Predicting Heart Disease from ECG Data with a 1D Neural Network

Joris Galema, C. Buch Madsen, Flavio Miceli, Abel Oakley, Florian Schroevers

October 28, 2020

Bachelor of Artificial Intelligence, University of Amsterdam

Table of contents

Introduction

Quick resume of project

ECG data

We've received a large set of tagged (specific heart diseases) ECG data. This set contains the ECGs of 1̃500 people, each divided in 8 channels containing 5000 data points each.

The Client

Our client is Sarah, a PhD (medicine) student working for the AMC. She (and her colleagues) has been tagging the ECGs and was seeking help from competent AI students to perform deep learning on her data.

Goal of project

Overall goal of the project

The goal of this 4 week project was to explore feature extraction methods (in signal processing) and to train a Neural Network on the data we've received that would have an accuracy of at least 70% in predicting the tagged heart diseases in the data.

Implementation

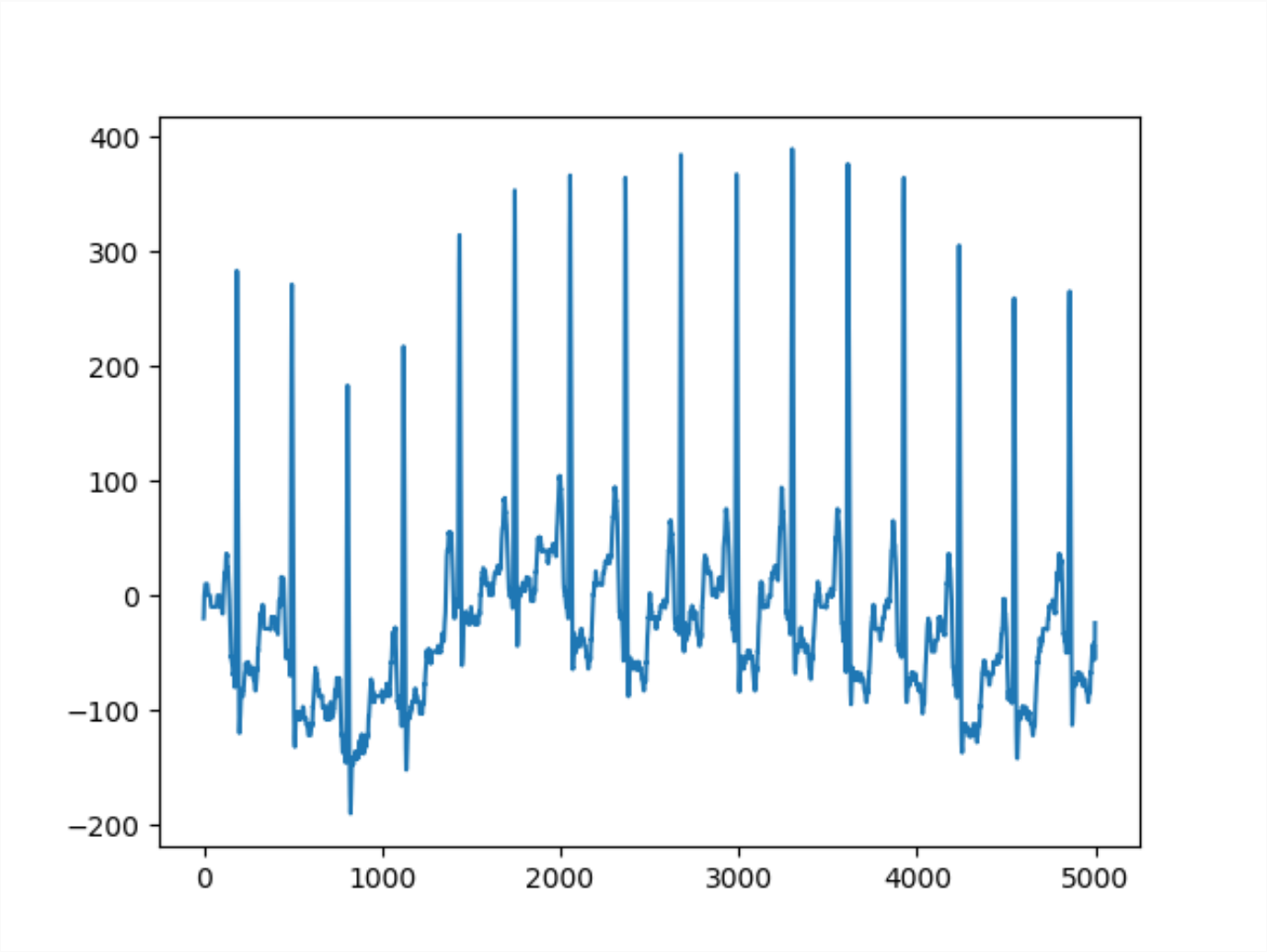
Data Preprocessing: Fourier Analysis

Fourier Analysis

- Mathematical procedure of reducing periodic data into a smaller set of parameters.
- We can use these to create a reconstruction of the wave.
- Low (linear) correlation between Fourier parameters and heart rhythm disorder.
- Low amount of parameters: bad approximation of the wave, but good approximation for baseline.

