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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.

![Current Problem Process Flow](image)

*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.

![Figure 2. Further Sleep Research](image_url)
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 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.

![Figure 6. Major Function Component Diagram](image)

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. All of this information will also be available to the user’s trainer, if they have one, through the trainer mode of the application. Trainers will be able to monitor their client’s progress and goals, as well as make adjustments to the workout plan the algorithm creates as they see fit.

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 FitBit’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, encrypted for user safety, 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. The SuperU team will also manage the administrative side of the serverbase. This means overseeing data migration, performing system checks and analysis, and running routine maintenance and repairs as necessary.

2.2.4 Testing

The SuperU team will be implementing unit testing in the development of the SuperU application in both Java, and Swift programming languages. These primary tests will be done through JUnit and XCTest. Starting with JUnit, it will allow the team to implement efficient automated unit testing. It informs the tester quickly when a test has failed, allows assertions for expected results, and is easily programmed to fit the needs of the tester. Next is XCTest, another unit testing framework that tends to play nicer with Swift, especially on iOS. Much like JUnit XCTest allows assertions for expected results and alerts for when tests fail.
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.

**Figure 8. User Roles and Stakeholders**

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. They can then 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. The result here would be mutually beneficial. Users who find the app of their own accord are encouraged to use our sponsoring gym of choice, increasing gym business. On the flip side, clients who get a trainer through the sponsoring gym on their own accord are introduced to SuperU via that trainer, leading to a greater user-base.

4. **SuperU Prototype Description**

The prototype for the SuperU application should mimic all of the all aspects of the final product described so far. This can be seen in more concise detail below in Figure 9. The only simulated data will be the clients inputted information such as weight, height, limitations, etc. This will be detailed further in the following section for 4.1.1.
### 4.1 Prototype Functional Goals and Objectives

Covering the goals of the prototype in more detail, the SuperU prototype should be able to take in various data sets just like the end product and produce a unique tailored workout plan for the simulated user. It should provide their current and projected progress and allow the option to sign on with a trainer if they so desire. In tandem, this potential trainer should be able to view all the data of their given client, allowing for multiple clients at once. They should then be able to adjust their client’s plan as they see fit. The prototype should have full functionality with the FitBit API, allowing for easing integration of compatible wearables. It should also allow all of the administrative backend capabilities you’d expect from the final product, allowing for routine database maintenance.
4.1.1 Simulate real-world data

The simulated data will consist of unique user inputted values. This will allow the SuperU team to test a variety of different user types, from simulated professional powerlifters all the way to a newcomer with poor form and asthma. Other than this, all other data points will be fully functional and real, including real-time data collection for sleep patterns, heart-rate, etc. via testers.

4.1.2 Produce a simulated routine based on dataset

The only thing simulated about the routine, will be the data being used to create it. The simulated data will run through the SuperU algorithm and produce a tailored routine for the potential user, based around the dummy data points provided by the testers. This will then be compared to the calculations results done by hand to assure there are no discrepancies.

4.2 Prototype Architecture (Hardware/Software)

The hardware utilized for the prototype will be an Android based smartphone or equivalent smart device, as well as a FitBit device or another smart wearable compatible with the FitBit API. These will be used for running the SUperU prototype application and running collecting the real-time user data. The prototype will be developed for Android using Javascript and the Android Studio IDE. While the final SuperU product will be available for both Android and iOS, the prototype and simulations will run solely on Android for the sake of efficiency. Other software being used for prototype development includes the main database run via Firebase Firestore, as well as the Firebase Web Server which gives the team access to the FireBase cloud and in-app messaging functionality. All Firebase implementations will allow development to run faster and more smoothly.
4.3 Prototype and Capabilities

The prototype will be capable of all the features the final SuperU product will include, unless it is decided post prototype development to implement additional features or remove features deemed unnecessary. The prototype will monitor heart-rate and estimated RPE in real-time via smart wearable. It will also monitor your average and resting heart-rate throughout the day for comparison so it may better estimate the RPE. The application will also store sleep patterns gathered via the smart wearable. The prototype will store you information, calculate your routines, and show you your current and projected progress. The SuperU prototype will also include functional routine alerts that it will show on your primary smart device and send to your wearable if it is active. These will include workout reminders, reminders to get good sleep if your sleep patterns are poor, and routine alerts for your next workout. All of which was shown in streamline detail in Figure 6, provided previously on page 8.

4.4 Prototype Development Challenges

By far the biggest challenges faced so far in development were questions in regards to the design. While the actual prototype itself is only beginning development, designing what the prototype is intended to look like has met us with some challenges. The first being whether to use a test harness or not? Ultimately it was decided that our Unit and manual test would be sufficient for our end goals. Next was to if we wanted to simulate the inputted user data. The original idea was to conduct something similar to a research study, running unsupervised tests with users supervised via SuperU or SuperU assisted trainer. Ultimately it was decided this would be better suited for the final product, and we opted for simulating the data for a prototype, so we may properly test outliers in the algorithms capabilities. Then there was the question as to whether or not to use the FitBit API? In the end we decided the FitBit API was sufficient for
testing the capabilities of our algorithm in our prototype, but the team is open to the idea of making our own API for the final product so we are no longer limited by only wearables compatible with FitBit’s API.

5. 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 (IRM)** - 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.
- **Plateau** - State where a lifter fails to improve their 1RM for a long period of time.

6. References


