Analyzing the impact of different types of cardiac diagnosis on deep neural network accuracy for heart rate-based person identification

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1. Introduction

- The problem with the current widely used biometrics systems is that people actively have to identify themselves.
- Person identification using heart rate and activity from consumer-grade wearables is possible [1] and can solve this problem; people are constantly being identified by their heart rate and/or step count.
- In this paper, the following question will be researched: "**How do different types of cardiac diagnosis affect the accuracy of deep neural networks to identify individuals by their heart rate?**". This is relevant because the accuracy might change depending on the cardiac diagnosis (e.g. obese). If these different types of diagnosis will have a noticeable effect on the accuracy of identifying individuals, then models should maybe be adapted to deal with this.

2. Methodology

- Groups of subjects with different types of cardiac diagnoses have been selected; (very) fit, obese, heart failure, and paroxysmal atrial fibrillation (irregular heart rate). There is also a reference group.
- The heart rates of the groups are being fed into the deep neural network (DNN) (figure 1); the groups are being fed in separately.
- The objective of the DNN is to undergo training using heart rate information, enabling it to classify individuals based on new heart rate data once the training is complete. The testing accuracies of this classification task will be measured.

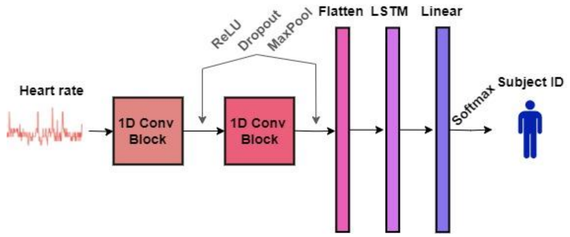

Figure 1: The proposed network; two convolutional layers followed by a flatten, LSTM and linear layer.

3. Experimental setup

- A diverse dataset that includes heart rate and cardiac diagnoses information from the Haga Ziekenhuis in The Hague, consisting of information from 14 subjects wearing different wearable devices was used for this research.
- To measure the effect of different types of cardiac diagnosis on the accuracy, groups of six subjects have been selected (figure 2). Two of those six subjects are subjects with a special type of cardiac diagnosis, the rest are reference subjects.

Figure 2: The subject set to measure the accuracy; two subjects with a special cardiac diagnoses, together with four reference subjects.

- A window size of one day was utilized (figure 3), together with a constraint of 1,000,000 data points (around 50 days of data).

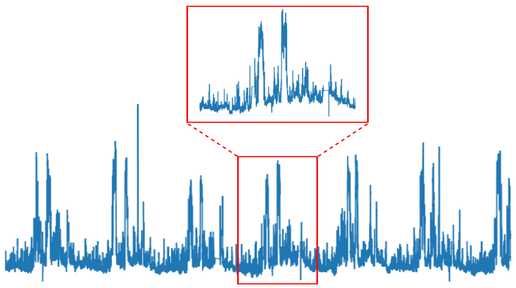

Figure 3: A window of one day is being taken from the heart rate data.

- The heart rate data was normalized (standardization).
- A learning rate of 0.001 together with a batch size of 256 was chosen [2]. CrossEntropyLoss has been used as loss function together with Adam as optimizer, both with default parameters.

4. Results

- Since the reference group consists of six subjects (table 1) and the other groups contain four of those, there are multiple combinations of the extensions. Each of these combinations have been tested and the average has been taken. Each of the combination have been run three times, which comes down to the average of 45 runs (initializations) of the DNN. The results of these runs can be seen in figure 4.

Subject groups	Subject IDs
Reference	1, 2, 3, 4, 5, 6
(Very) fit	7, 8
Obese	9, 10
Heart failure	11, 12
Paroxysmal atrial fibrillation	13, 14

Table 1: the subject groups with their respective subject IDs.

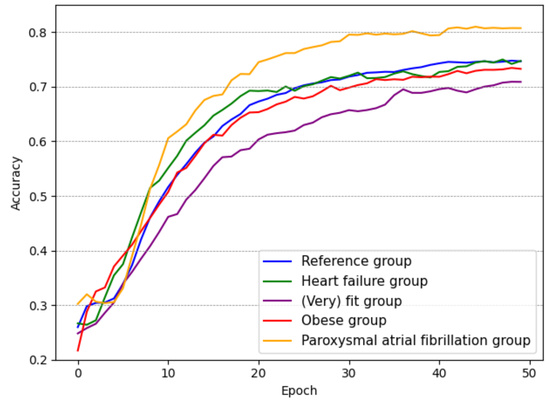

Figure 4: The average testing accuracies of 45 runs per subject group.

- Paroxysmal atrial fibrillation implies an irregular and more distinct heart rate [3] and is therefore easier to recognize and results in a higher accuracy.
- The heart failure subjects have a similar average hourly heart rate as the reference subjects and is therefore similar in terms of accuracy.
- Obese subjects have a similar heart rate as healthy people [4] and therefore the accuracy is similar.
- Fit people have a stable and less variable heart rate [5] and are therefore harder to distinguish which leads to a lower accuracy,

5. Conclusion and future work

- In this poster, the following question has been discussed: "How do different types of cardio levels and step count affect the accuracy of Deep Neural Networks to identify individuals by heart rate and step count data?".
- The subjects with the 'paroxysmal atrial fibrillation' diagnosis affected the accuracy in such a way that the average was the highest. Thereafter, the 'heart failure' and reference group had the highest accuracy, followed by the 'obese' and '(very) fit' group respectively.
- The hypothesis is that the paroxysmal atrial fibrillation subjects have the highest accuracy, because subjects suffering from paroxysmal atrial fibrillation have an irregular and more unique heart rate pattern compared to the other subjects, which means that the DNN has an easier time to recognize these subjects. More research is needed to confirm this.
- Future studies should include a larger number of individuals with special cardiac diagnoses while conducting experiments. In this research, each group contained only two subjects with a special cardiac diagnoses, which can make the results less reliable.

References

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