FACULTY OF SCIENCE & TECHNOLOGY

BSc (Hons) Software Engineering
May/2021

Automatic route generation for a fitness application

by

Maciej Gebski, s5111611

Faculty of Science & Technology

Department of Computing and Informatics

Final Year Project

Abstract

This individual project explores into a solution for a defined problem, the solution is creation of a mobile artefact which provides and generates a route for exercise for the user. This is aimed to provide motivation and allow young adults to discover a way to stay healthy. The artefact also includes an API solution which connects to a database to store user information such as calories burnt by using this application to show users their progress to further motivate them towards staying healthy.

The project was a show case of android application design and deployment to solve the pre-defined problem, together with literature review of the problem domain as well as design psychology, such as 6 principles of design by Donald Norman, and possible technologies, which were critically evaluated, to be used during the plan and implementation of the artefact. These include project methodologies, testing methodologies and requirements analysis. Certain formulas were explored in order to generate the route based on spherical coordinates.

Dissertation Declaration

I agree that, should the University wish to retain it for reference purposes, a copy of my dissertation may be held by Bournemouth University normally for a period of 3 academic years. I understand that once the retention period has expired my dissertation will be destroyed.

Confidentiality

I confirm that this dissertation does not contain information of a commercial or confidential nature or include personal information other than that which would normally be in the public domain unless the relevant permissions have been obtained. In particular any information which identifies a particular individual's religious or political beliefs, information relating to their health, ethnicity, criminal history or sex life has been anonymised unless permission has been granted for its publication from the person to whom it relates.

Copyright

The copyright for this dissertation remains with me.

Requests for Information

I agree that this dissertation may be made available as the result of a request for information under the Freedom of Information Act.

Signed: Gebski .

Name: Maciej

Date: 13/05/2021

Programme: Software Engineering

Original Work Declaration

This dissertation and the project that it is based on are my own work, except where stated, in accordance with University regulations.

Signed: Gebski .

Name: Maciej Gebski

Date: 13/05/2021

Acknowledgments

I would like to thank my friends and family for keeping me motivated and pushing me forward to complete this project. I would also like to thank my supervisor David Newell for guiding me with advice and support on this project.

TABLE OF CONTENTS

Contents

LIST OF FIGURES

TABLE OF TABLES

1 INTRODUCTION

1 This section provides a brief overview of the project as well as the definition of the problem and proposed solution for the problem. This chapter also explores the risks and how to avoid them to better understand the scope and a proposed solution effective.

1.1 Problem Definition

The problem domain is that there are not many applications which create a route on top of a map for the user to use to navigate in their morning/afternoon walk/run. In bigger cities and for people who recently moved homes not knowing the area or not having a plan for a morning run can discourage exercise.

Especially during the current situation in real life with the global pandemic with public gyms being closed due to lockdown and even after lockdown being limited, one of the best ways to exercise is by partaking in running/walking outside. (*Department of Health and Social Care* ., 2020) Because of forementioned problem young adults can be discouraged and lose motivation to stay healthy as they are not given another solution in front of them.

In today's age people miss daily needed excises which in many cases leads to obesity Currently 28% of the UK adult population is obese, leading to poor health and lower average life expectancy and increase the chance of serious health problems and diseases. Furthermore 36 % more adults are overweight not obese which can also cause long term health issues. (Baker 2021) Especially during the global pandemic obesity increases the risk of serious health issues with covid and increased mortality rate. (Kueppers 2015)

The problem with existing solutions is that they either require a monthly payment or are filled with advertisements which can lead to very irritating experience. The monthly subscription ranges from 5.99 to as far as 7.99 a month which can be a big expenditure for students and young adults. A lot of these free application are also riddled with in app purchases either forcing you to pay to have a better experience or outright asking to pay to unlock features. (Jewell 2020)

In conclusion young adults and adults need more of a motivation and encouragement to participate in weekly regular exercise, which would decrease the overall % of people who are overweight and above.

1.2 Scope

The scope of this project is to develop a simple application for android targeted at young adults. Currently there are no plans to extend the application to other platforms as the nature due to the

nature of the project and time constraint. As an extension to the application an api and database will be made to create a login and register system as well as keep track of user's data through a safe measure.

1.3 Aims and Objectives

1.3.1 Aims

"The aim of this project is to create a solution that will motivate and allow young adults to auto generate a running/walking route around their area in a form of a mobile application, while allowing to keep track of their statistics."

1.3.2 Smart Objectives Success Criteria

To create successful and effective objectives I will be using a methodology called SMART objectives. This will allow me to create and grade specific objectives which need to be completed to fully finish the project and artefact. Smart objectives allow the developers to give a deeper thought into the completion criteria and feasibility of the objectives which they have set themselves within the time constraint of the project.

Smart objectives stands for:

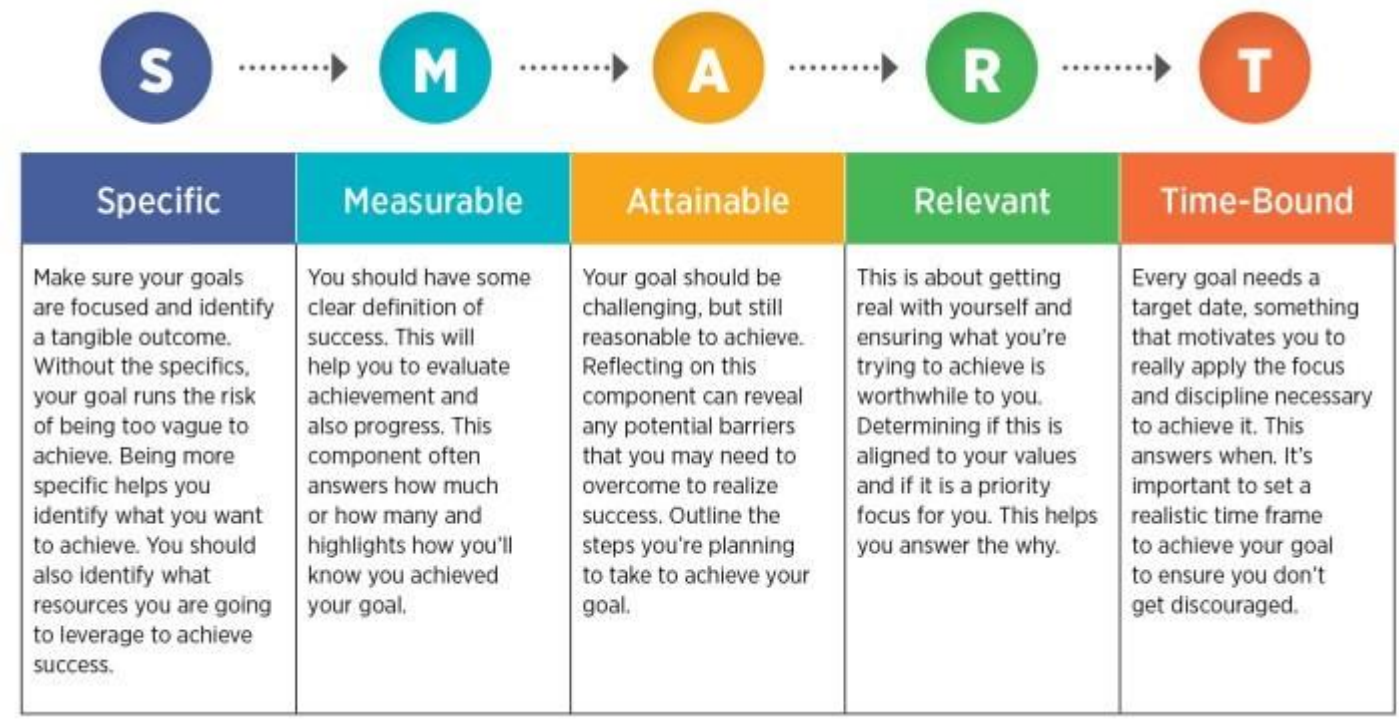


Figure 1-Smart Objectives(Canadian Management Centre 2012)

This will allow me to successfully fulfil my project aim by completing success criteria to aid me with the desired outcome from the artefact. Objectives will also be used as a form of evaluation and checklist to make sure that everything has been implemented and completed.

Obj. ID	Obj. Description	Specific	Measurable	Attainable	Relevant	Time-Bound	Success Criteria
1	Analyse and review literature surrounding defined problem and technologies needed as well as psychological design concepts to develop and deploy a successful mobile application	Conduct research towards surrounding the problem as well as technologies which help with solving it	This can be measured by how well the solution and problems were evaluated and analysed	This can be achieved by using online resources	This is needed for the project to understand the problem domain as well as solution	The given time frame should be enough to complete this objective	This can be achieved by properly identifying the problem, technologies which can solve the problem and reviewing existing solutions to build my own
2	Specify requirements to design and define features to solve the problem	To create the analyse needed requirements for the creation of artefact.	Evaluation of the success off the artefact and how well it was at solving the problem	This can be achieved by evaluating the problems and needed features for solution	This is a critical part of software development needed as a base to create quality software	Due to the time constraint requirement analysis will be conducted carefully, and with realistic mind set	How well the artefact solves the problem
3	Visualise and develop ui based on psychological effects studied, using wire frames	Research into Ui and UX design as well as their principles and create wireframes which use those	How well they were used and in how many instances, testing the user experience.	This can be achieved by carefully conducting research and designing wire frames based on requirements	This is needed to visualise and help to validate requirements and how realistic they are	The given time frame is enough to complete this objective	How well Ui principles were applied to the UI

		principles					
4	Build and deploy a successful android application using chosen methodology	Creation of the artefact based on research technologies and design principles as well as defined requirements	This can be measured by testing and requirements completed	This depends on how realistic and well defined the requirements are	This is the main part of the project, it is the solution to the given problem domain	Due to the time constraint only some features and requirements can be implemented, what will be implemented is prioritised by MoSCoW	This will be measured by the quality of design, user experience, testing and how well the artefact is at solving the problem
5	Evaluate and conclude the success of the artefact and project	To evaluate the usefulness of the product, and quality, as well as quality of the literature review of the domain	By completing this it will allow me to evaluate the overall performance of the project	This can be achieved by reviewing the project	This is necessary to learn lesson for future projects as well as evaluate the strength and weaknesses of the problem solution	This can be done withing the given time frame	This can be achieved by fully evaluating strengths and weakness of the project. The artefact will be evaluated through testing and design principles application

Table 1- Smart Objectives

1.4 Risk Analysis

1.4.1 Risk

Before starting the project, I have conducted a risk assessment in order to mitigate any future problems which could lead to delays or cutting down in implementations in order to save time. I have conducted this assessment using a tool called such as Risk assessment matrix. Risk assessment matrix works by identifying he like hood of a risk happening as well as calculating the damage it can potentially cause, allowing the developers to rank and focus on the most damaging and likely to happen risks in order, to make sure that the project runs smoothly. (Wilson 2020)

To rank these criteria's I have used this tables to grade each risk based on risk grade, allowing me to pick out the most dangerous risks which could lead to delays of my project or loss of work. These tables can be seen below.

Hazard analysis and risk assessment matrix with proposed actions					
	HAZARD SEVERITY				
HAZARD LIKELIHOOD	Critical Illness or Injury	Severe Illness or Injury	Moderate Illness or Injury	Minor Impact	Negligible Impact
Very Likely	Requires Control	Requires Control	Requires Control	Manageable	Manageable
Likely	Requires Control	Requires Control	Manageable	Manageable and Tolerable	Tolerable
Possible	Requires Control	Manageable	Manageable and Tolerable	Tolerable	Acceptable
Unlikely	Manageable	Tolerable	Tolerable	Acceptable	Acceptable
Highly Unlikely	Tolerable	Acceptable	Acceptable	Acceptable	Acceptable

Figure 2- Risk Matrix (Markovic 2019)

ID	RISK	Description	Likelihood	Risk Rank
1	Data loss	In case of any problems occurring with my SSD, PC, or data corruption	unlikely	manageable
2	Global Pandemic/national lockdown	There is a risk of me or close one getting infected by Covid which would reduce my productivity and time schedule	likely	Requires control
3	Time management	Failure to meet set project time and delivery deadlines	Very likely	Requires control

4	Unavailable supervisor	If my supervisor is unavailable to contact	Likely	manageable
5	Mental Health	In case my mental health is effect due to deadline stress or tiredness	possible	Manageable and tolarable
6	Requirement/ feature change	Scope creep could occur, creating more requirements then possible to complete withing time frame	possible	manageable
7	No available internet	Currently in a situation of moving homes, there is currently no internet available in the new building meaning that I have to use mobile data to complete the project, meaning that there can be internet shortages	Very likely	Requires control

Table 2- Risks

There are a few risks in this project which could lead to many delays and missed schedules for the project, as well as pressure of real-world issues and how they could affect the performance to the project.

1.5 Project overview

The purpose for this project is to research, define, design and develop a mobile application to solve a real-world problem, being motivation for young adults to do more exercise by creating a automatically generating route for them to use while running/walking, while showcasing my knowledge and skills learned during my time at Bournemouth University.

This chapters focused on defining the problem as well as proposed solution, and identifying aims and objectives, scope and risk assessment.

During the project report I will be discussing various software engineering methodologies and tools to help me plan and define the requirements to properly implement needed features for the artefact. The report will also explore various technologies and tools used for implementation of the mobile application as well as testing methodologies used to make sure the app is tested throughout and properly evaluates the quality of the implementation. The report also contains different psychological concepts to increase the user experience while developing the UI, and direct explanation to the steps of how I implement the artefact.

Finally, a conclusion and evaluation will be written at the end of the project, to summarise strength and weakness of the report and artefact, with the addition of future implementations which could be added to increase the quality of the artefact.

2 BACKGROUND STUDY

2.1 Possible problem solution

2.1.1 Human Habits

Humans get into habits and routines which can be healthy or negative and a possible solution to help young adults get into good habits, this would be to help young adults get motivated to do exercise daily. This can be achieved with different psychological methods such as gamification.

(Sailer 2017) This article explores gamification and the human mind and how it can lead to greater motivations to complete tasks as it can create a feeling of rewards or getting something in return, or even competition against other users.

This can be widely used in order to create systems where young adults are encouraged and rewarded for doing healthy things which then can become normality and become part of their daily life where they no longer need the push.

2.1.2 Benefits of doing exercise

Studies have shown that working out regularly, around 150 minutes a week can increase the average life expectancy by around 7 years. (A. Ahmed 2019) Studies have also shown that exercising regularly also have other positive psychological effects such as increased positivity. Other psychological benefits of regular exercising is improvement in thinking and learning as doing exercise stimulates the body releasing various chemicals to improve the structure of your brains. (Bains 2020)

Conducting more regular exercise can help with sleep and overall tiredness as working out helps with getting a better and longer sleep, as well as reduction of stress which also negatively impacts sleeping and the energy gained from sleeping. (Bains 2020)

2.1.3 Humans are naturally lazy and need a push

This article explores how human brains are naturally lazy and would always rather pick the easier option. The example of this is that our brain will always choose the easier route to limit the amount of energy we burn. This means that we ned to go against out nervous system to expend more energy, requiring more motivation to do so. This can be solved by increases individuals will power by giving them rewards or showing progress of their efforts. (Oaklander 2015)

2.2 Solution

The task for this problem is to create an artefact (android application) which allows the user to select parameters and create an automatic route for exercise. This application would use user preferences like how long they want to run for or how many calories they want to burn to create the route and display it on a live interactive map. The map will also display the user's current position to allow them to use the map to navigate while running. The application will allow the user to monitor their calories burned while using the app to increase their motivation as not seeing progress can lead humans to get discouraged. (Wein, Ph.D. 2018)

2.3 Existing Solutions

2.3.1 MapMyRun

This application is free to use with a premium plan which unlocks a feature called workout plan, this solution has over 10+ million downloads on google app store and over 4-star rating. The application forces the user to create an account to keep data such as their weight and height to help to estimate their needed and lost weight over the use of the application. It allows to either log in with Facebook or just a standard email. The application has agreements to data collection before account creation allowing users to not have to register if they do not agree to the TOS or data collection.

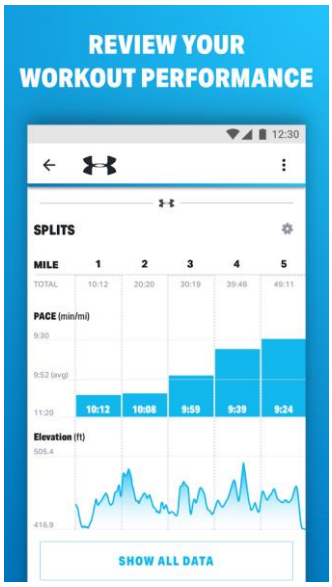


Figure 3-MapMyRun Screnshot 1 (MapMyFitness, Inc.Health & Fitness EveryoneEveryone 2021)

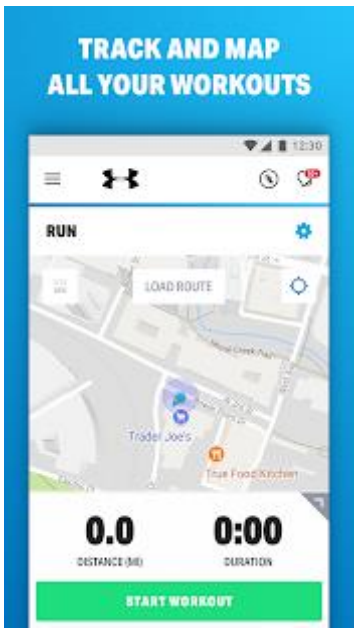


Figure 4-MapMyRun Screenshot 2 (MapMyFitness, Inc.Health & Fitness EveryoneEveryone 2021)

The overall ui of this application is remarkably simple with a simple use of the colour blue. The buttons feel responsive and are in natural positions, meaning navigation is very fluent. There are also sides rollers which enable the user to swipe information on the run revealing different data. For example, below the map there is bar which can be scrolled to swap displayed information from distance/pace/calories burnt, this is a good addition as it hides data that sometimes user does not want to see removing the visual pollution on the application, however in this case it is very hard to see that the information can be scrolled through. The bar is just white background with black text which overlaps with the background of the application there is no indication that there is text beyond what the user already sees.

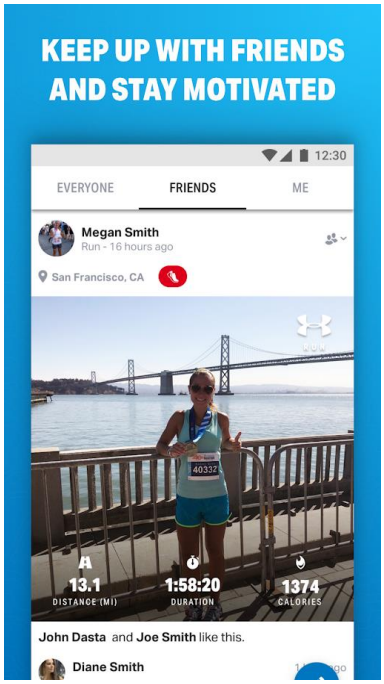


Figure 5-MapMyRun Screenshot 3 (MapMyFitness, Inc.Health & Fitness EveryoneEveryone 2021)

The application also has many over features like friends, fitness tracking and a shop as well as a vip upgrade which costs money, for a free application I have not felt like I was limited by not being a vip or seen any ads making this application a great free to use alternative. The social features of being able to add friends on the application enables users to share workouts as well as routes for running.

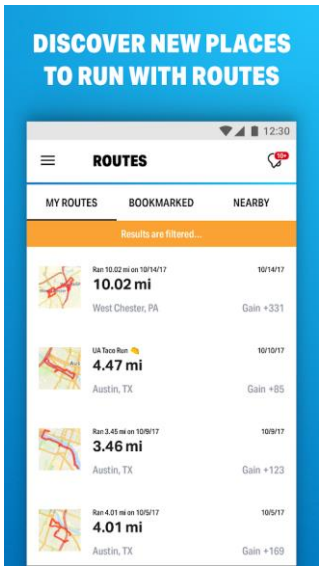


Figure 6-MapMyRun Screenshot 4 (MapMyFitness, Inc.Health & Fitness EveryoneEveryone 2021)

Overall, this application has a very good free model and overall good design, however at times the UI can feel clustered, and navigation or features are unclear to the user.

The application however is missing what my project is trying to solve, which is automatic track planning where the user does not have to think how they want to play the route but instead the program designs them a route based on their preferences. However, I would like to use the design of the My routes UI as a model for my route picking UI as it is a very good way of displaying this information in a list manner, and let the user pick a route.

Good Things	Bad things
- interactive Ui - Information is hidden smartly to reduce screen noise - Social features - Good free to use model	- UI can feel clustered in certain areas - Some features are not clear with their usage - Can only record route not generate one

Table 3- MapMyRun Comparison

2.3.2 Garmin Connect

Is a fitness application which allows the user to track their workouts calories and weight as well as monitor heart rate and record overall body performance. This solution also allows for full calendar plan of workout and activities which also can be integrated with office365 calendar to help with work and life planning around fitness activities. This solution requires a Garmin or Garmin compatible smart watch which allows of fitness tracking and use it as a workout display device.

Figure 7- Garmin Screenshot 1 (Garmin, 2021)

Garmin Connect also allows the user to browse through already created workouts from existing users and use their step-by-step plan to working out. It uses a smart watch to record and display the workout plan meaning it can be on the go.

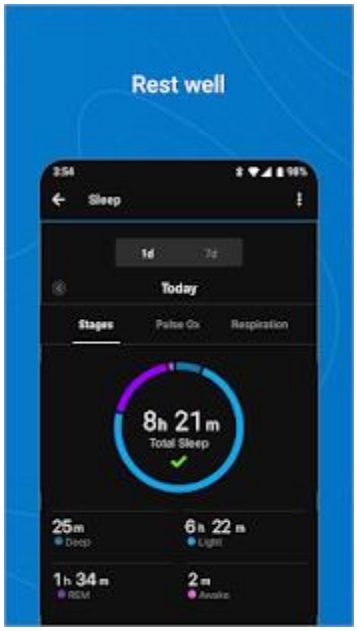


Figure 8- Garmin Screenshot 2 (Garmin, 2021)

This solution only records where the user has run/walked on top of a map, recording and displaying information such as how many calories the user has burnet, the distance runed and other information such as heartbeat recorded during different parts of the run using the Garmin smart watch.

Figure 9- Garmin Screenshot 3 (Garmin, 2021)

Just as the previous solution Garming includes a lot of social features such as groups which can be created with friends to share workouts or see activity of other people, this feature can be accessed by connecting a Facebook or google account which automatically sinks your information and friends who are also on the app.

