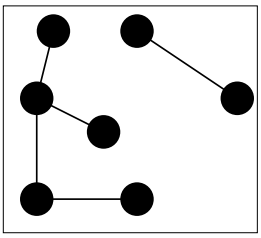
BNF079
Fall 2004

Exam Tuesday, January 18, 2005, 9.00-13.00.

20p in total feasible – roughly 10 p required for pass.



1. The figure above shows a small, undirected network. Calculate the degree distribution and present it in a table or a plot. [2]

2. Assume you have downloaded some network and you want to figure out whether a particular motif, say a feed forward loop, is overrepresented in this network. Descibe shortly the main steps you would go through in order to carry out this task. [5]

3. A What is the whole point of the rate equation investigation of the Drosophila segment polarity problem? [1]

   B Describe some key components of this system. How many cells are used in the simulations? [1]

   C Roughly how many components (proteins, protein complexes) and parameters are used in the investigation? [1]

   D How is the system initialized and what fraction of the solutions turn out to be good ones? [1]

   E How does this translate into parameter sensitivity for the variables one by one? [1]

4. In the TGFβ pathway the extracellular TGFβ binds to and activates a cell membrane receptor R. The activated receptor (R*) works as an enzyme for the phosphorylation of the protein Smad1. The phosphorylated Smad1 (PSmad1) then forms a complex with the protein Smad4, and the complex can also degrade back into Psmad1 and Smad4. Assume a mass action formalism in general and Michaelis–Menten formalism for the phosphorylation of Smad1 with a constant amount of active receptor.

$$\begin{array}{ccc} & \mathrm{R}^* & \\ & \Downarrow & \\ \mathrm{Smad1} & \longrightarrow & \mathrm{PSmad1} \end{array}$$

$\mathrm{Psmad1} + \mathrm{Smad4} \rightleftharpoons \mathrm{PSmad1Smad4}$

A Write down the differential equation for the time evolution of the concentration of PSmad1 (the phosphorylated Smad1 protein). [2]

B Assume a constant concentration of Smad1, Smad4 and complex (PSmad1Smad4). Make a rough plot of $\mathrm{d}x/\mathrm{d}t$ as a function of x (where x is the PSmad1 concentration). Describe the dynamics. [2]

5. **Gene auto-activation**: Assume a protein activating its own production, and a simple degradation proportional to the protein concentration. The activation is governed by the Michaelis–Menten formalism.

A Write down the differential equation for the time evolution of the protein concentration. [1]

B What happens for the protein concentration equal to zero? [1]

C Analyse the dynamics. [2]