



Bilkent University

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# Senior Design Project

*Project short-name: GymFeat - AI Training Coach*

## Analysis Report

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# 1. Introduction

Given the importance of healthy life, sports itself play a prominent role to develop a healthy body. Not only it helps people to develop the muscle mass, but it also improves the health of one's mind [1]. According to the researches about how sport affects the health of mind, it is shown that doing exercises “positively impacts the level of serotonin, a chemical that helps regulate mental health”, reduces the level of stress, improves mood, and distracts people from negative thoughts [2, 3]. In addition to these impacts of sport on mind, it also boosts the immune system [4]. Therefore, we should always prioritize doing exercises in our lives.

In normal circumstances, some people would prefer to go to the gym, and some people would prefer to do exercises at home and there used to be a trade-off between them. However, since the beginning of the pandemic, people are seeking new means to stay active inside the house, because many parts of our lives remain restricted. At this moment “maintaining an exercise routine at home can seem more like a ‘should’ than a ‘want to’” says Shannon Collins, an Integrative Manual Physical Therapist [4]. We, as a team, would like to encourage people to be more active at home.

Nevertheless, when people work out at home without the guidance of an expert, there is a risk of getting injured. Imagine yourself, trying to preserve your healthy body and mind, and while doing so, getting injured. Our project idea started out with the question, how we can prevent people suffering from exercise-related injuries, i.e. sprains, muscle strains, tendinitis, and so on. According to an article from Harvard Health Publishing, people should choose their workout carefully, learn the proper technique in order to prevent injuries and drink water to stay hydrated [5]. Hence, we would like to address these issues and provide a mobile application, which will prepare a training program for you, check your body movement to make sure that you are applying each movement correctly, and remind you of drinking water during the training.

In this report, we will first talk about the current system and mention the existing system related to our project, then we will explain our proposed system in detail. The proposed system includes the following sections: an overview, functional, nonfunctional, and pseudo requirements, system models. In the system models, the scenarios and related use cases will be explained in detail. Then, the class model of the proposed system, and dynamic diagrams will be shown for deeper understanding. In the last section, other analysis elements

including the various factors, risks and risk management strategies, the project plan will be discussed.

## 2. Current System

There are some systems which currently exist in the field of training, but GymFeat was mostly inspired by two applications, which are Kaia Trainer, and Nike Training Club. In the Kaia Trainer application, the user is able to correct his/her move with an AI Trainer. However, the user is not able to create a fitness program, or do a full workout. Instead, the user has to select each Single Exercise one by one [6]. In Nike Training app, the user is able to create a fitness program, although it cannot analyze the body of the user during the workout session [7]. Our application combines both, and lets users create a personalized program and work with an AI Trainer to fix his/her moves during the workout. Moreover, GymFeat adds a superior recommendation system and user-friendly AI trainer.

## 3. Proposed System

### 3.1 Overview

GymFeat is a training application for anyone who wants to work out alone without hiring a training coach. The main goals of this application are to encourage people doing exercises at home, to enhance the quality of training at home, and to prevent people from getting injured. In order to facilitate a work-out of high quality, we are offering a personalized training program, along with an AI-Trainer, which will compare your body lines with the ideal ones, and will tell you how you can enhance the quality of the movement.

This application is innovative, in the sense that it brings a free training coach with one-click, and assesses your movements, helping you improve them. There is already one existing workout app that provides movement tracking [8], however it lacks giving people personalized programs unlike other training apps in the commercial market [9, 10]. Our mobile application offers both, while also keeping track of the overall progress.

Our AI-Trainer will apply advanced models such as neural networks [11] to give feedback of each movement to the user in real-time, and it will count the number of each movement, as it happens with a real trainer. For this reason, we will apply the techniques from sub-domains of Computer Vision, that are Image Processing and Deep Learning [12,

13]. As a result, this project will demonstrate how some practical problems can be addressed with such technologies.

With this project, we are aiming to have a broad audience. Therefore, our application will be executable both for iOS and Android. Because our idea is to encourage everyone to do more exercises at home and, hence, everyone, who has a phone, will be able to download and execute our application.

## 3.2 Functional Requirements

In this section, the functional requirements of our system will be explained.

### 3.2.1 Personalized Fitness Program

- To be able to use online backup functionality the user will have to sign up and create an account. Otherwise, the user will create his profile, there can be several profiles in the same application.
- After creating a profile, the user will enter personal information such as weight, height, and his aim, i.e., getting fit, getting muscular, losing weight etc.
- According to the information given by the user, a personalized fitness program will be proposed by the application.
- The fitness programs that are suggested by the app will be pre-prepared programs with the help of professional fitness trainers.
- The user can adjust the proposed program by editing the order of the movements, or by changing the training-rest days that were suggested by the app.

### 3.2.2 Google Calendar Synchronization and Progress Log

- The personalized fitness program will include a weekly fitness schedule with both active and rest days, including the movements to be done given the active days.
- According to the desired time periods set by the user, the app will have the option to export the schedule to the Google Calendar
- A progress log within the app will keep information about which movements were made successfully daily so that users can track their progress and how much they follow their schedule.
- The suggested schedule will be editable so that users can add, remove or change active and rest days to get a schedule better suited to their life.

### 3.2.3 Synchronous Training with AI Fitness Trainer

- Before starting the training, the mobile phone of the user will be set leaning against the wall in a stable position. The application will guide the user to align the phone properly.
- The frontal camera of the mobile phone will observe the user so that the AI trainer can interact with the user by giving directions and warnings with voice.
- At the beginning of the training, the AI trainer will show how the movement should be made correctly, then the user will be able to observe himself while doing the movement to learn the correct way of making the move.
- While the user is doing each movement, the AI trainer will be tracking 16 points on the user's body to analyze how the user applies the move.
- If the user is not applying the movement correctly, the AI trainer will intervene to highlight how the movement should be adjusted to do it properly.
- The AI trainer counts the repetitions of the movements, and once the count reaches the predetermined set limit, training is set to be completed and the AI trainer scores your movement.

### 3.2.4 Additional User Interaction with the AI Fitness Trainer

- The application will send regular notifications to the user such as banners to enjoy the rest days, and reminders to keep him/her from missing a training.
- There will be an award/badge system, i.e., if the user follows the fitness program for a full week, they will be rewarded with the "Perfect Week" badge. This aims to make the application enjoyable for the users and keep them motivated and engaged.
- The AI trainer will determine the rest period between sets, and will remind the user to drink water between the movements and to engage in active recovery because according to the studies, practicing active recovery between sets helps clearing the lactate in the body faster than engaging in passive recovery, i.e. sitting [14]. Our application will give directions to the user in order to stay active during the rest period, by walking, or doing dynamic stretches, hence, the body will stay warm and it will keep the muscle and the tendon pliability [15].
- Users can skip the introduction of the movement at the beginning of the set and deactivate the warnings if he feels he is performing the movement properly.
- The rest period between sets can be shortened or extended according to the desire of users.

- The AI trainer will also do emotion recognition based on the user's face during training. If it detects that users are having too much trouble, it asks the user to finish the set, or it lightens the set depending on the emotion recognition result.

### 3.3 Nonfunctional Requirements

In this section, the non-functional requirements of our system will be explained.

#### 3.3.1 Usability

- The user should be able to use the application without logging in, or to keep logged in, to ease usability.
- There should be at most two pages before starting the training, and those pages should be the enrolment page and the initial setup page to generate a special training program.
- After the program is created, the user should be able to start training with only one click. To see the progress log, he should click at most two buttons.
- The user should be able to learn the use of UI with a tutorial video of at most thirty seconds.
- The user should be able to memorize the UI, in average, after fifth usage of the application.
- The user should be able to observe the fitness program along with the other activities within the same calendar, and to start training by clicking on the calendar event.

#### 3.3.2 Reliability

- The professional fitness trainers should be consulted to design healthy and reliable fitness programs.
- Real-time movement analysis should be done in high precision, hence, the users should be able to count on the application that they are performing the movement correctly, if it does not show any warning about the enhancement of the movement.

#### 3.3.3 Accessibility

- The system should be downloadable for free.
- It should be downloadable from the official website of the project for both iOS and Android, from Google Play Store, or from App Store.

### 3.3.4 Portability and Compatibility

- Flutter is used as a UI tool. Hence, we have the according requirements [16]. The system should run in
  - Android Jelly Bean, v16, 4.1.x or newer
  - iOS 8 or newer.
  - As mobile hardware: iOS devices (iPhone 4S or newer) and ARM Android devices.

### 3.3.5 Performance

- Screen loading and response times from the server side shouldn't take more than one second.
- The AI trainer will analyze the movements in real-time to give instant feedback.
- Creation of personalized fitness program, and Google Calendar Synchronization should not take longer than three seconds.

### 3.3.6 Security

- The user has the option to use the application without any internet connection and with having stored their progress logs in their local. Additionally, the user is also able to register and use the application from multiple mobile devices, therefore, the information about the user will also be stored in a database. Therefore, the system should provide a secure environment in order to keep the data about the user safe. The data that will be stored in the database are the progress log, e-mail, username, and password. This data should not be shared by anyone and should be kept according to General Data Protection (GDPR) [17].

### 3.3.7 Maintainability

- The network will have a modular structure, so modules should not be strongly bounded and they should not be affected by changes in other modules.
- In addition to the automated checks about the new code changes, there will be a specified code standard. Each pull request will be checked by the reviewer to increase the maintainability of the code in future changes.



### 3.3.8 Legal and Regulatory Requirements

- Each user will need to accept the terms and privacy policies, to be able to use the application.

## 3.4 Pseudo Requirements

In this section, we will discuss the development constraints, the economical constraints, and the social constraints.

### 3.4.1 Development Requirements

Since the application will be for mobile platforms, Flutter will be used as a UI tool due to its portability for both IOS and Android systems [18]. Another reason to use Flutter is that it is able to work with Python scripts which will come in handy while integrating the image processing part of the project.

1. Consequently, Dart will be used as a UI development language [18].
2. For the backend development of the application, Python will be used.
3. Firebase will be used for keeping the backups and user information.
4. Zoom will be used for team meetings.
5. Asana will be used for managing tasks [19].
6. Git and GitHub will be used as version control tools. Additionally, Github offers a tool to track issues to enable project management.
7. Object Oriented Programming paradigm will be used throughout the project.

### 3.4.2 Economical Requirements

- Libraries and tools that are planned to be used in the project are generally open source and free to use.
- To be able to publish the application, IOS Appstore requires a 99\$ annual fee for a developer account and Google Play Store requires 25\$ one time fee [20].
- The scale of the product will determine if the Firebase services will require additional money [21]. However for the initial product this doesn't seem to be a concern.

### 3.4.3 Social Requirements

- The exercises that are offered in the application will be according to the suggestions of a professional coach to best serve the users' needs as well as to not cause them harm.

- The main user group of this app is aimed to be young adults/adults since the exercise programmes will be prepared based on that group's capabilities. Thus, not all aspects of the application will be suitable for usage of children.
- The application will require an internet connection for the backup and registration functionalities. However, it will be possible to bypass these steps and still use the application with local data.

## 3.5 System Models

### 3.5.1 Scenarios

<b>Scenario</b>	Log-in
Participating Actors:	Registered user
Entry Conditions:	Log-in page is opened
Exit Conditions:	Log-in process is successful
Flow of Events:	<ol style="list-style-type: none"> <li>1. User put in their personal information (username, password) needed for log-in.</li> <li>2. User completes the log-in process. <ol style="list-style-type: none"> <li>a. If log-in is failed, the user tries again.</li> <li>b. If log-in is successful, the process is completed.</li> </ol> </li> </ol>

<b>Scenario</b>	Log-out
Participating Actors:	Registered User
Entry Conditions:	User clicks log-out button
Exit Conditions:	Log-out is completed
Flow of Events:	<ol style="list-style-type: none"> <li>1. User opens the side navigation bar and find the log-out button.</li> <li>2. User clicks on the log-out button.</li> <li>3. User is logged-out.</li> </ol>

<b>Scenario</b>	Sign-up
Participating Actors:	User
Entry Conditions:	Sign-up page is opened
Exit Conditions:	Sign-up process is successful

Flow of Events:	<ol style="list-style-type: none"> <li>1. User put in their personal information (username, email, password) needed for sign-in.</li> <li>2. User completes the sign-in process. <ol style="list-style-type: none"> <li>a. If sign-in is failed, the user tries again.</li> <li>b. If sign-in is successful, the process is completed.</li> </ol> </li> </ol>
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<b>Scenario</b>	Forgot Password
Participating Actors:	Registered User
Entry Conditions:	Forgot Password button is clicked in the log-in page
Exit Conditions:	User's password is reset
Flow of Events:	<ol style="list-style-type: none"> <li>1. User puts in their personal information needed to reset their password.</li> <li>2. User's password is reset.</li> </ol>

