

Thesis Portfolio

An Automated Machine Learning Pipeline for Monitoring and Forecasting Mobile Health Data
(Technical Report)

An Analysis of Mental Health Systems
(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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Sociotechnical Synthesis

For the technical project, I had the opportunity to create a system that would predict mental health states from cell phones. My STS research paper, “An analysis of mental health systems,” discusses the need for robust systems analysis of mental health systems, much like the one I designed in the technical project. I had the opportunity to begin engaging STS in engineering practice during the early stages of my Capstone team meetings. I would consider how why my technical project was important, and how I could ensure that my technical project would best serve the users we were facing, adolescents. This inspired my STS research paper topic, which discussed the importance of the work we are doing, and how we can evaluate systems like the one we developed to best improve the work we are doing. To further elucidate this, I will use the Sociotechnical Synthesis as an opportunity to briefly describe both these projects, their underlying connections, along with ethical implications.

To be able to synthesize these two projects, I will begin by describing them and showing their underlying motivations. First, we will discuss the STS research paper. My STS research paper discusses the importance of researching mental health systems. I use two items to convey the need for further analysis: existing literature to motivate future research, and a “toy example” to show such analyses are possible. Specifically, a survey of existing work focuses on concomitant factors that affect depression for teens. The toy example of a systems analysis is standardized; focusing on the feasibility of identifying performance measures and user groups for mental health applications. A qualification to my work is that we focus on the adolescent user group in the STS research paper, rather than a generalization to all age groups. Next, I would like

to shift the focus to discuss the Technical Project, which will answer questions on how to use smartphones to predict emotional state. To provide a candidate solution to this problem, we created a data pipeline that takes sensor readings from smart phones, and uses them to predict mental health states. A data pipeline is a set of computer scripts that will be executed in a certain order to perform tasks that would otherwise be burdensome or impossible for humans to accomplish. Specifically, our pipeline will take sensor output from phones, and predict future mental health states for the given user. We then have a web-portal that allows mental health professionals to see how certain sensors align with a user's mental health state. My capstone team and I had the opportunity to collaborate with two other organizations: The University of Pittsburgh Medical Center (through their Children's Hospital) and NuReIm, a Pittsburgh-area software company. To describe the inner workings of the project, I ask you refer to the Technical Report, which is a conference paper from the SIEDS 2021 Conference. Lastly, we will focus on the intersection of these items, the potential ethical hurdles, and future work opportunities.

To formalize the intersection of this work, we will look into the intersection of the Technical Project and the STS Research Paper and discuss associated ethical considerations for these projects. To begin, we will discuss the intersection of the two projects. Both the STS paper, the Technical Project, and their intersection can be discussed through the following overarching research statement: "Using smartphones to predict mental health state is an important and viable operation." My STS research paper focuses on the **importance** paradigm, while the Technical Project will discuss the **viability** principle. Specifically, our technical project focuses on the "**possibility** question." That is, how do create systems that leverage a user's smartphone actions to best predict their mental health states? Likewise, the STS research paper, "An analysis of mental health systems," focuses on the "**important** question." That is, why do we need to keep

sedulously analyzing systems that connect smartphones and mental health? Next, we would like to discuss potential ethical hurdles we foresee in both of these works. In the STS research paper, the paramount concern is in the development of evaluation criteria for our systems analysis. Specifically, how do we ensure that the criteria that we use to analyze applications do not negatively affect a given user group? Likewise, we should look into methodologies that allow us to develop metrics that promote mental health applications that do not disadvantage a given demographic group. This question was inspired by the book *Technically Wrong*, by Sara Wachter-Boettcher, covered in STS 4600 with Dr. Richard Jacques. For the Technical Project, a major ethical hurdle also lies in the inclusivity of our work. In the case of adolescents who do not own a smartphone, future research could look into actions with laptops or other educational equipment that a teenager uses at school. For example, we could develop tools that can harness the current research on web gamification of mental health tracking and engage the quantitative results from those games into our existing pipeline. Through this brief discussion of the STS research paper and technical report, we see further research in both fields proving to be very promising.

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