INNO4HEALTH, https://itea4.org/project/inno4health.html

EINDHOVEN UNIVERSITY OF TECHNOLOGY

Innovation4Health (I4H) creating intelligent solutions for cardiac patients, cancer patients and PSV players

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Introduction

INNO4HEALTH is a European consortium that focuses on stimulating continuous monitoring of personal and physical health outside the hospital or training environment to create recommender systems for preparation for surgery or training/matches. There are three use cases in the Netherlands: cardiac patients, cancer patients, and the monitoring of the Dutch sports club from Eindhoven, PSV. My research addresses these challenges, from implementing machine learning (ML) models that can be robust against drifts and heterogeneous data to validating the signal quality of wearable devices.

Cardiac patients with chronic coronary syndrome (CCS)

Quality signal in ECG health patches: Signal quality monitoring is a paramount initial step for ECG analysis and cardiac markers or event detection. We analyzed the quality of ECG signals recorded in a home setting during 5 consecutive days using a *Vital Signs patch* featuring self-adhesive dry electrodes technology. The changes in quality were studied between the days and daytime and night Figure 1. To address the goal, we selected a two-step approach. The first step is the comparison of four algorithms for signal quality assessment. Afterward, the best-performing quality metric was applied to an ECG dataset collected on six patients with chronic coronary syndrome (CCS) who wore the *Vital Signs patch* for 5 days continuously.

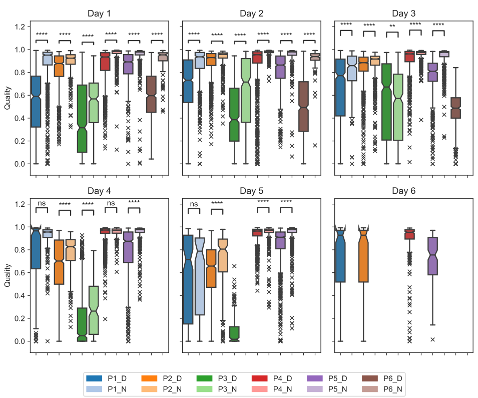

Figure 1: Distribution and statistical analysis of ECG quality during daytime and night for all patients.

AutoML for our use cases: we combined bio-inspired pipeline optimization using a generalized island model with successive halving (SHA). As such, this method aims to inherit the benefits of evolutionary techniques for AutoML while also speeding up convergence to the best pipelines [2]. In Figure 2, a statistical comparison of our proposal against the most commonly used AutoML frameworks [3] can be seen, as well as our results in convergence speed. With our experiments, we support our hypothesis that using multi-fidelity methods together with evolutionary techniques improves pipeline search for complex tasks.

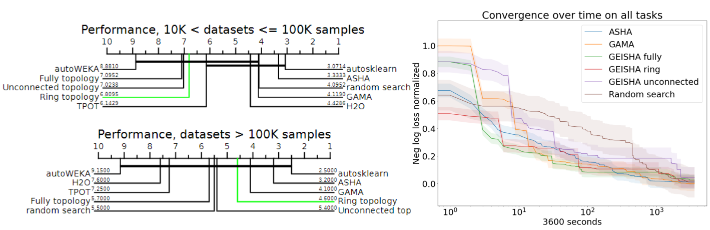

Figure 2: (2a) Benchmarking our method proposed against the best AutoML frameworks in the literature. Critical diagram of the frameworks used in this work, to assess the significant difference given the size of the datasets. (2b) Convergence process in time per second. Our method versus other frameworks where the goal is to find the most efficient ML model in the fastest way.

AutoML in action: we proposed a method for the classification of ST-segment deviation and the detection of such abnormality in millivolts (mV). The The output of the algorithm is ECG beats classification into either normal, elevated, or depressed classes. Additionally, we conducted a regression task to give the value of the deviation in mV, since another of our contributions is to provide a solution that is interpretable and does not require a great deal of computing power to reproduce. The algorithm can estimate ST-segment from a single lead ECG [1]. The video below shows an example of how it works (click on it).

Colon cancer patients, prehabilitation

In Máxima Medisch Centrum, prehabilitation is defined as the process of 12 exercise tests (HIIT) divided into 4 weeks, where the aim is to improve the functional capacity (FC) of patients to avoid poor outcomes after surgery, see Figure 3. Functional capacity tests the aerobic capacity to analyze the patient's fitness. It is usually tested with some physical test such as 6MW (the distance a patient can walk in 6 minutes). We will use a two-channel raw ECG sensor and a raw accelerometer data sensor for our $n = 20$ patients, where we will acquire data for one month. We hypothesize that we can substitute the functional capacity of patients usually measured by 6MW through sensor data and propose a model that allows us to identify the improvement in the aerobic capacity of patients.

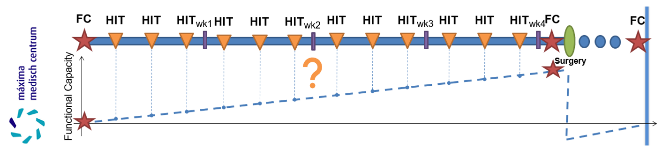

Figure 3: Methodology to be used to replace 6WM through sensor data.

Monitoring PSV club players

In PSV, we will use a body sensor by one of our partners in Canada, which measures several biosignals in 6 players for 5-7 days. The purpose is to use AutoML techniques to predict readiness for matches and training. In Figure 4 we can appreciate a diary of an anonymized PSV player, which used a GARMIN smartwatch and raw ECG patch during training. The final target is a recommender system provided to the sports scientist and coaches to speed up the process of readiness of a player.

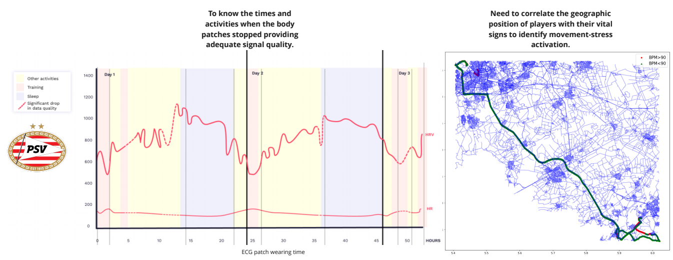

Figure 4: Activity logging through PSV player sensor data .

References

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[3] Joaquin Vanschoren. Meta-learning. In *Automated machine learning*, pages 35–61. Springer, Cham, 2019.

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