Thesis Project Portfolio

Machine Learning Algorithm for the Analysis of Cardiac Tissue Cross Sections

(Technical Report)

The Affordable Care Act's Mandatory Health Insurance Requirement and Penalties and the Causes of Its Abolition

(STS Research Paper)

An Undergraduate Thesis

Presented to the Faculty of the School of Engineering and Applied Science

University of Virginia • Charlottesville, Virginia

In Fulfillment of the Requirements for the Degree

Bachelor of Science, School of Engineering

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Spring, 2024

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Executive Summary

Introduction

For my technical project, my team produced an automated cell imaging pipeline that can quantify cardiomyocyte (CMC) populations and nuclear content. Medical researchers and pharmaceutical manufacturers will benefit from my project through the ability to conduct high-throughput studies of drug effects in vivo, and patients will benefit from the improved drug development and cheaper development process. From the analysis of the imposition and relinquishment of the ACA's mandatory insurance requirement in my STS project, government officials and policy makers, healthcare providers, and patients will benefit due to a better understanding of sociological conditions that govern the implementation, effectiveness, and public opinion of policy decisions. The technical and STS projects combine to address accessibility issues in healthcare and enable the expansion of the quality and affordability of treatment as well as equity in healthcare, respectively.

Capstone Paper Summary

Hypertrophic cardiomyopathy (HCM) is the hypertrophy, or cell growth, of cardiomyocytes (CMCs), or heart muscle cells, in response to damage and cell death within the heart. The hypertrophy of CMCs, while strengthening the heart contractions to compensate for the lower number of present CMCs, alters the heart's architecture and leads to other health complications, such as diastolic dysfunction, obstructions, and arrhythmias. The Wolf Lab at the University of Virginia is currently developing drugs to treat HCM by both ameliorating CMC hypertrophy and promoting CMC proliferation to replenish the cells that died over the course of the injury. To test the efficacy of drug candidates, the Wolf Lab performs in vivo testing on mice which have been genetically modified to have HCM. They then take tissue slices from the mouse

hearts, stain them, and examine the cardiac tissue under a microscope. The current method for quantifying hypertrophy employed by the Wolf Lab is to select 30 cells at random and measure them by hand. This process is time consuming and is vulnerable to bias and human error. Our capstone project developed a machine learning algorithm approach to objectively segment and quantify hypertrophy and nuclear content of CMCs in the tissue slice images. The algorithm will save researchers time by allowing for high throughput testing of HCM drugs while also providing more data points and greater objectivity to the measurements taken.

STS Research Paper Summary

To combat the increasing cost of healthcare in the United States and issues with accessibility, Congress enacted the Affordable Care Act (ACA) in 2010, which included a provision making health insurance mandatory for everyone under threat of monetary penalties. The insurance mandate was later repealed in 2019; however, the remainder of the ACA remained intact. This research paper examines the question: how did changes in social, economic, and political attitudes result in the repeal of the federal mandatory healthcare insurance requirement in 2019? The paper uses Actor Network Theory (ANT) to study the relationships between key actors and institutions that exist within the broader healthcare network and how they resulted in the elimination of the mandate. ANT emphasizes relationships rather than individuals and acknowledges the dynamic nature of these relationships, so this framework is ideal for exploring major turning points and changes in public policy and the healthcare system. This paper aims to identify key actors, both human and non-human, within the network, the effects of the mandate on society and the healthcare system before its repeal, and the interplay between actors that resulted in the mandate's abolition. By tying together actors in the social, economic, and political

realms, this research provides a single, cohesive analysis for a major shift in the institution of healthcare in the United States.

Reflection

Working on the Capstone and STS projects together has given me a better understanding of both the drug development process and how patients interact with healthcare systems. Aside from the chemistry and laboratory testing that is normally associated with drug development, the imaging, data processing, and coordination between researchers are essential for the success of a project. Though data analysis is a less visible element of drug discovery, it is critical for the proper interpretation of data and the correct guidance for future directions of the project. While my Capstone project focused on the early stages of drug testing, my STS project investigated patient treatment and public policy decisions that impact the accessibility of healthcare to the public, specifically through changes to the health insurance industry. Because curing patients is the goal of medicine, the management and allocation of healthcare resources is just as important as the discovery of new treatment methods. Together, these projects gave me a more complete view of the healthcare system and how individual researchers, physicians, patients, and institutions interact in a complex network from the beginning of therapeutic research to the management of its administration to human patients.