Introduction

The first generation of forest Free-Air Carbon Dioxide Enrichment (FACE) experiments has revealed about how young forest plantations are affected by increasing the carbon dioxide concentration in atmosphere. The Birmingham Institute of Forest Research (BIFoR) FACE, known as 'second generation' forest FACE site, is in the vanguard of a global initiative to investigate the effects of climate change on forests set in mature, unmanaged, temperate woodland. This project assumed that the overall environment of the forests is set in a high carbon dioxide concentration. The name of this project is called iForest aimed to design a sensible and concise application which is used to display the status of forests corresponding to the walk steps collection system. The walk steps collection system is designed to record the walk steps from individual users via daily walking or riding and automatically transfer the steps into numbers of reduced carbon dioxide emissions through internal calculations. The numbers of walk steps shall be collected by most of modern phones using gravity sensing system and users can choose either walking or riding to increase the walk steps. The dynamic response of forests to environmental change and climate change in this application is collected from FACE experiment. The numbers of reduced carbon dioxide emissions calculated in application are used to determine the numbers of carbon dioxide intake to the experimental forests in reality, in the meanwhile, a real-time data feed is provided to users displaying a serial of data includes data related to tree dendrometry, soil respiration, carbon dioxide concentration levels, wind speed, wind direction, levels of sun. The original purport is to encourage individuals to choose a green travel which is a choice of a healthy low-carbon-produced way to travel, enjoying walking or riding instead of driving or using other high-carbon-produced way to travel. Therefore, to attract more possible users using this application and to stimulate more users participating into the walk steps collection system, the walk steps collected from users can be transfer to numbers of credits in a certain ratio used to redeem to real train tickets as the reward.

Scope of the System

The scope of the iForest design is limited to the design of this project only. The application is activated when a user has enrolled with the username and password. Users can view the growth situation of the forests in the main screen. Two modules are provided for users, one displaying the forests in animation style corresponding to the real experimental forests and the other one displaying the forests incorporated with augmented reality technology. Users are allowed to select either module and switch over between two modules.

A finger swipe on the right side of the main screen displays a serial of data about the growth information of forests includes:

- tree dendrometry
- soil respiration
- carbon dioxide concentration levels
- wind speed
- wind direction
- levels of sun

A user may be able to view the daily changes of all data recorded for the forests and notice how young forest plantations are affected by changing atmospheric carbon dioxide in numeric level.

A finger swipe on the left side of the main screen displays the number of individual walk steps as well as the total numbers of reduced carbon dioxide emissions from all users. The application collects the walk steps and resets the records daily and a rank system is also provided to describe in what position the individual stays comparing to the overall users. The record is collected by this application if there are no other pedometers embedded in the phone and is synchronized to the any existing internal pedometers from individual modern phones in the meantime. The data is only updated once the users log into the application so the data keeps the last record and would not be renewed if a user is not logging to the application in the rest of the day. In this screen, users can transfer the daily walk steps to the numbers of credits and then convert to real train tickets whenever needed. A user may be able to choose to transfer the daily walk steps to the number of credits in a given ratio. The daily number of credits is then summarized by the background records and a user may be allowed to convert to corresponding train ticket once the total numbers of credits meet the minimal requirement. The ticket reward requires user to provide personal information to the system in case of multiple accounts gathering tickets by the same user.

Some further assumptions are:

Only one account is allowed to be registered at same phone in this designation.
All data collected from forests are displayed in remote real-time transmission.
The walk steps are recorded by this application with internal gravity sensing system if no pedometer embedded in the phone.
The walk steps are recorded by synchronizing to the other existing pedometer in the phone.
The collected walk steps including transferred and non-transferred are reset to zero at the end of the day.
The system stores the numbers of credits for users and decrease the number once the credits convert to the train tickets.
Users need to provide personal information to confirm the identity when exchange train tickets.

Functional requirements

1. Register and login

- A user may be able to browse for steps number and amount of carbon that are predicted to be saved of global users in one day
- A user may be able to browse for real-time status of the forest before signing into the app.
- A user need to both register and login to find their own daily steps number and all other individual information.
- The application must check whether the input username and password match and get access to the corresponding user account. And keep the access at the same device even the user is offline.

- Once someone tries to login this user account at a different device, a message to verify identity and warn the user should be sent to user.
- The app shall enable users to change password.

2. Switching interfaces

- After login, a user will get access to the home page firstly where the forest is showed. But he or she can flip between interfaces by simply flicking fingers on the screen.
- The app will provide access to all other interfaces and functions on the home page.

3. Forest status monitor

- One of most important information provided by this app is the forest status like temperature, relative humidity, Barometric Pressure and CO2 concentrations and so on.
- All this kind of information should be clearly listed as well as forest real-time pictures on the home page.
- And the pictures should be taken by Augmented Reality technology so users can see what the forest exactly looks like. For professional users, they can even monitor forest from a distant place such as their home.
- However, for amateur users, they may not be able to figure out how the forest is going by some AR pictures nor by data listed. So, the app should also provide cartoon pictures to demonstrate what kind of status the forest is under, like healthy or not, dry or not. The cartoon pictures should also change with environment, like cloudy or sunny.
- The app will have a button to switch between AR pictures and cartoon pictures which aim for professional and amateur users respectively.

4. Individual information

- What the users most care about in the app must be how much carbon they are predicted to save individually on this day. The app must calculate an expectation value with how many credits or steps users walk on foot instead of cars or other vehicles which will produce CO2.
- The apps will give this information on the home page as users will see it once login.
- Other relatively less important information, for example, how does a user rank globally should be displayed in other interfaces.

5. Redeem Rewards

- The subpage shall display the number of steps that each user walked in a day.Their number of steps would be collected by users' mobile device.
- The system shall display the points collected converted by users' number of steps.The default exchange ratio is 1 kilometer convert to 1 point. It is visible and memorable for users to know how distance they walk in a day.
- The system shall provide the button to donate their points to the institutions for environmental protection. The aim of application is the priority to educating the youths and adults thereby the function of donation can allow users to contribute to the environment.

- The system shall display the reduction in the emission of carbon dioxide caused by the total accumulated steps of all users.User can view the efforts from all users working in reducing carbon dioxide.
- The system shall provide the button to redeem the ticket of train or bus to engage users to travel by the public transportation. Users can redeem the type of ticket they need and received the e-ticket through email.
- The system shall provide the button for more options to redeem their collected point from the number of steps. It provides a list of others choice to redeem their points. However, these options would be related to environmental protection,such as sponsor the environmental researches and environmental events.

6. The real-time monitor
   - The system shall display the real time environmental indexes from monitor, including tree dendrometry, soil respiration, carbon dioxide, concentration levels, wind speed, wind direction, levels of sunshine.
   - These data are integer or integer in percentage.
   - The system should provide the description and explanation of all indexes displayed. After the user click on the index, it leads users into another subpages which contain the details information of that index and the static meaning of that index.
   - The system allows users to search for the historical data for these indexes. There are the button placed on right top corner. After clicking it, users can view the historical data in list or graph.
   - The system allows users to arrange the order of index according to their preference. When users keep longer touch with the index, it allows them to change the order of indexes.
   - The system could show the percentage of how the indexes change.For instance,the percentage is shown the period during the comparison between today and yesterday or today and today and the average of this week.
   - The system should simulate physical mechanism that how trees grow up and how the environment parameters affect trees.

Non-functional

1. Accuracy

1.1 The application must accurately pass the real-time data information of the trees collected by the Birmingham Institute of Forest Research (BIFoR) to the users.

1.2 The number of steps taken by users recorded by the application should be as accurate as possible.

1.3 The result of the user's daily reduction of carbon dioxide emissions calculated by the formula should be accurate.

1.4 The ranking in the list of users with the lowest daily carbon dioxide emissions should be accurate.

1.5 The number of credits that users can redeem on the day of the walk steps should be accurate.

2. Usability

2.1 The application can be used on a variety of mobile phone systems.

2.2 The application can detect the default language of the user's mobile phone system to adjust the language of the application. Customers can also change the application language according to their needs.

2.3 The application must have a clear and concise user interface that makes it easy for users to understand the features of the application.

2.4 The application provides a help option to introduce each feature in the application. The application also provides voice help, which allows users to ask the application about features they do not understand through microphone.

3. Reliability

3.1 The application must be connected to the BIFoR database stably to ensure that data and images captured by the BIFoR can be received in real time.

