Seeing Red: PPG Biometrics using Smartphone Cameras

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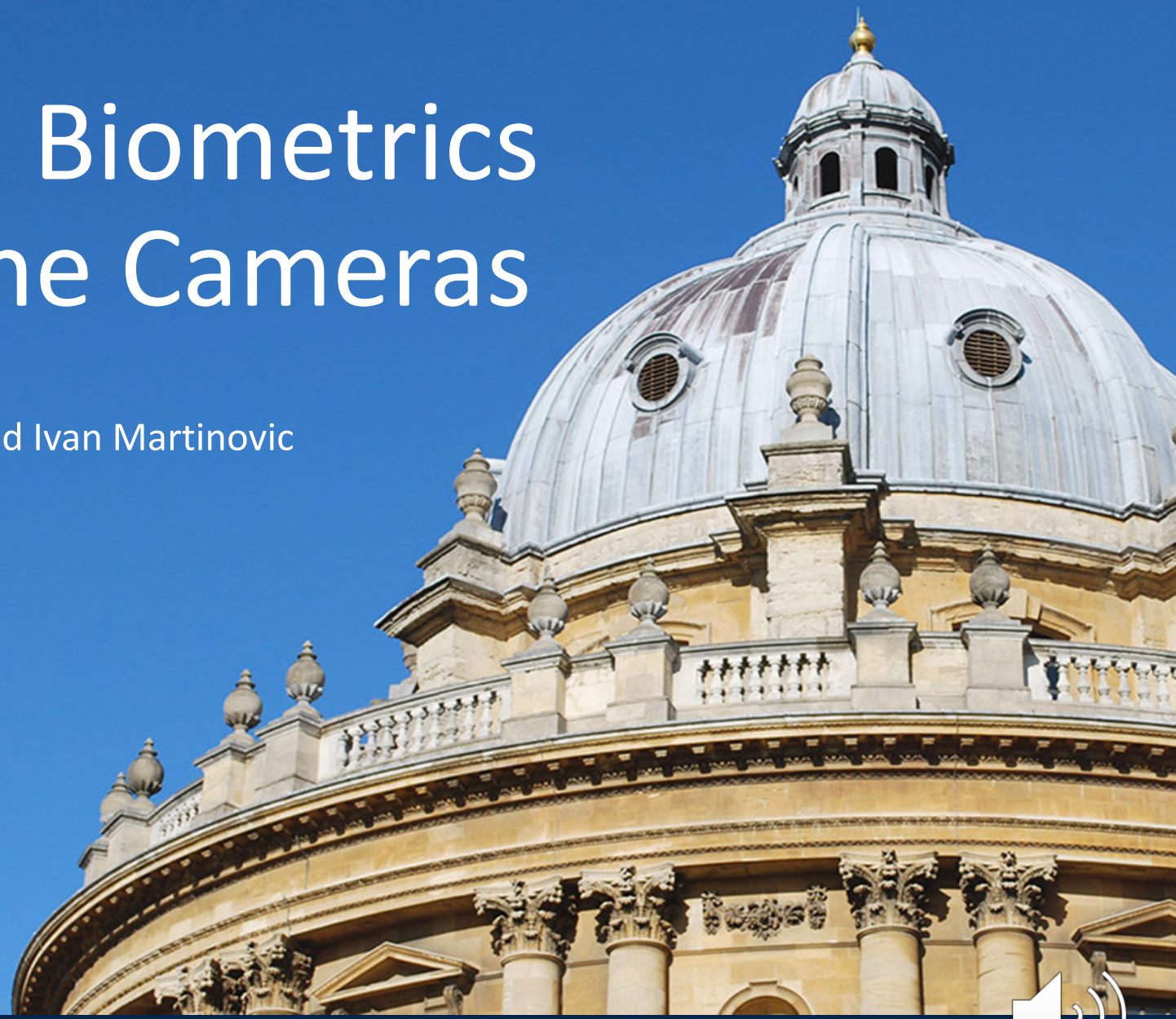