<b>Scenario</b>	Create Personalized Fitness Program
Participating Actors:	User
Entry Conditions:	User is in the personalized program creation (personal information) page
Exit Conditions:	Program is created
Flow of Events:	<ol style="list-style-type: none"> <li>1. User enters their personal information. <ol style="list-style-type: none"> <li>a. User enters their weight.</li> <li>b. User enters their height.</li> <li>c. User enters their gender.</li> </ol> </li> <li>2. User enters their goal with the program (lose weight, gain muscle etc.)</li> <li>3. System generates a fitness program personalized for the user.</li> </ol>

<b>Scenario</b>	View Personalized Fitness Program
Participating Actors:	User
Entry Conditions:	User is in the workous page.
Exit Conditions:	User goes back in the page
Flow of Events:	<ol style="list-style-type: none"> <li>1. User goes to the workouts page.</li> <li>2. User finds their personalized workout.</li> <li>3. User views the personalized workout.</li> </ol>

<b>Scenario</b>	Edit Workout
Participating Actors:	User
Entry Conditions:	User is on the workouts page.
Exit Conditions:	User has edited the workout.
Flow of Events:	<ol style="list-style-type: none"> <li>1. User goes to the workouts page.</li> <li>2. User selects a workout to edit.</li> <li>3. User edits the workout. <ol style="list-style-type: none"> <li>a. Adds a single exercise to the workout.</li> <li>b. Removes a single exercise from the workout.</li> <li>c. Edits the single exercise.</li> </ol> </li> </ol>

<b>Scenario</b>	Change Settings of a Single Exercise
Participating Actors:	User
Entry Conditions:	User is on the edit page.
Exit Conditions:	User has edited the single exercise.
Flow of Events:	<ol style="list-style-type: none"> <li>1. User goes to the edit page.</li> <li>2. User selects a single exercise to edit.</li> <li>3. User edits the exercise. <ol style="list-style-type: none"> <li>a. Changes the set information.</li> <li>b. Toggles introductions for the exercise.</li> <li>c. Toggles notifications for the exercise.</li> </ol> </li> </ol>

<b>Scenario</b>	Edit Calendar
Participating Actors:	User
Entry Conditions:	User is in the fitness program (calendar) page
Exit Conditions:	User has edited the calendar
Flow of Events:	<ol style="list-style-type: none"> <li>1. User goes to the fitness program page.</li> <li>2. User finds a workout to edit in the calendar.</li> <li>3. User edits the workout in the calendar. <ol style="list-style-type: none"> <li>a. Adds an exercise.</li> <li>b. Removes an exercise.</li> <li>c. Edits the exercise.</li> </ol> </li> </ol>

<b>Scenario</b>	Start Scheduled Workout
Participating Actors:	User
Entry Conditions:	User has a scheduled workout to do.
Exit Conditions:	User has finished the workout.
Flow of Events:	<ol style="list-style-type: none"> <li>1. User goes to the fitness program or workouts page.</li> <li>2. User starts the workout scheduled for them. <ol style="list-style-type: none"> <li>a. Before starting, user can modify the workout.</li> </ol> </li> <li>3. User is shown an introduction where every exercise in the workout is shown to the user in detail on how to perform it.</li> </ol>

<b>Scenario</b>	Start Stand-alone Workout
Participating Actors:	User
Entry Conditions:	User is in the workouts page
Exit Conditions:	User has finished their workout
Flow of Events:	<ol style="list-style-type: none"> <li>1. User goes to the workouts page..</li> <li>2. User creates a workout by choosing multiple exercises.</li> <li>3. User starts the workout.</li> </ol>

<b>Scenario</b>	Start Stand-alone Single Exercise
Participating Actors:	User
Entry Conditions:	User is in the exercises page
Exit Conditions:	User has finished their single exercise
Flow of Events:	<ol style="list-style-type: none"> <li>1. User goes to the exercises page.</li> <li>2. User creates an exercise.</li> <li>3. User chooses the single exercise they want to do.</li> <li>4. User starts the exercise.</li> </ol>

<b>Scenario</b>	View Profile
Participating Actors:	User
Entry Conditions:	None
Exit Conditions:	User leaves their profile page
Flow of Events:	<ol style="list-style-type: none"> <li>1. User clicks on the profile button on the top-right of screen.</li> </ol>

	2. User goes to their profile page.
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<b>Scenario</b>	View Awards/Badges
Participating Actors:	User
Entry Conditions:	User is in the profile page
Exit Conditions:	User leaves the awards page
Flow of Events:	<ol style="list-style-type: none"> <li>1. User goes to their profile page.</li> <li>2. User clicks on the awards button.</li> </ol>

<b>Scenario</b>	Change Trainer Voice
Participating Actors:	User
Entry Conditions:	User is in the main page
Exit Conditions:	User goes back from the settings page
Flow of Events:	<ol style="list-style-type: none"> <li>1. User goes to the settings page.</li> <li>2. User changes the trainer voice out of available voices.</li> <li>3. User may purchase new voice if they want.</li> </ol>

<b>Scenario</b>	Activate/Deactivate Notifications
Participating Actors:	User
Entry Conditions:	None
Exit Conditions:	User goes back from the settings page
Flow of Events:	<ol style="list-style-type: none"> <li>1. User clicks on the settings button on the top-right of screen.</li> <li>2. User toggles the notifications.</li> </ol>

