

RepXcel

A Barbell Velocity Tracking Solution

RepXcel is a barbell velocity tracking system designed to help barbell users optimize their lifting performance. Users simply attach their RepXcel device to their barbell and connect with the device through a mobile application. The application allows users to control the RepXcel device and provides a session history log for tracking progress. For each session, the rate of perceived exertion (RPE) value is provided as a quantifiable performance metric.

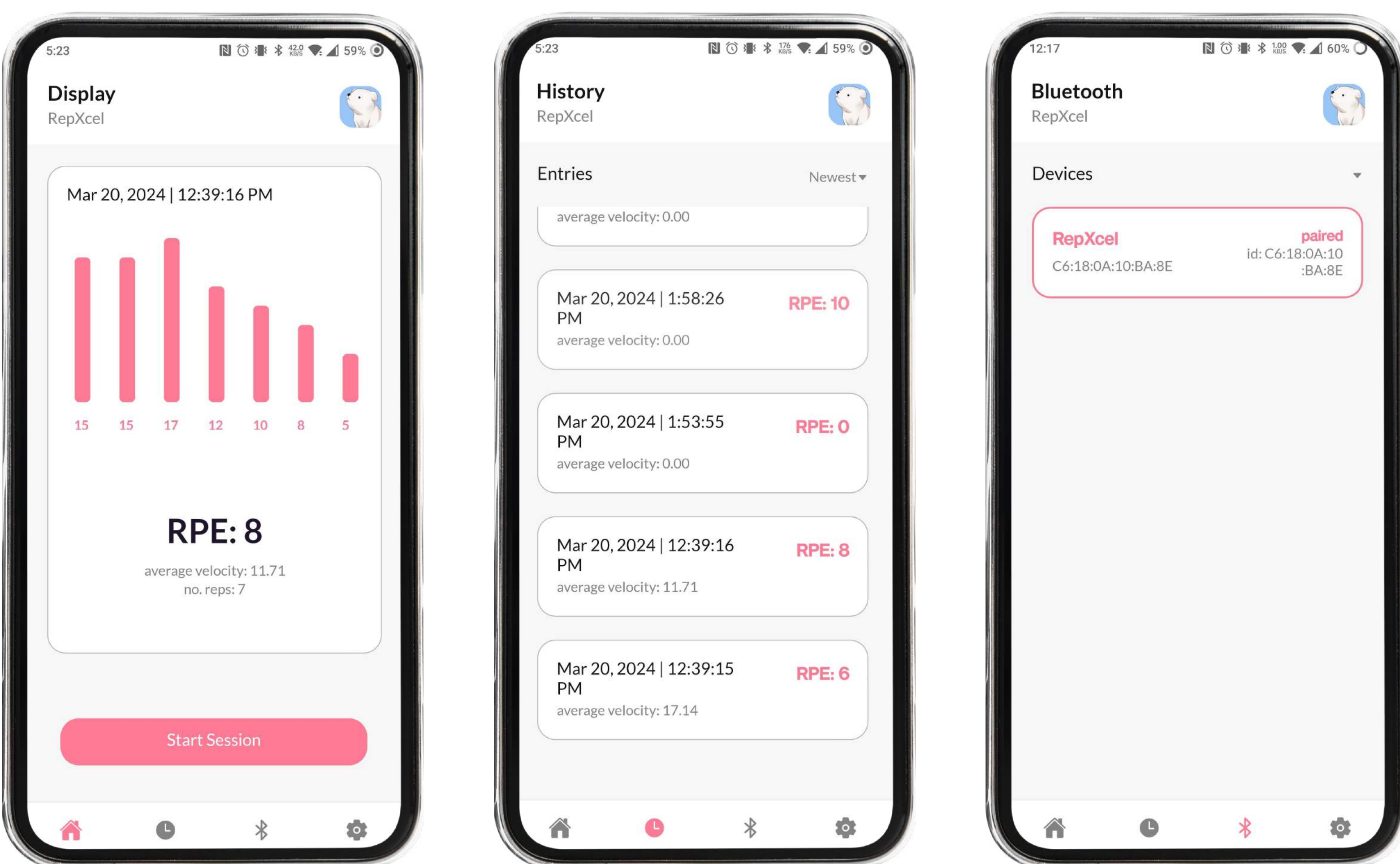
Why RPE?