Figure 10- Garmin Screenshot 4 (Garmin, 2021)

The big drawback with this solution is that it needs a Garmin compatible device and cannot be used with just a smart phone. This put a paywall between a user which wants to use the features which are locked without the Garming device, however they could be done through smartphone such as distance calculation for a run or number of calories burnt.

Another drawback of this application, which is a small security issue however the password field, while registering or log in is shown in plain text by default, there is an option to hide it however.

Good things	Bad things
- Modern and interactive UI - Can see friends worksouts - Can use pre created workout by other users or friends - Can sink with work schedule solutions	- Needs a external device to use - Payed features - Visible password when entering it - No auto route generation

Table 4- Garmin Comparison

2.3.3 Route Shuffle

Route shuffle is a website which generates automatic route for running walking or cycling. It allows the user to input desired distance to run and select their preferred way or exercising. The website then generates the track, with arrow direction in which way the user should path towards.

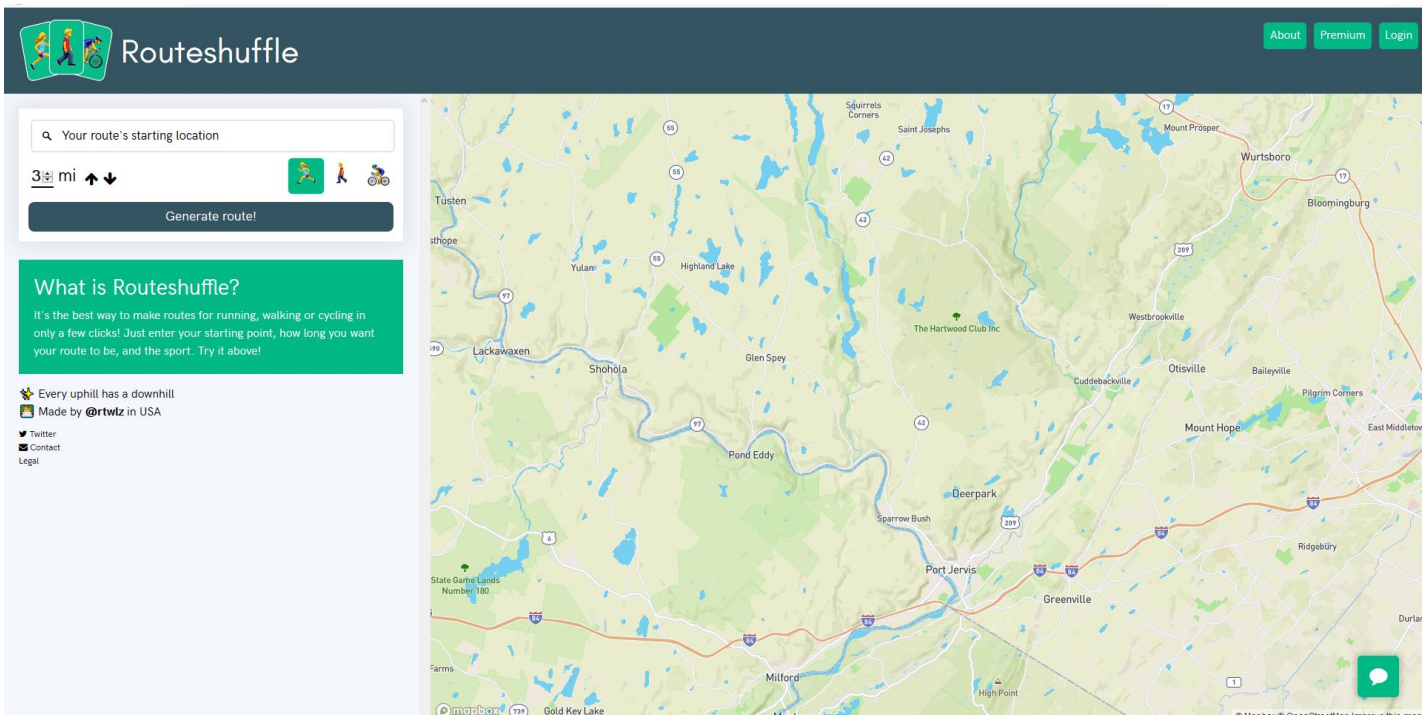


Figure 11- RouteShuffle Screenshot 1 (RILEY 2021)

Generated routes have arrows on them pointing to the direction the user should take.

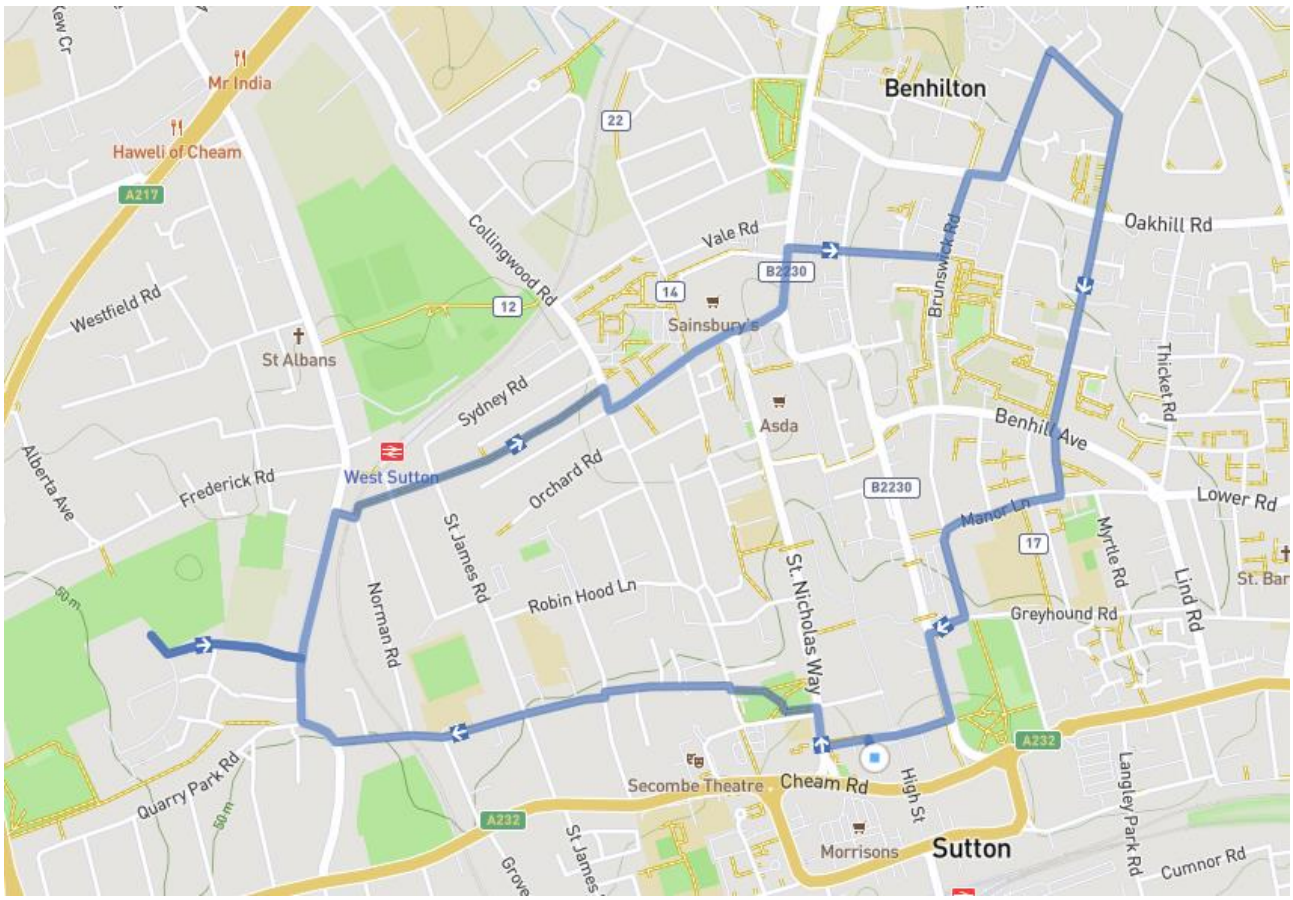


Figure 12- RouteShuffle Screenshot 2 (RILEY 2021)

There is a premium subscription of 5$ a month to unlock certain features such as being able to saving the route, exporting it to external applications or emailing randomly generated routes on specific days of the week.

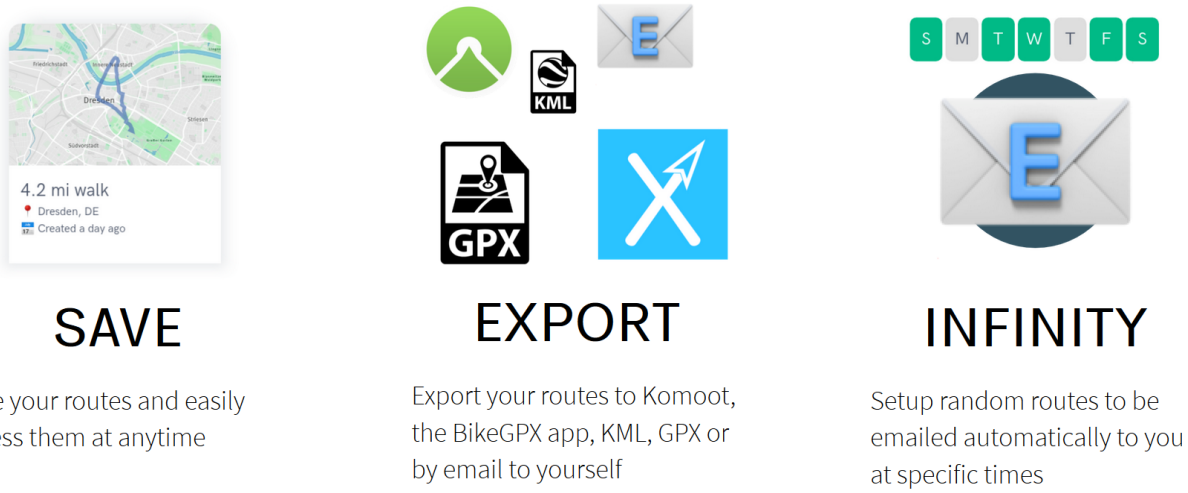


Figure 13- RouteShuffle Screenshot 3 (RILEY 2021)

The application however falls short by not being an application and including navigation as it is inconvenient to have to rely on third party application to be able to map out the route for exercising. This is especially bad for a free user as there is no way to export the generated route without paying for it.

Good things	Bad things
- Straight to the point design easy to understand and user friendly - Lines have directions - Have different modes for running walking or cycling	- Need to pay to export the directions - Need to use third party to navigate the route - Not an mobile application - Doesn't cover how many calories user will burn -

Table 5- RouteShuffle Comparison

2.4 Design Phycology

2.4.1 User Experience

User experience is a definition of how the user uses and what they feel while using a product. UX can be used for certain psychological effects such as increasing the likelihood of a user to purchase something of the website of recommend it to others due to them having a good experience with the product. (The Interaction Design Foundation. N/A)

2.4.2 Donald Norman

I have chosen to create and evaluate my design based on the Design Principles from Donald Norman. This will allow me to create UX and UI which is easy and comfortable to use for the user. To create my UI I will pay close attention to the 5 aspects of design principles defined by D Norman. These principles are called Visibility, Feedback, Affordance, Mapping, Constraint and Consistency. (Enginess 2021)

2.4.2.1 Visibility

This stands for the clarity and speed at which the user notices an element or a feature. The concept is that the more the function is visible then easier it is for the user to know what to do next. (Enginess 2021)

2.4.2.2 Feedback

Works by allowing the user to know that an action they have taken worked or notified them of something happening with in the system. This could be things like buttons making sound after being pressed to signify that the system is working on the next request, or a loading bar allowing the user to know that something is taking time to load onto the screen. (Enginess 2021)

2.4.2.3 Affordance

Is similarity or designing things that would be natural or standardized for users to use, a blue highlighted text on the screen usually signifies that it is a hyperlink linking it back to some information or webpage, or a play button letting the user know that the element is a video which can be played by pressing it. This concept works by giving the user a clue to what the functionality of the UI is. (Enginess 2021)

2.4.2.4 Mapping

This stands for the relation between a control and their effect, for example a burger menu when pressed will show an extended menu which can be used by the user, or an arrow pointing downwards would usually mean that the screen or element will move down. (Enginess 2021)

2.4.2.5 Constraint

Is a principle in which the developer limits what the user can do to reduce the chance of the user doing something wrong and breaking the system or application, by for example inputting wrong illegal characters into a search bar which would cause a database error it is easier to just not allow the user to type those characters. (Rekhi 2017)

2.4.2.6 Consistency

Refers to making the elements and features the same looking to keep the user knowledgeable of the steps they can take, and how they can interact with the application, for example each button should look the same for the user to instantly be able to recognize that that is a clickable button once they move to another page. (Rekhi 2017)

2.4.2.7 How I will use these principles

I will use these principles to base my UI design on to make sure that the user experience while using the application is good and to improve the overall quality of the application. By taking into count these principles it will allow me to build UI that is easy and familiar to use due to function of the application being very easy to use and recognizable.

2.4.3 Thumb Zone

Thumb zone is a design concept which works by taking in consideration a heatmap of a phone, or device which records the accessibility of the screen in terms of reachability of, in most cases your thumb. This is used to create UI that takes in consideration user experience to make UI that places most used features in areas in which the user does not have to stretch or use extra effort to reach. (Cardona,2019)

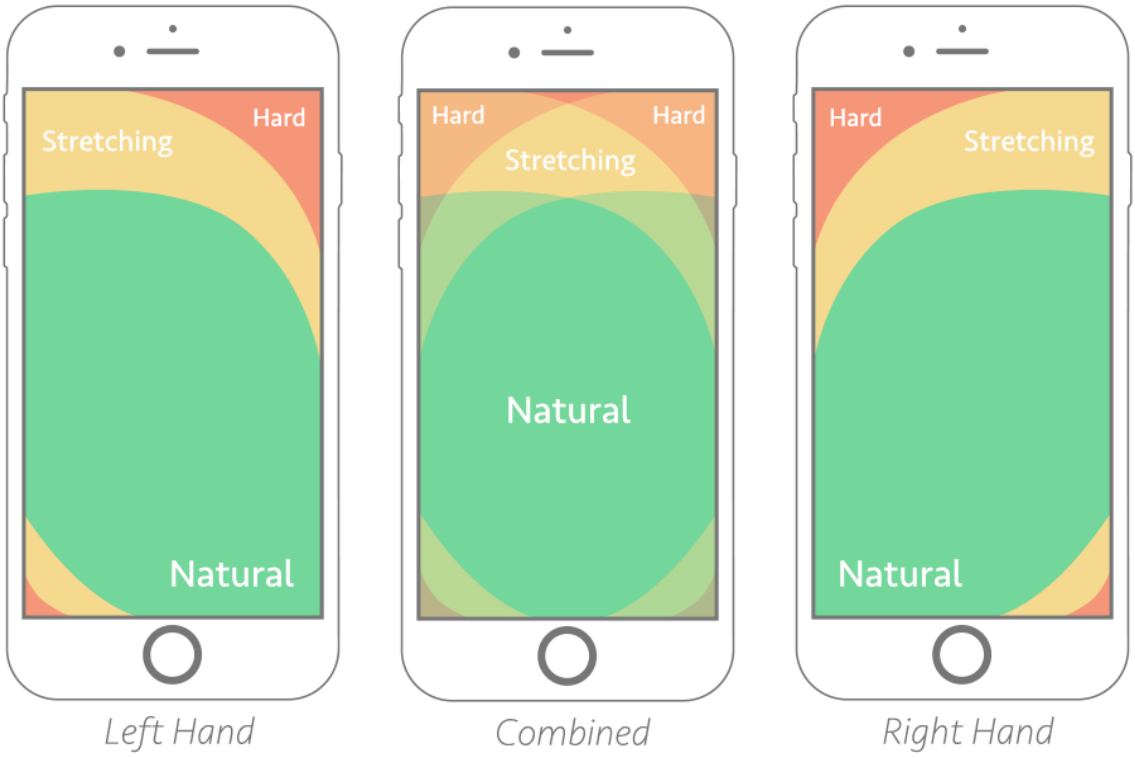


Figure 14- ThumbZone (Ingram 2016)

2.4.4 Scalability

In terms of device UI it means the scalability of the UI on different devices with different size screen.

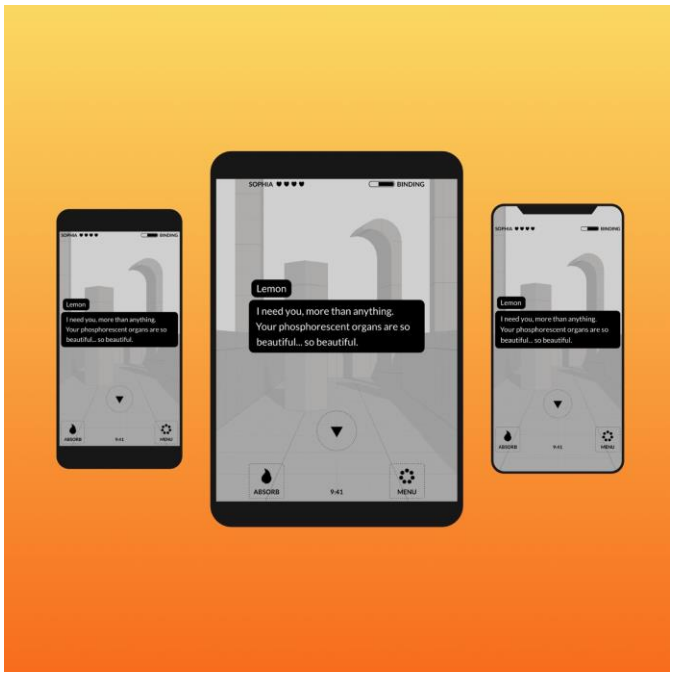


Figure 15- Scalability (Ocias 2017)

To make my application compatible with different android devices, as there is so many, I will make sure my UI is scalable by designing it in a way where the application takes the screen size and places elements by a % value away from the screen edge, same will be done for size of the elements. To help with this I will start my application on a smaller screen size meaning that there will only be more space added not taken away, this prevents UI elements being too close to each other or overlapping. (Lehtimaki 2015)

2.4.5 Fat Finger Syndrome

Having more white space on the screen can also prevent the fat finger syndrome, fat finger syndrome in terms of UI design is where a user accidently miss clicks something because either the ui elements are too small or too clustered together. (UX247 2019) This can be avoided by

taking into count the average size of a thumb and making sure to scale ui elements and design enough white space in between elements for them to be separated enough from each other to avoid miss clicks.

2.4.6 Wireframes

A wireframe is way to prototype a design and layout of a page, placing needed elements onto the page to plan the structure. Creating a so-called screen blueprint to make sure that the design meets the requirements needed for the application. These are used to apply different psychological concepts to together create the best possible user experience. (Climer 2021)

Wireframes are important in software development as they not only allow to visually and conceptualise needed elements and styling, they can be used as a way to communicate the project idea with stakeholders and up management.

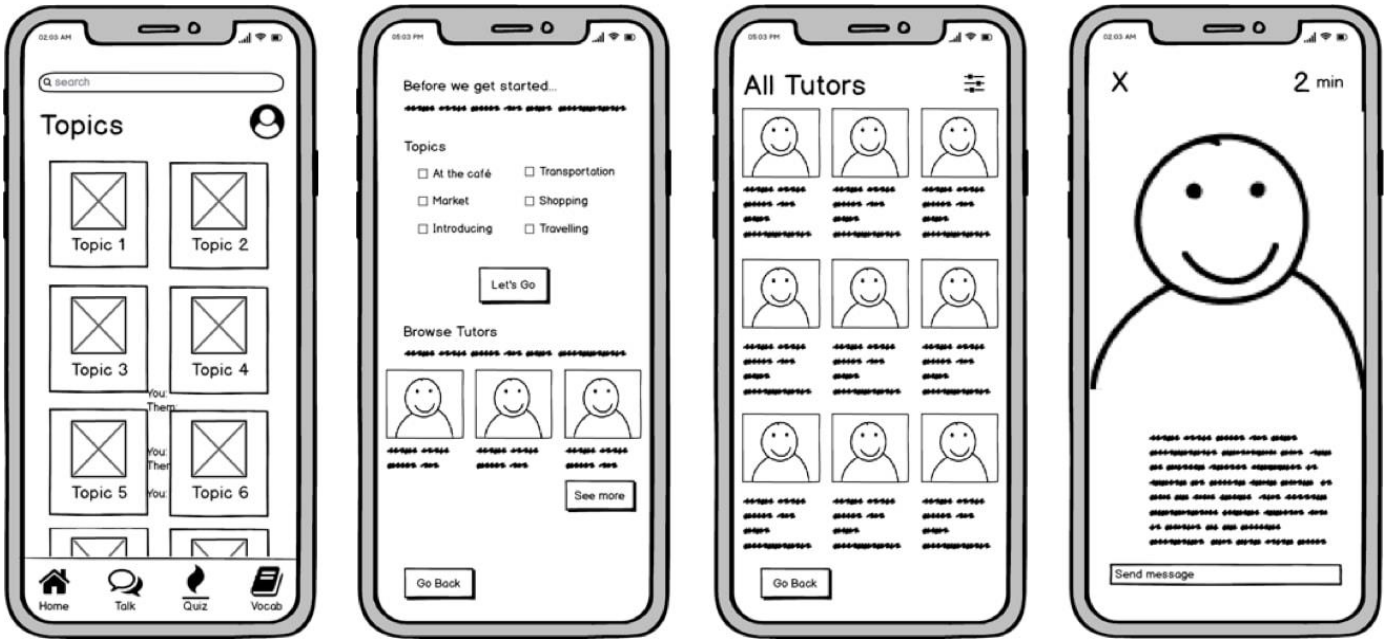


Figure 16- Wireframes (Lu 2021)

2.4.7 Gamification

Gamification is a process in which applications are given game like features to attract the audience attention and make sure that they come back to the application. This can include things like leader boards for top users or achievements. This is used a phycological trick to get users addicted to using the application. Things like beating high scores or competing on a leader boards with friends or even earning achievements can make a user want more and come back to the application more often. (The Knowledge Arcade 2021)

I am not going to use this in my application as it is currently out of my scope of the project to include these like features however things like achievements would have been a welcome addition to add to the application as it could get more young adults/teenagers to come back to use the application to do more exercise and see how many achievements their friends got. (DUPERRIN 2012)

Another reason why I'm not including gamification in my project is that it is very hard to implement properly, especially with a fitness application it can create a lot of negative effect such as stress and frustration of not being able to achieve something or comparing yourself to others to hard, as each body and person is different and has different limits.(Marczewski 2014) It is best to avoid creating direct competition between two users with physical workout as it can lead to not only psychical health issues but mental issues as well and possible have the opposite effect of discouraging the user

2.5 Geolocation

Geolocation is the identification of a geographic location of a user usually collected by a computer or a device from a GPS services. This data is usually displayed in latitude and longitude which are the measurements for locating a position on a global by using these spherical coordinates. A diagram of this can be seen in the figure below. (Encyclopaedia Britannica 2008)

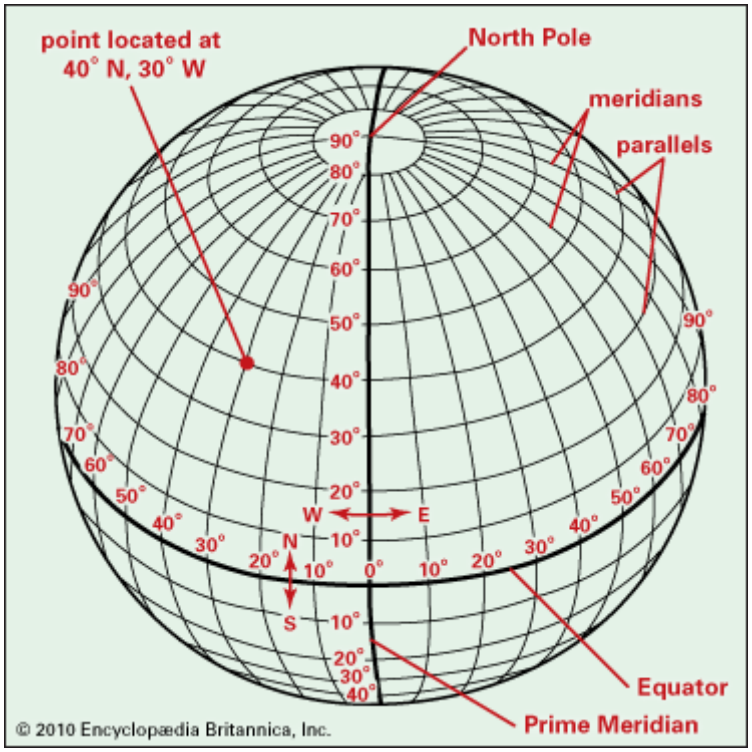


Figure 17- Sphearical GeoCoordinates (Encyclopaedia of Britannica 2010)

2.5.1 Haversine

To calculate distance in meters from longitude and latitude we use a formula called Haversine formula which converts distance from latitude and longitude in meters by taking in the count of the radius of earth. (geospatial 2017) This will be used to calculate the distance walked by user in my implementation.

