The Last Mile: Unobtrusive Digital Blood Pressure Prediction Anywhere and Anytime in Daily Life

Motivation

Worldwide, 7.6 million deaths are attributable to high blood pressure (i.e. hypertension), which has a prevalence of circa 22% [1] in adults and is the leading risk factor for cardiovascular diseases [2]. Around 54% of stroke and 47% of coronary heart disease are attributable to hypertension. Due to its asymptomatic nature, it was named by the World Health Organization as the "silent killer" [3]. Therefore it is pressing to make its management and diagnosis as easy as possible. Tremendous efforts are dedicated worldwide to develop and implement applications and digital solutions, that support hypertension management unobtrusively whenever and wherever, and that generate clinically-actionable measures from wearables (such as blood pressure). However, researchers still find it difficult to bridge the gap between application and model development, and their use in daily life, i.e. making sure that models work well in different conditions and individuals, and that applications are meaningful. Lastly, it remains unresolved how to finetune (personalize) models for each individual, taking into account their own data and characteristics?

Project Goals

Therefore, the goals of this project will be twofold:

(1) improve an existing app targeted at blood pressure monitoring and connect it to the Digital Me (Digit*Me*) Platform/Digital Discovery Program (DDP) at the Hasso Plattner Institute for Digital Health at Mount Sinai Health System (HPI.MS) in New York City. The goal is to make it available to thousands of patients at the HPI.MS ecosystem to gather feedback and collect validation data remotely from wearable devices, such as the Polar OH1 armband, and also personal home blood pressure monitors.

(2) evaluate and improve models for blood pressure prediction in daily life. Basically, to understand how to close the gap between model generation, their use in daily life and the retrieval of relevant metrics and data that will inform researchers about model performance and model finetuning using new collected data (see Figure 1 for the vision idea). All that taking into account user privacy as a key principle.
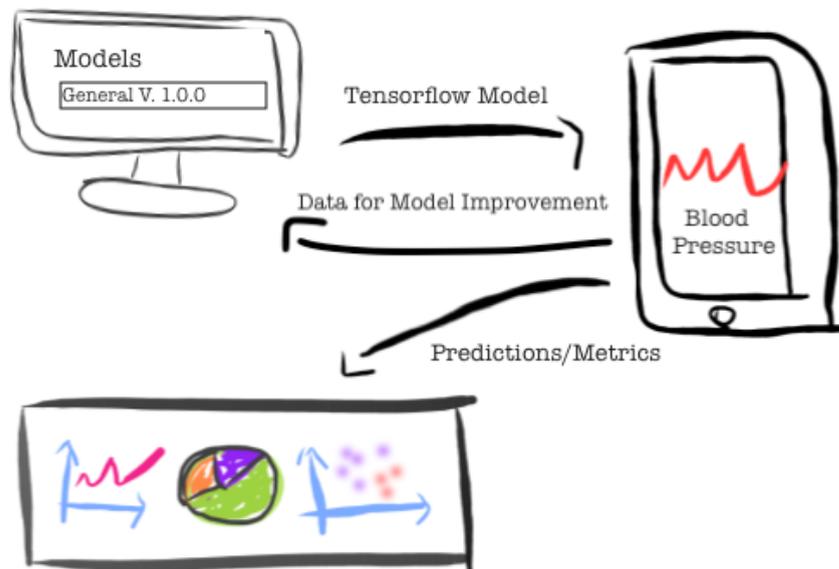
Figure 1. **Master project vision.** A dashboard on the left is where a researcher can access the different models. On the right there is an user facing application in which the model will be applied and the output generated. At the bottom we see graphs for model evaluation. In the middle there is data flowing back for model improvement.

Methodology

Even though we encourage the team to think about a general solution for model evaluation, this project will be based on the concrete use case of hypertension (i.e. high blood pressure) At the Fachbereich Böttinger and the HPI Digital Health Center, we have been developing models to predict blood pressure using wearables data and also an application for hypertension management. We want to bring them to the next level by making the application and models more likely to be evaluated and eventually used in real-life scenarios. The HPI.MS DigiMe platform will be used to plan a fully-digital validation study in a real-world healthcare context with real-world data.

You might work with programming languages and technologies such as Python, Tensorflow Lite[1], Parse[2] and Swift but are not limited to that. Concretely, we envision the following: you have an application that collects data from wearable devices, you can deploy different models to access blood pressure or hypertension based on this data. Which model would work better: a model personalized using your own data? A general model trained in a large dataset? A model tailored for younger individuals? This project will help answer those questions and also to gather user feedback around the application.

What You Will Learn

First you will learn about the use case, you will have to brainstorm on how to evaluate the application, think about a fully-digital validation study and how to evaluate and improve

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[1] https://www.tensorflow.org/lite

[2] https://parseplatform.org/

models for use in real life. Secondly, there will be the technical challenge of improving the application and connecting it with the HPI.MS DigiMe platform.

About You

You should be interested in working with a multidisciplinary team with backgrounds ranging from computer science to biomedical informatics and medicine. You should have an interest in working with digital health applications and on how to evaluate models in a scenario with multiple stakeholders. This project will require people with different backgrounds, such as engineering, design, healthcare life sciences skills. We strongly believe that success can be achieved through multidisciplinarity and this is what we expect from the group:

- Excited about designing applications for research and clinical purposes
- Experience with back-end programming and in designing services
- Eager to learn about machine learning models in the digital health context
- Interest in mobile applications and use cases for digital health

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