Thesis Project Portfolio

Study Space Occupancy Monitoring: Real-time Capacity Tracking and Reporting System

(Technical Report)

Opening the Black-Box: Improving Societal Understanding and Control Over Social Media Algorithms

(STS Research Paper)

An Undergraduate Thesis

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Bachelor of Science, School of Engineering

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Sociotechnical Synthesis

(Executive Summary)

User Understanding of the Data and Processes Used by Algorithms

"*An algorithm must be seen to be believed."*

- Donald Knuth, *Leaders in Computing: Changing the digital world*

Most days, I wake up and interact with at least five algorithm outputs every day before noon, and I am confident that this is true for most other people as well. While these algorithms tend to make all our lives easier, their black-box nature limits how much somebody can understand what is going on within them, leading to both a lack of trust and an opportunity for companies to take advantage of users. My technical project is an occupancy monitoring system for study areas on Grounds that utilizes a particular set of sensors programmed with a published algorithm, and my STS research paper focuses on how large social media companies can be influenced to adopt algorithmic transparency by their users. Initially, my technical topic involved designing a new recommendation algorithm for social media. Unfortunately, I found that this was infeasible because of the current secrecy around what information social media companies had access to. Therefore, I opted to design a new system that would solve a separate problem that I encountered in my daily life. My STS research influenced me to open this system to proper scrutinization by utilizing public algorithms for occupancy tracking.

My technical project was motivated by my own annoyances with showing up to a particular study area on Grounds during exam season and finding no seats anywhere. The system consists of specific infrared sensors being placed at the entrance of each major study space. A public blob detection algorithm uses the collected infrared data to determine whether a person is

present in the sensor's view frame. If a person enters or leaves the view frame, the occupancy count is adjusted based on which portion of the view their blob was last seen in. Figure 1 displays how the sensor's view frame is divided up. If the blob is last seen in Zone 2, it is leaving the area of interest, and if it is last seen in Zone 1, then it is entering the area. Finally, a webserver collects counts from all the occupancy spaces and publishes them on a private university website as a percentage ratio of how full the study space is.

Figure 1: This image shows how the sensor's view frame will be divided up. The direction of a person's movement can be determined based on which zone they were last seen in. Adapted from Mikkilneni, et al. (2019).

In my STS research project, I used a sociotechnical approach to determine a process for users to influence social media companies to adopt algorithmic transparency. Social media algorithms are uniquely influential in society, and they have not been studied properly due to their secrecy. Since social media users have a somewhat similar relationship to platforms as workers do to bosses, I used Geels' multi-level perspective to analyze how labor movements won concessions from their bosses in the 20th century. I found that collective actions were only effective if they were paired with effective government interventions and favorable circumstances. Millions of users voicing their concerns about algorithms cannot unilaterally change company policies. This conclusion reveals the importance of including algorithmic transparency at the creation of a new system rather than attempting to implement it once the system is established.

When I was first designing the occupancy monitoring system, I considered whether I should write another proprietary algorithm for the sensor. After all, this would increase the odds that I could patent it and sell if for profit. However, as my STS research advanced, I realized that this type of selfish thinking was what created the nightmare of social media today. If the occupancy monitoring system were ever implemented, the system would be collecting data on people's movements all over Grounds. People would be rightfully worried about the data being collected and how it was being analyzed, so I chose to use an approach that has already been published in scientific literature. In "Engineering as Social Experimentation", Martin and Schinzinger emphasized the importance of the virtues of beneficence and nonmaleficence for engineers. Working on both the technical project and my STS research paper together helped me to embody these virtues by utilizing a public algorithm from the start of the system. The people using my occupancy monitoring system can be confident that their data is not being collected for anything other than the stated purpose. I hope that this principle is adopted by software engineers everywhere for the public's benefit.