Fairness & Efficiency in Kidney Allocation

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Background

Current policies and systems for organ allocation (at least for kidneys) utilize a point system or scoring-based policies. Each patient/organ combination receives a Kidney Allocation Score (KAS) that factors score components and constant score weights. Their score is a sum of their different components and weights. The current U.S. policy, which is over 20 years old, utilizes waiting time, sensitization (how compatible a given patient is with a given organ), and tissue matching. However, as Bertsimas et al. [1] point out, advances in medicine (such as those that prolong survival of patients on dialysis), as well as long wait times, render the current policy “inappropriate.” It is not fully and adequately serving the needs of those in the kidney allocation system. Furthermore, there are discrepancies in who is served by our current kidney allocation systems; "Greater than 50% of patients awaiting kidney transplantation in the United States are ethnic minorities with African Americans (AAs) constituting >33% of those on the waiting list."

Our Measurements

We are focusing on two facets of measurement: factor posited by our simulation (defined below), and the question of fairness vs. efficiency.

Simulation factors. w_LYFT: Life years from transplant, equal to the expected incremental quality-adjusted life-years gain compared to remaining on dialysis
w_DT_DPI: Donor profile index, indicating the quality of the donated organ
w_DT: Dialysis time, which is equal to the years patient p has spent on dialysis
w_CPRA: Calculated panel reactive antibody, measuring the sensitization of the patient [1]

Fairness vs. Efficiency. Much of our current study in systems optimization highlights the tradeoff of fairness vs. efficiency in optimization algorithms. Typically, higher efficiency means less fairness (i.e., a very fast and efficient kidney allocation algorithm may overserve patients of a particular blood type, but an algorithm that fairly serves all demographics may take far too long to run in practice).

Future Work

In the future, we hope to expand the interactive aspects of this project, perhaps culminating in a web app or other interactive application. We would also like to further highlight the issues of social justice that optimization algorithms often leave behind, and incorporate these themes into our analysis of a “fair” algorithm versus an “efficient” one.

Implementation

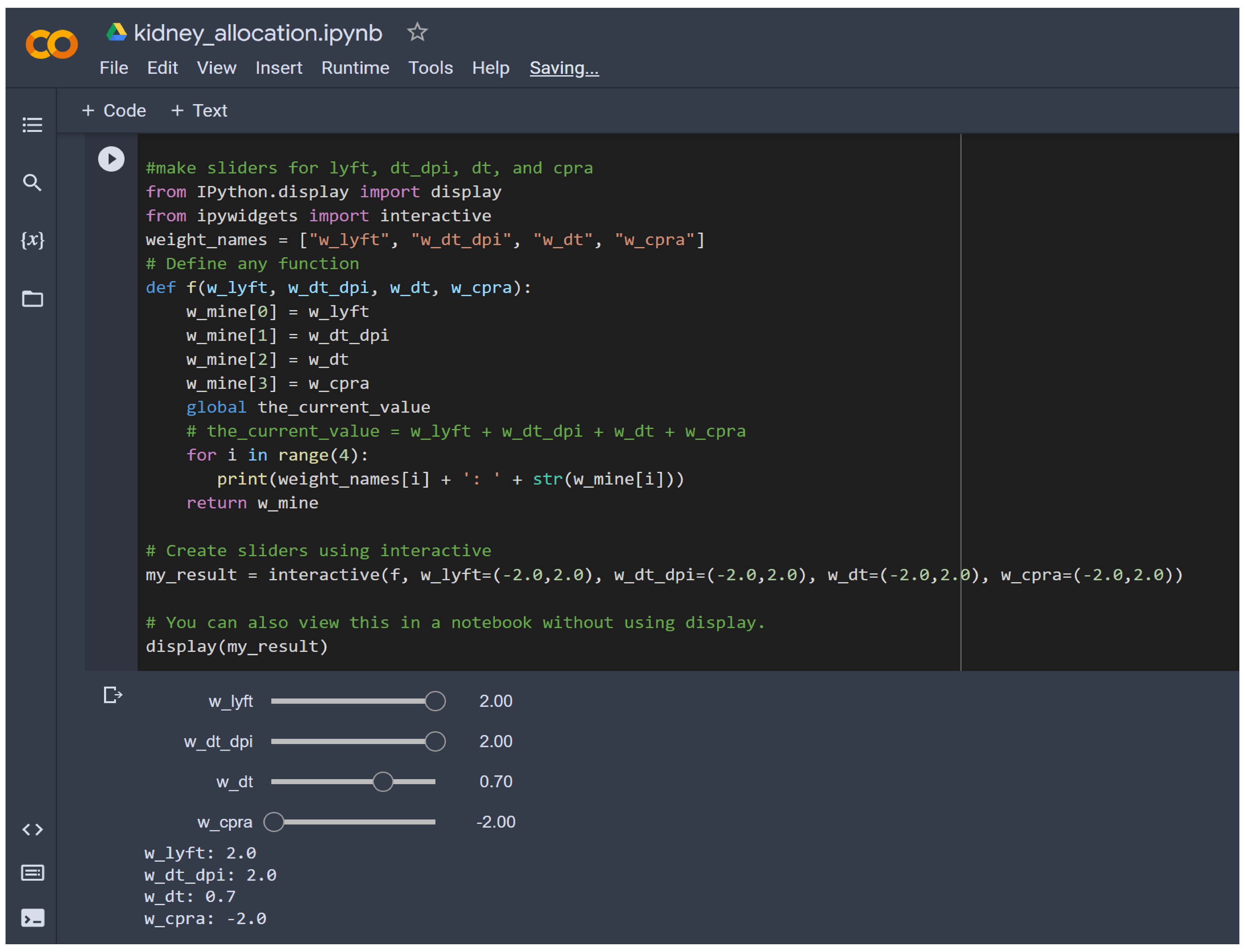

Fig. 1: Interactive Google Colab (Jupyter) notebook

We have created a Google Colaboratory notebook, coded in Python, to explain to our audience how a sample kidney allocation system under [1] may function. This notebook includes interactive features, such as sliders and buttons, that allow users to visually manipulate values that are later graphed in the code.

