



An Information System For a Multiplayer Geolocation Game

Artur Oghlukyan - a46037

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Supervisors:

Prof. Rui Pedro Lopes

Prof. Marine Usepyan

This document does not include the suggestions made by the board.

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Dedication

To my family, friends, and all others supporting me during my journey...

Acknowledgment

This work's completion was dependent on numerous incentives and forms of support.

First, I want thank to my supervisor Professor Rui Pedro Lopes, incredibly for supporting this project and the journey of all other ideas and ways of development.

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Abstract

A great deal of travel can educate tourists.

As tourism becomes more accessible, many new technologies are being used to provide interesting, appealing, and efficient trips so that travelers can find what they want, avoid getting lost, and get the most out of their trip.

Science, education, and culture all benefit from technological advancement. As many good ideas can now be turned into reality, interactive education has found a place in everyday life.

Research and review of geolocation-based applications (such as hiking path providers) and guide applications were conducted to better understand the technologies and tools related to the topic. The best features were designed to solve the problem after summarizing the results of applications, their advantages and disadvantages.

The purpose of this paper is to create a geolocation-based game that will allow travelers to explore nearby attractions, learn about local culture, and broaden their knowledge while traveling. To summarize, a dynamic platform that can be implemented in a variety of ways was created.

Keywords: Interactive Guide, Geolocation, Education, Tourism

Resumo

Uma grande quantidade de viagens pode educar os turistas.

À medida que o turismo se torna mais acessível, muitas novas tecnologias estão sendo usadas para fornecer viagens interessantes, atraentes e eficientes para que os viajantes possam encontrar o que desejam, evitar se perder e aproveitar ao máximo sua viagem.

Ciência, educação e cultura se beneficiam do avanço tecnológico. No muitas boas ideias podem agora se tornar realidade, a educação interativa encontrou um lugar na vida cotidiana.

Pesquisa e revisão de aplicativos baseados em geolocalização (como provedores de trilhas para caminhadas) e aplicativos de guia foram realizados para entender melhor as tecnologias e ferramentas relacionadas ao tema. As melhores funcionalidades foram projetadas para solucionar o problema após resumir os resultados das aplicações, suas vantagens e desvantagens.

O objetivo deste artigo é criar um jogo baseado em geolocalização que permita aos viajantes explorar atrações próximas, aprender sobre a cultura local e ampliar seus conhecimentos durante a viagem. Para resumir, foi criada uma plataforma dinâmica que pode ser implementada de várias maneiras.

Palavras-chave: Guia Interativo, Geolocalização, Educação, Turismo

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Chapter 1

Introduction

As humans, we are always looking for ways to improve our lifestyle, live in a more accessible world, and gain access to things with less effort. It means that in order to reduce asymmetries, countries with both urban and rural areas, as well as historical sites, must evolve in all meaningful areas. If you look carefully, you will find life's interests in unexpected places. It makes no difference whether it is a modern city or a historic village, with modern or ancient structures, innovative futuristic museums, or cultural heritages. It should be carried out in order to manage all of these and other entertainments that will easily and quickly open our minds. We can have a new opportunity to raise interest in many new things while not forgetting the old ones if we handle them intelligently.

Traveling is something which helps to relax, explore new things, see the old things from a different perspective, open a new and creative mindset, etc. Different generations prefer a different kind of tourism, depending on the country, culture, age and nationality. There are countries where relatively young people prefer to travel, whereas there are other countries with older tourists, like China [1]. Most people enjoy traveling because it provides positive emotions and energy, inspires them to think creatively, and provides them with new perspectives. Traveling has some amazing benefits, but it takes a lot of time and money.

The more you have of those, the more you can see, try, test, and be safe. But not

everything is affordable for everyone, for instance, visiting a historical place with an experienced and knowledge guide to introduce the place could cost too much. For the reasons mentioned, young travelers' most shared trends are economical tours and explorable ones or, in other words, educational tours [2]. Personal assistants, the most common of which are audio guides, that can run on a smartphone can be very useful for these. However:

1. It can be tedious to do things with audio guides that are the same everywhere and every time. It may even contribute to a reduction in a person's desire for educational tours.
2. Another issue here could be safety, as one may have difficulty trusting things around them and avoiding scams while simply following the audio guide without some basic knowledge background about the things nearby, or simply due to a lack of experience.
3. Participants may devote too much attention to their guide device rather than to a real-life pleasure.

Even though educational tourism is growing in popularity, some cultural and historical sites remain in disrepair. First and foremost, pay attention to displaying facilities. Now we shall see how innovative technologies can help.

Since technology is rapidly advancing and becoming more prevalent, the structure of any job or study is changing year after year. Tourism and education are not outlier industries.

1.1 Objectives

Critical questions have frequently been answered while traveling. It is difficult to pinpoint what exactly does exploring the reality model for collecting ideas and putting things into perspective: maybe it is the climate, or another reasons. Change the fact that one has enough physical and psychological space between himself and his daily life, and he will have the perfect formula for relaxing, resting or learning.

While visiting, in addition to memories, the tourist also has the opportunity to create knowledge, as long as he has access to information or to learning experiences. In this context, the main objective of this work is to study and develop a geolocation game for smartphones that combines an in-place experience with information and learning experiences. Users should perform some actions and movements and follow the recommended paths and instructions. It will provide an opportunity to examine activities in depth and comprehend their meanings and relationships to one another. While performing actions or activities or progressing through episodes, users answer questions, share their ideas, and provide judgment or feedback. The greatest advantage is being able to share the tour from a creative perspective while also educating the tourist. Meanwhile, an important consideration is not to bore the tourist with traditional methods. Also, they can concentrate on each specific point or step for as long as they want, and if necessary, they can easily rejoin the path after inspecting the surroundings.

1.2 Structure of the document

After the introduction, this document is structured as follows: Chapter 2 introduces the fundamentals of geological position usage in new technologies, provides background about some mobile game types, discusses applications and papers with similar features and purposes, and describes the three-tier architecture structure; Chapter 3 introduces the sustainable tourism, interactive education and provides a concept of solution for geolocation-based interactive guide; Chapter 4 explores the implementation details of the database structure and mobile application; Chapter 5 presents the final conclusions and future works of this project.

Chapter 2

Context and Technologies

A large proportion of jobs in the tourism industry (and elsewhere) will not be created through the sale of tourist products (this role becomes the entitlement of mobile internet technologies). Instead, innovative tourism services and products can fill that void. It is also worthwhile to forecast future demand for tourism specialists in light of the world's digitalization and technological advancement. People are using information technologies to find good places to visit, stay, eat, explore, and find the path to their destination rather than tour agencies and guide specialists. It would be preferable for tour operators to consider storing their knowledge on technological information systems and earning money in this manner as an alternative. This is a fantastic opportunity for those individuals to come up with new startup ideas and see them through to completion. So, it is essential to start with the technologies that power in-place experiences, such as geolocalized games and apps.

2.1 Geolocation

The method of determining the position of a computer, phone, or other network-based device is known as geolocation. This estimated location is based on latitude and longitude measurements to narrow down the position to a city, zip code, street, and even address [3].

Geolocation shows a device's location in terms of latitude and longitude coordinates, which can be derived from a variety of sources such as time of day and networking protocols. Geolocation also discloses local-specific data, such as a state or city, which can be quite useful to marketers. Geolocation data, including accurate GPS location information, property location, and IP address-based approximate location. Geolocation not only determines a device's location but it is also employed in a range of applications to assist in the location of human users. Geolocation allows users to receive all forms of information in real-time from any device connected to the Internet, as well as pinpoint the user's location at any given time.

The use of satellite and digital technologies allows the precise location of a device, such as a mobile phone, GPS device, or internet-connected computer, to be determined. This data can then be used with other digital tools, such as mapping software, to give users with pertinent information about their current position. Blogs were made possible by digital technology, and they are now widely used on the Internet. Personal thoughts, usually expressed in an informal style, are common on these often updated web pages. They are also becoming more participatory, with connections to movies and other material and, in many cases, reader comments.

With GPS-enabled smartphones, billions of people now have access to mapping technologies. The markets for GPS navigation devices and services, mobile phone location-based service applications, and geo-targeted mobile advertising services are all growing. The majority of the benefits accrue to end-users, primarily in the form of time and fuel savings, as well as new forms of mobile services. In addition, organizations are increasingly able to use geographic data to track assets, teams, and customers across several places in order to get new insights and increase productivity.

2.2 Mobile Games

Since the introduction of smartphones in 2007 [4], the popularity of mobile video games has skyrocketed. Mobile gamers have turned to social media platforms to attract their

friends and family since games like Clash of Clans give in-game benefits for suggesting new players. Some games even have social media integration, allowing players to communicate and compete with other players via in-game chat or “friends” features.

There are numerous genres in the mobile game market that can appeal to any taste. Despite the fact that we now have a large selection of mobile games to pick from, there are some genres that are more popular than others. Nonetheless, the same genres do not predominate across all devices. Many elements influence this feature, including the type of device, the screen’s dimensions, how the game is interacted with, the internet connection, and, ultimately, the user experience [5]. There are many types of video games, such as:

- Action games
- Action-adventure games
- Adventure games
- Role-playing games
- Simulation games
- Strategy games
- Sports games
- Puzzle games
- Idle games

2.3 Related work

More people than ever before can now afford to travel. This ability allows people to think more about how they will spend their vacation or complement their business trip. But what are the prerequisites for smart travel? One of the answers is to consider how you can help preserve the environment while avoiding bothering locals. However, tourism

does not only generate revenue. Instagram and other social media platforms fuel our desire to visit and photograph interesting places. Over-tourism occurs when there are more tourists than a particular location or its residents can handle. Can cutting-edge technology make travel more pleasant for both visitors and locals? With its ability to make information easily accessible, tourism digitalization has a great potential for increasing sustainability. If you have access to information such as real-time data on tourist numbers, you can more sustainably regulate their movement, resulting in less overtourism. Another option is to link smart travel options together. This allows us to travel from point A to point B more quickly. Tourists have access to a wealth of information and can choose more environmentally friendly options. Travel guides are useful when you're on the road, but they take up space when you get home. Smart tourism could be defined as using digitalization options to reduce risk as much as possible, with sustainability also being important.