### 3.5.2 Use Case Model

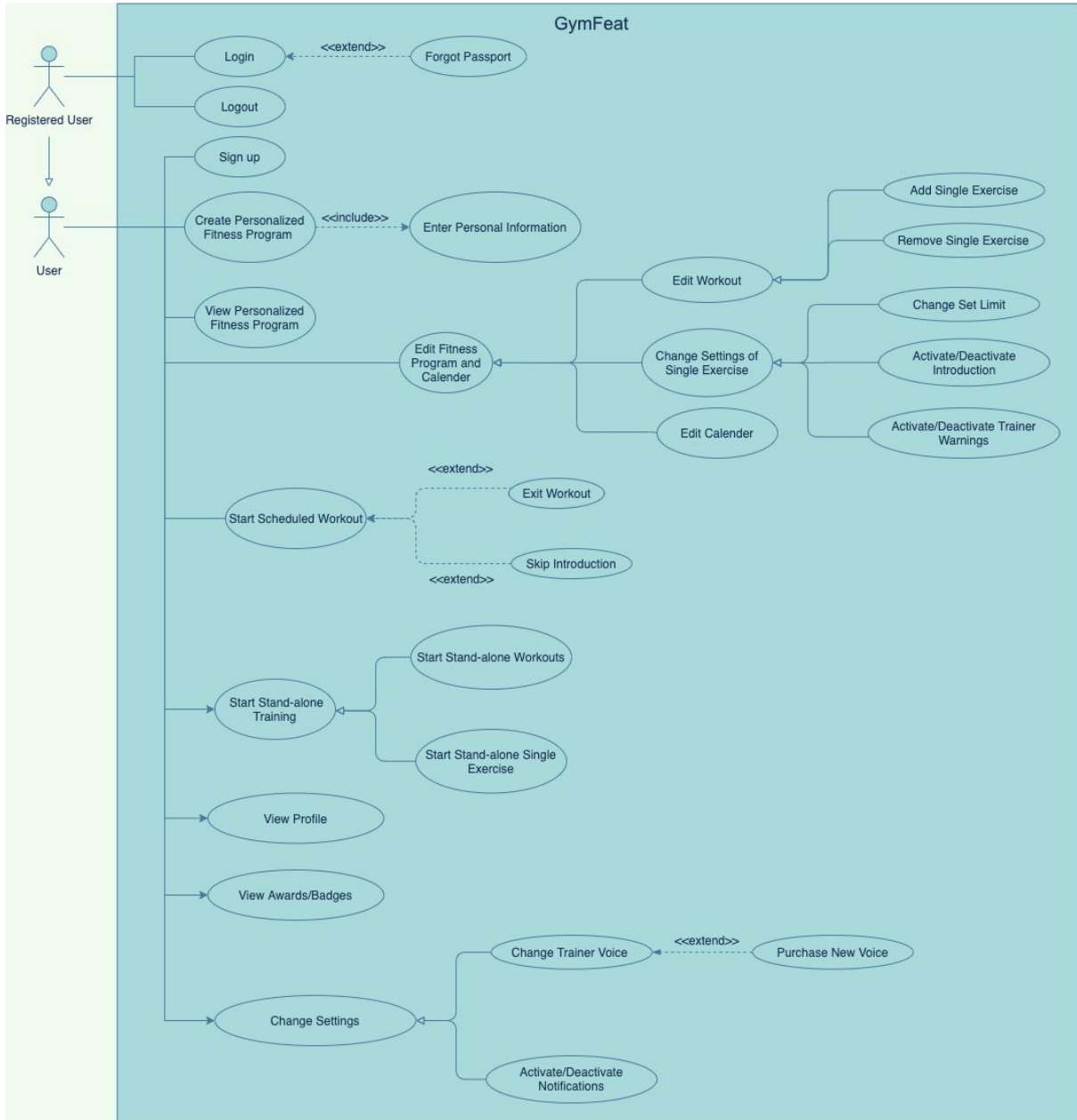


Figure 1: Use Case Diagram for all functionalities

### 3.5.3 Object and Class Model

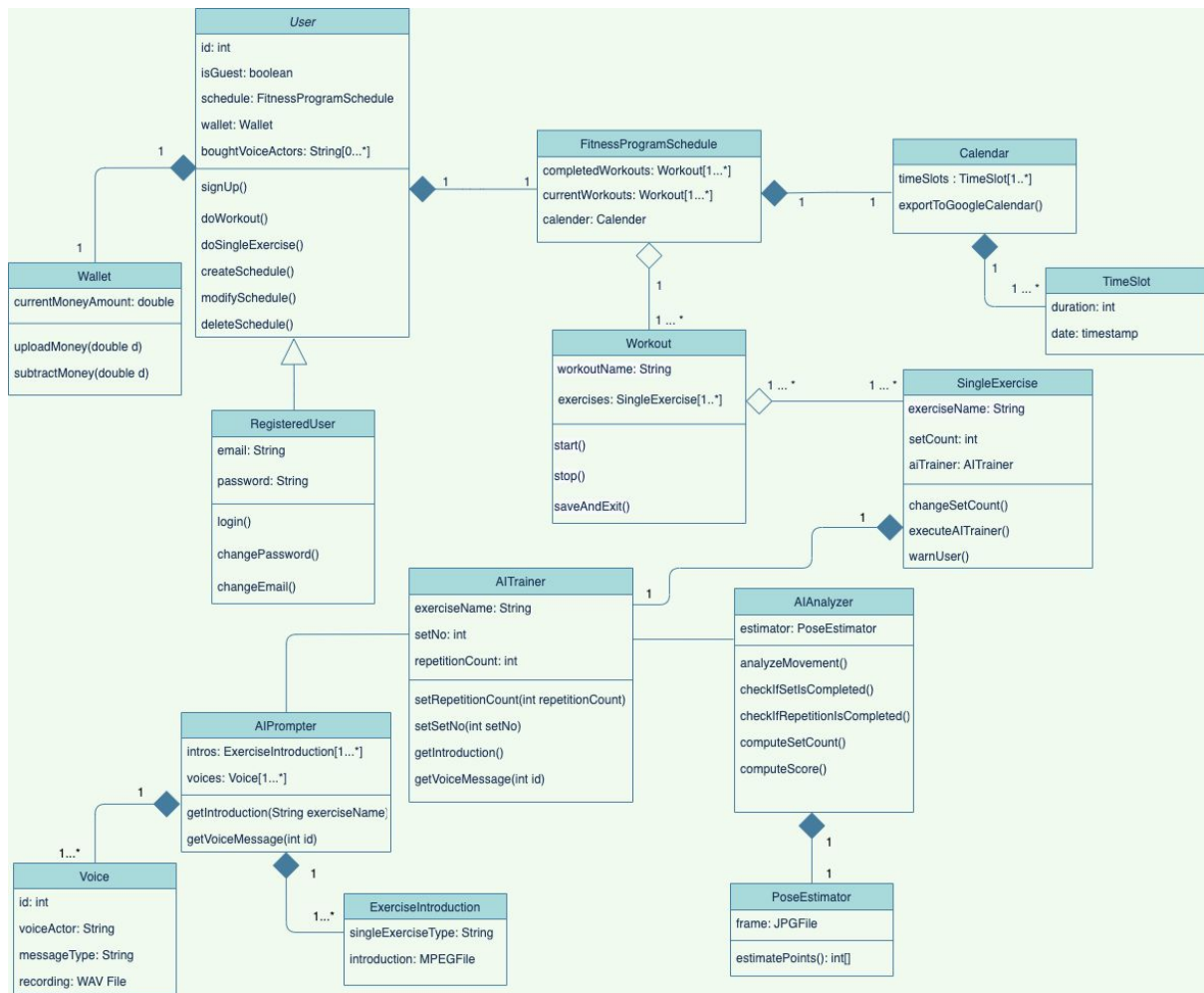


Figure 2: The class diagram of GymFeat



### 3.5.4 Dynamic Models

#### 3.5.4.1 Sequence Diagram

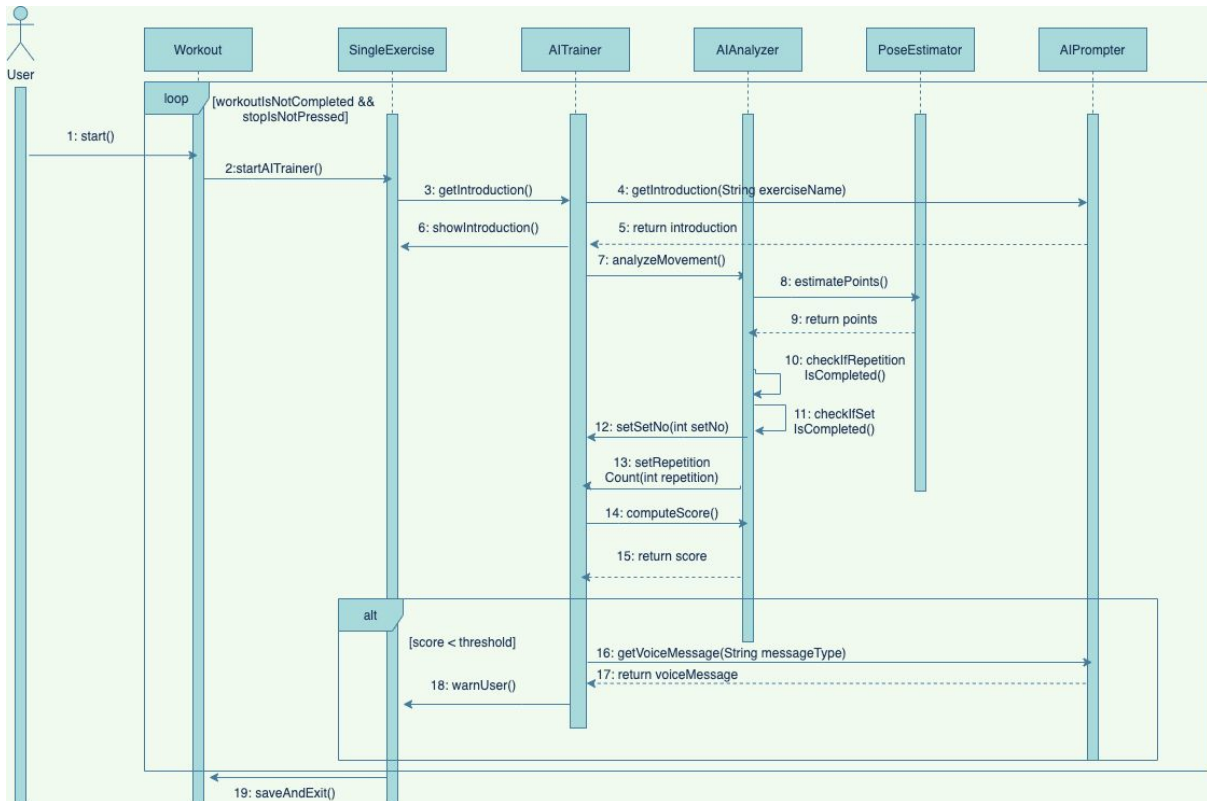


Figure 3: Sequence Diagram for the Interactions of Classes after Workout Session is Started

## 3.5.4.2 Activity Diagram

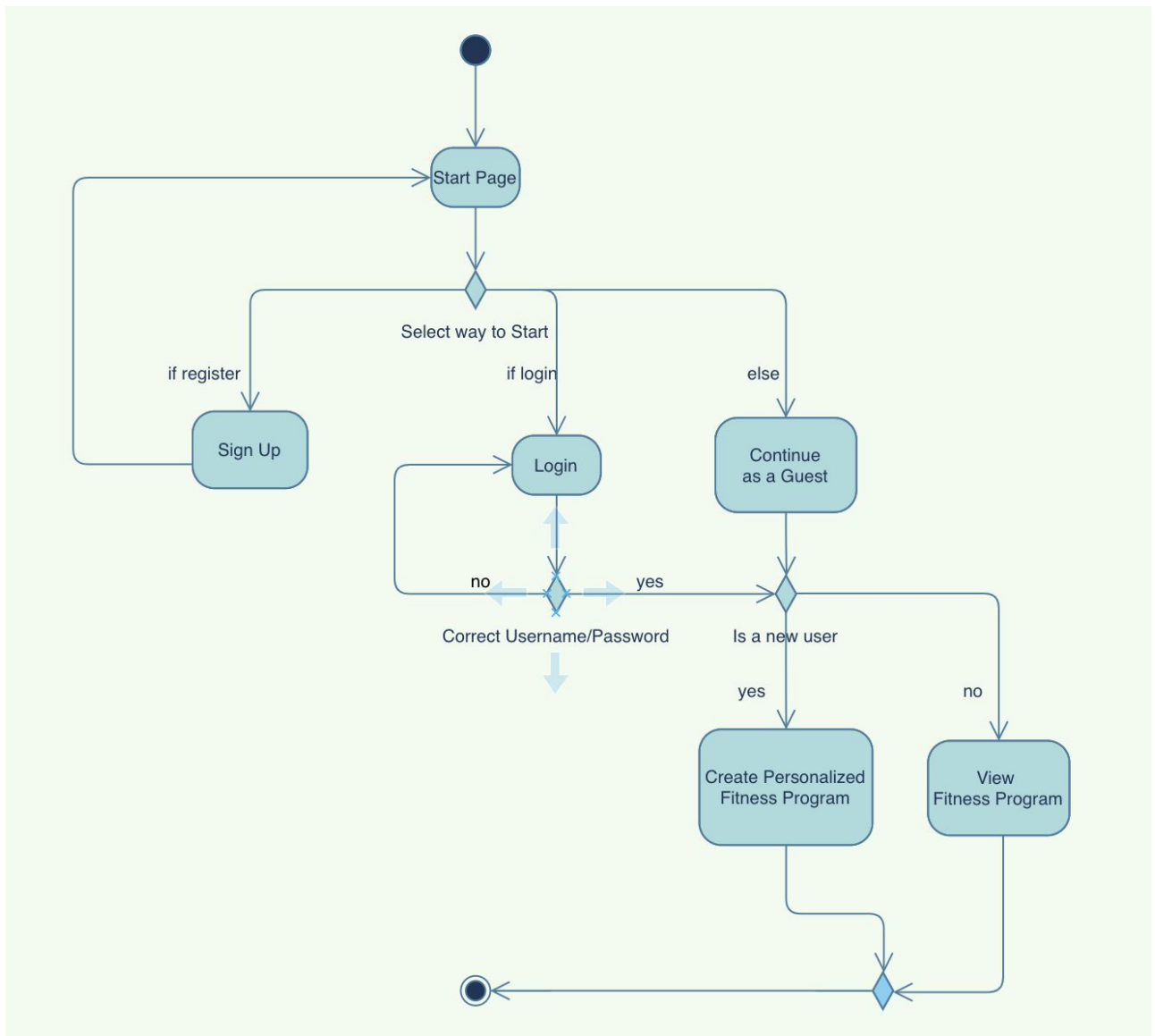


Figure 4: Activity Diagram for User

## 3.5.4.3 State Diagram

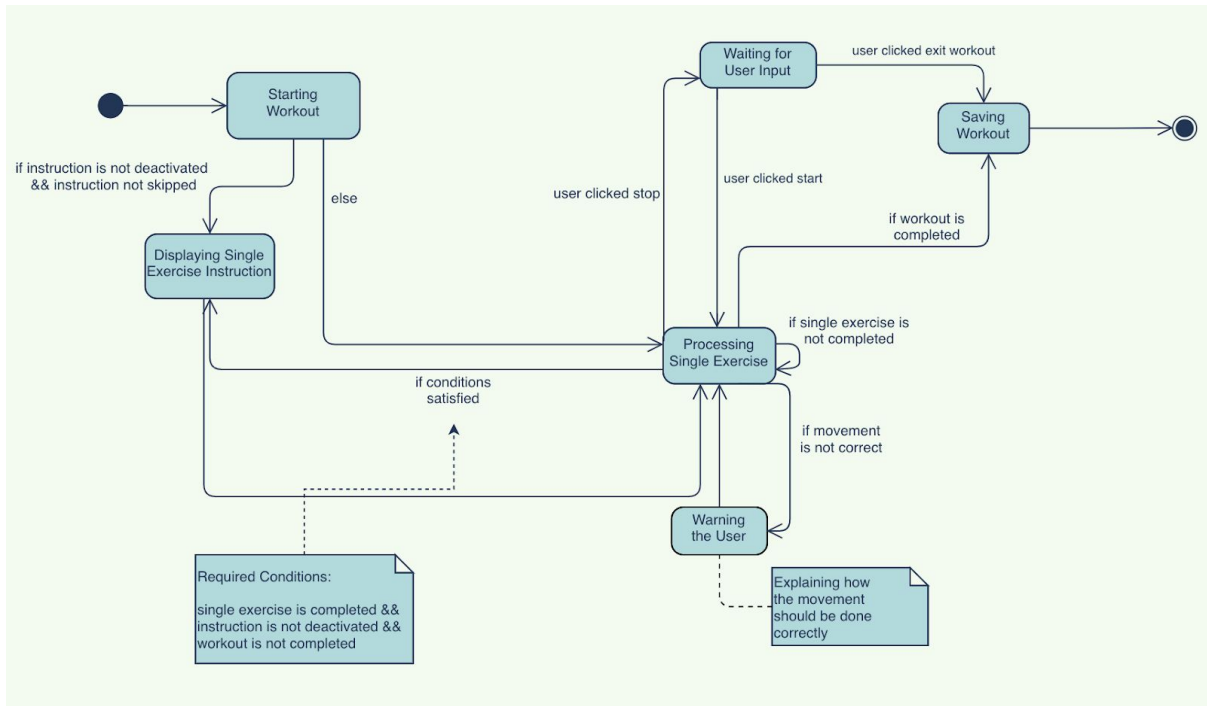
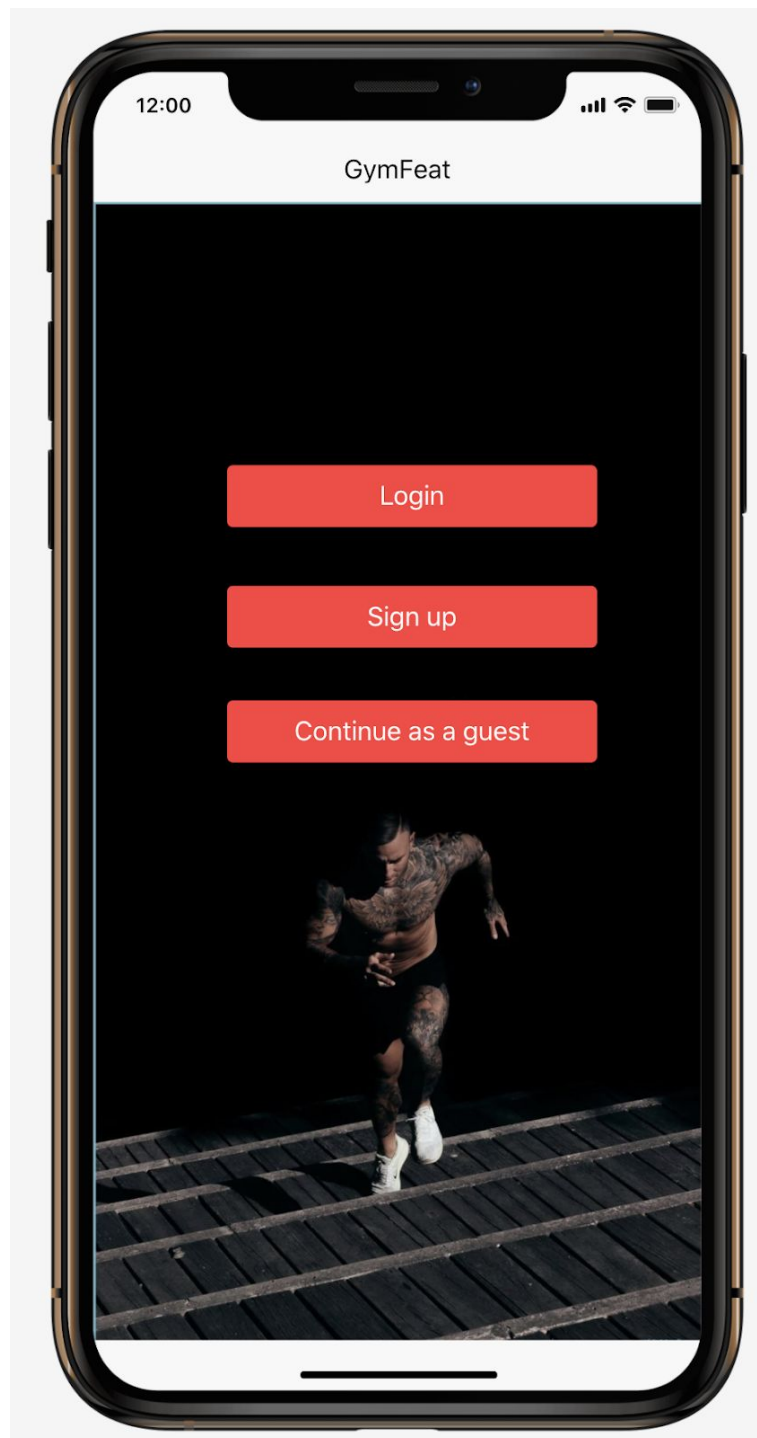


