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Project Type: Master Thesis

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Algorithmic Fairness in Organ Allocation Support

Background

Heart transplantation is a life-saving procedure for patients with end-stage heart failure, but the demand for donor hearts far exceeds the available supply. The allocation of donor organs for transplantation is a critical process that must balance medical urgency and ethical considerations. The United Network for Organ Sharing (UNOS) oversees the organ allocation process in the United States, maintaining a comprehensive database that includes detailed information on transplant candidates, donors, and outcomes for multiple thousands of patients. Initial modeling efforts using this database revealed that many top ranking features predicting 1-year patient survival rates included ethnicity, age, and gender, raising significant ethical concerns due to their potential to introduce bias. This project focuses on the application of fairness-aware machine learning techniques to investigate fairness of current allocation practice, with a specific focus on heart transplants using the UNOS database.

Goals

This project connects advances in the field of fair machine learning (fair ML) with predictive models to support organ allocations, which presents a highly sensitive and impactful context. While fair ML research has developed a comprehensive toolkit for conceptualizing, quantifying and mitigating bias in data and algorithmic outputs (Mehrabi et al. 2022, Mitchell et al. 2021), fairness considerations are highly context-specific and thus the selection and implementation of fairness-aware ML techniques needs to be carefully evaluated within the specific application context. The goal of this project is to critically evaluate ML models for predicting patient survival rates through the lens of algorithmic fairness and to implement fairness-aware ML techniques to mitigate potential fairness concerns in organ allocation support. Specifically, the project includes the following steps:

- Identifying sensitive features/ protected attributes in patient survival models and potential biases in the UNOS database
- Evaluate patient survival models developed based on the UNOS database with respect to fairness metrics and subgroup prediction performance
- Implement fairness-aware machine learning algorithms to build more equitable models of patient survival to support organ allocation decisions

References

Mehrabi, N., Morstatter, F., Saxena, N., Lerman, K., and Galstyan, A. (2022). A Survey on Bias and Fairness in Machine Learning. *ACM Computing Surveys* 54, 6, Article 115. <https://doi.org/10.1145/3457607>

Mitchell, S., Potash, E., Barocas, S., D'Amour, A., & Lum, K. (2021). Algorithmic fairness: Choices, assumptions, and definitions. *Annual review of statistics and its application*, 8(1), 141-163.