Home Gym Wearable

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The Team

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Problems

- During the Covid-19 Pandemic, It's a difficult time to find a personal trainer or workout at a gym.
- Gym access has been severely limited by social distancing, and many gym goers feel being at the gym is unsafe.
- In order to stay fit, people have to workout largely at home.

Objective

How might we help people to workout more efficiently, motivate them to get active, and measure success to exercise better at home?

Digital Personal Trainer

It guides users with simple workouts at home, gives feedback to build healthy routines.2)

No expensive gym equipment required.

Placement & Classifications

On head mounted wearable band

On arm mounted wearable

- It tracks user motion and classifies which exercise an user is doing: **Pulse Sit ups vs. V Sit ups.**
- It counts how many sit ups users did correctly.
- It detects movements' angles to define right or wrong ways.
- Application display will inform you how to measure success and guide to get better.

Pulse Sit ups

Engage your core and lift your upper body towards your knees.

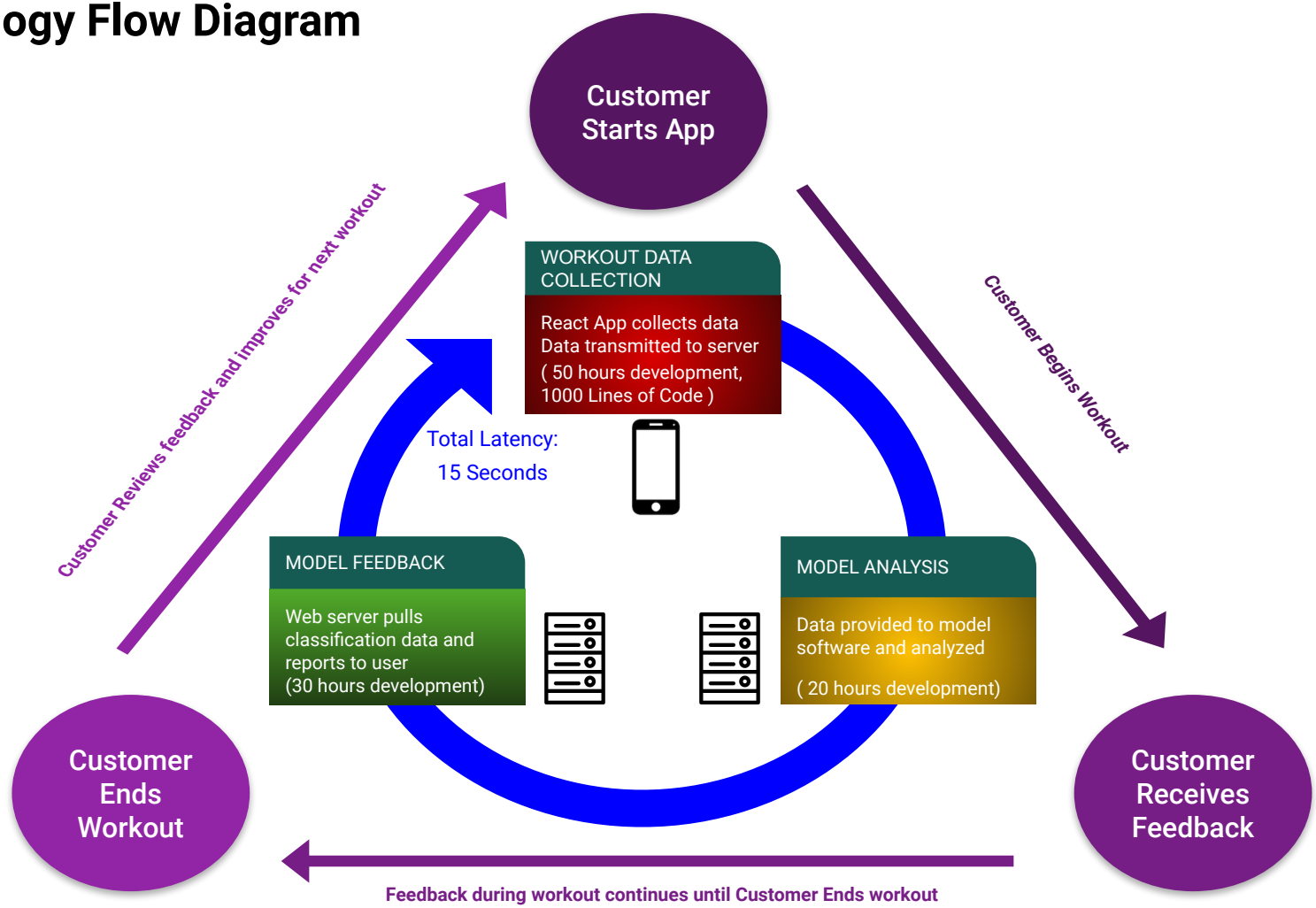
V Sit ups

Engage your core and lift both your torso and legs straight off the ground and reach for your toes. You body will resemble a V.

S*oftware* **W***earable* **E***xercise* **A***pplication* **T***ool*

S.W.E.A.T.

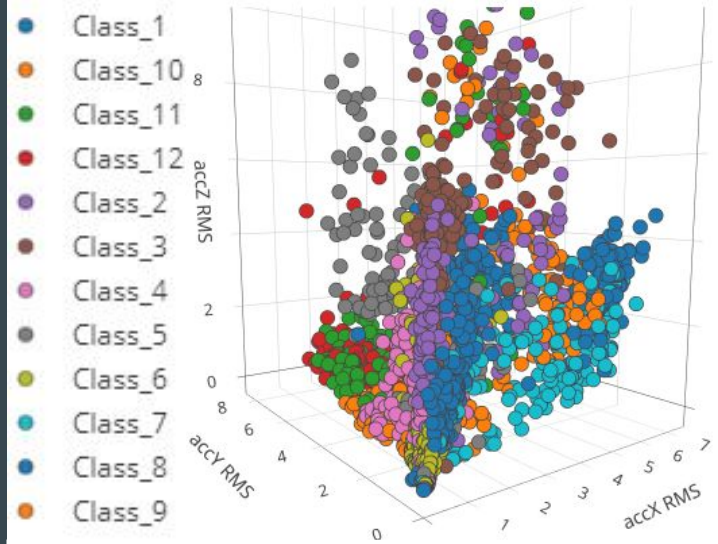
Technology Flow Diagram

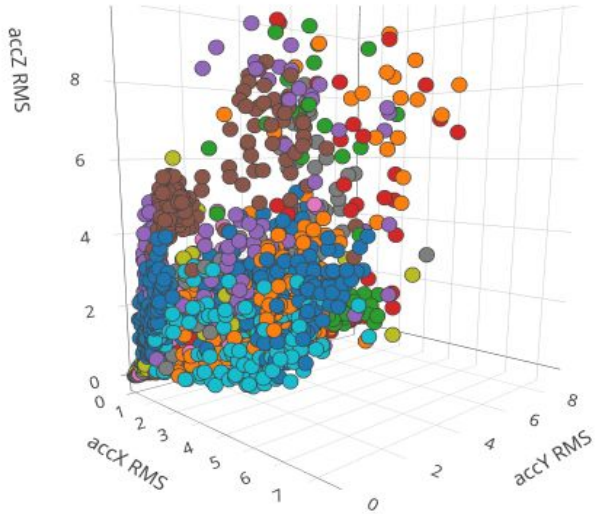


Data Collection

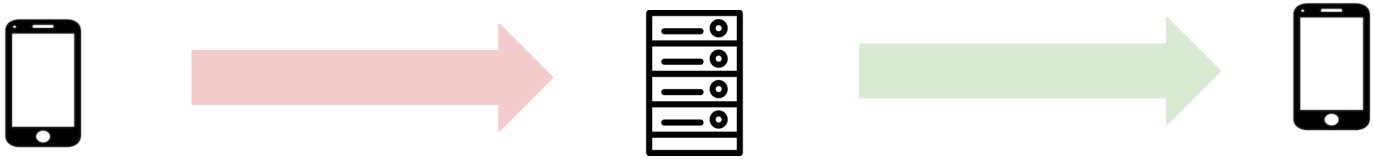
- **1 Hour 31 min of Training Data**
    - **12 Classes:**
        - 58% *Pulse Sit-ups* (6 Classes: 2 correct, 4 wrong)
        - 42% *V Sit-ups* (6 Classes: 2 correct, 4 wrong)
    - 50% Arm & 50% Head Sensor Data
- **11 min of Testing Data**