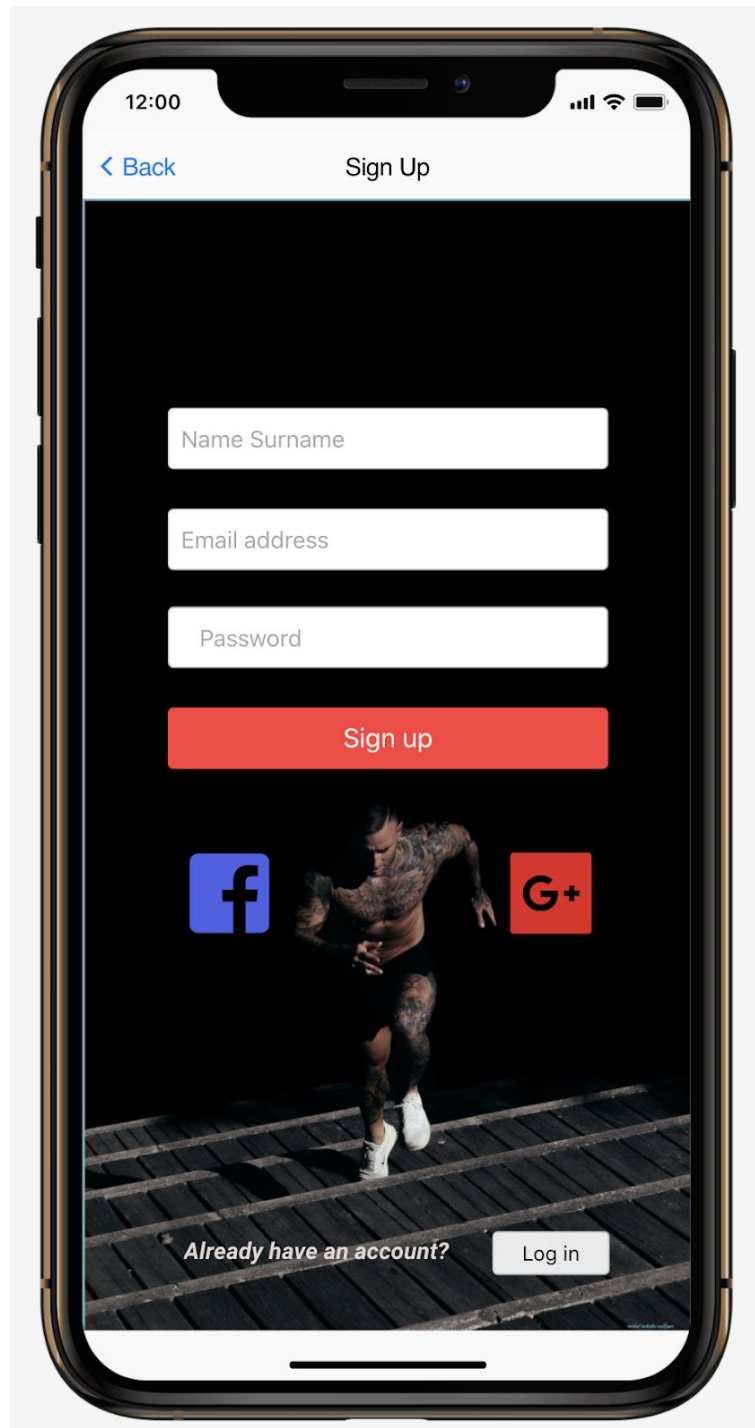
Figure 5: State Diagram of System during Workout Session

### 3.5.5 User Interface - Navigational Paths and Screen Mock-ups



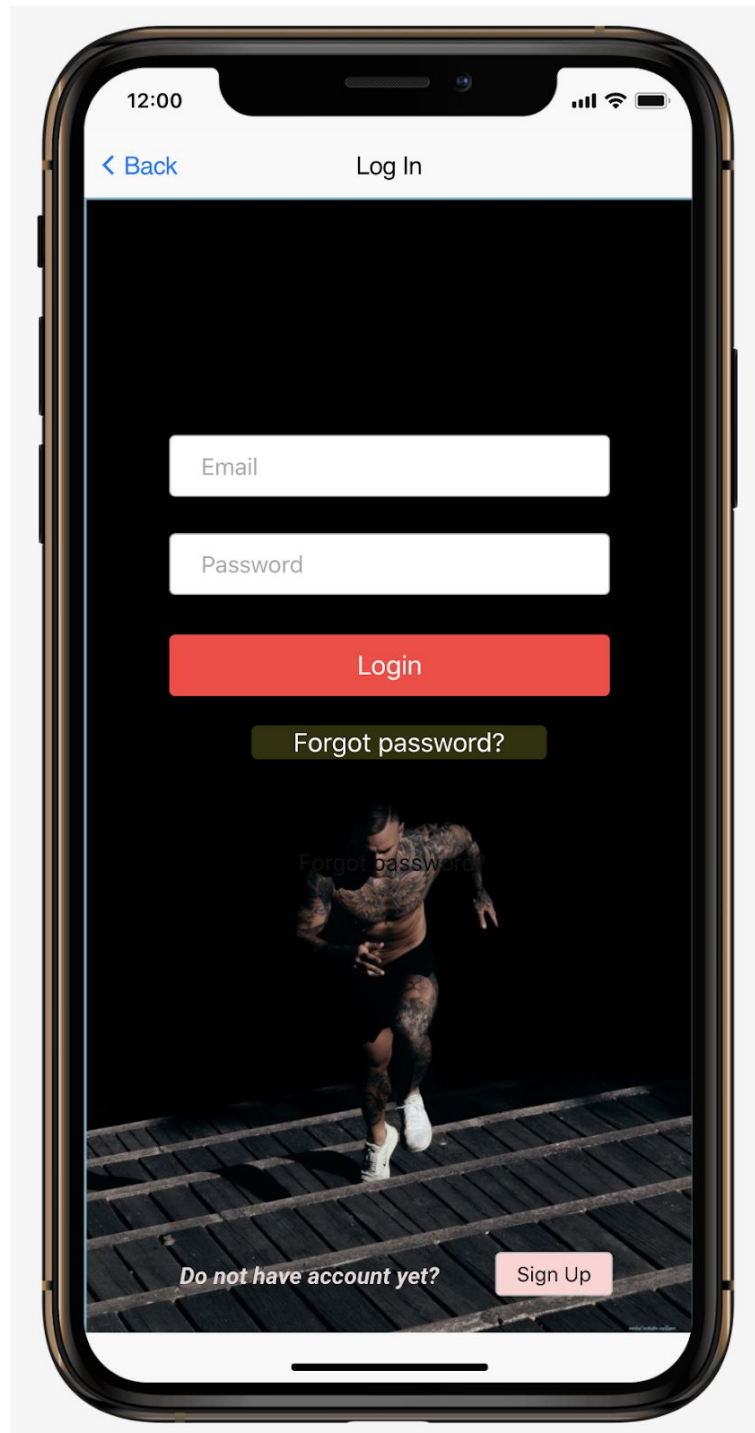
*Figure 6 : Home Screen*

Users can Log In, Sign up or Continue as a guest from this screen.



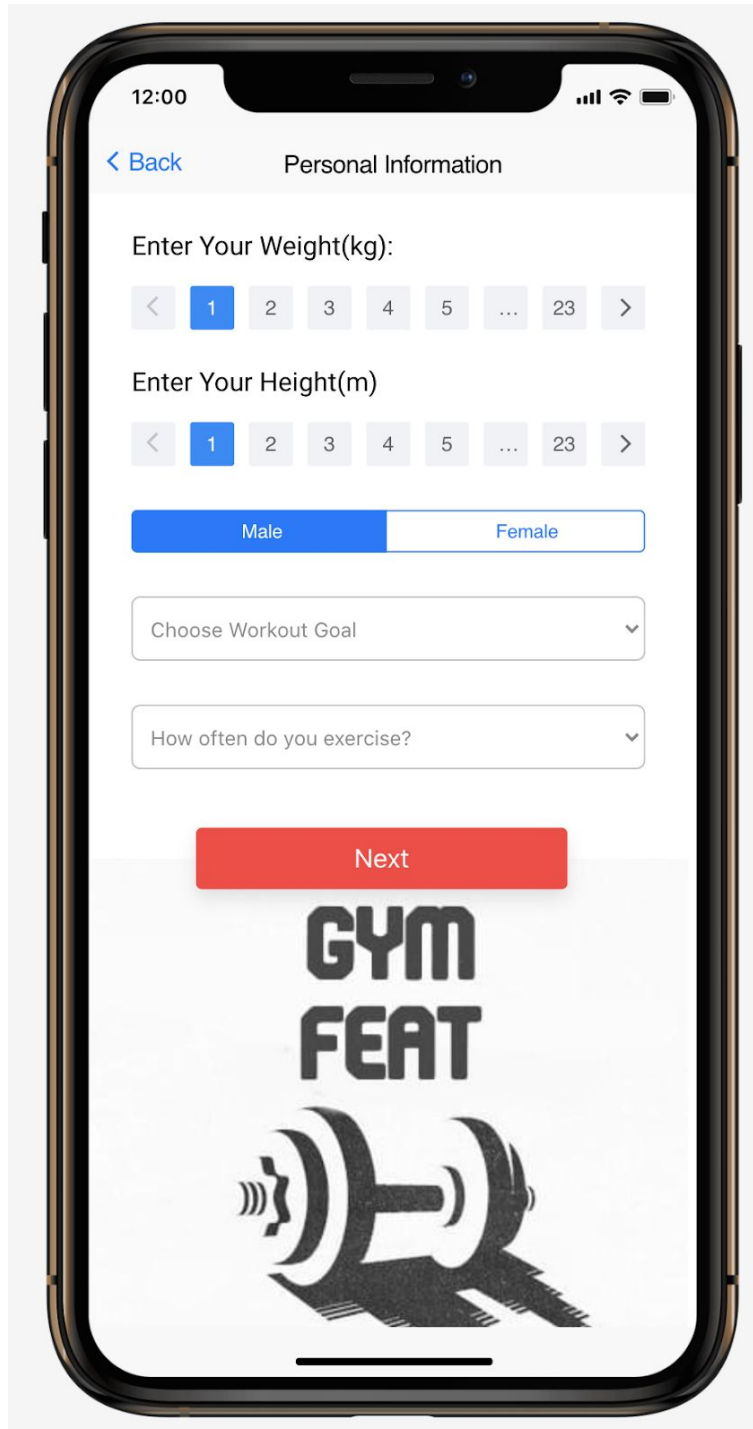
*Figure 7 : SignUp Screen*

Users need to fill the required blanks in order to sign up. Users are also able to sign up via Facebook or Google. Also if the user has an account then he/she can directly go to the Login screen by just clicking the Login button.



*Figure 8: LogIn Screen*

If the user has an account he/she can login by entering email address and password, otherwise the user can directly go to Sign Up screen by just clicking the Sign Up button. Also, users can recover the password by clicking “Forgot Password?” button.



12:00

< Back Personal Information

Enter Your Weight(kg):

< 1 2 3 4 5 ... 23 >

Enter Your Height(m)

< 1 2 3 4 5 ... 23 >


Male Female

Choose Workout Goal

How often do you exercise?

Next

**GYM  
FEAT**



*Figure 9: Personal Information Screen*

After signing up, each user needs to fill up the Personal Information, so the application can make up a personal fitness program according to the user's characteristics. Users need to enter their weight, height, gender and indicate how often they exercise.