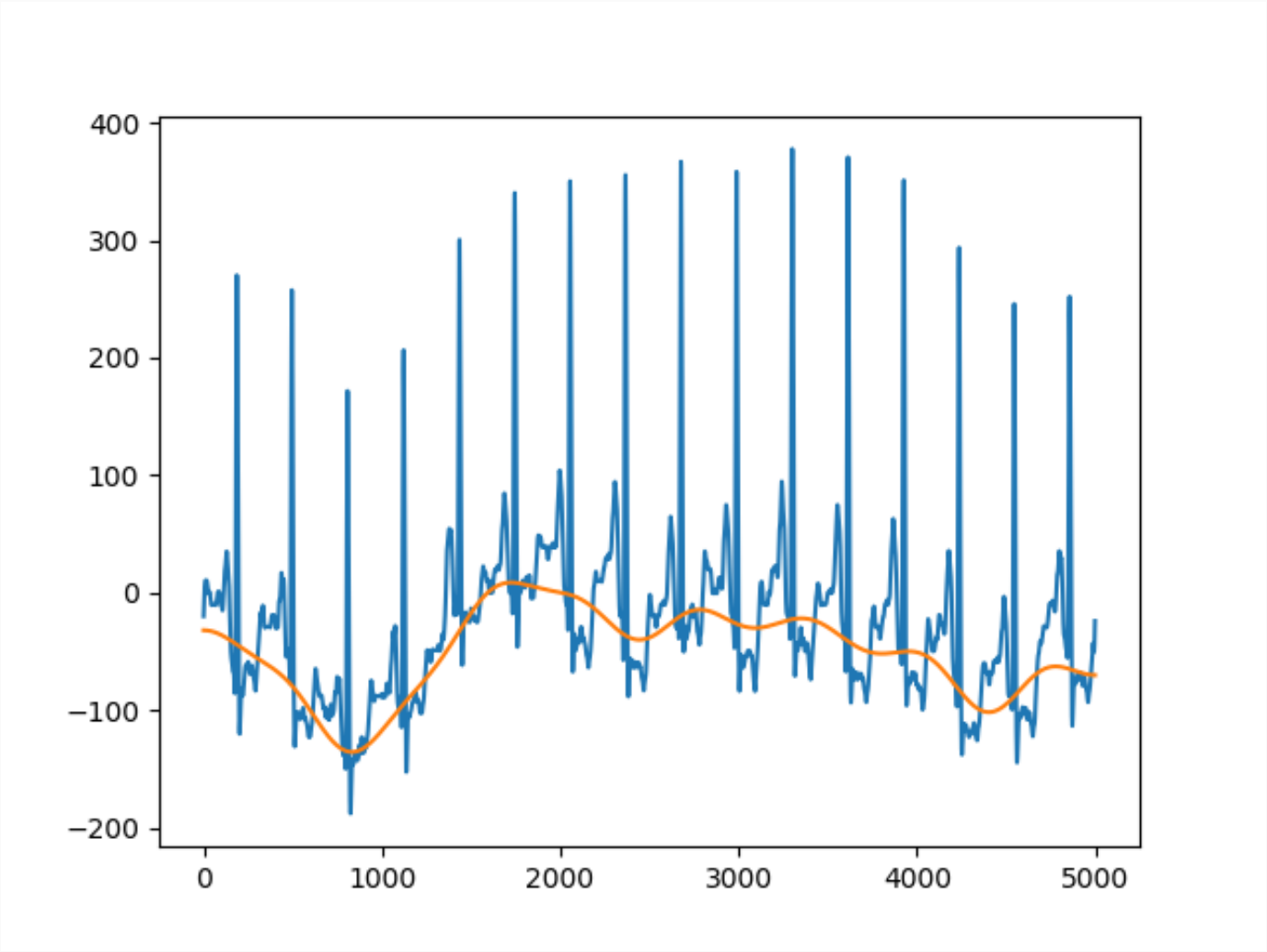
Data Preprocessing: Fourier Analysis

Baseline Wander



Data Preprocessing: Fourier Analysis

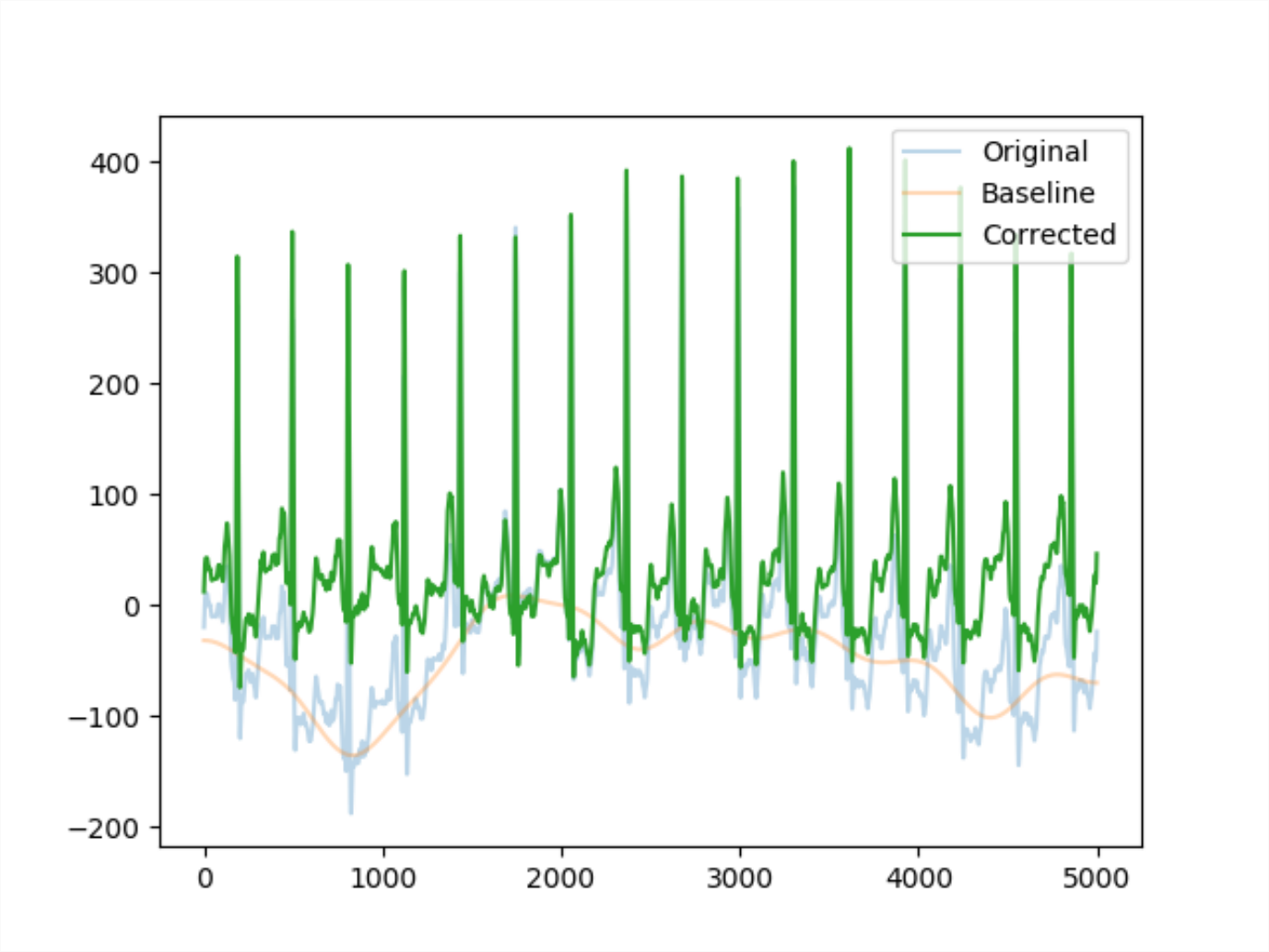
Baseline Wander detection



