Software Development Final Project

Driving Companion App

Final Report

Student: Chi Ieong Ng C00223421
Supervisor: Hisain Elshaafi
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1. Introduction

This Final Report is part of my final year project in ITCarlow Software Development Year 4. I decided to develop a mobile app called “Driving companion app”. The app will score and give feedback to drivers by monitoring their driving behavior.

Driving Companion App is a mobile phone application whose purpose is to analyze the user's driving behavior, obtain data from the monitoring process, and give scores and feedback to improve the user's driving behavior.

This document concluded the details of this project, the environment and requirements needed to develop the mobile phone application, how to calculate the driving score, the introduction of all the interfaces and functions of the final design, and the challenges and problems encountered during the development of this project. Things and techniques learned from developing this project.

2. Project Description

This project aims to improve the driving skills of all kinds of drivers, including beginners, experienced drivers, seniors, etc. To develop a simple-to-operate mobile phone application, obtain and analyze the driving data of the vehicle's speed, acceleration, and deceleration during monitoring driving. Scoring and reporting driving assessment enables drivers to understand their driving ability and driving faults. The Application will point out the location of driving errors and details to let users be vigilant and improve their driving skills. The app also provides other additional helpful functions, such as checking the driver's comprehensive ability, reviewing past driving records, encouraging drivers to challenge rankings, and selecting different scoring methods according to the driver's ability.

3. Technology Description

Since Project develops a mobile phone application for scoring driving behavior, the mobile phone is the most suitable platform for using this application during driving. Its convenience allows the driver to control the application while driving. The most appropriate operating system for the mobile phone is Android. Flutter is a platform for developing mobile applications, and it only supports the Dart programming

language. Its advantages are that it is easy to learn and use, and it only needs to write one programming language to support both Android and iOS platforms. The background of the mobile phone application uses Firebase as the cloud data storage. It can store data on the internet and has its login and registration system, saving time from coding login and registration; a Google service's security is guaranteed. In addition, to obtain the user's driving data can be obtained by turning on the mobile phone's hardware GPS function and the Google Road API service.

Below is a description of each technologies used in this project:

3.1 Flutter

Flutter is an open-source mobile application software development kit developed by Google. Its engine is mainly written in C++ and provides low-level rendering support using Google's Skia graphics library. Android and IOS also provide Platform-specific SDKs. It can use one programming language (Dart) to create cross-platform applications with Android and iOS and supported Web and desktop applications.

Flutter is a widget-based technology. It can apply object-oriented programming to any element and easily modify or customize widgets.

Flutter has numerous advantages over its competitors. These advantages are inherent in programming languages and development toolsets, allowing Flutter to solve problems that other languages cannot.

- One codebase for all platforms
- Widgets offer countless possibilities
- Rich libraries
- Fast testing with hot reload

Now Flutter is widely used to create apps for Alibaba, Yandex, Airbnb, Uber, eBay and other leading companies. Many excellent social media apps, service booking apps, productivity measurement apps, utility apps, product distribution apps and healthcare apps, all built with Flutter.

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3.2. Dart

Dart is a programming language developed by Google. It is an Object-oriented language similar to JavaScript. It can compile to either native code or javascript, and its grammatical style is close to the C language. It is a programming language very suitable for web and mobile application development. Dart can be executed on a native virtual machine, converted Dart code to JavaScript, and then performed directly on the Javascript engine. Dart can quickly use the Library provided by Google, and users can also offer their self-written Library for other developers or other projects to use.

3.3. Google Maps API / Roads API

Google Maps API is a Maps programming API provided by Google for developers. It allows developers to embed Google Maps data into web apps by using Javascript. Mainly used to get location, navigation, and map service. Roads API is part of Google Maps API. It maps GPS coordinates to the road and determines speed limits

and road segments. It is available via a simple HTTPS interface to expose Snap to roads, Nearest roads, and Speed limits services. And it is compatible with Java and Python. Its libraries make development more accessible by providing simple, native implementations of everyday tasks, such as authentication, request throttling and automatic retry. However, It is not entirely free to use. Google will charge it after the primary free usage is exceeded.

3.4. Firebase

Firebase is a back-end cloud platform (BaaS: Backend-as-a-Service) that provides real-time database service. It is a NoSQL cloud database and supports Android, iOS and Web apps. It can save data in JSON format and synchronize to the online client in real-time. And even if the user is offline, the data is still available.

4. Driving Score

The driving score is the core part of this application, and it is mainly influenced by three factors, including "Speeding", "Acceleration", and "Deceleration". According to the GPS positioning of the mobile phone, the three types of data are calculated through a specific Algorithm. The details are as follows:

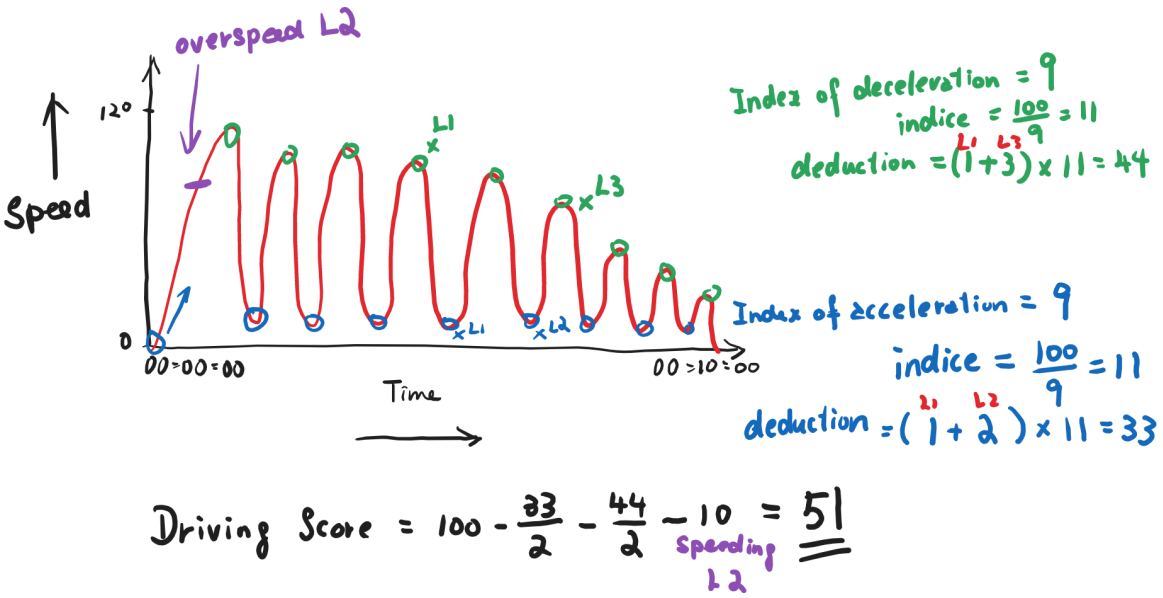
Speeding: It is the driving speed, which is mainly about the driving speed and the speed limit of the road. If the user's current driving speed exceeds the speed limit specified by the road, the system will deduct points and divide them into five grades according to the percentage of the exceeding speed. Level 1 is 5% over the speed limit; Level 2 is 10% over the speed limit; level 3 is 15% over the speed limit; level 4 is 30% over the speed limit; level 5 Level is 50% of the speed over the speed limit. The higher the level, the more points will be deducted.

Acceleration: it is the acceleration of driving, according to the data obtained from the speed of the previous second and the increase of the current speed, according to the change of the acceleration of one second, divided into five levels; the first level is the speed increase of 6km/h per second, the second Level 1 is an increase of 8km/h per second, level 3 is an increase of 10km/h per second, level 4 is a speed increase of 12km/h per second, and level 5 is a speed increase of 14km/h per second. The higher the level, the more points will be deducted.

Deceleration: It is the deceleration of driving, according to the data obtained from the speed of the previous second and the reduction of the current speed, it is divided into five levels according to the change of the deceleration of one second. The first level is the speed reduction of 7km/h per second. The second level is a reduction of 10km/h per second, the third level is a reduction of 13km/h per second, the fourth level is a reduction of 16km/h per second, and the fifth level is a reduction of 19km/h per second. The higher the level, the more points will be deducted. The specific number of deductions will be explained later.

