Information and predictability of epidemic spreading processes in temporal networks

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Abstract

We investigate how the information about contacts affect the accuracy and predictability of disease spreading simulations in empirical social networks. We find that temporal structures seem more important than topological, for these networks

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To model the spreading of infectious diseases in a population, one needs two components—a compartmental model and a model for the contact patterns. The former specifies the different states an individual can have with respect to the disease and the transition rules between these states. The latter specifies how people meet (in such a way that the disease can spread). Much of the recent research in theoretical epidemiology has been focusing on the role of the structure of the contact patterns. It has been shown that modeling contact structures as a network improves the predictions much compared to a well-mixed model [1]. Furthermore, if one includes information about the timing of events (i.e. studies a temporal network) the accuracy increases further [2] (see Fig. 1). In this work, we will look at how the process of adding information about the contacts increases the accuracy of the model and also how it affects the estimated predictability (measured by the standard deviation of the final outbreak size given the state of the system) as a function of time.

In our investigation, we use data sets of human contact networks relevant for disease spreading (11 data sets in total). We derive the well-mixed and static network that most closely describes these data sets. Then we run the Susceptible-Infectious–Removed model no these data sets in all three levels of contact information. Our main finding is that adding temporal information makes the biggest difference to both accuracy and predictability.

References

[1] R. Pastor-Satorras, C. Castellano, P. Van Mieghem, A. Vespignani, "Epidemic processes in complex networks", arxiv:1408.2701, 2014.

[2] N. Masuda, P. Holme, "Predicting and controlling infectious disease epidemics using temporal networks", F1000Prime Rep. 5, 6, 2013.
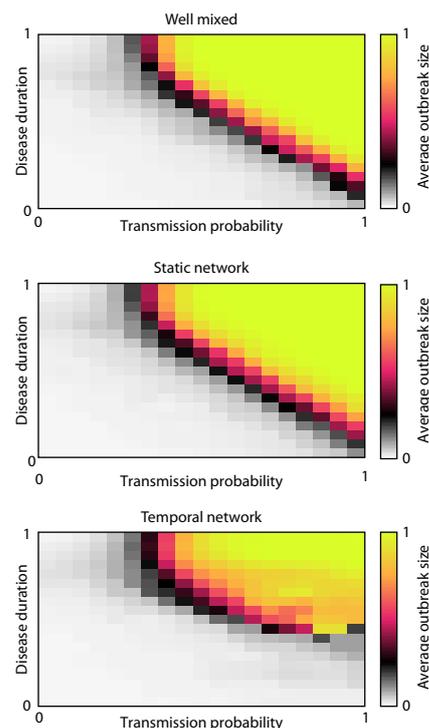
Figure 1. Outbreak sizes as functions of the SIR parameter values for a data set of face-to-face contacts in a school.