Data Preprocessing: Fourier Analysis

Baseline Wander correction

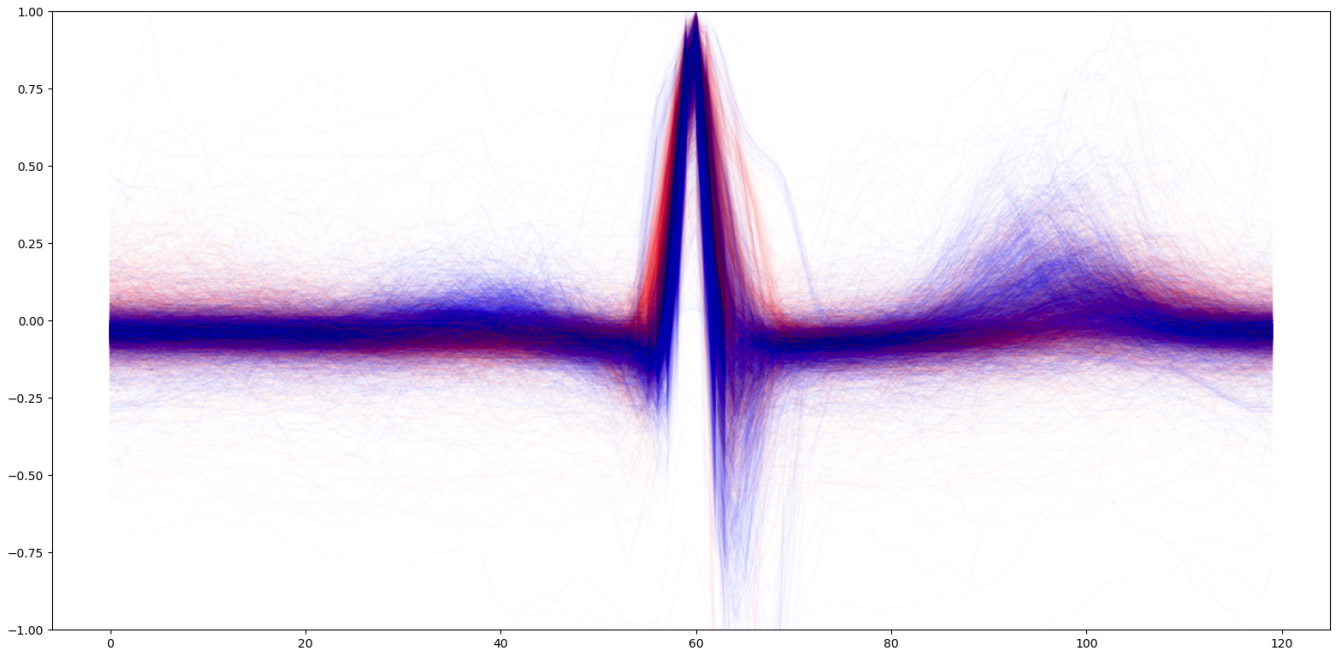
Subtracting the baseline from each value in the data results in a straightened ECG.



Data Preprocessing: Pulse Extraction

Extracting Pulses

Divide ECG's into pulses and scale them to a fixed size. Overlaying them results into a clear separation of healthy and non-healthy ECG's.



