

Thesis Portfolio

**Infectious Diseases Data Analysis Program: A Proof
of Concept for User-Friendly Patient Data Analysis**
(Technical Report)

**The Ethical Analysis of Introducing Artificial
Intelligence into Healthcare**
(STS Research Paper)

An Undergraduate Thesis
Presented to

The Faculty of the
School of Engineering and Applied Science
University of Virginia

In Partial Fulfillment
Of the Requirements for the Degree
Bachelor of Science in Biomedical Engineering

By Michael Hughes

May 8th, 2020

Technical Team Members:
Michael Hughes
Jessica Mahoney
Elnaz Ghajar-Rahimi

TABLE OF CONTENTS

SOCIOTECHNICAL SYNTHESIS

INFECTIOUS DISEASES DATA ANALYSIS PROGRAM: A PROOF OF CONCEPT FOR USER-FRIENDLY PATIENT DATA ANALYSIS

with Elnaz Ghajar-Rahimi, Jessica Mahoney

Technical advisor: Jason Papin, Department of Biomedical Engineering

THE ETHICAL ANALYSIS OF INTRODUCING ARTIFICIAL INTELLIGENCE INTO HEALTHCARE

STS advisor: Kent Wayland, Department of Engineering and Society

PROSPECTUS

Technical Advisor: Jason Papin, Department of Biomedical Engineering

STS advisor: Kent Wayland, Department of Engineering and Society

My technical work and my STS research are connected through the pursuit of diagnostic software, and exploring what implications such software or programs may have on the future of patient care. The mission for healthcare providers around the world is and has been to ensure that patients in the healthcare system are receiving the highest quality care possible. In today's day and age, every patient comes with a large amount of data that details the history of the patient's ailments, injuries, and care. In order for clinicians to provide the highest quality care tailored to each patient's needs, a great understanding and thorough analysis of such data are required. This means keeping accurate patient records, being able to access them quickly and easily, and being able to make sense of the data provided. Presently, there are inefficiencies in the way in which clinicians extract, visualize, and use data making it more difficult for them to make critical decisions. My technical project focuses on what kinds of programs would be helpful to clinicians in analyzing patient data, whereas my STS research uncovers the implications such programs, as well as more advanced ones, would have on the healthcare sector. Overall, both projects, despite approaching the problem from different angles, are centered around improving the quality of care for patients.

The technical work done in this project provides clinicians with a tool to better organize, visualize, and analyze data. The Infectious Diseases Data Analysis Program (IDDAP) is a supplemental material to work in coordination with the well-established electronic health records (EHR) system called EPIC. EPIC, a software that supports hospitals across the nation, is known by clinicians around the country to be complicated and confusing. It also lacks a way for clinicians to access and analyze patient data. My capstone team created IDDAP to provide clinicians with a meaningful way to analyze groups of data in order to understand how patients are affected by a variety of factors. My team utilized the host of packages included in RStudio to

develop the interactive web app. The app has so far been shown to accomplish common data analysis tasks that clinicians and researchers regularly perform faster than traditional methods and has shown to be both intuitive and user friendly. As this program is currently designed for use in infectious disease, we hope that it is a starting point for programs that can be made for all areas of healthcare research.

My STS research project provides an understanding of the ethical standing artificial intelligence has as it is considered for its use in healthcare. Historically, society has held the view that the more technology advances, the better off society will be. Advances in technology have brought us the combustion engine, the internet and so many other things we cannot live without. Many times, advances in technology are incredibly helpful; however, this is not always the case. Advancing technologies in industries such as healthcare can have sweeping effects on aspects that carry a lot of weight such as the life of a patient. Introducing such a disruptive technology like AI into healthcare can greatly affect the quality of care patients receive. Deontological ethics and utilitarian ethics were used in order to analyze the ethical questions that arise with such a technology. These two ethical lenses agree and contrast each other on specific ethical issues that AI in healthcare brings. Overall, it was determined that several ethical lenses should be used to analyze looming ethical questions such as those regarding privacy, accountability and program accuracy. Theories such as virtue ethics, egalitarianism and ethics of rights would provide even further understanding to the explanations given by utilitarianism and duty ethics.

These projects have added value to the assessment of programs for clinical use. The IDDAP development was completed for use in the OPAT program run by Dr. Joshua Eby in the Infectious Diseases Department at the University of Virginia. Due to the limitations presented by the COVID-19 pandemic, not all goals for the program were met; however, the program serves

as an excellent starting point for further development of patient data analysis programs for use in all areas of healthcare. The research done on the ethical standing of more advanced diagnostic programs, ones that may use AI, furthered the understanding surrounding the ethics of AI. The work done on both projects in tandem provided a better understanding of the topic. By having a ‘tangible’ program to work with I was able to better grasp how these programs would be used, and by performing more abstract ethical analysis I was able to better tailor the features of the IDDAP to fit the needs of society. Both projects would benefit from further development by expansion. The IDDAP has great potential for use in all areas of healthcare by expanding filter requirements and broadening the programs search criteria, and the ethical research can be advanced by analyzing the still looming ethical questions through other ethical lenses.