Lab 1 - SuperU Overview

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1. Introduction

SuperU is an application currently in development designed to promote and tailor to individuals interested in weight training as a means of exercise or competition. SuperU will gather data in real-time unlike other application on the market through the use of a wearable smartwatch device such as FitBit, or any other wearable that can access the FitBit API. This will allow the user’s exercise data and progress to be tracked automatically to create a routine via learning algorithm.

Typically, an individual looking to pursue powerlifting, especially as a career competitor would work with a trainer. A study was even conducted involving 20 male weightlifters separated with half supervised via trainer, the other half unsupervised. In this study conducted over a period of 12 weeks, results showed that the supervised group presented a one rep max greater than that of the unsupervised group. Trainers have also been proven to help prevent over and undertraining, which nearly 50% of individuals face causing extreme plateaus in reaching their goals. Figure 1 provided below depicts more eloquently the impact a trainer can have provided by our problem process flow.
Figure 1. Current Problem Process Flow

However, not all individuals have access to a personal trainer, whether it be to extraneous circumstances like that of the current global pandemic, or simply expensive costs that they cannot cover.

Another key issue that individuals face when weight training, and one that many ignore in other solutions is sleep. A research study conducted by the CDC found that 1 in 3 people do not get enough sleep on a day to day basis. Pair this with a study conducted by the US National Library of Medicine finding that athletes often experience sleep deprivation hindering their performance, and you already have a solid case as to why proper sleep patterns are vital to weight training. The sleep research does not stop there as shown further in Figure 2 provided below.
It was found that lack of sleep leads to increased risk of injury in athletes. This is also paired with the fact that increased sleep deprivation can have serious negative effects on motor function, mood, and cognitive performance. All of which can negatively affect an individual’s performance while weight training.

SuperU will look to offset this need for a trainer with its learning algorithm. It will take into account real time performance data such as RPE and heart-rate, while also monitoring your sleep patterns over time to assist its user-base in the most effective way possible.

2. SuperU Description

The initial data collection conducted by SuperU would be collected via user input and through the wearable consisting of static data points. These would include user inputs such as

Figure 2. Further Sleep Research
weight, height, health limitation (asthma for example), as well as recorded data such as resting heart-rate, heart-rate during day to day activities such as working or cleaning, and sleep patterns. While some of these data points are not technically static, they will not be recorded in real-time during the workout routine, but rather periodically likely averaging over a weekly to monthly basis. Next to be measured would be the fluctuating data points, including calculated data points like the current one-rep max, as well as recorded points such as workout intensity via RPE and heart-rate average with each individual exercise.

This data collection is why the wearable is so important. It must be compatible with the FitBit API, as they already provide impressive tools in gathering average heart-rate, sleep patterns, and other important data. It also must have a satisfactory heart-rate monitor, which most smart wearables on the market do, as well as an accelerometer for accurately determining RPE. The wearable will also be able to work in tandem with the SuperU application, alerting the user with key bits of information during their routine such as timers, and rep and set counts. This is so the user does not have to keep returning to their primary smart device to check what is next on their routine. This as well as work out reminders and alerts to assure proper sleep and eating patterns can allow the user to stay efficient and consistent in achieving their training goals.

The main SuperU application will take this data inputted by the user and recorded by the wearable and store in the cloud-based server. From there it will take that data and put it through the routine generation algorithm, better depicted in Figure 3 provided below. It will then provide a detailed routine to the user with proper instructions and images on how to perform each workout, how the workout should look, and what they are accomplishing as a result. They will also be able to track their process and fluctuating data points via the profile function within the
application, and make small adjustments to their routine as they see fit.

*Figure 3. Current Solution Process Flow*

### 2.1 Key Product Features and Capabilities

Recording data with SuperU will actually be very simple, seeing as all the data will be either input by the user directly or recorded by the wearable using the FitBit API, which already comes with all the proper algorithms to record the data necessary to generate the routine. The application will then put this data through a simple interpolation algorithm to gather the predicted RPE for the user, depicted in Figure 4 below. From there a similar algorithm will utilize this prediction along with other data points to calculate the desired weight lifted in the routine, the number of reps per set, the number of total sets, and target RPE. This is shown in further detail in Figure 5 also provided below.
2.2 Major Components

In order to address the necessary requirements for SuperU, we must first address how they will interact with each other, provided below. In greater detail in Figure 6, the Major Function Component Diagram. It provides a visual representation of how the FitBit API is necessary to project development and how it will work in tandem with the server and the main application. It also shows in simple terms what exactly the application does and provides.
2.2.1 Mobile Application

The first component is the main application that will run via smartphone or other primary smart device. The application retrieves the stored information from within the cloud server, which will be detailed more soon. The application then takes that data and puts it through a workout generation algorithm, as well as a progress prediction algorithm. The app provides access to user profiles where the user can view current progress and the predicted progress provided by the algorithm.

