

Epidemics on Dynamic, Empirical Networks

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Introduction

Contact networks are **intrinsically temporal**, but often analyzed as **time-aggregated** to simplify analysis and simulation. Simulation on empirical networks, however, may skip this aggregation with minimal additional complexity. We consider such simulation on a large population, multi-year dataset for geo-temporal co-location. The data are derived from access to a municipal WiFi system at business-based access points. We use that data to explicitly consider compare the time evolution of network measures when aggregating on shorter time scales up to aggregating over the entire period. We then use the network as a time-varying, empirical backbone for simulating infection spread.

Materials

Should describe the data set here. Collection times, number of data points, assorted other counts, etc. Probably a table. Links to source tools.

Methods

The network measures are derived in the standard way, with the edges aggregated on co-temporal, co-location within the varying windows. The epidemic simulation is based on conventional network Susceptible-Infectious-Recovered simulation. We established the reference transmission probabilities by fitting to final sizes for typical influenza outbreaks in the associated city. When simulating the epidemics, we randomly select an iniital infective. Infectives are uniformly infectious for a period of days τ , and while infectious spread the infection with transmission probability p to each of their susceptible neighbors each day. Who is in their neighborhood, however, changes each day according to the empirical contact network.

Mathematical Section

Probably not relevant. Maybe restate the network measures? Diagram SIR flow?

Conclusion

The aggregation of empirical observations has important implications for simulation results.

