Thesis Project Portfolio

An Automated Machine Learning Pipeline forMonitoring and Forecasting Mobile Health Data

(Technical Report)

Institutional Federalism Limits Implementation of Telehealth in the United States

(STS Research Paper)

An Undergraduate Thesis

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

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Bachelor of Science, School of Engineering

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Sociotechnical Synthesis
(Executive Summary)

Implications of Implementing Telehealth

The emergence of new telehealth technologies in the twenty-first century has led to a spike in awareness and promotion. The term telehealth has evolved since its first use in the early twentieth century to include services like mobile health. The COVID-19 pandemic has also increased telehealth usage. I originally planned to gather data about how the University of Virginia was changing its mental health resources but I received very little to analyze. Both of my projects focus on different aspects of telehealth. For the technical project, my team and I produced an automated machine learning pipeline for continuous processing of mobile health data which was tested on real-time assessment of adolescent depression. My STS research focused on what the limitations are for the implementation of telehealth in the United States.

There are many tools for mobile health data collection and processing but these remain offline and ad hoc. The technical project addresses this gap by presenting an automated machine learning pipeline for continuous and real-time collection, processing, and analysis of mobile health data. Our design was broken into four main sections, the first being data collection where we used AWARE to collect passive sensing mobile data and RedCap to collect patient's PHQ-9 scores securely. The main task was to prepare this data for signal processing. To do this we copy the data from the existing source, InfluxDB, to MySQL. The second step was data processing for which we used Rapids to extract features related to physical activity, phone usage, and sleep from the AWARE data which is connected directly to a MySQL database. Thirdly, XGBoostRF was selected as the best-performing machine learning algorithm. Lastly, the machine learning output was fed into the pipeline to our website for data visualization to the patient, clinician, and caregiver.

Telehealth has seen many roadblocks on its journey toward full implementation in the United States healthcare system. My STS research explores whether or not these roadblocks are due to the structure of the United States healthcare system. Mesthene (1969) presents a framework for

analyzing a proper economic and political organization which highlights the complexity of the different state and federal regulations holding implementation back. My analysis of the limitations of implementation suggests that the reason why implementation of telehealth is difficult is not because the United States does not have universal health care it is because there are varying regulations between state and federal government.

My analysis of the limitations of the implementation of telehealth places serious thought about whether the automated machine learning pipeline be limited in its implementation. This pipeline is not limited to depression, but it can be adapted for other mental health diagnoses. Different states having different regulations over telehealth including mobile health will limit those whose providers do not cover this service. As engineers, I've learned that we must always think about all possible outcomes of our product, design, or service to ensure that we solve the entire sociotechnical problem. Being aware of all the outcomes will put into perspective who will use and how they will use your product, design, or service.

References

Mesthene, E. (1969). Some General Implications of the Research of the Harvard University Program on Technology and Society. *Technology and Culture, 10*(4), 489-513. doi:10.2307/3101569