

Abstract

New challenges in kidney exchange: theory and practice

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Unfortunately, there are more and more patients whose only chance for survival is kidney transplantation. But even if they find a relative or friend who is willing to donate a kidney, it is very common that they are not compatible. The essence of *kidney exchange* is that if we match such incompatible pairs cleverly, then by switching the donors, the patients can receive a compatible kidney. Kidney Exchange Programs are organized in several countries to help matching these pairs. My external supervisor is working on the launching process of such a program in Germany, because surprisingly the country has no kidney exchange activity so far.

As the matching requires the comparison of the medical data of all the patients, it cannot be done by hand. My task was to write a computer program for this purpose, which they could use in Germany. The creation of the program required lots of research in the background of kidney exchange.

In the thesis, after introducing the medical background, I detailed different mathematical models, which can be used for modelling the problems of kidney exchange. Then, I studied a recent advancement, the immunosuppressant treatment, and the graph theory behind it. Besides the proved theorems connected to kidney exchange with immunosuppressants, I stated an open question, the problem of h -MAXKEI in the general model. I concluded that solving this open problem would be a big step towards the proof of the BUDGETED MATCHING problem, which is a well-studied unsolved graph problem. I explained this problem as well, moreover I also detailed the results about its complexity.

After the theoretical part, the explanation of the program code followed. The main point of the program is that it calculates a maximum matching among the pairwise exchange options of the participating pairs, which was the desired result. With the growth of the German kidney exchange activity, further development of the program might become necessary, which foreshadows future work.

Further research in the theoretical part can be done as well. Giving a polynomial time algorithm for h -MAXKEI in the general model is an interesting challenge. Also, the development of medical science will always supply this area of mathematics with new challenges.