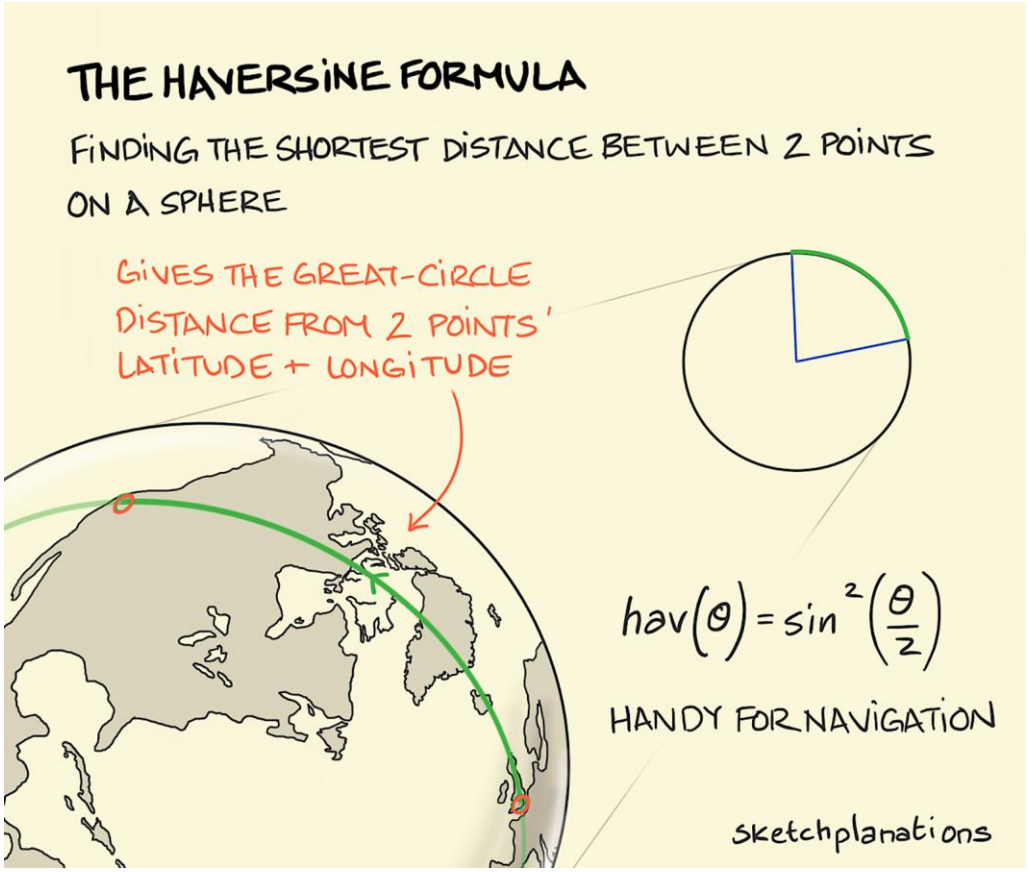


Figure 18- Haversine Formula (sketchplanations 2021)

2.5.2 Williams's aviation formula

To do the opposite we use Williams's aviation formula which converts meters into an offset that can be added to latitude and longitude within the accuracy of 10 meters by converting meters into radians offset which then can be calculated into latitude and longitude. (williams 2021)

2.5.3 For my implementation

For my implementation to calculate the distance chosen by user and generate lines from it I am going to calculate the distance into latitude and longitude.

To calculate latitude, It is simply:

Radians offset = Distance in Meters/radius of earth.

To add the radians offset to users position it Is:

Users position latitude + offset latitude*180/pi

To calculate longitude

It is distance in meters/(radius of earth*cos(pi*original user position latitude/180))

To add the radians offset it is the same as latitude

Users position longitude + offset longitude*180/pi

3 3 REQUIREMENT ANALYSIS

3.1 Requirements

Requirements are a fundamental part of software development as they act as a specification and plan, as well as an objective needed for the developer or a team to fulfil to make the right software which fulfil its needed purpose. Requirements are usually made by the development team with the help of user stories and are consulted with the stakeholders and clients as well as upper management to keep track of progress.

Requirements can also be used for as scope control as they allow for clear direction and feature set needed for the project. Requirements can also act as documentation for the project for maintenance as well as refactoring making it an important document during design, implementation and post release of the project.

There are two main types of requirements Functional and non-functional which both serve different purpose in specifying the design and needs of a software application in order for the system to meet the required and contracted needs.

3.1.1 Functional requirements

Are the things that the end user demands and requires from the system. These are things like being able to order a specific car part. These “objectives” are needed to be incorporated into the system as they are the baseline features needed for the software to fulfil it peruse. Functional requirements are usually displayed by and input and desired output.

3.1.2 Non-functional requirements

Are requirements which are objective which the system needs to fulfil in order for the system to be used the end user, which deals with things like portability, security and maintenance. This is usually defined as the quality of the system, which is measured by a metric for the system to meet in order to fulfil the contract.

3.1.3 MoSCoW

Is a requirement analysis technique works by placing importance on specific design features and in this case requirements. This technique can be used in other fields then software development however it is commonly used to define importance of critical features and helps with coming to agreement and improve understanding of importance of features in the project with stakeholders.

This technique works by creating 4 groups: Must have, Should have, Could have and Wont have. The requirements in this case will be separated into those four groups and done in order of importance to make sure all required features are implemented to the best standard and the scope of the project does not change due to the time constraint by implementing features that do not have high importance or priority.

3.2 Requirements from the users point of view

This was done to get a better understanding of users needs to better refine requirements.

ID	I want to be able to	So that
1	Create and account and log in	I can see my progress on the app
2	I was to be able to generate a route	I can run the route and see how many calories I have burnt
3	I want to see the route I have taken	To review my progress as I exercise and see the path, I have taken
4	I want to see past routes	To see how many calories, I have burnt or select the same route
5	I want my data to be safe	To make sure that my data can stay private
6	I want to see my calories burnt after a run	To see the progress of my work

Table 6- Requirements From User Point of View

3.3 Finished Requirements

Id	Requirement	Moscow Priority	Type
1	Display interactive Map	Must	Functional
2	Direction Line generation and display, based on user input	Must	Functional
3	Implementing Haversine and Williams aviation formula	Must	Functional
4	Get user location	Must	Functional
5	Account Registration	Should	Functional
6	Login system	Should	Functional
7	Moving user location calculated and displayed on the map	Should	Functional
8	Api which can send queries to database	Should	Functional

	and receive data to be fetched by the application		
9	MySQl Database Server	Should	Functional
10	Scalable UI	Should	Non-Functional
11	Application of Design Psychology	Should	Non-Functional
12	Log out	Could	Functional
13	Calorie calculator	Could	Functional
14	Password Encryption	Could	Non-Functional
15	Https data Transfer	Could	Non-Functional
16	Past routes/history of runner routes	Wont	Functional

Table 7- MoSCoW Finished Requirements

4 PROJECT METHODOLOGY AND TOOLS

4.1 Methodology

4.1.1 Scrum

Is a project methodology in which utilizes agile methodologies to produce, deliver and maintain complex projects, this methodology although used in other professional fields it is mostly used in software development.

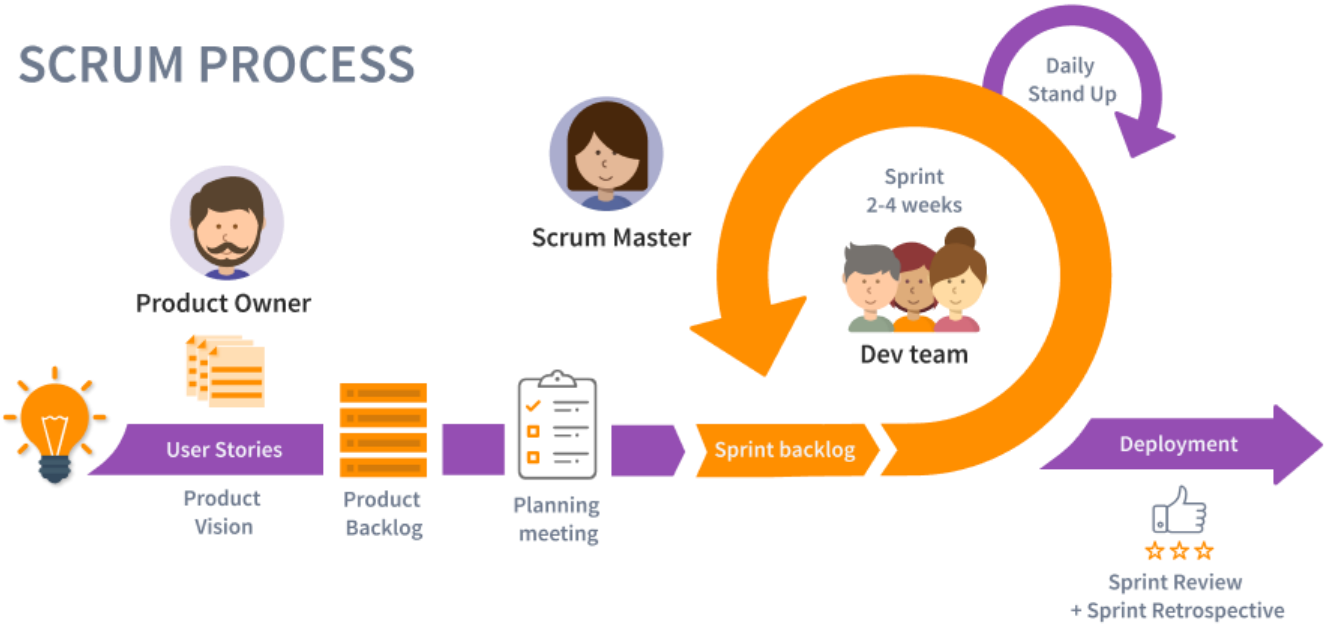


Figure 19- Scrum(tuleap 2021)

Scrum works by planning out review meetings which are weekly, making the team talk about their progress over the week and any issues with the project or that may incur. This methodology calls these meetings sprints, and after each sprint there is a review of the project and progress of developing and implementing of the feedback that was discovered during the sprint. This is repeated usually every week until the project is complete, and artefact is developed to set standards. (Scrum 2021)

The general steps for scrum require someone who is the leader, called scrum master, the leader keeps the order as well as reviews progress during the meetings. However, he is not responsible for any decision making, meaning that scrum master is usually someone from outside of the business hired to keep track of progress and order. (Scrum, Master, 2021)

Product owner who writes the specification and what needs to be done in the project into the project backlog. This includes communicating what needs to be developed and talk about the project goal. Product owner also has the responsibility of making sure that the product backlog is clearly communicated and understood by everyone in the team. (Scrum Product owner 2021)

4.1.2 Waterfall

Is a project management methodology is where tasks are ordered into a linear sequence, creating phases. Each phase depends on the deliverable from the previous phase. Phases are usually split into planning, development, testing and delivery phases. Waterfall aims to complete a single project usually with a small scope. (Project Manager 2021)

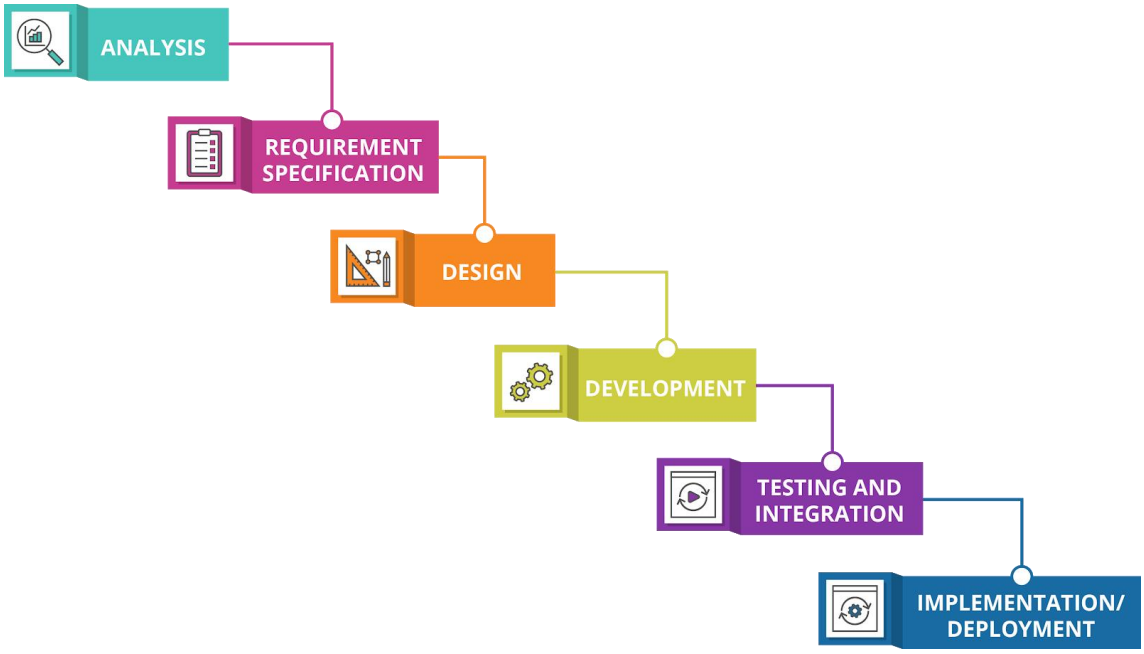


Figure 20- Waterfall (Waddell 2019)

The advantage of waterfall is that is a very simple methodology to understand and use. However, due to waterfall being a linear sequence methodology meaning that each phase is worked on in order step by step, leading to the quality of the deliverable for each phase rely on the phase before. This also means that it is very hard to go back and correct or change something without having to change everything meaning that waterfall it not friendly to changing requirements and scopes meaning it is only suitable for small project withs clearly defined requirements and goals (Tutorial Points 2021)

4.1.3 Kanban

For this project I decided to use Kanban, Kanban is a project management methodology which works depending on a Kanban board schedule which allows the team to monitor progress. Kanban board allows to balance demand and availability of work schedule spreading resources and making sure the team stays on schedule. (Smart Sheet 2021)

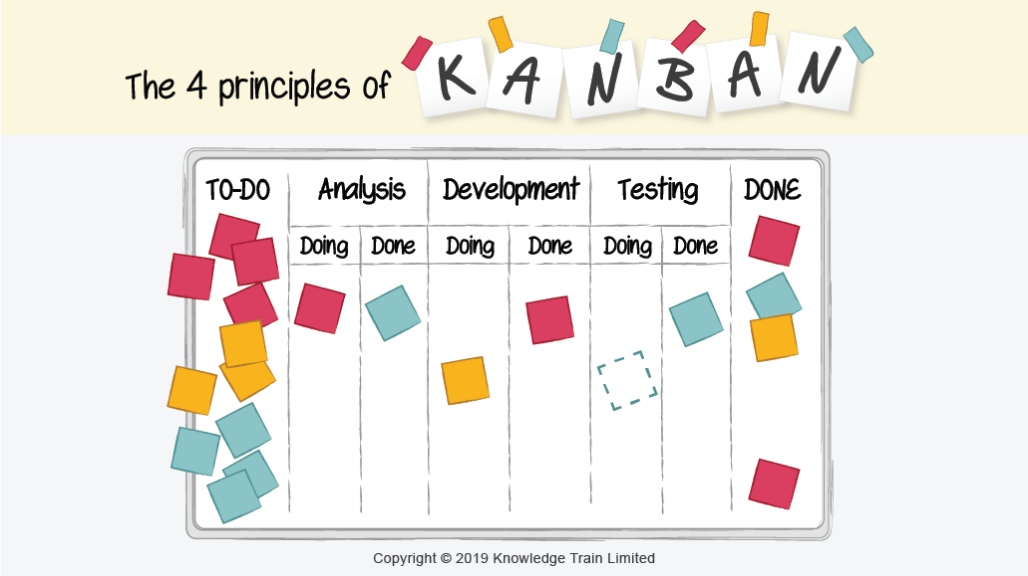


Figure 21-Kanban (Knowledge Train Limited 2019)

The above figure shows basic layout of a Kanban board. The board is usually split into sections, to do, progress and done which allows for monitoring of what needs to be done and what has been done already keeping a track of task.

The reason it was decided to use Kanban for this project as it allows me to create plan and schedule in which different elements of the project should be done as well as organize my workflow. Another reason why Kanban was chosen is that it works well in small teams or in a team of one as it does not require meetings such as scrum sprints. Kanban is also flexible with changing requirements as it is easy to add and remove features without having to go back in development like waterfall.

My Kanban board:

Figure 22- My Kanban Board

To create Kanban board, It was decided to use a free solution called Trello. This website allows for interactive board making, with moving note elements which can be moved to different categories.

It was decided that review meetings will be held every week by using Kanban as review of progress and things needing to be worked on, as well as create a future plan of things still needed to be implemented.

4.2 Test methodology

To evaluate and test my application I will use test cases generation methods like equivalent partitioning and boundary value analysis which I have learned in Software Quality and Testing.

To test my application, I will be using forementioned equivalent partitioning which works by making smart guesses for partitions which act as groups, the methodology works on the assumption that each number tested in the partition is going to give the same results. For example, any number between 1 and 9 is going to give the same result and same for 10-49. This methodology works without guidelines, there is not clear indication on what the partitions should be, mostly depending on the scope of the application and how critical it is.

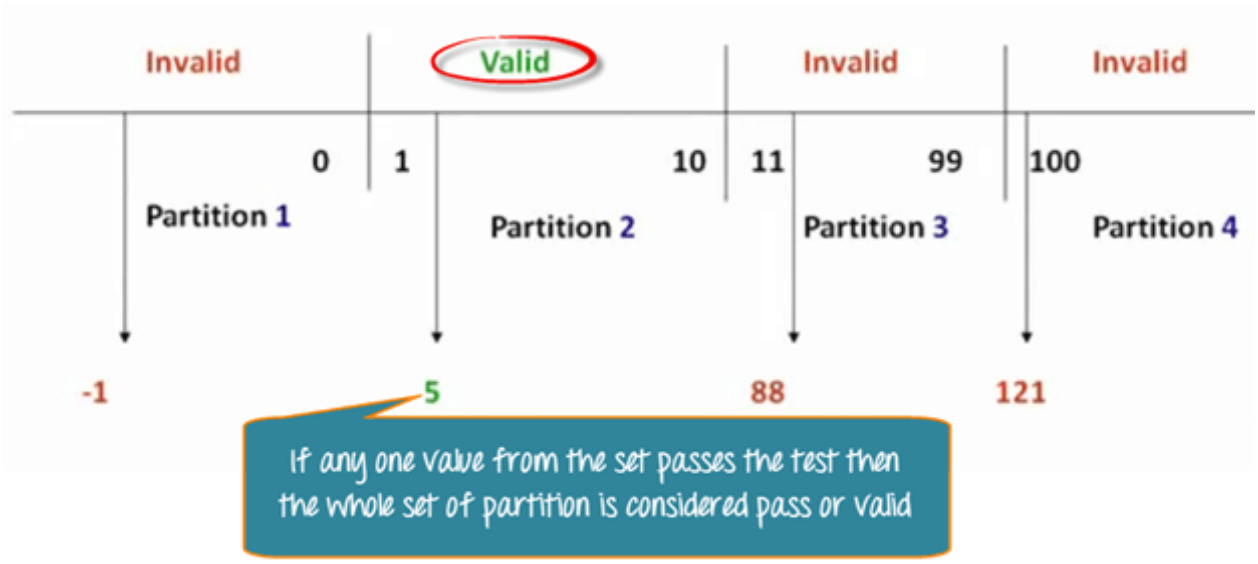


Figure 23- Equivalence partitioning (Guru99 2021)

Together with equivalent partitioning I will be using boundary value analysis which works on top of equivalent partitioning and uses its partitions to test both side extremes of the group. This testing method is used to further verify the integrity and usefulness of the partitions as well as increase the testing coverage.