3.2 The application should have a sophisticated neural network system that can corrects bugs automatically.

3.3 The server of the application allows tens of millions of users to access simultaneously without downtime.

4. Interoperability

4.1 The application can connect to an existing database.

4.2 In this application, users can purchase the transportation card issued by the subway company or bus company with the redeemed credits.

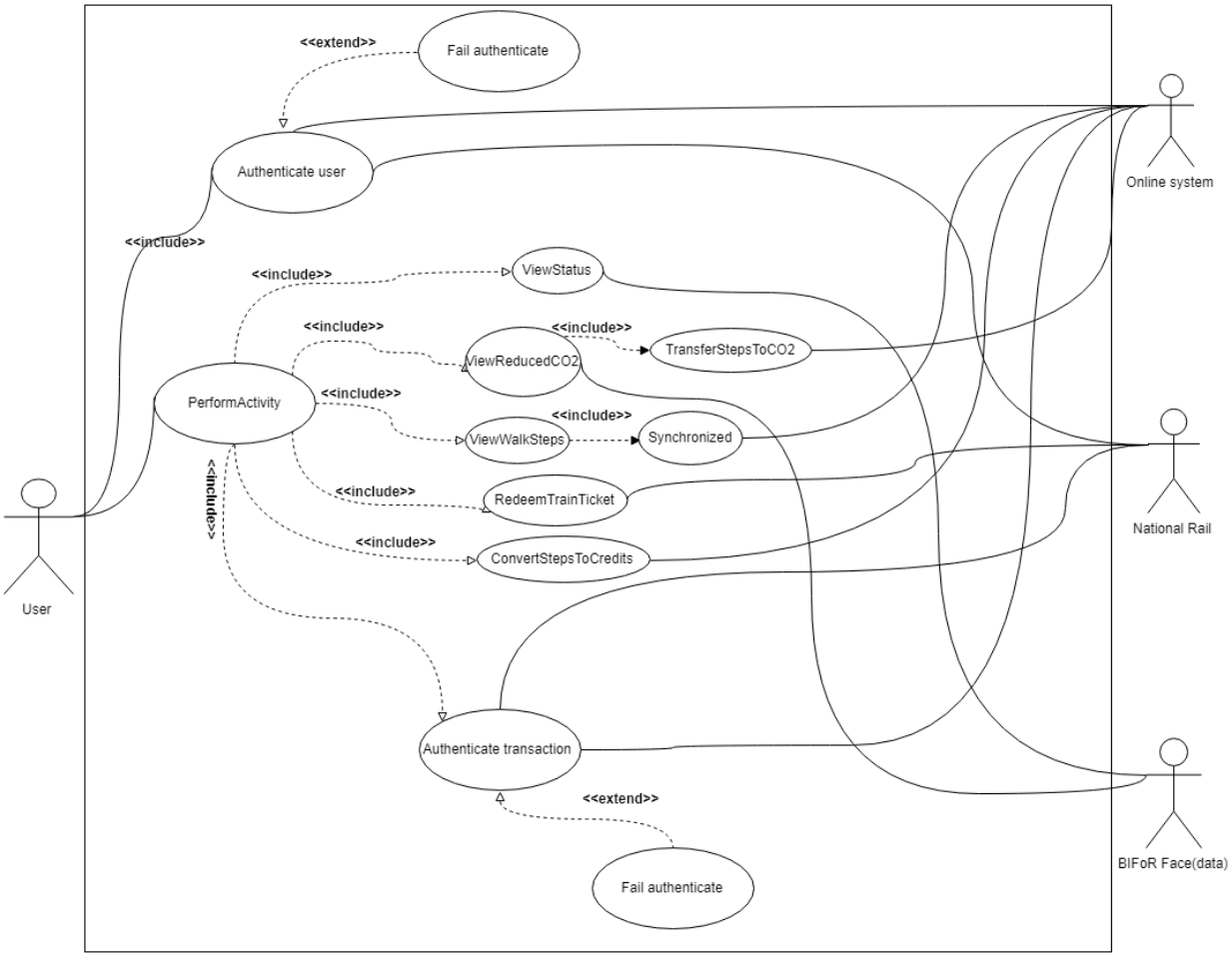
4.3 The equal amount of money redeemed for the number of credits donated by the user should be transferred to the bank account of BIFoR.

5. Privacy

5.1 The application must have a strong security mechanism to ensure the security of user information.

Use Case Diagram

The use case for iForest is presented below. The actors involved in the system have been showed out of the boundary of the system, displaying as the rectangle. The application offers five main functions as included in "PerformActivity". Additionally, one use case have been selected for the analysis with pre-conditions, post-conditions, flow of events, actors, and scenario.



Documented use case:
The use cases have been selected for further documenting as see below:

1. View forests, collect walk steps and redeem a train tickets for an individual new account.

The following sections are described below showing the relevant actors, pre-conditions, event flow and post-conditions.

Use Case Description One:
View forests and collect walk steps for an individual new account.

Actors: User, Online System, BIFoR, National Rail

Pre-conditions:

1. The user does not have an account yet.
2. The user walked a lot in daytime.
3. The online system has access to BIFoR databases.

4. The online system has access to fitness tracking of user's phone.

Flow Of Events:

1. The application sets up language according to user's phone's system preferences once a user downloads it.
2. But he or she can set up another language like French, German or Chinese.
3. The user decides to register an account and selects a way of travelling in cycling or walking to predict the accurate reduced emission of carbon dioxide.
4. However, users decide not to register can acquire access to the basic information about forest as well excluding his steps number.
5. In addition,the system provides a guided page to teach users how to use this software on the main page.
6. The application updates photos and parameters at home page.
    a. AR photos and environment parameters from BIFoR databases are displayed once it connects to Internet and receive authorization from BIFoR server.
    b. The user just click the cartoon convert button at top right corner of AR photos and the home page will display cartoon photos.
    c. The application updates cartoon photos which show healthy situation and environment of forest in the form of cartoon according to the data received.
    d. He or she just sweep the screen, it will switch to parameters page which contains all data.
    e. He or she clicks one parameter and the non-trivial explanation is then showed by a small popup window.
    f. The window will also show how these parameters affect trees' growth which is given by a physical mechanism that simulated by application according to all the data collected by a long time.
    g. He or she clicks the button at right top corner of this page and the page overturns and shows history data in form of numbers and charts.
7. The user sweeps again and the screen turns to the user_info window which contains steps numbers and predicted CO2 emission that reduced by user personally in this day.
    a. He or she still can also view all users' contribution of course.
8. The user views his steps history in form bar chart to evaluate his exercise situation.
9. The user can decide to transfer this steps number into credits that can be donated to environment charity or redeem public transportation card like train card.
10. If the user is already logged in, he can enter the page to redeem the public transportation card. If the user is not logged in, the application will jump to the login page.
11. The user selects the type of public transportation card that he or she wants to redeem.
12. The application system checks if the user has enough credits to redeem the public transport card selected by himself or herself.
    a. If the user has enough redemption credits, enter the redemption confirmation page.

    b. If the user does not have enough redemption credits, the application page pops up a window prompting the user not to have enough redemption credits to redeem his or her selected public transportation card.
13. The user enters the redemption confirmation page, and the application provides the user with a confirmation redemption option and a continued selection option.
    a. If the user chooses to confirm the redemption option, the confirmation redemption order is sent to the application server.
    b. If the user chooses the continues selecting option, the application returns to the public transportation card selection page.
14. After the user confirms the redemption information, the application will check if the user has filled the personal information.
    a. If the user has filled in the personal information, the application pop-up window prompts the user whether to set this information as a traffic card user information.
    b. If the user does not fill in the personal information, the application jumps to the user's personal information filling page.
15. The application system checks if the user sets the default personal information as the traffic card user information.
    a. If the user confirms that the personal information is set as the information of the transportation card user, the application server receives the user feedback.
    b. If the user chooses not to set the personal user information as the traffic card user information, the application jumps to the traffic card user information input page.
16. The application system prompts the user whether to authorize the completed traffic card user information to the public transportation company.
    a. If the user confirms that the information is authorized for use by the public transportation company, the redemption is successful.
    b. If the user refuses to authorize the information to the public transportation company, the redemption fails
17. After successful redemption, the user will receive the e-mail containing the selected transportation card sent by the application within 10 minutes.

