Thesis Project Portfolio

Development of Deep Learning Models for Predicting Cardiac Related Outcomes

(Technical Report)

Gender Bias in AI-Powered Cardiac MRI Diagnostics: Examining Disparities in Medical Outcomes

(STS Research Paper)

An Undergraduate Thesis

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Sociotechnical Synthesis

Introduction

Artificial intelligence (AI) has had a significant impact on cardiac medicine, enhancing diagnosis, treatment planning, and patient care across multiple clinical settings. Such major advances include increased ability for interpreting data from MRIs and ECGs to predict clinical outcomes such as. In this portfolio, I present two complementary reports that explore both the societal implications of AI in cardiovascular care and a technical analysis of my deep learning contributions to this rapidly evolving field.

Technical Project

In the technical report, I address three critical challenges in cardiovascular medicine through advanced AI techniques: optimizing patient selection for cardiac resynchronization therapy (CRT), improving risk stratification for implantable cardioverter-defibrillator (ICD) placement, and differentiating between genetic cardiomyopathy, cardiac sarcoidosis, and myocarditis. Current selection criteria for CRT based on QRS duration and morphology result in 30-40% of patients showing minimal benefit, while LVEF-based ICD placement fails to protect many at-risk patients while subjecting others to unnecessary procedures. I specifically develop models for ventricular arrhythmia prediction using scar imaging techniques, along with a convolutional neural network (CNN) for ECG analysis to improve ICD candidate identification and cardiomyopathy differentiation. With approximately 200,000 CRT devices and 150,000 ICDs implanted annually worldwide, my improved selection algorithms could significantly impact clinical decision-making, reduce healthcare costs, minimize procedural complications, and ultimately enhance patient outcomes through more personalized cardiac care.

STS Project

In this STS paper, I examine how AI-powered cardiac diagnostic systems reinforce gender bias, leading to poorer healthcare outcomes for women. I identify multiple factors contributing to this bias. Historical cardiac research and standardized models have prioritized male anatomy, creating fundamental knowledge gaps about female cardiovascular disease. Medical institutions have systematically underrepresented women in clinical trials and standardized cardiac care based on male presentations, labeling female symptoms as "atypical." I show how these biases transfer into AI systems through training data that reflects decades of gender-biased clinical practice and documentation. I analyze this evolution through a historical review spanning from the 1950s to present, tracing how power structures in medicine shaped both cardiac knowledge and AI development. My analysis reveals how intersectionality compounds these disparities, with particularly severe consequences for Black women from lower-income communities. I conclude that addressing gender bias in cardiovascular AI requires more than technical fixes—it demands fundamental reforms in data collection, medical education, and AI development processes that recognize women's cardiac presentations as equally valid rather than deviations from a male norm.

Relation of STS and Technical Project

These projects relate to one another as they address important dimensions of implementing AI in cardiovascular medicine. While my technical project focuses on developing specialized deep learning models to solve specific clinical challenges in cardiac care (patient selection for life-saving interventions, risk stratification, and disease differentiation), my STS paper examines how model development can amplify biases. Together, they demonstrate that effective AI implementation requires both technical innovation and critical social awareness. The technical advances I develop for predicting ventricular arrhythmias and differentiating cardiomyopathies could significantly improve patient outcomes, but their effectiveness ultimately depends on the quality and representativeness of the training data. My STS research reveals how historical biases in cardiac knowledge (particularly the prioritization of male anatomy and symptoms) create fundamental gaps that AI systems inherit and sometimes amplify. This shows that algorithms can reinforce inequitable outcomes if developed without addressing underlying systemic biases. The relationship between these projects highlights a crucial insight: advancing healthcare through AI requires not only adapting algorithms to specific clinical problems but also rigorously examining the knowledge frameworks upon which these technologies are built to ensure they serve all patients equitably.