Results

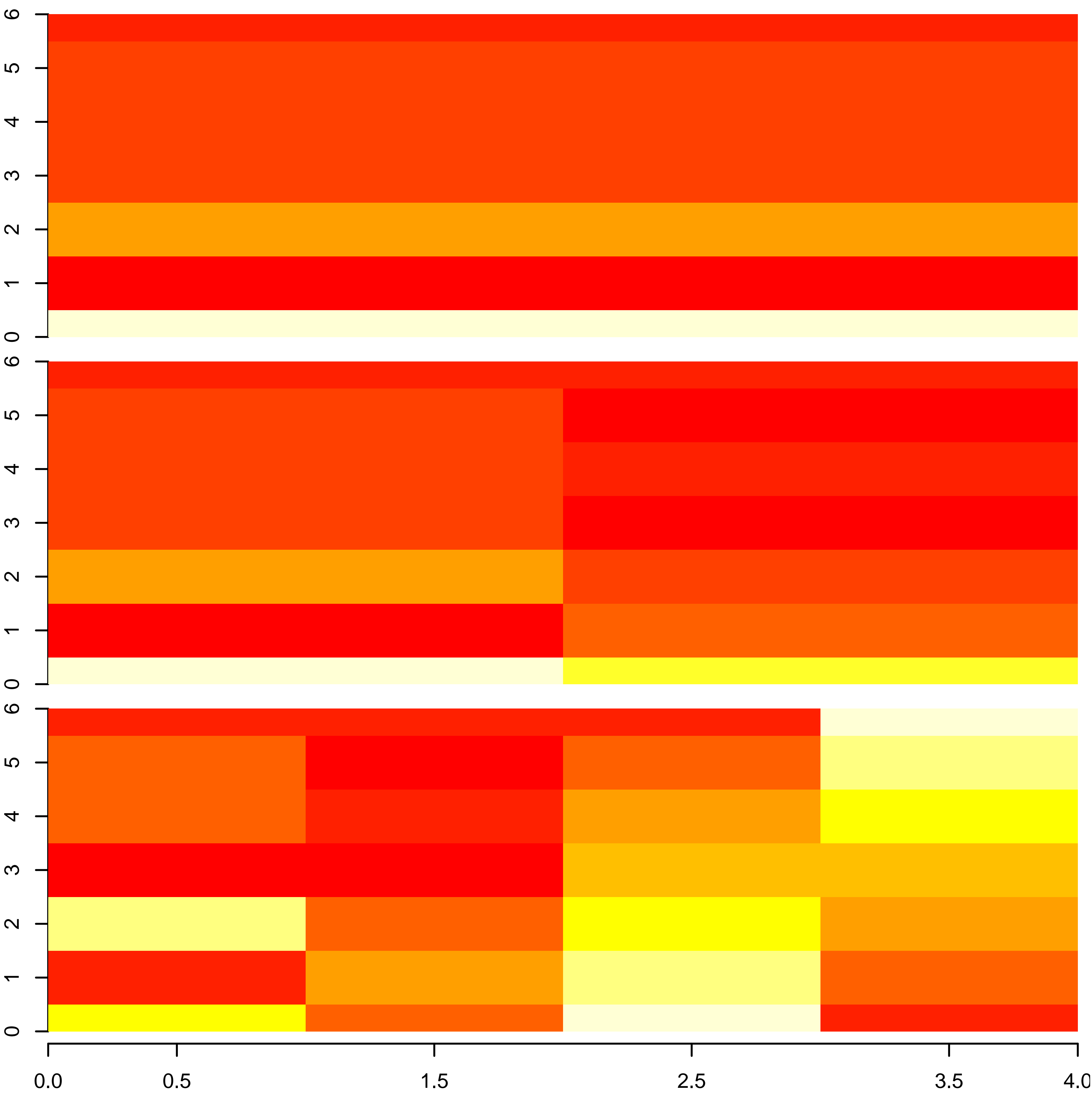


Figure: The first figure should be a series of comparisons of network measures (e.g., degree distribution) for the totally aggregated network vs averaged values of the network aggregated at different time periods - 1 year, 1 month, 1 week, 1 day. May also want to do some heat charts of those measures through time, since the averages might hide neat insights like seasonality. I also think we could use some plots of something approximating edge weights – like the distribution of edge duration proportion (time edge exists as fraction of interval).

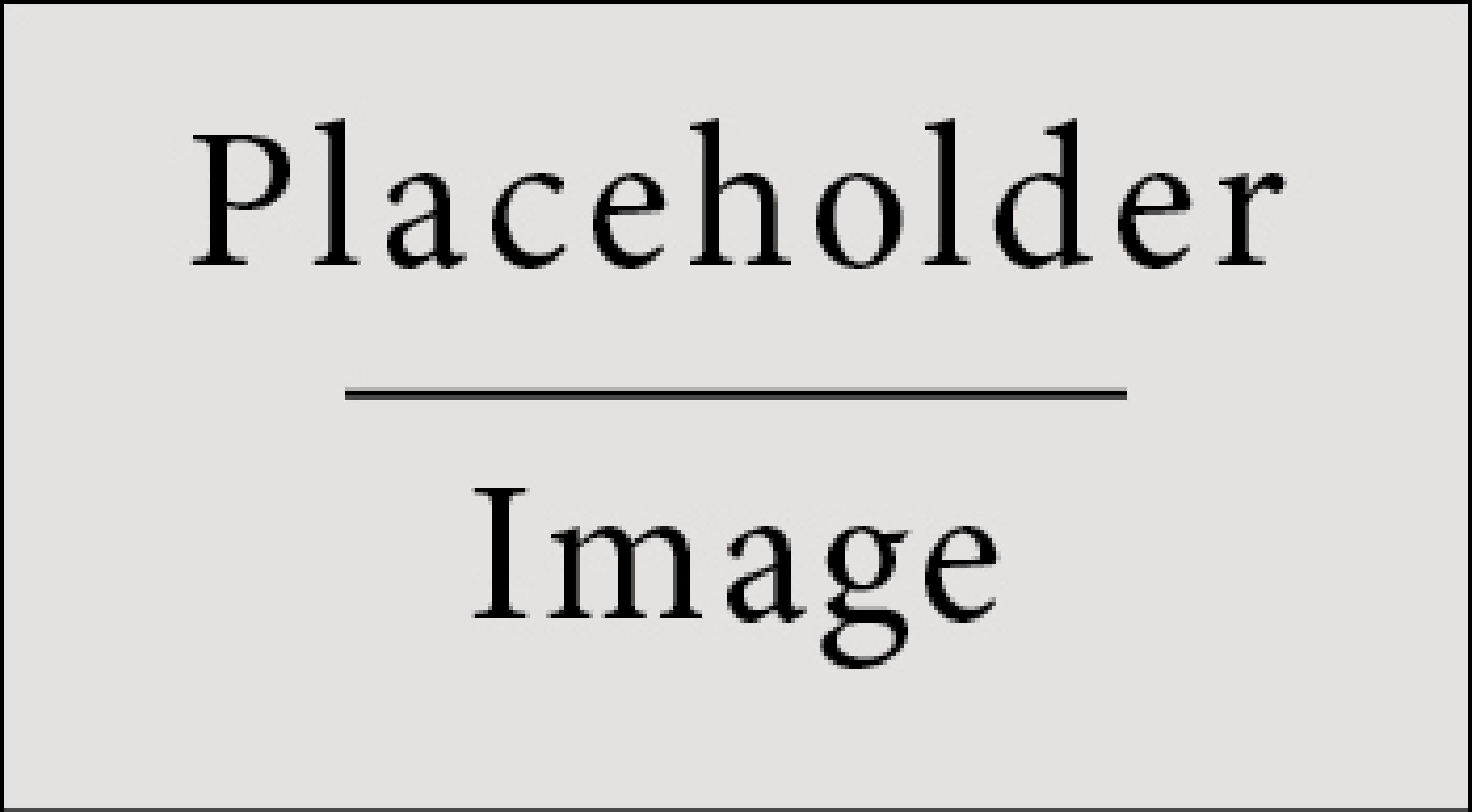


Figure: This should be the figure showing the simulation results for aggregation on whole network vs having day-by-day networks. Probably should be two figures, one for final sizes and one for trajectories. If we have time, multiples of these for some parameter variation.