Post-conditions:

1. A trees growth physical mechanism will be developed and perfected.
2. Forest and environment data will be saved in BIFoR databases.
3. Users exercise and credits data will be saved in application databases.
4. The system sent told the National Rail to send a ticket for the user.
5. The numbers of credits of the user has been reset.
6. User has received a confirmation email of ticket requirement from online system.

Scenario:

As a usual, Chloe, who is a student, ate the breakfast and watched the BBC news before going school in the morning. She noticed that there was much news related to the environmental protection. She hopes she can contribute to the forest protection. Therefore, she went to find

some application to achieve her goal.

After Entering the keyword “forest protection”, she could see a list of suggested applications. She attracted by our application since our highlight was the function to reduce the emission of carbon dioxide by recording the number of users’ step. It was a gimmick to attack her force, so she decided to download ones to experience.

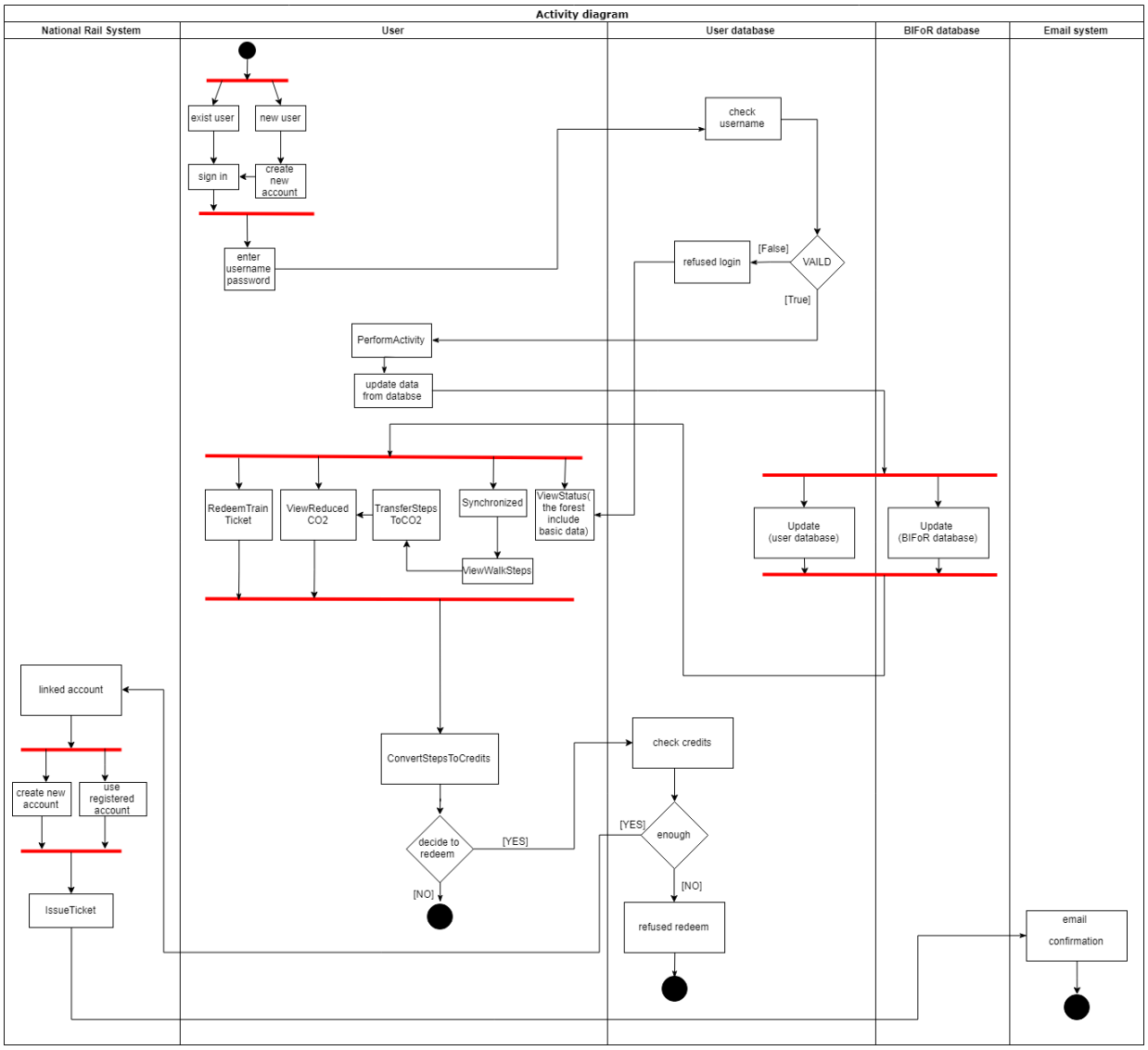
When she first opened the application, the language displayed in it was English depend on her phone’s system language setting. However, it allowed her to change to other languages in further setting, such French, German and Chinese. Following that, there was a screen for register for the new user for the better user experience. She hoped to register later, so she clicked the skip the step of registration.
Through the above process, she successfully enters the main page of the applications. She can see the cartoon forest in the centre of the screen with the sun (It represents to the real-time weather.) And, she tries to click the colour-dark AR (augmented reality) button on the right upper corner. The screen is switched to show the AR picture of the forest which authentic by BIFOR(Birmingham Institute of Forest Research). She can clearly see the details of the real-time picture of forest displayed in the AR technology. Even it provided more details in the technical arguments and historical analytic arguments, she did not have a big interest about it. She left this screen and back to the home screen.

At that time, she found there are 2 meaningful figures in the bottom of the home screen. The first figure was the number of steps collected by all users. The second figure was the reduced emission of carbon dioxide. She felt amazing to sees the thousands of million steps collected and thousands of millions of emission of carbon dioxide reduced. She wanted to be the one of those. So, she wanted to know how the application works to record her number of steps. To address this issue, she could select the guided page in the menu bar in the left upper corner of home page. It documented the users’ number of steps automatically collected in their default health applications of their phones only for the users who has created an account and convert to the reduced emission of carbon dioxide in formula. She was delighted that it is an easy way for her to support the environment. Immediately, she was going to create a new account and she noticed that she should select one of the transport means which are walking and cycling.Thus, she chose walking as her usual transportation means. After that, she could see her profile in the application, including her number of walking steps. In the future, she decided to go school by a 30 minutes walking instead of 5 minutes metro as usual in order to collect enough credits to donate the money to charity.
For the first few days as she starting to use this application, she found out the steps she collected do not seem to be reasonable because the steps collection system only update once the application is on use. She started to check the steps before he went to bed every evening and found that the number of the walk steps was updated reasonably. As she was using the application, she noticed that there is a button under the numbers of walk steps describing as transfering steps to number of credits. By touching the button, the walk steps are transferred and stored in the system as number of credits and this action was leading him to another scene of the application known as reward page. There are several options of unavailable buttons

displayed in front of his eyes and a tip displayed on the top of the page saying the number of credits can be redeem to a real train ticket as long as it matches the required numbers where the minimal number is 1000 credits. She continued to use the application for another week and finally collected 1011 credits which is enough to redeem the ticket. She noticed that the redeem button is now available for him. As she pressed the redeem button, the system now asked her to confirm her identity. She then linked to the National Rail which is relevant to the account in the online system of the application. Once she successfully registered with the National Rail system, she can redeem the ticket at any time. The numbers of credits has been reduced to 11 and the system sent him a confirmation email of ticket requirement after he press the redeem button at this time.

Activity Diagram

The Activity Diagram shown below represents the process for the above documented user case. This diagram demonstrates the dependencies and coordination between activities within this designed system.



Class Diagram

Noun/Verb analysis

Noun/Verb analysis was utilized to determine possible classes, class attributes and methods for the system. The following table of nouns were identified as potential classes, and the following table of verbs were regarded as potential operations.

