Intelligent Algorithms Genomics and Precision Medicine

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Although the next generation of genomic and sensing technologies produce entire genome, transcriptome, or exome and a deluge of physiological, imaging and clinical multiple phenotypes data, the current paradigm for analyzing these data is association analysis. The use of association analysis as a major analytical platform for omics and imaging analysis, diagnosis, prediction, and treatment development of complex diseases is unable to discover the mechanism of diseases and is a key issue that hampers discovery of the mechanism and efficient treatments of diseases. To overcome these barriers, it is time to take intelligent alternative approach to genomic data analysis and precision medicine and change the current paradigm of data analysis. In this talk, I will address the major issues in changing paradigm from association analysis to intelligent inference. I will discuss to develop a general framework to integrate deep learning, generative adversarial networks (GANs) and causal inference, and to use intervention calculus as a general framework to unify five school of causal inference: Bayesian networks, structural equation models (SEMs), counterfactuals, functional additive models and GAN Approach, and to show that Mendelian randomization and mediation analysis are special cases of SEMs. To illustrate these developments, I will present the results of real genome-wide causation studies, epigenomic-wide causation studies of complex diseases, integrated deep learning for disease prediction and causal interpretation, whole genome causal omics and clinical data analysis, dynamic causal networks for joint genetics-imaging-phenotypes-disease analysis in longitudinal studies, deep learning in single cell data analysis, counterfactual and individualized treatment effect estimation, and individual optimal treatment selection.