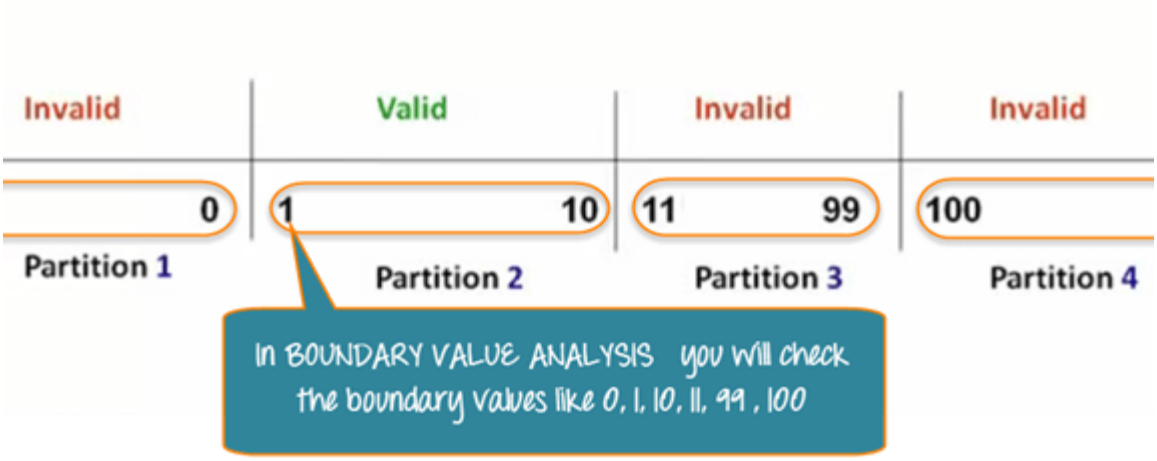


Figure 24- Boundary Value Analysis (Guru99 2021)

For my last testing method, I am going to be using error guessing, this is simply a technique in which the tester writes tests based on experience. I have chosen this technique because of the scope of the application, meaning that there will only be a limited number of tests needed to be written to cover most of the application. These tests can be written based on experience as well as knowledge of what is likely of causing errors. These tests will be recorded in a test case table and a separate defects table.

Testing will be used to evaluate the overall performance of the application as well as testing for the quality of the application.

4.3 Tools

4.3.1 Tools and Technologies

4.3.1.1 Python kivy

Is an android/windows gui development tool for python, which functions on its own styling scripts which are written like xml with backend running on python. (Kivy 2021) This package works on rendering the UI view in opengl to enable the developers to be able to see the preview of the UI. There are many advantages to Kivy for example its back end running on python as it allows for familiarity and integration with already running solutions. Python is also one of the most supported and popular programming languages currently with great support for third party libraries. There is a big draw back to Kivy as it is very complicated to get a apk file render which works on mobile needing a third party application packer which can only be used in Linux. Meaning that the solution is not very well supported, and after running a few tests It was decided not to use this solution due to problems of getting the application onto android.

4.3.1.2 Kotlin

Is a programming language which can be used on different platforms, Koltin is designed to work together and alongside with java making it easy to incorporate into existing applications and frameworks which already work on java. (Kotlin 2021) The benefits of this programming language are that it works inside android studio making it easy to develop and deploy as well as render almost instantly onto android. This enables for fast development and correction of mistakes and deployment of prototypes to test ui and specific elements of an application system.

4.3.1.3 JavaScript React native and expo

is a developing foundation and framework which works on top of JavaScript to develop android/JavaScript applications with the ability to fast-host and deploy the application live into a phone or emulator. (Expo 2021)This package allows developers to program within their own environments not needing specific tools like android studio, but instead can code from visual studio code or notepad++. Another advantage of this solution is the portability and interpretability as it is programmed with JavaScript many packages and tools which work with JavaScript also work with expo making library is more accessible to the developers.

React native also has an open community allowing the developers to download ui packages allowing for quick ui solutions such as quick deployment of a google map which I will be using to display directions onto.

React native styling language works by assigning a style sheet to a view or an element which is then rendered using expo to be displayed on the phone.

```
TopView:{
  flexDirection:"row",
  width:220,
  height:50,
  marginHorizontal:100,
  alignItems:"center",
  justifyContent: "space-evenly",

},
```

Figure 25- React Native Example

(Figure : React Native StyleSheet)

This styling is very simplistic in nature and allows for great customization of elements, react-native allows for size to be created by scale allowing the elements to automatically scale to window size meaning that it can be easily ported to other devices. (React Native 2021)

For this project I decided to use React native as this solution allows for fast deployment into android and live running environment allowing me to see changes and how the application looks on real android in real time without much compiling. The reason it was chosen over Koltin is my familiarity with expo as well as the easier UI styling. React native also holds many free, open-source packages which can allow for faster development of specific application features like in this case google maps. I also have a better understanding of JavaScript allowing me to develop backend logic faster and with less likely hood of error which makes it a better choice for time constraint on this project.

4.3.1.4 Third party Library's

React native Maps is a react native library which enables the developer to quickly layout a google map view inside a view element and render it onto android view. This map can be customized with parameters to change map size, lock location or zoom etc... This solution also comes with extensions to the map such as placeable and interactive markers which can be used to highlight points on the map. (mikehardy 2021)

React native Maps Directions This is a module which builds upon the previous library by using google directions Api to display a route between two placed markers. This solution requires a google Api key, which I have acquired by using the google Api trail for 90 days. The “polyline” can be customized and changed based on the developer's choice. I have decided to use this solution

as it allows me to not have to directly interact with the google direction Api, saving me time as I do not have to go through the trouble of drawing and extracting the undecrypted polyline information from the Api. (karimcambridge 2021)

4.3.2 Api and Server Technology

4.3.2.1 Node.js

Api(application programming interface) is software solution which allows two application to communicate with each other. (MuleSoft 2021)This is usually done over the internet, by http which is a protocol for transferring information between systems. The Api application can be used as a middle man to send queries and receive data from an database.

To create my Api and server It was decided to use node.js as the back-end programming language and technology. (node.js 2021) The reason node.js was chosen to create the back end is that it is a very scalable solution, enabling for easy expansion when needed. Node.js allows for easy implementation of https requests to allow other application to fetch data through a safe gateway. Node.js is also very light weight making it easily runnable on basic developer machines negating the need for an external server for the use of testing. (Karczmarczyk 2019)

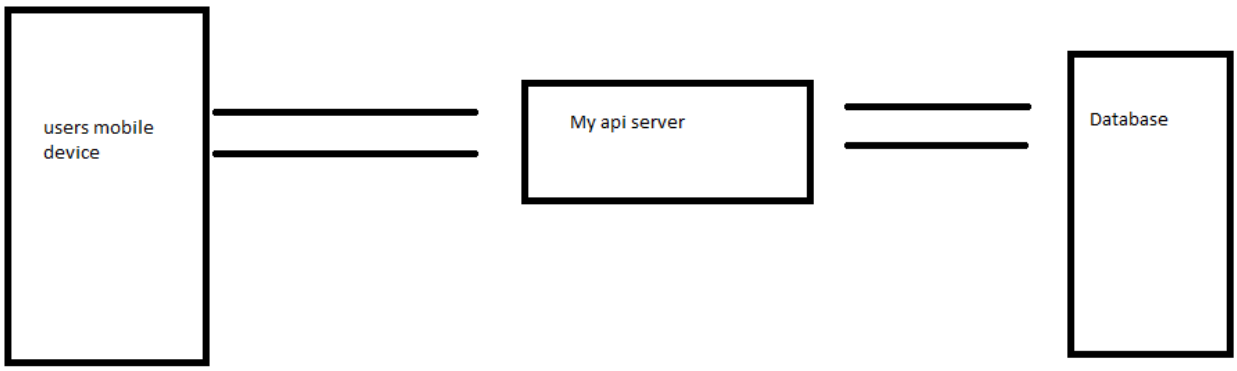


Figure 26- Api to User Diagram

The package and modules used for a node server are all compiled inside a normal directory making it very easily portable from machine to machine or an external server when needed.

4.3.2.2 Third party Libraries

Express is an extension tool which enables developers to quickly develop and deploy a web API. (Expressjs 2021) This works by defining and creating a router to allow the server to handle http request over internet connection by reaching a specific url. This is done by creating endpoints which can be reached with different urls to get responses.

MySqI2 this is a node.js module which allows for connection and use of query passing into MySQL server database from node.js server. (sidorares 2021)

Body parser is a middleware module for node.js which works together with express to extract data from a http request stream and translates it to a javascript object which can be accessed through a parameter called req.body. (dougwilson 2019)

4.3.3 Platform

For this project I was decided to use Android as my main platform that I will be developing. This is due to the time nature and time constraint of this project allowing me to only work on one development platform. Android was chosen as because not only does it allow me to test in real life as I am and owner of only an android phone it also has a bigger market share. Currently 71.9% of the human population who own a smart phone use android which makes it take priority in development. (StatCounter, 2021) Android is also a lot easier to develop and release on the google store as it can be quickly packaged and released to the google store.

Another reason I have chosen Android is that in my experience I have only worked with android devices and application for android making me more familiar with the structure and how they should be compiled and how the UI should be designed to keep consistency. Final reason is that there is a lot more third-party libraries and packages for the Android making it easier to import APIS and helpful tools as the development platform for Android is more open and bigger in the programming community.

4.3.4 Repository and version control

For this project I decided to use to use github as the main tool for version control, to mitigate the risk of losing data as well as keep stable version of the artefact while developing. This is a free solution for students and was chosen also because of its ease of use.

4.3.5 Database

For this project I decided to use MySQL as it is a free community solution with easy to setup server hosting, making it fast to learn and set up on the go. The reason for choosing MySQL compared to Mongo DB for example is the control and the light weight of the database meaning that I can be run anywhere even on a developer's computer making it easy, to create tests and changes during development and allows for good portability for when the server needs to run online on an external server.

5 IMPLEMENTATION

For development of the application, I will use a weekly review approach in which at the end of every week I review my progress using the Kanban board and requirement checklist. This will ensure that my progress on the application is consistent and helps me with keeping my time management to meet the final deadline of the project.

Due to the nature of the project, I have decided that I will implement my back end with very simple UI solution first, and then style the UI to need of the application, I have decided on this as I have gotten a very good idea of the elements needed for the application as well as the nature of the project meaning that requirements can change, and implementation of the UI can become obsolete due to changing of the back-end solution.

I have created this Wireframe to help me visualise the application and allow me to quickly assemble screen with needed elements to visualize and apply design principles and psychologies into the user experience.

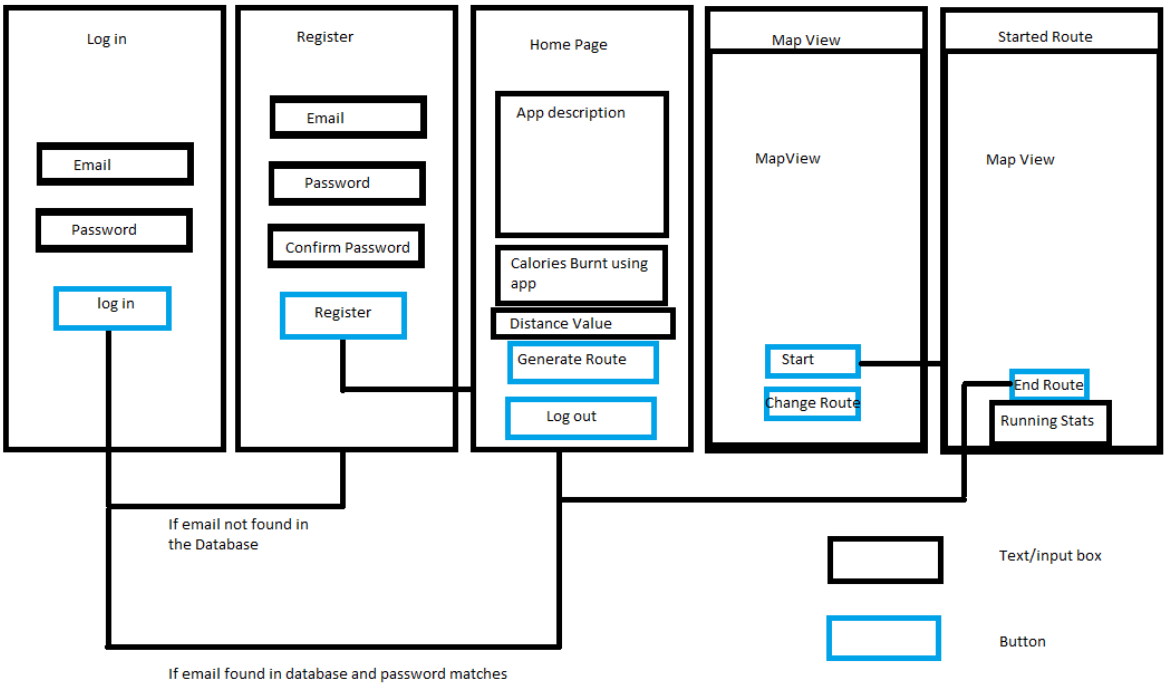


Figure 27- My Completed Wireframes

I have created a simple communication diagram which helps me visualise the data that's transferred and where it comes from:

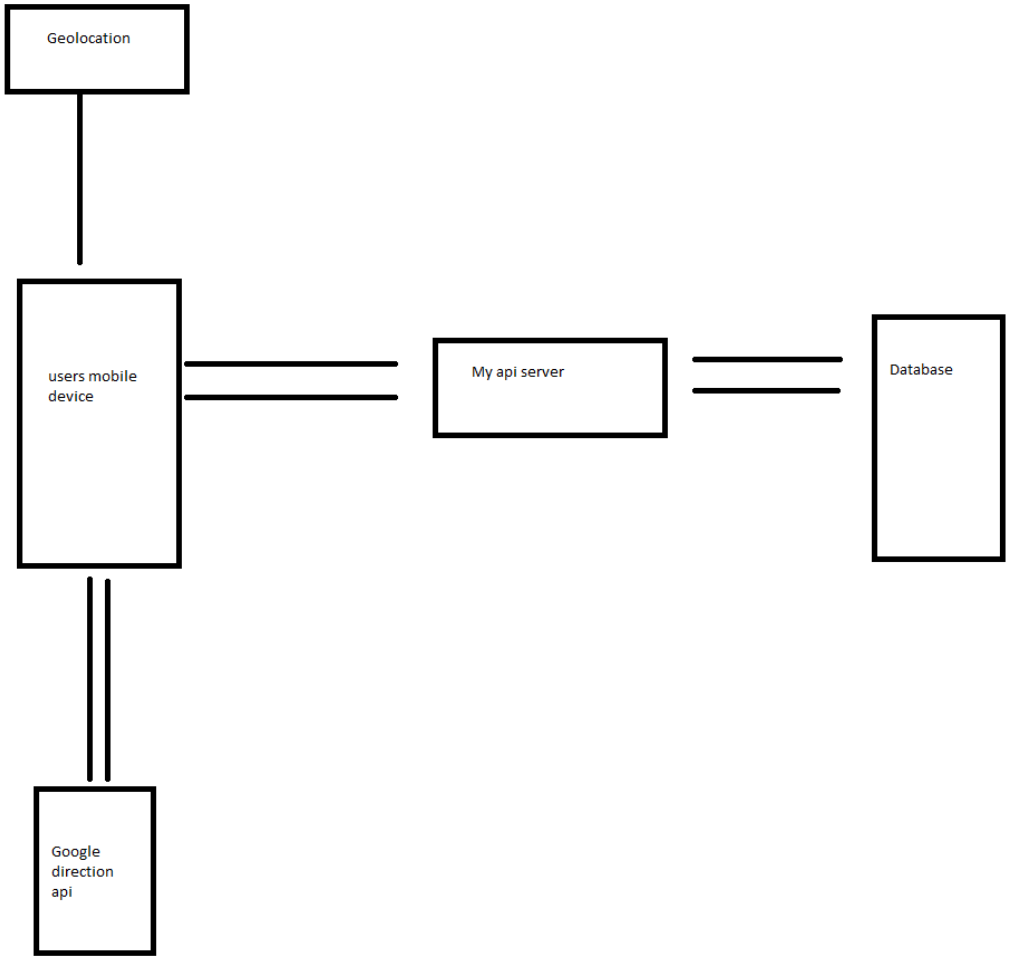


Figure 28- Completed Data Transfer Diagram

5.1 Week 1

5.1.1 Plan

For this week, I have started to prepare the working environment by creating an expo application, as well as installing needed packages and set up needed screen for my application with simple navigation buttons and display a map as well as a simple line to display 1 direction.

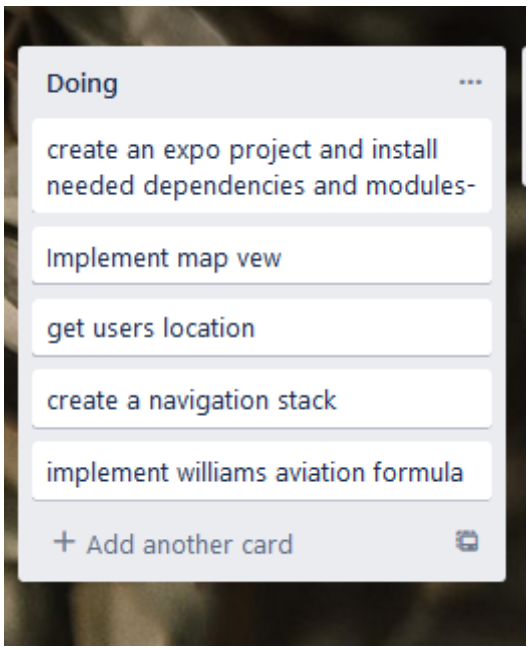


Figure 29- Kanban Plan week 1

5.1.2 Implementation

To start of the week, I have made a simple MySQL database server, which is hosted on my local machine currently for the ease of access and changing in case any modification needed to be made to the server. On the hosted database server, I have created a simple table which contain id which is the primary key of this table, email, password, calories burnt and DOB. Currently there is only 1 table in the database as the complexity and scope of the database is quiet small meaning that there is no need for separate tables, however this can change if the scope of the system changes or other additions are added such as being able to see the history of run tracks.

To Start implementing my application I have started by creating an expo structure, with “expo init projectName”, this ensures that all required dependencies and scripts for the project to run are installed inside the workspace.

In the first set up of the system I have created for now the 3 most important files to create the basic navigation and structure to the application, the app file, the homepage file and the map file. The app file contains basic navigation stack which can be seen in the figure below, this stack is created by importing each of the files into the main app file which allows the other files to be connected without needing to repeat the process on each file.

```
const Stack = createStackNavigator();//create a navigation state

export default function App(){


  return (

    <NavigationContainer >
      <Stack.Navigator>

        <Stack.Screen
          name="Home"
          component={HomePage}
          options={{headerTransparent:true,headerTitleAlign:"center",headerStatusBarHeight:30, headerLeft: ()=> null}}
        />
        <Stack.Screen
          name="map"
          component={map}
          options={{headerTransparent:true,headerTitleAlign:"center",headerStatusBarHeight:30}}
        />
```

Figure 30- Navigation Stack Implementation

This way to move around the application it will be as simple as calling the stack and referencing it with the prop navigate, this can be seen below.

```
navigation.navigate("map",{ lat:latitude,long:longitude,dist:dist})
```

Figure 31- Navigation Example Implementation

The application uses geo location to determine users location, this is necessary for the application to run, however in android this is not enabled by default for each app meaning that the application need to ask permission from the user for it to be able to read the users geo location. The react native implementation can be seen in the figure below. This function will later be used on the maps page to get the reading of the user's location.

```
async function locationPermission(){

  let { status } = await Permissions.askAsync(Permissions.LOCATION);//ask user permission fo
  if (status !== 'granted') {//make sure that if the user didnt give permission the applicat
      this.setState({
      errorMessage: 'Permission to access location was denied',
      });
      }

  }
```

Figure 32- Location Permission Implementation

The last implementation I have done this week was a first simple implementation of the map, by using react-native-maps. The basic implementation of an interactive google maps in react native

with this library is very simple and requires just one element with added parameters to style the map such as starting location and zoom.

There are however more complex parameters which can be added to the map such as, camera zoom lock and orientation. There is other, things that can be done with the react native map such as animating movement which I will be using to create directions, meaning that the camera will follow the user's location so they user knows where to run. This will be implemented in week 4, however appropriate set up has been done such as setting up as state to reset the map, to better plan out this feature as it will give me time to think of the implementation.

5.1.3 Week 1 Review

To review the progress made this week I will be checking requirements completed and progress with updated Kanban board.

Requirements completed this week:

ID1

1	Display interactive Map	Must	Functional

Figure 33- Requirements One Completed

ID4

4	Get user location	Must	Functional

Figure 34- Requirement 4 Completed

Kanban board progress:

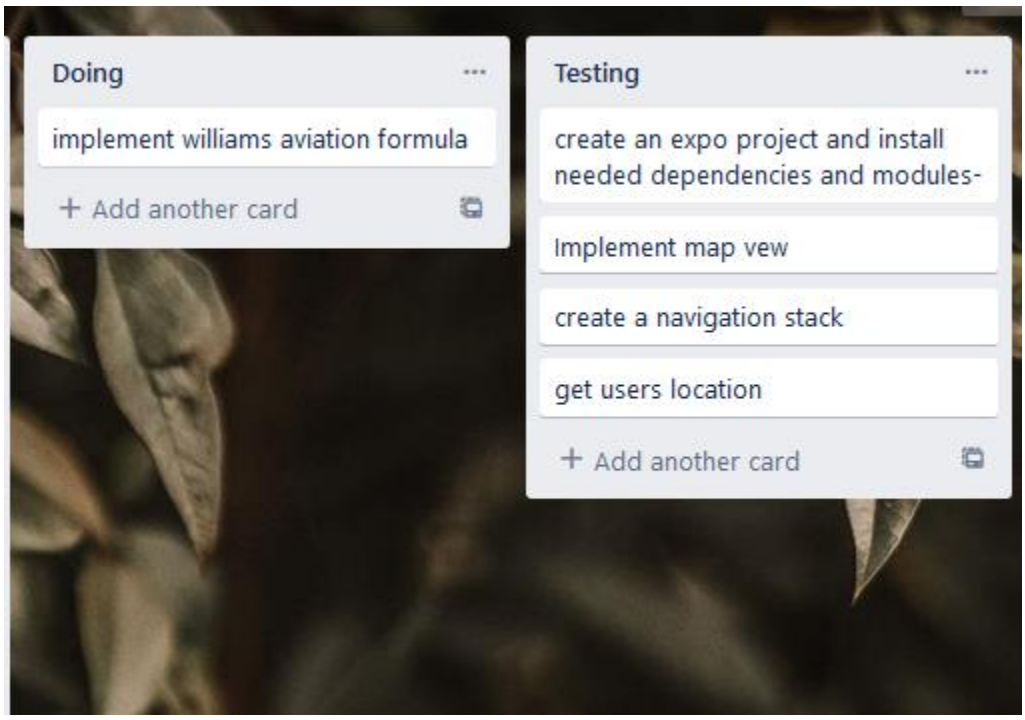


Figure 35- Week 1 Progress Review

At the end of the week I have review the implementation progress and reach most of the goals set for the week, Due to real life circumstances I did not have enough time to implement then williams formula for changing distance into latitude and longtitude this will be carried onto next week

Testing:

Id	Description	How it was tested?	Testing Type	Expected	Actual	solution
1	Checking if modules installed properly	Importing modules into the project and running metro	Error guessing	Modules to work properly	Works	n/a
2	Checking if metro renders andriod view	running the project in expo on andriod	Error guesssing	A blank page to render on my andriod device	Works	n/a
3	Checking if navigation stack works	Clicking on the generating route button	Error guesssing	The application to move me to the map screen	Works	n/a

4	Checking if program gets users location	Console.log users location	Error guessing	Program to print users location in console	Works	n/a
5	Checking if map is displayed and is interactive	Rendering the view and seeing if map is displayed	Error guessing	Render to show map view	Works	n/a
6	Check if Permission apear to the user to agree to location sharing	Render a new application with clear cache	Error guessing	For a alert to apear once generate route button is pressed which asks users permission for location	Works	n/a
7	What happens if user location if off	Render application and see what happens if user location is off	Error guessing	For the application to detect that no location has been found	Application throws a error into console and doesn't display any lines and map defaults to coordinates 0/0	Try catch to detect no location

Table 8- Testing Week 1

5.2 Week 2

5.2.1 Plan

For this week I have decided to implement an algorithm for creating the directions, the route. This requires me to complete a task set for last week to keep up on schedule. After experimenting on google maps I have decided that to generate a route for the user I will use three lines, A, B and C and use a concept of a triangle to create the route. This works by making line A start at users' current location and end at 1/3 distance away, which was chosen by user before. Then line B starts

from end of A and ends 1/3 of the distance away and C which starts at the end of B and ends at the user's location.

