# Final project
## BioBytes (Adam + Leonardo)

# Introduction

- Heart rate monitoring is key in health assessment, with applications in diagnostics and fitness.
- Remote Photoplethysmography (rPPG) uses facial video to extract pulse signals, offering a contact-free alternative.
- This project develops a smartphone-based rPPG system, integrating ROI selection, signal filtering, and fiducial point detection for accurate heart rate estimation.

# Data acquisition

- Face video and ECG were acquired simultaneously
- 40 sessions of 30 seconds each
- 20 videos from Adam, 20 from Regina
- Different conditions: neutral, illumination variation, facial expressions, head movement
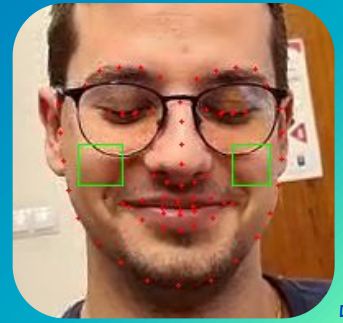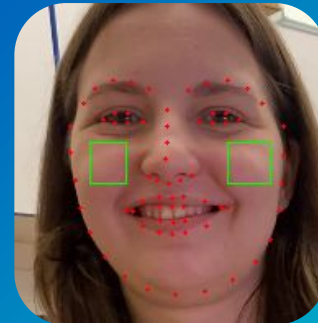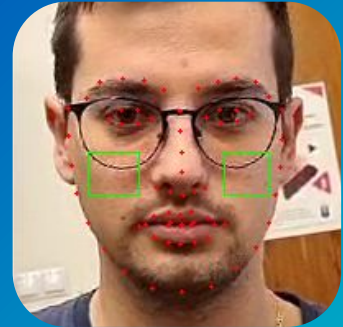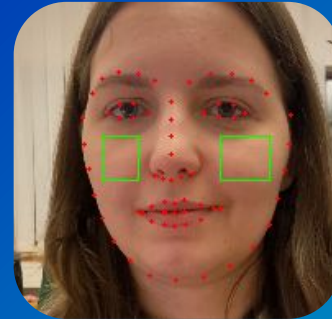- Normal heartbeat and accelerated heartbeat

# Face detection

- Library dlib
- HOG + Linear SVM
- Fast and simple
- Worked reasonably well for our dataset

fps: 30.30
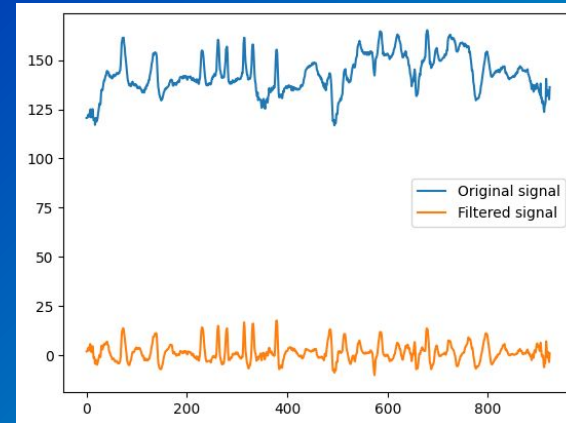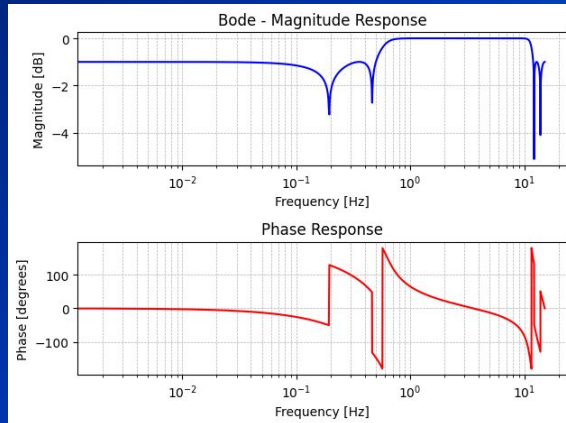HR_real: 100.00
HR_predicted: 109.09
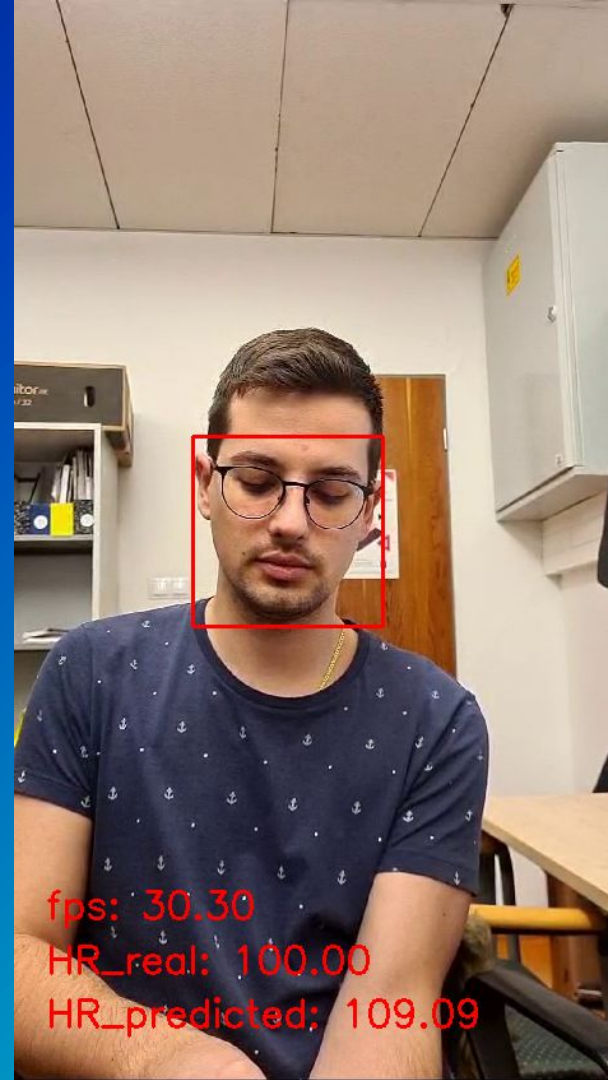
# Signal extraction