  55 sec each, 12 Classes





Impulse Analysis - Model Design



EDGE IMPULSE

CREATE IMPULSE (HOME GYM WEARABLE DEVICE (ID 5169))

s14wchfinalproject

Time series data

Axes: accX, accY, accZ

Accelerometer
3 Axes: X, Y, Z

Window size: 2000 ms.

Window increased: 80 ms.

Spectral Analysis

Name: Spectral features

Input axes: accX, accY, accZ

33 Features

Neural Network (Keras)

Name: NN Classifier

Input features: Spectral features

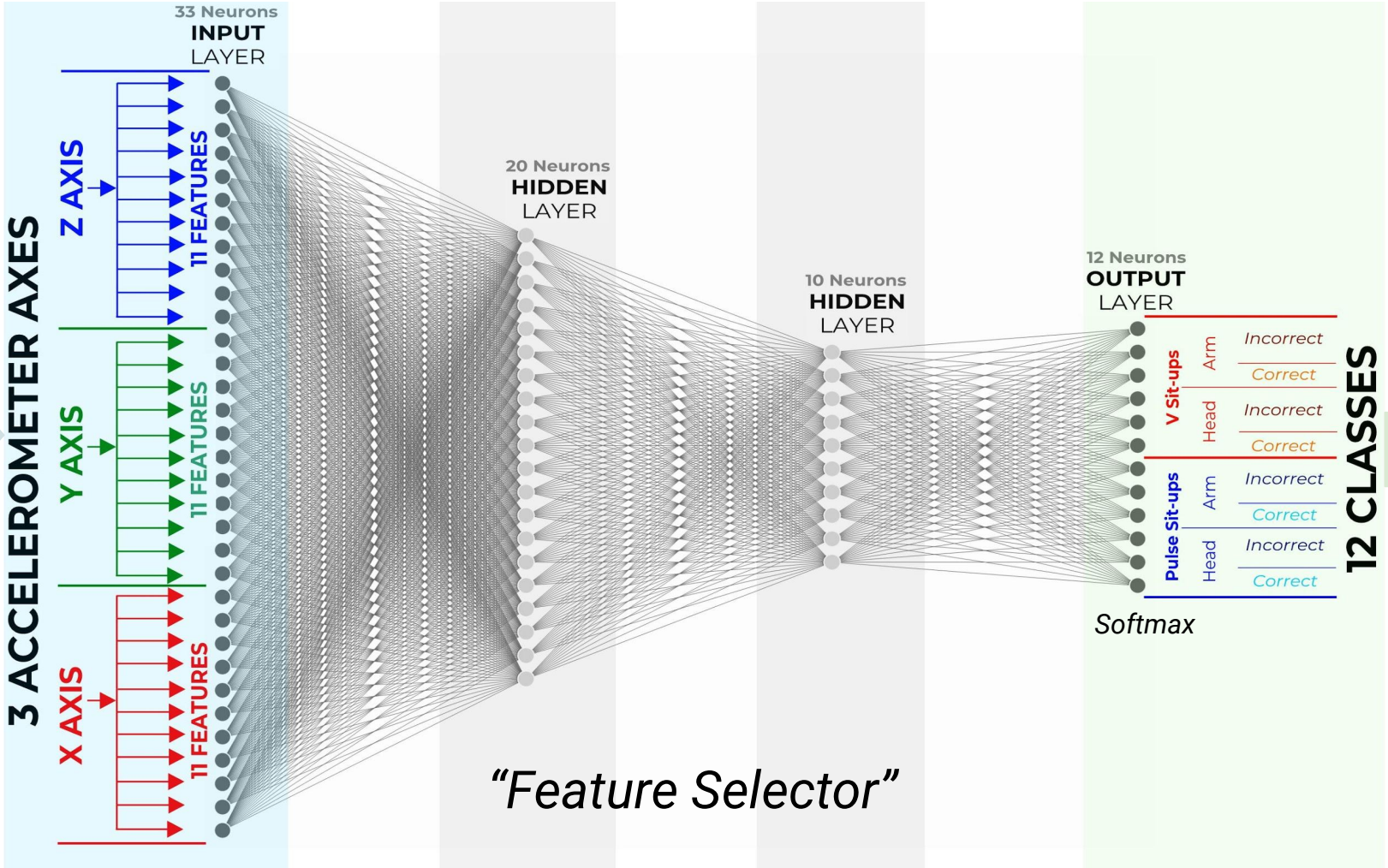
- K-Means Anomaly Net
- FCFF Neural Net

Output features

12 Classes

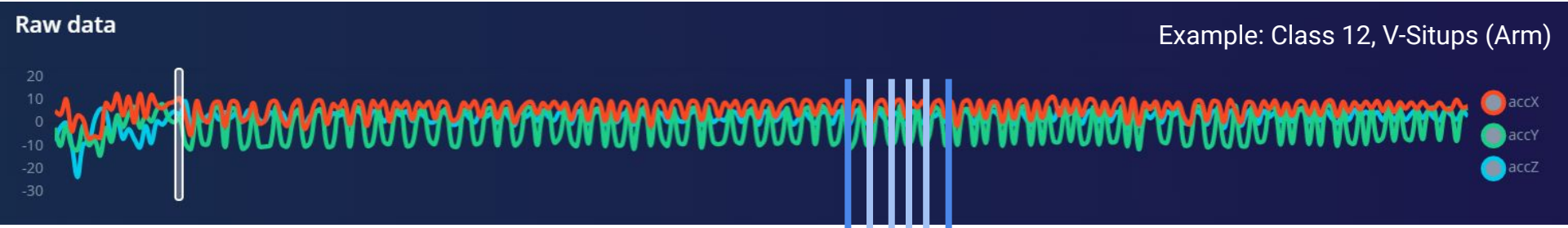
Save Impulse

Classifying - Neural Network Architecture - Fully Connected Feed Forward



Counting Sit-ups (Exercise Reps)

Counting the Peaks Over Time



1) Aggregate 30 seconds of Accelerometer Data;
Start of **Sampling** X, Y and Z Streams;
Find **maximum waveform** (where the signal crosses zero);
Monitor for repeat (*done on device, via javascript)*;

2) After **5 repeats** (5 "situps") at +/- 15% frequency (interval) **code *extrapolates* that interval** for as long as that exercise class is being done.

Pro: Reduces "Listening" and on-device processing time (choke point)

Con: Assumes the user has a routine "rhythm" during workout

Model Performance - Training

ACCURACY
77.1%

LOSS
0.83

CLASSES
12

Quantized Model

Creating job... OK (ID: 224563)

Copying features from processing blocks...

Splitting data into training and validation sets...

Training model...

Training on 53563 inputs, validating on 13391 inputs

Epoch 1/50 - 22s - accuracy: 0.1771 - val_accuracy: 0.2205

Epoch 2/50 - 22s - accuracy: 0.2621 - val_accuracy: 0.2808

.....

Epoch 75/75

1674/1674 - 22s - **accuracy: 0.7843 - val_accuracy: 0.7840**

Converting TensorFlow Lite float32 model...

Converting TensorFlow Lite int8 quantized model...

