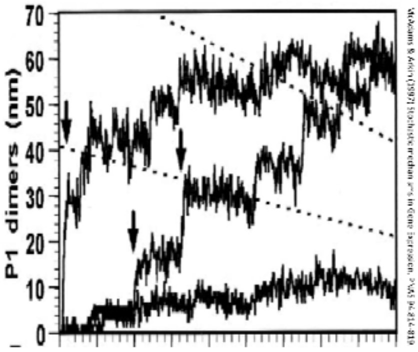
Stochastic Dynamics of Molecules on Networks

14.6.10

Objective: To give a presentation of about 60 minutes at the end of the week covering the key aspects of stochastic models in cellular biology.



Cells are small entities and the copy number of the key players like proteins, metabolites and regulatory molecules can be in the range from tens to millions. For number like tens to hundreds stochastic effects are important, while for numbers like millions it is sufficient with a deterministic treatment. In systems biology a variety of models have been developed to predict the behaviour of complete cells or subsystems. Historically, such models have first been deterministic, typically ordinary differential equations, but has the then moved on to include stochasticity. Stochasticity can be inherent in the system, due to small numbers involved or can enter through measurement error or lack of knowledge of the initial conditions of the system.

The Big Questions Are:

- What are the key phenomena in a cell that needs stochastic modelling?
- What are the approproptitate models for these phenomena?
- What are the assumptions made by such models?
- What are the computational needs of such models?
- Which kinds of errors are made if stochasticity is ignored?
- Is stochasticity ever an advantage to a cell?
- What are the key models to be developed?

Possible Contents of Presentation

1. What is a cell?
2. How do you describe the dynamics of a cell?
3. What are the key classes of stochastic models?
4. Major succcesses of stochastic models of cell dynamics from the last decade?
5. What is ahead?

Recommended literature

Arkin et al. (1998) Stochastic Kinetic Analysis of Developmental Pathway Bifurcation in Phage l-Infected *Escherichia coli* Cells Genetics 149: 1633–1648
Gibson MA, Bruck J. 2000. Exact stochastic simulation of chemical systems with many species and many channels. *J. Phys. Chem*. 105:1876–89
Gao, Hinkela, Rattray and Lawrence (2008) “Gaussian Process Modelling of Latent Chemical Species: Applications to Inferring Transcription Factor Activities”
Gillespie (2007) Stochastic Simulation of Chemical Kinetics Annu. Rev. Phys. Chem. 2007. 58:35–55
Gilman et al. (2002) GENETIC “CODE”: Representations and Dynamical Models of Genetic Components and Networks Annu. Rev. Gen Hum. Genet. 3:341–69
Lawrence, Sanguinetti, and Rattray (2007) “Modelling transcriptional regulation using Gaussian processes”
Lawrence, N et al. (2010) “Gaussian Processes for Missing Species in Biochemical Systems” in Learning and Inference in Computational Systems Biology MIT
Rattray et al. (2008). Gaussian process modelling of latent chemical species: applications to inferring transcription factor activities. Bioinformatics, 24, 7075.
Wilkinson, D (2006) Stochastic Modelling for Systems Biology Chapman Hall

“Big Questions”, “Contents” and “Recommended Literature” are only suggestions from which the student is welcome to depart from or completely ignore.