
Perturbation-response relation and network topology in biochemical reaction systems

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Abstract

In living cells, biochemical reaction pathways form complex networks, such as metabolic network. To elucidate the dynamics of these biochemical systems, one experimental approach is examining their sensitivities to perturbations where the amounts of enzymes, which catalyze the reactions, are increased/decreased. On the other hand, to study the systems mathematically, there is a limitation that we do not know quantitative details, such as reaction rate, of the dynamics.

In this work, we established a theoretical framework that determines the response to perturbations qualitatively from the network structure alone. It turns out that under a given perturbation (corresponding to enzyme knockout), only particular molecules can change their concentrations. We also found that there exists a topological condition that governs to what extent the effect of each perturbation can spread in the network.

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