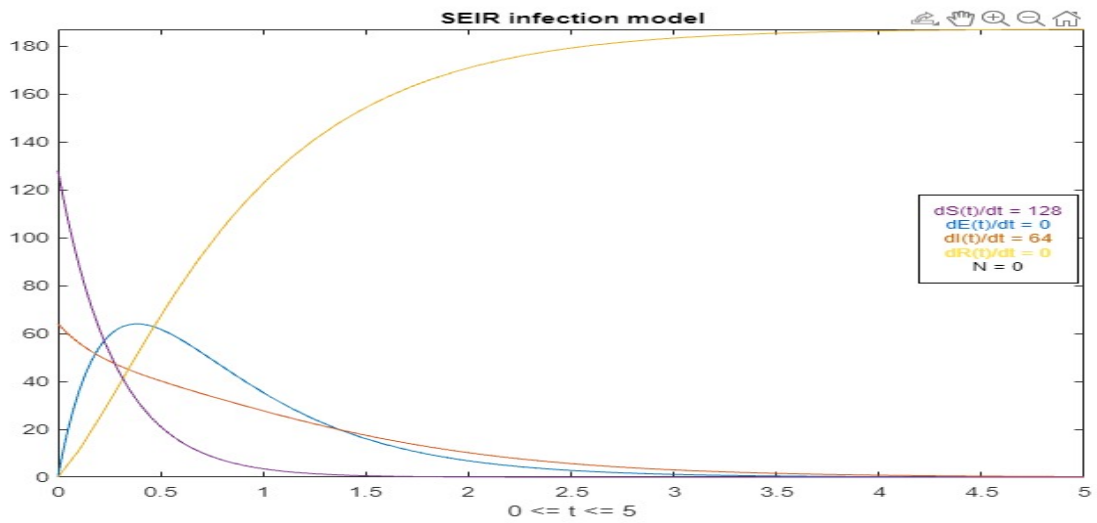
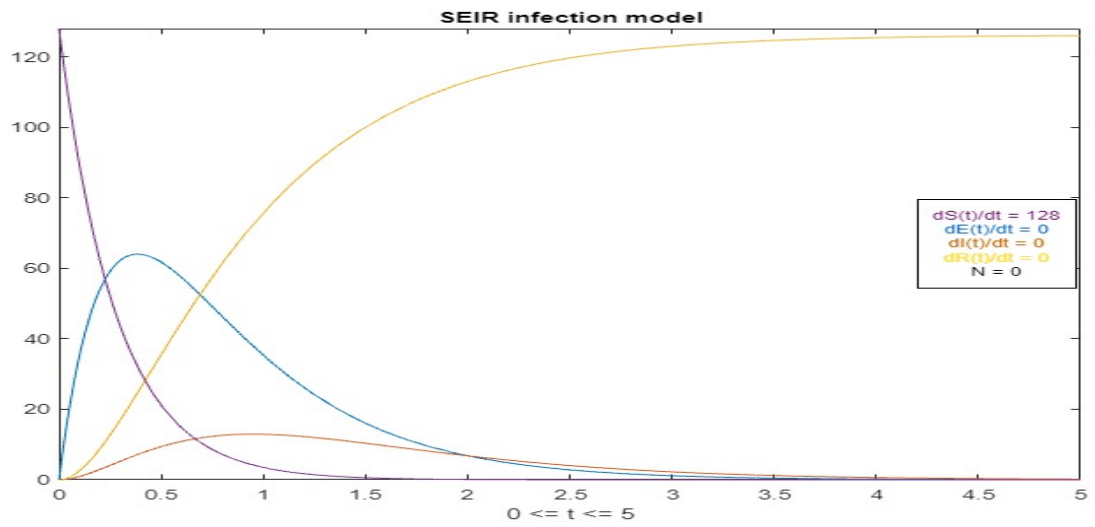