RPE is a 0-10 number scale system that defines how exhaustive an exercise is; 0 no exhaustion and 10 full exhaustion. The RPE correlates with the velocity of the barbell since users approach maximal exhaustion their movement slows.

How it Works

For compound movements involving a barbell, vertical force is applied by the user accelerating the barbell upwards. RepXcel's embedded application captures the vertical acceleration during the movement of the barbell and transforms it into velocity information. Bluetooth protocol transfers the velocity information to the user's phone application, where it is transformed to performance metrics and displayed in digestible graphical formats. To save user's session history, a cloud server is deployed and managed for users to access their history at any time.

Mobile App



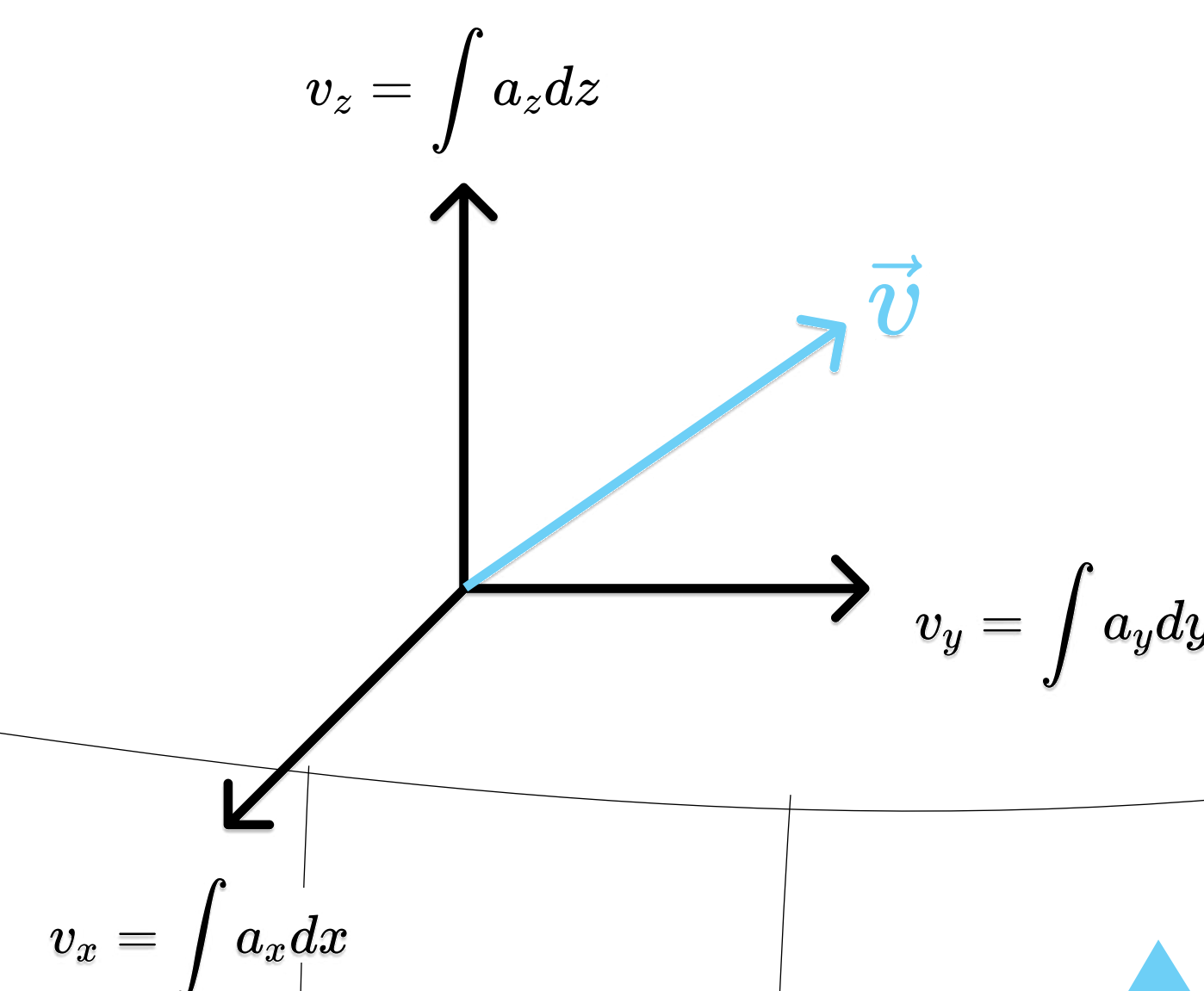
The app is created using React Native with TypeScript. The back-end is hosted on AWS Amplify. The app offers many features such as: user authentication, Bluetooth connectivity, RPE calculation, and data visualization and synchronization.

