Bio-behavioral Systems to Motivate and Reinforce Heart Health

WEARABLE INFORMATICS LABORATORY

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The Problem

In the United States (US), the prevalence of cardiovascular disease (CVD) among adults under age 60 is approaching 40% and nearly one-third of CVD deaths occur between 55 and 64 years. Physical activity (PA) is one of the most potent modifiable behaviors for the prevention and treatment of CVD. However, sleep deficits (e.g. short sleep duration) also exacerbate CVD risk factors. Multi-component behavioral interventions targeting changes in both PA and sleep could evoke synergistic improvements to cardiovascular health and inform novel CVD prevention strategies for mid-life adults.

Traditional intervention approaches typically hinge around coaching, both for exercise and for sleep. However, these are costly both in time and financially, and are often not covered by health insurance plans. This leads adults who should be receiving such coaching to forgo treatment. For those who do seek intervention, much of the coaching is based on self-report, a method known to be highly unreliable.

Wearable activity tracking monitors, such as Fitbit, offer significant opportunities to improve PA and sleep, with potentially greater reach and less cost than traditional intervention approaches. Not known is the extent to which Fitbit alone can elicit meaningful, sustained health behavior change. There is a critical need to develop and test Fitbit as well as wide range of other devices (including novel devices in future) that could drive "smart" platforms that enhance user engagement and motivation through individually tailored behavior change techniques and feedback to improved PA and sleep behaviors.

This project, the Bio-behavioral Systems to Motivate And Reinforce HearT Health (Be SMART) will leverage short message service (SMS) and Fitbit technology within a comprehensive cloud-based, bi-directional feedback system that provides individually tailored behavior-change messages based on the collection of objective behavioral and biometric data to increase MVPA and improve sleep metrics among midlife adults.

The Problem

Fitbit offers an API to connect and retrieve data. Third party data brokers, such as Fitabase, use this API to collect data for researchers to use in post analysis. However, Fitabase has no market incentive to create a closed loop system, where the data can be analyzed in real time to trigger messages to users. This project seeks to create a system similar to Fitabase, but with the option of creating participant specific triggers that would send a message to the participant, based on recent history of Fitbit data. For example, the system should be able to identify that you have been sitting for three hours, and thus would send you a message like "you know, you should get up and walk around for a few minutes." Or in a more advanced scenario, the system should be able to identify that you often go for a run Sunday mornings. Then, an hour before the system expects you to head out for the run, it should send you a message like "Are you going out for a

run this morning? For the last week you've run about two miles. How about you add an extra half mile today?"

No platform like this exists for the purpose of research and development of such smart systems. Existing systems, such as the nudging that Apple Watch provides, don't allow researchers to change what is under the hood to see how people respond. Specifically, what is needed is a secure web-app that connects to commodity data sources (such as the Fitbit API), is able to perform processing and predictions via a backend server side app, and then provides text message cueing to the participants based on the participant's activities, sleep, and a set of researcher defined rule-to-messages.

Project Features - Stage 0:

1. Secure user level web-app access, with admin management of users through the web-app.
2. Secure API access to third party systems, allowing another system to perform the analyses.

Project Features - Stage 1:

3. Online background data processing, with summary statistics around each participant.
4. A self-learning system to predict specific patterns in physical activity and sleep.
5. Relay of summary statistics and predictions to third party systems (using the API in 0-2).

Project Features - Stage 2:

6. Web-app dashboard that enables researchers to define specific rules for message cueing.
7. Text messaging of predefined messages to participants, based on the researcher defined rules and the participant's history and patterns of physical activity and sleep.

Prior Work

The Wearable Informatics Lab at NAU has piloted data collection from Fitbit using the Fitbit API. This system can be used as a starting point for this project.

Impact Potential

If successful, this project may have an impact on cardiovascular health of the research participants. More broadly, it is expected that this system will enable researchers to ask very different questions than previously thought possible, and may lead to insights that inform physical activity and sleep recommendations, and treatment methods, for middle-aged adults at risk of cardio vascular disease. It is anticipated that these both could lead to a reduction in deaths from CVD.

Exemplary students working on this project will be considered for graduate student positions in the Wearable Informatics Lab at NAU.

Knowledge, Skills, and Expertise Required

- GNU Linux server environments
- API development, including data transfer in such formats as JSON
- Data analysis in environments such as Sci-Py or Octave/MATLAB

Specialty Equipment

- This project will likely require a virtual machine environment - the sponsor will ensure this is provided should the team identity this is the best approach.
- Access to Fitbits and similar devices will be provided by the sponsor, as needed.
- No other specialty tools are expected to be required that are not also freely available online.

Software and Deliverables

- A fully functional system ready for use by the research team.
- Complete professionally-documented codebase, delivered via BitBucket, and on a USB drive.

- A strong as-built report detailing the design and implementation of the product in a complete, clear and professional manner. This document should provide a strong basis for future development of the product.
- As an optional bonus, the team could shoot for a conference or journal paper submission detailing the system (travel funding may be available to present your work at a domestic conference).