Candidate Classes (Nouns)

Candidate	Type		Candidate	Type
Update	Class		Age	Attribute in UserInfo
UserActivities	Class		Gender	Attribute in UserInfo
UserAccount	Class		Telephone	Attribute in UserInfo
Tickets	Class		IDCard	Attribute in UserInfo
Menu	Class		account	Attribute in UserActivities
Data	Class		Name	Attribute in Tickets
Scene	Class		Type	Attribute in Tickets
UserInfo	Class		Credits	Attribute in Tickets
BIFoRDATABASE	Class (subclass of Update)		Number	Attribute in Tickets

NationalRail	Class (subclass of Update)		BIFoRdatabase	Attribute in Update
isSynchronized	Attribute in Menu		nationalrail	Attribute in Update
Synchronized	Attribute in Menu		ticket	Attribute in NationalRail
account	Attribute in Menu		data	Attribute in BIFoRDATABASE
Username	Attribute in UserAccount		scene	Attribute in BIFoRDATABASE
Password	Attribute in UserAccount		TreeDendrometry	Attribute in Data
Vehicle	Attribute in UserAccount		SoilRespiration	Attribute in Data
Walksteps	Attribute in UserAccount		CO2Concentration Level	Attribute in Data
Email	Attribute in UserAccount		WindSpeed	Attribute in Data
RealName	Attribute in UserAccount		WindDirection	Attribute in Data
Firstname	Attribute in UserInfo		LevelOfSun	Attribute in Data
Lastname	Attribute in UserInfo		Animation and AR	Attribute in Scene

Candidate Operations (Verbs)

Possible Class method	Class		Possible Class method	Class
IntakeCO2ToForest()	Update		CheckEnoughCredit()	Menu
ConvertStepsToCredits()	UserActivities		SignIn()	Menu
ViewReducedCO2()	UserActivities		Register()	Menu
ViewWalkSteps()	UserActivities		TransferStepsToCO2()	Menu
RedeemTrafficTickets()	UserActivities		LinkedAccount()	Menu
ViewStatus()	UserActivities		IssueTickets	NationalRail
Update()	UserActivities		ConfirmationEmail()	Menu
ReceiveUser()	NationalRail		PerformActivity()	Menu
IssueTickets	NationalRail		Synchronized()	Menu

Responsibility Analysis using CRC cards:

UserAccount	
Responsibility	**Collaborators**
Maintain the personal information of registered users and record the collected walking steps from users.	Menu UserActivities

UserActivities	
Responsibility	**Collaborators**
Provide users the following operations including converting, transfering, and viewing walk steps as well as displaying forests	Update UserAccount Menu

status, and redeeming train tickets.	

UserInfo	
Responsibility	**Collaborators**
Store the real personal information from users which is used to link with national Rail.	UserAccount Tickets

Menu	
Responsibility	**Collaborators**
Maintain overall control of application functionality, including operation of recording and dealing with walk steps, managing user accounts, cooperating with BIFoR and National Rail system.	UserAccount UserActivities Update

Tickets	
Responsibility	**Collaborators**
Maintain data contained the details for redeeming the specific public transport ticket. It also includes the remaining stock of tickets.	UserInfo NationalRail

BIFoRDATABASE(subclass of Update)	
Responsibility	**Collaborators**
Maintain data concerning details about experimental forests, including scene information and various types of data.	Scene Data Update

NationalRail(subclass of Update)

Responsibility	**Collaborators**
Maintain data concerning details about dealing with tickets and linking with application system.	Tickets Update

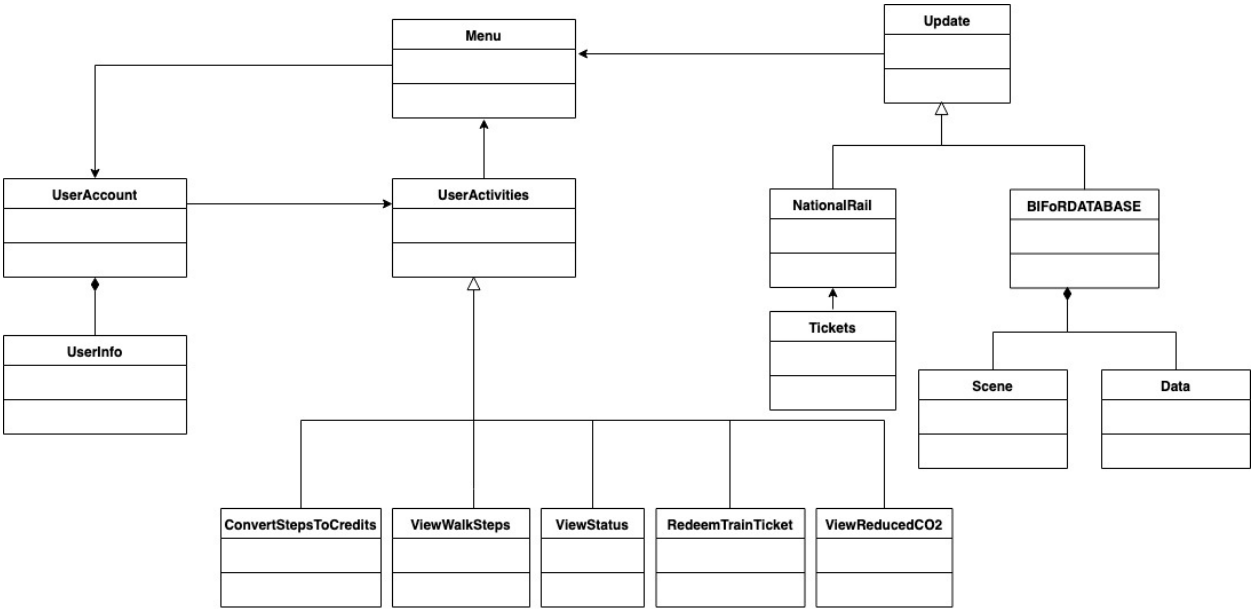
Scene	
Responsibility	**Collaborators**
Maintain the real-time data concerning to the AR scene and Cartoon Animation Scene from the experimental forest	AR scene Cartoon scene

Data	
Responsibility	**Collaborators**
Maintain the Collected environmental data from BIFoR system.	

Update	
Responsibility	**Collaborators**
Update data and pictures from BIFoR and National Rail system.	BIFoRDATABSE NationalRail

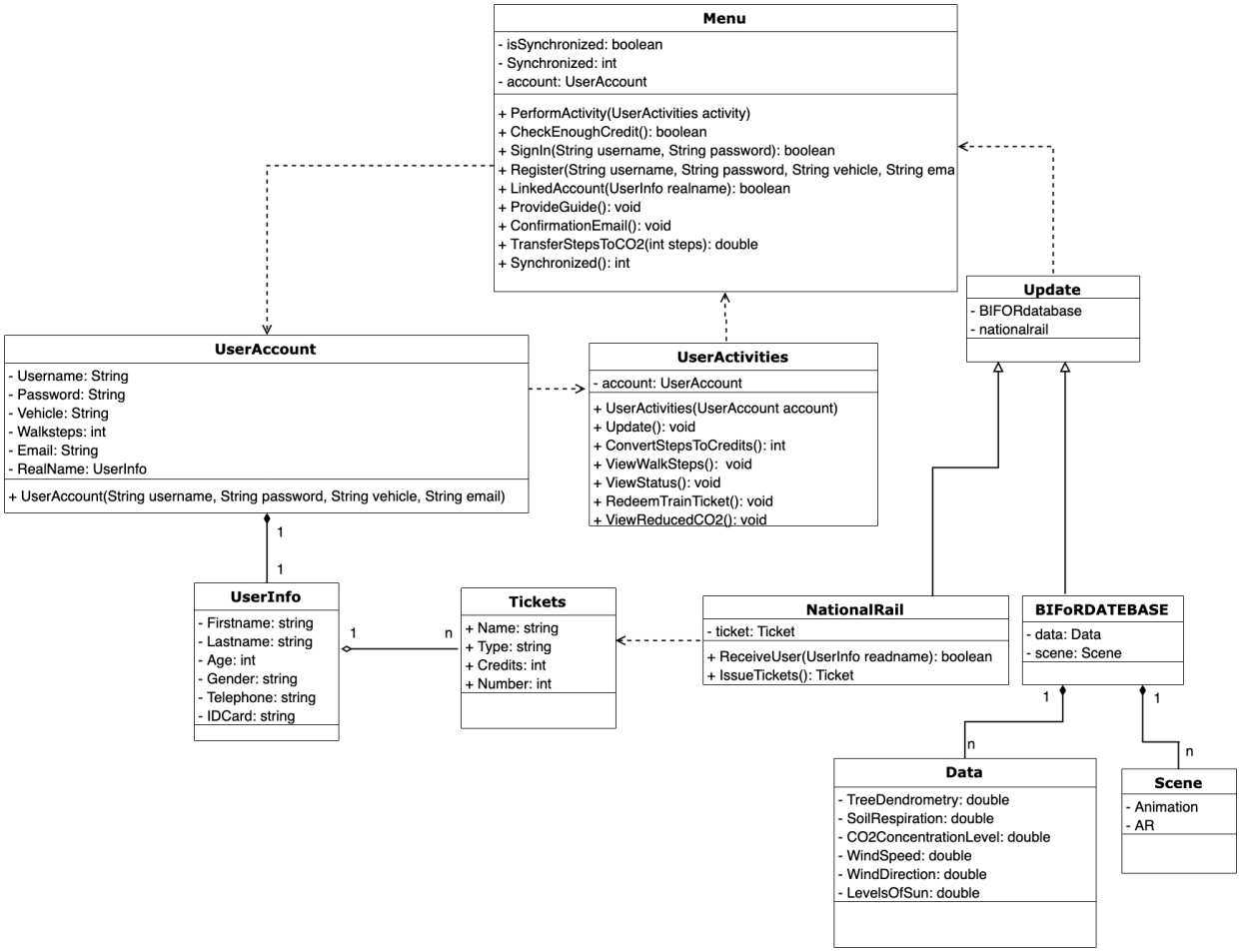
First cut and class diagram

According to Noun/Verb analysis and CRC cards listed above, a first cut diagram is developed just like below picture.



