Molecular circuits for dynamic noise filtering

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Abstract:

Artificial molecular circuits in living cells are exposed to a variety of noise sources, often causing a prohibitive mismatch between circuit specification and actual behaviour. In the emerging field of synthetic biology, this is considered a major limitation and a systematic approach to cope with noise in man-made biological circuits is still lacking. In this talk I will review recent advances that we have made in addressing this issue. More specifically, I will discuss how adaptive noise filters — usually operated on a computer — can be realized using molecules and reactions inside living cells. I will first formulate the optimal filtering problem for stochastic reaction networks in terms of a Kushner-Stratonovich equation and show how tractable closed-form filters can be derived from it under meaningful conditions. I will then discuss how these filters can be implemented at the molecular level and how they can guide the design of robust synthetic circuits. I will demonstrate our approach using both simulations and experiments and outline its future potential for creating “smart” biological devices.