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BSc THESIS

CultureSpot : Android Application for Areas of Interest using Linked Data.

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ABSTRACT

Linked Data is structured data which is interlinked with other data so we can acquire useful information through queries. With the use of the android UI, this information can be easily accessible and shown to the user.

The purpose of this project was to get accustomed to Linked Data and the Android development. In the application , databases such as OpenStreetmap and DBpedia were used in order to get useful information for places of interests (e.g museums) that can be later shown to the Google Maps API. Firebase, a Google database , was used to store user data/

To summarize , a user , in the application presented below , can signin/register to the application, get useful information and map directions for multiple places of interest and make one or some of them favorites , that are saved to his personal page.

SUBJECT AREA: Android Application with Linked Data

KEYWORDS: linked data, android, firebase, google maps, GraphDB database

ΠΕΡΙΛΗΨΗ

Τα συνδεδεμένα δεδομένα είναι δομημένα δεδομένα που συνδέονται με άλλα δεδομένα, ώστε να μπορούμε να αποκτήσουμε χρήσιμες πληροφορίες μέσω queries. Με τη χρήση της διεπαφής Android, αυτές οι πληροφορίες είναι εύκολα προσβάσιμες στον χρήστη.

Ο σκοπός αυτού του project ήταν η εξοικείωση με τα συνδεδεμένα δεδομένα και την ανάπτυξη σε περιβάλλον Android. Στην εφαρμογή, χρησιμοποιήθηκαν βάσεις δεδομένων όπως το OpenStreetmap και το DBpedia προκειμένου να ληφθούν χρήσιμες πληροφορίες για σημεία ενδιαφέροντος (π.χ. μουσεία) που μπορούν αργότερα να εμφανιστούν στο API Χαρτών Google. Το Firebase, μια βάση δεδομένων της Google, χρησιμοποιήθηκε για την αποθήκευση δεδομένων των χρηστών.

Συνοψίζοντας, ένας χρήστης, στην εφαρμογή που παρουσιάζεται παρακάτω, μπορεί να συνδεθεί / εγγραφεί στην εφαρμογή, να λάβει χρήσιμες πληροφορίες και οδηγίες χάρτη για πολλά σημεία ενδιαφέροντος και να κάνει ένα ή μερικά από αυτά αγαπημένα, που αποθηκεύονται στην προσωπική του σελίδα.

ΘΕΜΑΤΙΚΗ ΠΕΡΙΟΧΗ: Εφαρμογή android με συνδεδεμένα δεδομένα

ΛΕΞΕΙΣ ΚΛΕΙΔΙΑ: συνδεδεμένα δεδομένα, android, firebase, χάρτες google, GraphDB βάση δεδομένων

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I would like to acknowledge the support provided by my family, especially my brother Danny Mahjoub , who helped me the time I was working on this project .

I would also like to thank George Stamoulis , who assisted , by giving me useful advice and guidance .

Finally , I am grateful to Professor Manolis Koubarakis, who gave me the chance to work on something meaningful and work on a project which will help me in my first professional steps.

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PREFACE

This thesis is essential to the completion of my bachelor degree in the Faculty of Informatics and Telecommunications , National and Kapodistrian University of Athens.

Smartphones are becoming more and more essential in the last few years. As a passionate programmer , I chose a subject that will help me build something useful in a state-of-the-art user interface, such as Android.

I trust that the application developed will help all of the types of users , experienced and novice, whilst searching for information about places of interest . It is also my expectation that this thesis will aid future research in similar fields.

1. INTRODUCTION

It is common knowledge that the need for smartphone applications is becoming more and more essential , as they are the main point of information for all types of users .They offer a user-friendly environment, where one can get useful results in no time , regardless of being an experienced user or a user with no background .

This app was developed in order to provide information of several points of interest to people , who are not familiar with databases, such as OpenStreetMap, and are not able to use query languages .

By taking into account these needs and limitations of most of the people, I was urged to develop an android application which will deliver results in the most readable and user-friendly way possible , without the need of any programmatically knowledge.

Firstly , a user has either to sign in or to register in order to use the application.