The scoring calculation method first gives 100 total points and then deducts points from the user's mistakes according to the level of the above three factors. In terms of acceleration and deceleration, the system will calculate the total index of acceleration and deceleration. These indices will be proportional, and each has a certain percentage of points. For example, if the acceleration index is 20 (The algorithm for deceleration is the same), its proportion is calculated as 100%, and each index worth 5%. If the user makes mistakes in the corresponding index, points will be deducted according to the error level. If it is level 1 error, it will lose 1. Level 2 error loses 2, level 3 error loses 3, and level 4 error loses 4. Level 5 error loses 5. Finally, these deductions are multiplied by the percentage of the single index, divided by the Total Index, and multiplied by 100.

For example, If the total error of acceleration level adds up to 3, and the total acceleration index is 9, so each indice will be 11, then total error 3 will be multiplied by indice (11) and come out 33, Since acceleration and deceleration each account for 50% of the score, divide this number by 2. So, finally, the deduction for acceleration is 16.5. Then assume that the “deceleration” deduction is 22 and the “speeding” deduction is 10. Finally the acceleration deduction and deceleration deduction will directly subtract from the original score of 100, come out 100 - 16.5 - 22 - 10 = 51(int), The result of the driving score is 51 points.



Although the driving score has been tested many times, it may not be perfect. In order to take this into account, the user can select the driving classification according to their own driving score requirements in the settings of this program. It is divided into "Beginner", "Intermediate", and "Advanced". The previous rating is "Intermediate", which is the default level for all users, "Beginner" has lower requirements than "Intermediate", and "Advanced" has higher requirements than "Intermediate". Acceleration and deceleration are more sensitive than other methods. Suppose these three settings are not perfect if the user has admin permission. In that case, the admin users can change the values of these three factors in the settings of this application by themselves and by modifying these values to get the most satisfactory score calculation method.

5. Final Design

This section is the process of this application, starting from “Main Menu” and the connection relationship of each functional interface.

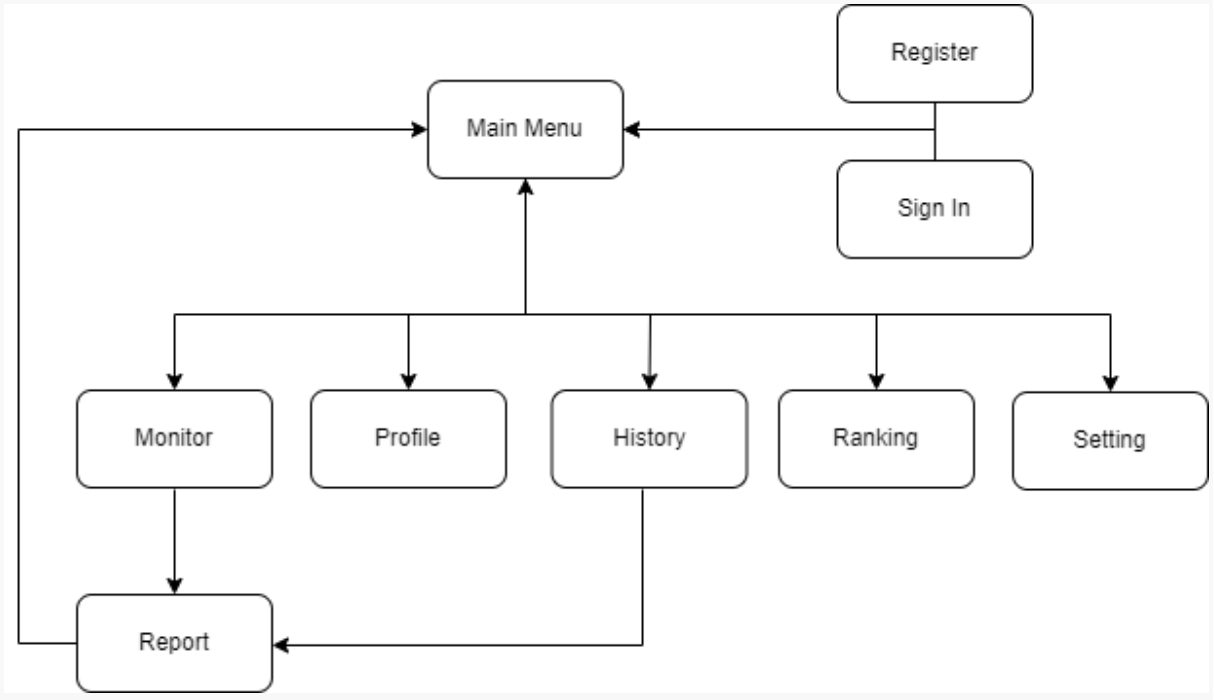


Fig 1 - Application process

5.1 Main Menu

The role of the main menu is to provide a path to various functions, including:

- Monitor - Used to monitor driving, obtain driving data, and finally report driving score;
- Profile - Displays the user's comprehensive driving score and comprehensive data;
- History - Review the user's past driving records and driving report;
- Ranking - Compare users with other users by driving score;
- Setting - Let the user choose a scoring method;
- Sign out - sign out the current user.

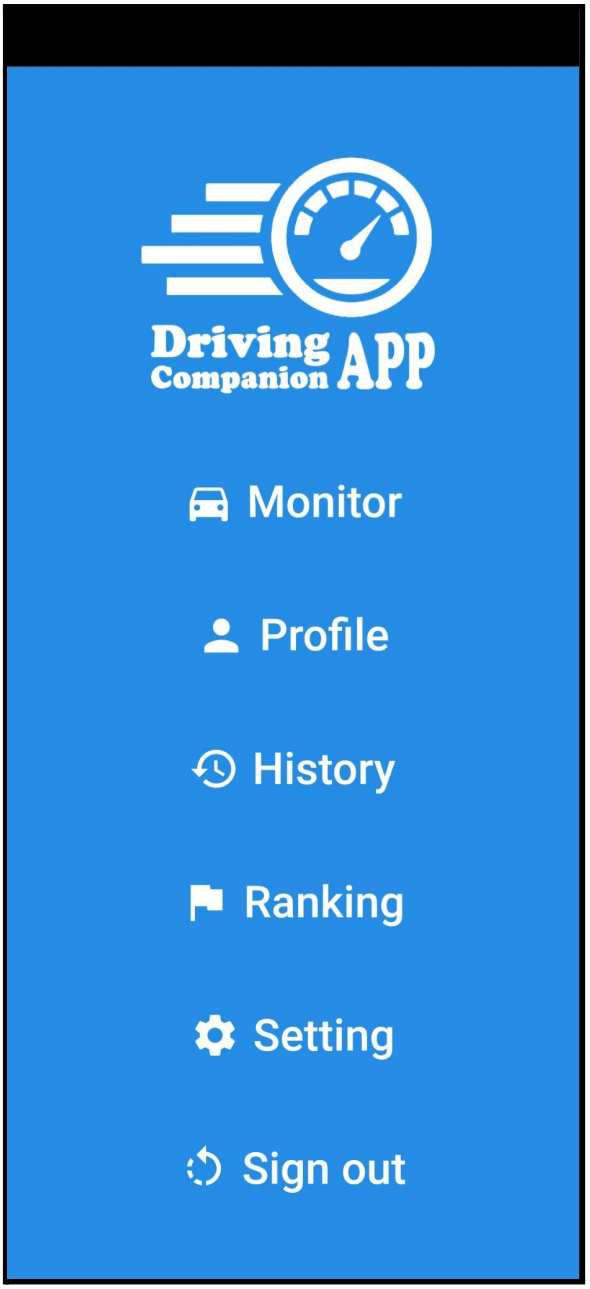


Fig2 - Main Menu Screen

5.2 Monitor

The interface of real-time driving monitoring mainly displays a real-time map, real-time speed and timer.

- The real-time map shows the user's location during driving; it draws the driving route and marks the icon at the location of the user error.
- The real-time speed is updated every second, indicating the vehicle's current speed.
- The timer is to count the current driving time.
- After the user presses the green circular "Start" button at the bottom, it will turn red, and the monitoring will begin, getting real-time speed data every second in the backend.
- When the driving is finished, the user presses the red "Stop" button. The monitoring will end. All the obtained data will be sent to the following "Report" page for further analysis and scoring.