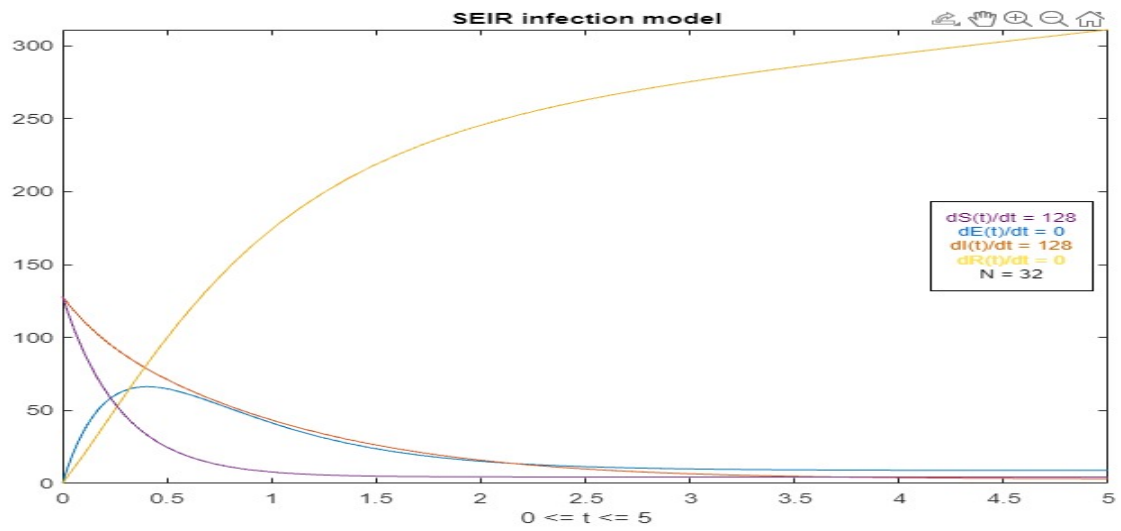
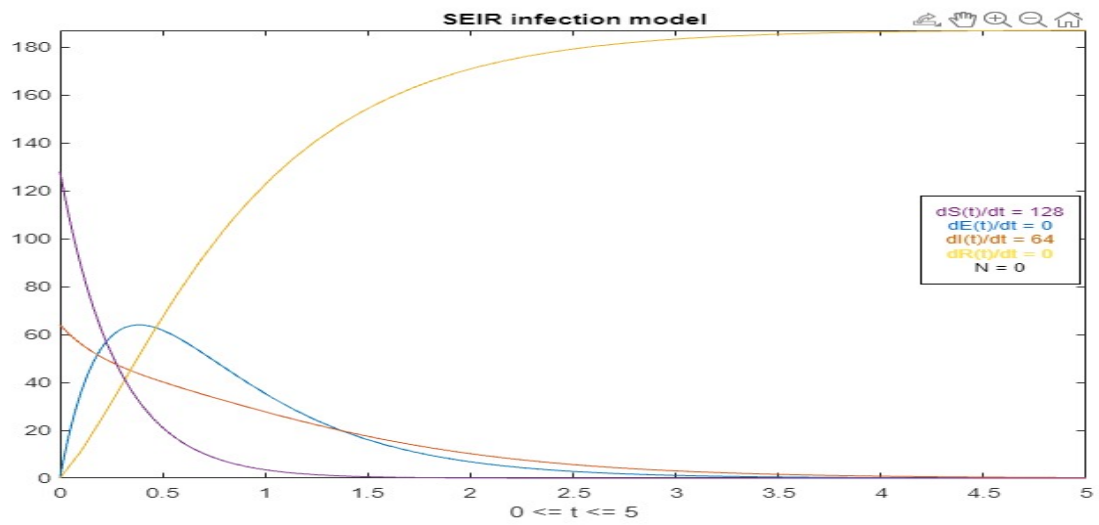
1.2 Differential Equations

$$\begin{aligned}\frac{dS(t)}{dt} &= rN - (\beta + \mu)S(t) \\ \frac{dE(t)}{dt} &= \beta S(t) - (\mu + \sigma + \kappa)E(t) \\ \frac{dI(t)}{dt} &= \sigma E(t) - (\gamma + \mu + \alpha)I(t) \\ \frac{dR(t)}{dt} &= \gamma I(t) + \kappa E(t) - \mu R(t)\end{aligned}$$