After that, he is presented with the basic interface of the application , where all of the points of interest are shown in a map, and information such opening hours or telephone are also shown for every point.

A user can search and he is shown a list of points of interest which correspond to the text he was written. For example , if he types “Acr” , the result “Acropolis Museum “ will be shown to him amongst others in a list.

Moreover, a user can personalize his search results by putting specific types of points of interest (e.g example “Castles”) or search in a specific area in a map .

He can also seek driving map directions between his location/a point of interest with another point of interest.

Of course , a user can also make a point a favorite one , so he can have his top choices saved to a personalized page. The favorite points are also deletable.

Lastly,a user can see his account information and logout so he can sign in or register with a new account .

2. BACKGROUND AND RELATED WORK

In this section information , about the background of the technologies used in this application , will be provided.

2.1 Linked Data , RDF and SPARQL

Linked data is a set of practices for publishing structured data on the Web.The main principles are the following :

1. Use URIs as names for things
2. Use HTTP URIs so that people can look up those names.
3. When someone looks up a URI, provide useful information.
4. Include links to other URIs. so that they can discover more things.

Linked data is used to retrieve useful information about various things that are published on the Web , which are interlinked in order to search and find more and more useful information. The main goal is to achieve the Semantic Web , an extension of the current web in which information is easily understandable by programs , no matter what their original design was.

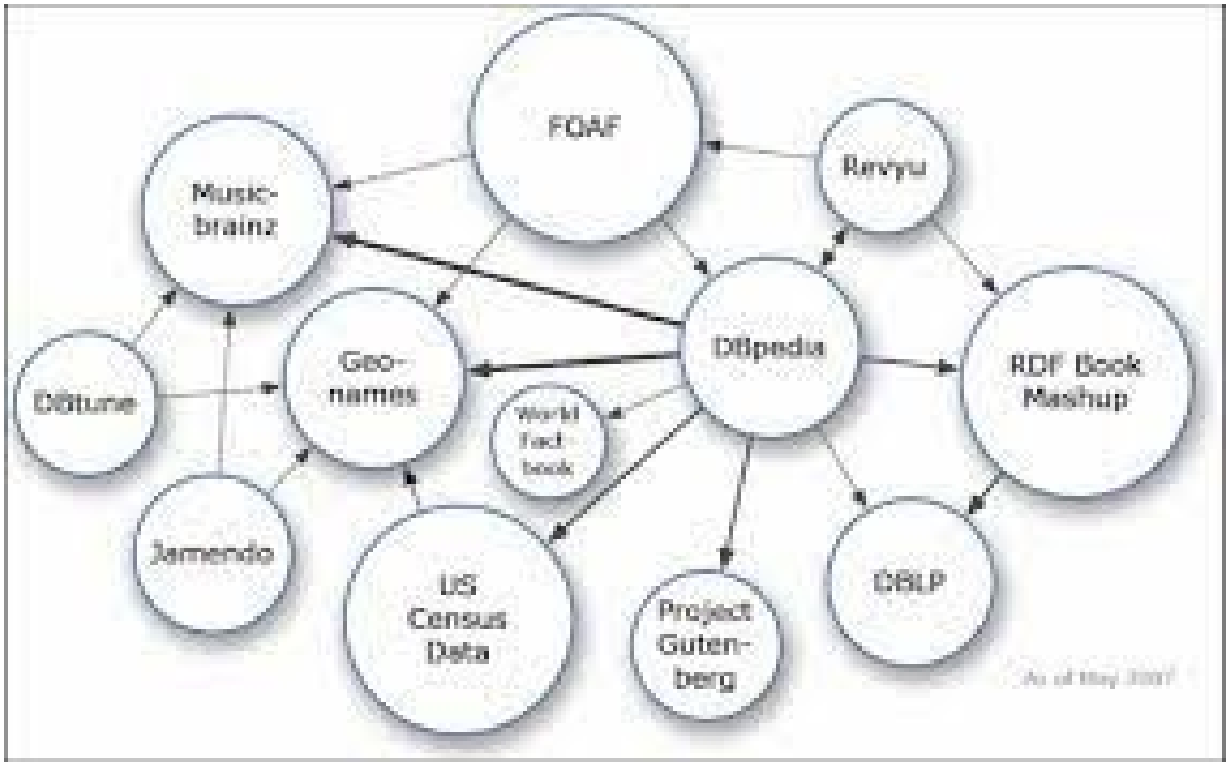


Figure 1 : Linked Data Example

RDF(Resource Description Framework) is a standard for data interchange , which was developed by W3C. It is considered to be the easiest and most powerful standard by now. It was first designed as a part of the Semantic Web , but now it is used for representing high-quality linked data that is read and analyzed by various software systems .

