Thesis Portfolio

Modeling Biological Rhythms to Predict Mental and Physical Readiness

(Technical Report)

Analyzing the Pacing Problem and Associated Ethical Controversies

(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

Kayla Spigelman
Spring, 2020

Department of Systems and Information Engineering

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Sociotechnical Synthesis

The two research topics presented in this paper are loosely related. The technical topic discusses using physiological data to study biobehavioral rhythms and their impact on human performance whereas the STS topic discusses the regulatory environment of technology and the pacing problem of the government. The technical topic describes an analysis of the physiological rhythmic features which influence human health and performance. The data used in the analysis is collected from consumer wearable devices. Because technological devices inherently come with security vulnerabilities, the technical project raises various concerns surrounding third party use of data and privacy and security rights for users. These concerns motivate further research about the regulation of technological innovation for the STS topic. The STS topic dives into how the law should pace itself in order to regulate technological systems in an ethical fashion and provides three cases which exemplify the legal-ethical controversies that stem from the problem. The two of these topics, coupled together, highlight the advantages and disadvantages of data collection and the use of technology in today's society.

To begin, the technical topic discusses using biobehavioral rhythms to understand relationships between physiological indicators and an overall performance metric. The longitudinal physiological data was collected from consumer devices which include the Empatica E4 wristband and the Oura ring. The Empatica E4 collected data on biometric indicators such as blood volume pulse (BVP), electrodermal activity (EDA), acceleration, skin temperature and heart rate. The Oura ring recorded data on sleep patterns, heart rate, skin temperature and activity level. Additionally, the Oura ring created a readiness score to indicate one's level of mental and physical capacity for the upcoming day based on the patterns of data collected. The biometric data from the Empatica E4 was used to build models of human rhythms

using a software package called Chronomics Analysis Toolkit (CATkit). Using preprocessed data, the research team performed a rhythms analysis using CATkit to extract rhythms features. These features were then combined with Oura's readiness score and jointly modeled using various statistical techniques including correlation analysis, classification, and logistic regression. As a result of this analysis, the research team derived insights about which rhythms features most highly impacted overall readiness. Overall, the results provided insights into the feasibility of using consumer devices to model biological rhythms and assess human performance and health.

The STS research topic discusses the pacing problem, provides three cases which demonstrate legal-ethical controversies stemming from the problem and presents factors to consider when evaluating a solution. The pacing problem describes the idea that Congress struggles to keep pace with the speed of technological growth in industry and society. The lag of government oversight behind new technologies has increased at an alarming rate, leaving no time to create an enforceable regulatory platform. Numerous cases exemplify the controversial problems faced by technological systems due to a lack of legal precedent. Facebook's Beacon Software, Facebook's Emotional Contagion Study and Amazon's Echo and the Arkansas v. Bates Case provide three such examples where a lack of legal precedent made finalizing a resolution that would suit the needs of all stakeholder groups more difficult. The Social Construction of Technology (SCOT) framework helps to provide a structure for analysis when evaluating these ethical dilemmas. Using the SCOT framework, the paper exposes the various stakeholder groups as well as their relative importance in establishing a resolution. In conjunction, the three cases prove that a common one-size-fits-all solution simply does not exist.

However, with adaptable legislation and institutional reform, these complex scenarios can be resolved by the government at a rate that parallels innovation.

In conclusion, the technical topic and the STS research topic demonstrate the array of complexities in technological systems. Opinions about how the government should regulate technology and big data vary tremendously from person to person. Daily news headlines show the extent of polarizing views on the ethics of using big data, especially when pertaining to peoples' privacy and security rights. When evaluating both of these topics simultaneously, one can see how advantageous data can be to advancements in science and technology but also how harmful the collection of data can be when it infringes upon human rights such as data privacy and security. Regardless, with a high degree of technological fluency on behalf of the government, company stakeholders and individuals, the pacing problem can be solved.