Interested people can use <https://www.socialbnb.org/>, which lets to put development for conservation projects and provides a feature to book an accommodation at a social or ecological project for the next trip. For a stronger focus on local projects, there are platforms like <http://workaway.info/>. For simply booking accommodation, Fairbnb is a Greener alternative. The commissions go to support local projects. The site is still in development, as are most of the services for sustainable traveling.

It would be great if we could expand the data networks and share data better. We even have the technology to collect data as tourists. If we use the data collection potential while traveling in the right way, we can also do good. We can contribute it to science, for instance by taking holiday snapshots: tourists can contribute their photos to citizen science projects and supply valuable data for research on coasts, animals, and clouds. The Wild Me project by an American NGO allows anyone, whether tourist or researcher, to upload photos of wild animals to the site. Artificial intelligence recognizes each animal by its individual traits and records the date, time, and location the photo was taken. This allows scientists to follow migratory patterns, and users can see where the animal they photographed on their holiday has moved on. Anyone can take pictures of clouds

with NASA's GLOBE Observer app and again help researchers. The U.S. Aeronautics and Space Administration compares photos and other data like time and place with their own satellite images, which among other things, helps them improve research on the atmosphere and climate. Scientists are not the only ones who benefit from big data; tourists can get too. In the city Hangzhou of China, for instance, tourists' movements are tracked so that the city can inform visitors how crowded a location will be, say, 2 hours in advance.

The UN World Tourism Organization contends that smart cities are best equipped to handle Mass tourism [6]. Now, anyone anywhere can explore Helsinki with a VR headset and without traveling. The project is called "Virtual Helsinki". The virtual duplicate of Finland's capital was created by the Zohan company. By slipping the headset on, you can see what it is like to stand in front of Helsinki Cathedral. In the future, it may even be possible for people to virtually attend concerts and exhibitions or go shopping in VR. Not everyone can afford to go there, or they don't have the means to go. Visiting Helsinki in VR saves travel time and the resulting CO₂ emissions. Those who head to Helsinki in person must decide what to do first. Among the many situations and food options, the website <https://www.myhelsinki.fi/> provides tips for sustainable options. Then there is the question of how to get from A to B: by subway, city rail, by bike, or with the nearest car share.

In addition to the web-based applications, there are also some mobile apps that were tested:

1. Traboules by Lyon tourism and Conventions
2. AllTrails
3. Wikiloc
4. SmartGuide
5. Rick Steves' Audio Guide

The other example of smart tourism in Europe is in Lyon in southern France. The app “Traboules by Lyon tourism and Conventions” guides users through Lyon’s traboules, a network of interconnecting Alleyways, corridors, and stairways [7]. It uses geolocation to lead tourists through Lyon’s most picturesque courtyards and passages in the old town. Provides background information on the traboules along the way. Lyon tells visitors how they can use the app to explore the city and discover Lyon’s insider spots. But locals also benefit. There are people living in traboules or, in other words, little passageways, and so they may open the treasures of architecture to the public but also preserve the quality of life of the inhabitants. Another part of the smart Lyon is iGiroutte digital signs that can rotate 360° and share up-to-date information, for instance, some festivals. Visitors can connect iGiroutte to a smartphone and be guided to the events or to parks or train stations. Especially useful for those without cars are the bikes available for rent at various points around the city also by an app. The concept of the Lyon Bike Tour is to give visitors a guided excursion through the city by e-bike instead of by tour bus (Figure 2.1).

AllTrails (AllTrails: Hike, Bike, and Run) is a fitness and travel mobile app used in outdoor recreational activities. AllTrails are commonly used for outdoor activities such as hiking, mountain biking, climbing, and snow sports. The app allows users to access a database of trail maps, which includes crowdsourced reviews and images [8]. It allows third-party authentication with Google and Facebook.

AllTrails represents paths that can be open or start and finish at the same point. It also shows the height above sea level. This path data is hardcoded in the app, and it’s complicated to rejoin the path in the middle of the trip after checking something nearby the path. It forces them to follow the exact path only, which can make some users get lost. This app is for hikers, which means they are in the mountains and without a stable internet connection. It has some good features which are, for example showing burnt calories and providing some health information relevant to the activity. Provides some weather and daylight information. Users also can create activities, attach photos to them, and share them with others. Other users can search by activity types, leave their

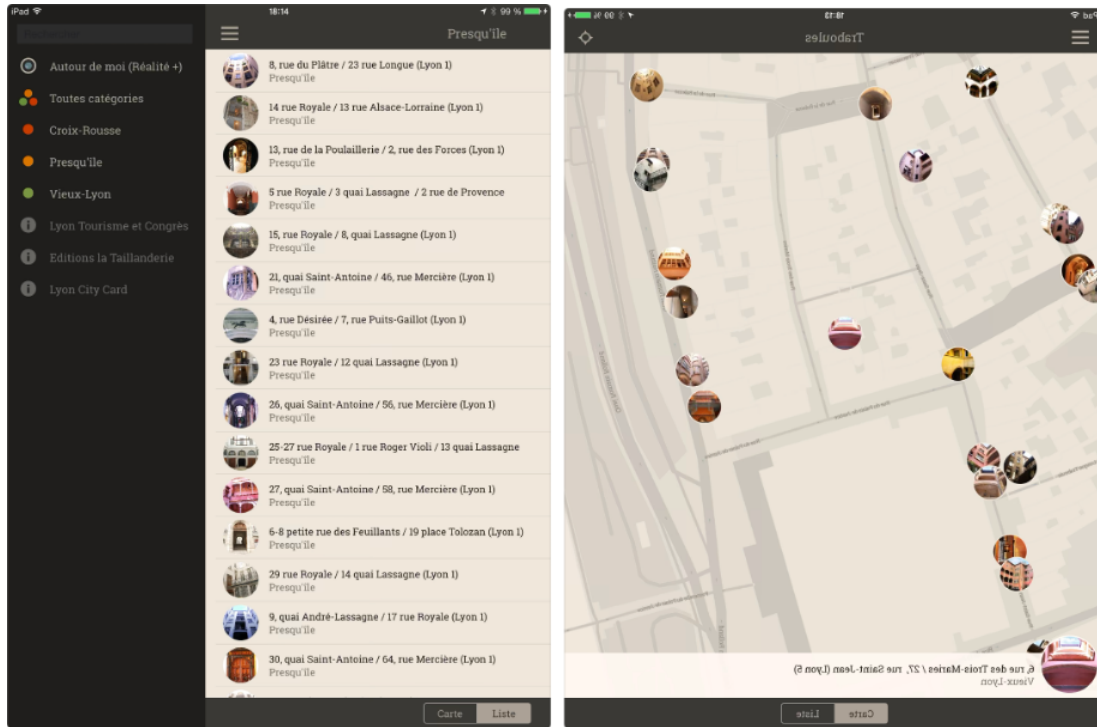


Figure 2.1: Screenshots from “Traboules by Lyon tourism and Conventions” iOS app

comments on them, rate, etc. The app has a good feature to record tracks, whereas it doesn’t allow to save those on the device. The app also has some user-friendly issues, like constantly taking the user back to his current location while planning a trip. UI part could be done better, like having more colors to determine different kinds of functionalities. As an example, it has too much red color: for path, for distance numbers, navigation of path is red which makes to struggle while using. Last but not least, it is a little expensive for a premium membership subscription (Figure 2.2).

Wikiloc is a website launched in 2006 containing GPS trails and waypoints that members have uploaded. This mashup shows the routes in frames showing Google Maps. The service is also available on Google Earth. There are mobile apps for Android and iPhone [9]. With Wikiloc it is possible to export GPX file. GPX, or GPS Exchange Format, is an XML schema designed as a common GPS data format for software applications. It can be used to describe waypoints, tracks, and routes. It is an open format and can be used without the need to pay license fees. Trips could be shared as well. The app calculates vertical

