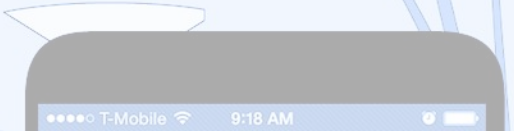
Smart BP

CSE 145

Jessica and Nathan

Overview

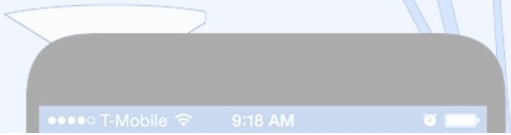


- Monitoring Blood Pressure (BP) outside clinical environments can be challenging:
  - Hospital exposure during COVID-19;
  - Lack of BP monitoring;
  - Inconvenient to carry around;
- Our goal is to overcome this challenges by implementing the SmartBP:
  - Blood pressure estimation by using oscillometric finger pressure monitoring and blood volume;
  - Reliable, use anywhere, accessible;
  - Centralized data storage;

Objectives

The MVP for this quarter is the full implementation of the work from Chandrasekhar et al., where we aim to use the hardware apparatus for accurately estimate BP using parametric modeling.

Milestones



W5: Device assemble (force and ppg) and real-time plot of sensor data;

W6: Code testing and preliminary data collection for start BP estimation algorithm;

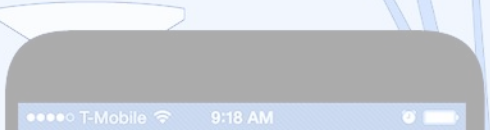
W7: Larger data collection using fitbit and cuff-based device, estimate heart rate(HR) using t and f analysis, validation of BP estimation algorithm.

W8: Replace PPG sensor with smartphone camera and add force sensing to phone; Start the website, and algorithm refinement and adjustment;

W9: Finish work on the website, start documentation in format of a poster submission.

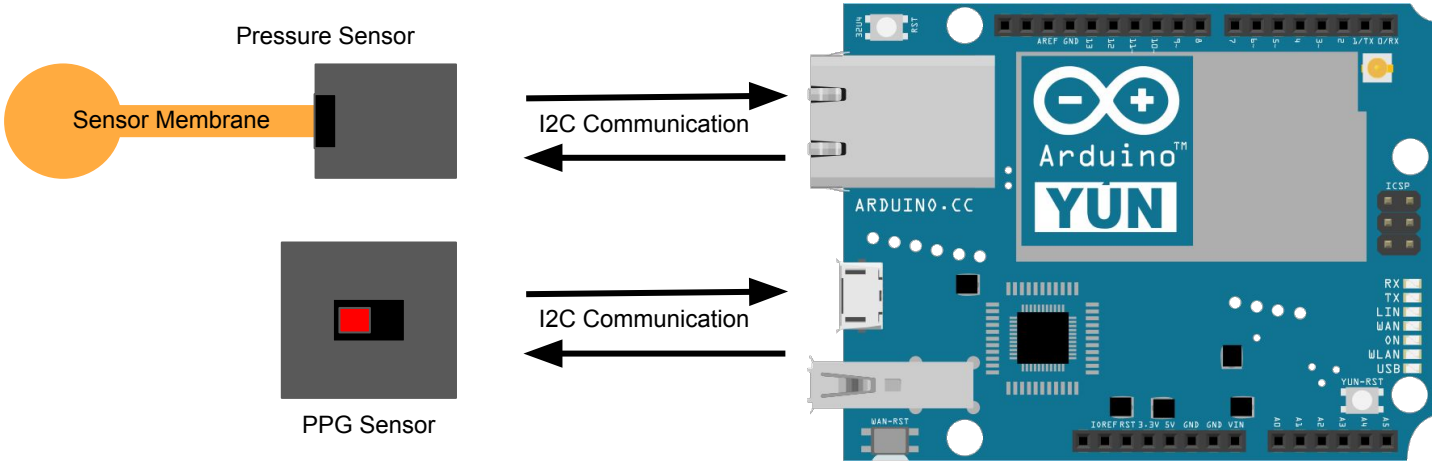
W10: Finish website, have full repository and video of the implementation and working device;