RDF is known for its simplicity as a uniform structure to express any kind of information and all other formats of data can be converted to RDF data.

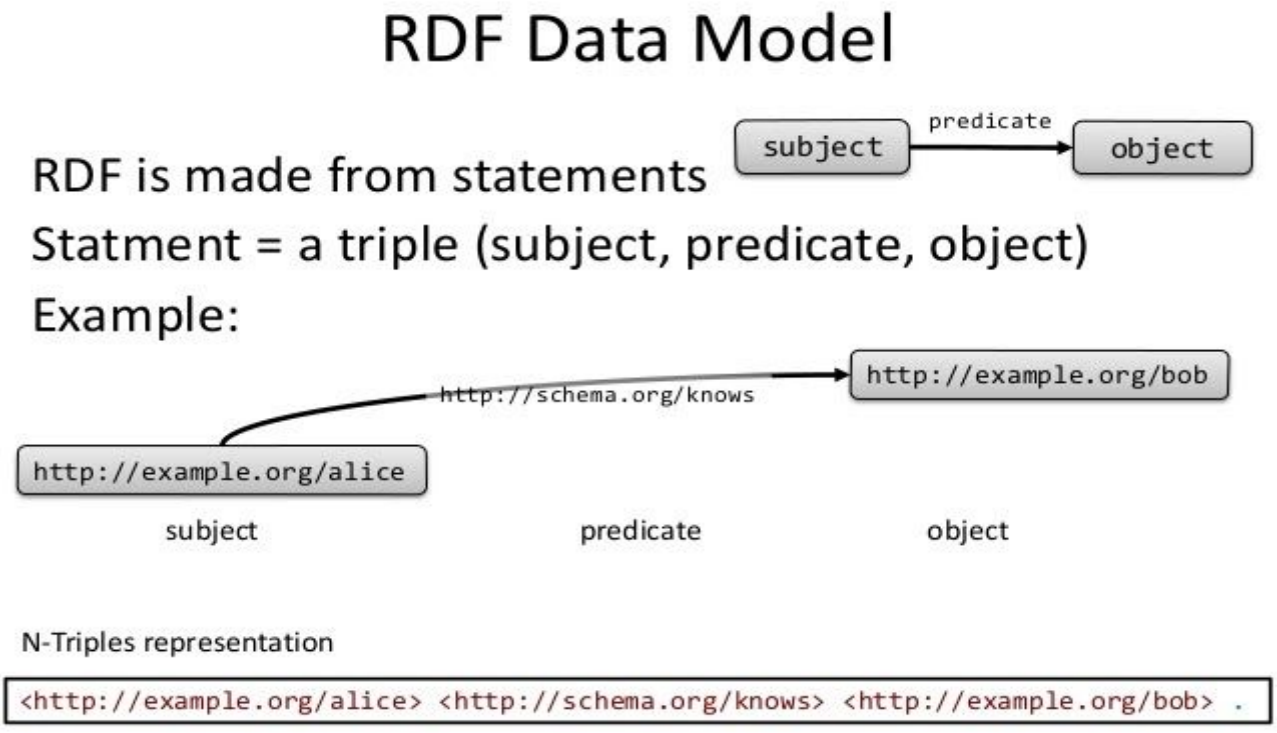


Figure 2 : RDF Statement Example

In the example the sentence : “Alice knows Bob” is expressed through the RDF structure.

1. http://example.org/alice (Alice) is the subject.
2. http://schema.org/knows (knows) is the predicate.
3. http://example.org/bob (Bob) is the object.