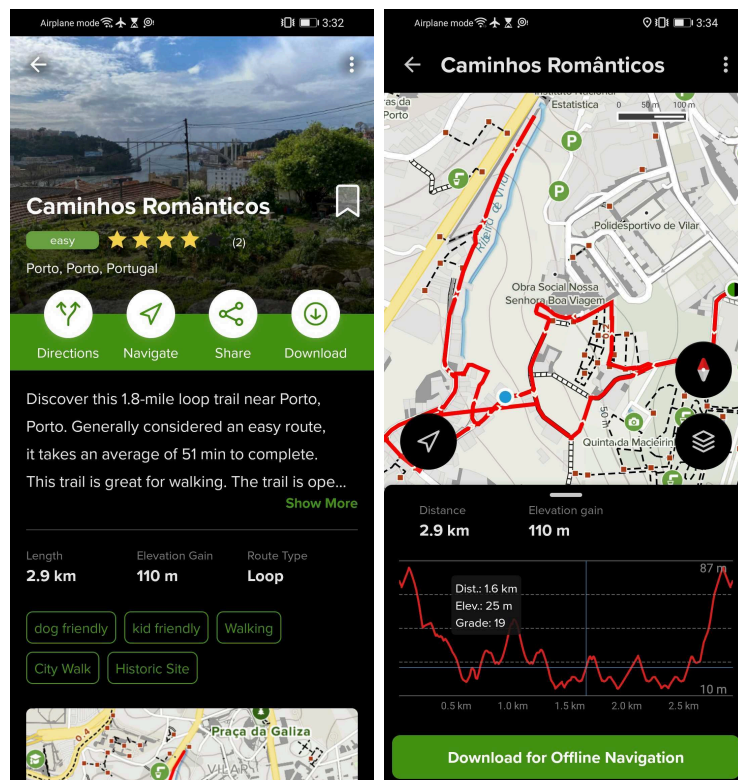


Figure 2.2: Screenshots from “AllTrails” Android app

gain and loss, which should be a good feature, but often they are calculated inaccurately, so the good feature is diminished. The app connects to sports watches such as products by Suunto. The disadvantage of this is that everything is being uploaded automatically to the app, while all activities are public by default until they are moved to a private list. If someone doesn't realize that all their Suunto fitness activities are public, then if they begin an activity from their house, the public trail shows the entire planet where they live. No ability to turn off automatic upload. While in navigation mode, it drains the battery rapidly. Other advantages are that it is possible to add waypoints with their descriptions and photos while walking. The user can plan the trip in advance, download it to the phone and use it later. In addition, if we do not consider all the features and look into the design part, this app has a more user-friendly UI/UX than AllTrails with a better interface (Figure 2.3).

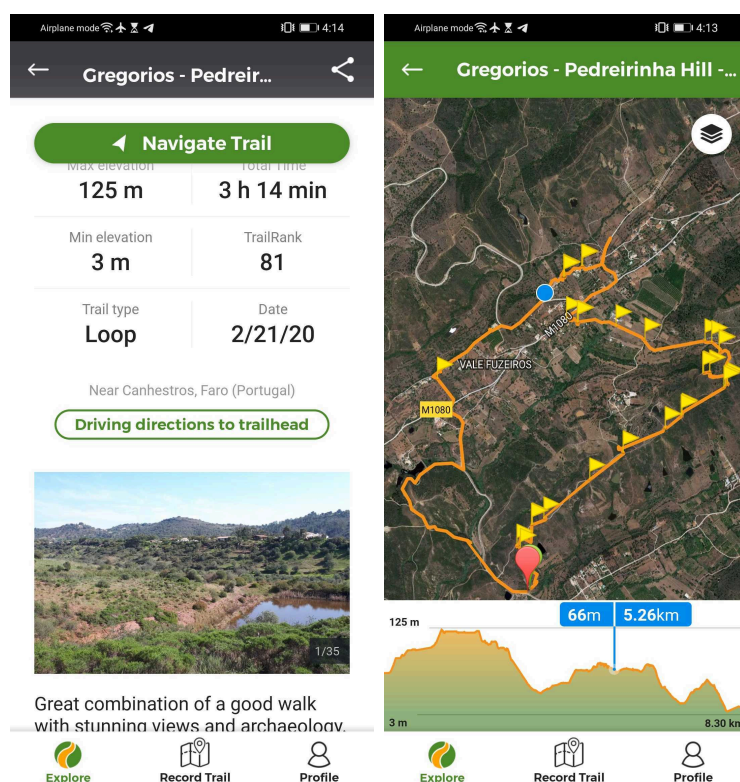


Figure 2.3: Screenshots from “Wikiloc” Android app

SmartGuide is a salable platform that makes creating an intuitive, professional mobile

guide simple and smooth. SmartGuide acts like a live guide, guiding visitors around and talking to them automatically when they reach an interesting spot [10]. It has audio directions feature, which is an interesting and useful thing. But hint does not exist for a lot of tracks. In some cases, users might need another app in parallel to check their direction. The app shows important site details along the route by both texts and audio automatically. Also gives a possibility to download and use pathfinder offline with info on each side (Figure 2.4).

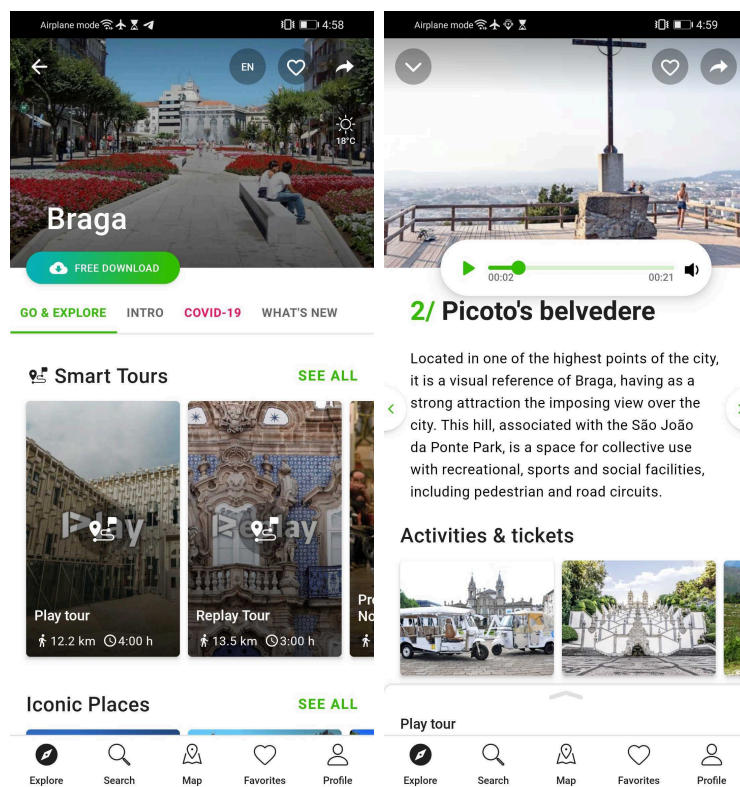


Figure 2.4: Screenshots from “SmartGuide” Android app

The Rick Steves’ Audio Europe™ app organizes Rick’s vast library of self-guided walking tours and radio interviews into geographic playlists covering Europe’s top sights, travel tips, and cultural insights [11]. Provides audio guides for a lot of places, which allows to have one app for multi-place guides and not struggle while switching among different sources. Provides audiobooks for places by skipping the intricate details and focusing on essential ones, which saves a lot of time. A good portion of humor is used

within the audio, which eases the boredom of tourists. In the end, it has GPS functionality but is not that good, which makes it swap between the app and a map app (Figure 2.5).

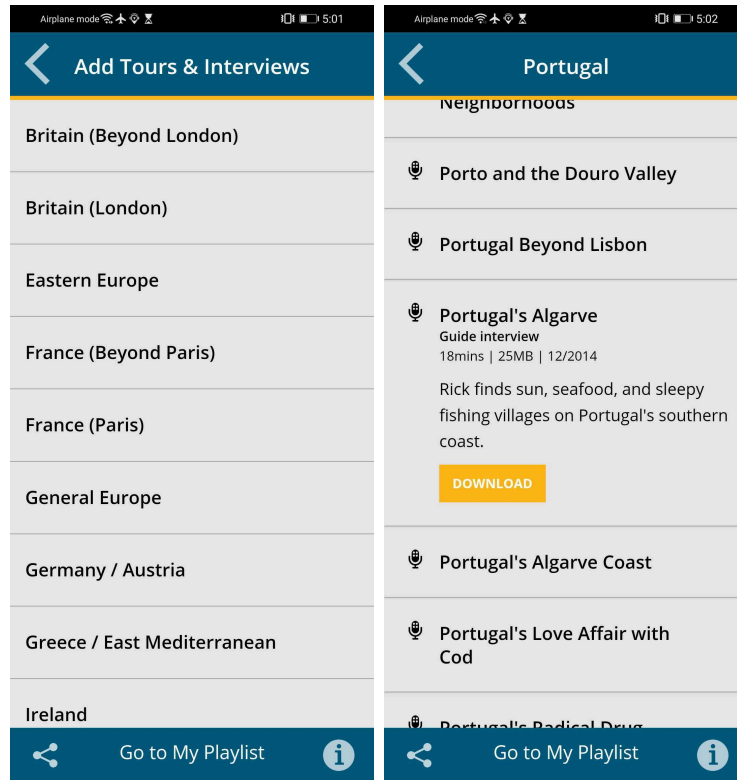


Figure 2.5: Screenshots from “Rick Steves’ Audio Europe” Android app

PokemonGo is a more funny way of geolocation based game. In 2016, Niantic, in partnership with Nintendo and The Pokémon Company, created and released Pokémon Go, an iOS and Android augmented reality game that is a part of the Pokémon series. It locates, catches, trains, and engages in battles with virtual animals known as Pokémon that seem to be at the player’s actual location using GPS-enabled mobile devices [12].

Mobile location-based games urge players to travel throughout a city in order to complete the game’s goals and objectives. Such urban-based games are usually referred to as “street games” or “urban games”. It is also worth noting that there are two basic categories of urban games. They can be designed to be played in a limited amount of time (event-based games) or for extended periods of time (long-term games) [13].

2.4 Tools and frameworks

Three-tier architecture is a well-established software application architecture that organizes applications into three logical and physical computing tiers: the presentation tier, or user interface; the application tier, where data is processed; and the data tier, where the data associated with the application is stored and managed (Figure 2.6) [14].

