

## Introduction

With the development of wearable technologies such as the Apple Watch, there is an increasing opportunity to use its sensors such as the heart rate monitor to curate workout routines.

## Problem

Machine learning algorithms have been developed to improve many parts of our lifestyle including healthcare. One aspect of healthcare that may be overlooked is fitness health and there can be improvements made.

This project aims to create an application that can use machine learning algorithms to guide users through a running or cycling workout.

## Objectives

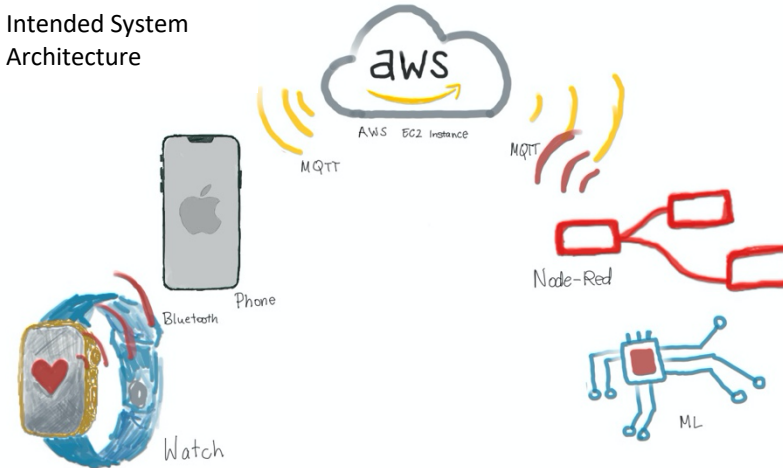
The original objective for this project was to create an application for the watch that would read heart rate data during a user's workout. Then it would send this data to the phone which would publish it to a MQTT broker hosted in AWS.

A Node-Red flow will subscribe to the user's heart rate data stream and conditionally provide feedback to the user based on their heartrate and current state. Initial objectives included the use of ML nodes to dictate the best action for the user to take next and publish the response back to the user's watch.

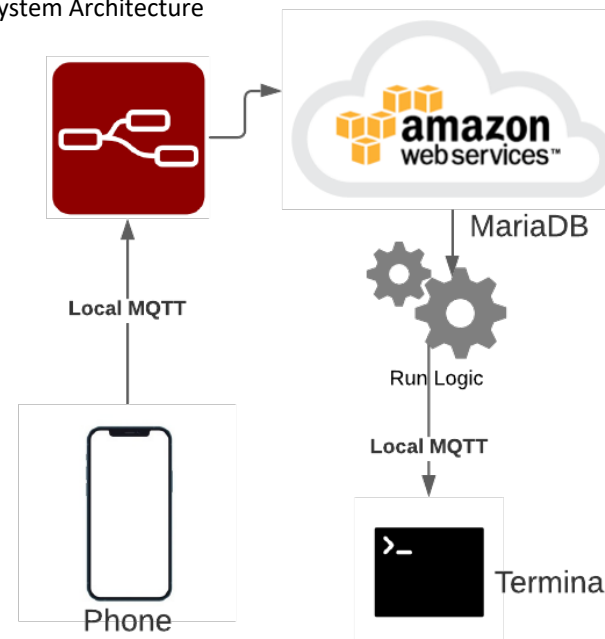
## Heart Rate Sensor

The optical heart sensor in the Apple Watch uses a technology known as photoplethysmography which works because blood is red since it reflects red light and absorbs green light. To detect the amount of blood flowing through your wrist at any given moment, the watch uses green LED lights paired with light-sensitive photodiodes. When your heart beats, the blood flow in your wrist – and the green light absorption – is greater. These LED flash hundreds of times per second to calculate the number of times your heart beats each minute, which is your heart rate. The optical sensor supports a range of 30-210 beats per minute and can adapt to low signal levels by increasing both LED brightness and the sampling rate. [1]

## Intended System Architecture



## Actual System Architecture



## MariaDB with AWS

In a Node-Red Flow, the user's current heart rate data is uploaded to a MariaDB hosted on AWS. Then, the most recent reading based on time is retrieved to determine where the user is currently at. This could be used in the future to prescribe a new workout based on how a user has previously responded to the application.

## Node-Red

A Node-Red flow interprets the user's heart rate and determines whether a user should speed up so their heart rate can enter a *High Intensity Level* and then starts a timer once their heart rate is in this zone. At the end of the countdown, the user is notified to slow down to take a break.

Some improvements to this algorithm would be to ensure that the user stays at the *High Intensity Level*, instead of just setting a timer for one recording to reach this zone. Another improvement would be that it would check if the user has just completed a sprint. If so, then the algorithm would notify the user to slow down for a certain period.

## Conclusion

While this is a prototype, this is a proof of concept that reading heart rate data and providing users with feedback can be done. Using WSession, data can be sent and received to and from the watch for recording user's heart rate and receiving feedback to the user from the user's phone. At this point, the application would be usable. With more work on the node-red flow, this could be used as a basis for future projects to improve cardiovascular health like TrainerRoad [2].

## Sources

- [1] <https://support.apple.com/en-us/HT204666>
- [2] <https://trainerroad.com>