Modeling of fairness for the kidney exchange problems with multiple agents*

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Kidney Exchange Programs (KEP) run in several countries and represent an alternative of transplant for patients in need of a kidney, with a willing donor that is physiologically incompatible with he/she, to still be transplanted. The underling optimization problem aims at maximizing the number of exchanges between such incompatible pairs. The problem can be represented on a directed graph and an exchange is a cycle in a graph. Nowadays it is common practice to include into KEP altruistic donors, persons willing to donate one of their kidneys, with no associated patient. Such donors may initiate a chain of exchanges, where the donor from the last incompatible pair donates to the first compatible patient in a waiting list. Bounds K and L are normally imposed on the length of cycle and chain, respectively, due to practical limitations. The kidney exchange problem is to find a set of vertex disjoint cycles and chains each of length at most K and L, respectively, that maximizes the total number of pairs in exchanges.

In a multi-agent framework we have a set of such programs that intent to collaborate jointly in order to increase total number of transplants performed. When maximizing the total number of transplants for the multi-agent pool, there may exist multiple optimal solutions, and some may benefit one agent more than others. It is essential to develop a procedure that ensures the selection of an optimal solution that will benefit equally all the agents in a long-term run. In this work, we considered different policies for pool management. To model the problem we used Integer Programming and proposed different models for fair distribution of transplants among agents. The models were validated and compared through exhaustive computational experiments.

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