Confusion matrix

	CLASS_1	CLASS_10	CLASS_11	CLASS_12	CLASS_2	CLASS_3	CLASS_4	CLASS_5	CLASS_6	CLASS_7	CLASS_8	CLASS_9
Class_1	672	4	2	0	0	0	1	2	6	22	1	0
Class_10	0	553	12	2	0	3	14	17	57	15	9	4
Class_11	0	105	486	60	0	0	24	22	6	6	2	7
Class_12	0	34	130	463	0	0	14	19	6	3	3	1
Class_2	9	0	0	0	672	10	25	0	0	0	0	0
Class_3	3	0	0	0	35	718	2	2	0	0	0	0
Class_4	2	25	16	5	21	0	948	10	76	2	2	2
Class_5	2	21	38	4	4	3	41	870	43	43	25	5
Class_6	24	5	9	8	0	0	134	73	874	14	6	9
Class_7	106	4	1	0	0	0	17	16	46	548	0	41
Class_8	4	12	12	10	0	0	27	82	44	19	445	96
Class_9	0	33	10	0	1	1	5	34	79	116	65	348

Model Performance - Testing

Prediction Accuracy: 37.82%

Class Accuracy: 66.67%

Actual	Predicted	Sample (Sec)	Anomaly		Correct	Incorrect	Accuracy
Class 1	Class 1	29	18	26.47%	310	68	82.01%
Class 2	Class 2	29	18	8.22%	261	219	54.38%
Class 3	Class 5	29	18	1.61%	0	1115	0.00%
Class 4	Class 4	57	19	12.75%	326	149	68.63%
Class 5	Class 5	57	18	3.51%	424	513	45.25%
Class 6	Class 11	57	18	1.61%	56	1118	4.77%
Class 7	Class 9	29	19	6.19%	225	307	42.29%
Class 8	Class 2	29	19	4.25%	0	447	0.00%
Class 9	Class 9	29	19	4.86%	211	391	35.05%
Class 10	Class 10	57	18	4.58%	165	393	29.57%
Class 11	Class 11	57	17	2.81%	528	604	46.64%
Class 12	Class 12	57	15	2.73%	454	550	45.22%

Exercise Accuracy: 83.33%

	P Situp	V situp
Class 1	378	0
Class 2	480	0
Class 3	569	546
Class 4	462	13
Class 5	818	119
Class 6	451	723
Class 7	3	529
Class 8	447	0
Class 9	36	505
Class 10	53	546
Class 11	94	1038
Class 12	249	755

Testing Confusion Matrix

	Class 1	Class 2	Class 3	Class 4	Class 5	Class 6	Class 7	Class 8	Class 9	Class 10	Class 11	Class 12
Class 1	310	17	1	20	0	30	0	0	0	0	0	0
Class 2	0	261	135	36	34	14	0	0	0	0	0	0
Class 3	1	14	0	83	446	25	17	44	34	73	378	0
Class 4	0	16	0	326	8	112	0	3	6	0	4	0
Class 5	1	105	6	206	424	76	1	75	7	9	19	8
Class 6	1	0	0	67	327	56	57	73	29	149	389	26
Class 7	0	0	0	1	2	0	225	20	270	7	7	0
Class 8	1	242	57	95	8	44	0	0	0	0	0	0
Class 9	0	1	0	1	14	20	36	80	211	166	73	0
Class 10	3	0	1	2	3	44	37	77	153	165	73	0
Class 11	1	0	0	26	31	36	19	8	0	349	528	134
Class 12	0	0	0	0	236	13	18	39	11	33	200	454

Sensor Location Accuracy: 91.67%

	Head	Arm
Class 1	328	50
Class 2	396	84
Class 3	110	1005
Class 4	25	450
Class 5	195	742
Class 6	160	1014
Class 7	328	17
Class 8	300	147
Class 9	328	274
Class 10	271	287
Class 11	28	1104
Class 12	68	936