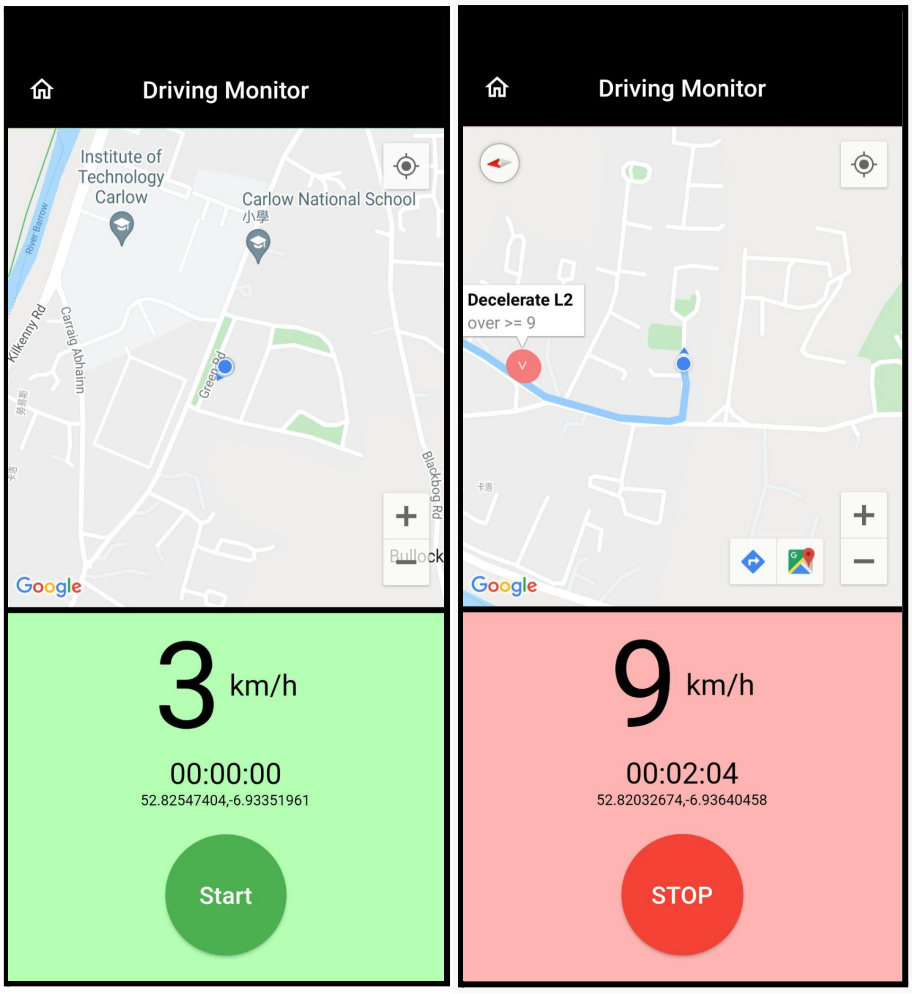


Fig 3 Driving Monitor Screen

5.3 Report

When the driver completes the driving monitor, it will show the driving score and short evaluation and the total driving time and distance traveled.

Short evaluations are divided into: Excellent - 90 points or more, Very Good - 80 points or more, Good - 70 points or more, Average - 60 points or more, Fair - 50 points or more, Poor - 40 points or more, Very Poor - 40 or less.

In addition, pressing the "Details" button will jump to another page, where the technical evaluation of speed, acceleration, and braking is displayed. The map can review the route of the driving journey and point out the error in the location.

Acceleration errors are orange, from shallow to deep according to the level, and deceleration errors are red, from shallow to deep according to the level. Click to see the time and speed changes.

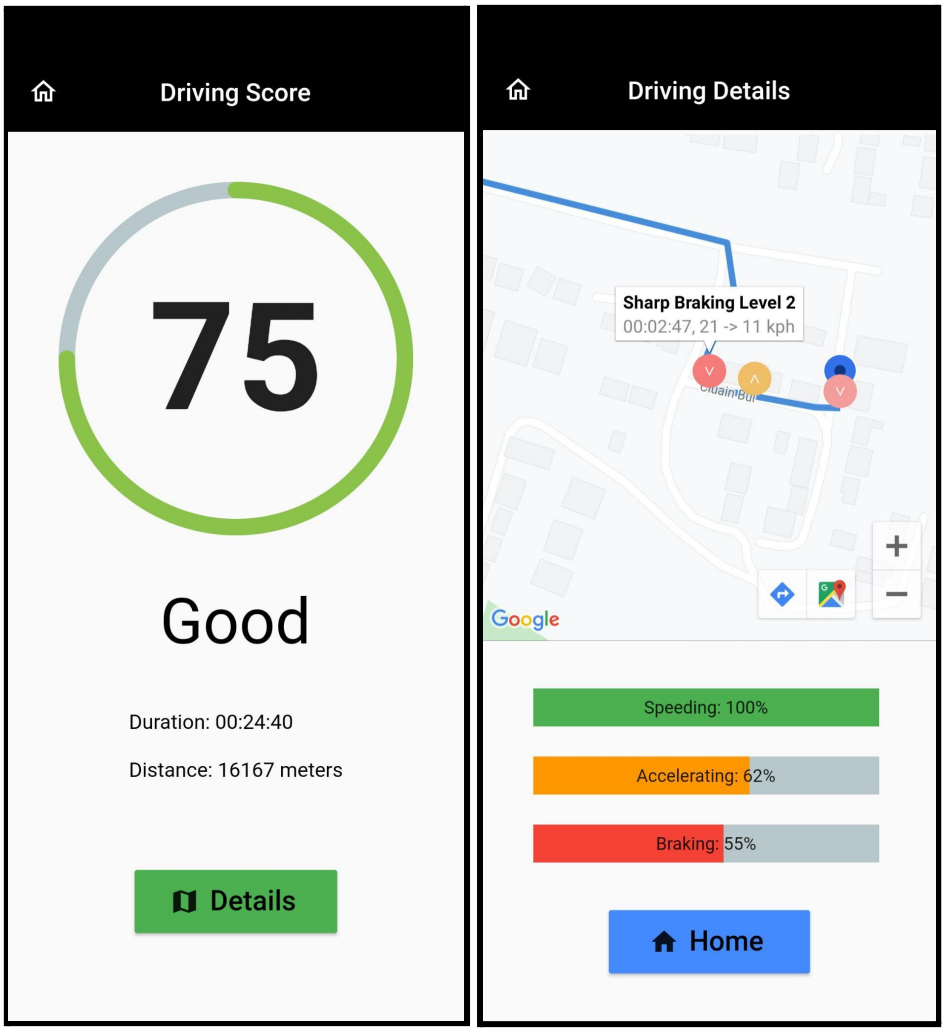


Fig 4 Report screen

5.4 Profile

The profile shows the current user's comprehensive evaluation, calculated based on the last ten driving records. It shows a linear graph of score changes, where users can see their driving improvement, total driving times, total driving time and total driving distance.