Neural Network

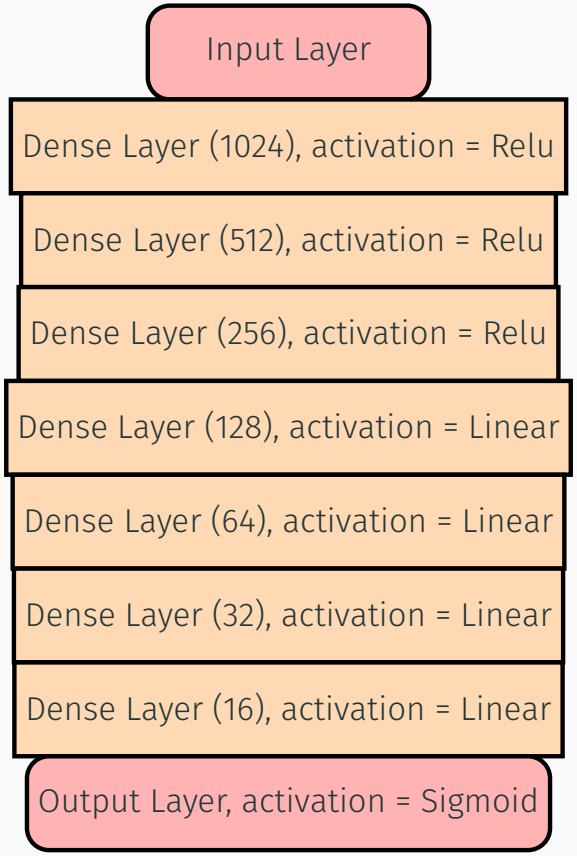
The model

Model created in Keras; a high-level python neural network API.

- Input: The normalized and scaled pulses extracted from the ECG's.
- Hidden Layers: 7 feed forward layers in reverse pyramid format.
- Output: Binary classifier for Sinus Rhythm or Atrial Fibrillation.

Neural Network

The model



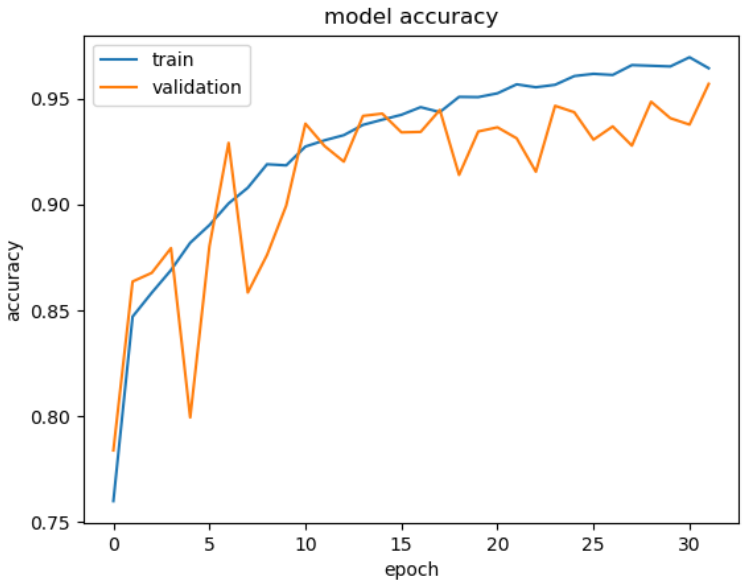
Results

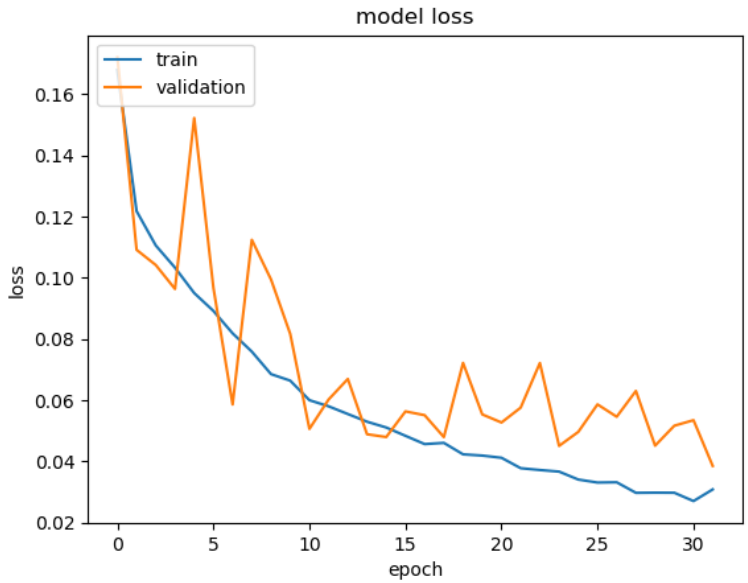
Results

The final results of our Neural Network on predicting Sinus Rhythm and Atrial Fibrillation