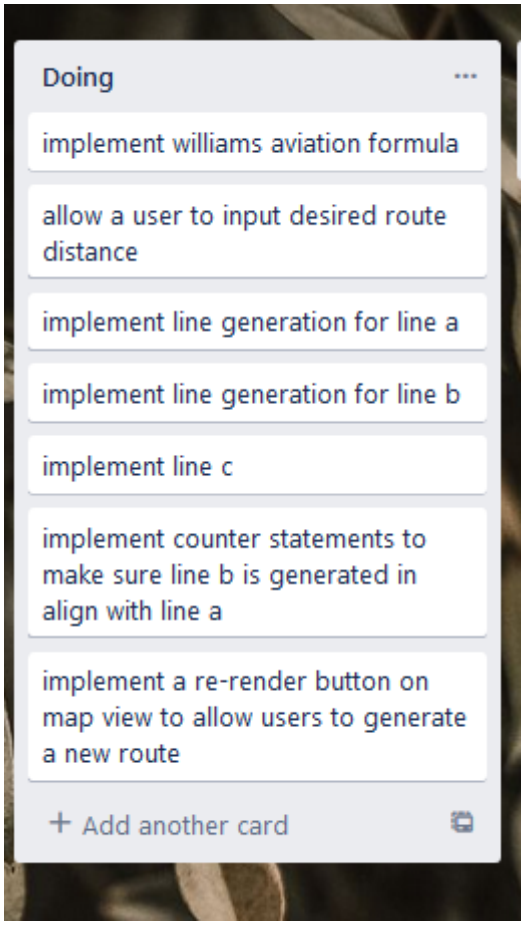


Figure 36- Kanban Plan Week 2

5.2.2 Implementation

The Location of the End of line A and B is decided by a random generator which generates a random number between 0 and 7. This number then decides in which direction the first line will go towards. As seen in the figure below inside the if statements there are formulas which decide where the distance decided by the user gets added, if its towards positive latitude or negative or longitude or both. These numbers are then added to the starting location of the user to generate the end of line A. These coordinates are stored in an array together with the other lines which are calculated later.

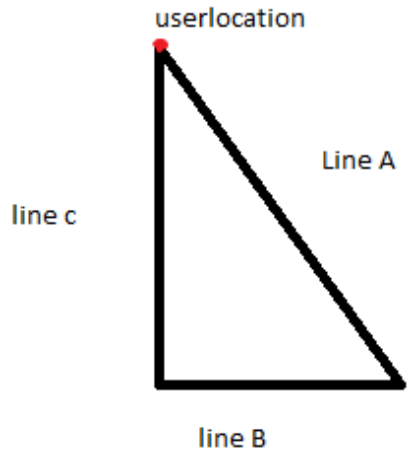


Figure 37- Route Generation Concept

The program decided in which way the line is going to generate by creating a random number between 0 and 8 which corresponds to a direction, this will also be done for line B. For example 0 means that the line is going to go south.

```
if(h==0){//down
  dLat=dLat*-1
  lat0= lat+dLat*180/Math.PI


}else if (h==1){//top
  lat0= lat+dLat*180/Math.PI

}
else if (h==2){//left
  dLon= dLon*-1
  lon0= long+dLon*180/Math.PI

}else if(h==3){//right
  lon0= long+dLon*180/Math.PI
}else if (h==4){//top right

  lat0= lat+dLatDouble*180/Math.PI
  lon0= long+dLonDouble*180/Math.PI
}
else if(h==5){//bottom right
  dLatDouble=dLatDouble*-1
  lat0= lat+dLatDouble*180/Math.PI
  lon0= long+dLonDouble*180/Math.PI
}
else if(h==6){//top left
  dLonDouble= dLonDouble*-1
  lat0= lat+dLatDouble*180/Math.PI
  lon0= long+dLonDouble*180/Math.PI
}
else if(h==7){//bottom left
  dLatDouble=dLatDouble*-1
  dLonDouble= dLonDouble*-1
  lat0= lat+dLatDouble*180/Math.PI
  lon0= long+dLonDouble*180/Math.PI
}
```

Figure 38- Line A Generation Implementation

```
var h = Math.floor(Math.random() * 8)
```

Figure 39- Line A random number Implementation

The distance for line a is calculated with the implementation of Williams Aviation Formula in the figure below where the latitude is calculated by taking in a count the radius of earth and dividing it by the distance, in this case the distance of that the user chose divided by 3 as there are three

lines. Longitude is calculated by multiplying the radius of earth by PI divided by the latitude of the start point (user location) divided by 180. This can be seen in the figure below.

```
var r=6378137
var distance=8000
var firstLine = distance/3
var secondLine = firstLine/2

var dLat=firstLine/r
var dLon=firstLine/(r*Math.cos(Math.PI*lat/180))
var dLatDouble=secondLine/r
var dLonDouble=secondLine/(r*Math.cos(Math.PI*lat/180))
```

Figure 40- Williams Aviation Formula Implementation

The Calculation which can be seen under dLatDouble and dLonDouble is the calculation for when latitude and longitude is added together to make sure that the program does not add double the distance to keep better accuracy of the distance chosen by the user.

The end of line B is calculated in a similar way, however the line is made based on the Direction that line A went. As I have used the concept of a triangle to generate the track, I must write counter statements for line B number generation. For example, if line A went straight up north on the latitude line B cannot go straight north or south or northwest or northeast to make sure that line C can reach the users starting point in the same or similar distance as line A and B.

The above diagram shows an example of line validation inside my solution, meaning for example that if line A goes up line b cannot be any of the red lines as shown in the top left example and can only be lines that are indicated in green.

In the figure below I have shown how to generate line B, the only difference to line A is that to calculate the longitude it needs the latitude from the end of line A.

```
var dLat1=firstLine/r
var dLon1=firstLine/(r*Math.cos(Math.PI*lat0/180))
var dLatDouble1=secondLine/r
var dLonDouble1=secondLine/(r*Math.cos(Math.PI*lat0/180))
```

Figure 41- Williams Aviation Formula Implementation for Line B

In the figure below I show how to make sure that the second line is generated based on the first line, if the first number is x the second number cannot be x or x or x etc... if does not meet the requirement it will generate a new number for second line and repeat the process until conditions are met.

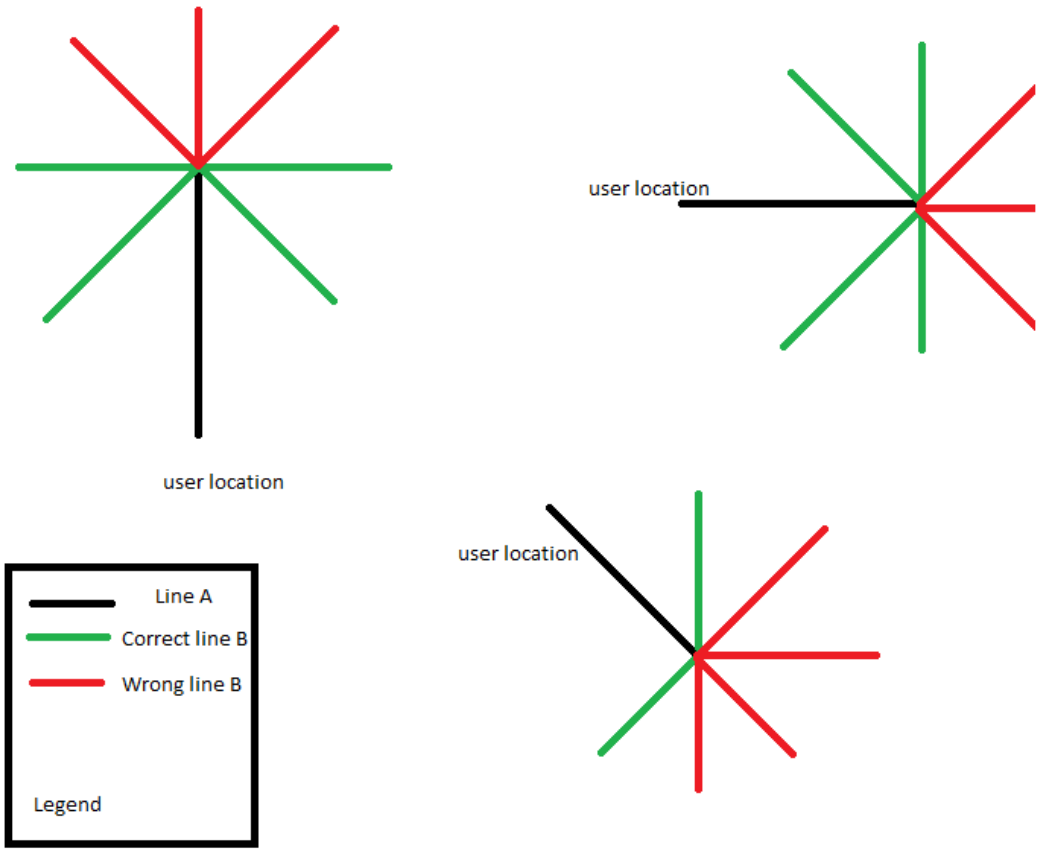


Figure 42- Concept Diagram for line B generation

```
var firstLineRandomNumber = Math.floor(Math.random() * 8)

var secondLineRandomNumber = Math.floor(Math.random() * 8)
while(firstLineRandomNumber==secondLineRandomNumber){
  var secondLineRandomNumber = Math.floor(Math.random() * 8)

}
var bLineCounter = 0
while(bLineCounter==0){
  if (firstLineRandomNumber==0 && secondLineRandomNumber!=0 && secondLineRandomNumber!=1 && secondLineRandomNumber!=7 && secondLineRan
    bLineCounter = 1

  }else if (firstLineRandomNumber==1 && secondLineRandomNumber!=1 && secondLineRandomNumber!=0 && secondLineRandomNumber!=6 && secondL
    bLineCounter = 1
  }
  else if (firstLineRandomNumber==3 && secondLineRandomNumber!=3 && secondLineRandomNumber!=2 && secondLineRandomNumber!=5 && secondLi
    bLineCounter = 1
  }
  else if (firstLineRandomNumber==2 && secondLineRandomNumber!=2 && secondLineRandomNumber!=3 && secondLineRandomNumber!=6 && secondLi
    bLineCounter = 1
  }
  else if (firstLineRandomNumber==6 && secondLineRandomNumber!=6 && secondLineRandomNumber!=5 && secondLineRandomNumber!=1 && secondLi
    bLineCounter = 1
  }
  else if (firstLineRandomNumber==7 && secondLineRandomNumber!=7 && secondLineRandomNumber!=4 && secondLineRandomNumber!=6 && secondLi
    bLineCounter = 1
  }
  else if (firstLineRandomNumber==4 && secondLineRandomNumber!=4 && secondLineRandomNumber!=7 && secondLineRandomNumber!=6 && secondLi
    bLineCounter = 1
  }
  else if (firstLineRandomNumber==5 && secondLineRandomNumber!=5 && secondLineRandomNumber!=6 && secondLineRandomNumber!=3 && secondLi
    bLineCounter = 1
  }else{
    var secondLineRandomNumber = Math.floor(Math.random() * 8)
  }
}
```

Figure 43- Line B counter statements implementation

Once the latitude and longitude for starting position, end of line A and B is generated and added into the array, the program then generates the line directions in three different react native direction components displaying them on the map.

The user can reload the map.js view to re-render and redraw the lanes generating a new route if the user does not like the current route. This is done simply by giving a new value to a state at the top of the file, meaning that react detects a change and re-renders the view generating new lines.

I have also implemented a simple input box on the homepage to allow user to input the desired distance of the route which I am then passing through react navigation props to the maps screen to then generate the distance of the lines.

5.2.3 Week 2 review:

Requirements completed this week:

ID 2

ID 3

2	Direction Line generation and display, based on user input	Must	Functional
3	Implementing Haversine and Williams aviation formula	Must	Functional

Figure 44- ID2 ID3 Requirements completed

Kanban board:

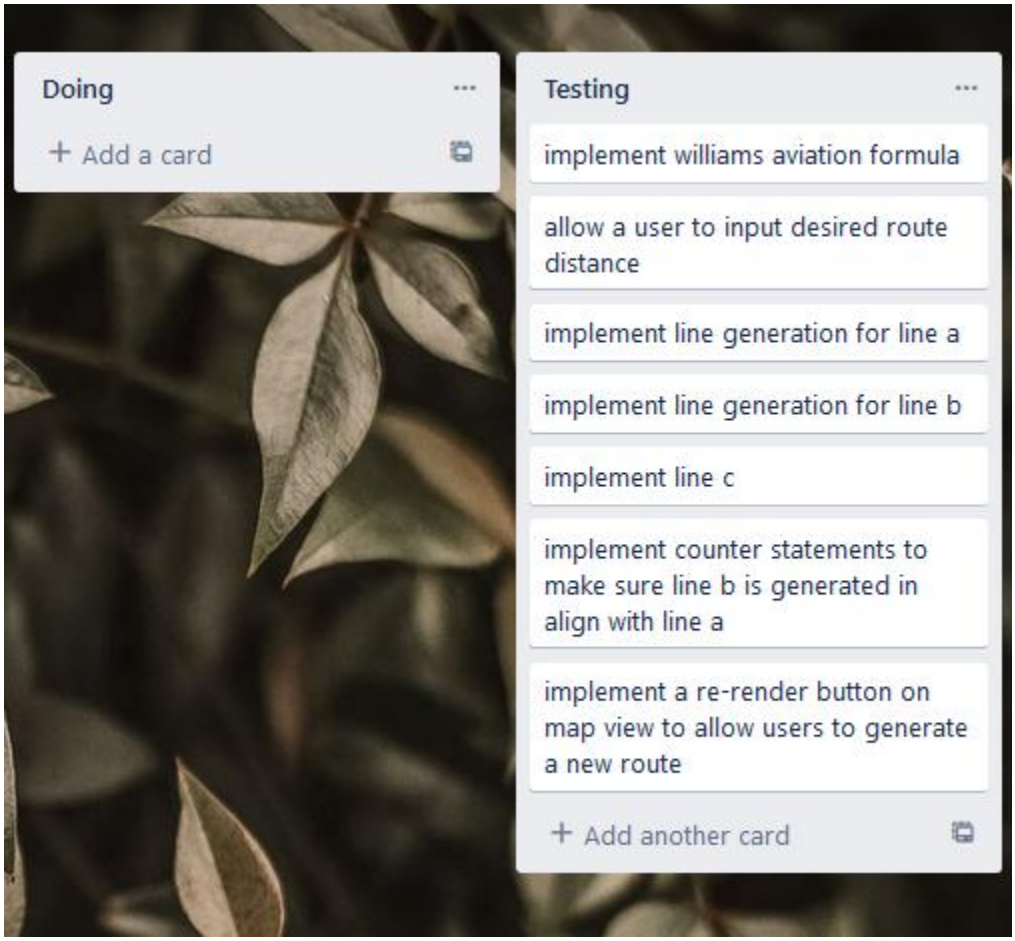


Figure 45- Week 2 Progress Review

For this week before testing I made sure to finish all given task, this was acomplished within the given time frame and was ready to be tested.

Testing:

Id	Description	How it was tested?	Testing Type	Expected	Actual	solution
1	Checking if williams aviatian formula is properly implemented	Creating a line and using a built in feature to map directions to display their distance	Error Guessing	The line distance of line to be near what the user inputed	Works	n/a
2	Check if the distance the user inputed goes from hopepage to map screen	Console.log the distance on map screen	Error guessing	The console to print out the distance user selected	Works	n/a
3	Generating each line of the route which is 1/3 of the distance of the route each, based on their latitude and longtitude	Directly checking if the map redered lines which are lebeled in different colours, and using printing its distance	Error guessing	Lines to generate with 1/3 of the distance and are displayed on the map	Works	n/a
4	Check if line B generates based on line A properly	Forcibly making line A, a certain random number to see if B	Error Guessing	Line B to generate in the right way, menaing that with line c the route will form	Works	n/a

		generates properly and running to over until all possible outcomes are achived		sort of a triangle		
5	Test if the button re renders the line generation	Simply watching the map view, re render the lines	Error guessing	The map to re-render the lines and generate new one which are different	Works	n/a-
6	Check what happens when users inputs non numerical characters into distance input box	Test the input box with non numeric characters	Error guessing	The program to stop the user and tell them to re type only numeric characters	The program throws an error and crashes	Simply limit what the user can input. By changing input box to numeric only
7	Check what numeric values work well with the route gneration	Input a variaty of numeric values using equivalent paritiona and boundary value analysis	Equivalent partitioning And value boundary analysis	The program to generate lines based on distance	The program doesn't generate lines as well if the distance is small then 1000m	Limit the user to only be able to enter more then 1000 m distance
7	Explanation of how the above test was conducted	Partitions:1-100 101-1000 1000-30000 Tested by taking one number from each partition and test bounderies of the partitions				

Table 9- Week 2 Testing

5.3 Week 3

5.3.1 Plan

This week I plan to implement a simple database and Api to connect to my database to be able to fetch data from it. Together with the Api I also plan to have the login, register and calories data working inside the app by fetching and posting data from the Api. To make constrain the user from entering values that would not be accept by the database validations will be made within the application.

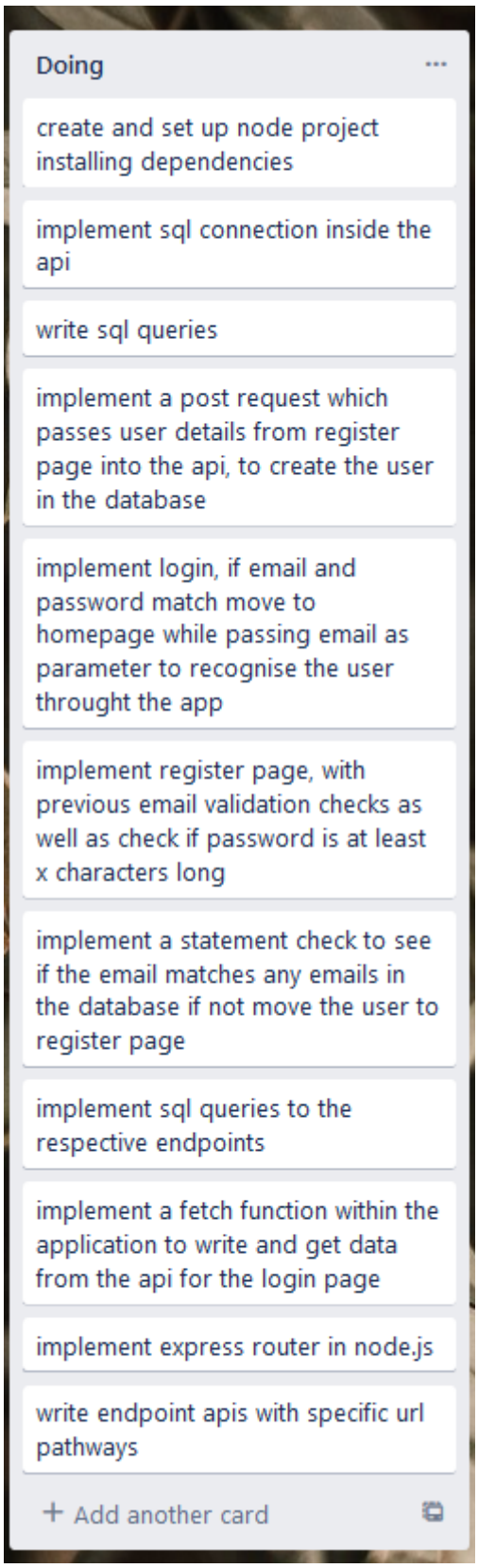


Figure 46- Kanban Week 3 Plan

5.3.2 Implementation

To start the week I have implemented solutions after previous weeks testing to improve the application quality. A numeric lock was added to the distance input box on the home page, as well

as a statement check too not allow numbers lower than 1000 or it will alert the user and not proceed to the next page.

I start by creating a MySQL server with MySqL workbench and hosted it on my local machine for now to allow for quicker changes and testing. The database was created with MySQL workbench in week 1.

To create the Api I have started by initializing a node project inside my chosen directory to create the package.json file which includes starting parameters and imports of external modules which are needed for sql connection and json body parsing.