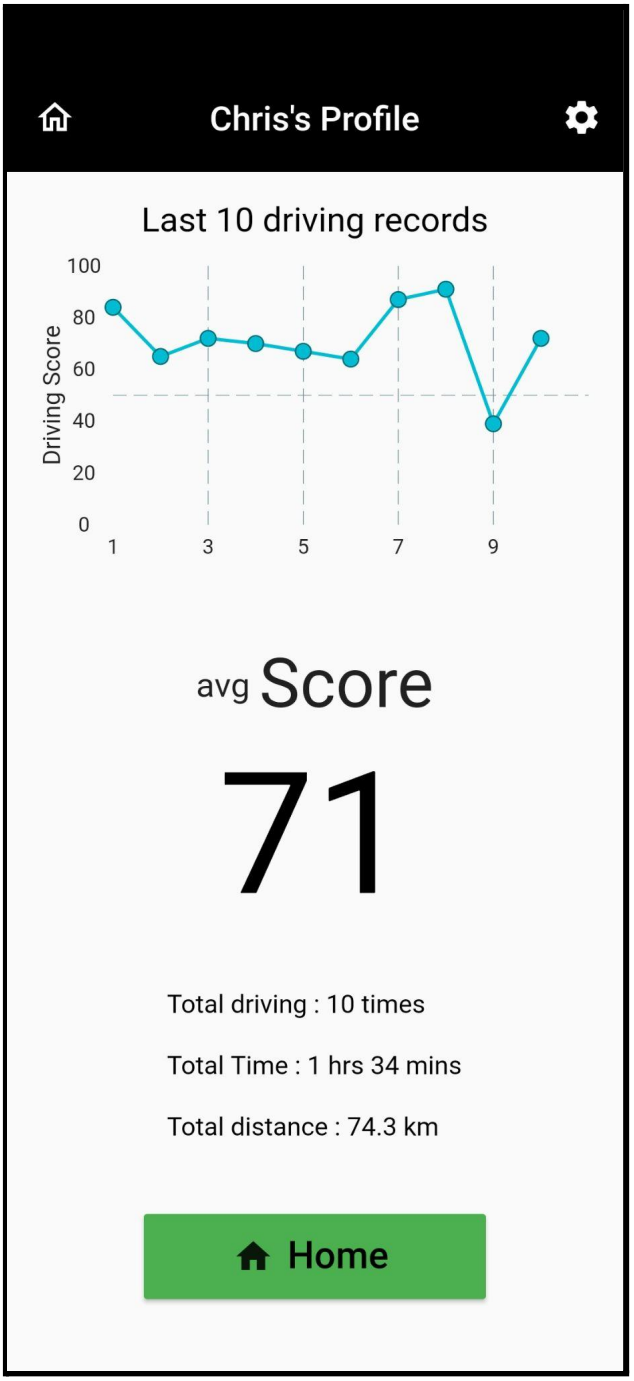


Fig 5 Profile screen

5.5 Review

Review can review the past driving records of the current user. It displays in the form of a list and supports gestures to drag up and down. Each row is a driving record. The short display information includes the driving date, driving time and driving distance. Press the "Details" button to Jump to the "Report" page of 3.3 to display the driving report for that record.

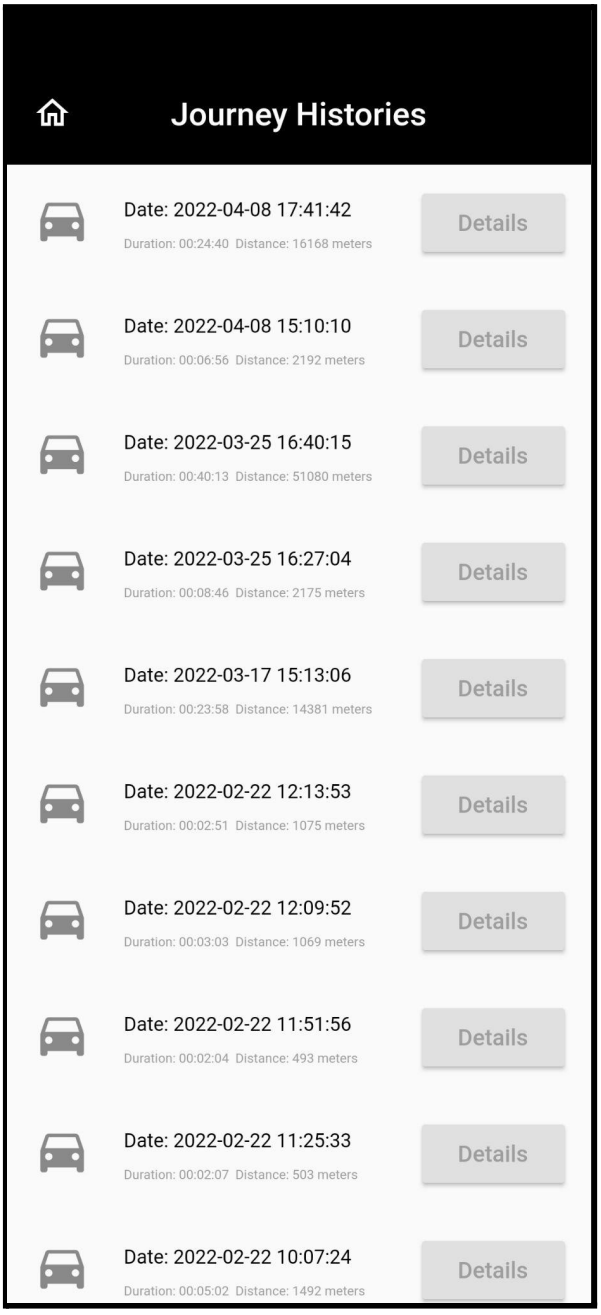


Fig 6 Review screen

5.6 Ranking

In order to encourage drivers to improve their driving behavior, the Ranking system allows drivers to actively improve their scores to improve their rankings through the comparison of driving scores between users. This system also allows drivers to know which level their driving skills belong.

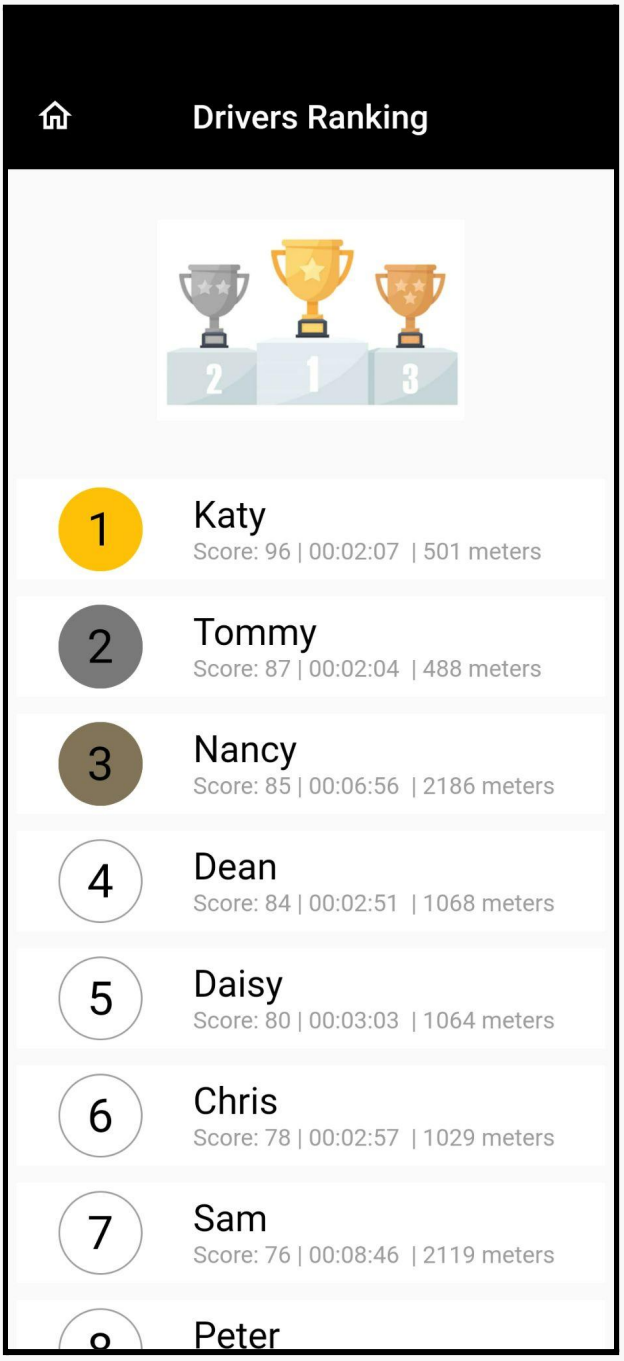


Fig 7 Ranking screen

5.7 Setting

Settings allow users to choose a driving scoring method, which is divided into three categories:

- Beginner - Lower scoring requirements can accommodate more errors;
- Intermediate (default) - the default scoring method;
- Advanced - higher score requirements, more deductions, and more speed-sensitive.

When the user selects the method from the option and presses the "Save" button, the scoring will use the chosen method.

In addition, if the user is at the admin level, the admin user can press the "Edit" button to modify the value of the scoring factor and change the scoring method.