1. The presentation tier is the application's user interface and communication layer, which is where the end-user interacts with it. Its primary function is to present information to and gather data from the user. This top-level tier, for example, can be accessed via a web browser, a desktop program, or a graphical user interface (GUI). HTML, CSS, and JavaScript are commonly used to create web presentation levels, whereas modern mobile application development requires the usage of other programming languages, such as Java or Kotlin, Swift, etc. Depending on the platform, desktop apps can be built in a variety of languages.
2. The heart of the application is the application tier, often known as the logic tier or middle tier. Information from the presentation tier is handled at this tier, sometimes in conjunction with data from the data layer, using business logic or a set of business rules. The data tier can also be added to, deleted from, or modified by the application tier.
3. The data tier, also known as the database tier, data access tier, or backend, is where the application's data is kept and maintained. A relational database management system, such as PostgreSQL, MySQL, MariaDB, Oracle, DB2, Informix, or Microsoft SQL Server, or a NoSQL database server, such as Cassandra, CouchDB, or MongoDB, can be used.

The tiers in Web and mobile development have different names but serve the same functions:

1. Web (Frontend) or mobile application

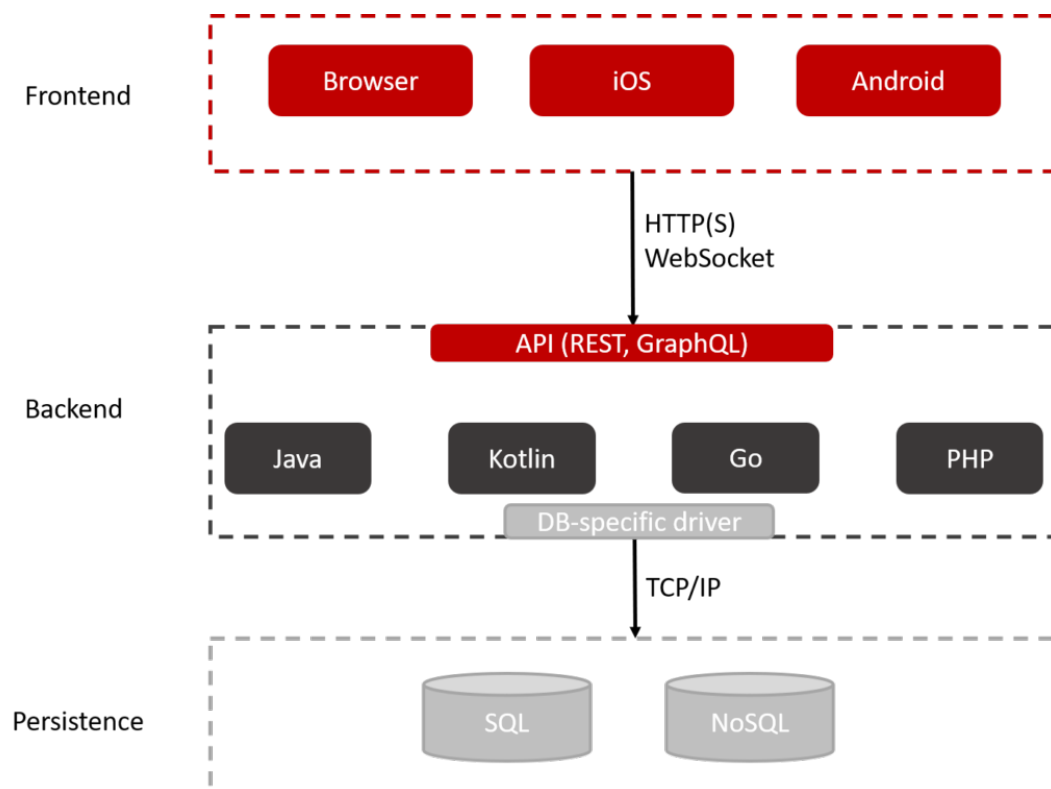


Figure 2.6: Three tier architecture

2. Application server (Backend)
3. Database server (Persistence)

2.4.1 Presentation Tier (Frontend or Mobile)

The user interacts with the front end of a web or mobile application directly. It is commonly referred to as the program’s “client-side”. The frontend contains everything a user sees when using a website or app, such as text colors and styles, images, graphs and tables, buttons, colors, the navigation menu, and more. Frontend developers provide the structure, appearance, behavior, and content of everything that appears on browser displays when websites, online applications, or mobile apps are opened. Among the most important aspects of frontend development is responsiveness. A frontend developer must ensure that the website is responsive, which means that it works properly on all devices. The performance of the application should be consistent at all times, regardless of the device used to access it.

In-app development frameworks or libraries give developers the right tools to aid them in the development process. ReactJS, AngularJS, and jQuery are the most widely used frontend libraries.

The term “native app” refers to software that runs on platforms such as Mac and PC, with examples including the Photos, Mail, and Contacts apps that come pre-installed and configured on every Apple machine. In the context of mobile web apps, however, the phrase “native app” refers to any software designed to run on a certain device platform. Apple’s iOS and Google’s Android are the two most popular mobile operating systems. Native apps are created in the same code that was used to create the device and its operating system. For instance, iOS applications are written in Objective-C or Swift, but Android-native apps are written in Java or Kotlin. Native apps interact with the device’s operating system in ways that allow them to perform faster and more flexibly than other types of apps. Developers generate unique app versions for each device type if the app is marketed to consumers of various device types.

Native applications provide the following benefits:

- extensive functionality due to the underlying device's capabilities
- fast and responsive software performance
- push alerts
- a UI that better complements the OS's user experiences
- and quality assurance through app store ratings

Native programs have the following drawbacks:

- a cost for additional developers to build and manage a code base for each platform
- multiple code bases because each device has its own version of the app
- time was invested on several builds for different platforms

A (hybrid app) is a software application that incorporates features from both native and web apps. Web apps that have been wrapped in a native software shell are known as hybrid apps. The shell can connect to whatever features the mobile platform gives through a browser embedded in the app once it's downloaded and installed locally from an app store. The browser and its plug-ins are invisible to the end-user since they run on the back end.

Hybrid application features include:

- The capacity to work regardless of whether the gadget is connected or not
- Integration with the file system on the mobile device
- Web-based services integration
- An embedded browser that allows you to view dynamic web material more easily

Native apps are designed expressly for the platform on which they are deployed. They can use the hardware of a mobile device efficiently, such as the accelerometer, GPS, and camera. Native apps are created in the same programming language as the platform's operating system, such as Swift for iOS apps.

HTML, JavaScript, and HTML are the most prevalent languages used to create web applications. Web applications do not require downloading and are accessed via the device's browser. Web programs are unable to take advantage of the hardware on a given platform.

Hybrid apps mix native and Web apps in that they are installed and act similarly to native apps while also having the inner workings of a Web app.

2.4.2 Application Tier (Backend)

The backend of a computer application or program refers to the sections of the code that allow it to run but are not visible to the user. The backend of a computer system stores and accesses the majority of data and operational syntax. One or more programming languages are usually used in the code. The backend, often known as the data access layer of software or hardware, encompasses any functionality that requires digital access and navigation.

Everything that happens before it reaches the browser is referred to as the backend: the systems and structures that edit, store, and source the data and content that makes up the website user is viewing. While booking a flight, for example, the prices are checked, itineraries are booked, and credit cards are paid on the backend of the website. A backend might be extremely simple or quite complex. The backend can also be changed without the user being aware of the changes.

It is made up of servers, apps, and databases and it allows browsers to communicate with databases and save data in databases, read data from databases, update data, and delete data or information from databases. Backend developers are in charge of developing and maintaining technology for a website's backend (the server, database, and

application). Without the technology offered by a backend developer, the appealing visuals developed by designers, UX professionals, and front-end developers would not be possible.

There are two kinds of backend programming languages:

1. Object-oriented (OOP), a programming architecture that's based on the idea of classes and objects. It's used to break down a program into small, reusable code chunks (called classes), which are then used to generate individual instances of things. A class is a generic blueprint that may be used to make more specific and concrete things. A class's instances are called objects. Statements are performed in a specific order in object-oriented programming languages. Python, Java, and .NET are examples of prominent object-oriented backend languages.
2. Functional, a programming paradigm in which all operations are expressed as mathematical functions. It is a method of software development that involves the creation of pure functions. OOP principles such as shared state and mutable data are avoided in functional programming languages. They place a greater emphasis on expressions and declarations than on execution. The declarative syntax is used in functional programming languages, which means that statements are frequently executed in random order. Haskell, Clojure, SQL, and R are examples of functional languages.

Data security on the backend is crucial. It is crucial for sensitive data, especially now that new data protection rules have been implemented around the world. Using the greatest security methods, we may avert the most serious threats and provide the groundwork for the product's long-term security.

HTTP requests are used to communicate between the front end and the backend. Because frontend code can be misled, the backend may then validate the data again before storing it in a database.

On the frontend, an API can be used to retrieve data from a server. An API, for example, could be used by a frontend JavaScript application to request data from a

backend PHP application. Alternatively, a backend API can be used to expose data to a frontend application.

Representational state transfer (REST) is a software architectural style that was developed to help in the design and development of the World Wide Web's architecture. REST establishes a set of guidelines for how an Internet-scale distributed hypermedia system, such as the Web, should be designed [15].

2.4.3 Data Tier (Database)

A database is an ordered collection of data that is stored and retrieved electronically in computing. Large databases are housed on computer clusters or cloud storage, whereas small databases can be stored on a file system [16].

The functionality of early databases was quite limited. Initially, computer hobbyists employed flat databases, which were just plain text files. This means the information must be in text format and be of reasonable length. The programmer had to type a delimiter - a particular character chosen to establish the border – to mark the start of each new field (e.g., a comma or a colon). A flat database is difficult to search and traverse because there are no relationships between the fields. It does, however, work for a tiny quantity of data that needs to be read but not changed. CSV (Comma Separated Values) files are basic examples of this sort of database.