HSweat

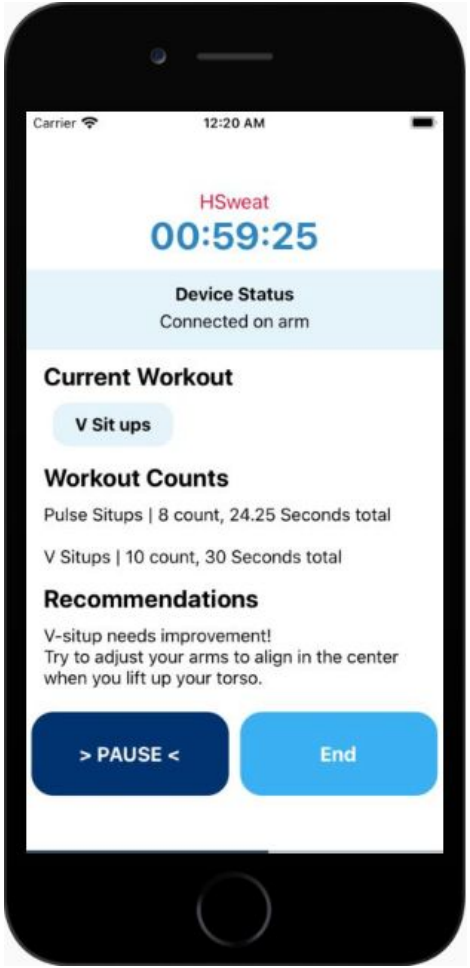
Try the App for Yourself

1) iPhone → Download Expo Client

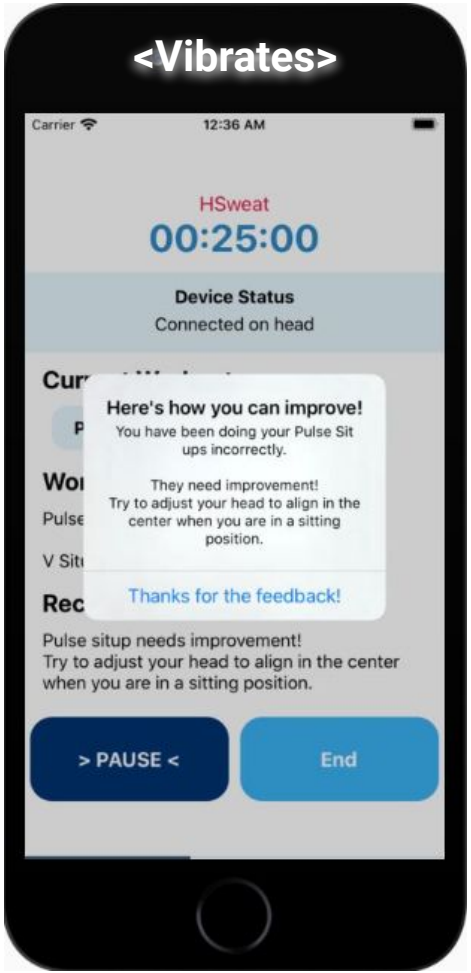
Android → Download Expo

2) Scan this QR Code

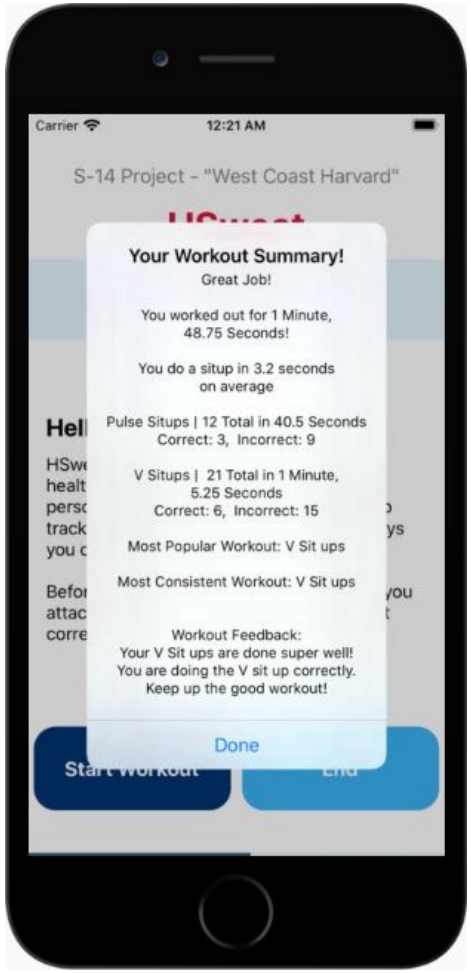
Live Workout Monitoring



Haptic Feedback



