MIT
Department of Mathematics
& The Theory of
Computation Group
At CSAIL

Bioinformatics Seminar

Speaker: Leonid Mirny, Harvard-MIT Division of Health Sciences and
Technology, and Physics
Title: Information Transmission and Fluctuations in Signaling Cascades
Date: Monday, 15 November 2004
Time & Location:
Refreshments: 11 am in the Theory of Computation Lab at MIT's
Building 32, Stata Center Room G-575
Talk: 11:30 am the Theory of Computation Lab at MIT's Building 32,
Stata Center, Room G-575
URL: http://www-math.mit.edu/compbiosem/

Abstract:

Signaling pathways inside cells typically amplify and propagate information by reversibly
phosphorylating proteins. Intracellular signalling proteins often have low copy number, and
spontaneous fluctuations have a potentially strong impact on these networks. How can a cell
behave and respond reliably in spite of this intrinsic stochasticity?

Here we investigate the stochastic dynamics of a generic "biochemical switch", a ubiquitous
building block of eukaryotic signalling pathways (MAPK, EGF, PDGF, etc). Considering the switch
as an information channel, we attempt to identify mechanisms that facilitate the transfer of
information amidst random biochemical fluctuations and parameter variations. We analytically
characterize intrinsic fluctuations and switching times in two regimes—hyperbolic (exhibiting
graded responses) and ultrasensitive (exhibiting switchlike responses). These two regimes show
qualitatively different behaviour. We finally interpolate between these regimes using Monte-Carlo
simulations.

Our results show the switch behaves like a low-pass filter, filtering out rapid input fluctuations.
The quality of information transmission depends on the number of molecules in the switch. For a
given input frequency there is an optimal number of molecules that maximizes information
transmission through the switch. We show that (1) a cascade can work reliably and even benefit
from a small number of molecules and, (2) there is a limited range of enzymatic kinetic
parameters that allow for effective information transmission.

The seminar is co-hosted by Professor Peter Clote of Boston College's Biology and Computer Science
Departments and MIT Professor of Applied Math Bonnie Berger. Professor Berger is also affiliated with CSAIL &
HST.

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