Computational Biomarker Discovery: From Systems Biology to Predictive and Personalized Medicine Applications

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Abstract

With the advent of Genome-based Medicine, there is an escalating need for discovering how the modifications of biological molecules, either individually or as an ensemble, can be uniquely associated with human physiological states. This knowledge could lead to breakthroughs in the development of clinical tests known as "biomarker tests" to assess disease risks, early onset, prognosis, and treatment outcome predictions. Therefore, development of molecular biomarkers is a key agenda in the next 5-10 years to take full advantage of the human genome to improve human well-beings. However, the complexity of human biological systems and imperfect instrumentations of high-throughput biological instruments/results have created significant hurdles in biomarker development. Only recently did computational methods become an important player of the research topic, which has seen conventional molecular biomarkers development both extremely long and cost-ineffective.

At Indiana Center for Systems Biology and Personalized Medicine, we are developing several computational systems biology strategies to address these challenges. We will show examples of how we approach the problem using a variety of computational techniques, including data mining, algorithm development to take into account of biological contexts, biological knowledge integration, and information visualization. Finally, we outline how research in this direction to derive more robust molecular biomarkers may lead to predictive and personalized medicine.

Indiana Center for Systems Biology and Personalized Medicine (CSBPM) was founded in 2007 as an IUPUI signature center by Dr. Jake Chen and his colleagues in the Indiana University School of Informatics, School of Medicine, and School of Science. CSBPM is the only research center in the State of Indiana with the primary goal of pursuing predictive and personalized medicine. CSBPM currently consists of eleven faculty members from the School of Medicine, School of Science, School of Engineering, School of Informatics, and Indiana University Simon Cancer Center. The primary mission of the center is to foster the development and use of systems biology and computational modeling techniques to address challenges in future genome-based medicine. The ultimate goal of the center is to shorten the discovery-to-practice gap between integrative “Omics” biology studies—including genomics, transcriptomics, proteomics, and metabolomics—and predictive and personalized medicine applications.