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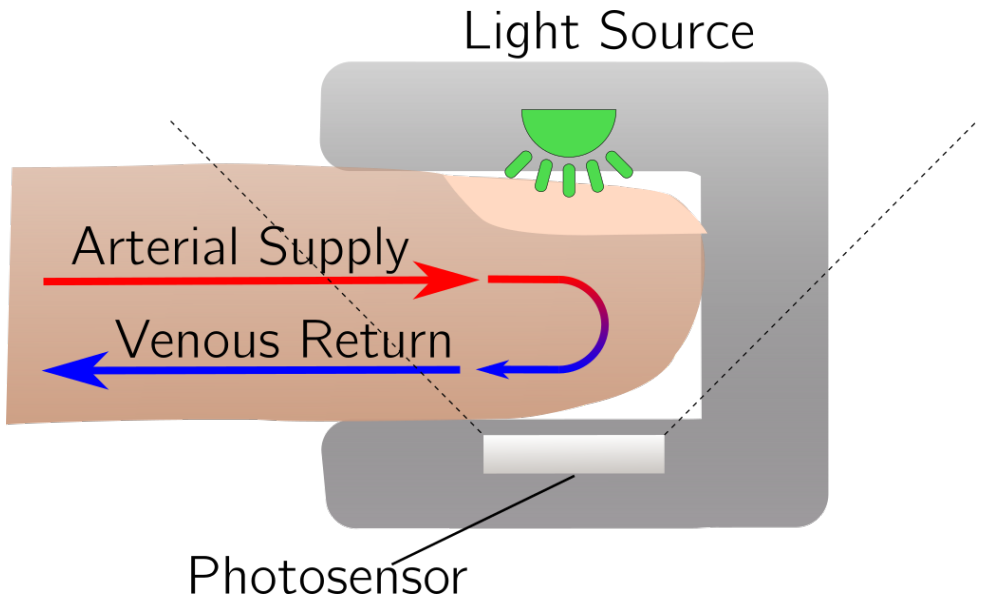
Motivation

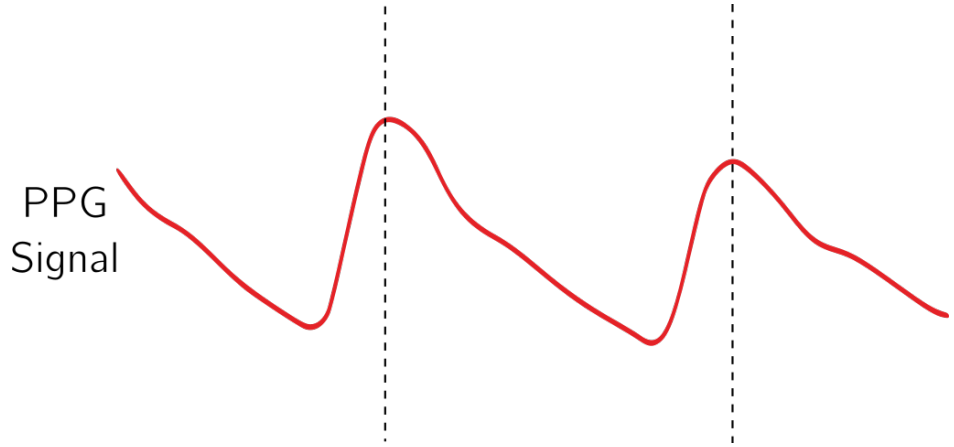
- Commonly used biometric traits are **observable** or **collectable**

- Presentation attack detection (e.g., liveness detection) is an **arms race**
- What about using **unobservable** traits?

