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Regulatory dynamics and stability in discrete and continuous models[1] FAKHTEH GHANBARNEJAD, KONSTANTIN KLEMM, Bioinformatics Group, Institute for Computer Science, University of Leipzig — Biological processes such as cell deviation, cell differentiation and so on are regulated dynamics. These dynamics are often described by continuous rate equations for continuously varying chemical concentrations. Binary discretization of state space and time leads to another class of models, Boolean dynamics, which are dealing with larger systems, higher complexity and less computational details. Here we study the reaction of discrete and continuous dynamics to perturbations. When asking if a gene-regulatory system reproduces a prescribed trajectory despite noise, large perturbations are to be considered in the case of low copy numbers of regulatory molecules and bursty stochastic response. Small perturbations, however, are more appropriate when modelling systems with large copy numbers and an integrative response to filter out bursts. In Boolean networks, the dynamics has been called unstable if flip perturbations lead to damage spreading. We find that this stability classification strongly differs from the stability properties of the original continuous dynamics under small perturbations of the state vector. In particular, random networks of nodes with large sensitivity yield stable dynamics under small perturbations and chaotic regime disappears.

[1]Physical Review Letters 107, 188701 (2011)

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