Undergraduate Thesis Prospectus

Personalization in Circadian Rhythm-Based Event Scheduling

(technical research project in Systems Engineering)

Healthcare Innovation and Patient Trust in
the United States

(sociotechnical research project)

by

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General Research Problem

How does sociotechincal innovation affect healthcare?

Vaccinations, minimally invasive surgeries, and organ transplantation exemplify technology's benefits in medicine. Such developments have extended life expectancy, improved care, and made once deadly injuries survivable. Yet, new medical technology can introduce problems of safety, care, and privacy. For example, despite provisions of the Health Insurance Portability and Accountability Act of 1996 (HIPAA), sensitive medical data can be vulnerable to third parties. For example, Flo, a women's health tracker, was recently charged by the FTC for selling consumer data to Meta and Google for several years (FTC, 2021).

Using Heart Rate Data to Promote Lifestyle Changes

How can heart rate data support health and lifestyle recommendations?

This capstone project is being done within the Systems Engineering department under Professor Afsaneh Doryab, along with undergraduate students Jackson Batinger and Prachi Sadekar. Our goal is to make a google calendar widget that uses heart rate data to make habit/lifestyle recommendations. There are plenty of fitness and scheduling apps available which assist in tracking, however none found that build a tailored schedule to individual needs. The goals of this project in the form of a final deliverable is the ability to make scheduling recommendations purely based on personal survey data and parallel heart rate tracking, and a system that integrates seamlessly with an established calendar of activities to schedule times for exercising, work, and sleep. Constraints specific to this project include data accessibility (collecting a sample pool, prolonged tracking, survey takers), researcher limitations through SBS protocol, and technology supply bottlenecks with data collection.

With the technology available now, neural networking and other AI tools have been used to utilize heart rate data in fields such as heart disease (tachyarrhythmia) detection (Taye et al., 2020) and athlete training health and fitness through heart sound signal recording (Li et al., 2021). In this era, it is possible to create accurate predictions using heart rate variability (HRV) data and its timing throughout the day. What's left is the gap between said prediction and actionable suggestions for a client to use in their daily lives. We wish to capitalize on this existing technology to cater an individualized routine with preferences. This will be achieved through the use of IRB-SBS protocalled survey data along with health data gathered from supplied FitBit watch devices. Metrics such as resting heart rate, heart rate fluctuations due to exercise or stress, and threshold zones will be categorized and weighted heavily in the final schedule recommendations and analysis. Trial runs will be conducted to evaluate the efficacy of daily tracking on participants, and there will be possible experimenting to determine accuracy while minimizing recording time. If this project succeeds, we will have a robust system that allows daily users to further flesh out their life routines with an optimal system specific to their body's function patterns. This will help deliver suggestions and lifestyle benefits that the end user will trust and be willing to do, along with being integrated into a software they would use otherwise. Use of this technology could be taken into greater athletic realms, with optimization geared towards dieting and metabolism, strength training/cardio timing, and workout specific logging and recommendations.

Healthcare Innovation and Patient Trust in the United States.

In the U.S. since 2000, how have patients responded to sociotechnical innovations in healthcare?

Successful healthcare depends upon the physician-patient relationship, the security of personal information, and the affordability of care. Medical technology has yielded major developments such as lab-grown cartilage implants for severe joint injuries (OSU, 2015) and neural network HR tracking for fitness recommendations (UCSD, 2019), but it has sometimes also complicated problems of security, patient rights, care efficacy, and equity. For example, researchers at the University of Chicago found that one third of physicians and patients distrust the US healthcare system (NORC, 2021). Rising care costs and health data vulnerabilities can compound distrust. Divisive controversies in healthcare, such as public health responses to coronavirus and the overturning of Roe v. Wade, exacerbate the problem. With the uncertainty of healthcare in the U.S, how much is technology contributing to patient dissatisfaction?

The American Association of Retired Persons (AARP) contends that "older Americans need affordable health care services and prescriptions"; it advocates for public policy that would reduce insurance premiums and drug costs for old people (AARP, 2017). Medical technology has often contributed to rising healthcare costs. Health insurance has increased care access for patients, driving demand for innovation and enticing providers to favor expensive treatments. For those uninsured, the affordability gap only widens. The cost effects have sometimes caused personal bankruptcies, even among the insured (Institute of Medicine, 1991; Himmelstein et al., 2009). In the tradeoff between expensive, state-of-the-art medicine for the well insured and affordable healthcare for all, the U.S. healthcare system has favored expensive care. According to Dr. Madara of the American Medical Association (AMA), "The lack of transparency in health care pricing and costs is primarily the result of a health care financing system that depends largely on the complex arrangements between and among employers, third-party payers, providers and patients" (Madara, 2018). Mandatory price transparency was imposed in 2021, but

according to Patient Rights Advocate (PRA) only 14 percent of hospitals comply with the new standards. According to PRA, "This acceptance of the failing status quo is offensive" (PRA, 2022; Lyons, 2022).

Third parties can threaten the privacy of patient information. Health devices such as fitness watches and trackers store substantial personal health information but remain unregulated. Since Roe v. Wade was overturned in June 2022, patient advocates have stepped up their demands for privacy. Data from phones and other personal devices can yield evidence of an intention to seek an abortion. According to the Center for Democracy in Tech (CDT), "most data can be 'reproductive health data' if it is used for such purposes, even if it appears unrelated on its face." CDT demands data encryption to protect the public (Lapperuque et al., 2022). This information can then be accessed via third-party selling or subpoena, increasing the opportunities of harm for marginalized communities. Daly Barnett, staff technologist at the Electronic Frontier Foundation (EFF), calls for data security following the overturning of Roe, warning that "patients, their family members and friends, doctors, nurses, clinic staff, reproductive rights activists, abortion rights counselors and website operators, insurance providers, and even drivers who help take patients to clinics may face grave risks to their privacy and safety." According to Barnett, "other legislation that does not depend on deputizing 'bounty hunters,' but rather criminalizes abortion, presents even more significant risks" (Barnett, 2022).

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