Photoplethysmography

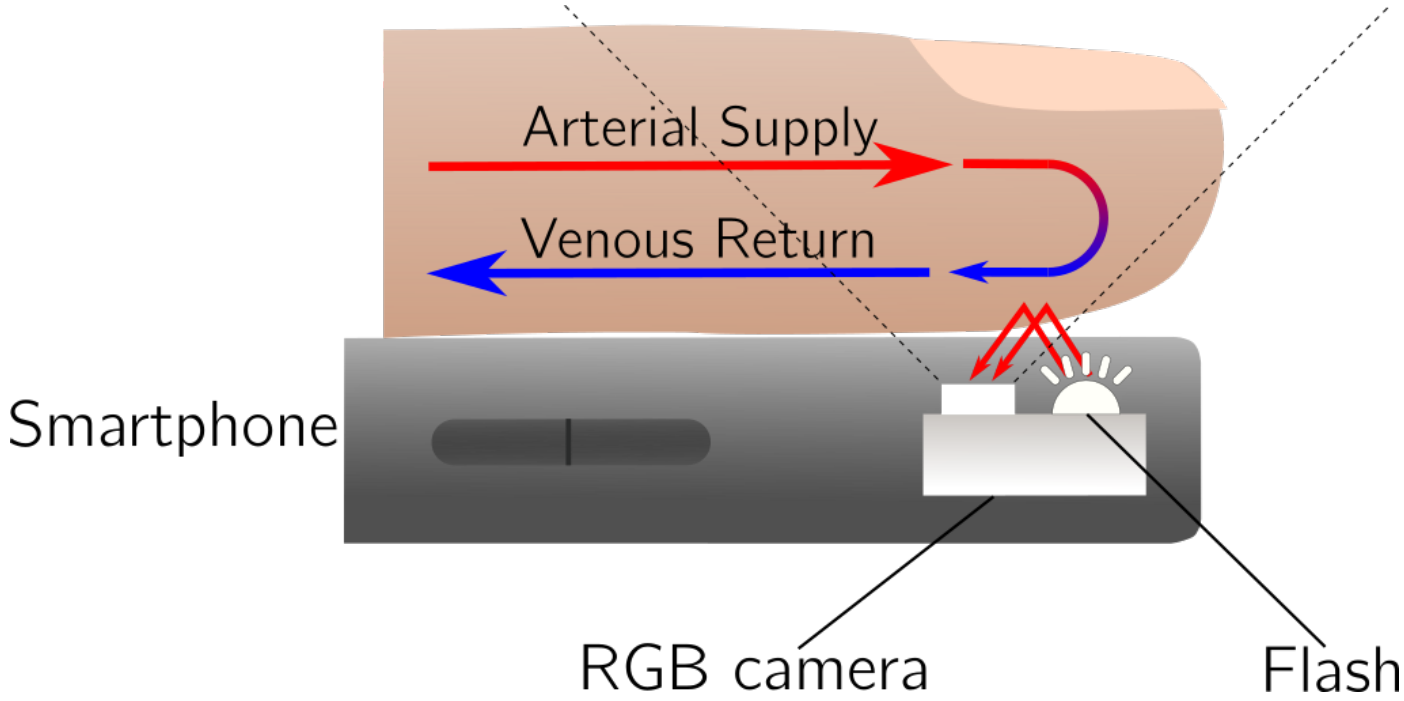
- Photoplethysmography (PPG) is an optical technique used to detect volumetric changes in blood in peripheral circulation



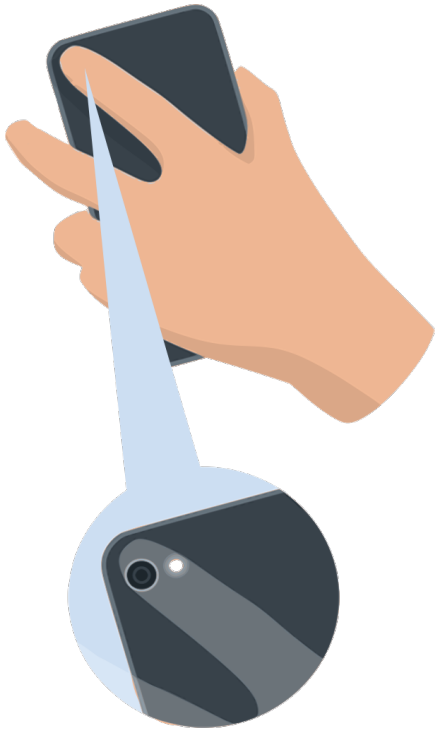


Photoplethysmography - Reflection

- PPG can be collected with a (smartphone) RGB camera by leveraging changes in skin reflective properties
- Advantages:
  - **Resilient to observation**
  - **No additional hardware**
- Challenges:
  - Noisy signal



