

Development of methodologies for modeling and designing molecular biological systems

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Genomic-alerted diseases (e.g., obesity, cancer, HIV, H1N1) stem from the dysfunction of molecular biological systems, not only their isolated components (e.g., genes, proteins). With advances in high throughput measurement techniques such as microarray, ChIP-chip, and mass spectrometry, large-scale biological data have been and will continuously be produced. Such data contain insightful information for understanding the mechanism of molecular biological systems and have proved useful in diagnosis, treatment, and drug design for genomic-alerted diseases. However, even if our ability were adequate for the task to measure the functional states and interactions among biological network components, computational limitations alone would prohibit us to understand the behaviours of molecular biological systems because their complexity exponentially grows with the number of network components and interactions among them. With such various types of biological data, my research has been focused on developments of advanced methodologies for understanding the details and principles of molecular biological systems while aiming at designing (or controlling) them to have a desired behaviour (e.g., robustness to). The long-term objective of my proposed research is to advance methodologies for modeling, analyzing and designing molecular biological systems (networks). To achieve the long-term objective, three specific short-term objectives are designed for my proposed research: 1) inferring gene regulatory networks from various types of biological data; 2) molecular biological system identification and parameter estimation based on various types of biological data; and 3) analyzing and simulating molecular biological systems for designing them. While ambitious, the successful outcome of the proposed research will have considerable ramifications for designing and engineering molecular biological systems with the potential to benefit many areas of industry such as personalized pharmaceutical development and crop yield enhancement.