Embedded Algorithms

There are two algorithmic problems to solve to make this all work.

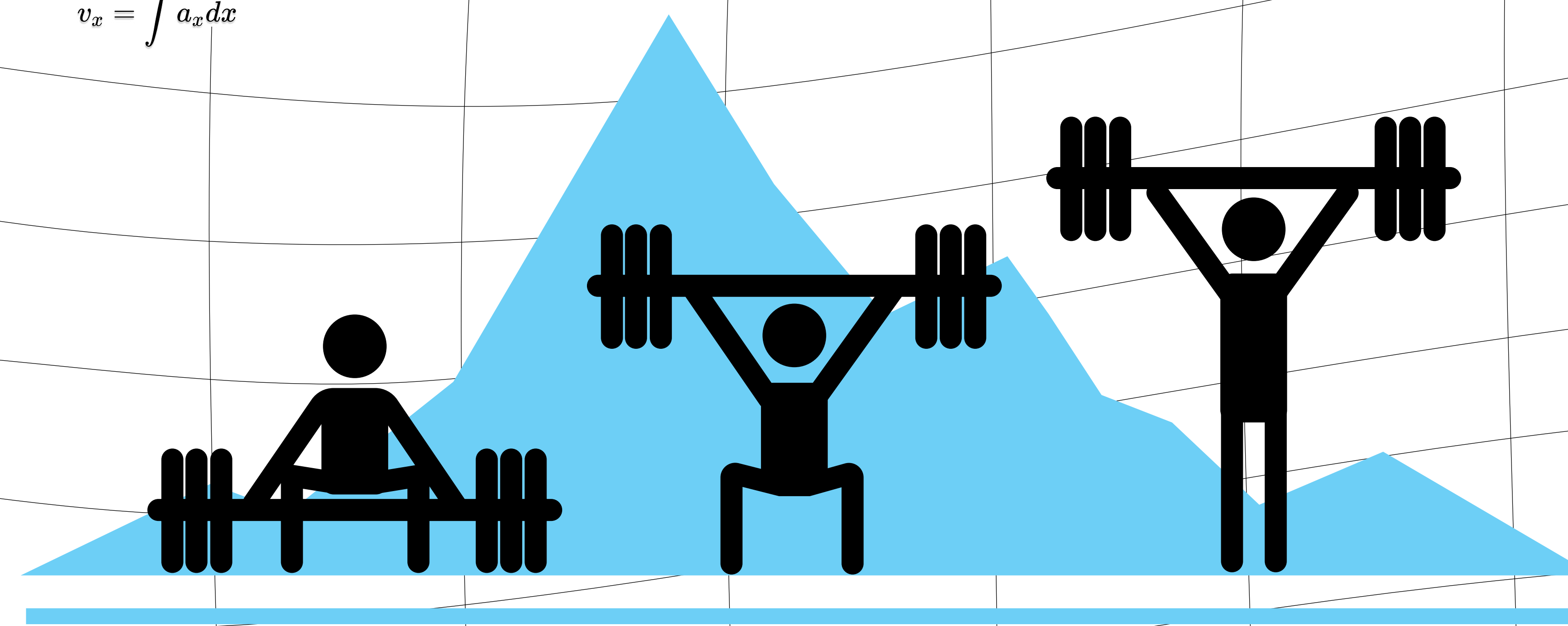
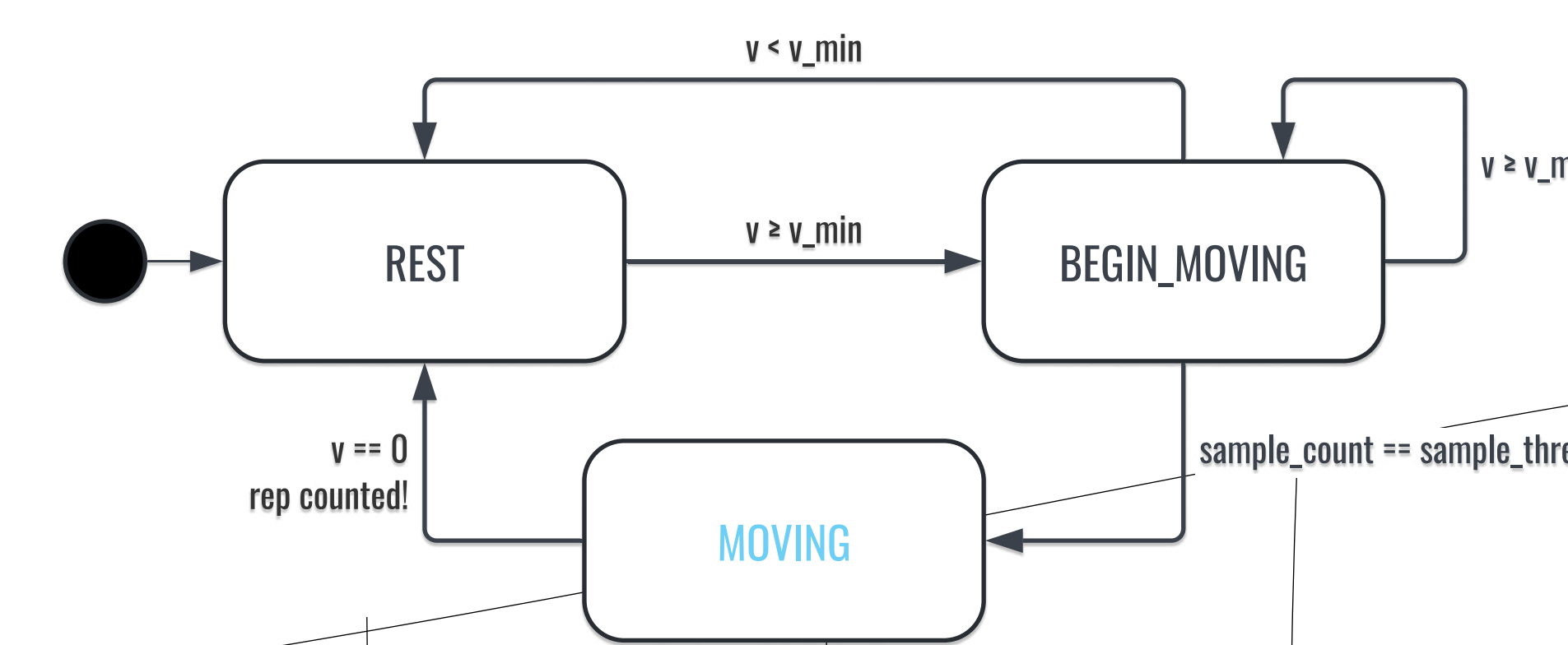
How do we integrate acceleration?