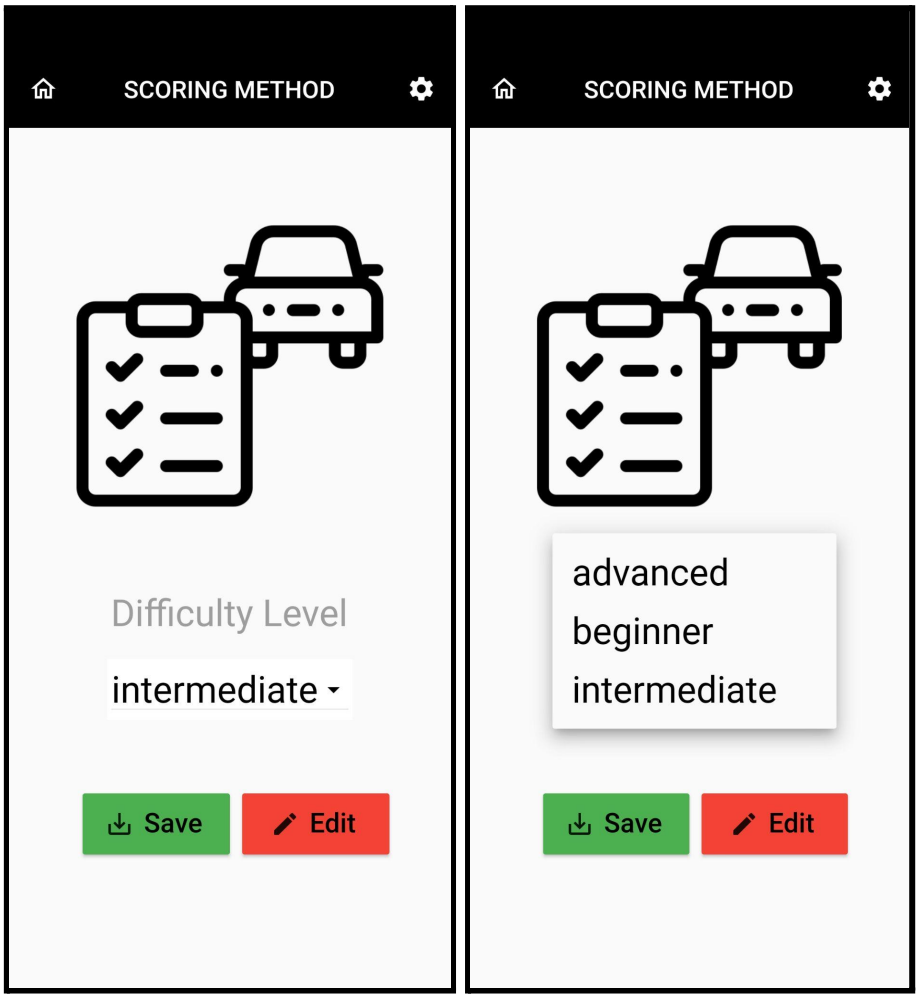


Fig 8 Setting screen

5.8 Authentication

When the user uses the program for the first time, he needs to register a new account, click the text button "Register new account" on the login page to enter the registration page and fill in the required information to register as a new user.

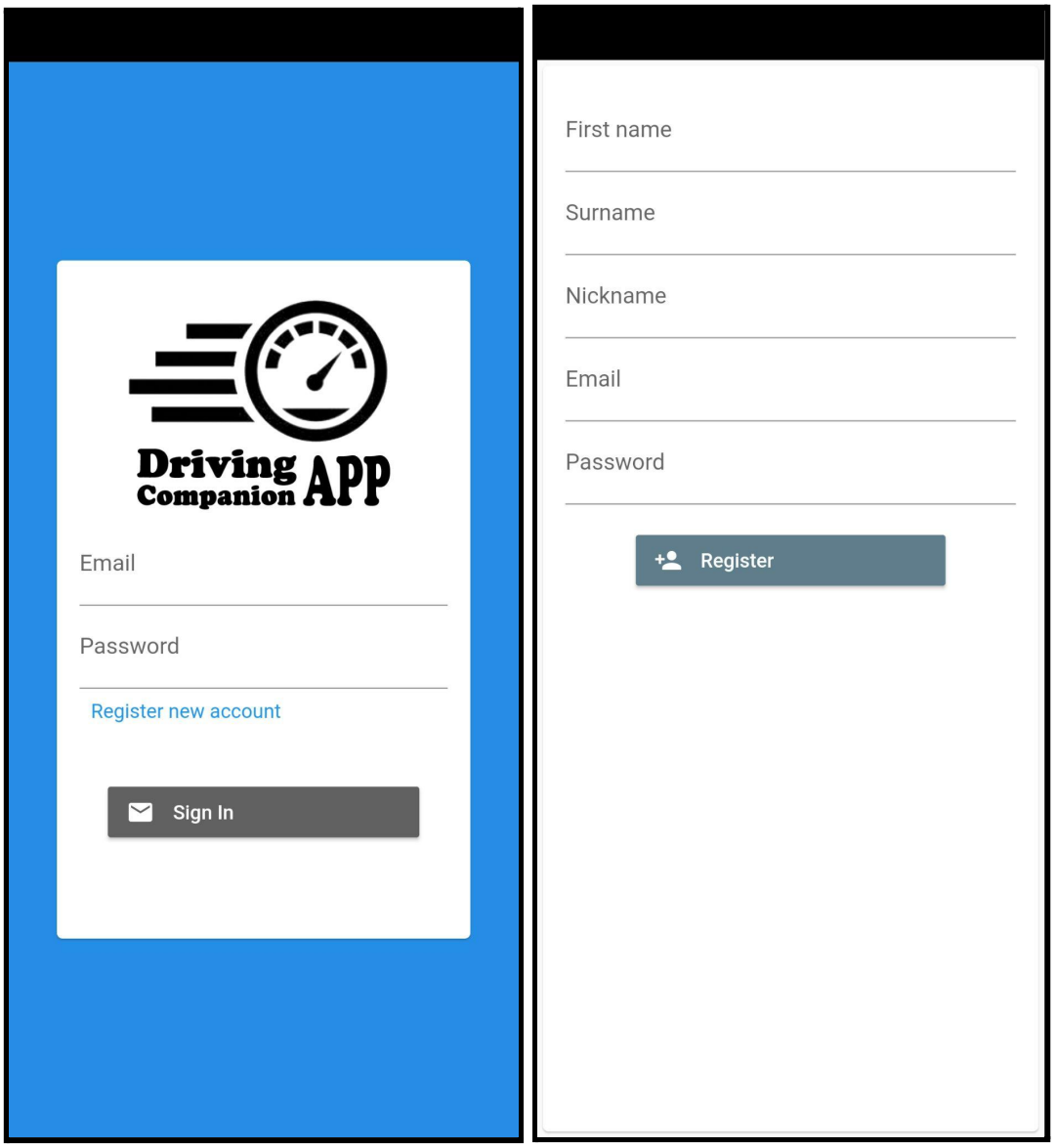


Fig 9 Register and Login screen

6. Final Database Structure

The database of the "Driving Companion App" is performed through the Firebase cloud platform. It is a back-end cloud platform (BaaS: Backend-as-a-Service) that

provides real-time database service. It is a NOSQL cloud database and supports Android, iOS and Web apps. It can save data in JSON format and synchronise to the online client in real-time. And even if the user is offline, the data is still available.

The main cloud data is divided into “Algorithms”, “Journeys” and “Users”. The details are as follows:

6.1 Algorithm data

It is mainly responsible for accessing the driving score scoring methods, and each scoring method has three factors that affect the driving score:

- **“Speeding”** : The percentage value of 5 levels exceeding the speed limit of the road is a List stored in int format.
- **“Accelerating”** : 5 levels of driving acceleration values, it is a List that stores values in int format.
- **”Decelerating”** : 5 levels of driving deceleration values, it is a List that stores the value in int format.

And each file is named by scoring: "Beginner", "Intermediate", and "Advanced", and their respective three-factor values are stored and read in List mode.

