Undergraduate Thesis Prospectus

A Machine Learning Analysis of Health Data from Personal Devices

(technical research project in Computer Science)

How Health Professionals Respond to Health Data from Wearable Technology and Smartphones

(sociotechnical research project)

by

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On my honor as a University student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments.
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General Research Problem

How is data generated from personal devices useful?

The personal device market is growing dramatically. Many of these devices can track an individual's usage, sleep schedule, heart rate, and more. The average personal device user is likely to generate over 1 million gigabytes of data in their lives (UIC, 2019). These devices are supplied by tech companies and used by individuals. Researchers at the PervasiveHealth 2017 Workshop stated that four key challenges to making use of such data are: making sure the data supports clinicians' goals, facilitating actionable insights from multiple data sources, cultivating sustainable data collection, and ensuring the clinical relevance of collected data (Choe et al. 2018). The data are valuable to tech companies, consumers, insurance companies, and healthcare providers, but because their interests diverge, data policies are contested.

A Machine Learning Analysis of Health Data from Personal Devices

How can we automatically collect, visualize, and analyze health data from smartphones and wearable technology?

I aim to conduct research on this topic alongside Professor Afsaneh Doryab in the Systems Engineering department. My participation has not yet been confirmed; however, I am in communication with Professor Doryab and hope to work alongside her and a group of peers next semester.

The three distinct parts of this project are: The automated collection of data from smartphones and personal devices, the presentation of that data, and the analysis of that

data to make health predictions about the user. I expect that my contributions to the project will be focused on the analysis portion.

The goals of this project can also be divided into three sections. The first being devising a method to efficiently collect health data from personal devices. Second, to develop a way automatically organize and present that data. Third, to create algorithms that can analyze the data and make predictions relating to the user's health.

This project will be constrained by the quantity and diversity of data we are given access to. Many people wish to keep their health data private especially data that originates from a personal device.

Currently, systems exist which efficiently collect and visualize data directly on personal devices. Examples of this include the Apple Health app on apple devices or a Fitbit wristwatch. These systems are meant to be intuitive but offer no predictions or conclusions based on what is measured.

I expect to be using machine learning methods to learn from a training set of data and build a model that can make educated predictions from new data. This will most likely be developed using the python programming language.

At the conclusion of the project there will be a system that can take data from personal devices and generate predictions related to the health of the user. This will provide a possible value to the data generated by personal devices. I also expect that much will be learned about which metrics offered by personal devices can be transformed into relevant predictions and which metrics that are not offered by personal devices might be useful to include. With the conclusion of the project there will be some time when an evaluation of the final system can be done to see the accuracy of predictions. The system

could then be further improved or a new conclusion regarding the relevance of data from personal devices may be proposed.

How Health Professionals Respond to Health Data from Wearable Technology and Smartphones

Personal devices collect health data, such as heart rate, blood-oxygen level, and activity level. Mobile health apps are expected to be a $31 billion industry by the end of 2020 (Jahns, 2017).

Windt et al. (2020) found that some healthcare professionals distrust data from personal devices, suspecting that they may have not "inherently communicate a message." Because the collected data are necessarily incomplete, they can be insufficient or even hazardous, physicians and coaches may find wearables of little practical use (Windt et al., 2020). In a survey, Kong et al. (2020) found that while most physicians perceive valuable possibilities in mobile health apps, most agree that they need more validation and better integration into medical record systems. Dr. Joseph Kvedar sees the potential in such data but believes that healthcare systems need to figure out the best use for it, stating, "If we don't, we are leaving so much useful information about our patients on the table" (Kvedar, 2014).

Others, however find the data immediately valuable. For example, doctors at the Mayo Clinic have used Fitbit devices to remotely track the activity level of cardiac-surgery patients following surgery (DeAngelis, 2015).

Some insurers, such as John Hancock (Ingraham, 2018), offer incentives to beneficiaries who use devices to document health regimens. Theoretically, some insurers may eventually require such data, and even penalize those whose data indicate deficient regimens (Raber, McCarthy & Yeh, 2019).

Device manufacturers include Fitbit (Fitbit, 2020).

Kaiwaiola C. uses a Fitbit to track his sleep to ensure he gets enough rest (Kaiwiola, 2017). Device user Breigha Adeyemo, bought the Fitbit Charge 4 wearable because she "wanted to be able to track daily and exercise calorie expenditure, steps, and heart rate." (Adeyemo, 2020)

References

Adeyemo, Breigha. (2020, July 10). Amazon.com Customer Reviews. https://www.amazon.com/Fitbit-Fitness-Activity-Tracking-Included/product-reviews/

DeAngelis, S. F. (2015, Aug. 7). Wired. Patient Monitoring, Big Data, and the Future of Healthcare. https://www.wired.com/insights/2014/08/patient-monitoring-big-data-future-healthcare/

Choe, Eun Kyoung. B. Lee, T. Andersen, L. Wilcox and G. Fitzpatrick. (2018) "Harnessing the Power of Patient-Generated Data" in IEEE Pervasive Computing, vol. 17, no. 02.

Fitbit, Inc. (2020). Fitbit. Who We Are. https://www.fitbit.com/global/us/about-us

Ingraham, Christopher. (2018, Sep. 25). The Washington Post. An insurance company wants you to hand over your Fitbit data so it can make more money. Should you? https://www.washingtonpost.com/business/2018/09/25/an-insurance-company-wants-you-hand-over-your-fitbit-data-so-they-can-make-more-money-should-you/

Jahns, R. (2017, Nov. 27). Research2guidance. Mobile Health app market reaches $31 billion by 2020. https://research2guidance.com/the-mhealth-app-market-reaches-31-billion-by-2020/

Kaiwiola, C. (2017). Fitbit. Kaiwiola needed more rest to help him save lives - Fitbit Stories. https://stories.fitbit.com/featured/kaiwiola/

Kong, T., Scott, M., Li, Y., & Wichelman, C. (2020, Feb. 20). Digit Health. Physician attitudes towards-and adoption of-mobile health. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7036486/

Kvedar, Joseph. (2014, May 30). Mobihealth News. In-Depth: How patient generated health data is evolving into one of healthcare's biggest trends. https://www.mobihealthnews.com/33645/in-depth-how-patient-generated-health-data-is-evolving-into-one-of-healthcares-biggest-trends

Raber, McCarthy, and Yeh. (2019, Aug. 26). American Medical Association. Insurers want patients to use wearables. That could be a problem. https://www.ama-assn.org/practice-management/digital/insurers-want-patients-use-wearables-could-be-problem

Ryan, T. (2019, Aug. 26). American Medical Association. Insurers want patients to use wearables. That could be a problem. https://www.ama-assn.org/practice-management/digital/insurers-want-patients-use-wearables-could-be-problem

UIC (2019, Sep. 17). University of Illinois at Chicago. Big Data and Wearable Health Monitors: Harnessing the Benefits and Overcoming Challenges. https://healthinformatics.uic.edu/blog/big-data-and-wearable-health-monitors-harnessing-the-benefits-and-overcoming-challenges/

Windt, J., MacDonald, K., Taylor, D., Zumbo, B., Sporer, B., & Martin, D. (2020, Sep. 1). Journal of Athletic Training. "To Tech or Not to Tech?" A Critical Decision-Making Framework for Implementing Technology in Sport. https://meridian.allenpress.com/jat/article/55/9/902/444132/To-Tech-or-Not-to-Tech-A-Critical-Decision-Making