



Network Sampling in Epidemiological Simulations

Summary

Sampling of static random networks is a fairly well-researched area whereas sampling of dynamic networks has been largely overlooked. We have designed and implemented three different sampling methods that generate dynamic networks with weighted link strengths. The networks we have studied include a semi-static network, an activity driven network and a random Barabasi network.

The methods were implemented in the R programming language with future integration into the SimInf epidemiological simulation software in mind.

Disease Models

We tested our random networks using the basic SIR/SIS-models. Each model defines a set of transition rates between the compartments S, I and R.

SIR –Susceptible (S) Infected (I) Recovered (R)

$$S \rightarrow I$$

$$I \rightarrow R$$

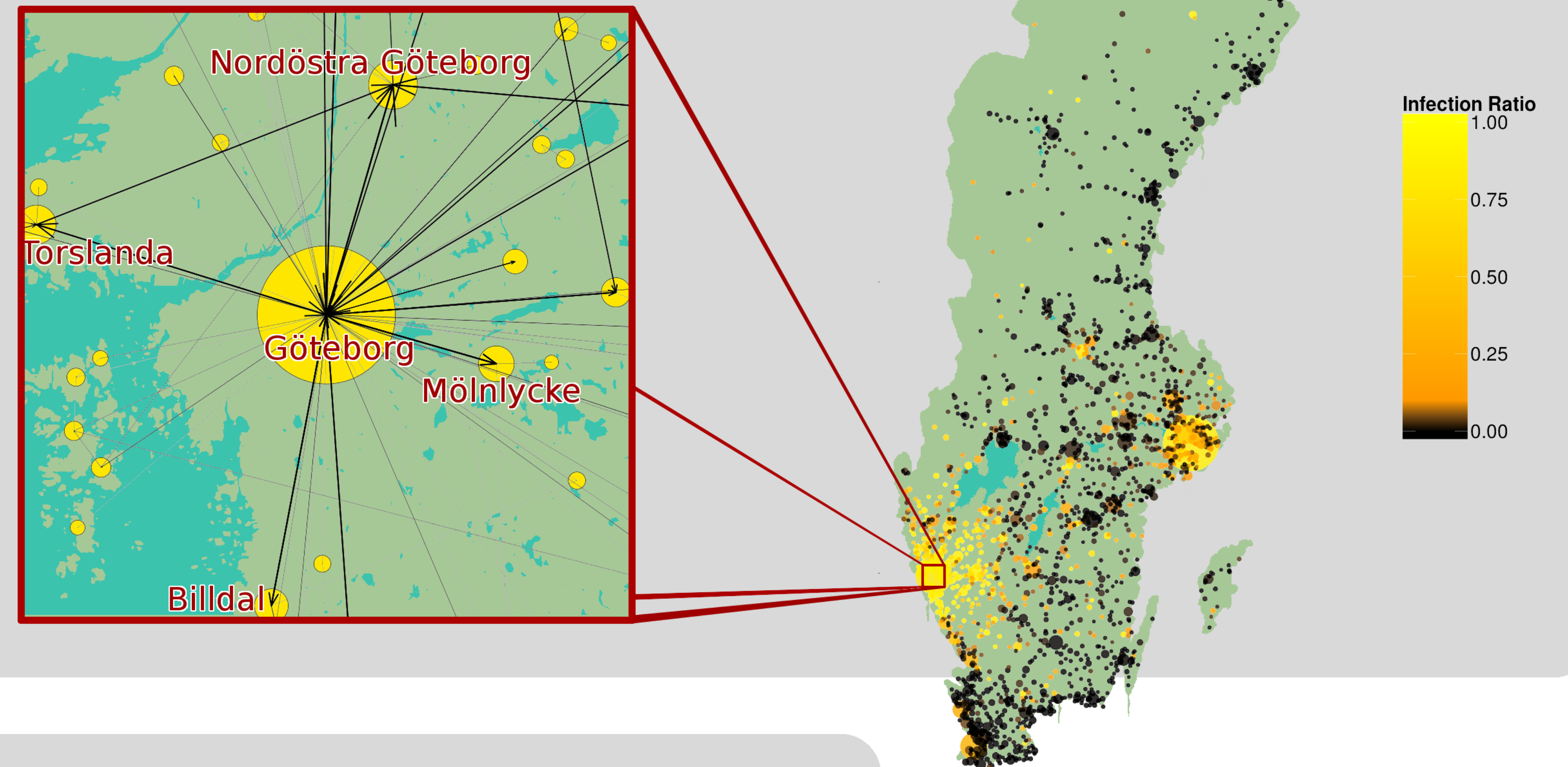
SIS –Susceptible (S) Infected (I) Susceptible (S)

$$S \rightarrow I$$

$$I \rightarrow S$$

Simulating Measles Outbreak in Gothenburg

Simulation using SIR model on an activity driven network. Fifty days have transpired since outbreak in Gothenburg.