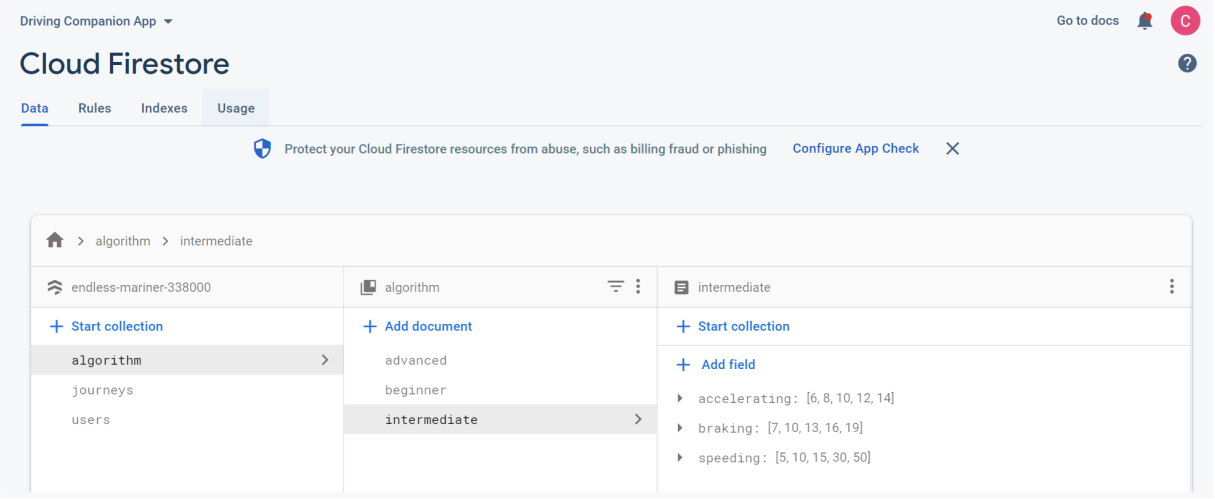


Fig 10 - Algorithm data structure

6.2 Journeys data

It is responsible for the driving data of all users. Each file is named with a unique automatic ID. The file name will not be repeated. Each file is an independent driving record, including:

- **”createdAt”** : The creation time and date of the driving record, stored in timestamp format.
- **“geoPoint”** : The coordinates of the geographic location, it is a List that stores the value of each geopoint format.
- **“speed”** : Driving speed, it is a List that stores each value in int format.
- **“time”** : Driving time, it is a List that stores each value in String format;
- **“userUID”** : The ID of the user to which the driving record belongs, stored as a value in String format.

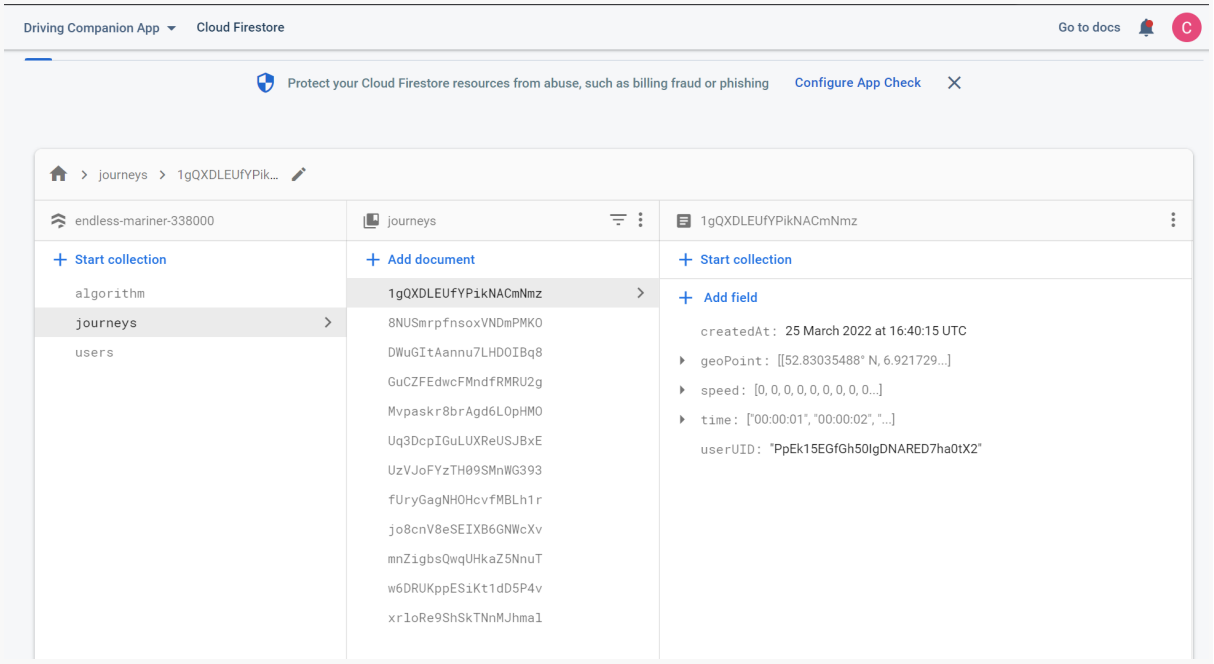


Fig 11 - Journeys data structure

6.3 Users data

It is the data responsible for all user information, each file is named with userUID (ie user id), and the data of each user includes:

“algorithm” : The scoring method selected by the user, the general default is "Intermediate", which is stored in String format.

“createdAt” : The date and time when the user was created, stored in timestamp format.

“email” : User's email address, stored in String format.

“firstname” : The real first name of the user, stored in String format.

“group” : The group to which the user belongs, generally divided into "admin" and "user", which are stored in String format.

“nickname” : The nickname of the user, used to avoid exposing the real name when ranking, it is stored in String format.

“surname” : The real surname of the user, stored in String format.

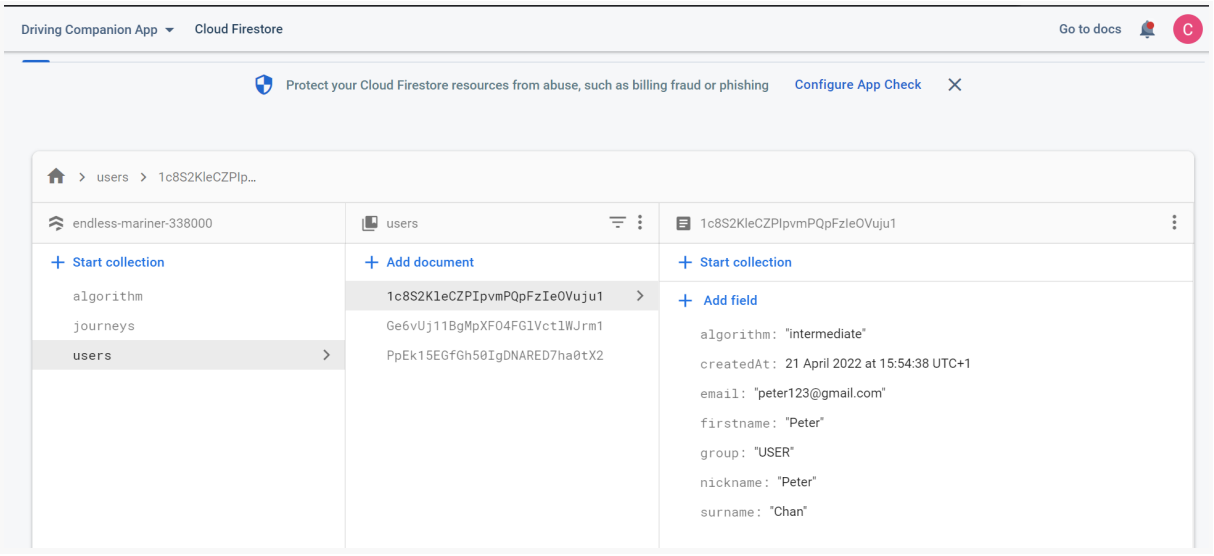


Fig 3 - Users data structure

In addition, the user account is managed by using Firebase's built-in Authentication system, which records the "User name", "Created date" , "Last Signed in date", "User UID" (automatically generated by the system).

