

## **Nonlinear regulatory elements in signaling pathways**

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In the first part: In will discuss characteristic nonlinear regulatory elements that shape dynamic of regulatory pathways: stoichiometric saturation, negative and positive feedbacks, feedforwards, kinase cascades. We will analyze temporal dynamics associated with these elements, and learn how this dynamics can be predicted based on bifurcation diagrams. Next we consider three dynamically distinct combinations of positive and negative feedbacks.

In the second part we will look how these elements regulate behavior of regulatory pathways in the presence of noise, and in the case when the spatial aspects of the signaling are important. If time permits we will consider bistable, spatial stochastic systems.