Genomics Signal Processing – An Overview

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Abstract: Genomic Signal Processing (GSP) is the emerging discipline that brings to genomics the structural model based analysis and synthesis that form the basis of mathematically rigorous engineering. The aim of GSP is to integrate the theory and methods of signal processing with the global understanding of functional genomics, with special emphasis on genomic regulation. This talk consists of two parts. In the first part a brief tour to cell biology is given and the scope of genomic signal processing is explained. In the second part, a specific GSP problem of inference of binding sites is presented in detail. Specifically, finding conserved motifs in genomic sequences represents one of essential bioinformatic problems. However, achieving high discovery performance without imposing substantial auxiliary constraints on possible motif features remains a key algorithmic challenge. We present BAMBI—a sequential Monte Carlo motif identification algorithm, which is based on a position weight matrix model that does not require additional constraints and is able to estimate such motif properties as length, logo, number of instances and their locations solely on the basis of primary nucleotide sequence data. Furthermore, should biologically meaningful information about motif attributes be available, BAMBI takes advantage of this knowledge to further refine the discovery results. In practical applications, we show that the proposed approach can be used to find sites of such diverse DNA-binding molecules as the cAMP receptor protein (CRP) and Dint-family site-specific serine recombinases.

Speaker: Xiaodong Wang received the Ph.D degree in Electrical Engineering from Princeton University. He is a Professor of Electrical Engineering at Columbia University in New York. Dr. Wang's research interests fall in the general areas of computing, signal processing and communications, and has published extensively in these areas. Among his publications is a book entitled “Wireless Communication Systems: Advanced Techniques for Signal Reception”, published by Prentice Hall in 2003. His current research interests include wireless communications, statistical signal processing, and genomic signal processing. Dr. Wang received the 1999 NSF CAREER Award, the 2001 IEEE Communications Society and Information Theory Society Joint Paper Award, and the 2011 IEEE Communication Society Award for Outstanding Paper on New Communication Topics. He has served as an Associate Editor for the IEEE Transactions on Communications, the IEEE Transactions on Wireless Communications, the IEEE Transactions on Signal Processing, and the IEEE Transactions on Information Theory. He is a Fellow of the IEEE and listed as an ISI Highly-cited Author.