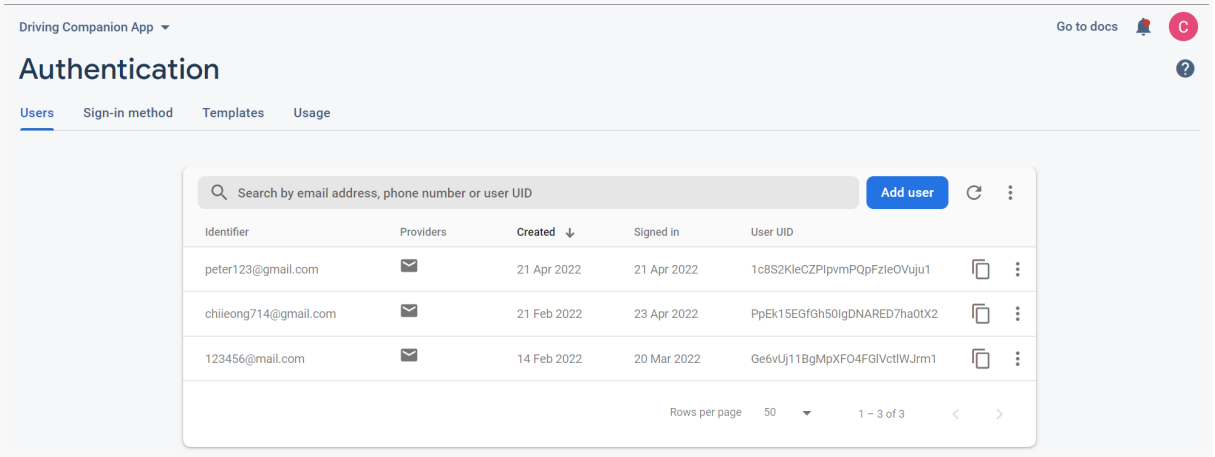


Fig 12 - Authentication data

7. Final Testing

The app for my test project is basically focused on getting the accuracy and reporting of driving data in actual driving. The authentication system is connected and relies on Google Firebase, which can be guaranteed in terms of security. And this app is also designed for seniors, and they may be unfamiliar with using mobile apps, so just press "Start" and "Stop" to use. Since there is almost no input request by users, all class functions are internal, so there are no unexpected inputs, and every time a class function is written, it passes the test, prints out various results, and passes it one by one before it is used.

The testing documentation as follows:

Test environment

- Mobile phone model: Oppo Reno4
- OS: Android 10
- CPU: Qualcomm SDM765G 5G
- Storage 128GB Ram 8GB
- Network: Eircom limited Ireland, 4G signal

Testcase

ID	Action	Input	Result	Test
1	Double-click the app's icon on the phone		The application is opened and the login page is displayed	Pass
2	Login screen without entering account and password to log in		not logged in	Pass
3	Login screen only enter email	email: 123@mail	not logged in	Pass
4	Enter the correct email and wrong password on the login screen	email: 123@mail password: 0000	not logged in	Pass
5	Enter the correct email and correct password on the login screen	email: 123@mail password: 123456	Login successful and move to main menu	Pass
6	Press the "Register new account" button on the login page		Successfully entered the registration page	Pass
7	Do not fill in anything on the registration page and press the "Register" button		Stay on the registration page	Pass
8	After filling in all the information on the registration page, press the "Register" button	email: abc@mail password: 123456	Successfully go to the login page, the account has been created and can be successfully logged in	Pass
9	Fill in the registered email on the registration page and press the "Register" button	email: 123@mail password: 123456	Failed to create an account, user must re-fill and stay the original registration page	Pass
10	Press the "Monitor" path in the main menu		Successfully go to the “Monitor” page	Pass
11	Press the "Profile" path in the main menu		Successfully go to the “Profile” page	Pass
12	Press the "History" path in the main menu		Successfully go to the “History” page	Pass
13	Press the "Ranking" path in the main menu		Successfully go to the “Ranking” page	Pass
14	Press the "Setting" path in the main menu		Successfully go to the “Setting” page	Pass
15	Press the "Sign out" path in the main menu		User is logged out, back to login page	Pass

ID	Action	Input	Result	Test
16	Press the "Home" button on the "Profile" page		Return to main menu successfully	Pass
17	Select a driving record on the "History" page and press the "Details" button		Successfully entered the report page for this driving record	Pass
18	Press the "Details" button on the Report page		The page that successfully displays the "Route Map"	Pass
19	Press the "Home" button on the "Route Map" page		Successfully returned to the "Main Menu" page	Pass
20	Press the top-left corner "Home" icon on the "Report" page		Successfully returned to the "Main Menu" page	Pass
21	Press the top-left corner "Home" icon on the "Route Map" page		Successfully returned to the "Main Menu" page	Pass
22	On the "Setting" page, select the "beginner" scoring method and press the "Save" button		Then go back to the "Report" page and see that the driving score has changed	Pass
23	On the "Setting" page, select the "intermediate" scoring method and press the "Save" button		Then go back to the "Report" page and see that the driving score has changed	Pass
24	On the "Setting" page, select the "advanced" scoring method and press the "Save" button		Then go back to the "Report" page and see that the driving score has changed	Pass
25	Open the "Monitor" page in the "Main Menu"		The "Monitor" page is successfully entered, and the user is in the correct position on the map.	Pass
26	Turn off the mobile phone GPS and turn on the "Monitor" function		The system will pop up a prompt asking the user for authorization to turn on the GPS function	Pass
27	On the "Monitor" map, use gestures to zoom in and out		Map successfully zooms in and out with gestures	Pass
28	On the "Monitor" map, use the move gesture to drag the map		The map location tracks the movement of the finger	Pass

ID	Action	Input	Result	Test
29	Press the "Start" button on the "Monitor" page and start real driving		The theme style is successfully switched from green to red, the map tracking user location is correct, the route indicated by the blue line is correct, the speed is consistent with the speedometer of the vehicle, the error is less than 2km/h, the update per second is normal, the time of the time hand is normal, the screen Smooth and no lag.	Pass
30	Sharp acceleration of the real driving while using the "Monitor" function		Successfully detected sharp acceleration errors and correctly displayed relevant hints on the map	Pass
31	After the above sharp acceleration occurs, finish driving, press the "Stop" button		Successfully entered the "Report" page, "Accelerating" was correctly deducted points.	Pass
32	Sharp deceleration of the real driving while using the "Monitor" function		Successfully detected sharp deceleration errors and correctly displayed relevant hints on the map	Pass
33	After the above sharp deceleration occurs, finish driving, press the "Stop" button		Successfully entered the "Report" page, "Decelerating" was correctly deducted points.	Pass
32	While using the "Monitor" function, increase the speed of the vehicle above the road speed limit on the highway "M9", then finish the driving and press the “Stop” button		Successfully entered the "Report" page, "Speeding" was correctly deducted points.	Pass
33	While using the "Monitor" function, increase the speed of the vehicle above the road speed limit on the national road "M80", then finish the driving and press the “Stop” button		Successfully entered the "Report" page, "Speeding" was correctly deducted points.	Pass

ID	Action	Input	Result	Test
33	After completing the "Monitor" function, open the "Report" page		The recorded time is consistent with the real time, and the difference between the driving distance and the distance calculated by Google Maps is less than 3%, which is acceptable	Pass
34	Turn on the "Monitor" function and drive for 20 minutes		Phone keeps running and doesn't go into sleep mode	Pass
35	Turn on the "Monitor" function and do a real drive, hitting the app on the way from foreground, hidden to background operation		Bring the app back to the foreground again, the time meter is calculated normally in the background, and the route also continues to draw normally in the background	Pass

8. Project management

This project is very orderly and follows the guidelines. My Project Supervisor and I have an online meeting every week, and every week I will report my progress to my Project Supervisor, who will provide me with helpful comments and ways to improve. It was my first time developing a mobile application. The technology used was never learned, so I chose to learn the newest mobile development platform, Flutter and its corresponding programming language, Dart. I spent the whole Christmas vacation concentrating on learning Those new technologies; doing some online tutorials, I applied the techniques I learned to the coding process, making my coding very smooth. I spent most of the time testing how to get driving data accurately. Even when I had almost finished my app, my Project Supervisor suggested adding some extra features, so I finally added different scoring methods and allowed admin users to modify them to make driving scoring more flexible; users can set better driving score values to perfect it. The subsequent Easter break had everything sorted and prepped for the final demonstration and prepared all possible questions to review the entire project.

