Patient Type Bayes-Adaptive Treatment Plans: The Case of Chronic Kidney Disease

Presented by:
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Patient heterogeneity in disease progression is prevalent in many settings. Treatment decisions that explicitly consider this heterogeneity can lower the cost of care and improve outcomes by providing the right care for the right patient at the right time. In this study, we analyze the problem of designing ongoing treatment plans for a population with heterogeneity in disease progression and response to medical interventions. We create a model that learns the patient type by monitoring the patient health over time and updates a patient’s treatment plan according to the gathered information. We formulate the problem as a multivariate state-space, partially observing Markov decision process (POMDP) and provide structural properties of the value function, as well as the optimal policy.

We extend this modeling framework to a general class of treatment initiation problems where there is a stochastic lead-time before a treatment becomes available or effective. As a case study, we develop a data-driven, decision-analytic model to study the optimal timing of vascular access surgery for patients with progressive chronic kidney disease, and we establish policies that consider a patient’s rate of disease progression in addition to the kidney health state. To circumvent the curse of dimensionality of the POMDP, we develop several approximate policies, as well as simpler heuristics, and evaluate them against a high-quality lower-bound. Through a numeric study and several sensitivity analyses, we establish the high quality and robustness of an approximate policy that we develop. We provide further policy insights that sharpen existing guidelines for the case-study problem.

About the Speaker:
Dr. Reza Skandari completed his PhD in Management Science at the Sauder School of Business, University of British Columbia. He is currently a post-doctorate research fellow at the Department of Medicine, University of Chicago. His research is broadly focused on decision making under uncertainty and optimal learning, with applications to healthcare operations management and analytics. One line of his research focuses on designing treatment plans for patients with heterogeneous chronic disease progression and treatment lead-times. Another line of his research investigates the optimal assignments of patients to primary care providers targeting improved timely access and continuity of care, balanced provider workload, and decreased provider burnout. He is also involved in a project studying the optimal deployment and staffing of a hospital’s rapid response team to minimize hospital cardiac arrests. Methodologically, he has used various analytics tools including partially observable Markov decision processes, simulation, statistics, and machine learning. Reza’s research has been published in Manufacturing & Service Operations Management and Computers & Operations Research, as well as top medical journals including the Annals of Internal Medicine and American Journal of Kidney Diseases.