Accuracy	Precision	Recall
0.96	0.95	0.96

Results


model accuracy
train
validation
accuracy
epoch
0.75
0.80
0.85
0.90
0.95
0
5
10
15
20
25
30


model loss
train
validation
loss
epoch
0.02
0.04
0.06
0.08
0.10
0.12
0.14
0.16
0
5
10
15
20
25
30

Conclusion

Conclusion

Good results and a happy client

- Accuracy 96% $\longrightarrow$ Sarah very happy
- Only Sinus Rythms and AF
- Results exceed expectations

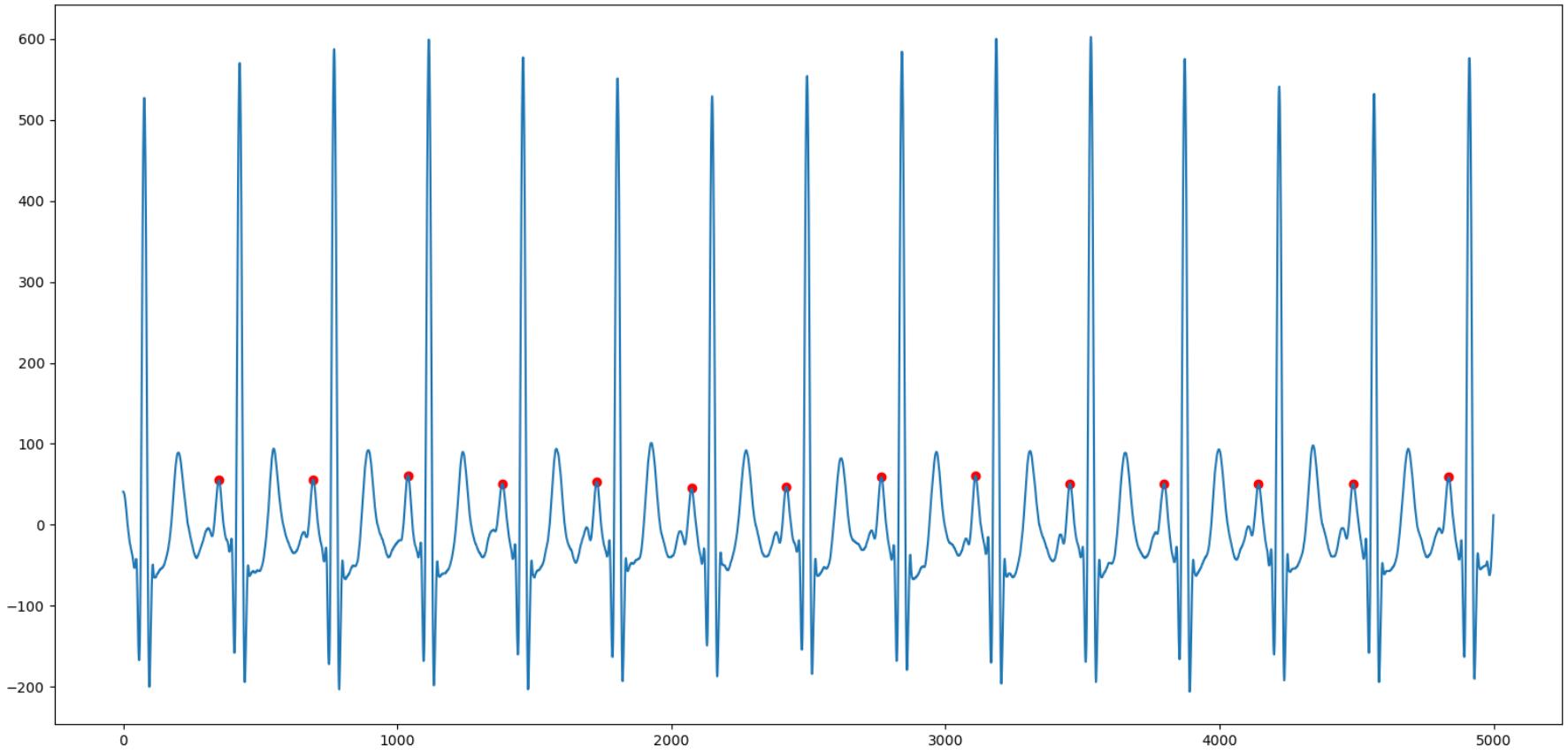
Future Work