Over time, database technology has altered and evolved. It is easy to get confused between relational, NoSQL, and hierarchical databases. Data storage does not have to be a hassle.

Here is a guide to the properties and usage of each database type while attempting to choose the ideal one for the company or the project (Figure 2.7).

Since the 1970s, relational databases have been used. The name stems from the way data is stored in a series of interconnected tables. Data is kept in rows and columns within the tables. The relational database management system (RDBMS) is a program

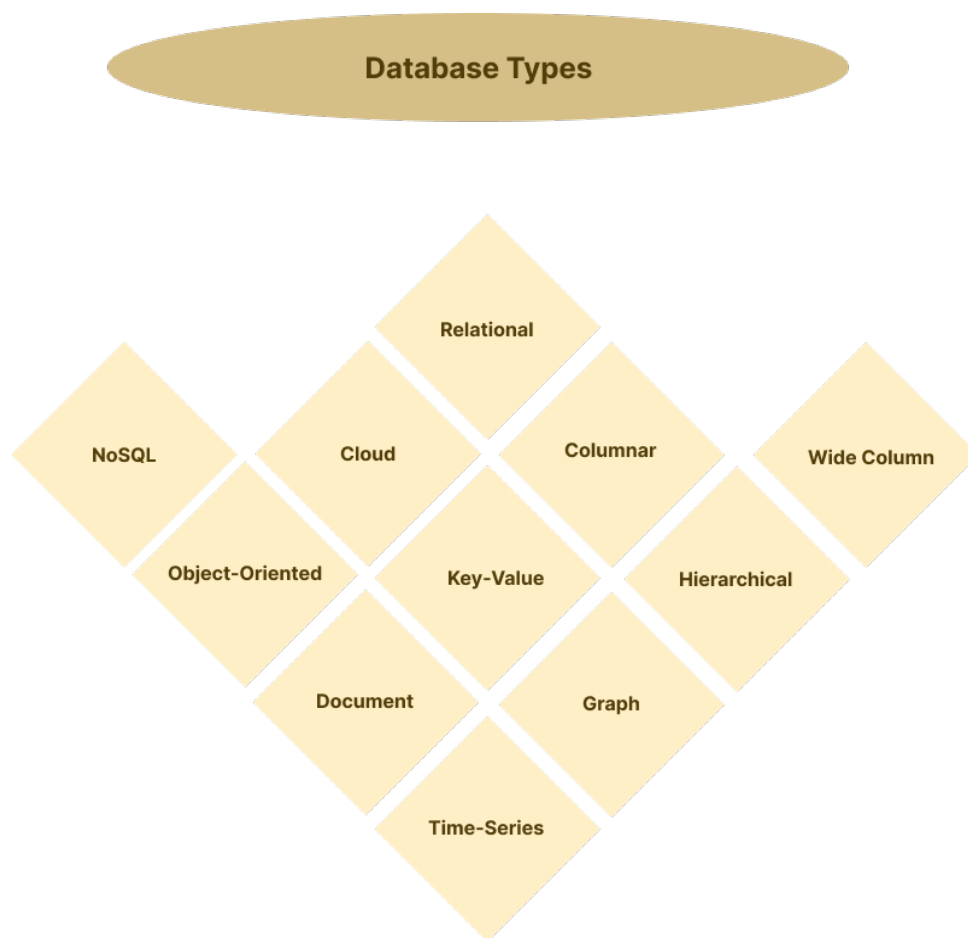


Figure 2.7: Types of Database

for creating, updating, and administering relational databases. The most common language for reading, generating, updating, and deleting data is Structured Query Language (SQL). Relational databases have a high level of dependability. They adhere to ACID (Atomicity, Consistency, Isolation, and Durability), which is a set of properties for ensuring the integrity of database transactions. Structured data works nicely with relational databases. A relational database should not be considered by organizations with a lot of unstructured or semi-structured data. Database normalization is the process of structuring a relational database in accordance with a series of so-called normal forms in order to reduce data redundancy and improve data integrity. It was first proposed by Edgar F. Codd as part of his relational model [17]. Some examples are Microsoft SQL Server, Oracle Database, MySQL, PostgreSQL.

Any database that does not use SQL as its primary data access language is classified as NoSQL. Non-relational databases are a term used to describe certain sorts of databases. Because data in a NoSQL database does not have to comply with a pre-defined schema, unlike data in relational databases, these databases are ideal for storing unstructured or semi-structured data. One benefit of NoSQL databases is that they allow developers to make changes to the database on the fly without disrupting the apps that use it. Examples: Apache Cassandra, MongoDB, CouchDB, and CouchBase

Any database that is built to run in the cloud is referred to as a cloud database. Cloud databases, like other cloud-based applications, provide flexibility, scalability, and high availability. Because many cloud databases are provided as a service, they are frequently low-maintenance. Examples: Microsoft Azure SQL Database, Amazon Relational Database Service, Oracle Autonomous Database.

Columnar databases, also known as column data stores, store data in columns rather than rows. Because of their ability to handle analytical queries, these databases are frequently employed in data warehouses. Because you may extract information from only the columns you desire when querying a columnar database, it essentially ignores all of the data that doesn't pertain to the query. Examples: Google BigQuery, Cassandra, HBase, MariaDB, Azure SQL Data Warehouse

Broad column databases, also known as wide column stores, don't care about the schema. Rather than rows and columns, data is kept in column families. Wide column databases are perfect for supporting real-time big data applications because they are highly scalable and can accommodate petabytes of data. Examples: BigTable, Apache Cassandra, and Scylla

Data and all of its attributes are brought together as an object in an object-oriented database, which is based on object-oriented programming. Object-oriented database management systems are used to handle object-oriented databases (OODBMS). Object-oriented programming languages like C++ and Java perform well with these databases. Object-oriented databases, like relational databases, follow ACID guidelines. Examples: Wakanda, ObjectStore

Key-value databases are one of the most basic types of NoSQL databases, storing data as a group of key-value pairs, each of which contains two data items. They're also referred to as a key-value store on occasion. Session management for web applications, user sessions for enormous multi-player online games, and online shopping carts are all activities that benefit from key-value databases' scalability and ability to handle high levels of traffic. Examples: Amazon DynamoDB, Redis

A parent-child model is used to store data in hierarchical databases. A hierarchical database would resemble a family tree, with one entity at the top branching down to several things underneath it. Because the one-to-many structure is strict, kid records can only have one parent record. Hierarchical databases, first developed by IBM in the early 1960s, are often employed to serve high-performance and high-availability applications. Examples: IBM Information Management System (IMS), Windows Registry

Instead of rows and columns, document databases, also known as document stores, utilize JSON-like documents to model data. Document databases, also known as document-oriented databases, are designed to store and manage document-oriented data, also known as semi-structured data. Document databases are easy to use and scale, making them ideal for mobile apps that require frequent updates. Examples: MongoDB, Amazon DocumentDB, Apache CouchDB

Graph databases are a sort of NoSQL database that uses graph theory to store information. The software in Graph-Oriented Database Management Systems (DBMS) is designed to find and interact with relationships between data items. As a result, graph databases are frequently used to evaluate the relationships between heterogeneous data points, such as in fraud detection or social media data mining. Examples: Datastax Enterprise Graph, Neo4J

A time-series database is one that is designed to store data that is time-stamped or in series. Network data, sensor data, and application performance monitoring data are examples of this type of data. All of those Internet of Things sensors that are becoming increasingly embedded in everything emits a continuous stream of time series data. Examples: Druid, eXtremeDB, InfluxDB

With the main issues covered in this chapter, the next step is to start analyzing how to harness this knowledge for the development of the geolocalized game.

Chapter 3

Analysis

This chapter describes the analysis and initial approach to the development of a mobile and geolocation app to improve tourism and education quality.

3.1 Sustainable Tourism

Sustainable tourism is described by the United Nations World Tourism Organization (UNWTO) (<http://www.unwto.org>) as an enterprise that strikes a balance between the environmental, economic, and socio-cultural aspects of tourism development in order to ensure long-term benefits to recipient communities. This is known as the triple bottom line for sustainable development: environmental, economic, and cultural returns on investment. The fourth advantage of well-managed tourism, according to some, is public education for visitors and people to improve awareness of cultures and ecosystems, albeit this is also a cultural benefit.

Traveling provides experiences that contribute to long term persistence of knowledge. The further you travel, the more you will see, and there is no variation for firsthand experience. While the lessons, experiences, and realizations available are infinite and vastly different for each individual, there are a few that are relatively familiar. When you travel the world, you learn how to create a fairly unique route for wherever you go through trial and error and education. You understand what is important to you, where

to splurge, how to figure out, and how much time you need to spend performing specific actions and in various cases of destination. You also learn how to use various travel apps and websites to get the best deals on transportation, land transportation, and lodging.

3.2 Interactive Lessons

Our interactive, technologically-based reality has raised expectations far beyond the days of teacher-centric lecture-based “learning”. Alternative training models advocate for dynamic education. Excellent programs can be designed that are not only paper-based (volumes, speaking and work actions, short problems to solve). All of these programs pique students’ interest in interactive education, real-world experiences, and networks. They are not the only answer, nor are they the best answer for all learners. Integrating highly interactive boards, various games, and educational tools broadens the learning opportunity frame for all. Games, whether used as a standalone instrument or as part of a larger program, provide teachers with easy-to-collect formative assessment data for understanding students’ new knowledge and needs, while also allowing students to learn while having fun.