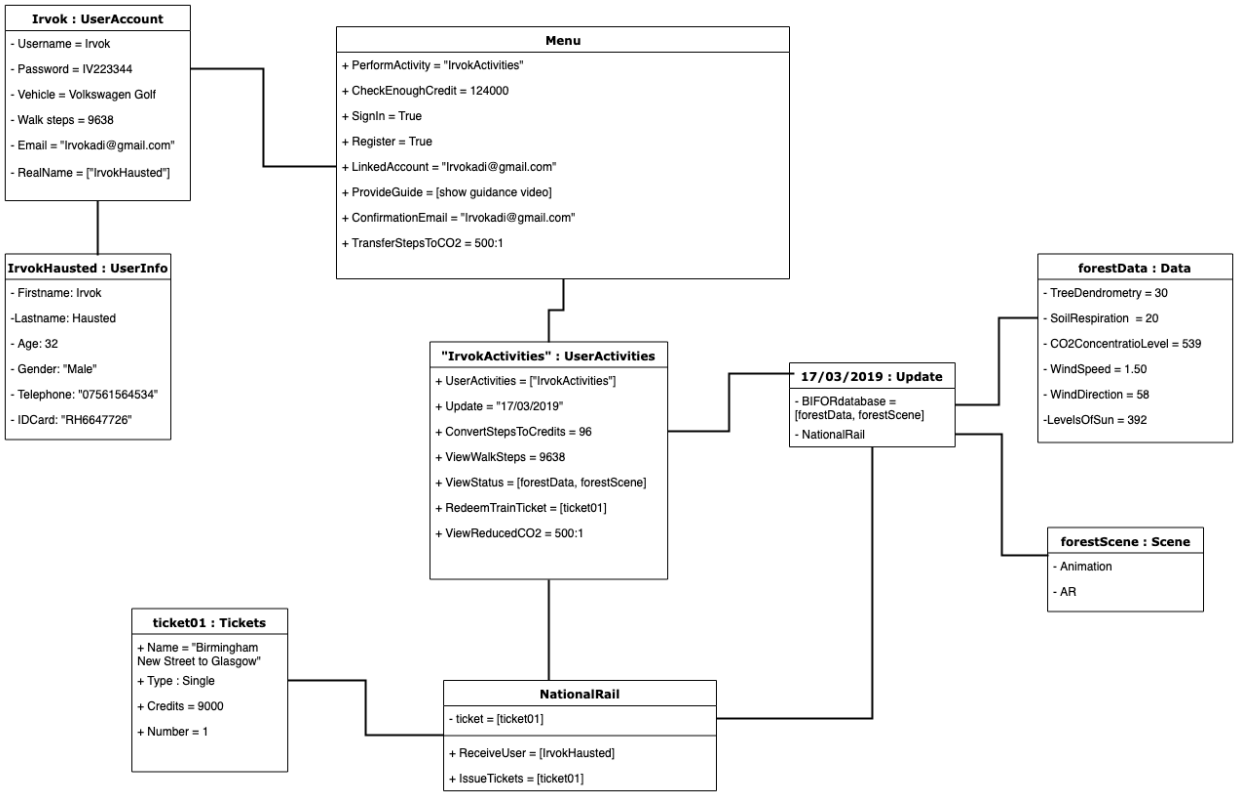
In this diagram, it lists all important classes, operations and their relationships for realising the application. But it is only the first cut design, more specific modification will be contained in next diagram.

Class diagram


Menu
- isSynchronized: boolean
- Synchronized: int
- account: UserAccount
+ PerformActivity(UserActivities activity)
+ CheckEnoughCredit(): boolean
+ SignIn(String username, String password): boolean
+ Register(String username, String password, String vehicle, String ema
+ LinkedAccount(UserInfo realname): boolean
+ ProvideGuide(): void
+ ConfirmationEmail(): void
+ TransferStepsToCO2(int steps): double
+ Synchronized(): int
Update
- BIFORdatabase
- nationalrail
UserAccount
- Username: String
- Password: String
- Vehicle: String
- Walksteps: int
- Email: String
- RealName: UserInfo
+ UserAccount(String username, String password, String vehicle, String email)
UserActivities
- account: UserAccount
+ UserActivities(UserAccount account)
+ Update(): void
+ ConvertStepsToCredits(): int
+ ViewWalkSteps(): void
+ ViewStatus(): void
+ RedeemTrainTicket(): void
+ ViewReducedCO2(): void
1
1
UserInfo
- Firstname: string
- Lastname: string
- Age: int
- Gender: string
- Telephone: string
- IDCard: string
1
n
Tickets
+ Name: string
+ Type: string
+ Credits: int
+ Number: int
NationalRail
- ticket: Ticket
+ ReceiveUser(UserInfo readname): boolean
+ IssueTickets(): Ticket
BIFoRDATEBASE
- data: Data
- scene: Scene
1
1
n
n
Data
- TreeDendrometry: double
- SoilRespiration: double
- CO2ConcentrationLevel: double
- WindSpeed: double
- WindDirection: double
- LevelsOfSun: double
Scene
- Animation
- AR