Acceleration in each cardinal axis is numerically integrated with Euler's method: $v_{k+1} = v_k + a\Delta t$

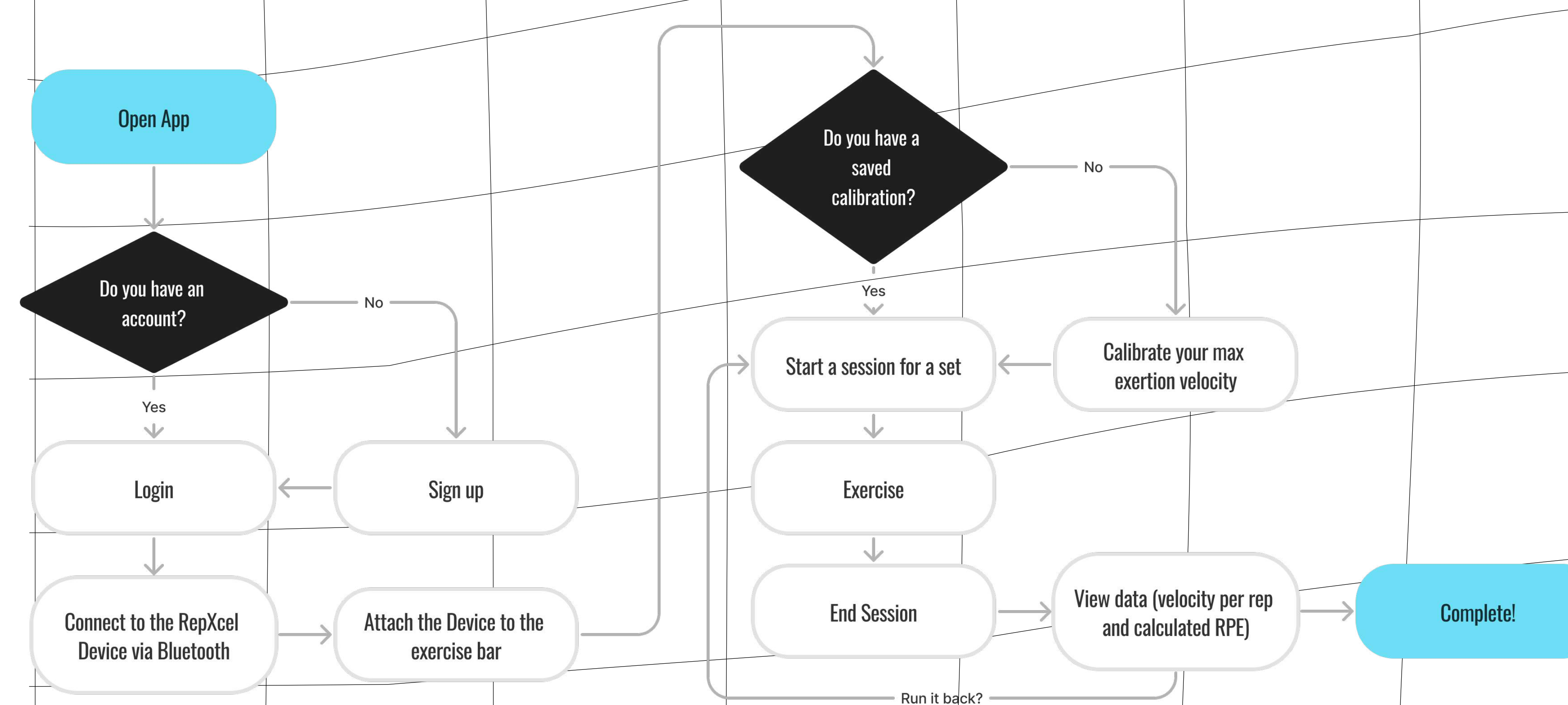


How do we track per-rep velocity?

A state machine tracks the device state and determines when repetitions are tracked



Application User Experience



Try it Out!

Calibrate your benchmark velocity for maximum exertion and start a session to receive an RPE based on your benchmark! Your data is easily tracked and displayed in our app. Ask us to try it out!

