Mini-Project Assignment:
MS6a Analysis of Biological Networks

Deadline

TWO COPIES of your completed mini-project for MS6a Analysis of Biological Networks should be handed in at the Examination Schools by the deadline of **12 noon on Monday 18 January 2010.**

The details of this mini-project assignment are on pages 2-4 below.

Mini-Project Assignment:
MS6a Analysis of Biological Networks

The assignment is to write a report devoted to a topic that has been covered in the course.

Your report may be on one of the five main lecture topics listed below, or may be on a sub-topic of one of these five. The starting point for your report is for you to choose a topic, or sub-topic, on which to write your report. Then you should consult the appropriate references given in the lectures and below. You may of course consult further references if you wish.

The report should contain:

- Introduction. This includes motivation for the problem chosen, a short sketch of its history, and a preview of what comes in the rest of the report.
- Technical background.
- Main results in the literature on the problem.
- Discussion, including critical comments and suggestions about current unsolved problems.
- References.

Assessment and marking

As there is clearly not a precise model solution for this assignment, each mini-project will be double-marked.

The evaluation criteria used when marking will be:

- How well has the topic been motivated? (15%)
- How well has the technical background to the topic been described? (30%)
- Is there good explanation and presentation of the topic, its main problems, and their suggested solutions? (40%)
- Is there a good assessment of the current state of work on this topic, and are there possible suggestions for what to do next? (15%)

Lecture topics

The lecture material is available at
http://www.stats.ox.ac.uk/research/genome/teaching2/ms6a/compbiol08

The lectures have presented a series of key topics – listed here with a few key references:

- "Integrative Genomics and High-throughput Data" (2 lectures). A.L. Barabási & Z.N. Oltvai (2004) Network biology: understanding the cell's functional organization. Nature Reviews Genetics 5, 101-113.
- "Algorithms and Networks" (6 lectures). See the lecture notes by R. Lyngsø available at http://www.stats.ox.ac.uk/research/genome/teaching2/ms6a/compbiol08
- "Enumeration, Probability Theory and Sampling of Networks" (4 lectures). See the lecture notes by B. Thatte available at http://www.stats.ox.ac.uk/research/genome/teaching2/ms6a/compbiol08

- "Evolution of Networks" (2 lectures). R. Sharan et al. (2006) Modeling cellular machinery through biological network comparison. Nature Biotechnology 24(4):427-33. A. Mithani et al. (2009) A stochastic model for the evolution of metabolic networks with neighbor dependence. Bioinformatics 25(12):1528-153.
- "Inference of Networks" (2 lectures). G. Karlebach (2008) Modelling and analysis of gene regulatory networks Nature Review Genetics 9, 770-781.

Example outlines of possible reports

Below are 3 example outlines of possible reports on 3 different topics. Please note that these 3 examples are only suggestions.

In addition to the references mentioned below, the appropriate references from the lectures listed above could be consulted.

Example 1. "Inference of Regulatory Biological Networks from Expression Data" - Expression levels of mRNAs in a cell are often determined by an underlying genetic network that cannot itself be observed, though the expression levels can be. Inferring this underlying network is a key challenge in biology.

- *G. Karlebach (2008) Modelling and analysis of gene regulatory networks. Nature Review Genetics 9, 770-781.*
- *N. Friedman (2004) Graphical Models Inferring Cellular Networks Using Probabilistic Graphical Models. Science 303, 799.*

This could lead to a report with following content:

- Introduction. The basic problem – observable data/unobservable networks. 1 page
- The key models and properties of data. 3 pages
- Some detail of the key models. Illustration of why they lead to better data analysis. Applications of these models. 4 pages
- Are the existing models good enough? Any ideas for better models? 2 pages

Example 2. "Evolutionary Models of Metabolic Pathways" - Explain the basic purpose of evolutionary models. Sketch the basic models. What are the key applications?

- *R. Sharan et al. (2006) Modeling cellular machinery through biological network comparison. Nature Biotechnology 24(4):427-33.*
- *A. Mithani et al. (2009) A stochastic model for the evolution of metabolic networks with neighbor dependence Bioinformatics 25(12):1528-153.*

This could lead to a report with following content:

- Introduction. The purpose of evolutionary modeling. 1 page
- Technical background. Short sketch of basic models and how to use them. 3 pages
- Some detail of the key results of evolutionary analysis - for instance the rate, heterogeneity and function conservation of evolution. 3 pages
- What are the main challenges ahead? 1 page

Example 3. "Probability Theory of Networks" - The analysis of networks make ample use of probability models of networks to test biological hypotheses.

- *P. Erdös and A.Renyi (1960) On the evolution of random graphs. Publ. Math. lnst. Hung. Acad. ScL, 5 17-61. [Please contact the Academic Administrator, Department of Statistics, if you have any difficulties in getting hold of this reference.]*
  or
  B. Bollobas (2001) Random Graphs (second edition), chapter 2. Cambridge University Press.
- *A.L. Barabási & Z.N. Oltvai (2004) Network biology: understanding the cell's functional organization. Nature Reviews Genetics 5, 101-113.*

This could lead to a report with following content:

- What is the basic models of random networks? 2 pages
- Discuss properties of these models. 3 pages
- What are the main biological applications of these models? 3 pages
- Discuss possible useful extensions of these models. 2 page

Again, please remember that these 3 examples were only suggestions.

[End of Mini-Project Assignment]