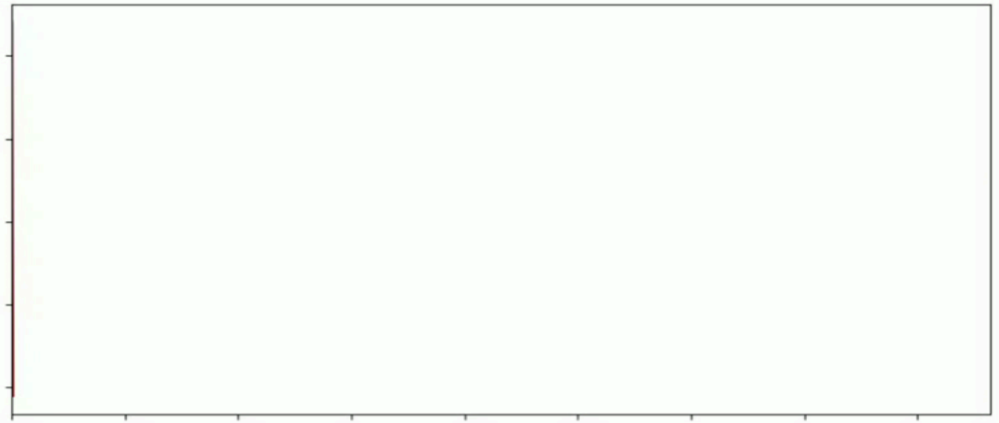
PPG Extraction



reference

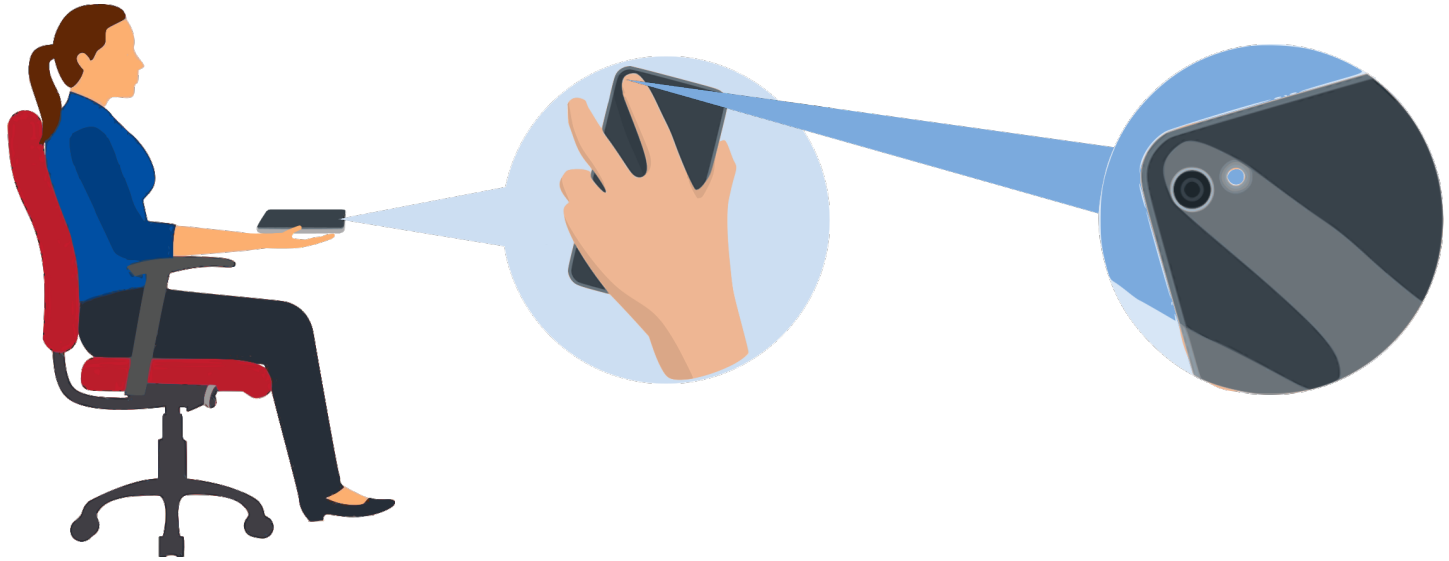
Recorded video

Extracted signal
(luma component)



Data Collection

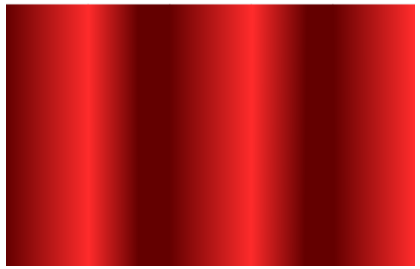
- 15 participants, 6-11 measurement sessions per participant
- Each session is >2h apart
- One session consists of the following:

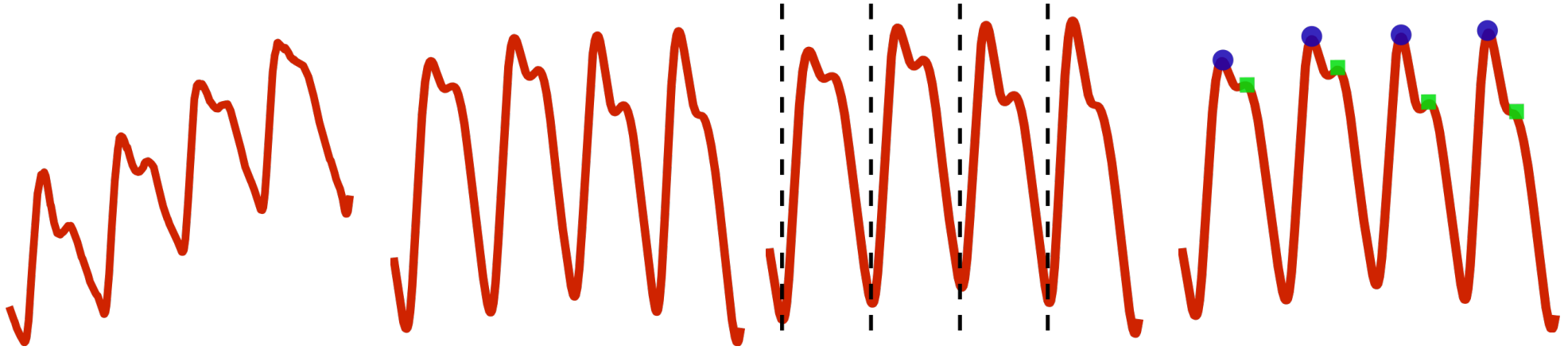


30 seconds video

Analysis Pipeline

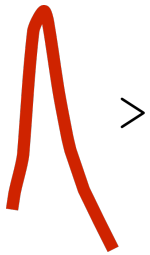
Video Recording → Signal Extraction → Signal Processing → Beat Separation → Fiducial Points





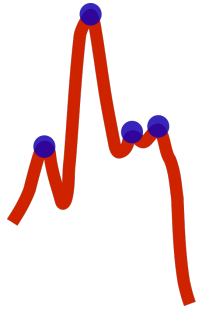
Signal Quality – Failure to Acquire

- Lot of noise in signal leads to inconsistent features
- We filter some of this noise by introducing three beats quality filters:
  - 1. Length:



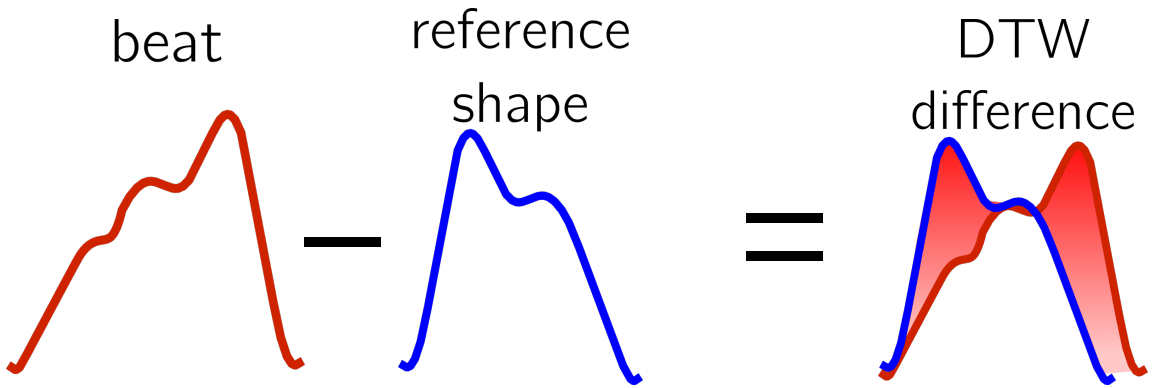
>120 bpm

2. no. of peaks:



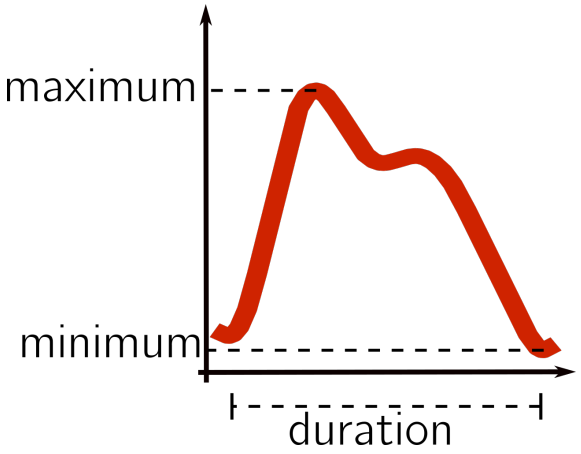
>3 peaks

  - 3. Distance from reference:

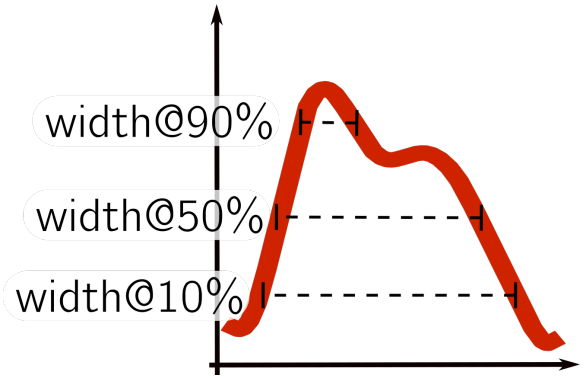


Features Extraction

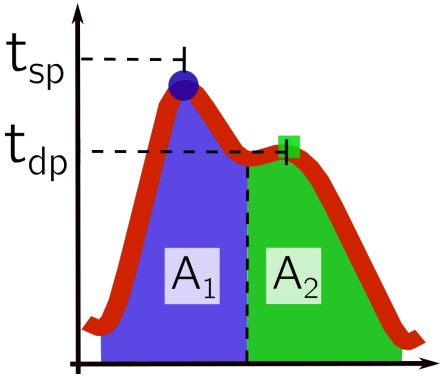
Statistical



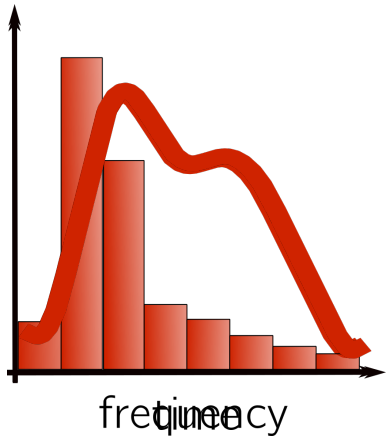
Curve Widths

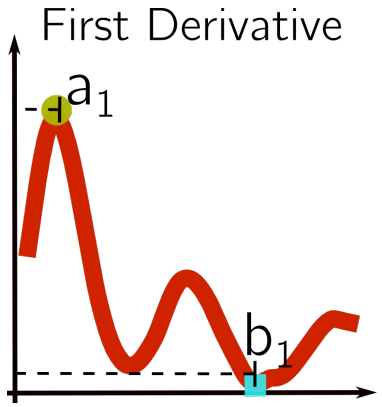


Fiducial Points



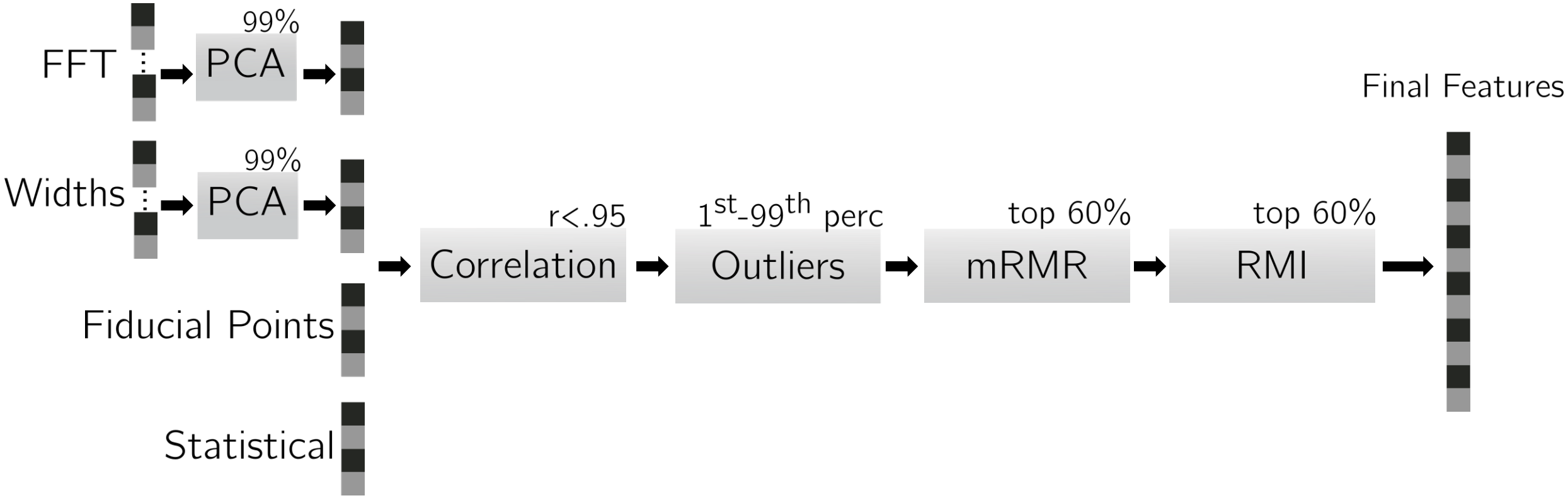