2.2.2 Smartwatch Connection and FitBit API

The interaction with the smartwatch as it relates to SuperU is relatively simple. Now up until this point we have mostly focused on FitBit, as their products are designed specifically to work with their API, but in theory other smart wearables are fine as well. The only true limitations for the wearable is that they are compatible with the device SuperU is on, have a sufficient accelerometer, have a sufficient heart-rate monitor, and are compatible with the FitBit
API. As long as it has these capabilities it should be able to operate in tandem with the SuperU application. The role of the smart wearable through the FitBit API is to gather the sleep patterns, accelerometer reading, and heart-rate, uploading it to the cloud server for the application to grab. This fluctuating data is the key to the routine algorithm. The wearable will also provide other minor features such as alerts and timers tied to the app, alerts of how many reps are left in a set, or what exercise is next on the agenda for an example.

2.2.3 Cloud Server and Server-Side Database

The cloud server being used for SuperU’s development is Firebase, and it’s implementation is not that complicated. Seeing as the server communicates directly with FitBits’s API cloud server, it is really just a matter of transferring the data and organizing it using Firebase’s tools they already provide to the developer. The Data will be organized via user profiles in the form of documents, transferring the necessary information for the week and active workout days to the proper exercise classes, and then directly to the application local server for the algorithm to play its role. This is shown in Figure 7 below.
2.2.4 Workout Creation Algorithm

All of the information regarding the information regarding the routine algorithm will be stored on the local server found on the main SuperU application. The algorithm will take the data points inputted by the user and provided by the FitBit API via wearable, interpolate that data on a bounds of 0-1, and result in various outputs that make up the routine. The key outputs will be the number of sets, the number of reps per set, the target RPE, and the weight limit to use for each routine. All of which can be reviewed again in Figure 5 previously provided.

2.3 Identification of Case Study

The target audience for SuperU can be seen in an understandable format in Figure 8, but let us work to expand those short descriptions some.
User Roles and Stakeholders

Users:
- **Weightlifter**: Individual that trains to increase their lift.
- **Trainer**: If enabled, analyzes the progress and workout plan generated by the algorithm and is able to modify the workout plan for the weightlifter.

Stakeholders:
- **Gyms**: The gym will hire trainers and distribute the application to them.

Starting with the weightlifter, or client rather. This individual would be the main demographic for the SuperU application, someone who is looking to commit to powerlifting as a sport or hobby, but may lack the capability to get a personal trainer, or simply prefer to workout alone. Now this is not true for all cases as we will see when covering the trainer role, but especially in the current world climate it can be difficult to find a trainer, let alone afford one’s services. This is where SuperU steps in with our use of real-time data and an expert learning algorithm to mimic what a trainer is capable of providing their client at a fraction of the cost. But what if affording a trainer is not an issue for the user, and they prefer the expertise of a trainer for their routine? This is where the trainer role comes in. Through the SuperU application, trainers can sign up as the trainer in charge of a given user. From there, the trainer will be able to monitor all the same data provided by the wearable and the user, see how it is being used to create their routine, and adjust it as they see fit to ensure the satisfaction of the user.
Lastly is the stakeholders, in this case gyms. The theory here is that if you are interested in powerlifting, you will likely need a gym membership unless you want to purchase large amounts of expensive machinery and equipment. This is where SuperU comes in. If a gym chain like Planet Fitness for example were to sponsor SuperU, then SuperU would in-turn advertise that gym as our gym of choice. A gym that would encourage their trainers to use the app to track client progress and develop tailored routines, gaining more clientele as a result of them using the application.

3. SuperU Prototype Description

Provide a top-level description of the SuperU prototypes as it relates to the end product goals.

3.1 Prototype Functional Goals and Objectives

3.1.1 Simulate real-world data

3.1.2 Produce a simulated routine based on dataset

3.2 Prototype Architecture (Hardware/Software)

How will the prototype be structured to demonstrate the key features of the product? Provide Prototype MFCD

- Describe watch data collection
- Describe how application was developed
- How is the software utilized?
- Describe how server sends and receives this data
- Describe how API detects this data
- Describe the routine creation process
- Describe how it is delivered to the user

Figures: Slides 18
3.3 Prototype and Capabilities

What does the prototype demonstrate? What is the significance in showing how the problem is solved? How have you demonstrated success? How does the prototype address project risk mitigation? Describe the functional goals and objectives.

- Monitor movement and heart rate during workout
- Compare with monitored heart rate throughout the day
- Collect data on sleep patterns
- Functional routine alerts on smartwatch device

Figures: Slides 19

3.4 Prototype Development Challenges

Not included in our Lab 1 Final Draft, our Lab 1 was created prior to our prototype design, so enough information for not gathered regarding our prototype to properly implement it in our Lab. From further research it appears that previous semester’s of the course had Lab 1 due after the prototype design.

4. Glossary

- **Rating of Perceived Exertion (RPE)** - A way of measuring physical activity intensity level based on objective parameters and the person’s experience[1].
- **One-Rep Max (1RM)** - The maximum amount of the weight you can lift for a single repetition of a given lift[1].
- **Weightlifter** - One who lifts heavy weights for exercise, muscle strengthening, or athletic competition.

5. References