1.3 Experimental Results



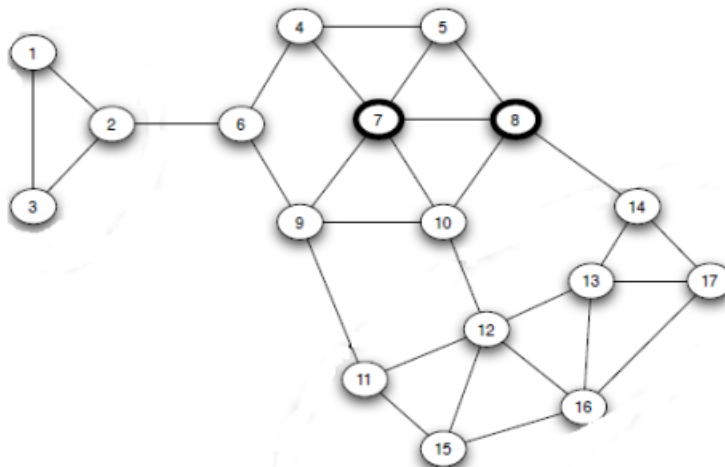




2 Exercise 2

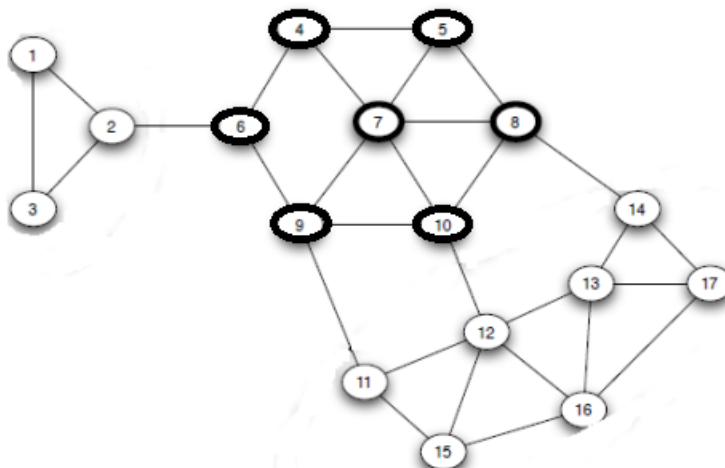
2.1 Pronunciation of Exercise

Consider the LT (Linear Threshold) diffusion model on the following network, and assume that each node starts in state B (uninfected) and that each node has the same threshold $q = 1/2$ to go to state A (infected).



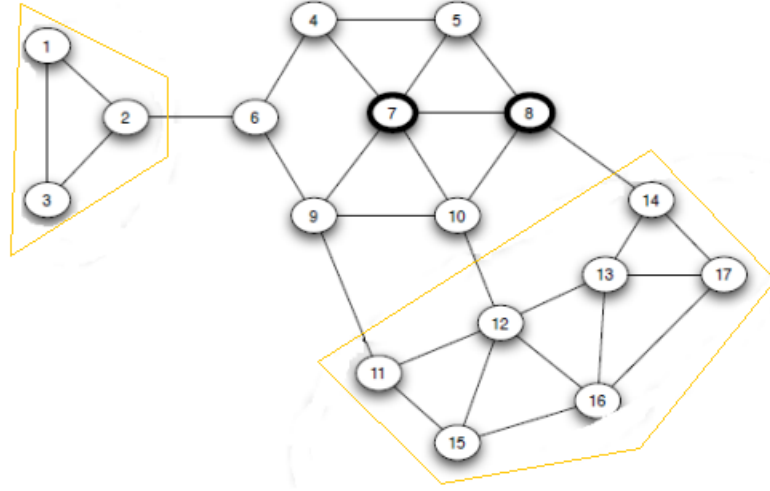
2.2 Answer to Question 1

Since nodes 7 and 8 are infected, they will initially infect 5 and 10 nodes because the links they have are 2 in 3 infected $> q$ ($1/2$). Then 4 and 9 nodes will be infected, 4 because it has 2/3 infected links while 9 has 2/4 which are \geq from q , so they are also infected. Finally 6 is also infected after $2/3 > q$. No one else is infected since they did not exceed q .