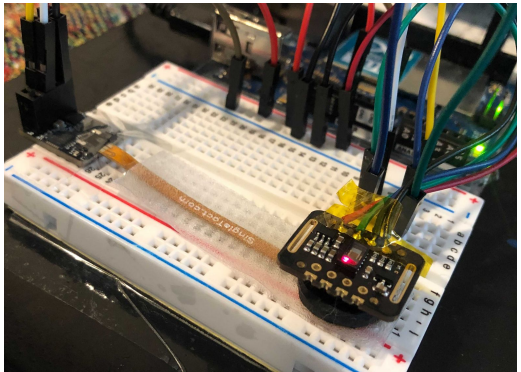
Accomplishments

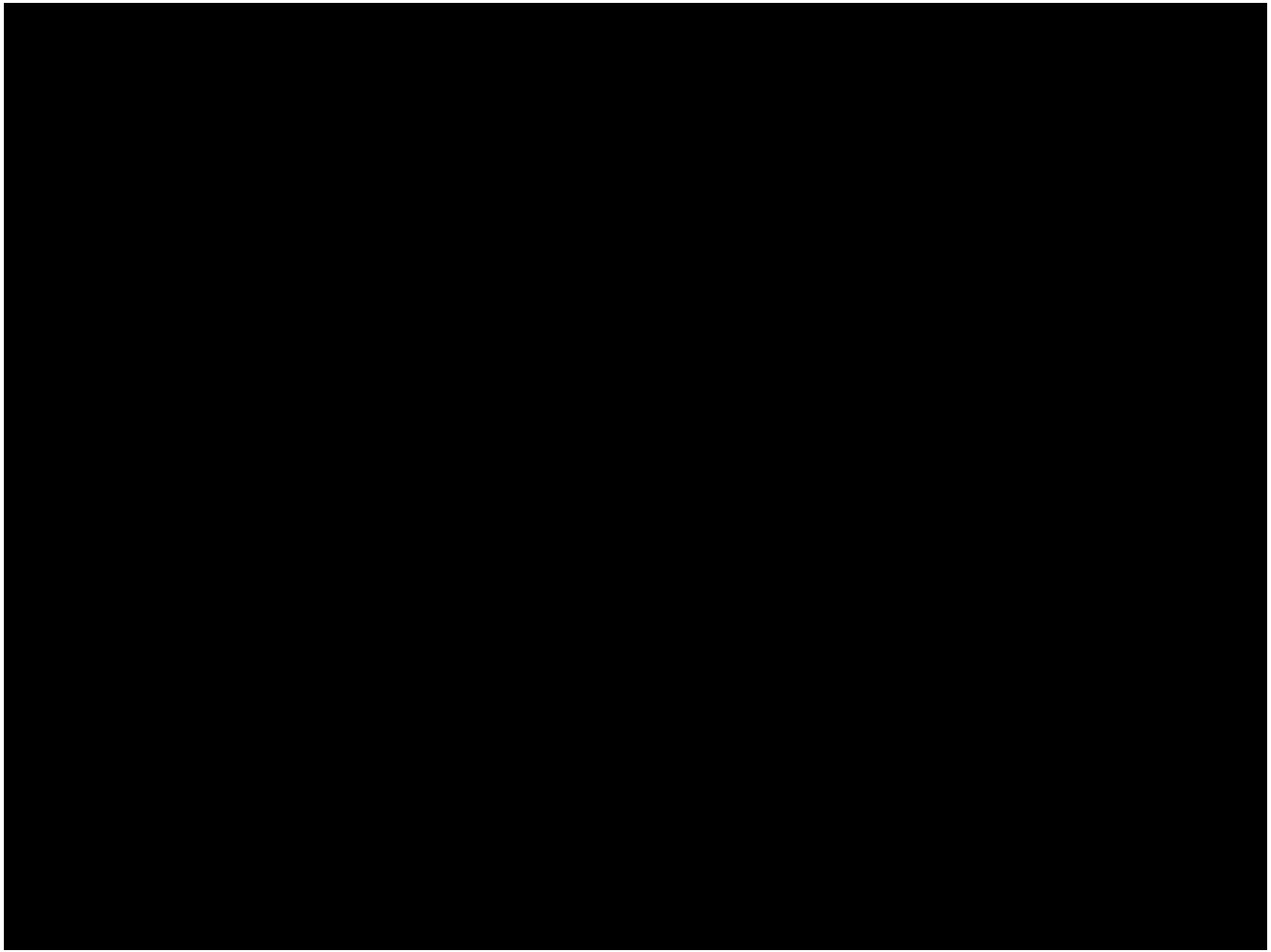


- Applied Force sensor and PPG sensor are assembled, and able to record raw signals record signals as .txt files on a computer, which can be pipelined to a processing algorithm.