Workout Summary

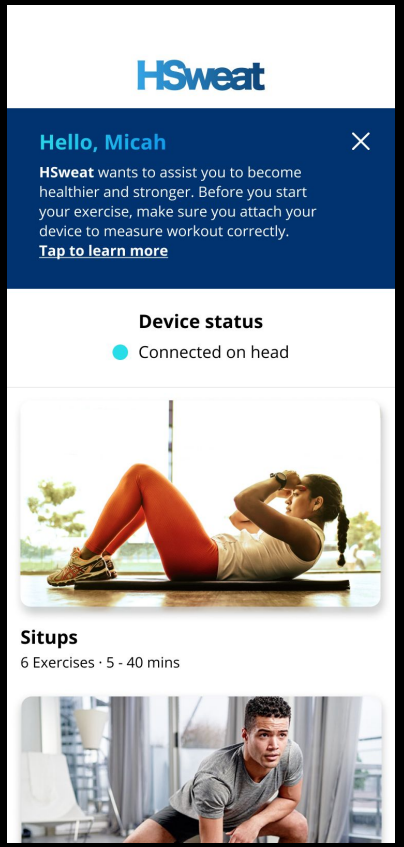


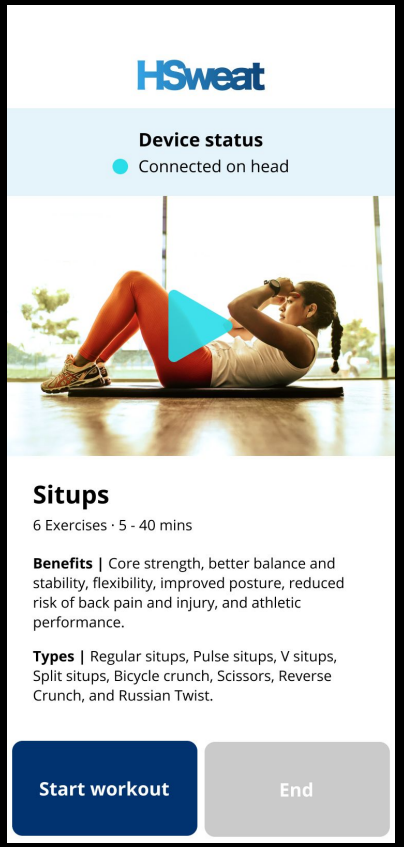
Wearable Features

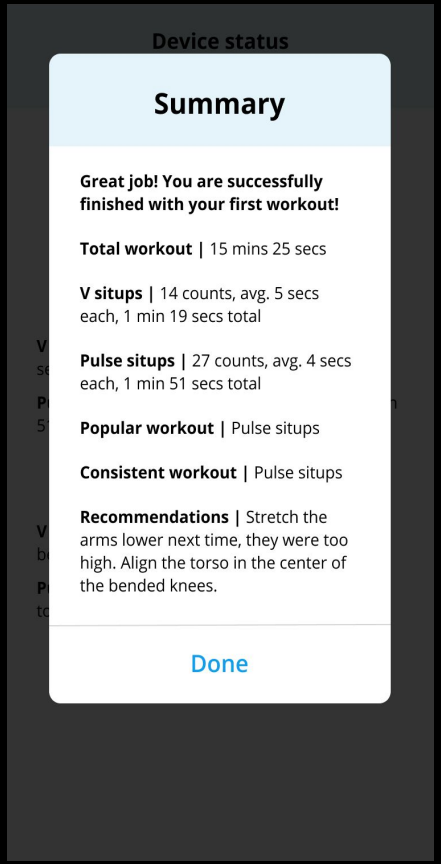
1) 

2)

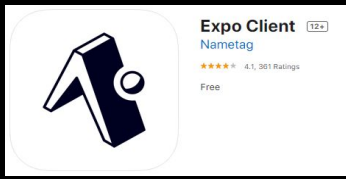
HSweat app design







1)



2)

Thank you. Questions?