The predicate expresses the relationship between the subject and the object.

SPARQL is the standard query language and protocol for Linked Open Data and RDF databases,which was also designed by W3C.SPARQL queries can also be executed on databases that are not formatted on RDF standard ,but are viewed so by a middleware.

SPARQL was designed to enable Linked Data for the Semantic Web. That can be easily understood as queries on this language can work on multiple endpoints (data stores).

SPARQL has four types of queries. It can be used to:

1. ASK whether there is at least one match of the query pattern in the RDF graph data;
2. SELECT all or some of those matches in a tabular form (including aggregation, sampling and pagination through OFFSET and LIMIT);
3. CONSTRUCT an RDF graph by substituting the variables in these matches in a set of triple templates;
4. DESCRIBE the matches found by constructing a relevant RDF graph.

RDF has multiple extensions , one of which is GeoSPARQL for querying geospatial data, which is used in CultureSpot (e.g in order to show points of interest in a specific map area).

2.2 Android Development

Android is a mobile operating system , based on a modified version of the Linux Kernel and other open source software , designed primarily for touchscreen mobile devices such as smartphones.

On top of the Linux kernel, there are the middleware, libraries and APIs written in C, and application software running on an application framework which includes Java-compatible libraries. Development of the Linux kernel continues independently of Android's other source code projects.

Android development is the process by which applications are created for Android devices. The most common languages used for this process are Java and Kotlin (CultureSpot was written in Java).

The Android software development kit(SDK) is a set of development tools(e.g debugger,libraries etc) ,which is used by programming languages.

Finally, the most common way to develop and Android application is to use the Android Studio application suite , which comes with a lot of plugins that help novice and experienced Android Developpers