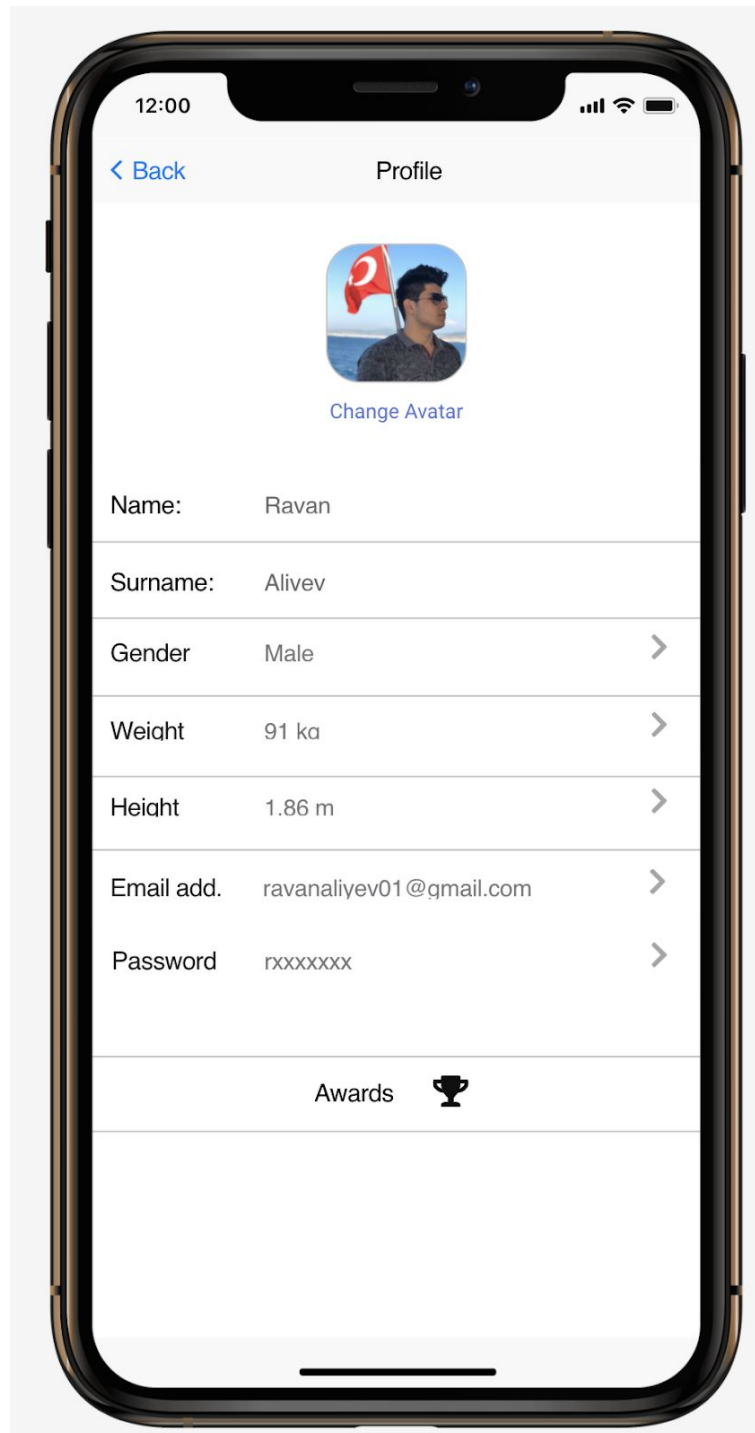
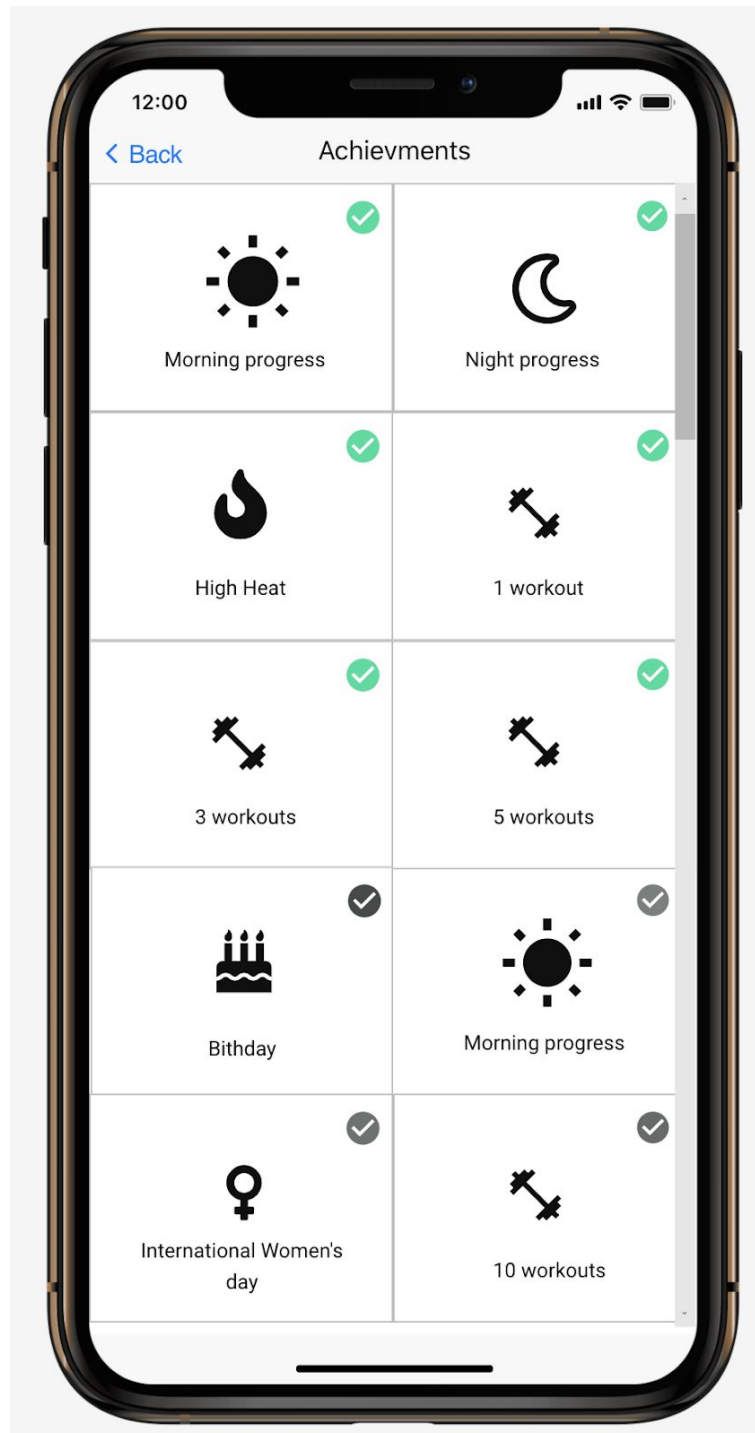


Figure 10: "Profile" Screen

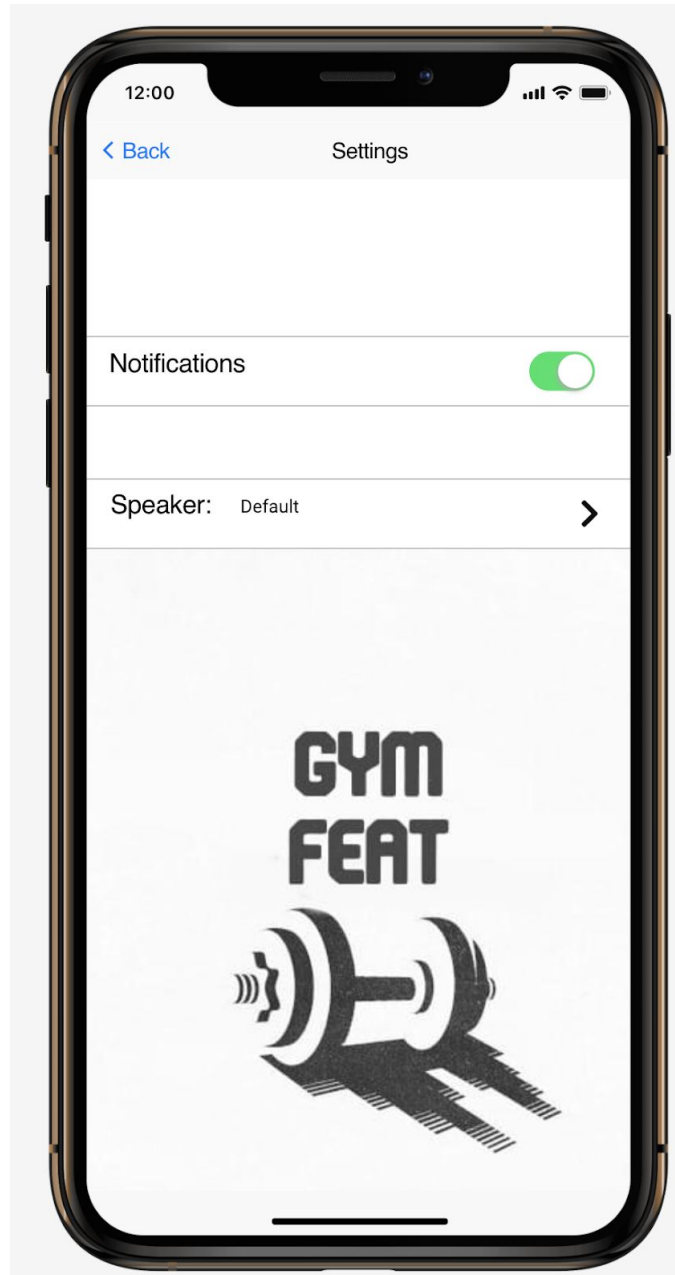
"Profile" screen allows users to see their personal and account information and edit those data accordingly. By clicking the Awards button users can view their achievements.





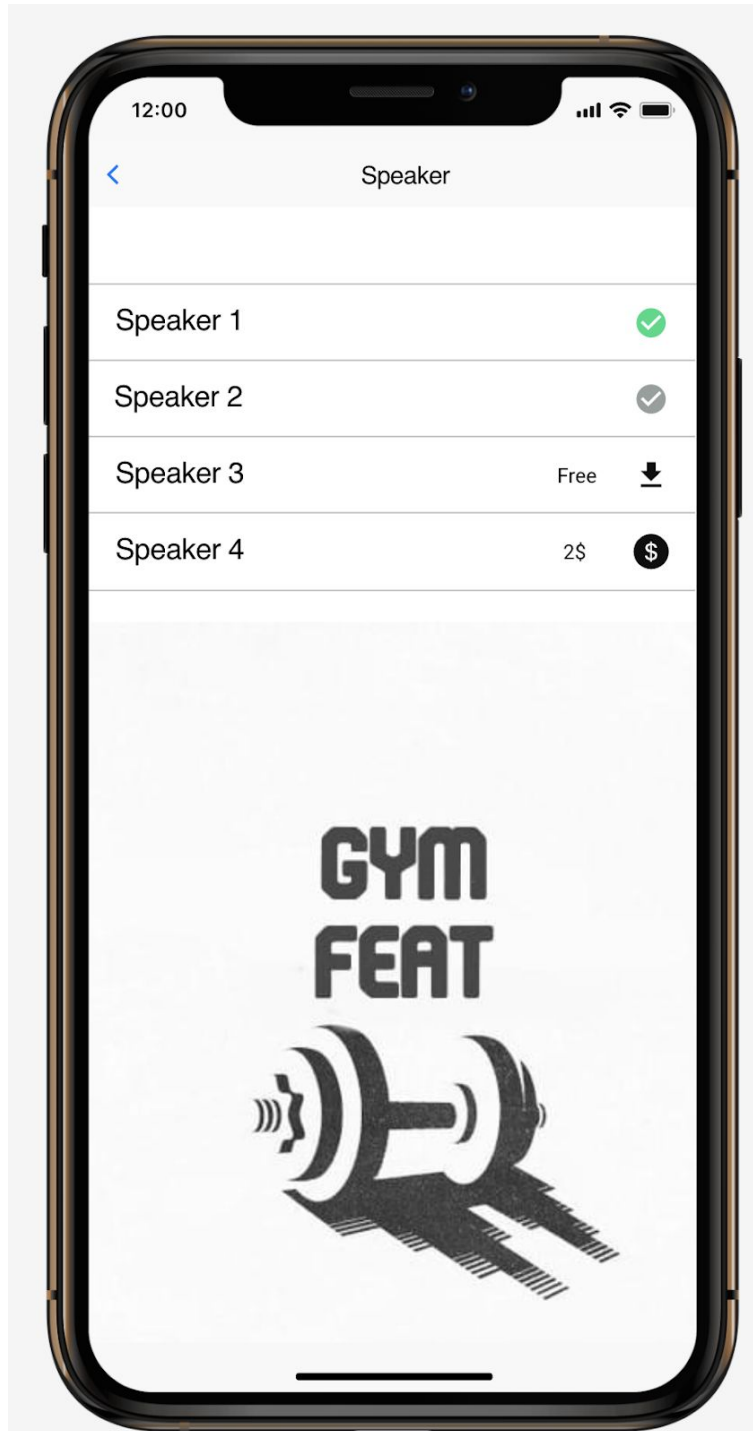
*Figure 11: Achievements Screen*

This screen allows users to view their completed and uncompleted achievement goals.



*Figure 12: Settings Screen*

From this screen users can turn on/off the application notifications and change the voice of the speaker.



*Figure 13: Speaker Screen*

Users can change the voice of the speaker from this screen. Some of the speaker voices are free and some are paid, so they can choose free speaker voices or pay to buy paid ones.

