Thesis Portfolio

Adaptive Mobile Sensing: Leveraging Machine Learning for Efficient Human Behavior Modeling
(Technical Report)

What Sensitive Data-Sharing Examples Tell Us About the Potential for a National Health Monitoring System in America
(STS Research Paper)

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In recent years, technology has become so intertwined in people's lives, that millions of Americans have become dependent on such information, such as fitness analytics or sleep trackers (Sapacz, Rockman, and Clark, 2016). Coupled with a continuously advancing healthcare field, it is possible for healthcare organizations to rely on these devices to collect data and monitor patient activity for their benefit, but with increasing data privacy regulations, it is understandable why the healthcare field is so cautious. My technical paper focuses on a system that is currently being studied regarding students living on college campuses. Through an application on participant's phones, we are able to collect various types of data that allow us to have a better understanding of their movements and activity throughout the day. This will hopefully allow us to detect an illness or injury before the participant detects it themselves. Our team's main focus is how best to optimize battery usage while collecting this data. The STS research portion will focus on the feasibility of expanding this to a national health system by looking at other examples of similar systems that have been implemented. My technical team is already struggling with privacy issues and how to anonymize the information that we are collecting, so it led me to think about if this would even be possible at a national level if there are already privacy concerns with paid participants. With the research I will perform, I hope to explore the existence of a perfect balance between leveraging the power of smart devices while also avoiding any privacy concerns from participants.

My technical project provides a framework for how smartphone sensor data can be collected, cleaned, stored, and modeled to effectively predict human states as a step towards health monitoring. To develop robust contextual models, a three-week study was conducted to collect data through a mobile crowdsensing application named Sensus. In this study, participants used multiple sensing strategies, ranging from infrequent sampling to continuous sampling, to

determine the effect each has on data integrity and battery life. For a future study, a dynamic data collection strategy was developed that uses a machine learning model trained on existing data collected from participants to forecast when a smartphone will be active and trigger sensor sampling accordingly. Results of this study include 1) extraction of model features that deliver maximized data quality with minimized battery consumption as compared to pre- existing baseline models, 2) implementation of context- driven modeling of user smartphone data on user's contextual environment, and 3) customization of a time- series database for optimized data queries used in metadata visualizations. The adaptive sensing models produced could be used in future large population studies that efficiently examine patterns of behavior in multiple individuals over extended periods to identify disease indicators present in an average user's daily life.

By combining the continuous technological advancements in the healthcare field with data analytics, a national health monitoring system is a major possibility. It would be a way to track and monitor various types of data so that a better understanding of the overall health of participants could be achieved. After analyzing a Public Health Records system in Germany and a mental health system in the Dominican Republic, there are several key takeaways that would help in the design and implementation of a successful national health monitoring system. These takeaways include ways to increase user trust in the goals of such a system, ways to increase user retention rates, and ways to make participants feel protected from data breaches rather than at risk to them. With a successful national system in place, benefits such as lower healthcare costs, faster illness detection, and the possibility of conducting more health studies may be achieved.

Both my technical project and my STS Research Paper continued to be interesting and also challenging throughout the year. It was disappointing to my technical team that we would not be able to conduct a full-on experiment with around 200 participants because of COVID-19, but we were able to collect our data internally and use that to conclude our findings. My STS Research Paper turned out to be even more intriguing than I had originally thought, and I am incredibly happy with how I was able to execute the analysis for such a complex topic. In terms of my technical project, I would recommend to anyone wanting to continue the research to not only go through with the experiment to solidify the results that were collected this year, but to also focus on ways to encourage long-term use of the application, potentially using ideas from my STS research paper.