- Upper part of the cheek
- For each patch, we calculate the average value of the green channel
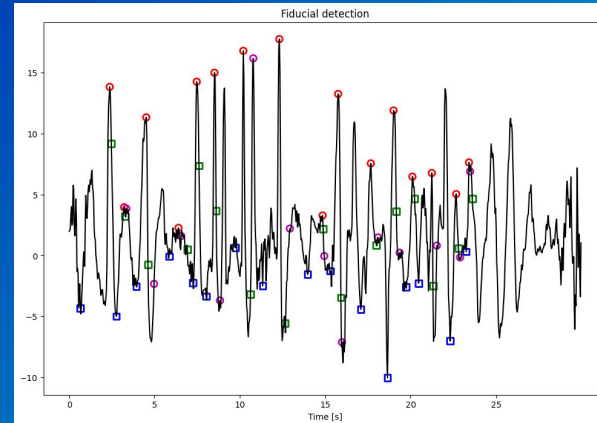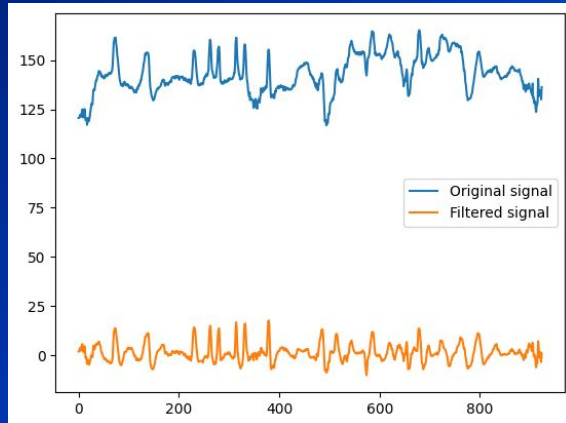
# Signal filtering

- Chebychev bandpass filter of 4th order
- Lower and upper cutoff frequency of 0.5 Hz and 12 Hz
- Inspired by filtering used in the PyPPG library

# Fiducial points detection

- Heart rate = median time between consecutive systolic peaks
- Saved for future analysis the position of the systolic peaks and the dicrotic notch
- Using PyPPG

# Validation

- To validate the extracted PPG signals, comparisons were made against data collected from a Palmare PM10 device, which serves as a reference standard
- The comparison focused on the similarity between the extracted signals and those obtained from the ECG device under identical conditions.
- Metrics such as signal shape, frequency, and waveform patterns were analyzed to ensure the accuracy and reliability of the smartphone-based PPG extraction method.