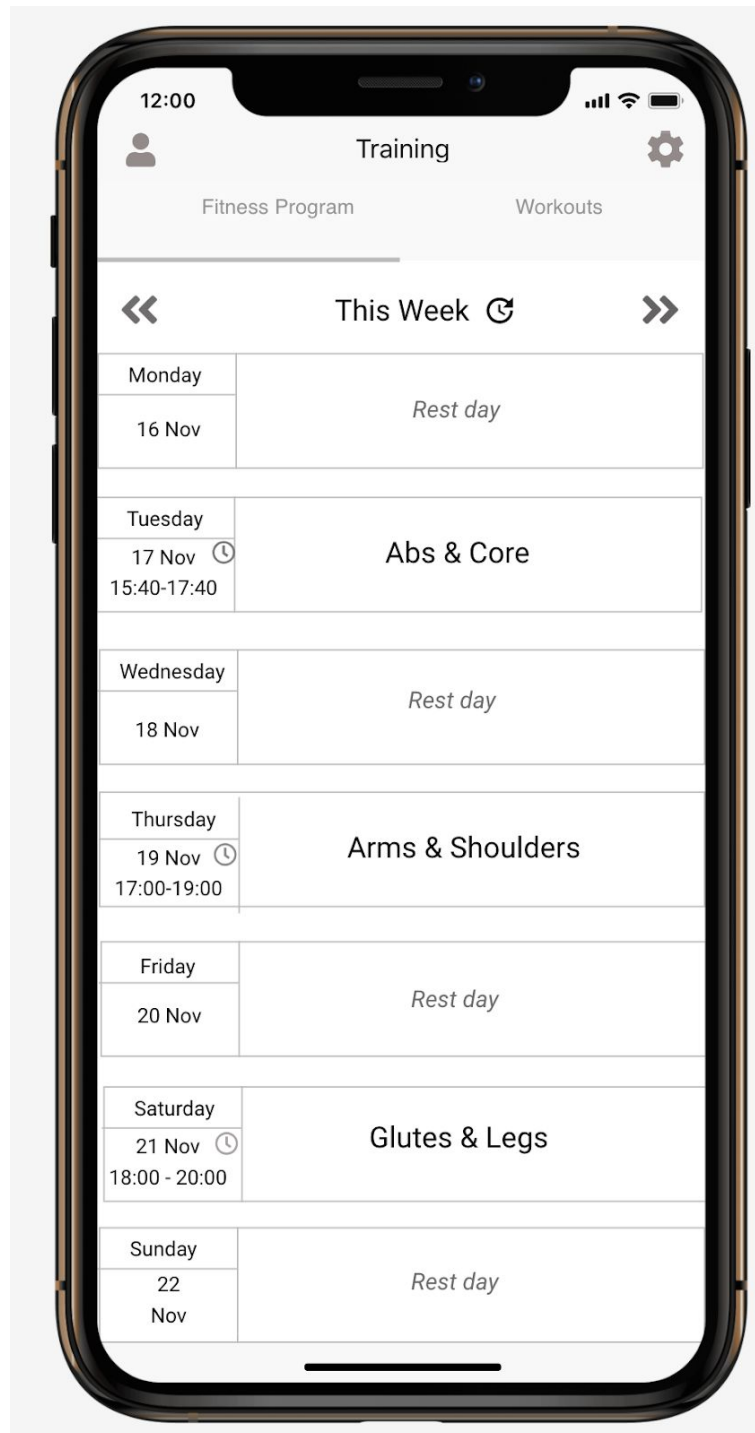
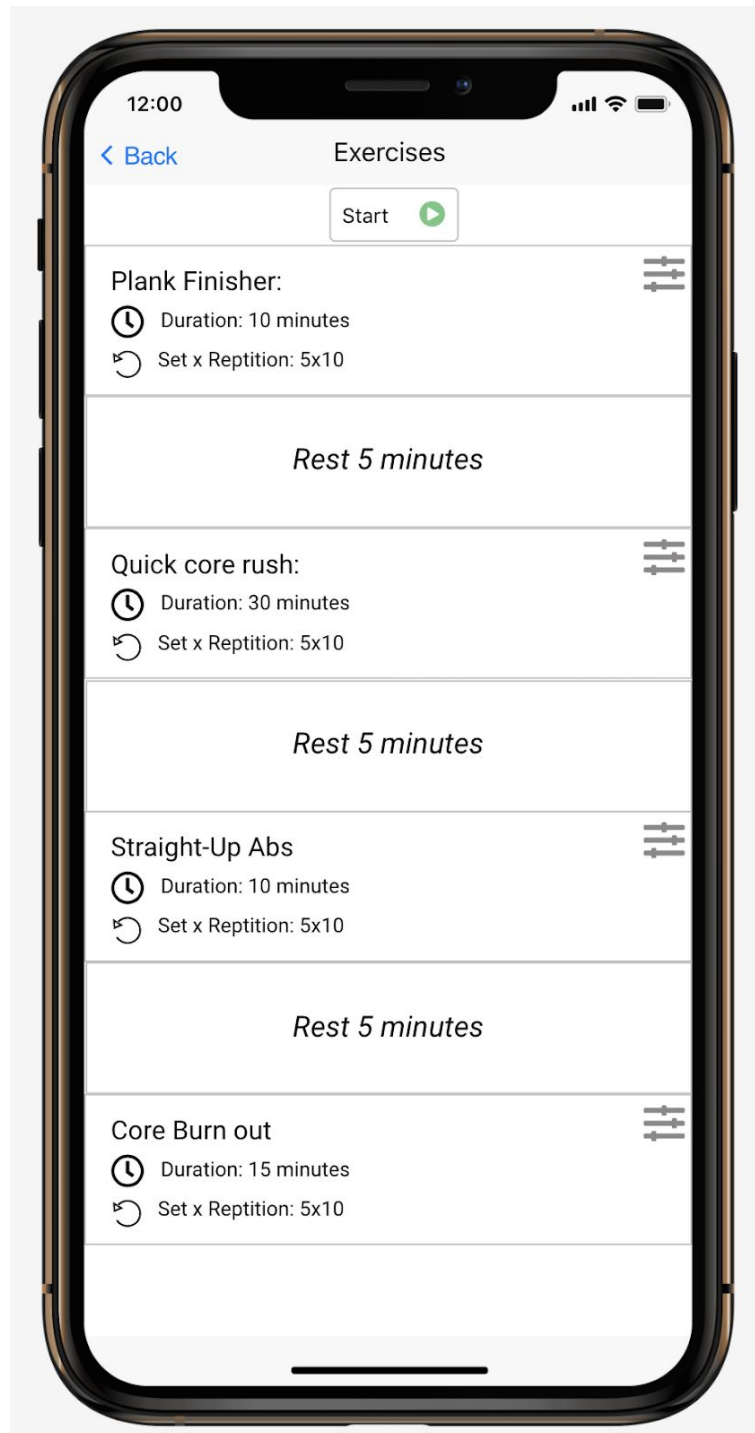


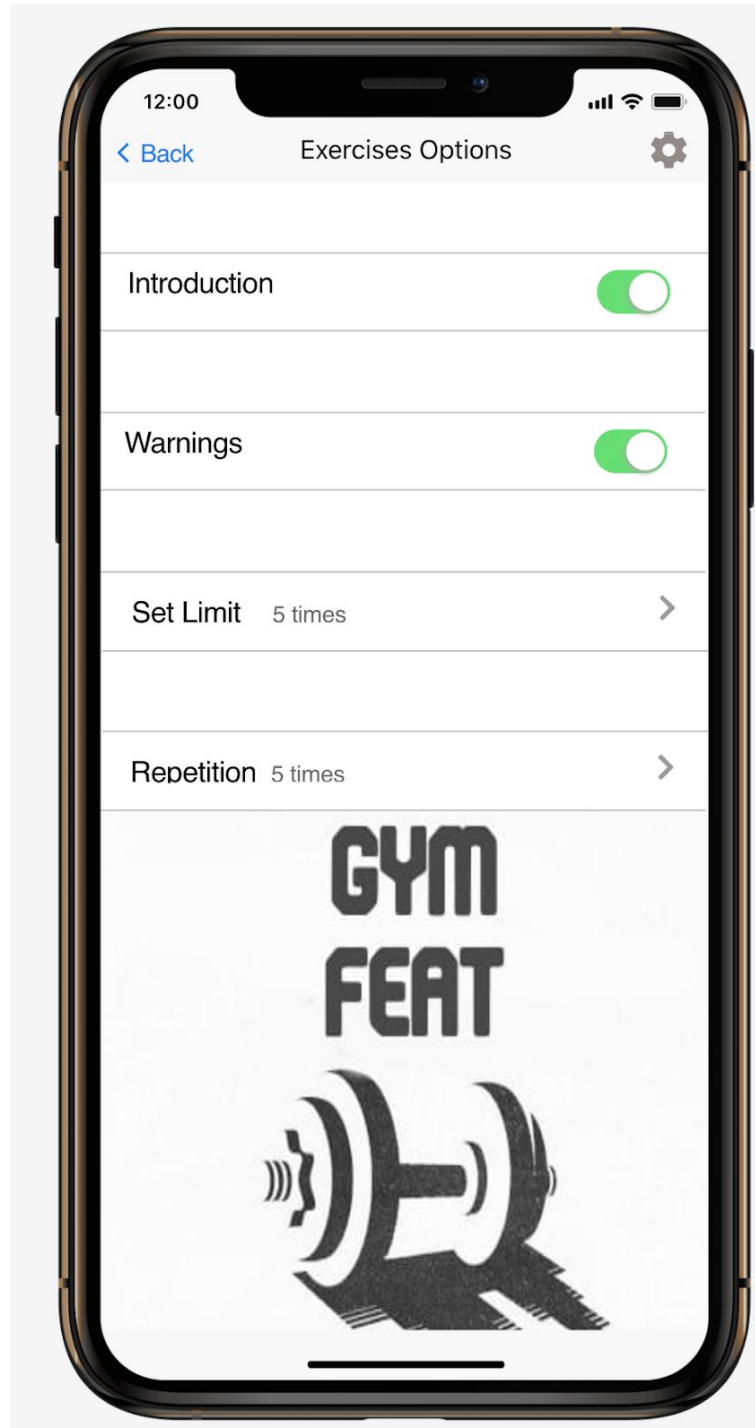
Figure 14: Fitness Program Screen

This screen shows the training program of the user. Users can view previous and upcoming weeks, edit their schedule by clicking the “clock” buttons near to each date and go to the workout screen of the current day by clicking on that day.



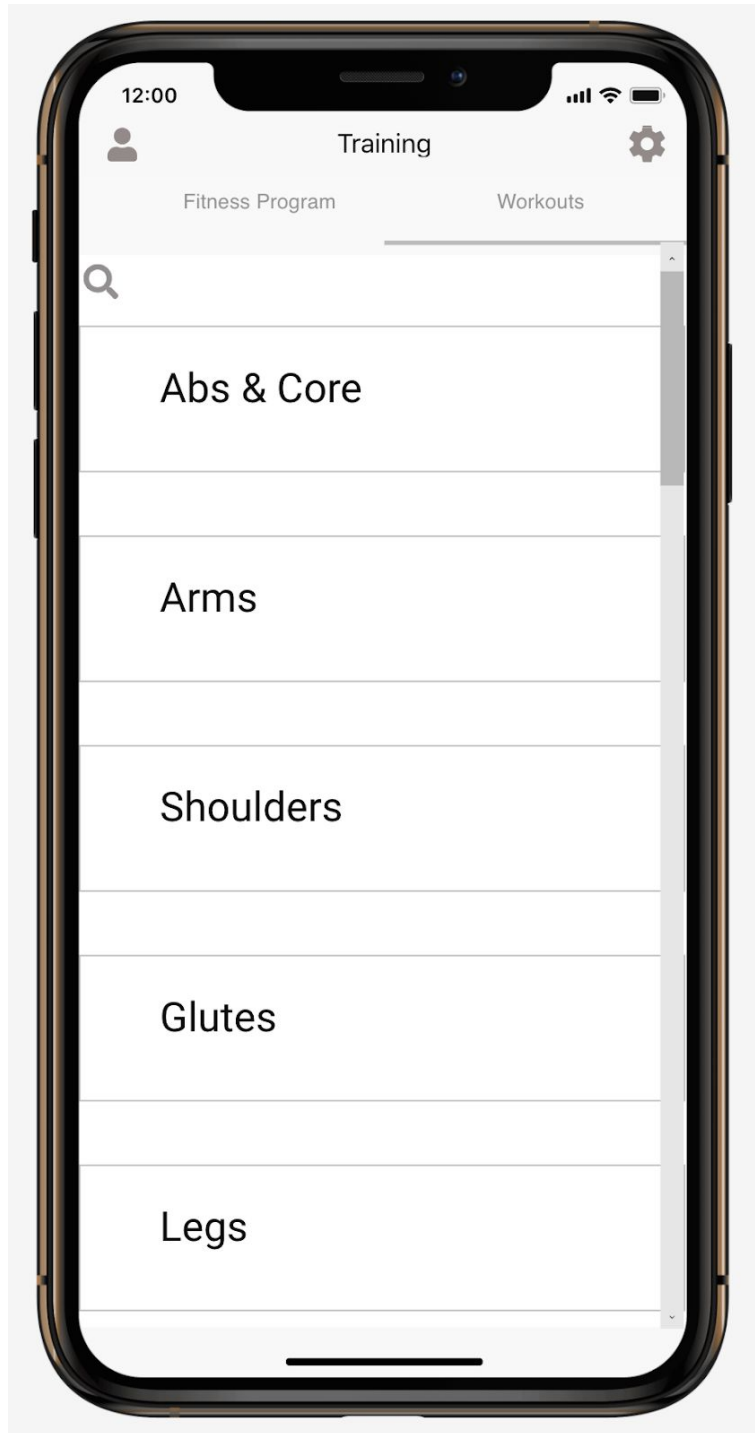
*Figure 15: Exercises Screen(For Fitness Program)*

This screen shows up if the user clicks on the current day's workout program on the "Fitness Program" screen and this screen allows the user to view the exercises which that workout includes. Also users are allowed to change the options for each exercise by clicking the options button on the right side.