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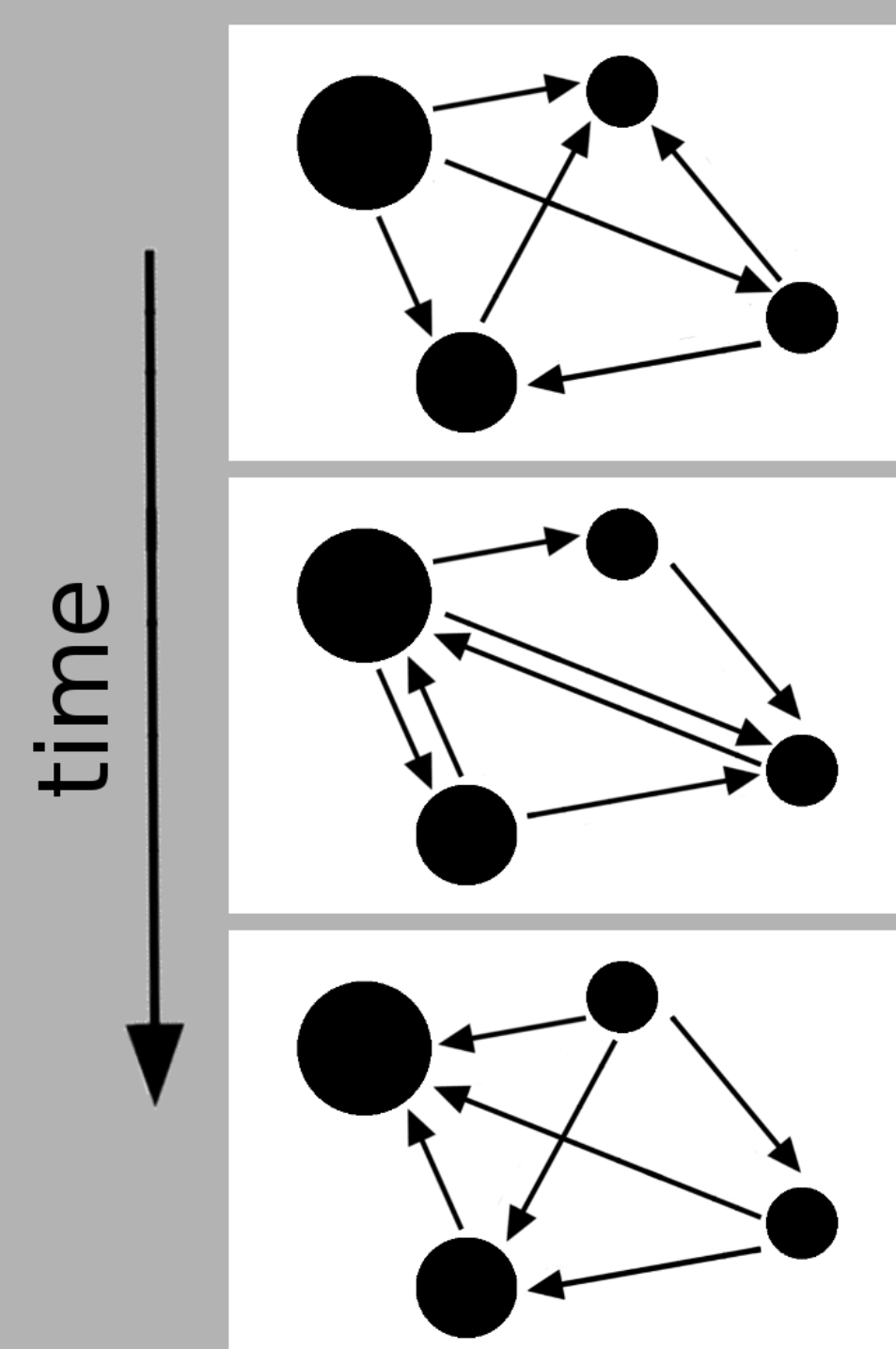
