Invited Talk 2.2

BOOLEAN NETWORK MODELS FOR BIOLOGICAL REGULATION: PROSPECTS AND LIMITATIONS

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Abstract

Computer models are valuable tools towards an understanding of the cell's biochemical regulatory machinery. Possible levels of description of such models range over a vast range, from modeling the underlying biochemical details to top down approaches, using tools from the theory of complex networks. The latter, coarse-grained approach is taken where regulatory circuits are classified in graph-theoretical terms, with the elements of the regulatory networks being reduced to simply nodes and links, in order to obtain architectural information about the network. Further, considering dynamics on networks at such an abstract level seems rather unlikely to match dynamical regulatory activity of biological cells. Therefore, it came as a surprise when recently examples of discrete dynamical network models based on very simplistic dynamical elements emerged which in fact do match sequences of regulatory patterns of their biological counterparts. I will here review such discrete dynamical network models, or Boolean networks, of biological regulatory networks. Further, we will take a look at such models extended with stochastic noise, which allow to study the role of network topology in providingrobustness against noise. In the end, we will discuss the interesting question of why at all such simple models can describe aspects of biology despite their simplicity. Finally, prospects of Boolean models in exploratory dynamical models for biological circuits and their mutants will be discussed.

Biography

Stefan Bornholdt is a Professor of Theoretical Physics and leads the Complex Systems Lab at the Institute for Theoretical Physics at the University of Bremen, Germany. His research focuses on complex systems using methods of theoretical physics to study the dynamics and origins of complex systems from diverse disciplines. One theme is complex networks, characterizing structure and working principles of natural networks, ranging from biological networks such as gene regulation networks, to social networks and the internet, WWW, and E-mail networks. A second research focus is on the dynamics of evolutionary processes (co-evolution, macro-evolution).