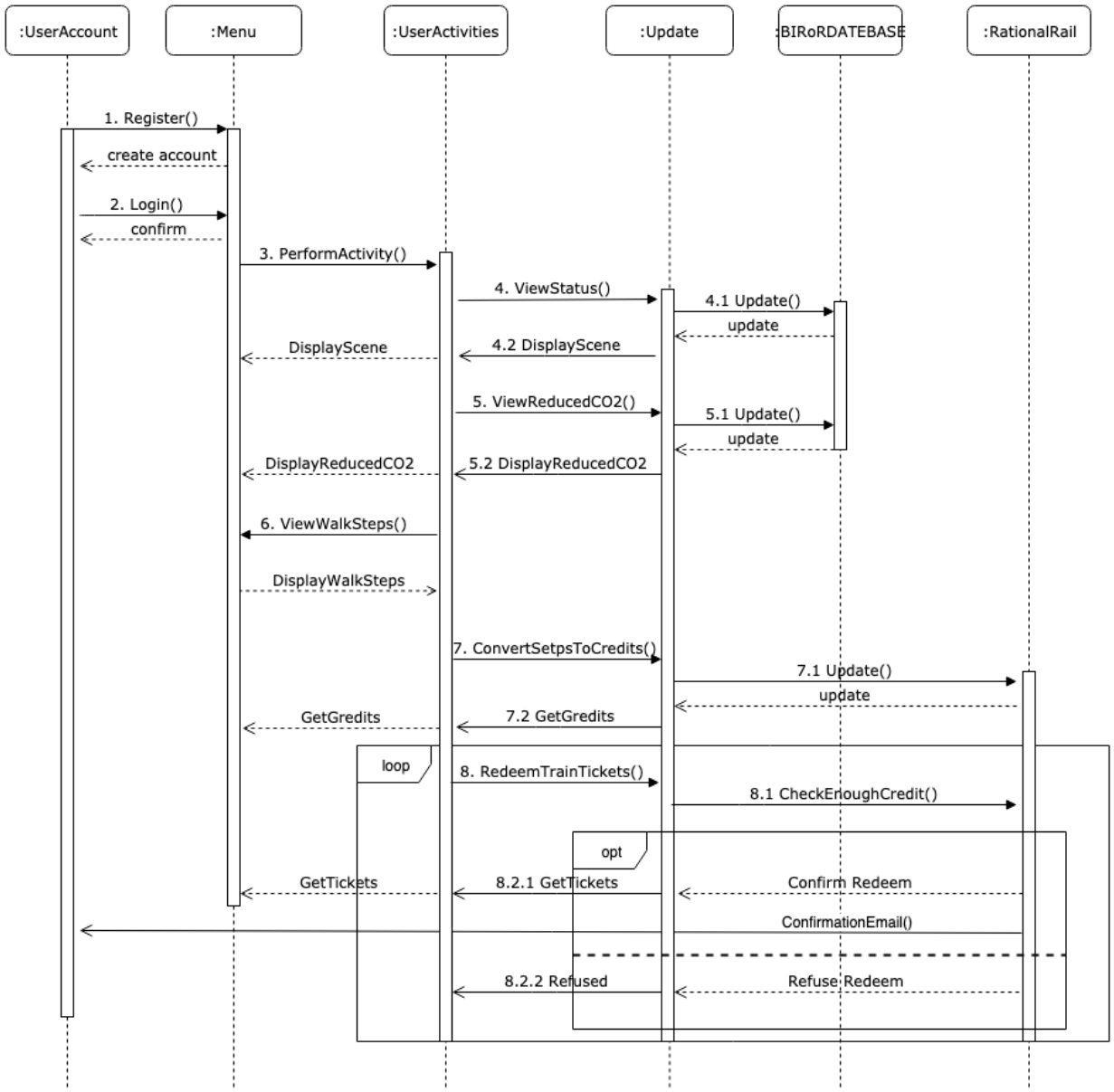
Object diagram

The object diagram was built based on the class diagram showing above. The diagram represents the class instances and the links between them within the contents of the attributes during operation.



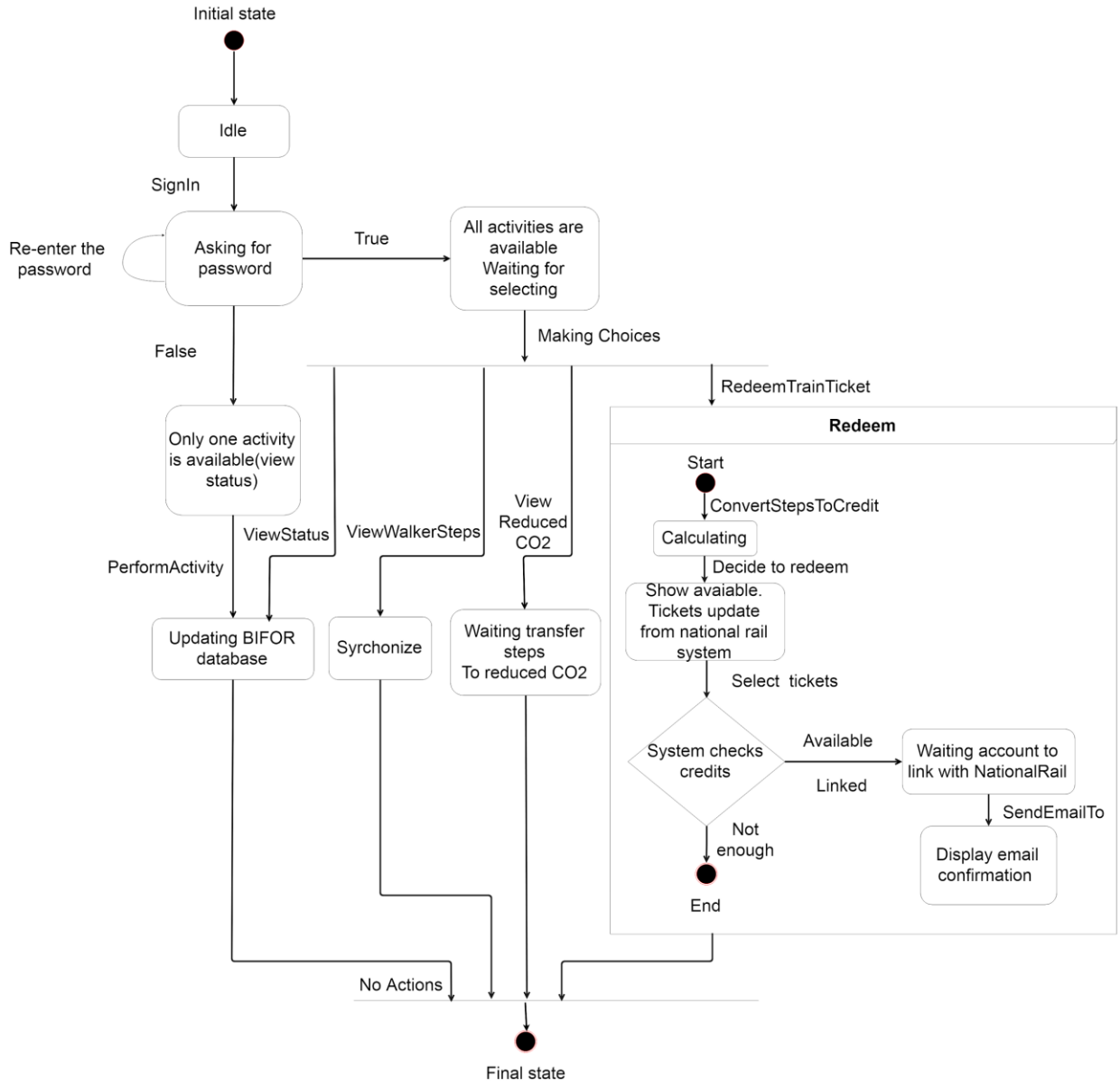
Sequence diagram

This sequence diagram shown below demonstrates the behavior of objects in the use case for the scenario of performing activities in iForest applicant. The sequence starts with the user actor registering and logging to the system. Following the sequence, the user has redeemed tickets and has been announced via email confirmation.



State Diagram

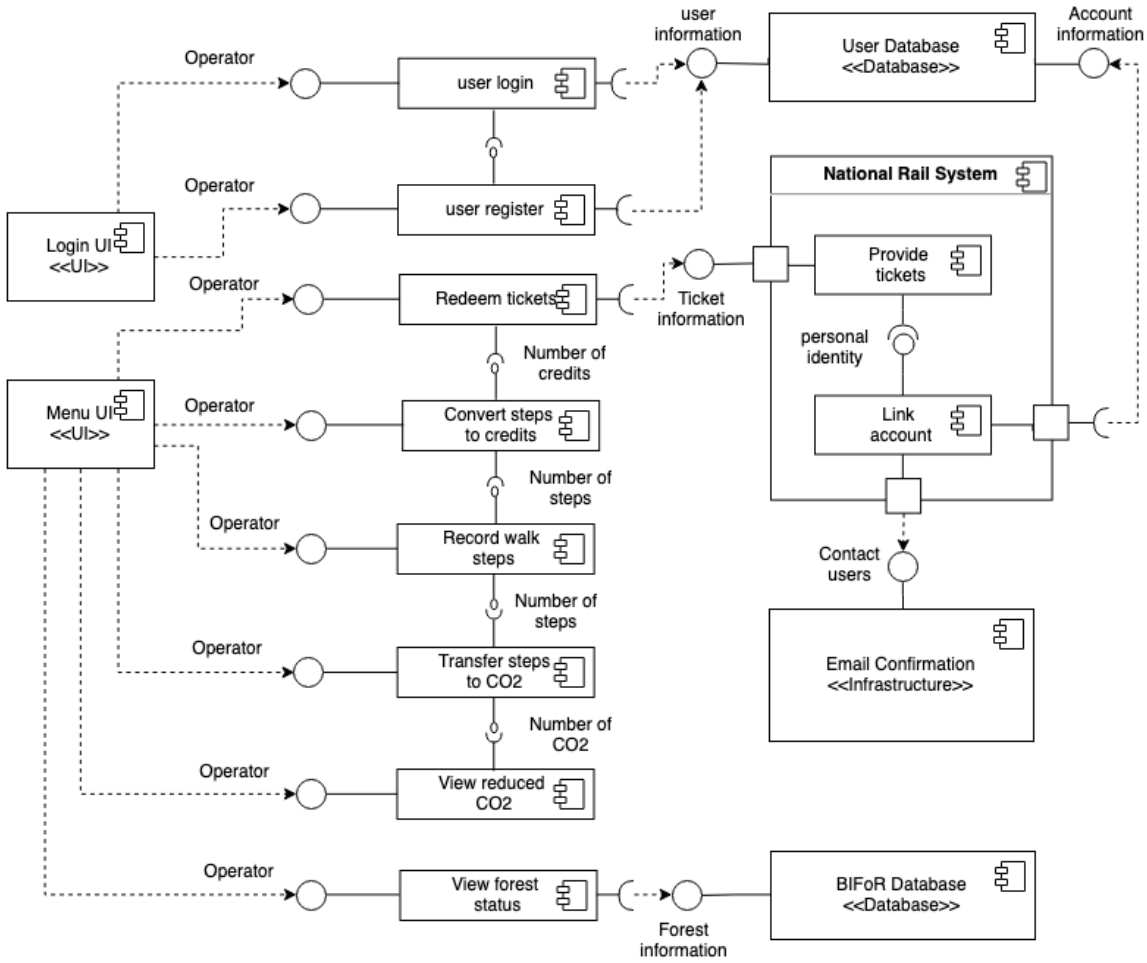
The state diagram shows the states of the application after each operation. It also models how an object's reaction to a message depends on its state. Especially, if user choose to redeem tickets, it will activate a substate just as shown in the diagram.