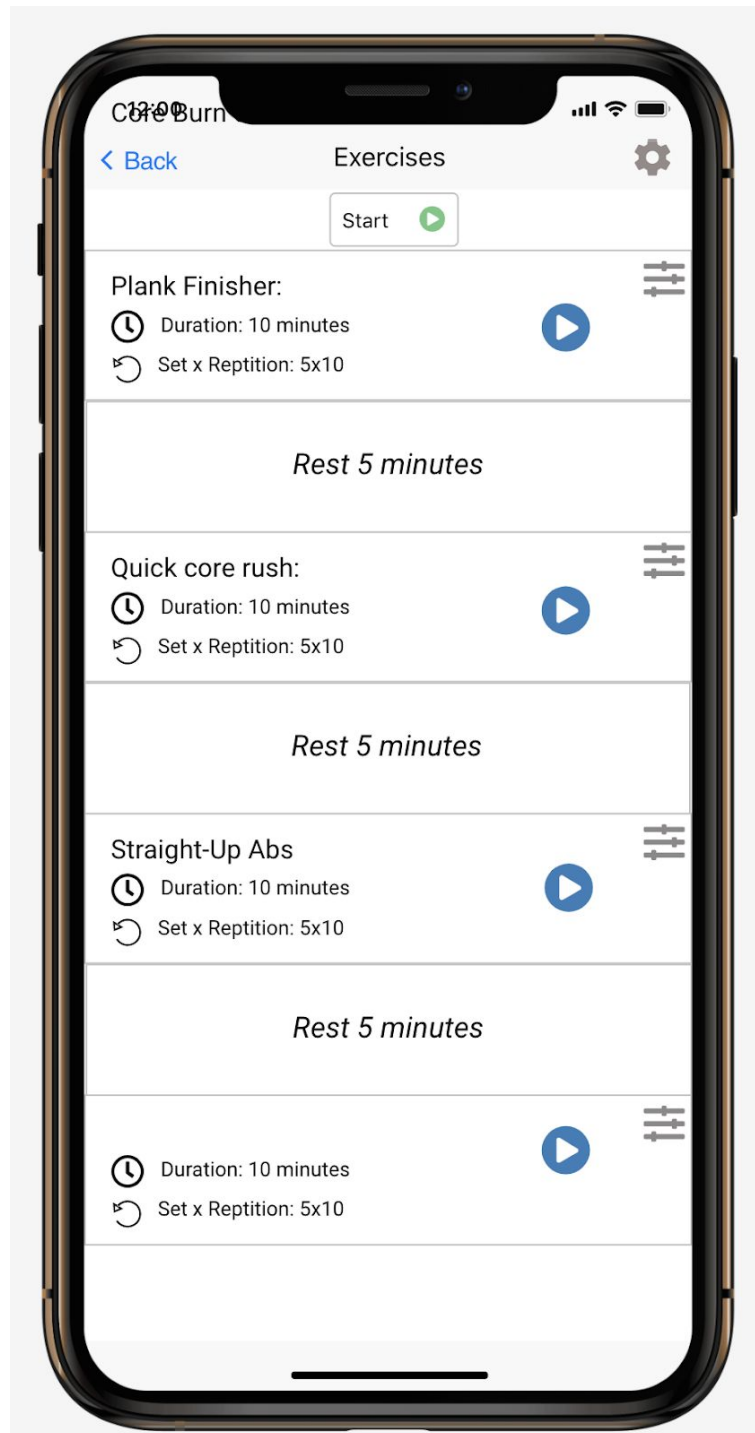
*Figure 16: Exercises Options*

Users can turn on/of introduction and warnings and change set and repetition count for each exercise from this screen.



*Figure 17: Workouts Screen*

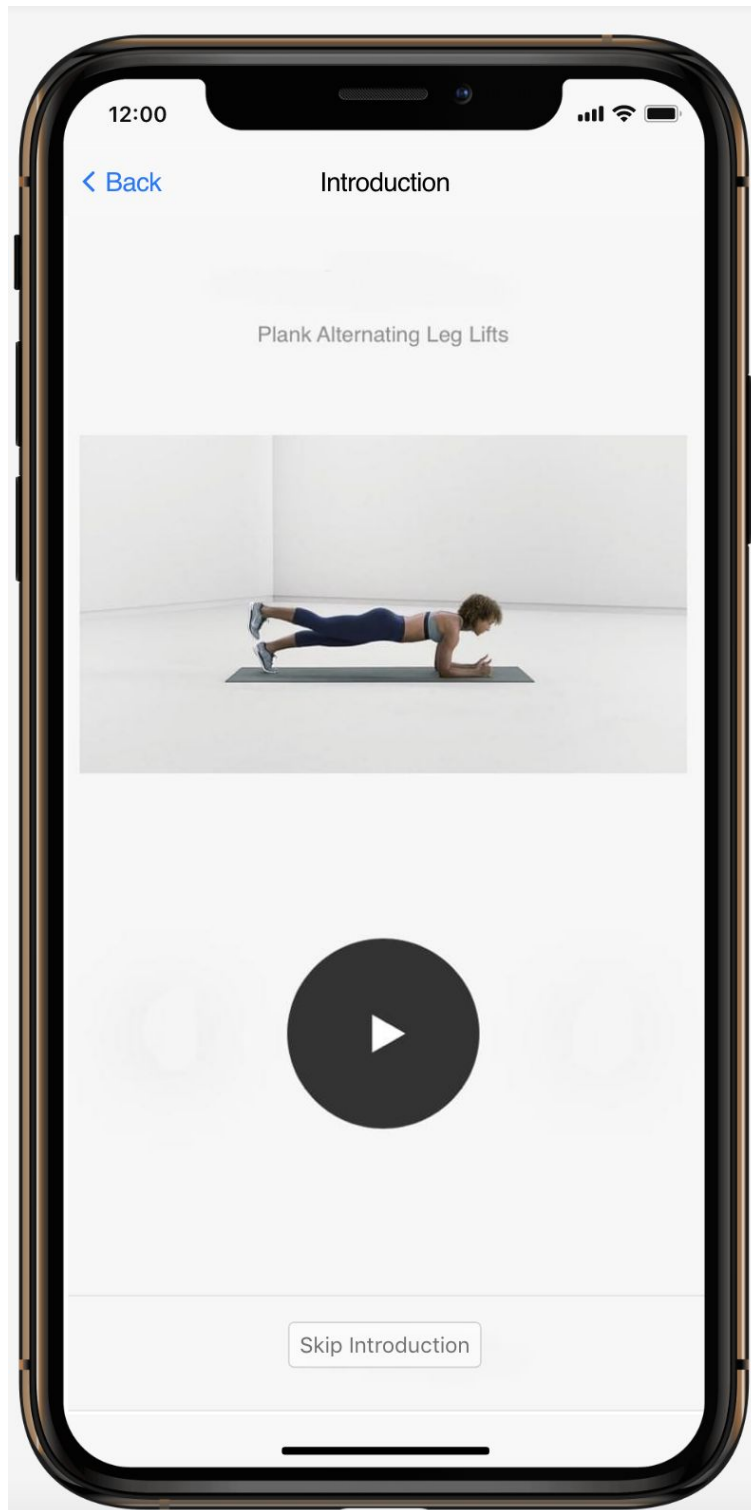
Users can choose workouts additionally to their fitness program. Clicking on any of the workouts opens the “Exercises” screen.



*Figure 18: Exercises Screen(For “Workout”)*

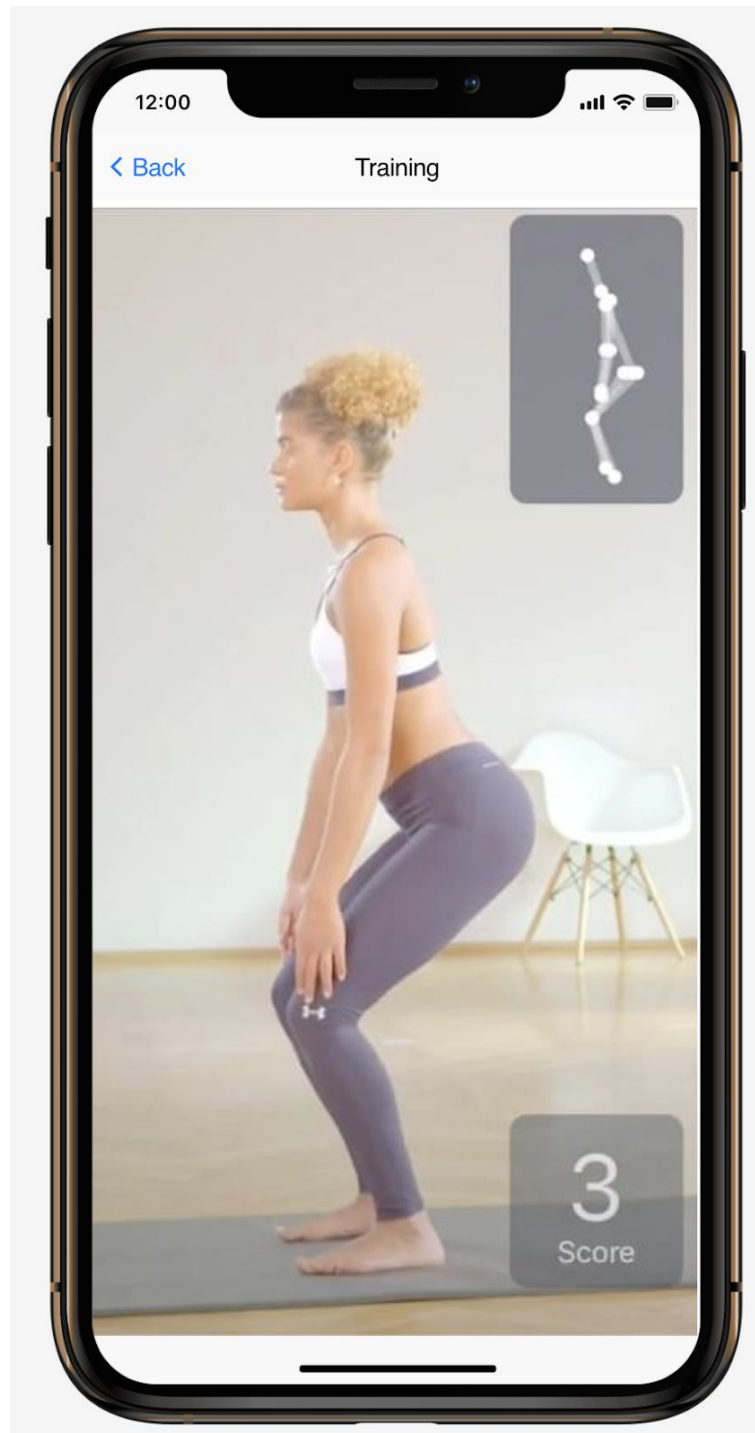
Users can choose any individual exercise or start the workout as a whole. They can also change options for each exercise.





*Figure 19: Introduction Screen*

This Introduction screen appears before each exercise in order to show how to do each move. Users can skip, stop and play the video.



*Figure 20: Training Screen*

This screen shows the user via camera and detects the body lines and checks whether each move is done correctly, if not then it warns the user. This screen also counts the number of repetition for each move.



*Figure 21: Earning badge screen*

After the workout is done, if the user has completed any of the milestones or gained any achievement then this screen shows up.

## 4. Other Analysis Elements

### 4.1 Consideration of Various Factors

There are various limiting factors that must be addressed in the GymFeat. This section of the report aims to address these limiting factors in detail.

#### 4.1.2 Public Health

Main use case of the GymFeat is to help people exercise more often and more safely. Therefore, public health will be increased by GymFeat as people using the app will be exercising more and without any dangers.

#### 4.1.3 Public Safety

One of the main points of the GymFeat is helping people do exercises safely. While not directly related to public safety, with the help of GymFeat, people will be doing exercises more safely than otherwise they would be doing on their own without the help of GymFeat.

#### 4.1.4 Public Welfare

GymFeat, essentially, is a free mobile app with in-app purchases. The in-app purchases are not related to the main use cases of the app therefore in-app purchases can be neglected in terms of welfare. Other than that, one can use and benefit from all of what GymFeat offers by only having a smartphone and a stable internet connection. Therefore, we can say only people at a certain welfare level who have smartphones and internet connection can use GymFeat.

#### 4.1.5 Global Factors

GymFeat will be in English and the app will be the same for everyone. Thus, it can be said that it is a global app which can be used by anyone who knows English. Also, GymFeat will collect user's data to some extent, so, it will be made sure that GymFeat complies with certain data regulations of countries.