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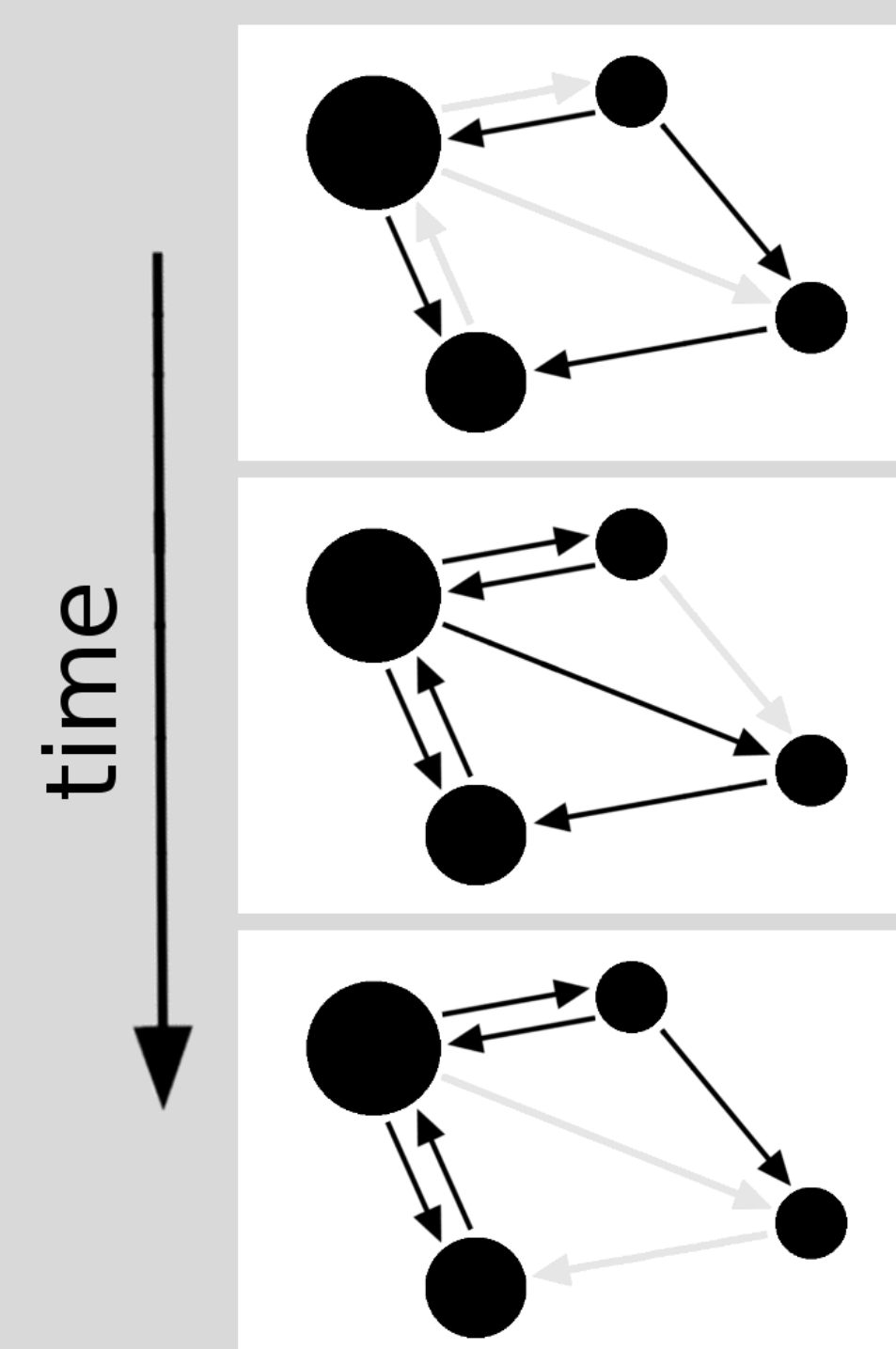
Temporal Networks