To start laying out the Api function I decided to create an new file called config which will contain all the parameter information to connect to the database, so it does not lay in the main server file. These credentials are stored in an environment variable, to make the global and available throughout the whole node project. This is done by simply calling the process.env at the top of the page inside a construct variable to assign a name to it and exporting the module file at the button to make it available to be used by other parts of the project.

config.js > ...

```
1   const env = process.env;
2
3   const config = {
4     db: {
5       host: env.DB_HOST || 'localhost',
6       user: env.DB_USER || 'root',
7       password: env.DB_PASSWORD || '1234',
8       database: env.DB_NAME || 'fitness',
9     },
10  };
11
12
13  module.exports = config;
```

Figure 47- Api Config File Implementation

The second file I have created is the db.js file which contains the connection between the Api and database and returns results based on Api endpoint used by the application (which will be implemented later). The below figure shows the implementation of the sql connection and result return. The program awaits for the database to give back a result and then returns it whenever called to be displayed by the server an available to fetch by the app, this also works for query's that

add or edit the database elements such as registering a user. For this function to be used in the main server file, the function needs to be exported which has been done at the bottom of the file.

```
const mysql = require('mysql2/promise');
const config = require('../config');

async function query(sql, params) {
  const connection = await mysql.createConnection(config.db);
  const [results, ] = await connection.execute(sql, params);

  return results;
}

module.exports = {
  query
}
```

Figure 48- Api My Sql Implementation

Next file I implemented was the endpoint queries. These queries are generated and stored inside each function to be able to call them when an endpoint is reached from the application to the server and then passed onto the MySQL connection to be passed onto the database.

An example of the query can be seen in the figure below. This query simply selects edits the calories column where the email matches the users. In this case user.calories and user.email is the body passed into the Api from the application.

```
async function updateUser(user){
  const result = await db.query(
    `UPDATE login
    set
    calories=?
    WHERE email=? `,
    [
     user.calories,user.email
    ]
  )
```

Figure 49- SQL Query Implementation Example

There is currently 4 endpoints implemented into the Api, one to get back all results from the database, another on the to register a user, the one which can be seen in the figure above and one to take out only calorie data based on email to display to the user.

The next file is the one that allows the application to access and call the Api endpoints, a route file connecting most of the Api functions together to be used based on which endpoint was hit by the application.

The figure below shows a declaration of an express router which allows, an express router allows for a listener inside the node server to look for post and get etc.. in a http method to increase the security of the connection in between the Api and the user's application.

```
const router = express.Router();
```

Figure 50- Express Router Implementation

The figure below shows my implementation of a router endpoint function, this function simply get triggered by calling the Api endpoint which then fires the function which passes the body parameters from the Api call to the sql server, awaits for response and then either based on the functions purpose and pushes data into the server to allow the application to fetch it or simply responds that it completed the Api call for writing or editing to the database.

```
router.post('/adduser', async function(req, res, next) {
  try {
    res.json(await users.create(req.body));
  } catch (err) {
    console.error(`Error`, err.message);
    next(err);
  }
});
router.put('/updateuser', async function(req, res, next) {
```

Figure 51- API Endpoint Implementation

The endpoint can be called by calling the ip which in this case is local host then port followed by /users which is the main call followed by /adduser to call the right function inside the Api server. A completed Api call URL would look like this:

```
var url='http://192.168.43.120:3000/users'
```

Figure 52- Endpoint Url Example

The final file needed for the Api is the main server.js file which start, the server as well as creates and initiates the listener on the chosen port. This is done simply in the figure below.

```
const port = process.env.PORT || 3000;
```

Figure 53- API Port listener Implementation

To create the router which enables passing of https requests and display data to be fetched I simply needed to call app.use with the indication of the endpoint which in this case I made to be /users and calling back router which is an import from the endpoints file containing all the query functions.

```
app.use('/users', router);
```

Figure 54- Url Endpoint Setter

Now that the Api has been created I have moved on onto implementing the login and register system with the application.

To start I have implemented a simple email, and password state to enable react to display character inside the input boxes as a user types as well as read in what they entered. The function gets called once the user presses the log in button which passes the email and password parameters to the logic function.

To make sure that the user does not type in anything that is not an email format I have implemented a simple regex if statement check as can be seen in the figure below.

```
let reg = /^\w+([\.-]?\w+)*@\w+([\.-]?\w+)*(\.\w\w+)+$/
if(reg.test(email)===true){
```

Figure 55- Email validation regex

If it does not match the email format the application will alert the user, with an alert message.

```
}else{
  alert("incorrect email format")
}
```

Figure 56- Email validation alert implementation

The figure below shows the implementation I have used to connect to the Api and fetch data returned by the endpoint from the database. It simply passes the url to the fetch function and takes data displayed from the Api and turns it into a json format variable.

```
var url='http://192.168.43.120:3000/users'
const repsonse = await fetch(url)
const result = await repsonse.json()
```

Figure 57- Application fetch implementation

I needed to iterate over each element of the returned array and get the number of elements returned. This can simply be done by a for loop or Object.keys which functions as a loop over an array and counts each main element, with the implementation of.lenght it just returns the number of rows in the array. (MDN Web Docs 2021)

```
var resultLenght= Object.keys(result["data"]).length
```

Figure 58- Object.keys Implementation

The next step in implementation of the login system was to make the application cycle through every returned result from the Api and check if the email entered matched the email inserted by the user. This was simply done by creating a counter variable and making it a condition inside the while loop comparing it to the length of the result array like so.

```
var counter = 0
while(counter!=resultLenght){
```

Figure 59- Result Loop Implementation

The function the operates by checking each element in the array matches the returned result. The if statement for it can be seen below.

```
if(result["data"][counter]["email"]==email.toString()&&result["data"][counter]["password"]==password.toString()){
```

Figure 60- Login Statement Implementation

This if statements check if email and password entered by the user match any in the database. If yes, an option Counter variable was created to later select an option of what the program should do next. If login and password are correct optionCounter will =1 and counter will = to value of resultLenght to end the while loop.

```
var optioncounter = 0
```

Figure 61- Counter Implementation

If the email matches but password does not the program will make optionCounter=2 and counter will = to resultLenght to end the while loop and if email and password do not match the value of counter will increase by 1.

This whole operation can be seen in the figure below.

```
while(counter!=resultLenght){
  if(result["data"][counter]["email"]==email.toString()&&result["data"][counter]["password"
    optioncounter=1
    counter=resultLenght
  }else if (result["data"][counter]["email"]==email&&password!=result["data"][counter]["pas
    optioncounter=2
    counter=resultLenght
    }
  else{
    counter=counter+1
  }
}
```

Figure 62- Login operation Implementation

Once the above operation has been completed and optionCounter has a value, I implemented a condition statement based on the value of optionCounter. If optionCounter is 1 send the user to the home screen and pass the email as a parameter, to be read on the home screen to keep track on which user is logged on.

If option counter is 2 it will just alert the user that the email and password do not match and allow them to enter the detail again.

If option counter is something else, that means that the email does not yet exist in the database, this option then passes the user to the register screen with email as parameter.

```
if(optioncounter==1){
    navigation.navigate("Home",{
      email: email})

}else if (optioncounter==2){
    alert("Email and Password dont match")
}
else{
  navigation.navigate("register",{ email1:email})

}
```

Figure 63- login back end options implementation

Brining the implementation to the register page, which simply copies most of the implementations from the login page, the only two differences is that there is a new confirm password input box with a new statement check to make sure that the password is at least 6 characters long and the Api post request is structured differently to also pass on a body with parameters to the Api endpoint.

```
(parameter) password: any
if(password.length>=6){
```

Figure 64- Password character constraint implementation

```
var url='http://192.168.43.120:3000/users/adduser'

await fetch(url, {
  method:"POST",
  headers: {
    'Accept': 'application/json',
    'Content-Type':'application/json'
  },
  body: JSON.stringify({
      email: email,
      password: password,
      calories:0
      })
```

Figure 65- POST implementation with body parameters

Finally, this week I have implemented a simple text box and Api call to retrieve and display calories burned using this app. The Api call was done almost identically to the figure above with a change to the Api endpoint being getCalories instead.

5.3.3 Week 3 review

Requirements completed this week:

ID5

ID6

5	Account Registration	Should	Functional
6	Login system	Should	Functional

Figure 66- Completed requirements 5 and 6

ID 8

8	Api which can send queries to database and receive data to be fetched by the application	Should	Functional

Figure 67- completed requirement 8

ID9

9	MySQl Database Server	Should	Functional

Figure 68- completed requirement 9

ID 12

12	Log out	Could	Functional

Figure 69- completed requirement 12

Kanaban board review:

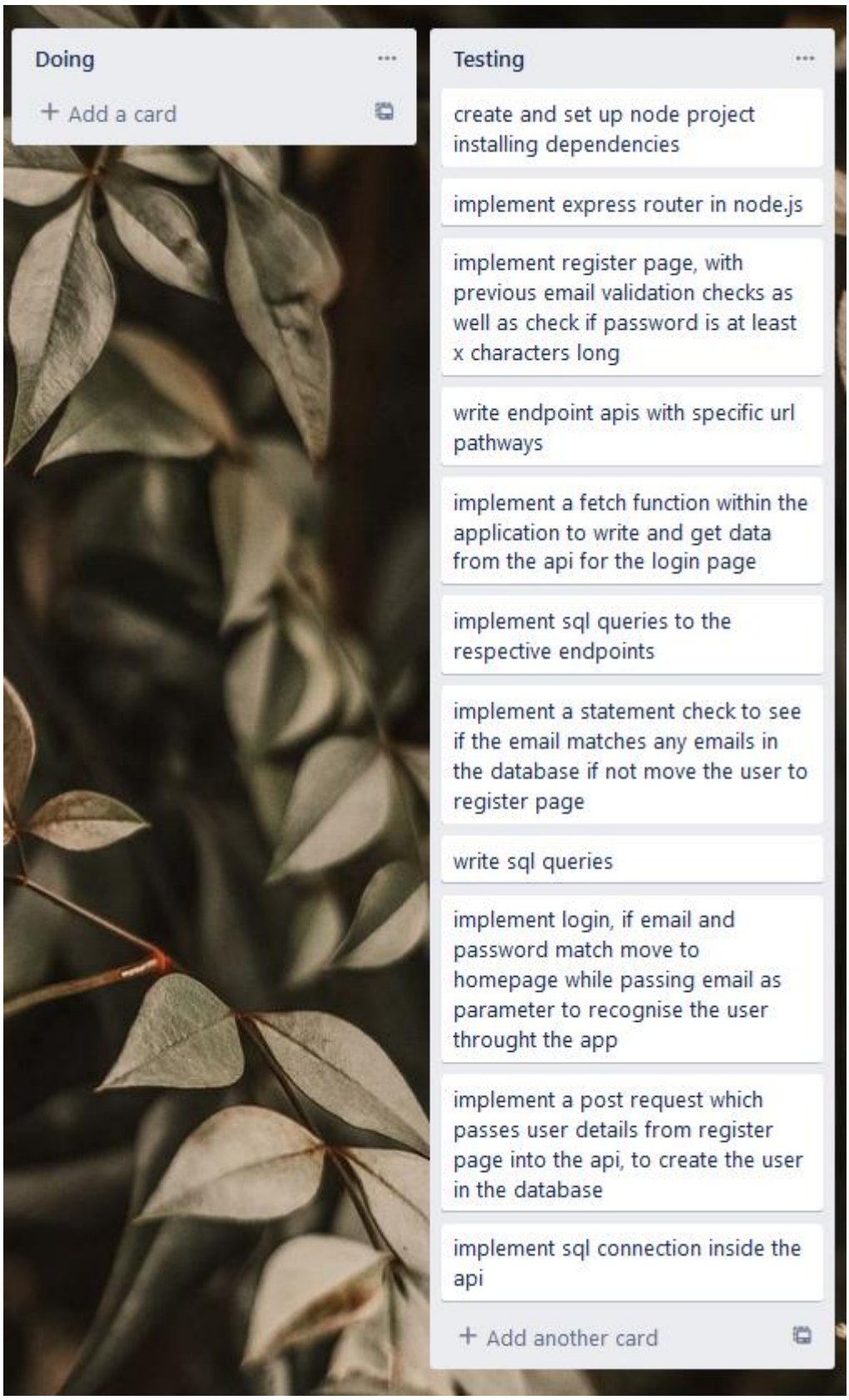


Figure 70- Week 3 progress review

All tasks set for this week have been completed and are ready to be tested.

Testing:

Id	Description	How it was tested?	Testing Type	Expected	Actual	solution
1	Testing if node modules installed properly	Simply importing them into file and starting server	Error guessing	The server to load	Works	n/a
2	Create an sql connection inside the node server	Simply sending connecting and console.log result to see what is returned	Error guessing	The server to print out connection status with ip	Works	n/a
3	Test if sql queries gets passed into the sql	Write a simple select * from query an pass it into the sql connector and return the result	Error guessing	The server to show results on localhost:3000	Works	n/a
4	Test if api request send into the server triggers the querry and gets sent to the database	Send a endpoit request from postman	Error guessing	The server to display information on localhost:3000 and or see database changes	Works	n/a
5	Test if user can log in into the application with correct cresidentials	inputting correct cresidentials into the log in input	Error guessing	The application to move me into homepage	Works	n/a

		boxes				
6	Test if email validation works	By putting an invalid email format into email input box	Error guessing	The application to alert the user that email is wrong format	Wroks	n/a
7	Test if the program moves the user into register page if log in is not found in the database	By putting an email which isnt yet in the database	Error guessing	The application to navigate user to register page	Works	n/a
8	Test if register. Registeres the user in the database	Filling in the register formula	Error guessing	The application to register the user and see database change	Works	n/a
9	Test if the program doesn't allow user to type less then 6 characters for password	Inputing 4 character password	Error guessing	The application to alert user that password is to short	Works	n/a
10	Test all queries requried for the application	Run all test quriesin postman	Error guessing	The server to display and send information to database baseed on endpoint hit by postman	Works	n/a
11	Test character size in email and password input boxes	Run throught eqivalent partitioning and boundary value analysis	Equvalient partitioning and boundary value analysis	The application to work with any amount of characters	Sql database has a set character limit of 45 on each respective field	Simply alert user then this limit is reached

		Partitions for email 1-10,11-25 26-60 Password- 6-10 11-25 26-60				
12	Test if server can be accessed from other ips not only local	Connect throught normal ip	Error guessing	The application to connect and communicate with api	Works	n/a
13	Test if calories from the user are being displayed on the homepage	Log into the app with a user	Error guesing	The application to render calories on the homepage	Works	n/a

Table 10- Testing week 3

5.4 Week 4

5.4.1 Plan

For this last week I plan on implementing a direction function which tracks the user's location as they move and displays the moving location on the map. This is the final implementation week according to my plan, which mean I will also be implementing UI styling making the ui user friendly and applying design techniques researched beforehand to generate better user experience.

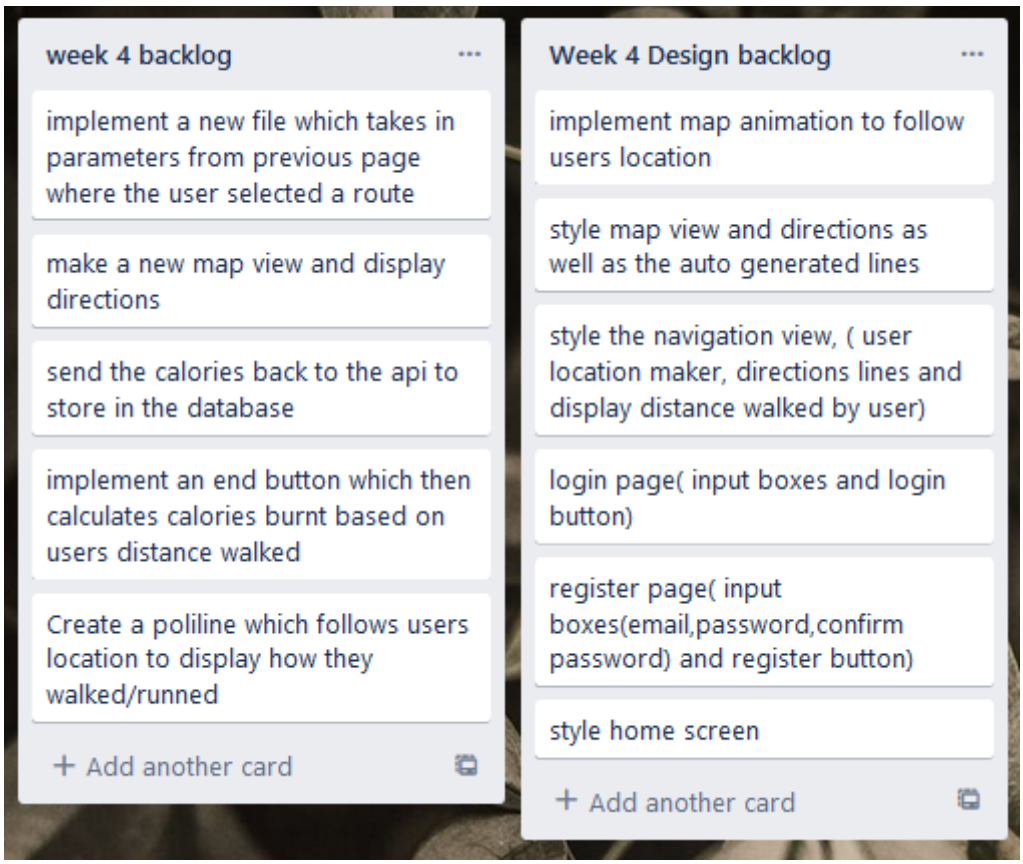


Figure 71- Kanban plan week 4

5.4.2 Implementation

To implement the route and moving location of user I have decided to move this implementation to a new file called startedRoute while passing the route parameters for the directions generated in maps.js with a press of a button simply called start route, the user is then moved to the new file with directions lines drawn to start walking/running the generated route. To simply end the route even before finishing the user can simply press the end button which will bring them back to home screen and save their calories burnt while they were walking/running on the route.

To achieve my goal for this week I used something called geolocation.watchPosistion, this installs a listener onto the system, checking for any changes within the geolocation coordinates of the user, if change is detected return new geolocation position.

```
navigator.geolocation.watchPosition(
  position => {
    const { latitude, longitude } = position.coords
```

Figure 72- user live position implementation

```
this.setState({
  latitude,
  longitude,
```

Figure 73- state update for user location implementation

I have then used these values by setting them into a state array to be used in the rest of the code. To display the user's location on the map I have simply created a react native map marker and used the state coordinates as the marker position coordinates, once the system detects a change in the state(when the users moves geolocation) the marker is re-rendered with new geolocation position on the map allowing the user to see their movement.

I have also implemented a function which allows users to see their path taken, this is done by simply recording users' new coordinates into a state array and drawing a Polyline as they move on the map. This data is retrieved and stored the same way as the solution for the moving user location.

```
<Polyline coordinates={this.state.routeCoordinates} strokeWidth={5} />
```

Figure 74- polyline implementation

Final implementation for the application was calculation users distance covered while on route and displaying it, as well as calculating on average how many calories they have burnt and updating the database with the new value through the api.

To implement this feature, I simply created three states, one which holds the previous user location before the user's location changes, one which holds the total distance they covered and one which holds the new coordinates after watch position detected a change in location. Then to calculate the distance I put both values into a haversine function and return distance in meters which gets added into a state and the process repeats until user selects to end the route. After users presses the end button the distance is returned to a new function which calculates how many calories, they have burnt using an assumption that on average a person burns 0.0625 calories a meter. This information is then passed onto the api to update the user.

A refresh button was implemented on the home screen to refresh the calories burnt, this is needed due to limitation with navigation stack when going back to a previously rendered screen.

5.4.3 UI implementation and Final look of the artefact

After finishing the back-end implementation, I have started to clean up and layout the UI elements based on my previous wireframe plan. As background to the first three screen, I have used royalty free images, to make the application look more appealing together with the minimalistic UI design.

I have taken care to ensure that psychological design techniques and user experience was fully utilized and implemented into my UI. Certain examples can be seen such as buttons and input boxes being consistent, affordable, visible and mapped, following the 6 principles of design by Donald Norman reviewed in chapter 2.

While designing and placing the elements onto the application canvas I made sure this was done using a % inside marginVertical or Horizontal as value allowing for scalable UI which as expected result should mean that most android devices, with different screen sizes should be fully compatible with this application. This works by placing an object X% away from the margin.