#### 4.1.6 Cultural Factors

People from different cultures may want to have different exercises that are unknown to other cultures or to us. GymFeat will try to have a diverse set of exercises to target people from different cultures.

#### 4.1.7 Social Factors

In GymFeat, users will only directly communicate with the AI trainer. Therefore, GymFeat can be said to have no effect in terms of social factors.

	Level	Effect
Public Health	9	Increasing public health by helping people exercise
Public Safety	4	Having people exercise safely
Public Welfare	1	People need smartphone and internet connection to use the GymFeat
Global Factors	1	GymFeat will comply with data regulations
Cultural Factors	1	Different cultures will be considered for exercises
Social Factors	0	Not affected

## 4.2 Risks and Alternatives

The project's phases pose some risks that might be crucial later in delivering results.

Therefore, these risks are mentioned in this section, and the approach we will take, in order to handle these risks are explained in detail.

1. A team member might leave.

This would affect the available workforce, and might increase the time of completing a task. This is not a low likely risk, since all members are dependent on this project to graduate. However, it should still be considered before starting to share the workload. Our strategy would be to mitigate the risk by assigning someone else so that he/she can take over that particular task, in case the responsible person decides to leave.

2. Team members might be unfamiliar with the aforementioned technologies that will be used in the project.

This is a medium level risk. In order to deal with this risk, the members should spare some of their time for the project to use it for learning, and for getting familiar with those technologies. In this case, necessary help and support should be provided to those team members by the project manager and other team members.

3. The application might get banned from at least one of the stores.

This would highly affect the outcome, because we would not be able to deliver the results to the customers from the planned stores. In this case, the first strategy would be to avoid this risk, by reading the guidelines of Apple Store and Google Play Store thoroughly [22, 23]. The second strategy, if the first strategy does not work out for either of the stores, is to web deployment of the project.

4. Google Play Store, or AppStore might increase the fees for publishing an application and it might exceed our budget.

In this case, our strategy would be to deploy the application to the web, instead of publishing it in a store.

5. The model that will be used for pose estimation in the Machine Learning (ML) part of the development might require more resources than a mobile phone hardware has.

This is a risk with low possibility, because there is an open source pose estimator that has been found, and which has been tested on iPhone X, and Android Mi Mix2s platforms [24]. However, if it is found inadequate later to perform on mobile devices, as the requirements change, then AWS servers can be used to deploy the models. In that case, new budget estimation will be required.

6. There might be conflicting requirements realized later in the development phase.

To handle this risk, our strategy would be to analyze those requirements and decide, which one of the conflicting requirements is more crucial for the customer's sake.

7. The planned duration of the project might not be adequate for all of the functionalities.

This is a medium level risk, because every team member is already occupied with other tasks unrelated to the project, but they were involved in the estimation of each task's duration. In this case, the requirements should be reassessed and the most important requirements should be kept, while some others are getting eliminated.

8. It might be realized later during the development phase that the design of the project is not suitable to meet the requirements.

In this case, the design should be revisited, and a more suitable design should be developed.

A summary of the risks mentioned above can be found below.

Risk	Level of the Risk	Effect of the Risk	Risk Management Strategy
A team member leaving	Low	Decreasing the available workforce	Mitigating by assigning back-up person for each task
Being unfamiliar with technologies	Medium	Higher workload on members	Providing additional resources, i.e., time for learning
Application getting banned from publishing in planned stores	Medium	Not being able to deliver results to the customers	Avoiding by reading guidelines, and accepting by deploying to web
Increase in the prices of publishing the application	Medium	Not being able to deliver results to the customers	Web deployment
ML model, not being able to perform in mobile	Low	Not being able to estimating the pose of the user	Using AWS servers, and re-estimating the budget with the additional cost
Conflicting Requirements	Medium	Not delivering all functionalities	Accepting and rearranging the initial requirements
Time shortage	Medium	Not delivering the results	Rearranging the initial requirements and eliminating some of the functionalities
Unsuitable design of the project	Medium	Not implementing the remaining functionalities	Revisiting the initial design

## 4.3 Project Plan

### 4.3.1 Project Plan

- Analysis report will be written.
- Learning and using Flutter NodeJS, Firebase, Python, and Tensorflow.

- Mobile application infrastructure will be developed with firebase connection and main registration functionalities.
- UI designs will be made.
- High-level Design report will be written.
- Low-level Design report will be written.
- Wallet System for user based purchases will be added.
- Tests will be implemented and used for testing.
- Final Report will be written.

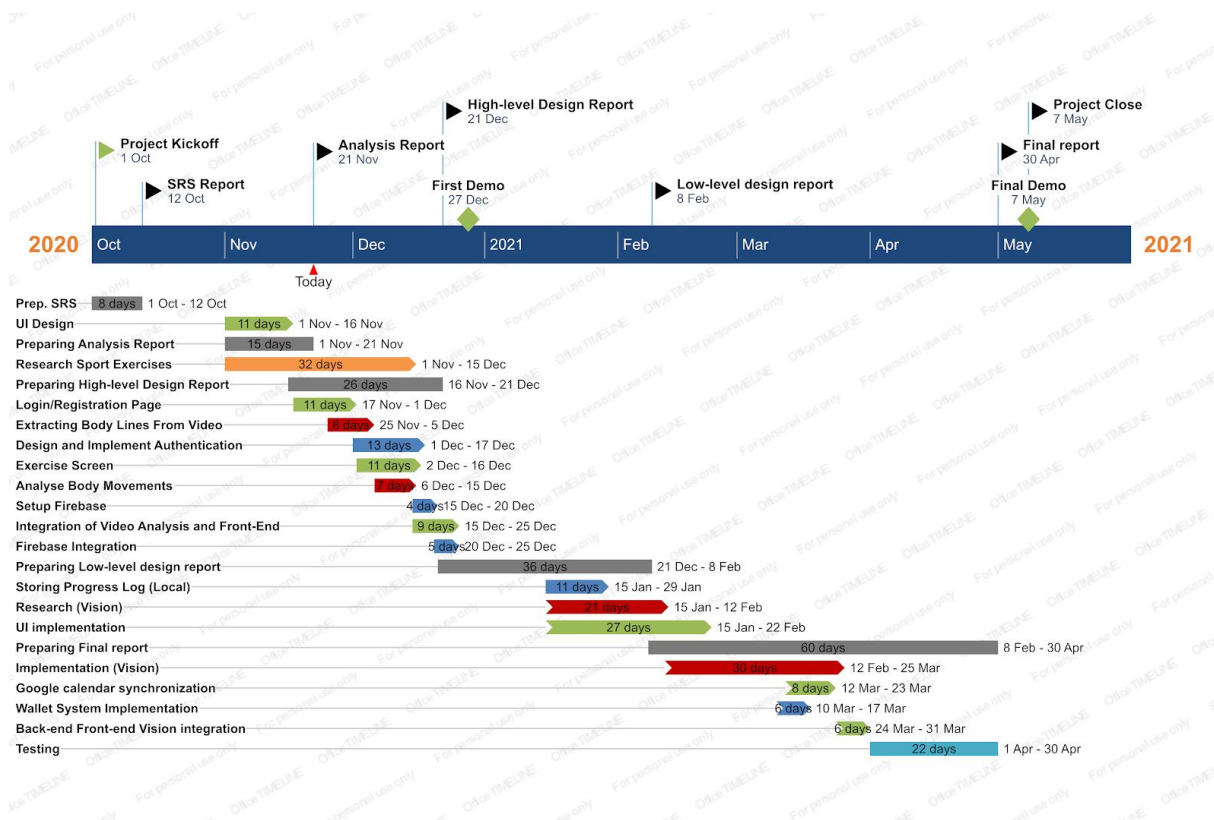
#### 4.3.2 Work Packages

- Work Package 1
  - Leader: Gonca Yılmaz
  - Start Date: 1 Nov
  - End Date: 21 Nov
  - Milestone: UI design is made. Project is planned for the rest of the year. The risks for the project are investigated and paired with risk management strategies. Analysis report was prepared.
  - Deliverable: Analysis Report
- Work Package 2
  - Leader: Ayşe Ezgi Yavuz
  - Start Date: 22 Nov
  - End Date: 21 Dec
  - Milestone: Exercise routines to be added to the application will be decided. Login and registration functionalities will be completely implemented with firebase connection. Research for implementing pose estimation will be conducted. The most suitable pose estimation ML model for mobile devices will be chosen, and modified according to our needs. Body-figure extraction, as lines, from real-time video will be implemented. High level design report will be prepared to be submitted.
  - Deliverable: High level Design Report
- Work Package 3
  - Leader: Ravan Aliyev
  - Start Date: 1 Dec



- End Date: 27 Dec
- Milestone: Work-out screen will be added to the application. Single exercise and training tutorials will be added with their tutorials. Body line extraction will be integrated to the application. First demo will be made using the MVP version of the application.
- Deliverable: MVP (Minimum Viable Product) and First Demo
  
- Work Package 4
  - Leader: Mustafa Çağrı Güngör
  - Start Date: 21 Dec
  - End Date: 8 Feb
  - Milestone: Research will be conducted for the ML part. From the extracted body lines of the user, the score will be calculated. Also, counting sets and repetitions of a single exercise will be automated.
  - Deliverable: Low level Design Report
  
- Work Package 5
  - Leader: Talha Burak Çuhadar
  - Start Date: 8 Feb
  - End Date: 30 Apr
  - Milestone: Back-end/Front-end/Vision Integration, Google Calendar export functionality will be added. “Wallet” for registered users will be added for purchasing additional content, testing of the application will be made. Final report will be prepared. Final product will be presented.
  - Deliverable: Final Report and Demo

#### 4.3.2 Gantt Chart



## 4.4 Ensuring Proper Team-work

To maintain proper teamwork, the team needed an environment in which it was easy to address project management and documentation in a systematic way. Asana and GitHub have been explored for this reason, and because everyone already has a GitHub account, the team has agreed to use it as a project management tool. For creating the Gantt Chart we have used a tool called OfficeTimeline.

We assume that the key to a successful product is effective team-work. We don't want anyone to be solely responsible for a certain aspect of our project. We therefore strive to circulate duties and responsibilities so that everyone shares leadership and that everyone has sufficient knowledge of the sections of the project. We suggest an environment of collaborative creation, where every participant is involved in most aspects of the project. The task of these leaders in each work package is to supervise the specifics of that particular work package:

- Knowledge of the work package perceptions and assumptions and being able to take appropriate precautions .
- Empowering each of the group members to modify and adjust the work package while serving as a contact channel for them.
- Being able to keep each participant responsible for particular actions and motivate them in a robust and respectful way .

- Ensuring the smoothness of the phase of a production while still keeping to the deadlines

Since each member of the organization is a leader with a clear job kit, everyone will have the ability to learn leadership. Although the community members have diverse priorities, these interests are known to be the leadership of the job packages distributed. By ensuring a close number of GitHub commits, we expect everyone to make around the same contribution in implementation of the project. We also expect that everyone will actively engage in Asana tasks and participate in real-life meetings. In case certain members fail to contribute as much as others, we will immediately plan meetings where we aim to motivate those particular members.

## 4.5 Ethics and Professional Responsibilities

- Keeping the piracy issues in the sector in mind, the source code of the project will be kept private.
- To be able to keep up with the tight schedule, our team will meet at least twice a week. Later, based on the project schedule, the meetings will transform into weekly Scrum meetings [25].
- The decisions regarding this project will be made democratically within the team.
- Team members will all have separate roles per divide and conquer development strategy [26]. The roles of the group members are as follows:
  - Gonca Yılmaz, Mustafa Çağrı Güngör: Machine Learning Engineer
  - Ayşe Ezgi Yavuz, Ravan Aliyev: Mobile Developer
  - Talha Burak Çuhadar: Backend Developer

Ethical:

- In this project, we will apply General Data Protection Regulation (GDPR) and the Code of Ethics [17, 27, 28].

## 4.6 New Knowledge and Learning Strategies

The list of necessary software engineering and computer science concepts for this project is listed below.

- Back-end development
- Front-end development
- Android app development

- iOS app development
- Image analysis

Our team will learn and improve the listed skills above for our project before and during the implementation process. Our team will use different sources like online learning, framework documentation and existing example repositories in order to be able to satisfy these requirements. Distribution of the tasks will be done according to the interests and previous experiences of each team member to get better results.

## 5. Glossary

- General Data Protection Regulation (GDPR) : This is the set of regulations drafted and passed by the European Union (EU) in order to protect privacy and security in the world [17].
- Minimum Viable Product (MVP): This is “a development technique in which a new product or website is developed with sufficient features to satisfy early adopters” [29].
- AI (Artificial Intelligence): It is “a technology that is already impacting how users interact with, and are affected by the Internet” [30].
- ML (Machine Learning): This is “an application of artificial intelligence (AI) that provides systems the ability to automatically learn and improve from experience without being explicitly programmed” [31].
- AWS (Amazon Web Services): Amazon offers web service, that is “a comprehensive, evolving cloud computing platform” [32].

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