The primary means of accessing the internet are mobile phones and personal computers. The majority of these students are accessing the Internet via mobile phones. This could be explained by the fact that, since the invention of intelligent phones and the increased services provided by these web companies, most students access the Internet through their phones for the sake of convenience and accessibility. There are no filters required, allowing them to browse other websites without restriction. Alzayyat and others reported similar discoveries.

An interactive lesson, in its most basic form, consists of a textual monograph followed by a post-test. This method of continuing education is similar to journal-based (print) continuing education, but it is delivered via the Internet. Some interactive programs may be enhanced with slide shows or streaming video, which may be preferable to online print-based training for some learners. This type of class would include audio, video, and

visual enhancements, as well as a variety of interactive self-evaluations, such as quizzes, interactive branching logic clinical case studies, and other high-level learning activities.

3.3 Main concept

While analyzing the similar technologies, applications, and solutions to these kinds of problems, comparing their advantages and disadvantages, the geolocation-based interactive guide system structure was designed, which would be easy to use, make the users explore with have fun and educate themselves.

The virtue of this project is to design the expected API structure of a system, details of which will be described in the following paragraph, and develop the end-user part: the mobile application.

One of the goals set is to have an abstract background of the system, which means it can be implemented to solve multiple similar problems by providing dynamic and interactive content for exploring the things nearby, such as a city self-tour guide. Also, it can be used in a lot of ways, such as:

- path provider educational tours
- guide for museums
- hiking paths
- and even as a geological position based game
- etc.

Systems with this kind of problem require solutions that should provide the features below:

- map based geolocation usage
- interactive usage flow

- motivate users with rewards

A user story diagram is a visual representation of user needs. User stories can be categorized into hierarchies and time periods (called sprints). Epics are at the very top of the user narrative hierarchy (Figure 3.1).

User Story Mapping

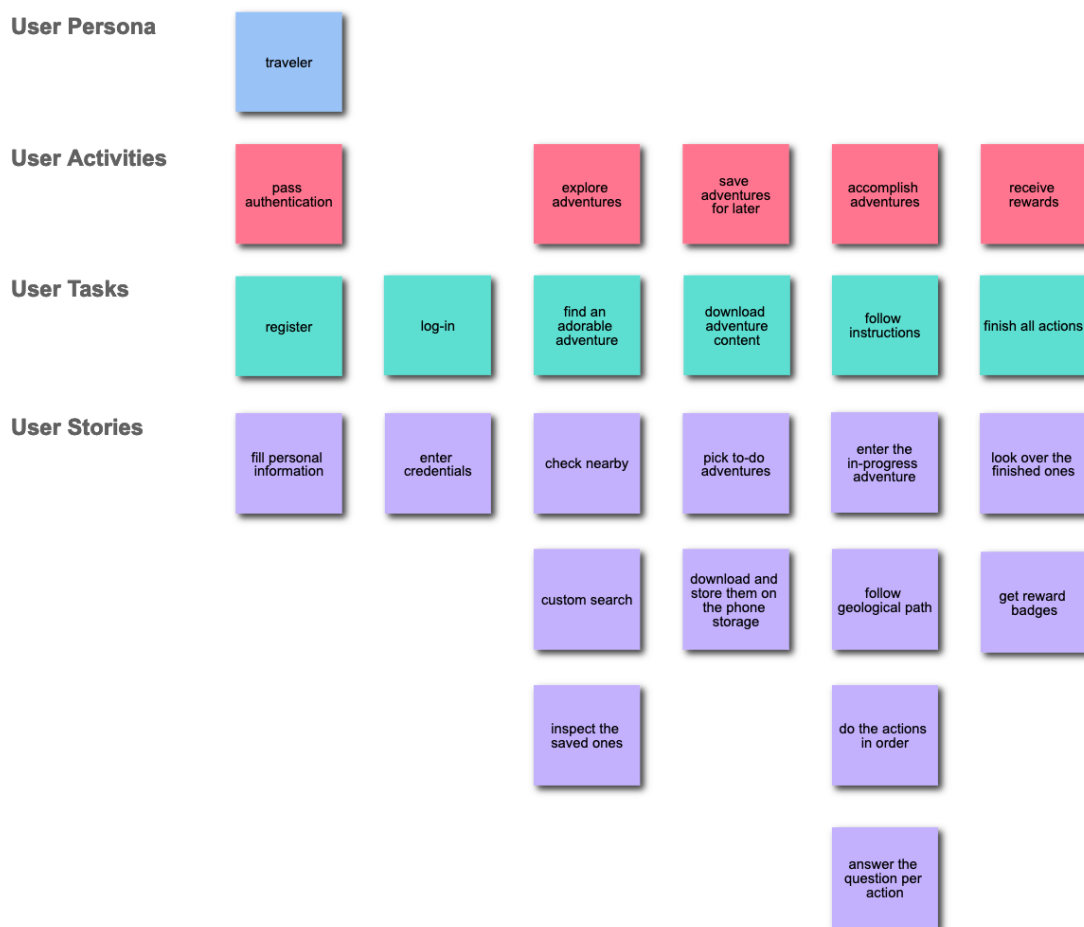


Figure 3.1: User Stories Diagram

First of all, the user needs to pass authentication (register or log in to the system) so that he can track everything related to him whenever he wants, such as adventures, rewards, and private details.

Second, he should be able to explore adventures nearby, search them in case of being far from it and check their contents. Also, it is possible to download and store some for offline usage. The adventure itself is a path of activities. Each of them is located at some geological point. So it means that adventure has some geographical area covered with these location combinations.

Once the user has picked an adventure to accomplish, he starts to do the activities given to him in order. Each activity location is provided to the user so that he shall follow the provided path. After reaching the spot and exploring the area, the user shall answer the question asked or to the action mentioned and move to the next one.

All the finished adventures are stored as user history and listed in his profile. It is possible to do the same adventure as much as one wants and have the history of the answer for all of them.

By summarizing all the user's history, he is being achieved some rewards as the motivation comes from two sources, according to self-determination theory: extrinsic and intrinsic [18]. Extrinsic motivation is based on rewards, which are usually given by others in the form of negative or positive reinforcement.

A state diagram is a sort of diagram used to illustrate the behavior of systems in computer science and related subjects. State diagrams imply that the system being depicted has a finite number of states; in some cases, this is true, while in others, it is a valid abstraction [19].

Next is provided the UML-based state diagram for the description above (Figure 3.2).

A database is a collection of information or records. The goal of database management systems is to manage databases. A database management system (DBMS) is a software system that stores and organizes data in a standardized manner. To add, update, delete, or traverse the data, various standard techniques and queries can be used. A hierarchical database model organizes data into a tree-like structure. The data is organized into fields,

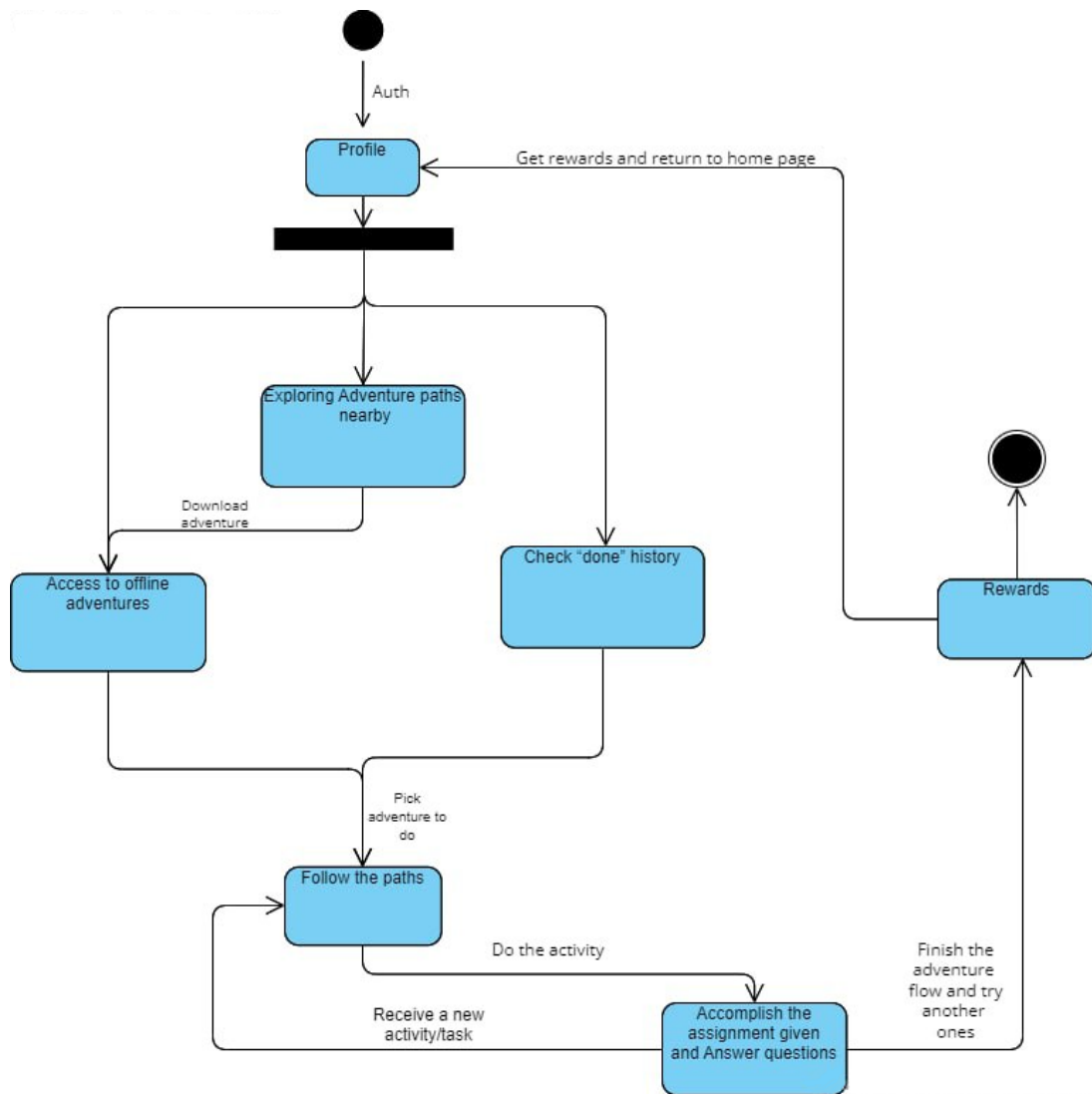


Figure 3.2: State Diagram - UML

each with a single value. The entries are linked together in a parent-child relationship. Each child entry in a hierarchical database model has only one parent. A parent may have more than one child.