# Validation
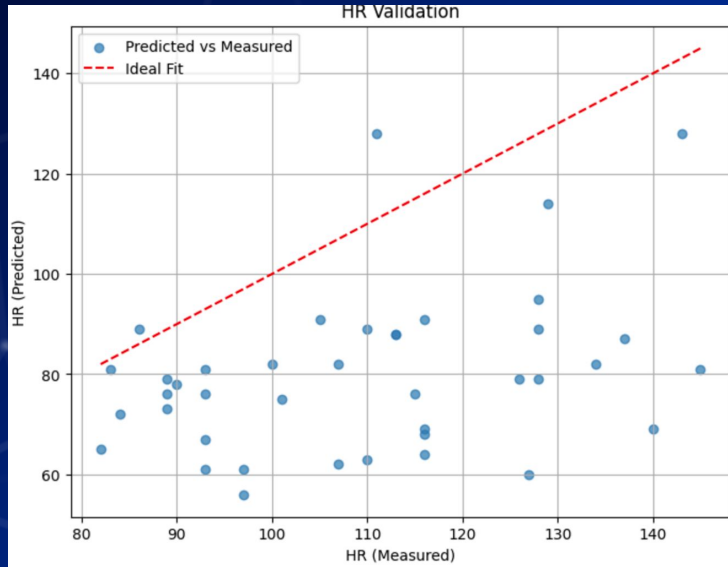


HR validation
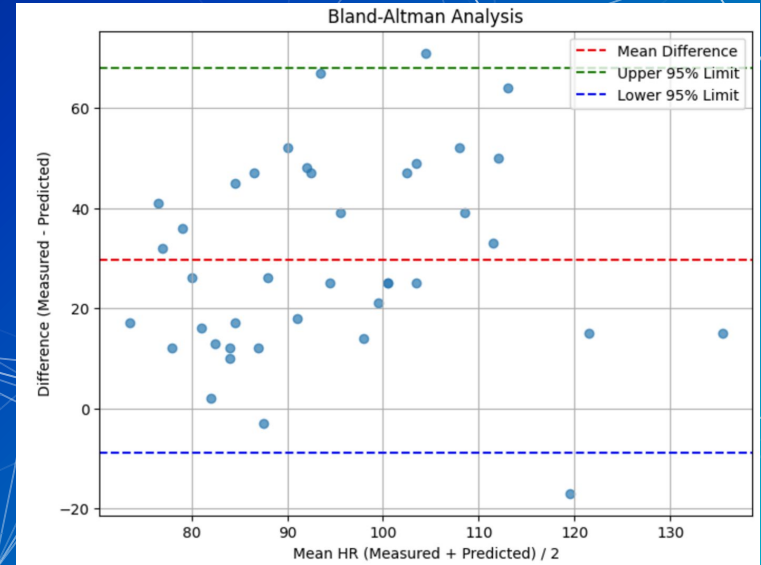


Bland-Altman Analysis

# Validation



Mean error by condition

# Future works

- Select another part of the face as ROI
- Improve the filtering (adaptive filtering, etc)
- Use other techniques for identifying fiducial points (CNNs, LSTMs, etc)


- Smartphone app
- Integrating with other physiological monitoring solutions

# References

- Waqar, M., Zwiggelaar, R., Tiddeman, B. (2021). Contact-Free Pulse Signal Extraction from Human Face Videos: A Review and New Optimized Filtering Approach. In: Rea, P.M. (eds) Biomedical Visualisation. Advances in Experimental Medicine and Biology, vol 1317. Springer, Cham. https://doi.org/10.1007/978-3-030-61125-5_10
- Dingliang Wang, Xuezhi Yang, Xuenan Liu, Jin Jing, and Shuai Fang, "Detail-preserving pulse wave extraction from facial videos using consumer-level camera," Biomed. Opt. Express 11, 1876-1891 (2020)
- Habom2310. (n.d.). *Heart rate measurement using camera* [GitHub repository]. GitHub. https://github.com/habom2310/Heart-rate-measurement-using-camera
- Ubicomplab. (n.d.). *rppg-web* [GitHub repository]. GitHub. https://github.com/ubicomplab/rppg-web