- Weekly meetings for working on the project.
- Began migrating codebase to Github.
- mmHg and blood volume are the main inputs to estimating the heart rate and blood pressure.

Hardware Implementation

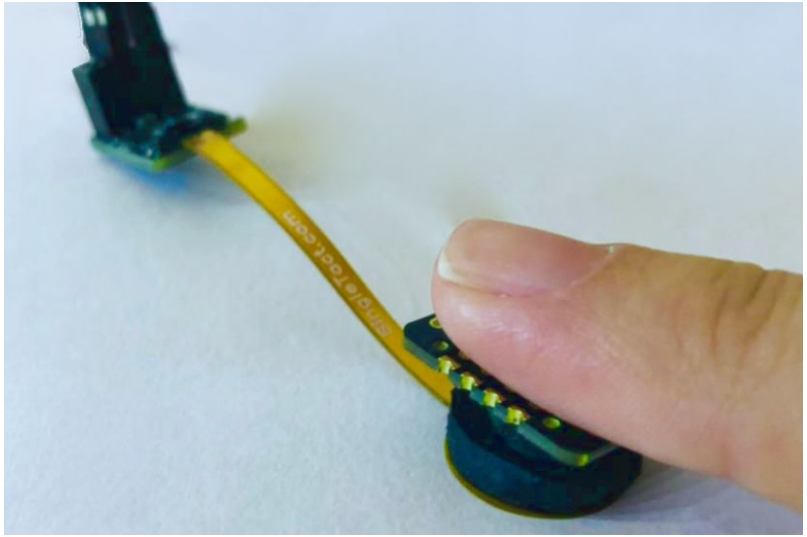


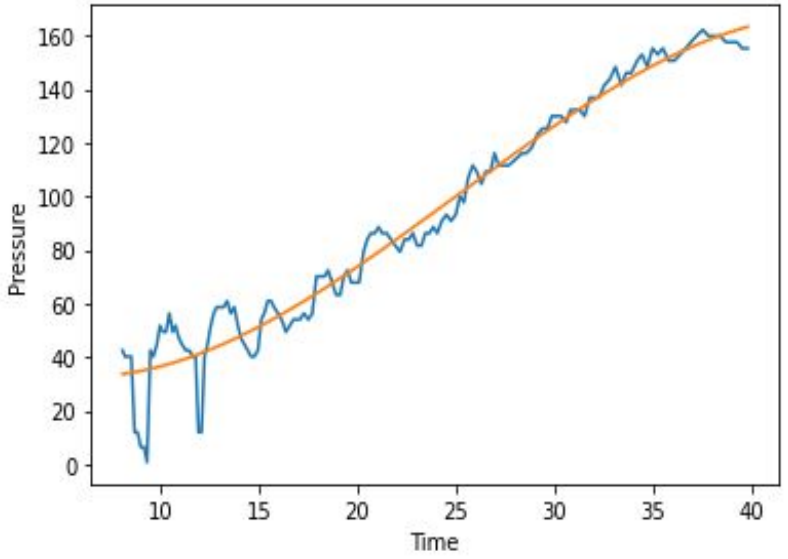




Basic device constructed:

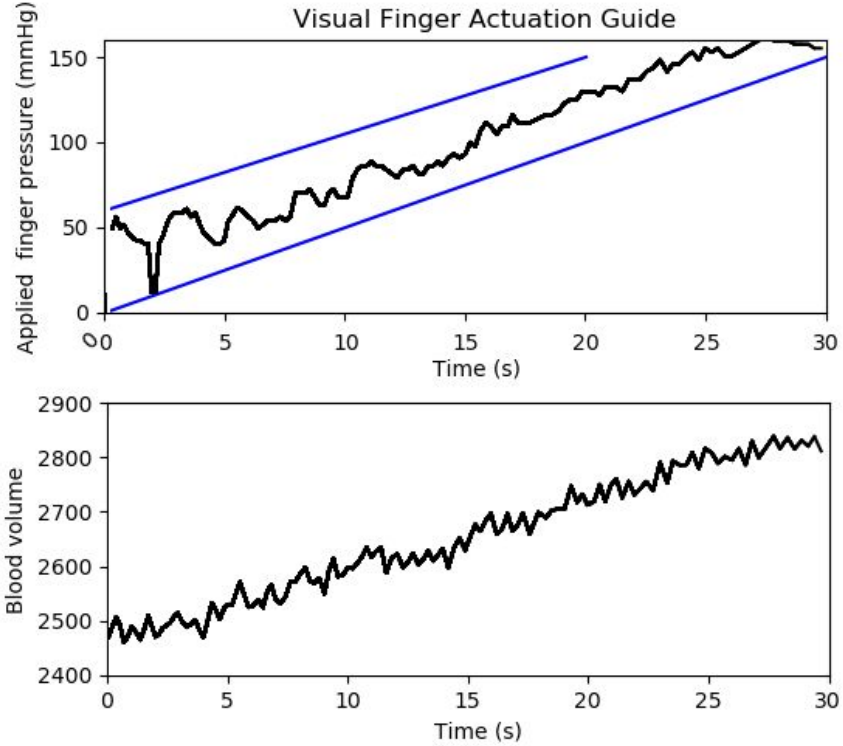
- Pictured: Jessica's finger on the applied force sensor;
- Can record basic raw signal and smooth with moving average and 3rd order polynomial fit;





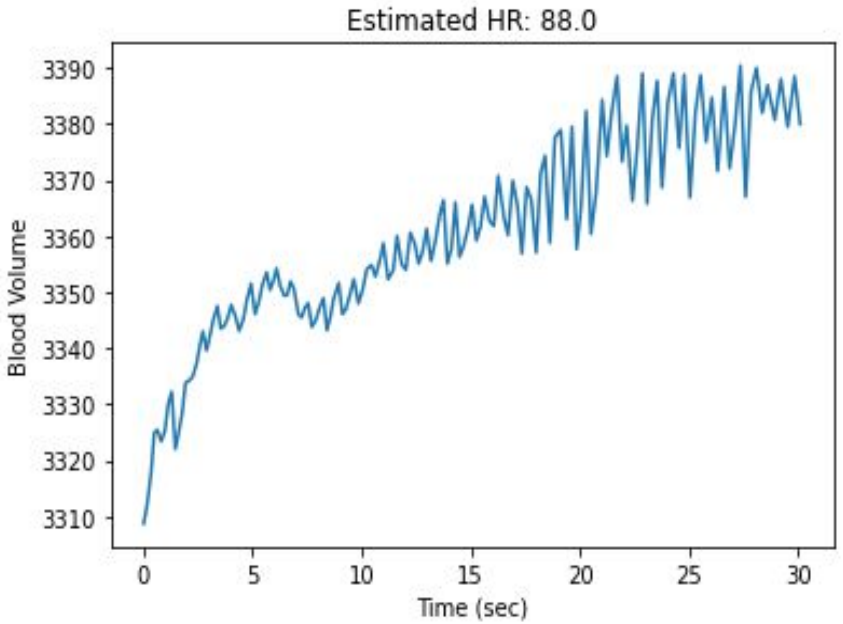
Signals we can currently record:

- Top: Applied Pressure from finger sensor;
- Bot: Blood volume waveform data from PPG sensor;
- TODO: signal filtering, fit a parametric model to these signals to construct oscillogram;
- Signals are raw data recorded with Jessica's device!