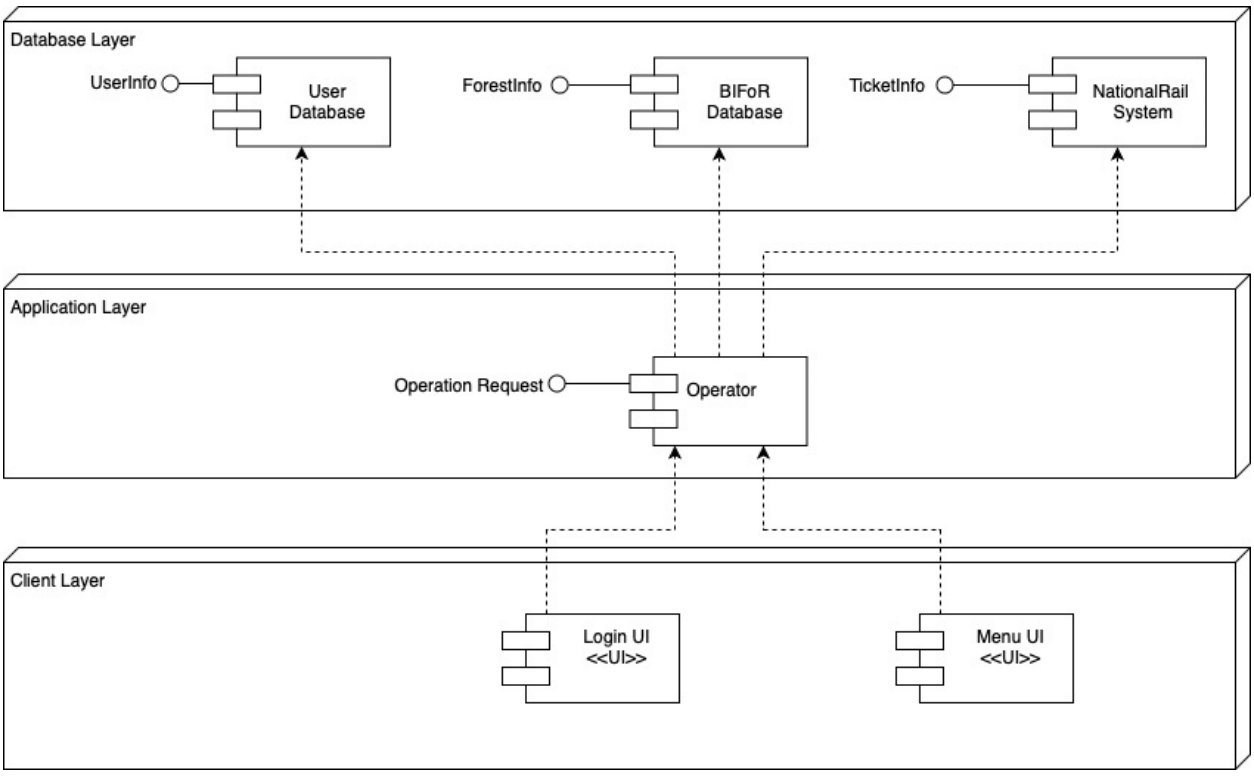
Component diagrams

This is the first design of component diagram using three-tier architecture which shows the structural relationships between the components of the system. From left to right, the GUI of client is the presentation layer. The middle layer contains all operations and can access to User database, BIFoR database and NationalRail system.
The second design bases on client-server style. There is no middle layer to buffer the massive data and instructions to improve system performance.

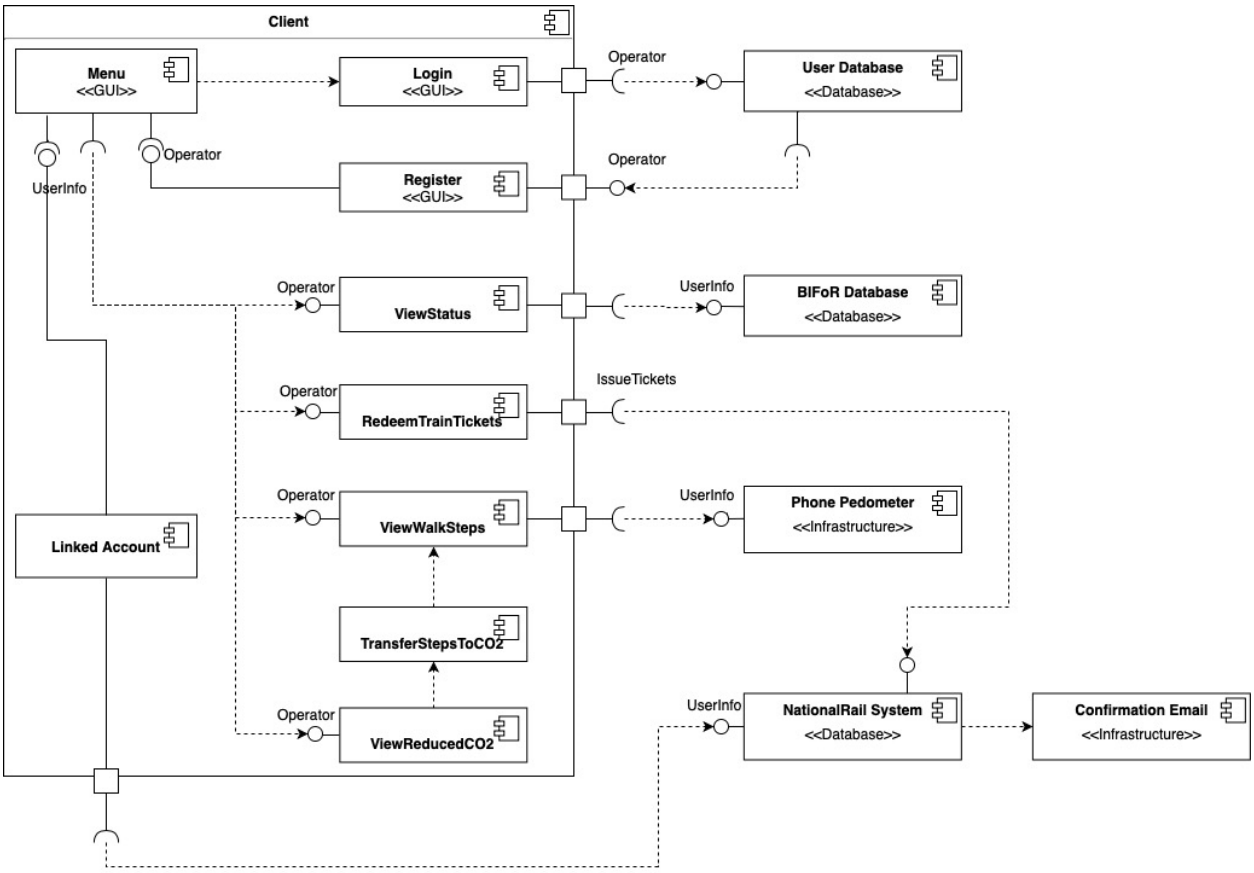
Design one:



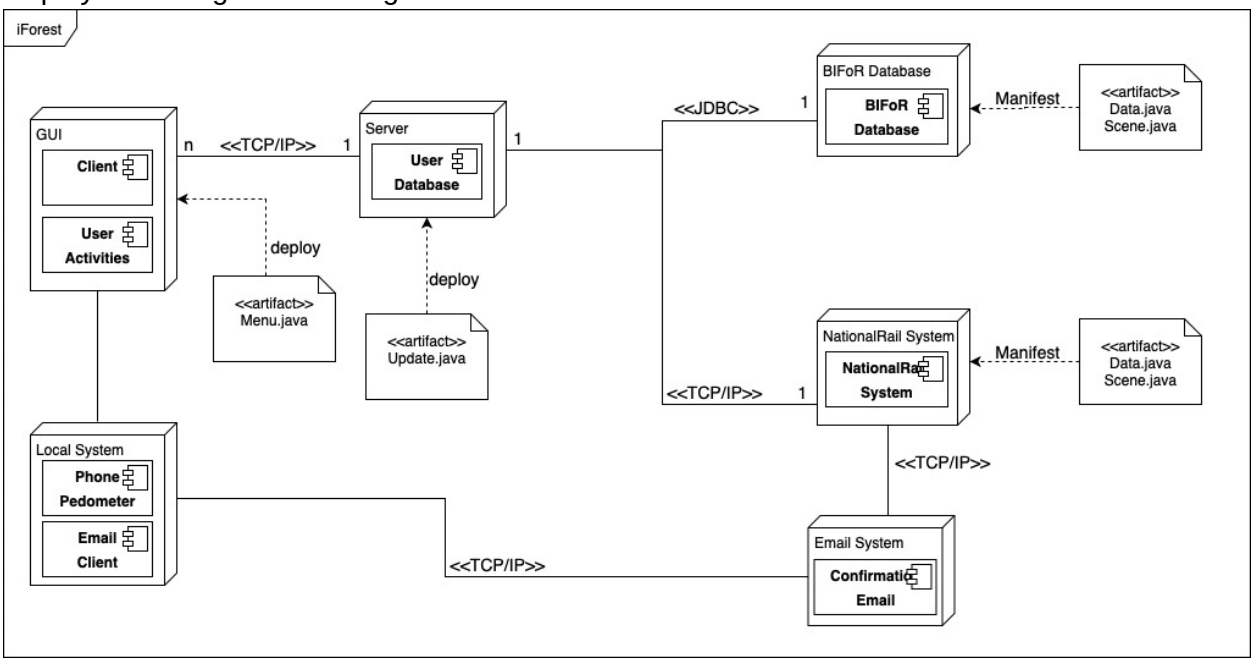
Deployment Diagram for design one:


Database Layer
UserInfo
User Database
ForestInfo
BIFoR Database
TicketInfo
NationalRail System
Application Layer
Operation Request
Operator
Client Layer
Login UI
<<UI>>
Menu UI
<<UI>>

Design two:

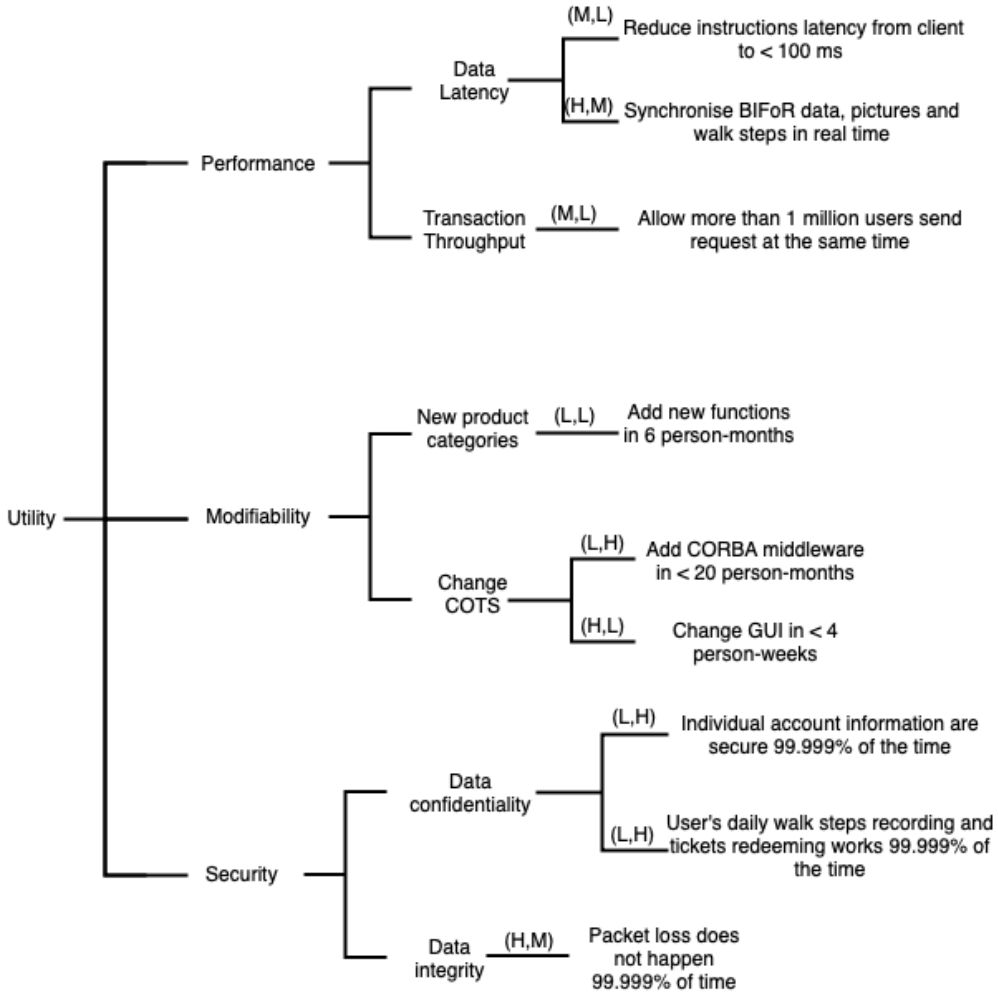


Deployment Diagram for design two:



Tradeoff Analysis

When determine the architecture that used for the designing of whole system, the non-functional requirements of the system were taken into the consideration. The system ideally needs to be secure, modifiable, and easily maintainable so the trade-offs must be made during the designation of the system. Three-tier architecture was used and considered to be a better choice for meeting the above requirements. In choosing components for the system architecture, the aim was to enhance the security of user's information, reduced the dependence between each layer, and easily to maintain in the stage. The client can only access the data layer through the middle-tier thus only data layer can operator database and perform actions directly including adding, deleting, modifying, updating, and searching. The secure of the user's information could be enhanced as a result. The purpose of separate each layer is to keep a high level of closely bonding between each element in the same module and reduce the interconnection between different modules within a software architecture in the meantime, therefore, different module keeps a high dependence which is conducive to upgrade and maintain in the later stage.



Extension

Big data is a method that can be used for data analysis to systematically extract information from a particularly large or particularly complex data set for processing by conventional data processing software. Big data technology can extract the most influential factors in the data set from the cumbersome data set. For our projects, we can use Big Data technology to make the following adjustments to our features and architecture:

a. Analyze existing BIFoR data using big data technology. Using principal component analysis, we can analyze one or several factors that have the greatest impact on tree health from BIFoR's existing dataset. As an educational application, it is necessary and responsible for us to share the results of the analysis with the users. Based on the results of the analysis, we can provide users with reasonable advice to allow users to protect trees in future life in a more scientific way.
b. In this application, we collect the number of steps of the user's daily exercise and predict how much carbon dioxide emissions can be reduced based on the user's daily steps. Using big data technology can make the predicted results more accurate. In addition, based on daily forecasts of reduced CO2 emissions to users, these data can be collected and a new database can be established. Based on these data, big data technology can be used to predict the Earth's carbon dioxide emissions in the next 10 or 20 years and the future ecological environment.
c. Using big data technology, we can analyze each group of data in BIFoR data set separately and find out their impact on tree health. We can use the results of the analysis to apply in the application of tree animation effect function, users can change a variable of the natural environment to observe the impact on tree health.