Future work

Detecting P-peaks

- code to detect P-peaks
- Detecting Atrial Fibrillation
- Redundant

Future work

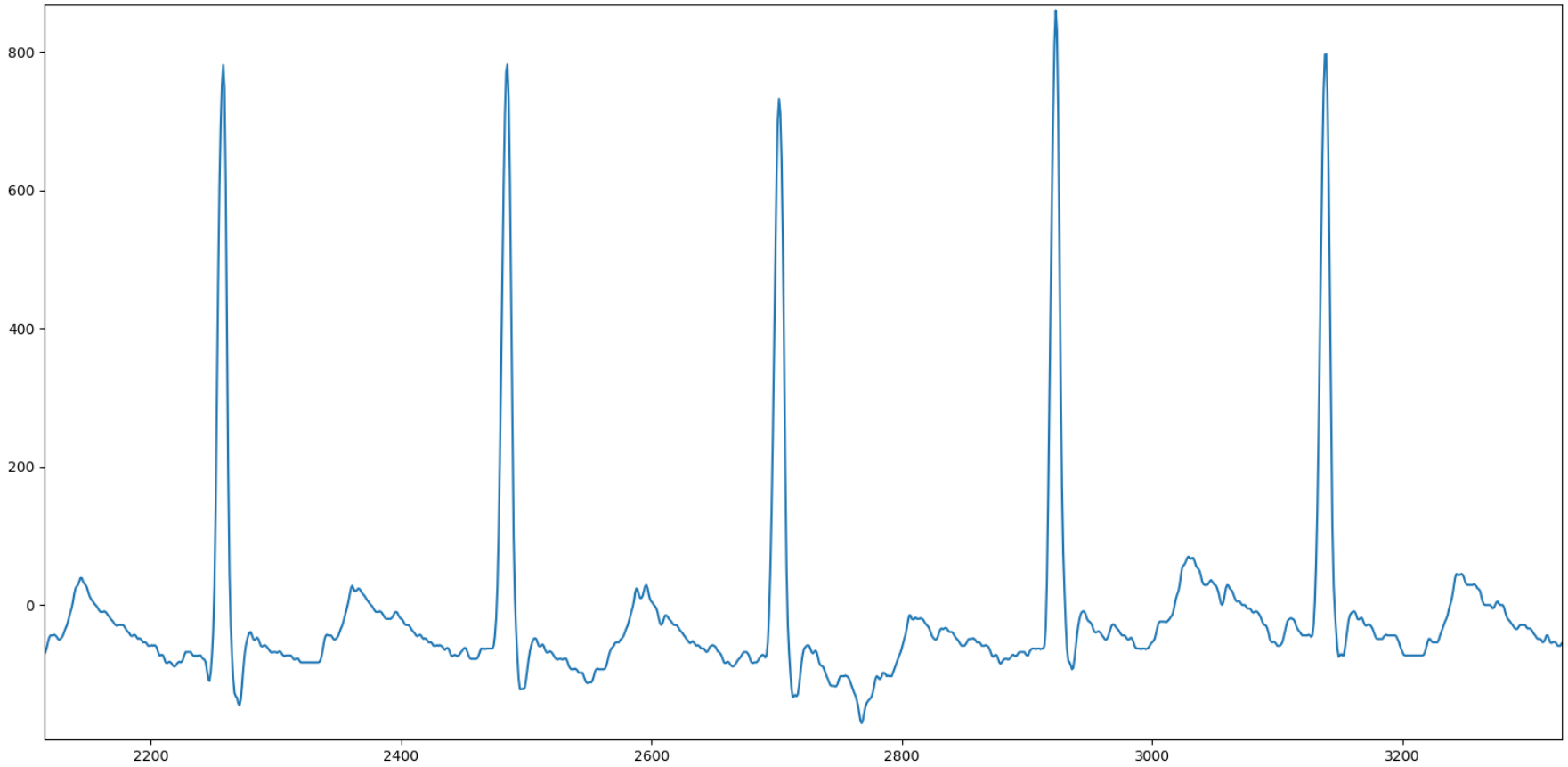


Future work

Other feature extraction methods

- features to extract
- ”Zig-Zaggy” data $\longrightarrow$ Atrial Flutter
- exploring in the future

Future work



Future work

Other Models

- 1D Convolutional Neural nets
- LSTMs
- composite of our model and others may improve accuracy

Questions?