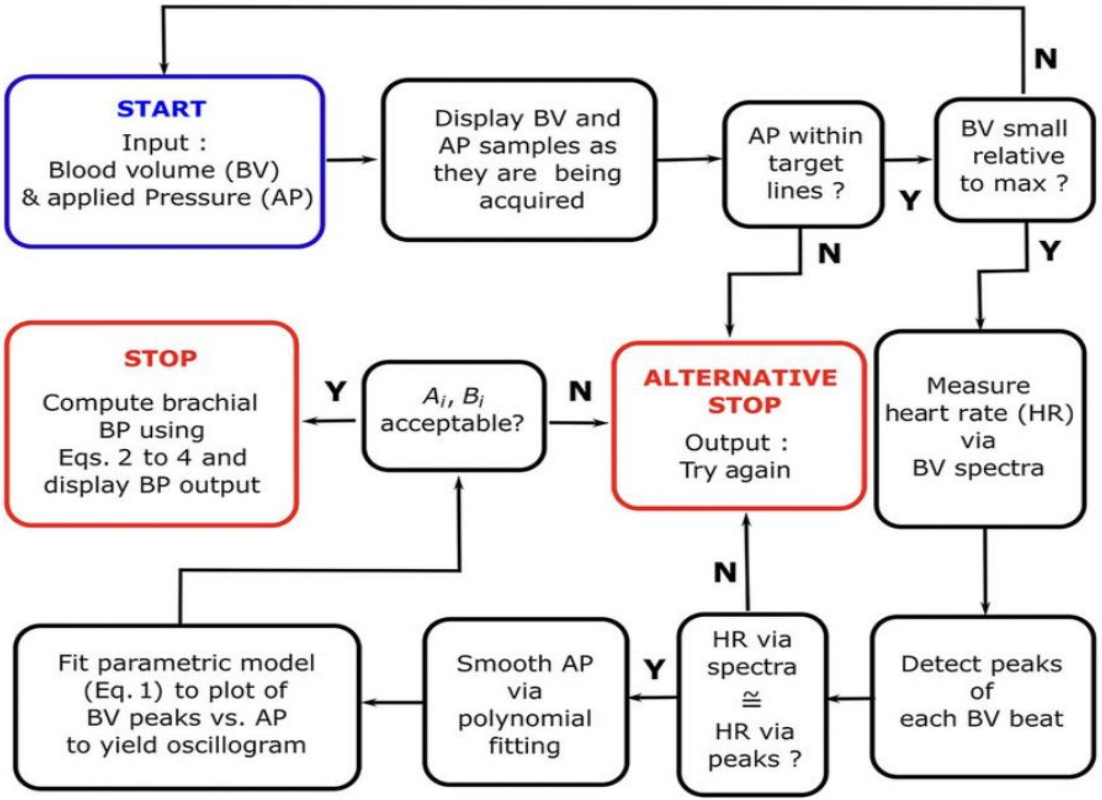
Signals we can currently record:

- We can also currently estimate the average heart rate with the device within 10% accuracy when compared to ground truth
- Left: estimated 88bpm / ground truth 84bpm



Implementation/Algorithm pipeline

- Basic skeleton of the data pipeline is being established
- Can display and smooth raw data
- TODO: estimate heart rate using BV data
- Code up oscillogram fitting algorithm
- Estimate BP



Quarter Plan:

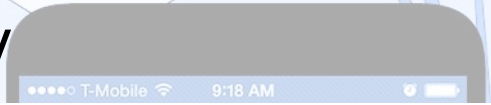
1. Replicate the computer algorithm which converts the applied force and blood volume waveform into average heart rates and blood pressure

2. Meet in person and build a data set of applied force, blood volume, and our ground truth heart rates and blood pressures using standard blood pressure cuff-devices

3. Verify our device accurately measures BP from the applied force and blood volume signals wrt ground truth measurements