Since their origin, database types have grown tremendously, and new database ideas are continually being created today. Given the appropriate access patterns, data properties, and needs, each of the kinds used in existing systems offers unique benefits worth investigating. When beginning a new project, one of the first and most important decisions the development team will make is analyzing their needs and choosing the type that best meets those needs. Using a combination of multiple database types to manage project data is frequently the best approach. Their applications and services will impact the sort of data created, as well as the features and access patterns required. User data for the system, for example, may be best kept in a relational database. However, whether it is a combination of several types of databases or merely a relational one, each database usage need a simple drawn diagram.

Modeling graphs: Mind maps, which rely on the arbitrariness of mnemonic systems, have no strict right or wrong. Structured elements model relationships in a UML diagram or a semantic network, using lines connecting items to express links. In most cases, this is done in black and white with a well-defined iconography. Mind maps, on the other hand, serve a different purpose: they aid recall and organizing. Mind maps are collections of words arranged by the author's mental context with visual mnemonics and are informal and important to the mind map's proper functioning through the use of color, icons, and visual links.

Next is shown the UML diagram of the designed database description (Figure 3.3).

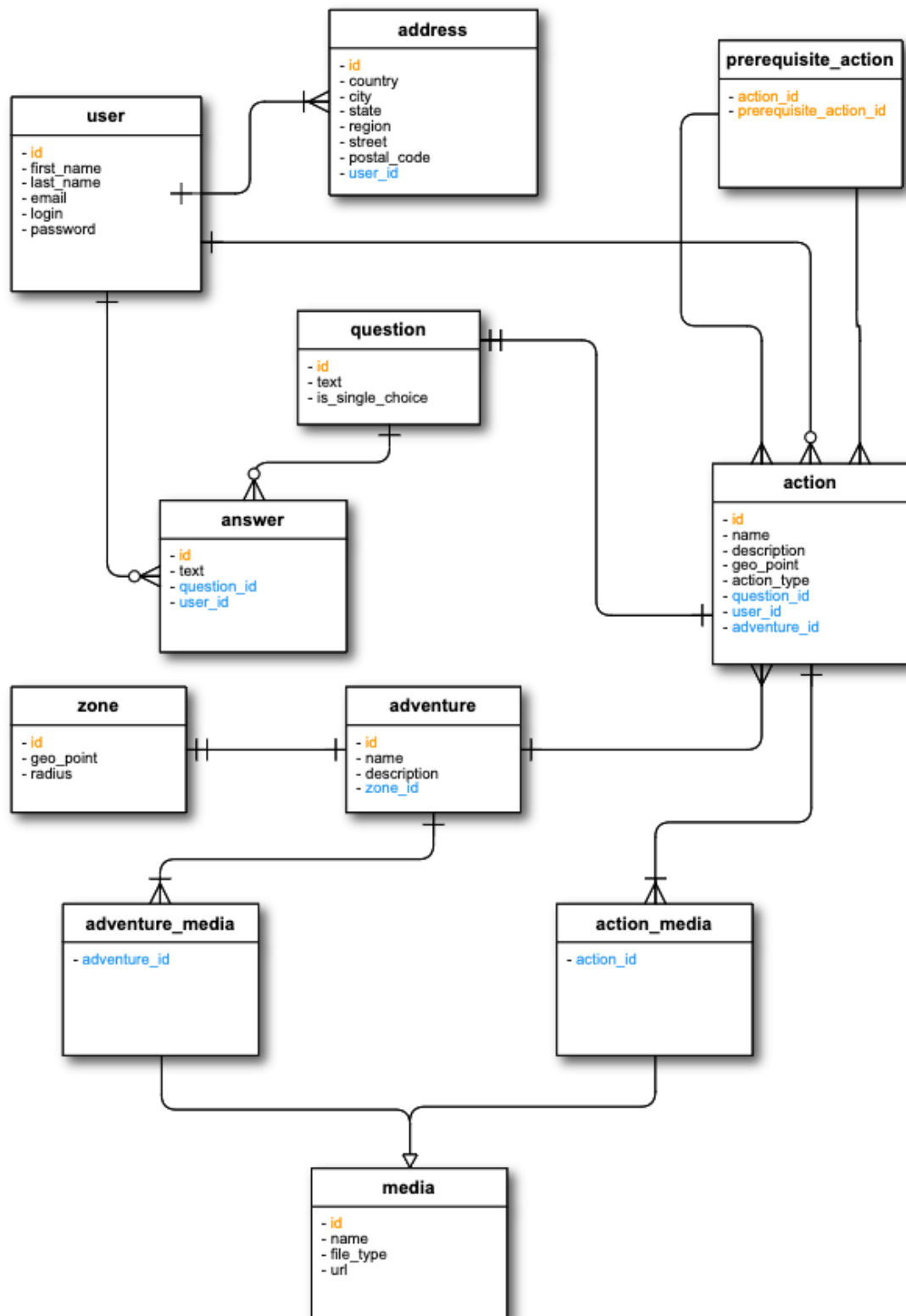


Figure 3.3: Database Diagram - UML

Chapter 4

Development

This chapter describes the problem-solving project, database structure, and user-end application development.

There are numerous types of engineering. Because, at its most basic level, engineering is the application of specialized knowledge to the solution of a problem. Because we face a wide range of problems, we have an equally wide range of engineering disciplines, many of which are extremely specialized, built to deal with those difficulties. In any case, this type of software includes a database to store all of the data.

4.1 Database

Relational database is used for the development. A relational database is a digital database that is based on the 1970 relational data model that E. F. Codd proposed. RDMSs are relational database management systems, which are used to maintain relational databases. For database querying and maintenance, several relational database systems offer the option of utilizing SQL [20]. Following are some screenshots of the database core tables.

First of all, UUID (Universally unique identifier) is used in identity columns in each table. A column (also known as a field) in a database table that contains values produced by the database is referred to as an identity column.

One of the tables is "Adventures Table" shown in (Figure 4.1). It simply includes the name and description of the adventure. Also, it includes a relation to zone which is stored in another table (Figure 4.2). "Zones Table" is responsible to keep a geological point as SRID (spatial reference identifier) and radius around that point which includes the area of adventure's actions. The spatial reference system that will be utilized to understand each spatial object is identified using the SRID. The WGS84 standard, which is also used for the Global Positioning System, defines longitude and latitude coordinates on the Earth's surface as a common SRID. This SRID, 4326, encodes geographical data using these coordinates (GPS) [21].

As far as each adventure consists of multiple actions, actions table has "adventure_id" to which it depends (Figure 4.3). The table also includes geolocation by SRID standard, the type of it (fill blank, multi choice, etc.) and relation to a question from another table (Figure 4.4). Questions table is responsible to keep the text of question, and whether it is multi choice or not as far as only multi choice question can have multiple answers.

id	name	description	zone_id
1	9436aa96...	Braganca	Visit the historica...
			a3151586-b525-...

Figure 4.1: Adventures Table

id	geo_point	radius
a3151586...	0101000020E610000...	1

Figure 4.2: Zones Table

id	name	description	geo_point	action_type	question_id	user_id	adventure_id
1	d1e8d932... Pelourinho	The Pillory of Bra...	0101000020E610...	NUMERIC	f64b5b62-59fe-4fab...	25b60394-d69f...	9436aa96-c51e-4bdd-...
2	51eed98a... Window	Windows in a real ...	0101000020E610...	FILL_BLANK	8f27a757-bb67-4b68...	25b60394-d69f...	9436aa96-c51e-4bdd-...
3	ab95b6d1... Castle history	Until the 12th cen...	0101000020E610...	TRUTH	d8ccdb0b-605c-441d...	25b60394-d69f...	9436aa96-c51e-4bdd-...

Figure 4.3: Actions Table

	id	1 text	2 is_single_choice
1	f64b5b62-59fe-4fab-9ccb-d60e96af3bc0	How many stairs does the pillory have?	false
2	d8ccdb0b-605c-441d-b8e8-f26277572ab9	Is the castle built in 12th century?	false
3	8f27a757-bb67-4b68-9e15-930504136055	How is it possible to reach the windows?	false

Figure 4.4: Questions Table

4.2 Mobile Application

First, the mobile application is created for Android and iOS devices, and it is worth mentioning that native system design components (such as buttons, text inputs, etc.) are used for both so that the user would be more user-friendly. Meanwhile, the common UI/UX design is the same for both, so there are no differences in the usage flow. Regardless of using an Android or iOS device, the functionality is exactly the same. For development, the combination of Angular and Ionic frameworks was chosen.

