Optimizing Dynamic Resource Allocation: Models and Insights for Chronic Disease Care

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Abstract: Dynamic resource allocation problems for chronic disease management have received much attention due to excessive healthcare costs and poor quality of care. The goal is to identify optimal intervention strategies under resource constraints to improve population health outcomes over time, while accounting for patients' heterogeneity in disease progression and population dynamics. The problem is challenging due to the complex disease trajectories, unclear intervention priorities, and uncertain intervention effects. I present two applications under U.S. healthcare settings. *First*, I discuss our current research on designing predictive and optimization models to adaptively monitor chronically depressed patients. Mitigating depression has become a national health priority as it affects 1 out of 10 adults in the U.S. Prognostic-based monitoring that stratifies patients' disease risk and adaptively allocates intervention resources to high-risk patients can improve overall health outcomes. Our objective is to translate electronic health record data into solutions regarding who should be monitored and how often, and study how cost-effective these adaptive monitoring strategies could be. *Second*, I present our current research on designing an efficient algorithm for hepatitis C screening and treatment policy implementation. We consider a discrete-time finite-horizon budget allocation problem within a closed birth-cohort population. To address the computational challenges associated with large-state and multiple-period dynamic decision-making problems, we propose a low fidelity value approximation that preserves the population dynamics under a stationary policy. We then embed the low fidelity value approximation into the high fidelity optimization model to efficiently identify a good non-stationary sequential intervention policy. We show how our approach scales well to problems with high dimensionality due to many decision periods.

Bio: *Shan Liu* is an assistant professor of Industrial & Systems Engineering at the University of Washington. She received her Ph.D. in Management Science & Engineering from Stanford University, a S.M. in Technology and Policy from MIT, and a B.S. in Electrical Engineering from The University of Texas at Austin. Her research focuses on the evaluation of new medical technologies and healthcare interventions to improve patients' health and enable cost-effective care delivery. She develops methods in optimization, decision analysis, and systems modeling to solve both clinical decisions and population health policy problems. In particular, she is interested in building decision theory and applied mathematical models for optimal disease management when there is rapid technological development. Prof. Liu has collaborated with the Stanford Center for Primary Care and Outcomes Research, the Veteran Affairs Palo Alto Health Care System, Department of Radiation Oncology at the UW, and the Kaiser Permanente Washington Health Research Institute in Seattle. She is a member of the Institute for Operations Research and the Management Science (INFORMS), the Society for Medical Decision Making (SMDM), Institute of Industrial and Systems Engineers **(**IISE), and the Tau Beta Pi Engineering Honor Society.