Digital Health - Connected Healthcare
Prof. Dr. Bert Arnrich
Bachelor Project 2020/2021

Tracking behavior and eating habits using smart devices
to support treatment of diabetes and obesity

Introduction and Motivation

The number of people with diabetes rose from 108 million in 1980 to 422 million in 2014 [1]. The global prevalence of diabetes among adults above 18 years has risen from 4.7% in 1980 to 8.5% in 2014 [1]. The leading risk factor for type 2 diabetes is obesity [1]. Obesity is usually caused by overeating and moving too little. According to the research in the addiction and nutrition field, food is the cause of obesity, particularly palatable and energy-dense ('addictive') food [2]. Moreover, addictive behavior for food is one of the ways to regulate affective states, which are caused due to stress [3]. Affective states such as anxiety, anger, depressive mood, and other negative emotions have a correlation to eating behavior [4].

In this project, user's context, behavior and affective state are monitored with the help of wearable sensors. Correlations between context, behavior, affective states and eating habits are investigated. The project is based on an existing sensor data collection application and will be extended with respect to further sensor integration and data analysis functionality.

The project is done in collaboration with the Oviva AG. Oviva is a startup based in Potsdam with branches in Switzerland, France, and the UK. Oviva provides and supports digital solutions for patient-oriented therapy for changing dietary behavior with a mobile application. One aspect of Oviva's treatment has been implemented with the help of neural networks, whereby the patient sends a picture of their meal and the network the food category. Based on the classified food categories, the nutritionist assigned to the patient supervises the patient's eating behavior and provides intervention if necessary.

Goal

There are three objectives for this bachelor project:

1. To extend the already developed mobile application (SensorHub) with additional functionalities like data from other sensors and surveys for experience sampling.
2. To develop an analytics platform to recognize different user contexts and their interactions in daily life such as the environment (noisy/silent, indoor/outdoor), social interactions (alone or with group), activities (i.e., walking, sitting, standing, eating, sleeping, going upstairs or downstairs, running, driving/riding, traveling and, doing exhausting exercise).
3. To classify different affective states for the recognized context using physiological signals.

Methodology

You will be accessing different sensors via smartphone (e.g., ambient light, proximity, GPS, signal strength, microphone, temperature and barometer), smartwatch, and (clinical) wearables (e.g., Empatica, delivering, i.e. Photoplethysmogram (PPG), Electrodermal Activity (EDA) and other key indicators). Furthermore, you will implement the functionality to deliver short prompts to assess the user's current affective state and activity at random time points throughout the day. This method is called experience sampling through surveys. You would include those functionalities into the SensorHub data collection pipeline. An additional measure within this project will be assessing of the affective state from voice prompts using audio engineering (audio analysis by machine learning models). Since the speech, in particular, carries prominent information on the user's mood and affective state, the user will be prompted with experience sampling surveys to describe their mood briefly.

The workflow with the existing pipeline is as depicted in figure 1. The pipeline is as follows: The SensorHub application collects the data from the devices and uploads them to the server. Your task will be to build an analytics platform, as mentioned above, for the analysis of different user contexts using supervised and unsupervised machine learning algorithms.

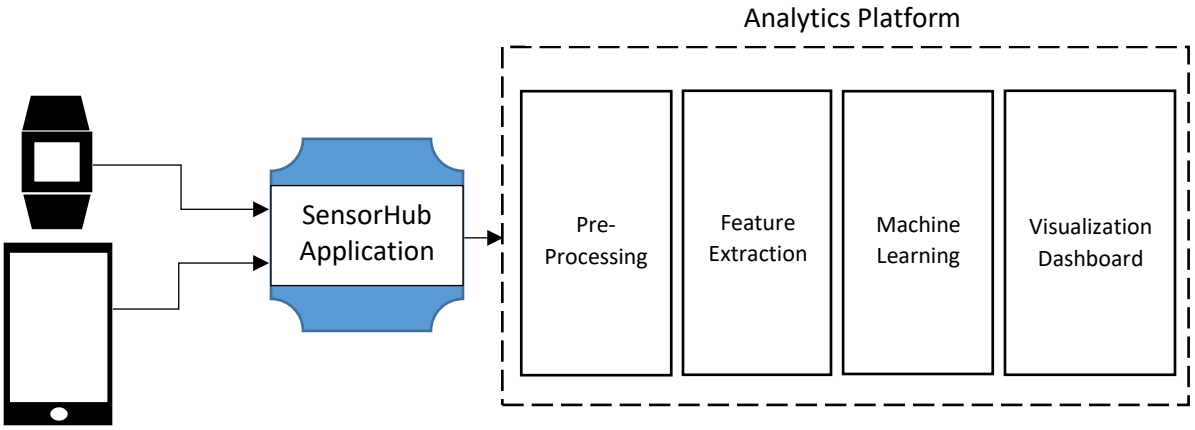

Figure1: The pipeline for the context recognition platform.

Learning Expectations

In this project you will learn how to access and track data from sensors such as EDA, PPG, ambient light, microphone, accelerometer, gyroscope, GPS, temperature and barometer incorporated in your smartphones and wearables. You will have the opportunity to enhance your skills in android application development, pattern recognition and machine learning.

About You

You should be interested to work in a multidisciplinary project. Good programming skills are required and you should know python. You should have an interest in developing mobile applications.

References

[1] Roglic, G. (2016). WHO Global report on diabetes: A summary. International Journal of Noncommunicable Diseases, 1(1), 3.

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[3] Sinha, R. (2018). Role of addiction and stress neurobiology on food intake and obesity. Biological psychology, 131, 5-13.

[4] Nyklíček, I., Vingerhoets, A., & Zeelenberg, M. (Eds.). (2010). Emotion regulation and well-being. Springer Science & Business Media.

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