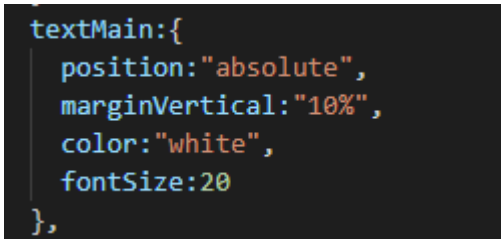


Figure 75- Ui scalability implementation

Care was also taken into placing usable elements inside the comfortable thumb zone making sure that one finger operation was possible. These examples can be seen in the figures below:

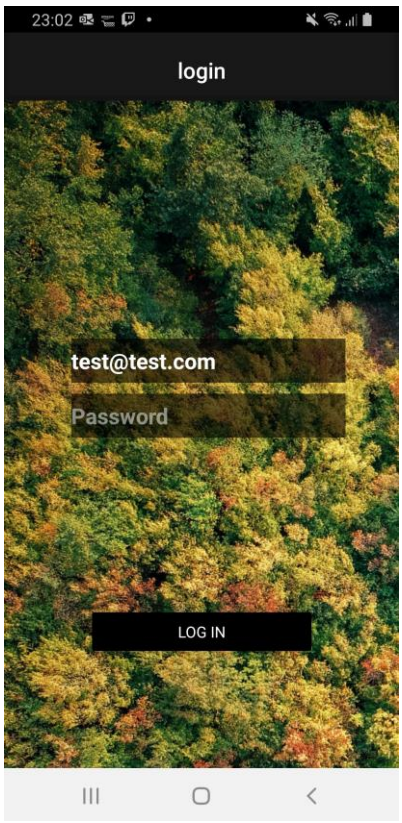


Figure 76- Completed login page Background image ref: (Tuğ 2021)

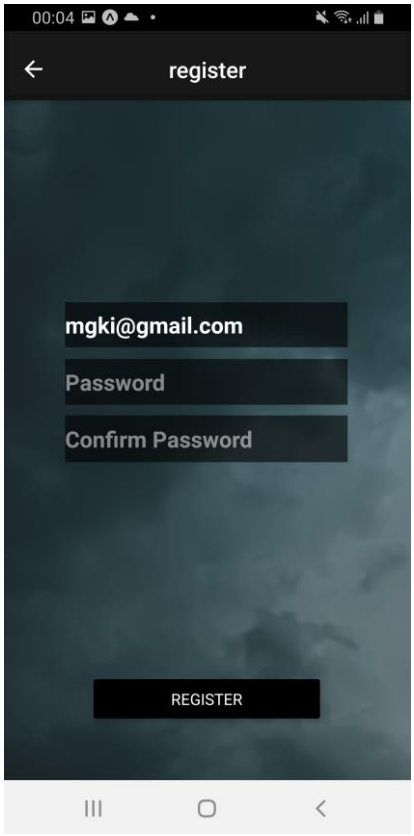


Figure 77- Completed register page Background image ref: (Conchillos 2021)

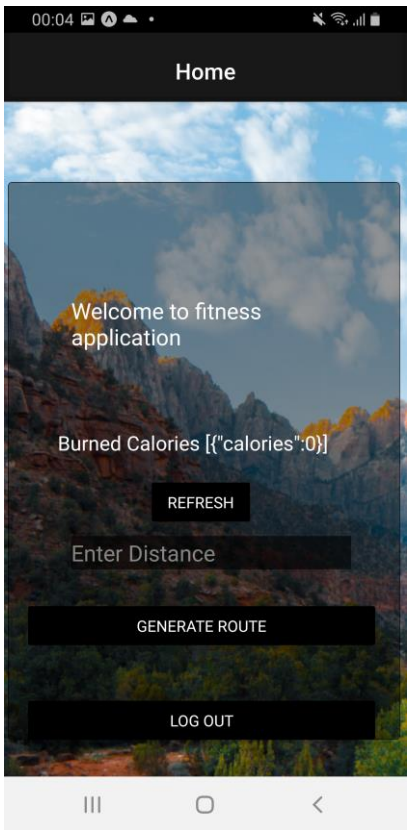


Figure 78- Completed Home page Background image ref: (Block 2021)

Figure 79- Completed route generation screen

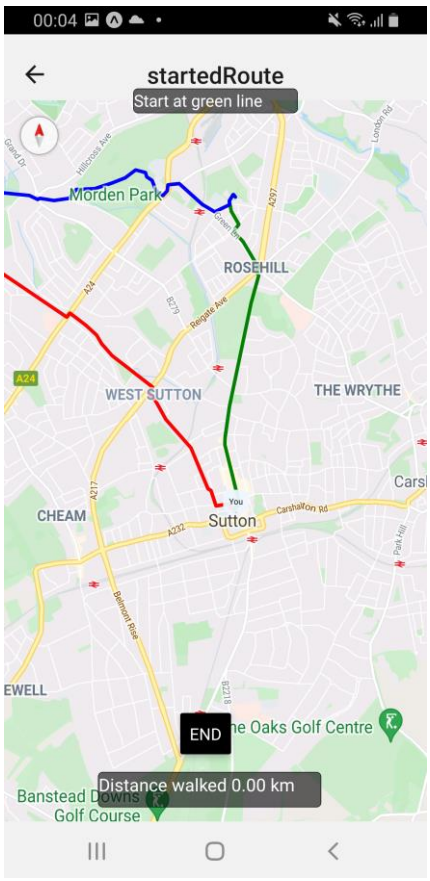


Figure 80- Completed Navigation Page

5.4.4 Week 4 review

Requirements completed:

ID 7

7	Moving user location calculated and displayed on the map	Should	Functional

Figure 81- completed requirement 7

ID 10

10	Scalable UI	Should	Non-Functional

Figure 82- completed requirement 10

ID 13

13	Calorie calculator	Could	Functional

Figure 83- completed requirement 13

Kanban Board

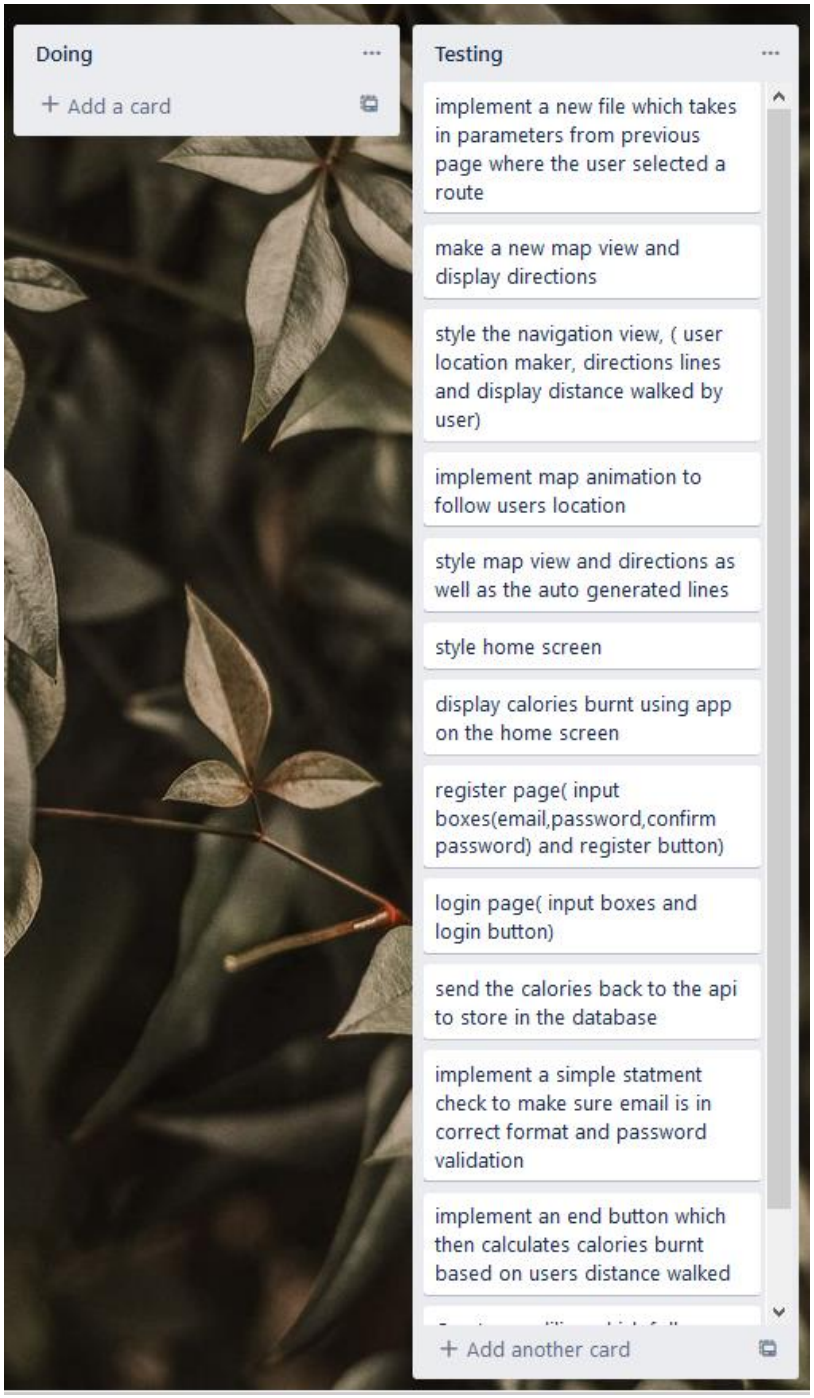


Figure 84- Week 4 Review

All objectives have been completed and ready to be tested

Testing

Id	Description	How it was tested?	Testing Type	Expected	Actual	Solution
1	Test if parameteres are passed to the new file	Console log inside the new file	Error guessing	Paramters to pass properly to the next screen	Works	n/a
2	Test if the new map displays the route lines	Render in andriod view and see if it renders	Error guessing	Map view to render in and display route lines which are the same as previous page	Works	n/a
3	Test if end button takes the user back to the end screen and calculates the distance in meters	Console.log the distance in meters once end button is hit	Error guessing	User to move to homepage and calories print out in console	Works	n/a
4	Calculate calories	Console .log calories and I calculated the calories my self to see if the result is corect	Error guessing	Calories to be calculated based on distance run	Works	n/a
5	See if marker updates when users moves	Used joystick app which enables to manipulate user location live	Error guessing	Marker to move based on user position	Works	n/a
6	Watch position to calculate user distance based on their movment	Joystick application and move	Error guessing	Distance to be properly calculated in meters	App crashes, unkown cause	Re installation of haversine

						module fixed the issue
7	Users leaves a black pollyline to show route they have taken	Joystick app to manipulate live movement	Error guessing	A line generates to follow users movmenet	Works	n/a
8	Test that background images render properly	Rendering in the views	Error guessing	View to just render in the image as background	Works	n/a

Table 11- Week 4 testing

At the end of the week I have also fixed an issue from test ID 6, to make sure that the application does not crash any more.

6 CONCLUSION

6.1 Artefact Evaluation

After finishing the implementation phase of the artefact and testing, I can now evaluate the quality of the product. I will do this by reviewing the overall outcome of testing, and how many tests have passed or been corrected and fixed.

Whilst some bugs/errors were found within the project they have been evaluated and fixed or changed to increase the quality of the product. Leaving currently 0 known bugs pushing the application to be more of a finished product.

The artefact solves the problem by allowing users to create a route around their location based on their preferred distance and allows them to see how many calories they have burnt at the end of the route. This means that the project was successful and requirements where analysed and implemented successfully.

Another way to evaluate the success of my artefact in solving the problem, is by comparing it to other solutions which were reviewed in background study chapter. The features which my application solves compared to the competition are:

- Automatic generation of routes
- It is totally free with no advertisements and in app purchases.
- Calories burnt during the run are calculated and displayed to the user as well as total burnt while using the app.
- Navigation is included inside the app allowing the user to use the solution to run the generated route with stats.

To evaluate the design, I have user heuristic evaluation, by listing features which correspond with the Donald Norman principles of deign in the figure below:

Principle	Description
Visibility	The example of this can be seen with the input boxes as they have placeholder text allowing the user to instantly know that, information can be put inside the box, same can be seen with buttons are

	they have text on them which tells the user its action
Feedback	An example of feedback which can be seen inside my application, is when a user pressed a button to re generate the route, the route directions re render on the map view
Affordance	This can be seen on buttons and input boxes as they notify the user of their function. This can also be seen on certain screens such as map which show a arrow in the top left corner which allows user to go back to the previous page.
Mapping	This can be seen with the interactive map which allows the user to zoom in and zoom out using to finger motion. Another example of this is the arrow on map page which allows the user to go back.
Constraints	example of this can be seen, in the login page where the user needs to input a correct email format, other examples are limit characters when registering, limiting the user from entering non numeric values into the distance input box.
Consistency	This can be seen through my project as all buttons and input boxes hold the same theme being: Black white text for buttons And half opacity with grey place holder text, and white inputted text for input boxes. The overall design is minimalistic with low screen pollution.

Table 12- Design principal Evaluation

In the figures below I show comparison example of how I successfully implemented the design of the UI based on the principle of thumb zone, by comparing it to a research figure.

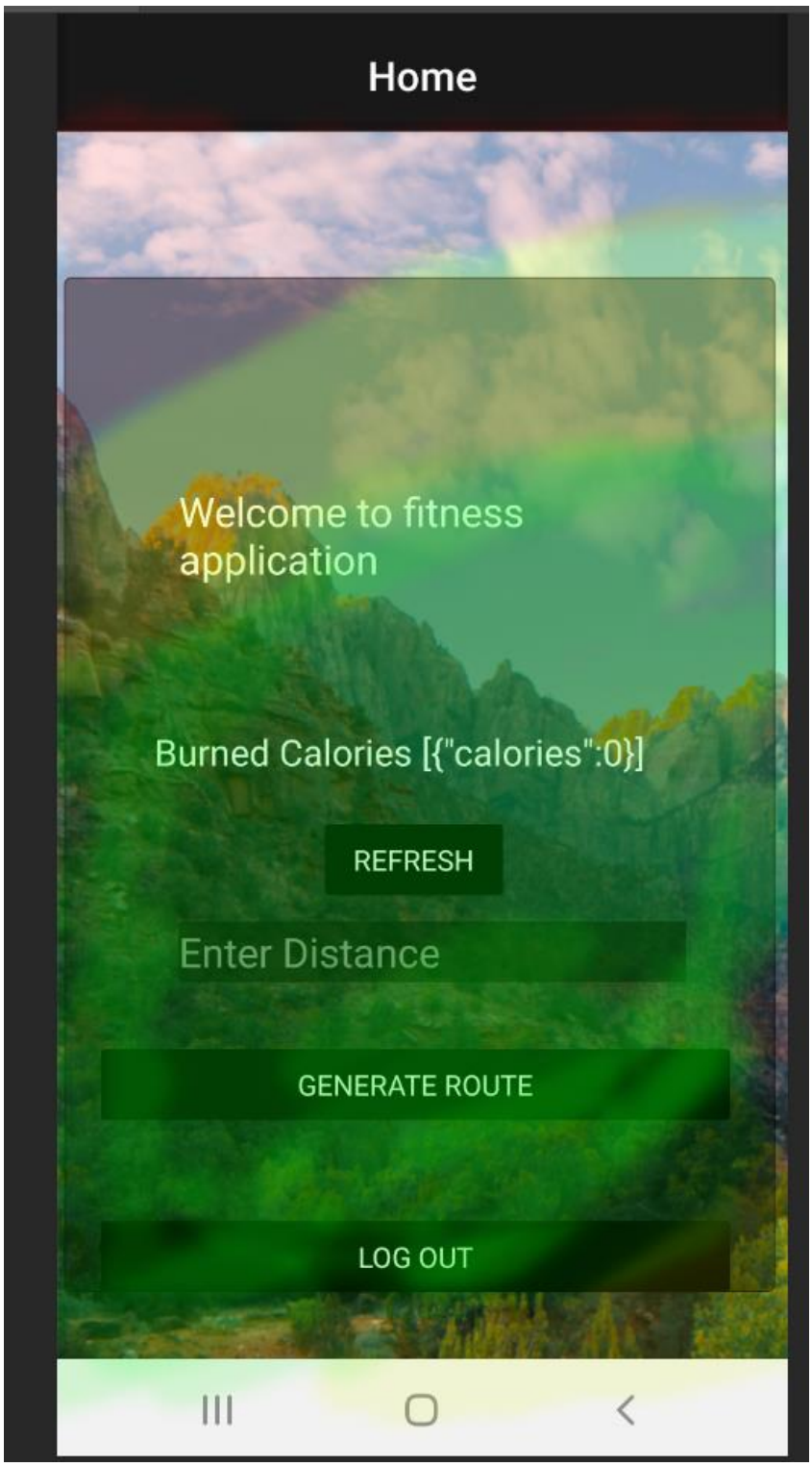


Figure 85- Thumb Zone Implemented into my Ui example

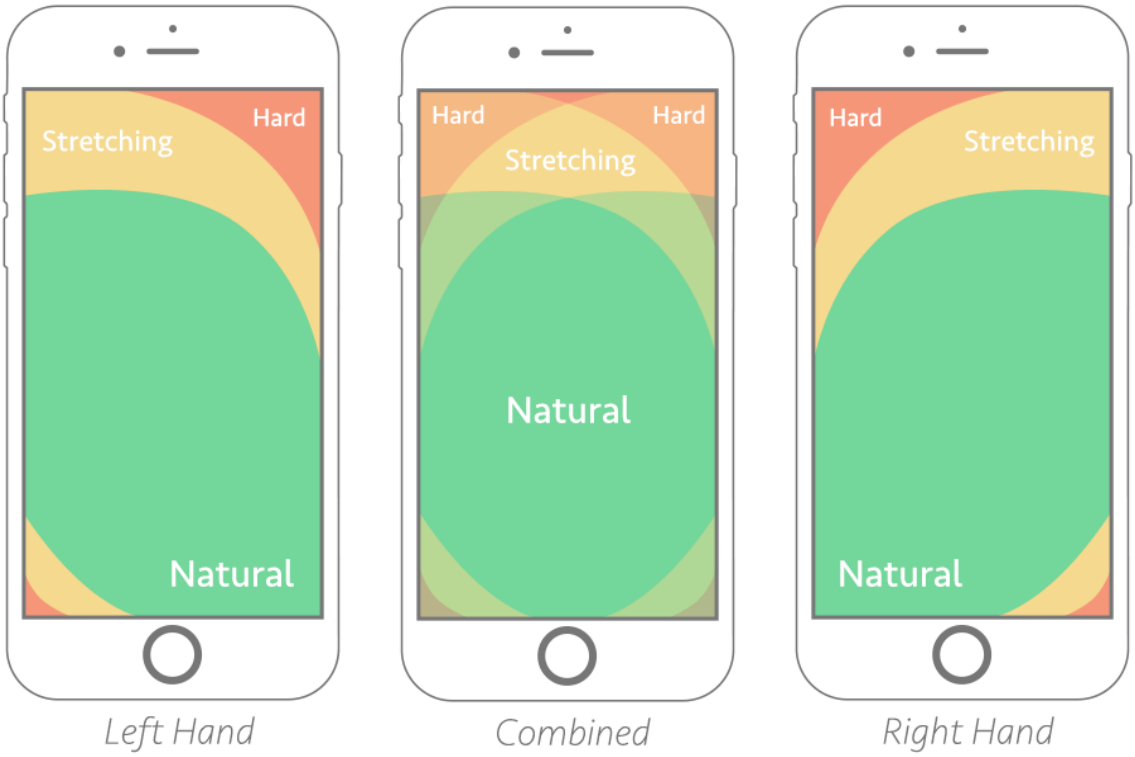


Figure 86- Thumb Zone example

(Ingram 2016)

Security of the application:

Whilst most requirements were implemented within the application some were left out such as security of the data. This happened because of time constraints on the project, as well as the set priority of them during Moscow analysis. They were not completed due to the product being a concept not a fully finished product, and as such security should be implemented at the end, this will be talked about in the future work chapter below.

There are security risks such as passwords being stored in plain text, the data transfer protocol is not encrypted and when a user attempts to log in every user is pulled from the database to do the checks within the application instead of pulling just the user needed or the verification being done on the server back end.

6.2 Project conclusion

During the project I have gained more knowledge in the problem domain, as well as technologies and methods around application development. This allowed me to successfully evaluate and create a solution to the forementioned problem.

This project aimed at building an artefact, which was an android mobile application together with the API to solve the problem off not having a set route for running. Together with conducted literature review on the problem domain, a concept of an android application was created with technologies and design principles researched within the report.

Requirement analysis was conducted with the help of MoSCoW to identify and rank their priority of the requirements needed to solve the problem as well as eliminate unneeded requirements to avoid scope creep and set real expectation for the project.

Project plan and Time management:

Due to the current real-life situation, my project plan and objectives have slightly changed due to time constraint, as certain deadlines have not been reached on time. This force me to re create and replan my project by changing my Gantt chart to fit the project schedule more. This new Gantt chart can be seen in the appendix F.

Project objectives Evaluation:

The project objectives have been met meaning that the project, and its aim has been successfully completed.

Objective table:

ID	Objective	Success criteria	Condition	Evaluation
1	Analyse and review literature surrounding defined problem and technologies needed as well as psychological design concepts to develop and deploy a successful mobile	This can be achieved by properly identifying the problem, technologies which can solve the problem and reviewing existing solutions to build my own	Met	Literature review was conducted into the problem domain, and practices into UI design and technologies to

	application			create the artefact
2	Specify requirements to design and define features to solve the problem	How well the artefact solves the problem	Met	Requirement's evaluation was conducted using MoSCow as a technique to create and prioritize, requirements to avoid scope creep and make sure most important features were developed on time
3	Visualise and develop ui based on psychological effects studied, using wire frames	How well Ui principles were applied to the UI	Met	Wireframes were created for each screen needed for the problem solution with the implementation of the design techniques
4	Build and deploy a successful android application using chosen methodology	This will be measured by the quality of design, user experience, testing and how well the artefact is at solving the problem	Met	The artefact was successfully created, implementing must and should requirements with the help of Kanban as the project methodology
5	Evaluate and conclude the success of the artefact and project	This can be achieved by fully evaluating strengths and weakness of the project. The artefact will be evaluated through testing	Met	Testing was conducted to evaluate the quality of the artefact as well as comparison to previously

		and design principles application		researched competition as well as evaluation in used design principles

Table 13- Objective Evaluation

6.3 Future Work

To continue with the development and enhancement of the application, steps should be taken to keep the consistency in design as well as follow design principles to keep high quality of UX design. The recommendation is based on additions which would further improve the quality of the artefact and further pursue the problem domain as well as missed requirements due to the time constraint.

Recommended features

-Increase in application security by using HTTPS to encrypt the data packets

-Create data encryption using SHA-512

Change the Api endpoints so they do not pull all users data but only the one that's needed.

- allow users to register using Google or Facebook

- Create a full menu where the user can see how many calories, they burnt a day/week with their stats as history, by developing the SQL further

- generate more random route lines to make them look more polished by either:

Making the generation statements more specific for example adding a random amount of distance to latitude and longitude respectively instead of a static amount

Making a whole neural network or a cart decision tree machine learning algorithm to learn and design route which better generate more random and polished lines (further research would have to be conducted)

6.4 Lessons Learnt

During the project I have gotten a increased understanding of the problem domain as well as psychology surrounding it such as human habits. This helped with the creation of the application to solve the problem as well as gain experience for future development.

I have gained increased knowledge into project management by having to plan out and develop an artefact by using a project management methodology, which for this project Kanban was chosen after a critical review of other methodologies, which allowed me to learn where to use each methodology.

Learning about MoSCow requirements evaluation technique allowed me to further refine my skills in creating useful and quality requirements, which is good experience and prepares me for more software development projects. This allows me to better plan my time as well as reduces the risk of scope creeps happening in my projects.

While researching technologies to develop the application and critically evaluating them to pick the best ones I have learned about many tools which will be useful to me in future projects. I have learned that each tool has it uses, and some are better than others depending on the context. I have also learned how to make a simple Api server using node.js and using it with end points to gain results from my sql database. I have also learned more about UI and Ux design, which allowed me to create user friendly application. This is important step in software development as it is mostly created for the user further preparing me for the future projects.

Before starting the project, I have had no knowledge in the domain of spherical coordinate system and how it can be used to calculate distance in metric system as well as the other way around. During the research I have learned about Haversine, and Williams formula of aviation and applied it to my artefact. This will be useful to me in the future for more projects as well as real life scenarios which require to use coordinate systems.

6.5 Word Count

Word count (main body of the report): 7321

Word count Artefact(requirement analysis, implementation, artefact evaluation):5237

Total:12558

7 REFERENCES

Department of Health and Social Care ., 2020. New obesity strategy unveiled as country urged to lose weight to beat coronavirus (COVID-19) and protect the NHS [online]. GOV.UK. Available from: https://www.gov.uk/government/news/new-obesity-strategy-unveiled-as-country-urged-to-lose-weight-to-beat-coronavirus-covid-19-and-protect-the-nhs#:~:text=Living%20with%20excess%20weight%20puts,of%20the%20general%20population

Kueppers, P., 2015. *What's more important: Exercise or diet?* [online]. Allinahealth.org. Available from: https://www.allinahealth.org/healthysetgo/move/whats-more-important-exercise-or-diet

Baker, C., 2021. *Obesity Statistics* [online]. House of Commons Library. Available from: https://commonslibrary.parliament.uk/research-briefings/sn03336/ [Accessed 7 May 2021].