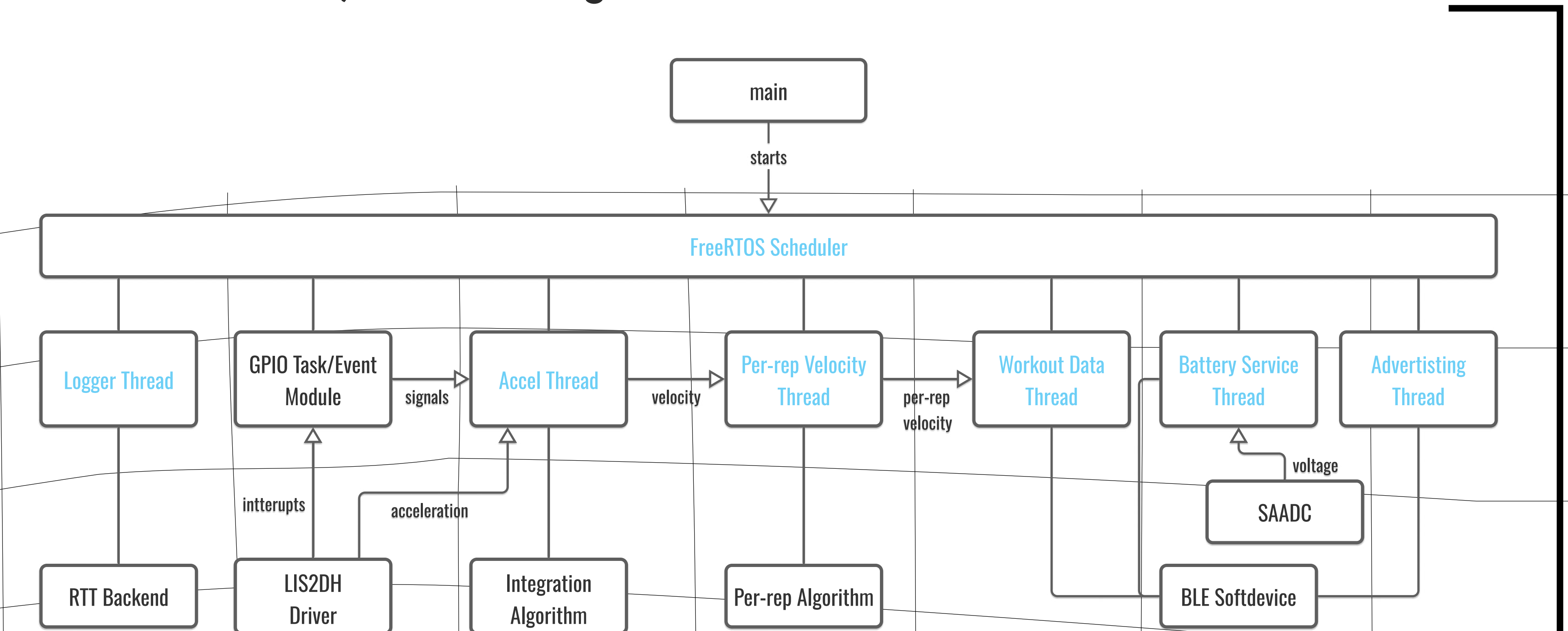
GARMIN.



Embedded Programming

The embedded application is a Bluetooth peripheral device responsible for measuring, processing, and sending velocity data. The application takes measurements from an LIS2DH12 accelerometer and calculates the per-repetition velocity of a barbell. This velocity is then sent over BLE using our custom workout data service to our mobile application. The app then analyzes the set to calculate for RPE!

Under the hood, the following FreeRTOS architecture is used:



System-on-Chip

Power efficient nRF52 SoC; containing Arm-M4 processor, 2.4GHz transceiver, and additional important functional blocks.

Bluetooth Antenna

Chip antenna for minimizing space and a 50Ω impedance matching network for maximal power transfer.

Motion Sensor

3-axis accelerometer with serial interface and ultra-low-power operation.

Voltage Regulator

3V voltage rail for digital system operation.

Battery Charger

5V micro USB 1-hour charging for single cell 110mAh Li-Po battery pack. Allows the device to be fully wireless for power on states.

Hardware Design

Development is centred around the nRF52 SoC, because of its internal functional blocks and low-power operation. Surrounding the nRF52 are peripheral components and functional circuits for programming, radio frequency (Bluetooth), user interface, motion sensing, and power. To program and debug firmware for the RepXcel device, a J-Link programmer is used and interfaces with the programming connection. Buttons are provided for power state and Bluetooth pairing state control of RepXcel device. The PCB is a 4 layer stack-up and is impedance controlled for optimal RF performance.

Ask us for more details!