Angular is a TypeScript-based free and open-source web application framework developed by Google's Angular Team in collaboration with a community of individuals and businesses. Angular is a complete rebuild of the AngularJS framework by the same team that created AngularJS [22].

Drifty Co.'s Max Lynch, Ben Sperry, and Adam Bradley launched Ionic, a comprehensive open-source SDK for hybrid mobile app development, in 2013. The first version, which was launched in 2013, was based on AngularJS and Apache Cordova [23].

The Google Maps API is one of those amazing pieces of Google technology that allows developers to take Google Maps' functionality and put it right on their own site. It allows them to customize the appearance and feel of the map to match the site's aesthetic and include pertinent content that is valuable to their visitors [24].

Next are the descriptions of feature implementation with their screenshots.

Once the user is authenticated, the first thing visible is the list of adventures to explore. He can surf through the features via the tabs located at the bottom of the screen. Each adventure has options to be downloaded or checked on the map via the bottom icons before starting the trip. Also, it is possible to search by name (Figure 4.5).

As each adventure consists of Activities which have their geological positions, it has

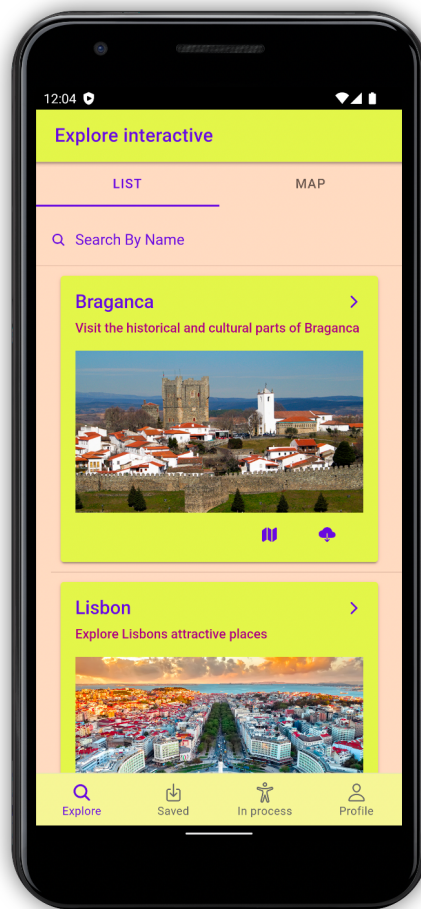


Figure 4.5: List of available adventures

an area covered by those points (Figure 4.6).

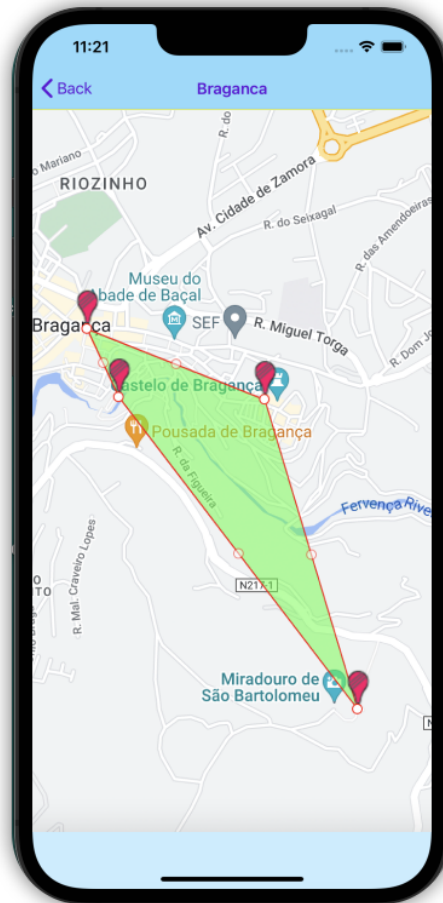


Figure 4.6: Showing the adventure on a map

After starting the adventure, the activity list is given to the user to do them in order.

Each activity has its description, the ability to be shown on a map, media, and a question to be answered once the user is on the spot (Figure 4.7).

There are six different types of activities:

1. Fill The Blank
2. MultiChoice (Single answer or Multiple answers)
3. Numeric Response

4. Truth
5. Download some content about Activity
6. Hot Spot (pick a point on a picture relevant to the question)

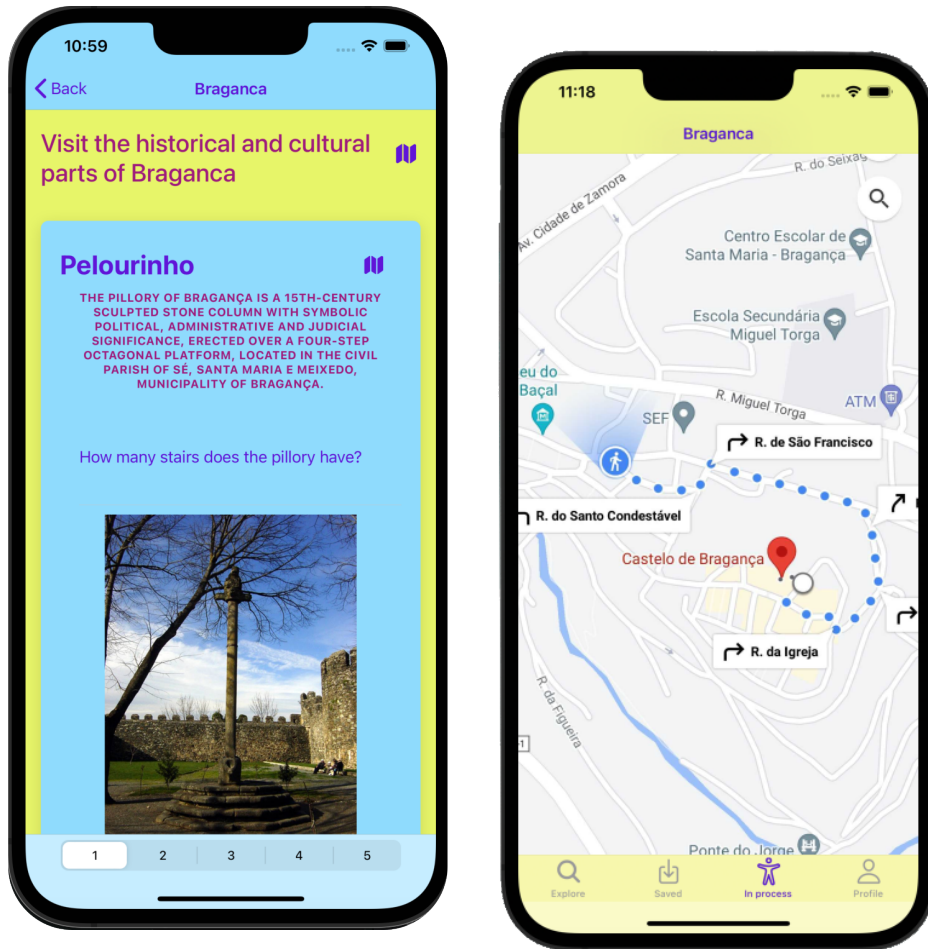


Figure 4.7: Single Activity

And finally, the user can check his profile (Figure 4.8). There are shown the rewards, claimed while accomplishing different adventures, and the list of those adventures.

The geolocation game described here allows the user to follow a path and, along the way, interact with the underlying knowledge through several learning experiences and activities. By showing simple graphics, the main focus is on the experience.

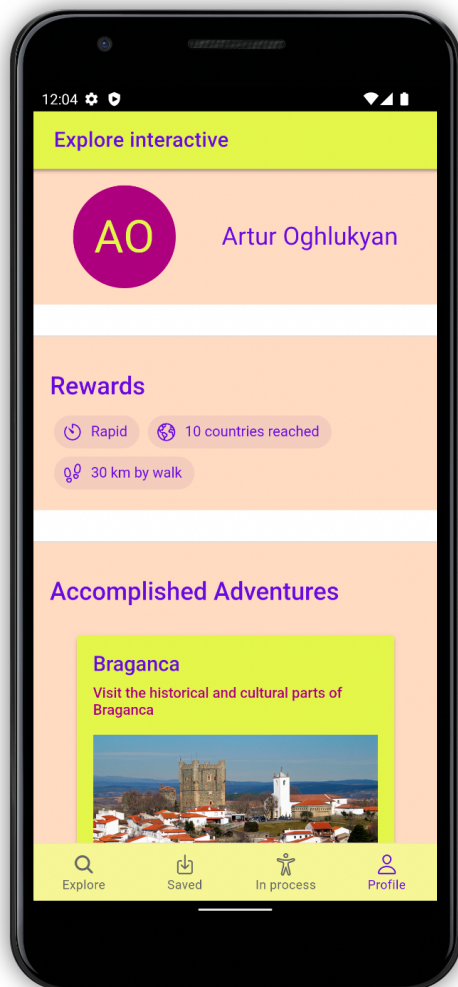


Figure 4.8: User Profile Page

Chapter 5

Conclusions and Future Work

The fundamental goal of this thesis was to design the database structure, create the mobile application, and implement the connection between them.

The initial work was placed into researching the applications, reading scholarly papers with similar features, and evaluating their benefits and drawbacks. Tourism was studied in terms of its various sorts, such as sustainable tours, educational tours, and so on. Also studied was interactive education and how new technology may make it more efficient.

The second step involved creating the issue solution with the best feature implementations discovered and implementing them. It entails researching technologies, selecting the best one for solution creation, and putting it into action.

Future development might include application improvements to make it more user-friendly, as well as expanding features such as writing reviews on trips and reading other users' thoughts for a better experience.

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