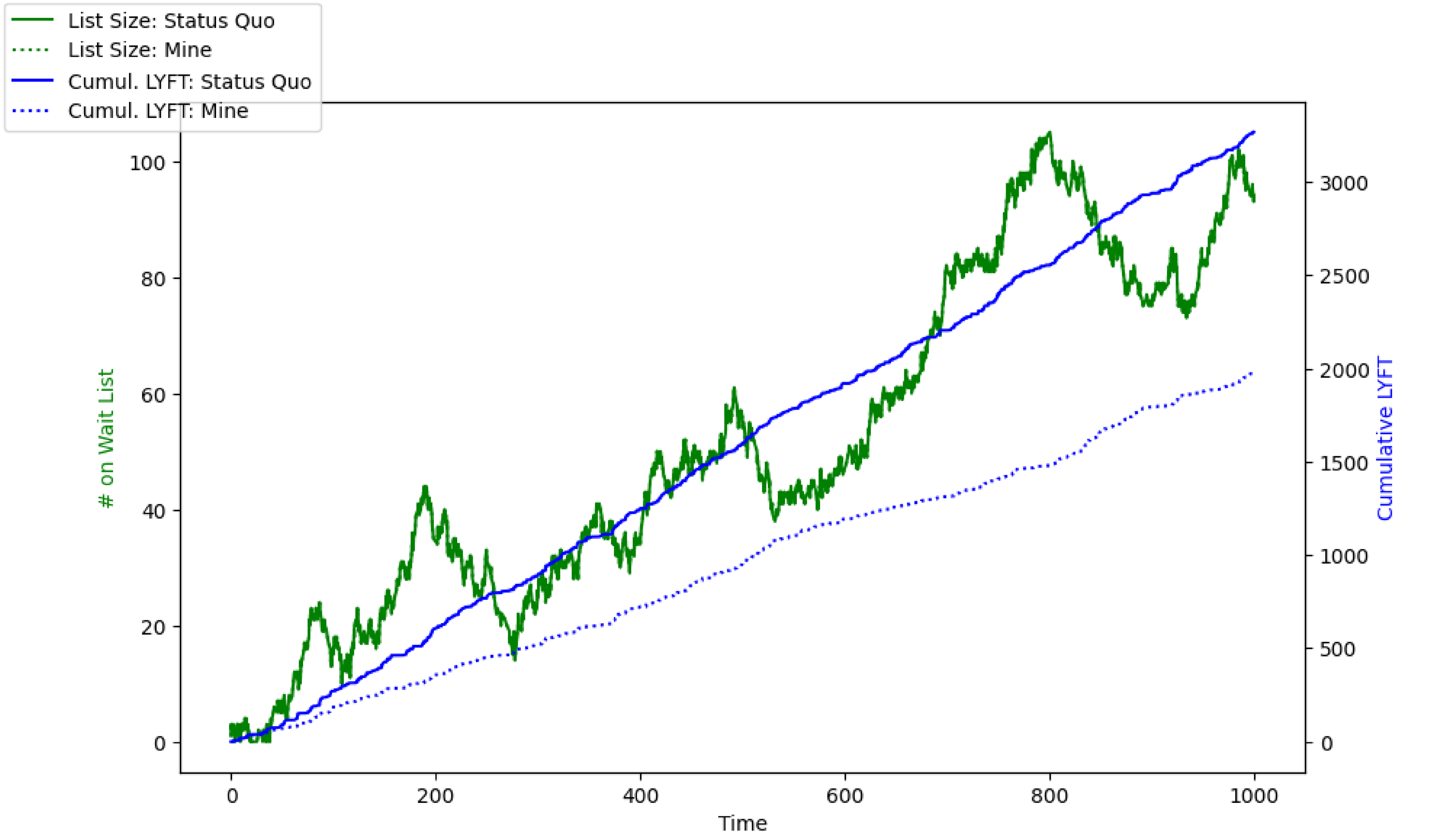

Fig. 2: User’s values from Fig. 1 are fed into a graph displaying LYFT for a sample group of patients versus with the user’s weights

References

[1] Dimitris Bertsimas, Vivek F. Farias, Nikolaos Trichakis, (2013) Fairness, Efficiency, and Flexibility in Organ Allocation for Kidney Transplantation. Operations Research 61(1):73-87. https://doi.org/10.1287/opre.1120.1138
[2] Harding, Kimberly et al. “Health Disparities in Kidney Transplantation for African Americans.” American journal of nephrology vol. 46,2 (2017): 165-175. doi:10.1159/000479480

Acknowledgment(s):

IDEAS Undergraduate Research Symposium, Lehigh University

Prof. Bill Best, Hinata Moriyama (Tokyo Institute of Technology), Josie & Charlotte Rabeno

LEHIGH UNIVERSITY