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2. Excercise Sheet – Networks (with applications to neuroscience)

Due date: Fr. 17.06.2011 14:00

This excercise sheet is meant to provide help in order to recap the topics of this week's lectures. Solutions will be discussed during the Friday lecture.

Problem 4: *SI model*

Consider the SI model for an infectious disease:

$$S \longrightarrow I \longrightarrow S,$$

where S and I denote *susceptible* and *infected* nodes ($S + I = N$), respectively.

1. Determine a differential equation according to the following reaction kinetics:

$$\begin{aligned} S + I &\longrightarrow 2I \qquad \text{with rate } \alpha \\ I &\longrightarrow S \qquad \text{with rate } \beta \end{aligned}$$

   for a normalized density $j = I/N$.

2. Calculate the stationary state of the system.

3. How can the model be generalized to a network with subpopulations including transitions between them?

Problem 5: *SI model adapted*

Models for an infectious disease are often considered on a static network. For a random network, for instance, the basic reproductive number, which denotes the secondary infections caused by a single infected node, is given by

$$R_0 = \frac{\alpha \langle k \rangle}{\beta}$$

with mean node degree $\langle k \rangle$, infection rate α, and recovery rate β.

1. What will change assuming that the network becomes adaptive, i.e., the topology varies?

2. What kind of adaptive rewiring law is plausible for a node in order to avoid infection?

3. How would the adaptation rule influence the node degree $k(t)$, which now becomes time depedent? Sketch $k(t)$ for a plausible rewiring law?