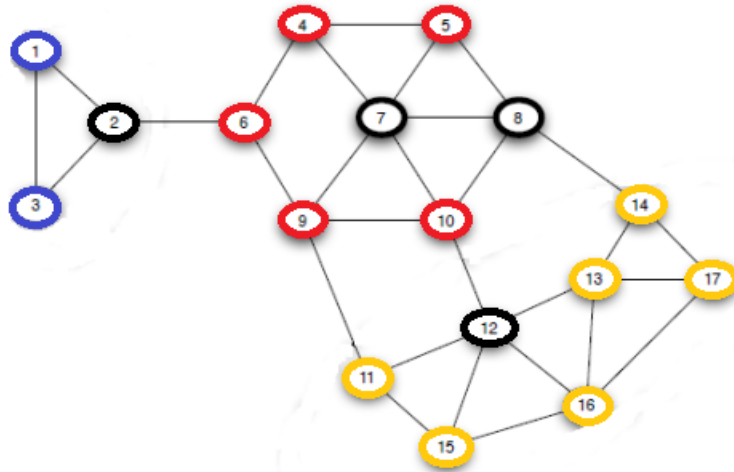
2.3 Answer to Question 2

The clusters that have q greater than $1/2$ are the ones shown in the yellow area, cluster A (1, 2, 3) and cluster B (11, 12, 13, 14, 15, 16, 17). Because for A the only contact with the rest of the graph is at node 2 which has a threshold greater than $1/2$, while for B it is nodes 11, 12 and 14.



2.4 Answer to Question 3

In order to infect the whole graph, nodes from clusters A and B must be added to the set S , otherwise there will be no total infection. From cluster A whichever node we add we will have the same result, so we add 2, infecting the blue nodes. Similar for cluster B, with threshold $2/5$ we get the same result. Selecting node 12, infecting the yellow nodes. And finally the initial nodes 7 and 8 infect the red nodes.

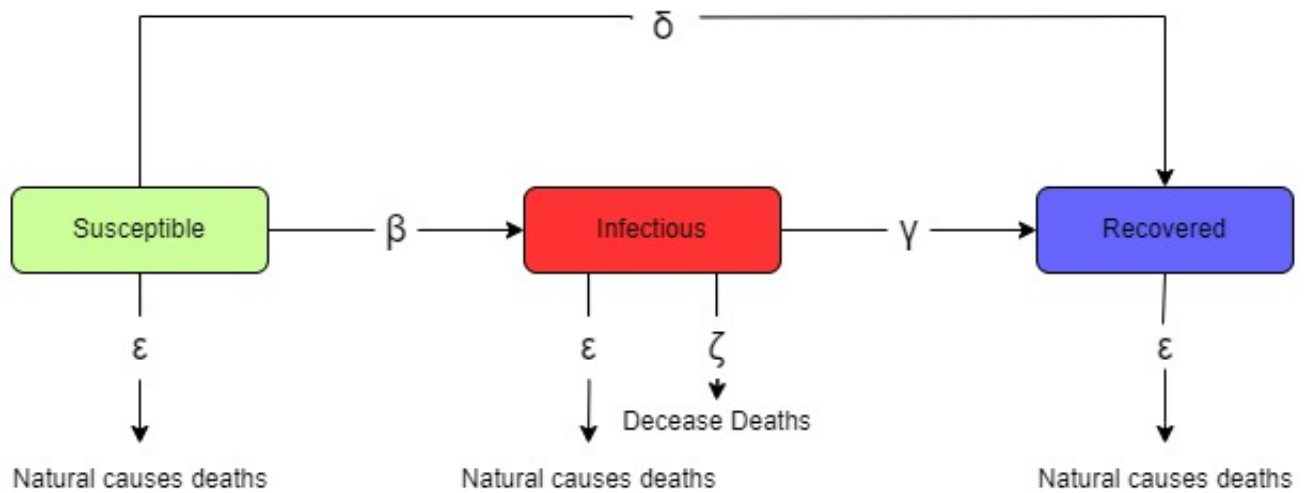


2.5 Answer to Question 4

With threshold $2/5$ or $1/2$ we have the same result, that means that we need another 2 nodes to be added.

3 Exercise 3

3.1 SIR infection model Graph



3.2 Differential Equations

$$\frac{dS(t)}{dt} = \beta S(t)I(t) - \epsilon S(t) - \delta S(t)$$

$$\frac{dI(t)}{dt} = \beta S(t)I(t) - (\epsilon + \zeta + \gamma)I(t)$$

$$\frac{dR(t)}{dt} = \gamma I(t) + \delta S(t) - \epsilon R(t)$$