

Biology and Information

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Course Material – Fall/Winter 2008/09

Papers we will cover

Physics of information

1. Szilard: On the decrease of entropy *Z. fur Physik*, 1929
2. Feynman: Ratchet and pawl, *Feynman Lectures on Physics*, Vol. I, Ch. 46
3. Magnasco: Forced thermal ratchets, *PRL* 1993
4. Libchaber: Optical thermal ratchet, *PRL* 1994
5. Attneave: Some informational aspects of visual perception, *Psychological Review*, 1954
6. Shannon : Communication in the presence of noise, *Proceedings of the IEEE*, 1948

Information and computation

7. Bennet: Logical reversibility of computation, *IBM Journal of Research and Development*, 1973
8. Landauer: Computation: a fundamental physical view, *Physica Scripta*, 1987
9. Turing: Computing Machinery and Intelligence, *Mind* 1950
10. von Neumann: The general and logical theory of automata, *Hixon Symp. on Cerebral Mechanisms in Behavior*, 1951

Biological computation

11. Adleman: Molecular Computation of Solutions to Combinatorial Problems. *Science*, 1994
12. Barkai: Robustness in simple biochemical networks, *Nature*, 1997
13. Ptashne: Imposing specificity by localization: mechanism and evolvability, *Current Biology* 1998
14. Winfree: Universal Computation via Self-assembly of DNA: Some Theory and Experiments, 1999: Design and self-assembly of two-dimensional DNA crystals, *Nature*, 1998

Coding and error correction

15. Shannon: A universal Turing machine with two internal states. *Automata Studies*, 1956
16. Tlusty: A simple model for the evolution of molecular codes driven by the interplay of accuracy, diversity and cost, *Physical Biology*, 2008
17. Miller: The magical number seven, plus or minus two: some limits on our capacity for processing information, *Psychological Review*, 1956
18. Hamming: Error detection and error correction codes. *Bell Syst. Tech. J.* 1950
19. Hopfield: Kinetic proofreading: a new mechanism for reducing errors, *PNAS* 1974
20. Libchaber: Protein-DNA computation by stochastic assembly cascade, *PNAS*, 2002
21. MacKay and McCulloch: The limiting information capacity of a neuronal link, *Bulletin of Mathematical Biology*, 1952

Genetic information

22. Siggia: Building a dictionary for genomes: Identification of presumptive regulatory sites by statistical analysis, *PNAS* 2000
23. Holter: Fundamental patterns underlying gene expression profiles, *PNAS* 2000
24. Rubin: Comparative genomics of the eukaryotes. *Science* 2000
25. Claverie: What if there are only 30,000 human genes, *Science*, 2001

Language

26. Shannon: Prediction and entropy of printed English. *Bell System Technical Journal*, 1951
27. Paabo: Molecular evolution of FOXP2, a gene involved in speech and language *Nature* 2002

Organization of information - Networks

28. Brenner: The structure of the nervous system of *Caenorhabditis elegans*, *Trans R Soc Lond B Biol Sci*, 1986
29. Uetz: A comprehensive analysis of protein–protein interactions in *Saccharomyces cerevisiae*, *Nature*, 2000
30. Barabasi: Emergence of Scaling in Random Networks, *Science*, 1999
31. Alon: Network Motifs: Simple Building Blocks of Complex Networks, *Science* 2002

Synthetic biology

32. Elowitz: A synthetic oscillatory network of transcriptional regulators, *Nature*, 2000
33. Lim: Rewiring MAP Kinase Pathways Using Alternative Scaffold Assembly Mechanisms, *Science*, 2003
34. Collins: Programmable cells: Interfacing natural and engineered gene networks, *PNAS*, 2004
35. Weiss: Programmed population control by cell-cell communication and regulated killing, *Nature*, 2004

Books in the background

Sneppen and Zocchi: *Physics in Molecular Biology*

Feynman: *Lectures on Computation*

Nelson: *Biological Physics - Energy, Information, Life*

Leff and Rex: *Maxwell's Demon - Entropy, Information, Computing.*