4. Experiment with/improve estimation algorithm (machine learning)

Addressing Concerns: Verification strategy

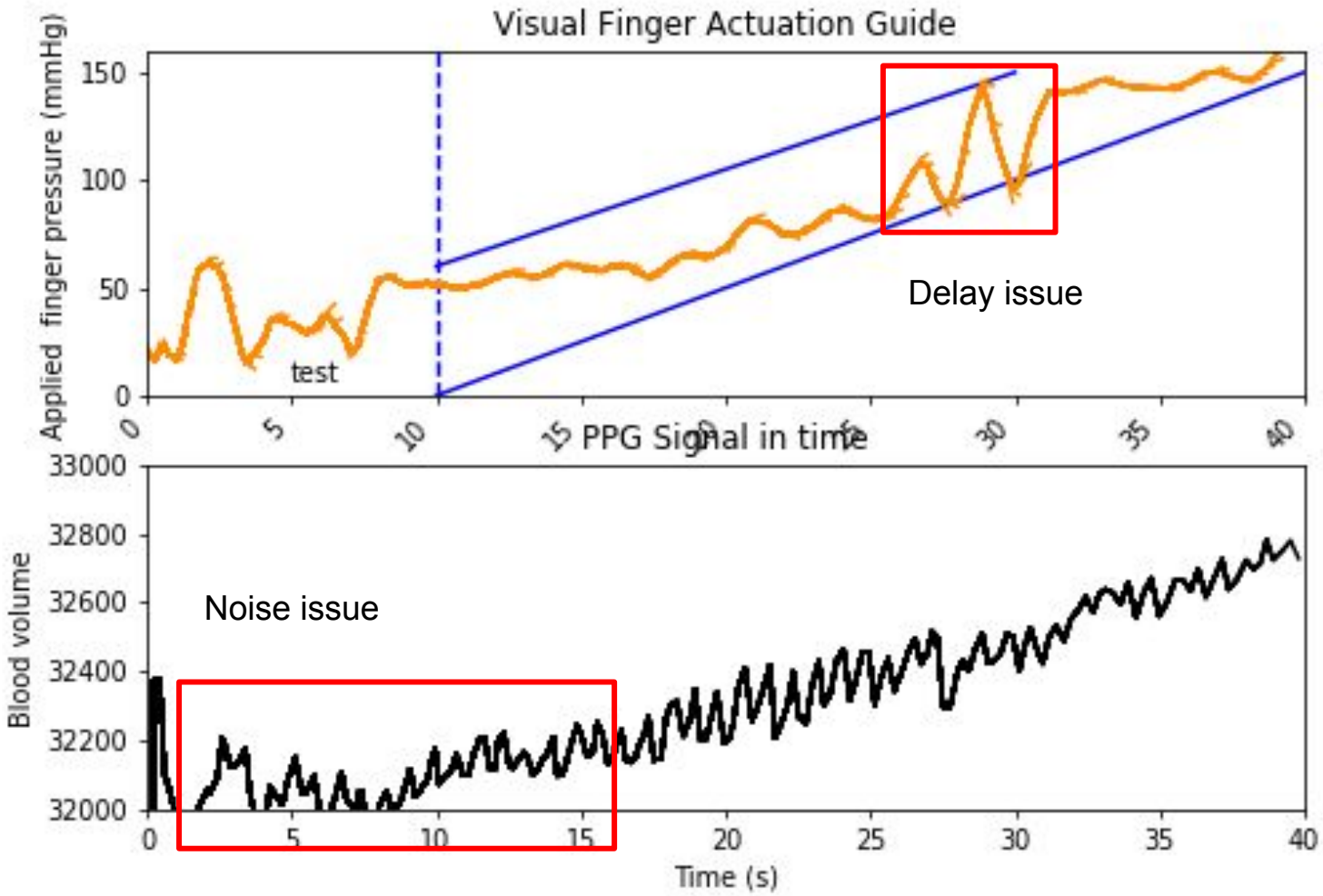


- Jessica and I will build a data set of the signals and ground truth HR/BP using ourselves and volunteers in various positions (sitting, standing, lying down, before/after exercise). Paper used **31** human subjects. We will try to get as close to 10 people (being positive!).

- Use our device to estimate the HR/BP and compare to ground truth HR/BP (is part of the replication and a good way to see we are correct).

- Do statistical analysis: compute mean bias, standard deviation, mean squared error, and compute confidence intervals & statistical significance

- Consider algorithm *correct* if probability of a difference between *estimated* HR/BP and *ground truth* HR/BP is low (e.g., prob < 0.05)


Visual Finger Actuation Guide
Applied finger pressure (mmHg)
150
100
50
0
test
Delay issue
0
5
10
15
20
25
30
35
40
PPG Signal in time
Blood volume
33000
32800
32600
32400
32200
32000
Noise issue
Time (s)