Contrary to static networks links are time varying. They exist during limited time periods.



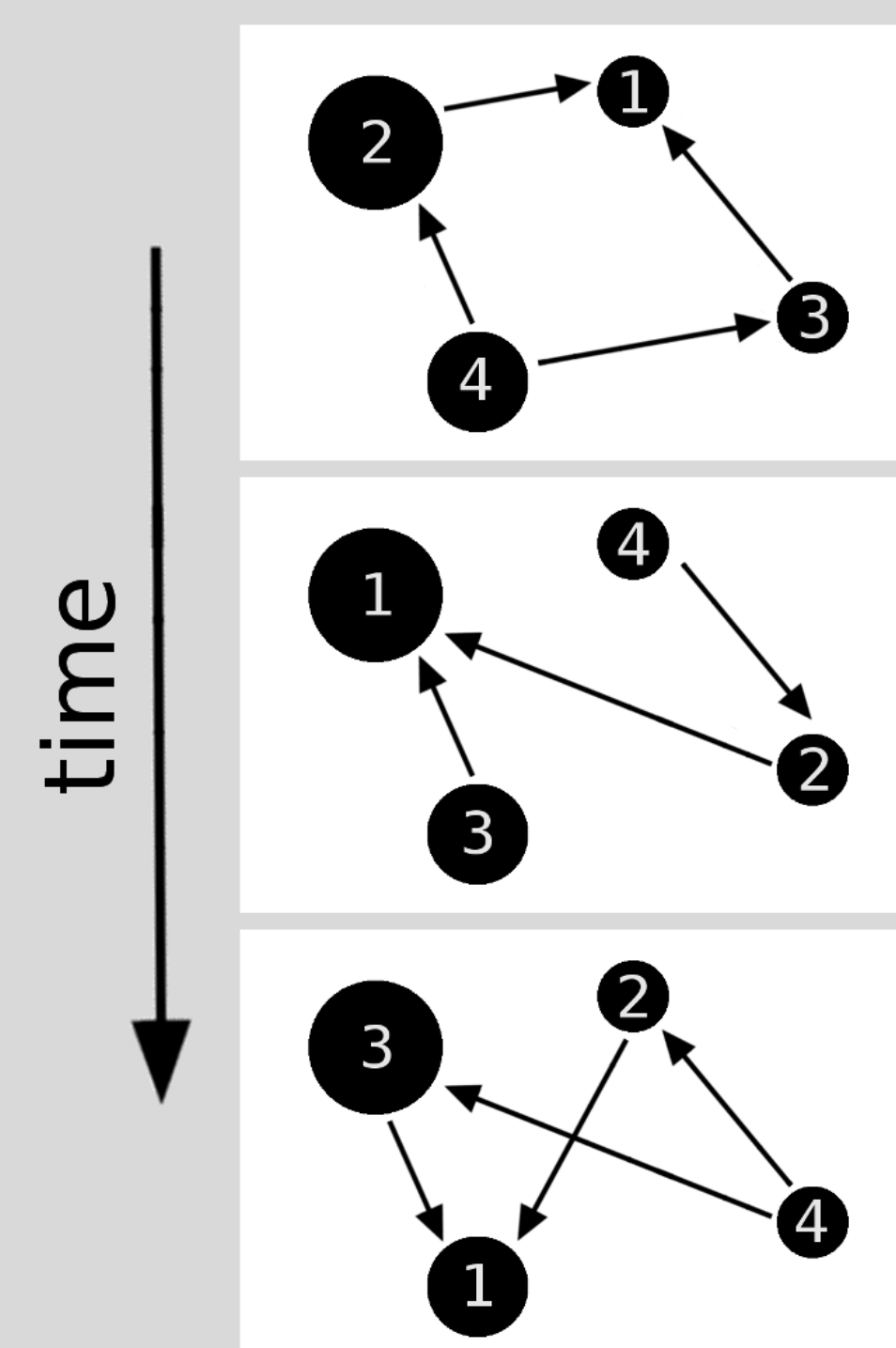
Semi-Static Network

Has a predefined underlying structure of paths between nodes. In each time step links are generated on the paths.



