Industrial & Systems Engineering

Seminar Announcement

Valuing Prearranged Paired Kidney Exchanges: A Stochastic Game Approach

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Abstract: End-stage renal disease (ESRD) is the ninth-leading cause of death in the U.S. Transplantation is the most viable therapy for ESRD patients, but there is a severe disparity between the demand for kidneys for transplantation and the supply. This shortage is further complicated by incompatibilities in blood-type and antigen matching between patient-donor pairs. Paired kidney exchange (PKE), a cross-exchange of kidneys among incompatible patient-donor pairs, overcomes many difficulties in matching patients with incompatible donors. PKEs have grown rapidly over the last two decades. In a PKE, transplantation surgeries take place simultaneously, so that no donor may renege after his/her intended recipient receives the organ. Although others have modeled PKEs, we are the first to consider patient autonomy and the timing of the exchange. As current PKE practice aims to maximize only the number of transplants, the question of determining a more accurate value of a match remains unclear.

We consider a cyclic PKE with an arbitrary number of patients and construct life-expectancy-based edge weights under patient autonomy. Because the patients' health statuses are dynamic, and transplantation surgeries require compatibility between the patients' willingnesses to exchange, we model the patients' transplant timing decisions as a stochastic game in which each patient aims to maximize his/her life expectancy. We explore necessary and sufficient conditions for patients' decisions to be a Nash equilibrium, and formulate a mixed-integer linear programming representation of equilibrium constraints, which provides a characterization of the socially optimal equilibria. We empirically confirm that randomized strategies do not yield a social welfare gain over pure strategies. We also quantify the social welfare loss due to patient autonomy and demonstrate that maximizing the number of transplants may be undesirable. Our results highlight the importance of the timing of an exchange and disease severity on matching patient-donor pairs.

Bio: *Murat Kurt* is a Scientist of Outcomes Research at Merck & Co. He earned his PhD in Industrial Engineering at the University of Pittsburgh and served as a faculty in Industrial and Systems Engineering at the University at Buffalo prior to joining Merck. His research interests involve the implementation of Markov decision processes and mathematical programming on medical decision making, scheduling and service operations problems. His research in applied health sciences span varying contexts from treatment planning for Type 2 diabetes and colorectal cancer patients to the timing of kidney exchanges for end-stage renal disease patients. His research on healthcare applications has been recognized by the IIE's Pritsker Doctoral Dissertation Prize and INFORMS Service Science Section's Best Paper Awards as well as Seth Bonder Scholarship in Applied Health Sciences.

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