Epidemic Spreading in Localized Envrionments with Recurrent Mobility Patterns

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The spreading of infectious diseases has been proved to be radically dependent on the population networked structure of interactions and on the mobility of individuals. Network scientists have made significant progress assessing the critical behavior of spreading dynamics at large geographic scales, but the prediction of the incidence of epidemics at smaller scales, localized environments, is still a challenge.

Representative examples of localized environments are university campuses, schools and work offices, to mention a few. The problem of modeling such realistic scenarios relies on finding the appropriate level of abstraction to grasp the main singularities of the epidemic spreading process for individuals using the particular environment. The analysis of these over-simplified model abstractions is of outmost importance to separate the effect of single parameters on the incidence of spreading process, yet allowing an analytical approach that could be used for prediction purposes and to test prevention actions.

In particular, we are interested in studying the spreading dynamics of influenza-like illnesses (ILI) inside university campuses. In most U.S. universities, most of the students live in the university residence halls and university dorms. The main activity of the students within campuses is dominated by a recurrent pattern of mobility that consist of attending classes and residing in dorms. This recurrent pattern of mobility between the bipartite structure of dorms and classes, is identified as a major player on the endogenous spreading of diseases between students.

We propose a metapopulation model on a bipartite network of locations, that account for the interplay between mobility and disease contagion for this particular scenario. The model is as follows: there are two types of nodes (populations): *dorms* and *classes*. Individuals correspondence to a dorm is unique, while classes are shared by individuals of any dorm. Each individual returns to its dorm after their academic activities are over. These recurrent pattern turns out to be essential to understand the impact of quarantine-like policies on the sick students, and specially on the determination of the proper time to be assigned to these isolation strategies.

The results of our analysis for a SIS dynamics on this particular scenario allows to test different strategies to contain the spreading of epidemics, identifying for example the lowest quarantine bound to be applied to sick students for the containment of the disease spreading. We find analytical expressions amenable to quantify the final incidence of the epidemics on these localized scenarios with recurrent mobility patterns.

a)

b)

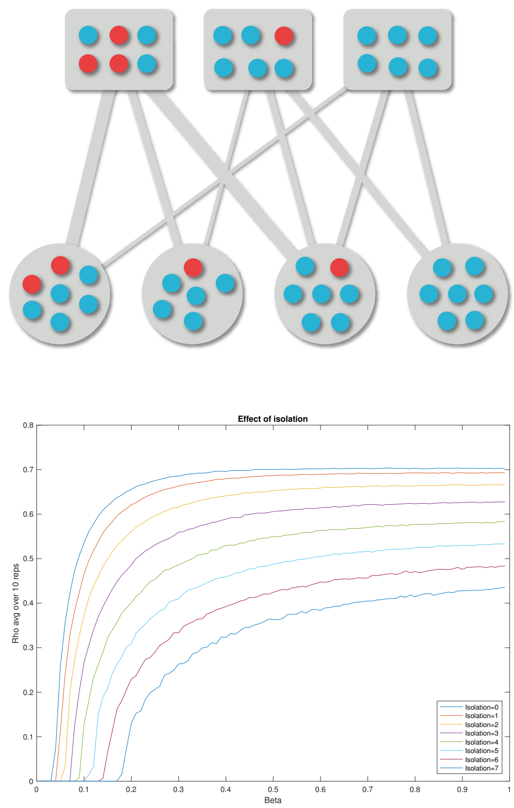

Figure 1: **(a)** Sketch of the bipartite metapopulation network accounting for the mobility of students between *dorms* and *classes*. **(b)** Number of infected students in the steady state as a function of the infectivity parameter β, for different values of the isolation policy implemented. As we can see isolation is able to shift the onset of the epidemics as well as to significantly decrease the total incidence.