Jewell, T., 2020. *Best Fitness and Exercise Apps of 2020* [online]. Healthline. Available from: https://www.healthline.com/health/fitness-exercise/top-iphone-android-apps#8-fit-workouts-meal-planner [Accessed 7 May 2021].

Bains, P., 2020. *Exercise is key to living longer* [online]. Allinahealth.org. Available from: https://www.allinahealth.org/healthysetgo/move/exercise-is-key-to-living-longer [Accessed 7 May 2021].

Oaklander, M., 2015. *Here's Proof That People Are Wired To Be As Lazy As Possible* [online]. Time. Available from: https://time.com/4027942/lazy-walking-exercise/ [Accessed 12 May 2021].

A. Ahmed, M., 2019. *Can exercise extend your life? - Harvard Health Blog* [online]. Harvard Health Blog. Available from: https://www.health.harvard.edu/blog/can-exercise-extend-your-life-2019031316207 [Accessed 7 May 2021].

Wein, Ph.D., H., 2018. *Creating Healthy Habits* [online]. NIH News in Health. Available from: https://newsinhealth.nih.gov/2018/03/creating-healthy-habits [Accessed 7 May 2021].

Sailer, M., 2017. *How gamification motivates: An experimental study of the effects of specific game design elements on psychological need satisfaction* [online]. Science direct. Available from: https://www.sciencedirect.com/science/article/pii/S074756321630855X [Accessed 7 May 2021].

Canadian Management Centre, 2012. *Smart Objectives* [online]. image. Available from: https://thinkmarketingmagazine.com/how-to-create-smart-goals/ [Accessed 7 May 2021].

Markovic, I., 2019. *Hazard analysis and risk assement matrix* [online]. image. Available from: https://tms-outsource.com/blog/posts/risk-assessment-matrix/ [Accessed 7 May 2021].

Wilson, F., 2020. *How to Use the Risk Assessment Matrix in Project Management? - nTask* [online]. nTask. Available from: https://www.ntaskmanager.com/blog/risk-assessment-matrix/ [Accessed 7 May 2021].

MapMyFitness, Inc.Health & Fitness EveryoneEveryone, 2021. [online]. image. Available from: https://play.google.com/store/apps/details?id=com.mapmyrun.android2&hl=en_GB&gl=US [Accessed 7 May 2021].

Garmin, 2021. [online]. image. Available from: https://play.google.com/store/apps/details?id=com.garmin.android.apps.connectmobile&hl=en_GB&gl=US [Accessed 7 May 2021].

The Interaction Design Foundation., N/A. *What is User Experience (UX) Design?* [online]. The Interaction Design Foundation. Available from: https://www.interaction-design.org/literature/topics/ux-design [Accessed 7 May 2021].

Enginess, 2021. *The 6 Principles Of Design, a la Donald Norman | Enginess Insights* [online]. Enginess.io. Available from: https://www.enginess.io/insights/6-principles-design-la-donald-norman [Accessed 8 May 2021].

Rekhi, S., 2017. *Don Norman's Principles of Interaction Design* [online]. Medium. Available from: https://medium.com/@sachinrekhi/don-normans-principles-of-interaction-design-51025a2c0f33 [Accessed 8 May 2021].

Ingram, S., 2016. [online]. image. Available from: https://cloud.netlifyusercontent.com/assets/344dbf88-fdf9-42bb-adb4-46f01eedd629/496f7bc0-4c6c-4159-b731-ec3adcf91105/thumb-zone-mapping-opt.png [Accessed 8 May 2021].

Cardona, M., 2019. *Does Your Mobile Site Pass the Thumb Zone Test?* [online]. Volusion Ecommerce Blog | SMB Marketing, Design, & Strategy. Available from: https://www.volusion.com/blog/does-your-mobile-site-pass-the-thumb-zone-test/ [Accessed 8 May 2021].

UX247, 2019. *Mobile Usability Testing: Fat Finger Syndrome - UX24/7* [online]. UX24/7. Available from: https://ux247.com/mobile-usability-testing-fat-finger-syndrome/ [Accessed 8 May 2021].

The Knowledge Arcade, 2021. *The Ultimate Definition of Gamification (With 6 Real World Examples)* [online]. Growth Engineering. Available from: https://www.growthengineering.co.uk/definition-of-gamification/ [Accessed 8 May 2021].

DUPERRIN, B., 2012. *When gamification creates addiction and not engagement* [online]. Bertrand Duperrin's Notepad. Available from: https://www.duperrin.com/english/2012/12/11/when-gamification-creates-addiction-and-not-engagement/ [Accessed 8 May 2021].

Marczewski, A., 2014. *Why does Gamification Fail?* [online]. Gamified UK - #Gamification Expert. Available from: https://www.gamified.uk/2013/05/06/why-does-gamification-fail/ [Accessed 8 May 2021].

Climer, S., 2021. *What Is a Wireframe? 7 Reasons Why Wireframing Is Important In Web Design | Orbit Media Studios* [online]. Orbit Media Studios. Available from: https://www.orbitmedia.com/blog/7-reasons-to-wireframe/ [Accessed 8 May 2021].

Lu, k., 2021. [online]. image. Available from: https://careerfoundry.com/en/portfolios/katherine-lus-portfolio/ [Accessed 8 May 2021].

Encyclopaedia of Britannica, 2010. [online]. image. Available from: https://cdn.britannica.com/63/2063-004-606AA722/Perspective-globe-grid-parallels-meridians-longitude-latitude.jpg [Accessed 8 May 2021].

Encyclopaedia Britannica, 2008. *latitude and longitude | Definition, Examples, Diagrams, & Facts* [online]. Encyclopedia Britannica. Available from: https://www.britannica.com/science/latitude [Accessed 8 May 2021].

geospatial, 2017. *Distance on a sphere: The Haversine Formula – Geospatial Geoscience Ltd.* [online]. Ggspatial.co.uk. Available from: http://www.ggspatial.co.uk/distance-on-a-sphere-the-haversine-formula/ [Accessed 8 May 2021].

sketchplanations, 2021. [online]. image. Available from: https://sketchplanations.com/the-haversine-formula [Accessed 12 May 2021].

williams, E., 2021. *Aviation Formulary V1.47* [online]. Edwilliams.org. Available from: http://edwilliams.org/avform147.htm [Accessed 8 May 2021].

tuleap, 2021. [online]. image. Available from: https://www.tuleap.org/agile/agile-scrum-in-10-minutes/ [Accessed 8 May 2021].

Scrum,Master, 2021. *What is a Scrum Master?* [online]. Scrum.org. Available from: https://www.scrum.org/resources/what-is-a-scrum-master [Accessed 8 May 2021].

Scrum Product owner, 2021. *What is a Product Owner?* [online]. Scrum.org. Available from: https://www.scrum.org/resources/what-is-a-product-owner [Accessed 8 May 2021].

Scrum, 2021. *What is Scrum?* [online]. Scrum.org. Available from: https://www.scrum.org/resources/what-is-scrum [Accessed 8 May 2021].

Project Manager, 2021. *Waterfall Model: The Ultimate Guide to Waterfall Methodology* [online]. ProjectManager.com. Available from: https://www.projectmanager.com/waterfall-methodology [Accessed 8 May 2021].

Waddell, S., 2019. *watterfall* [online]. image. Available from: https://medium.com/@joneswaddell/the-cascading-costs-of-waterfall-5c3b1b8beaec [Accessed 8 May 2021].

Tutorial Points, 2021. *SDLC - Waterfall Model - Tutorialspoint* [online]. Tutorialspoint.com. Available from: https://www.tutorialspoint.com/sdlc/sdlc_waterfall_model.htm [Accessed 8 May 2021].

Smart Sheet, 2021. *Kanban* [online]. Smartsheet. Available from: https://www.smartsheet.com/content-center/best-practices/project-management/project-management-guide/kanban-methodology [Accessed 8 May 2021].

Knowledge Train Limited, 2019. *Principles of Kanban* [online]. image. Available from: https://www.knowledgetrain.co.uk/agile/kanban-principles [Accessed 8 May 2021].

Guru99, 2021. [online]. image. Available from: https://www.guru99.com/equivalence-partitioning-boundary-value-analysis.html [Accessed 8 May 2021].

Kivy, K., 2021. *Kivy: Cross-platform Python Framework for NUI* [online]. Kivy.org. Available from: https://kivy.org/#home [Accessed 7 May 2021].

Kotlin, K., 2021. *Kotlin Programming Language* [online]. Kotlin. Available from: https://kotlinlang.org/ [Accessed 7 May 2021].

Expo, E., 2021. *Introduction to Expo - Expo Documentation* [online]. Expo Documentation. Available from: https://docs.expo.io/ [Accessed 7 May 2021].

React Native, R., 2021. *Introduction · React Native* [online]. Reactnative.dev. Available from: https://reactnative.dev/docs/getting-started [Accessed 7 May 2021].

mikehardy, m., 2021. *react-native-maps/react-native-maps* [online]. GitHub. Available from: https://github.com/react-native-maps/react-native-maps [Accessed 7 May 2021].

karimcambridge, k., 2021. *bramus/react-native-maps-directions* [online]. GitHub. Available from: https://github.com/bramus/react-native-maps-directions [Accessed 7 May 2021].

node.js, n., 2021. *Documentation | Node.js* [online]. Node.js. Available from: https://nodejs.org/en/docs/ [Accessed 7 May 2021].

Karczmarczyk, K., 2019. *Should you use Node.js as your backend? • Future Mind* [online]. Futuremind.com. Available from: https://www.futuremind.com/blog/node-js-backend [Accessed 7 May 2021].

Expo, E., 2021. *Introduction to Expo - Expo Documentation* [online]. Expo Documentation. Available from: https://docs.expo.io/ [Accessed 7 May 2021].

MuleSoft, M., 2021. *What is an API? (Application Programming Interface) | MuleSoft* [online]. MuleSoft. Available from: https://www.mulesoft.com/resources/api/what-is-an-api [Accessed 8 May 2021].

sidorares, s., 2021. *sidorares/node-mysql2* [online]. GitHub. Available from: https://github.com/sidorares/node-mysql2 [Accessed 8 May 2021].

dougwilson, d., 2019. *body-parser* [online]. npm. Available from: https://www.npmjs.com/package/body-parser [Accessed 8 May 2021].

StatCounter, S., 2021. *Mobile Operating System Market Share Worldwide | StatCounter Global Stats* [online]. StatCounter Global Stats. Available from: https://gs.statcounter.com/os-market-share/mobile/worldwide [Accessed 7 May 2021].

RILEY, 2021. [online]. image. Available from: https://routeshuffle.com/ [Accessed 9 May 2021].

Tuğ, Y., 2021. [online]. image. Available from: https://www.pexels.com/photo/green-and-yellow-trees-beside-road-7485147/ [Accessed 10 May 2021].

Conchillos, A., 2021. [online]. image. Available from: https://images.pexels.com/photos/3941855/pexels-photo-3941855.jpeg?auto=compress&cs=tinysrgb&dpr=2&h=750&w=1260 [Accessed 10 May 2021].

Block, M., 2021. [online]. image. Available from: https://images.pexels.com/photos/3225517/pexels-photo-3225517.jpeg?auto=compress&cs=tinysrgb&dpr=1&w=500 [Accessed 10 May 2021].

MDN Web Docs, 2021. Object.keys() - JavaScript | MDN [online]. Developer.mozilla.org. Available from: https://developer.mozilla.org/en-US/docs/Web/JavaScript/Reference/Global_Objects/Object/keys [Accessed 12 May 2021].

APPENDIX A PROPOSAL FORM

Project Proposal Form

Please refer to the **Project Handbook Section 4** when completing this form

Degree Title: Software Engineering	**Student's Name:** Maciej Gebski
	Supervisor's Name: David Newell
	Project Title/Area: **Mobile Application – fitness app/running route planner**

Section 1: Project Overview

1.1 Problem definition - use one sentence to summarise the problem:

Deciding on where to run and how to plan a route for running in the morning and afternoon, finding out more about local area.

1.2 Project description - briefly explain your project:

The project is a mobile application, made to help people decide/learn about their local area while doing morning exercise. This application will produce a route for a user to run based on inputted parameters as well as be able to calculate calories.

1.3 Background - please provide brief background information, e.g., client, problem domain:

The main target is young adults/working class, there are currently a limited amount of application that solve this problem of being able to quickly make a route for running based on preferences, this application will plan the route with return to original destination in mind allowing the user to return to their home while continually running without running through the same streets, path.

1.4 Aims and objectives – what are the aims and objectives of your project?

Aim:

- This project aims for the artefact to be able to produce a route based on parameters and display it on a map.

Objectives:

- Create different routes
- Count calories burnt
- Calory calculator for food intake a day/week
- Evaluate the final product

Section 2: Artefact

2.1 What is the artefact that you intend to produce?

A mobile application that allows the users to choose distance for a morning/afternoon run. The application will choose a route depending on the desired parameters. The artefact will also track things like calorie burned and a daily calorie calculator.

2.2 How is your artefact actionable (i.e., routes to exploitation in the technology domain)?

It is an application made for a mobile phone, in this case android. Mobiles phones have become an item that most people carry with them everywhere, which means they are acquainted with the device. Mobile application produces an effortless way to access information at any time which enables the portability of the application, people are always going to bring a mobile phone with them on a morning or afternoon run where the application can be used.

Section 3: Evaluation

3.1 How are you going to evaluate your work?

I will evaluate my work using MoSCow which will allow me to rank requirements based on their priority which will allow me to weight the project and see if the success criteria has been met.
I will also compare other similar application with features that they have and compare my implementation to see if the application solves the given problem.
I will write a test plan and a test table to test all aspects of my application and requirements.
Throughout the project I will contact my supervisor to see if my work is satisfactory and if there is any suggestion for improvement.

3.2 Why is this project honours worthy?

This project is honours worthy because it combines all skills and knowledge, I have learned over the 3 years at Bournemouth university. This project is complex enough to challenge me and showcase my apply as a software engineer and use the principles I have learned to engineer a software application. This application requires a lot of preparation and planning which will improve my skills that are vital to produce high quality software, as well as learn new concept and knowledge through research. By creating this mobile application, I will also demonstrate my coding as well as problem solving skills to create the artefact.

3.3 How does this project relate to your degree title outcomes?

The software engineering degree requires a software related end-product, mobile application in this case which allows me to cover most of topics in software engineering. I have acquired knowledge from different modules which I have studied through my time at Bournemouth university, I will be using these skills to complete this project and create the artefact to high standards and quality.
In these 3 years I have studied about system design, which taught me how to use UML to visualize software and data flow and Application of programming, Application of programming principles and Principles of Programming which all taught me the basics to writing code as well as taught me coding standards and version control.
I also have studies databases and security units which are always used in all applications which contains data and used everywhere, which allows me to understand how to create databases and protect the data from basic threats and data theft. I am also still learning about UX and UI design from the module Ubiquitous computing which is teaching me to create a friendly interactive application which is easy to use and understand for the user.

3.4 How does your project meet the BCS Undergraduate Project Requirements?

This project allows me to display my skills and knowledge which I have acquired over the course of 3 years at Bournemouth university, in software engineering.
My project produces an artefact; a mobile application, and to make this artefact I will use required skills such as research and use of different project management methodologies and other skills such as

planning, designing, defining, testing and requirement engineering.

3.5 What are the risks in this project and how are you going to manage them?

2020 Pandemic - I will make sure I follow Government Guidelines as well as minimize my risk of infection by proper hygiene, and make sure I am prepared for any unforeseen circumstances by following my time management plan

Data loss - I will make sure I keep online backups, for this I will use one drive as well as GitHub private repo

Running out of time- For this I will make a Trello plan to track how I'm getting on with specific aspects of the application and if specification have been met on time

Section 4: References

4.1 Please provide references if you have used any.

Section 5: Ethics (please delete as appropriate)

5.1 Have you submitted online ethics checklist to your supervisor?	No
5.2 Has the checklist been approved by your supervisor?	No

Section 6: Proposed Plan (please attach your Gantt chart below)

	Name	Duration	Start	Finish
1	**Initial Stage**	12 days?	**01/02/21 08:00**	**16/02/21 17:00**
2	planning	12 days?	01/02/21 08:00	16/02/21 17:00
3	competitor research	12 days?	01/02/21 08:00	16/02/21 17:00
4	**First Task**	6 days?	**16/02/21 08:00**	**23/02/21 17:00**
5	Technical research	4 days?	16/02/21 08:00	19/02/21 17:00
6	Technical scope	2 days?	19/02/21 08:00	22/02/21 17:00
7	review of research	2 days?	22/02/21 08:00	23/02/21 17:00
8	**Design**	5 days?	**23/02/21 08:00**	**01/03/21 17:00**
9	Define the Structure and Architucture	5 days?	23/02/21 08:00	01/03/21 17:00
10	Review with a supevisor	1 day?	01/03/21 08:00	01/03/21 17:00
11	**Implementation**	18 days?	**02/03/21 08:00**	**25/03/21 17:00**
12	Create First Prototype	18 days?	02/03/21 08:00	25/03/21 17:00
13	**Testing phase**	8 days?	**25/03/21 08:00**	**05/04/21 17:00**
14	create testing plan	4 days?	25/03/21 08:00	30/03/21 17:00
15	evaluate effectivnes of testing	4 days?	30/03/21 07:00	02/04/21 17:00
16	evaluate the application	2 days?	02/04/21 07:00	05/04/21 17:00
17	**Conclusion phase**	29 days?	**05/04/21 08:00**	**13/05/21 17:00**
18	Write dissertation paper	15 days?	05/04/21 08:00	23/04/21 17:00
19	draft submittion	2 days?	23/04/21 08:00	26/04/21 17:00
20	polishing the application	5 days?	26/04/21 08:00	30/04/21 17:00
21	time unforeseen circumstances	10 days?	30/04/21 08:00	13/05/21 17:00
22	Submiton	67 days?	11/02/21 08:00	14/05/21 17:00

APPENDIX B MID TERM PROGRESS REVIEW

Department of Computing and Informatics

Undergraduate Project First Progress Review

To be completed and signed by the Supervisor and Student during week commencing 8 March 2021.

Student: Maciej Gebski	**Supervisor: David Newell**

Assessment

1. Definition of the problem *Has the problem been defined, has the artefact been identified and have objectives been set?*	
Comments: Satisfactory. Title is 'Mobile Application – fitness app/running route planner'. Aim and objectives clear. Deliverable is a mobile app. Although it is not novel there is a fair level of intellectual challenge.	
2. Review of literature and related work *Is there evidence of appropriate research?*	
Comments: Satisfactory. Literature review underway - feature analysis of comparable apps. Could be expanded.	
3. Methodology and Artefact *Is there evidence of appropriate analysis of the problem and design of a solution and appropriate evaluation?*	Choose an item.
Comments: Satisfactory. Some design underway with screen shots, needs further work.	
4. Dissertation *Have sections of the dissertation been written and has the Supervisor seen these?*	Choose an item.
Comments: Some sections completed, some catch up needed.	
5. Planning & Progress *Is there an acceptable plan for this project and is it being followed?*	Choose an item.
Comments: Satisfactory. Plan being followed.	
6. Proposal & Online Ethics Checklist *Are proposal and ethic checklist submitted? Are they approved?*	Choose an item.
7. Overall Assessment	Satisfactory
Signed: Supervisor: David Newell, Student: Maciej Gebski Date: 10 May 2021 V2	

- Supervisor to retain the signed form and supply the student with a copy if required.
- Supervisor to upload the form on Brightspace and grade as *Satisfactory, Requires Major Improvement, Requires Minor Improvement, Unsatisfactory or Invalid*.
- Supervisor to notify the Project Coordinator if the student is at risk of failing the project or not engaging.

APPENDIX C ETHICS CHECKLIST

Bournemouth University

Research Ethics Checklist

About Your Checklist	
Ethics ID	36302
Date Created	12/02/2021 13:20:47
Status	Approved
Date Approved	11/05/2021 18:12:06
Date Submitted	12/02/2021 13:25:38
Risk	Low

Researcher Details	
Name	Maciej Gebski
Faculty	Faculty of Science & Technology
Status	Undergraduate (BA, BSc)
Course	BSc (Hons) Software Engineering
Have you received funding to support this research project?	

Project Details	
Title	Fitness application
Start Date of Project	01/02/2021
End Date of Project	14/05/2021
Proposed Start Date of Data Collection	01/02/2021
Supervisor	David Newell
Approver	David Newell

Summary - no more than 600 words (including detail on background methodology, sample, outcomes, etc.)

A fitness application made for a user to input their desired prefrences and the application to create route for the user to walk/run and calculate calories and meters walked

None of the filter questions apply to my study

I am confirming that my proposed project does not:

- Involve human participants
- Involve the use of human tissue

Printed On 11/05/2021 22:05:47

- Involve medical research requiring NHS ethical / REC Approval
- Involve the use of animals (or tissues/fluids derived from animals)
- Involve access to identifiable personal data for living individuals not already in the public domain
- Involve increased danger of physical or psychological harm for researcher(s) or subject(s)
- Raise any ethical issues associated with the use of genetically modified organisms

On this basis, my proposed project does not require a formal ethics review.

If any changes to the project involve any of the criteria above, I undertake to resubmit the project for formal ethical approval.

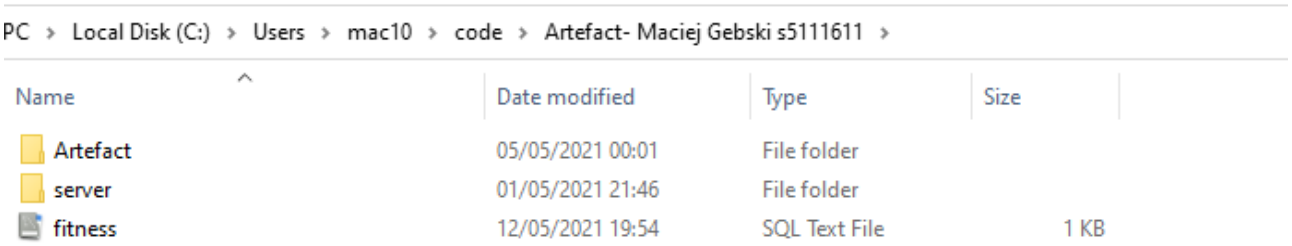
APPENDIX D LIST OF CONTENT

List of content of the artefact submition:

Artefact andriod application In expo Folder name : dest

Server folder, node.js Folder name : Server

MySQL schema File name :fitness



APPENDIX F NEW GANTT CHART