Frequency



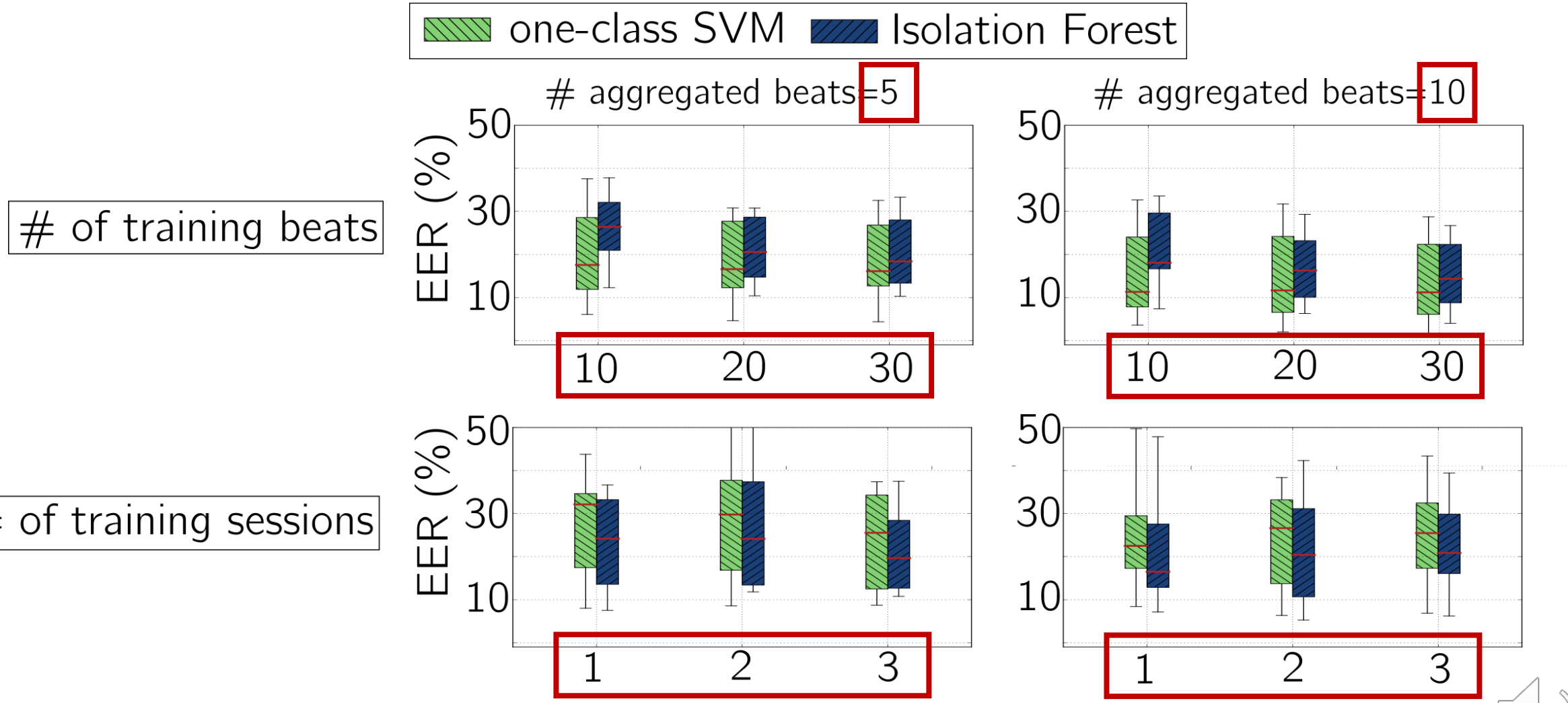


Feature Selection

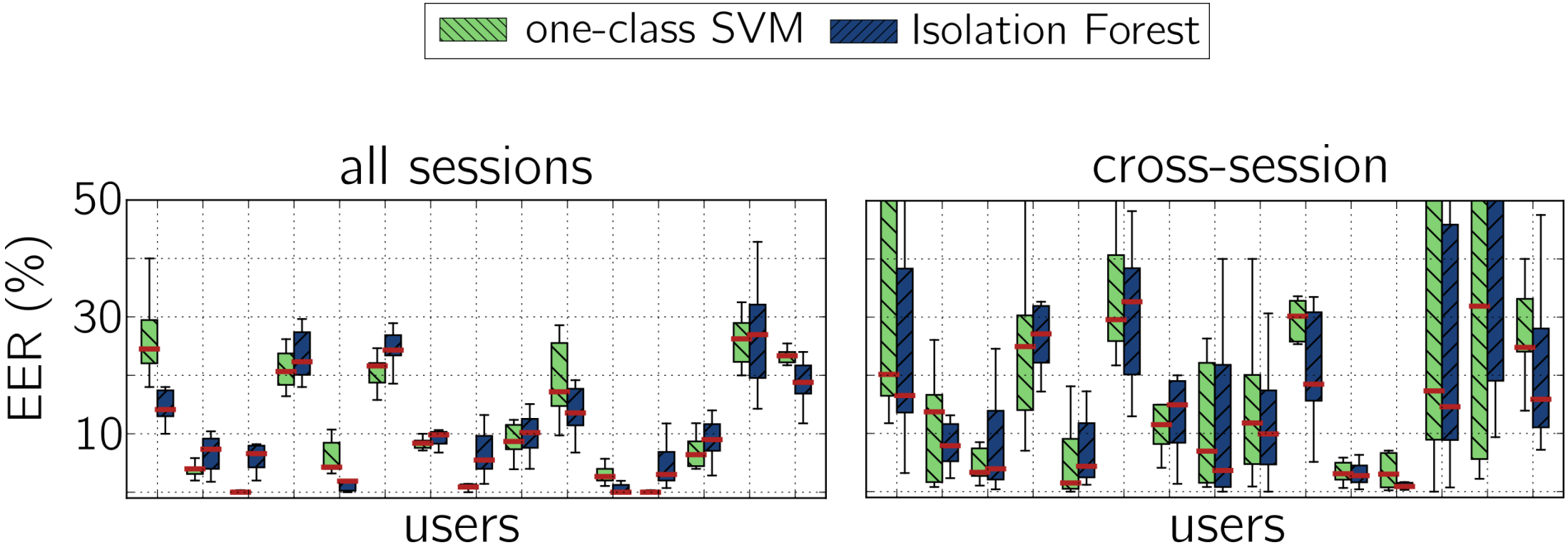
- Each beat is described by 541 features, feature selection as follows



Results – Authentication



Results – Users EER Distribution



Conclusion and Future Work

- **Insights**
  - PPG works well in single session, performance drops across sessions
  - Works significantly better for some users
- **Future Work**
  - User-specific analysis pipelines
  - Detect ``noisy'' sessions due to: finger warmth, finger placement, hand movement
  - Larger evaluation with more users and different hardware

Questions

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- https://github.com/ssloxford/seeing-red