Control systems theory and neuronal modeling

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The systemic approach in the actual researches in the field of biomodeling aim to fit together the different level at which complex biological systems are working, from genes through cells, organs to the whole organism.

Control systems theory applied in the neuronal modeling is used to analyse the dynamic properties of the neuronal reaction pathways (metabolic pathways, cell signaling pathways) in order to reduce models of high dimension to models of low dimension and to understand the role of feedback loops in such networks. The essence of this approach lies in the dynamics of the system and cannot be described merely by enumerating the components of the system. The system –level understanding of the neuronal cell is solidly grounded on a detailed molecular-level understanding.

From the systems theory viewpoint, the neuronal cell is an open system with distinct input and output ports and specific response mechanisms. The input ports are the input ionic channels and receptor sites from the neuronal membrane where signaling molecules initiate coupled sets of chemical reactions within the cellular space The output ports are the output ionic channels and the specific binding sites from the neuronal membrane where the signaling molecules are binding and initiate bio-chemical reactions outside the cell.

Signaling action through the pathways result in different categories of cellular responses like ionic channel opening or closing, neuronal differentiation or neuronal cell death. The dynamical models of signaling pathways are nonlinear and the analysis of their behavior in challenging request specific algorithms.