Adaptive Mobile Sensing: Leveraging Machine Learning for Efficient Human Behavior Modeling

A Technical Report submitted to the Department of Systems and Information Engineering

Presented to the Faculty of the School of Engineering and Applied Science

University of Virginia • Charlottesville, Virginia

In Partial Fulfillment of the Requirements for the Degree

Bachelor of Science, School of Engineering

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Spring, 2020.

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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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Today, smartphones and other wearable devices are capable of collecting millions of data points about each of its users daily activities. However, while the potential power of this data in improving society and providing other benefits is unprecedented, there is still much work to be done in creating predictive models that can efficiently extract valuable information from this data. In the Reliable Analytics for Disease Prediction capstone project, such unstructured smartphone data will be analyzed as part of an effort to create predictive health models.

The technical project, advised by Professor Laura Barnes, Medhi Boukhechba and Lihua (Lee) Cai, specifically seeks to predict the user's health status based on smartphone-extracted contextual data. The project is a part of ongoing research conducted for the Defense Advanced Research Projects Agency (DARPA) to design and develop reliable disease detection analytics through data collected from smartphones. The ultimate goal of the research is to create " a mobile application that passively assesses a warfighter's readiness immediately and over time," (Patel, n.d., para. 5); by building predictive health analytics that utilize smartphone sensors, the onset of illnesses, concussions, or even mental health issues can be noticed in real time. In the current stage of research, the technical team will develop the tradeoff between data collection frequency and battery life. This is an important step in the feasibility of this technology and in understanding the user's environment. By gaining a better sense of these limitations, accurate predictive models can be built without the noise of dead phones or other unwarranted stimuli.

Mobile sensing data used in this research will be collected through the Sensus Application. This app, developed at the University of Virginia (UVA), uses "event-driven architecture that triggers actions in response to changes to the device or network state" (Lockheed Martin & Advanced Technology Laboratories, 2017, p.10). This data will be utilized to create context recognition models, which determine what ambulatory state the user is in, like walking, running, or sitting. Additionally, the Sensus app will push surveys as notifications to participant's mobile phones to create additional context around the data collected. These surveys will ask questions about the user's activities immediately before answering the survey, such as the user's location, length of activity, phone position, and more. This additional collected data will allow the team to build the strong foundational truth for these predictive health models.

The technical project group consists of nine undergraduate Systems Engineering students. Because of the large size, the team is divided into three subteams: the Data Modeling Team, the Data Visualization Team, and the Data Collection Team. These teams were constructed for the current needs of the project, and are subject to change and overlap depending on the need in each area. The Data Modeling Team will work to prove the efficacy of adaptive sensing in an attempt to find a balance between data collection and battery usage. Ultimately, the team will develop an algorithm as a potential alternative to the adaptive sensing model currently being used. The Data Visualization Team will make significant improvements to the web-based visualization platform used by the researchers to increase understanding and context of the data they are collecting. Improvements to this platform will allow better insights to be easily accessible. The Data Collection Team is designated to complete the IRB so that the data collection among the student cohort can begin. Once the IRB is completed and approved, the team will be responsible for organizing the participants in the study.

At the end of the study, the team will deliver a recommendation for smartphone data collection that effectively accounts for a user's battery life and critical predictive data and a recommendation for intuitive data visualizations for the researchers' web platform.
The technical project is funded through a grant provided by DARPA. Additional resources include test phones and desktop computers to run software and view data. The technical project will produce a conference paper for the Systems Information Engineering Design Symposium (SIEDS) that will take place in May 2020.

References

Lockheed Martin & Advanced Technology Laboratories (2017). DARPA warfighter analytics using smartphones for health (WASH) ReADI technical section. Cherry Hill, NJ: Lockheed Martin and Advanced Technology Laboratories

Patel, T. (n.d.). Warfighter analytics using smartphones for health. Arlington, VA: DARPA: Defense Advanced Research Projects Agency website: https://www.darpa.mil/program/warfighter-analytics-using-smartphones-for-health