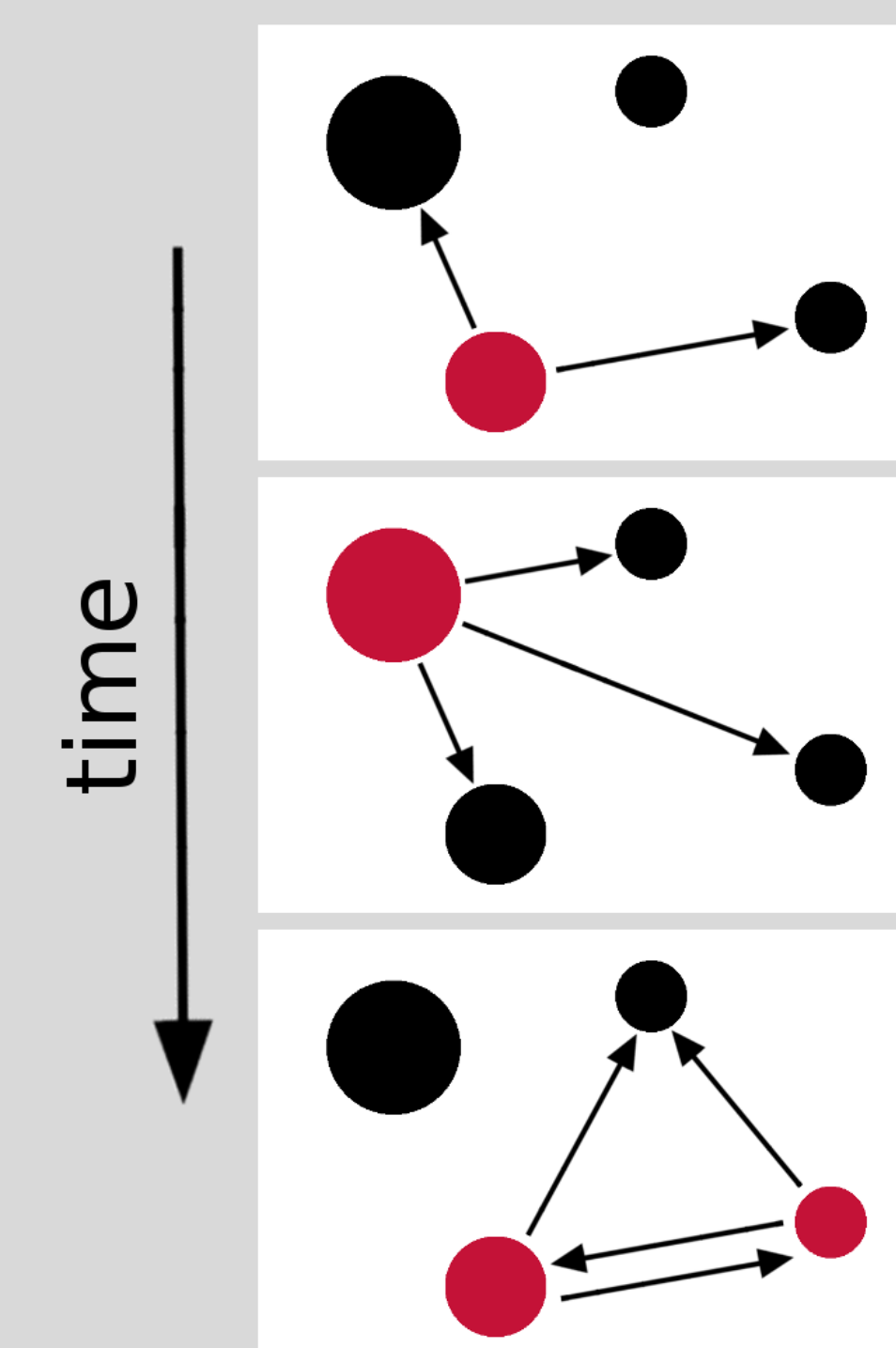
Random Barabazi Network

Each time step the network is rebuilt by adding one node at a time in a random order. The indices represent the order of addition.



Activity Driven Network

Each time step all nodes have a chance to become active. An active node samples other nodes to create links.



SimInf

SimInf is a framework for simulating data-driven stochastic disease spread in the R programming language. It was designed to study spread of infections on national scale, incorporating available movement data. In this project, we focused on the SIR and SIS disease models, and the proposed methods to generate synthetic network data would further strengthen SimInf.



Future Work

- Port to C language for speedup
- Investigate other methods that capture reality more closely