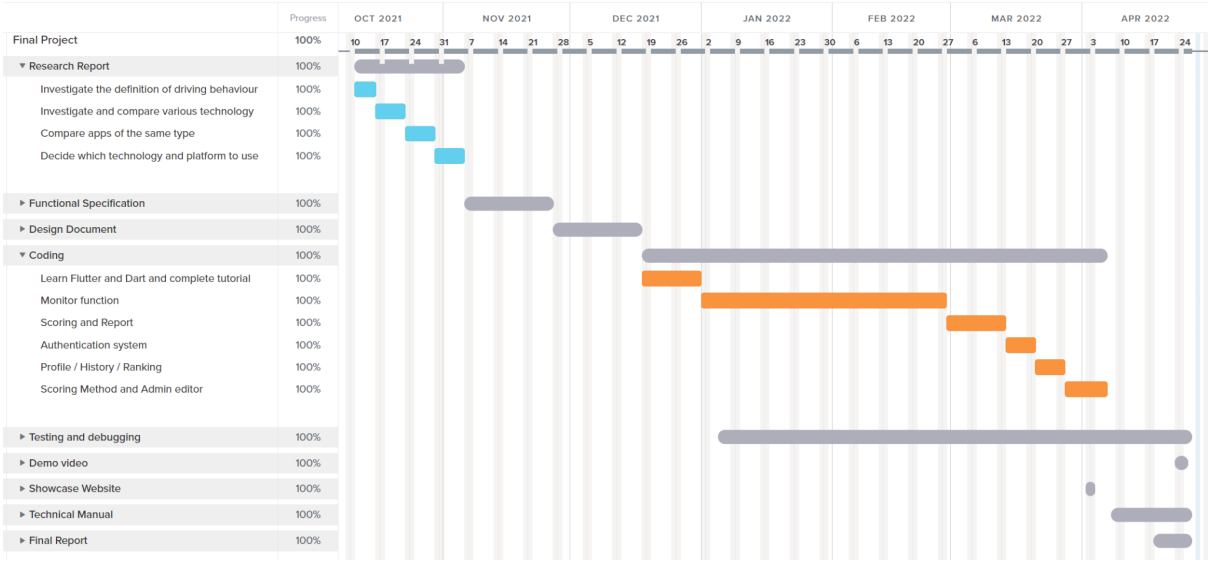


Fig 13 - Project Gantt Chart

9. Challenges and Learning Outcomes

This section describes the challenges encountered during this project's development, what was learned from these studies and techniques by solving problems, and various things experienced in completing the project

9.1 Challenges and learnings from Flutter

Using Flutter to develop in this project is already a challenge. It is a new mobile phone development environment that has never been touched before. It is developed by the Google team and can output its programs across platforms Android and iOS. The process of installing and setting Flutter is not very friendly. Before it is set up, it must pass a function called "Flutter doctor", so Flutter must pass all conditions before being executed. There are not many prompts in themselves on how to pass those conditions. Then, the Android app can be output by Windows and Linux, but the iOS app must use Mac OS. Without an Apple computer, the iOS app cannot be output. However, based on Flutter, it is cross-platform. As long as the program code is copied to the Apple computer, it does not require much modification. It may be necessary to change some packages that support Mac OS. In theory, the program code of this project is allowed to be output as an iOS app on the Apple computer. Then there is Flutter's Library, which has a rich library with a large number of different functions, but some of them are time-limited, the version is too old, it is not allowed to be installed in Flutter, and a large number of libraries are independent

developers, some even Instructions for use are not detailed and difficult to use. Some quality is good, and some quality is bad, so suggest mainly using the Library developed by the Google team, and the quality is guaranteed. Many library installations will require modification of some internal files of Flutter itself, and even the installation requirements of Flutter itself also need to modify the environment parameters of Windows operating system itself, which makes testing and problems caused by improper installation, once because of wrong modification of the value of environmental parameters and causes the entire Flutter system to be broken, and even reinstallation is ineffective. It is necessary to find out the problem and change it back to the original value. This became the biggest obstacle in the development of this project, but all the failures in finalizing the project became a valuable learning experience.

9.2 Challenges and learnings from Dart

Dart is the only programming language supported by the Flutter platform. Learning a new programming language is a challenge for this project, but it is easy to learn. It takes about a week of course learning, and each example of the course is completed, which will be smoothly used in the subsequent development process. Its statement is simple like Python, and the structure is like Java. Although not as popular as other mainstream programming languages, it is a great experience to learn new skills through the development of this project.

9.3 Challenges and learnings from Firebase

Firebase is a cloud data storage developed by Google. The challenge encountered in the development process is that its structure is different from the SQL that has been learned. It is linked to the web platform for management. The data structure itself is divided into "Collection", "Document", and "Document Field". The reason for using it is that it supports the location value "GEOPOINT", which can be obtained from the mobile phone's GPS. Coordinate data: Direct storage, no need to convert, and output directly on the map. But most of Firebase's teaching is the React version, and Flutter's tutorial is not enough. It requires a lot of tests to understand. The writing data part is fine, but the reading data part uses snapshots to output data. The output of unknown Document names is very unfriendly, especially with the random 20-digit

value of Auto Document ID. A lot of time in development is spent testing and troubleshooting file output for syntax errors. But Firebase is a very popular and widely used cloud database for mobile applications. Learning and mastering this technique is a major gain in this project.

9.4 Challenges and learnings from Google API

The Google API used in this project is mainly maps, landmark data and geographic location information. The challenges encountered are mainly from how to know the road speed limit. Since the speed limit function is unique to Google Premium members, ordinary users cannot use it. So, I chose to use geographic location information to achieve speed limits. The address obtained from the geographic location information can know the current road section and then compare it with the location in the list to obtain the speed limit. For example, the road with the first letter M plus a number is Motorway, and the speed is 120km/h, while the road with the first letter N plus a number is National Road, with a speed of 100km/h, but because there are too many roads with other names, it takes a lot of time to complete the data. Finally, considering the limited time of this project, I cannot add every road name to the data, so only two roads, Motorway and National Road are used to detect whether the user's speed exceeds the speed limit. During project development, experience in using maps and landmark data is also a learned technique.

9.5 Challenges and learnings from defining Driving Score

Defining the driving score is a big challenge. There is no specific standard, and the calculation methods of each similar scoring program on the market are different. The formula will not be made public, so it isn't easy to find a reference object. Through research, the scoring method is gradually changed from various pieces of information. Then the rationality and reliability of these scores are evaluated through much actual driving, and finally, a satisfactory result is obtained and implemented in this program.

9.6 Challenges and learnings from Testing and debugging

The biggest challenge of the test and debugging is that the speed displayed by the program is inconsistent with the actual speed. It is not that the speed is inaccurate,

but there is a delay. This speed may be the speed of a few seconds ago. The program itself is connected to the cloud and API, which all require the Internet to provide data, and the network speed of the Internet itself will affect the computing speed of the program. In particular, this program displays a real-time map, and the delay is more serious. Therefore, in the program code for monitoring the driving function, these other functions that depend on the network will affect the smoothness and delay. The unnecessary codes are deleted as much as possible and make them simplified to achieve the effect of the lowest delay. The final version has much testing to fit them, and under regular 4G networks, the latency is less than one second, ensuring accurate data during driving.

10. Conclusion

By developing "Driving Companion App" as the final project, it is a great challenge for me, who has never developed a mobile app. This is my first mobile phone app developed by myself. In this project, I followed the guidelines from lecturers. It starts from research and planning, making "Research Report", "Functional Specification Document", and "Design Manual Document". To understand the functions of drivers' needs, driving behavior, target platform, required technologies and tools, draw out the entire project development direction. Then I learn the new development platform (Flutter) and the new programming language (Dart), complete the learning course, writing the code, communicate with the supervisor and listen to valuable opinions weekly, conduct testing many times, adjust the accuracy of driving, and modify the score many times Formula, complete a program that can realize real-time map, obtain real-time driving data and score driving behavior. The whole project started from scratch, gradually took shape of the project, challenged to learn and use various new things, encountered various difficulties, overcame it and grew, and finally completed the development of the whole project. This valuable experience will be an inspiration for my future software development and prepare me for future challenges.

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During four years of study, from my zero knowledge of developing software until today, I finished delivering the final project. Thank you very much.

13. Declaration

PLAGIARISM DECLARATION

- I declare that all material in this submission e.g. thesis/essay/project/assignment is entirely my/our own work except where duly acknowledged.
- I have cited the sources of all quotations, paraphrases, summaries of information, tables, diagrams or other material; including software and other electronic media in which intellectual property rights may reside.
- I have provided a complete bibliography of all works and sources used in the preparation of this submission.
- I understand that failure to comply with the Institute's regulations governing plagiarism constitutes a serious offence.

Student Name: (Printed) Chi Ieong Ng
Student Number(s): C00223421

Signature(s):

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