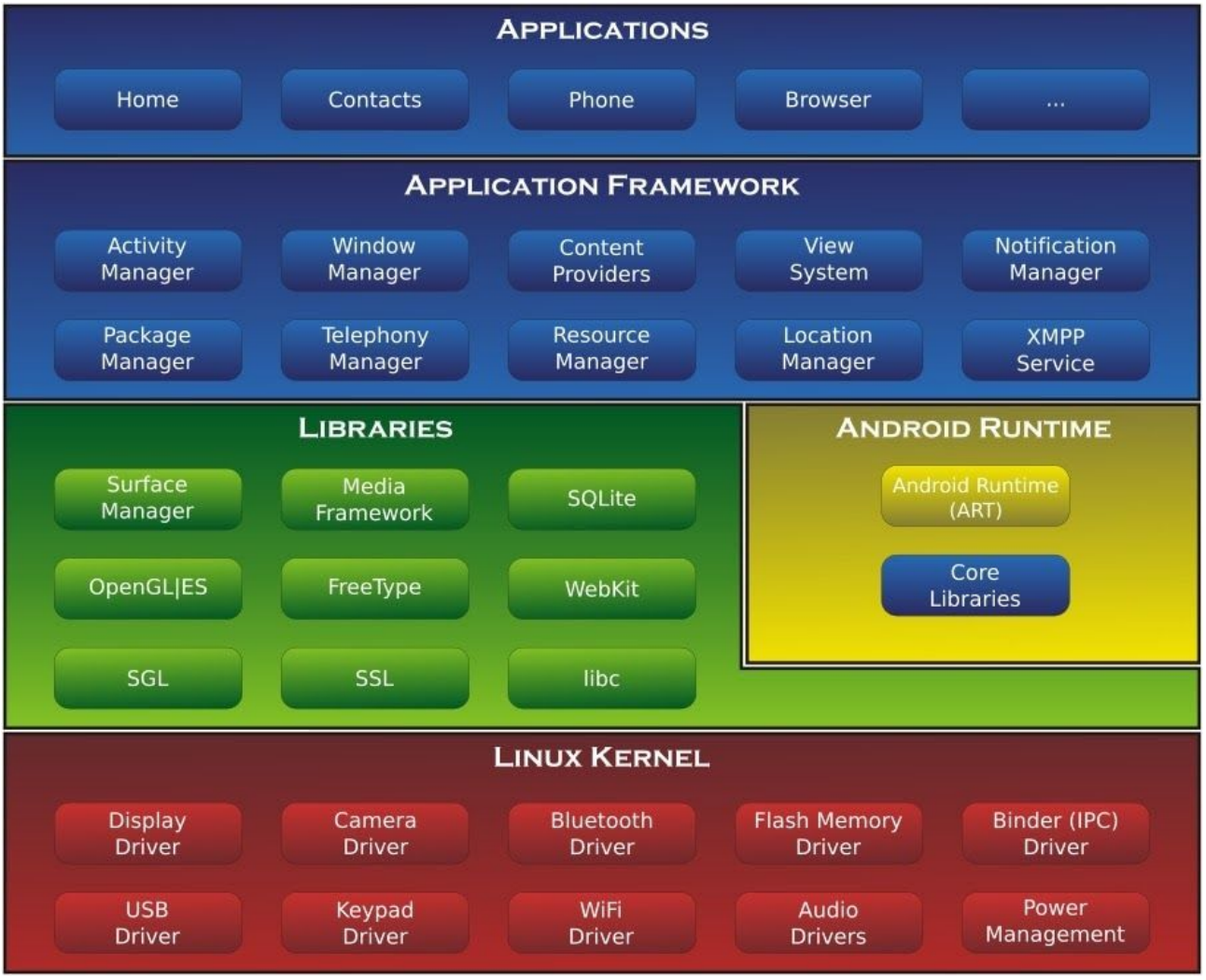


Figure 3 : Android System Architecture

2.3 Databases

Two databases were used in order to retrieve as much information as needed for the application to be fully completed.These databases are OpenStreetMap and DBpedia .

The Overpass API is a read-only API that serves up custom selected parts of the OSM map data. It acts as a database over the web: the client sends a query to the API and gets back the data set that corresponds to the query.

An example of a map query is the following :

```
(node(51.249,7.148,51.251,7.152);
  <;
);
out meta;
```

The order of values in the bounding box (51.249,7.148,51.251,7.152) is minimum latitude, minimum longitude, maximum latitude, maximum longitude (or South-West-North-East).

Results format fetched from this API vary from XML to JSON.In this application we fetched JSON results which were later converted to CSV and then to RDF format by using the GeoTriples application.This data was later saved to the GraphDB database , which will be analyzed in the sections below.

DBpedia is a crowd-sourced community effort to extract structured content from the information created in various Wikimedia projects. This structured information resembles an open knowledge graph (OKG) which is available for everyone on the Web.

The DBpedia RDF Data Set is hosted and published using OpenLink Virtuoso. The Virtuoso infrastructure provides access to DBpedia's RDF data via a SPARQL endpoint, alongside HTTP support for any Web client's standard GETs for HTML or RDF representations of DBpedia resources.

3. APPLICATION

In this section the reader will be provided with information about the architecture and the technologies used while developing CultureSpot.The role of the app , its UI and its features will also be shown.

3.1 Role of the App

CultureSpot is an android application that serves as an information “center” for points of interest currently(18/3/21) for the metropolitan area of Athens , but could be easily extended to the whole world with the correct data.

A user has to connect (through registration or signing in) in order to have access to the app. By using this app , a user can personalize his search , by searching categories , such as museums , and specific sub-area(e.g the center of Athens) . He can also , of course , search for a specific name ang get a list of possible results , depending on what he typed. By clicking on a specific point of interest in the map he can see various information about a point of interest (e.g Acropolis Museum’s wiki page) . It is well coordinated with other apps , as he can press on telephone and be redirected to the dialer app or press on a link and be redirected to the browser app of his choice. Moreover, he can search for points of interest near his chosen one . It is also possible to get map directions of the driving route he has to follow in order to get to that specific point , from his current GPS location(app permission must be handed) or from another point of interest. There is , of course , the option to make this point a favorite one amongst others. Lastly, he can see his data such as his username,email etc and see his favorite points of interest , which are deletable in a personalized page.

In conclusion , CultureSpot can serve as a tourist information app where people can search for cultural centers to visit when they are on vacation.

3.2 Architecture

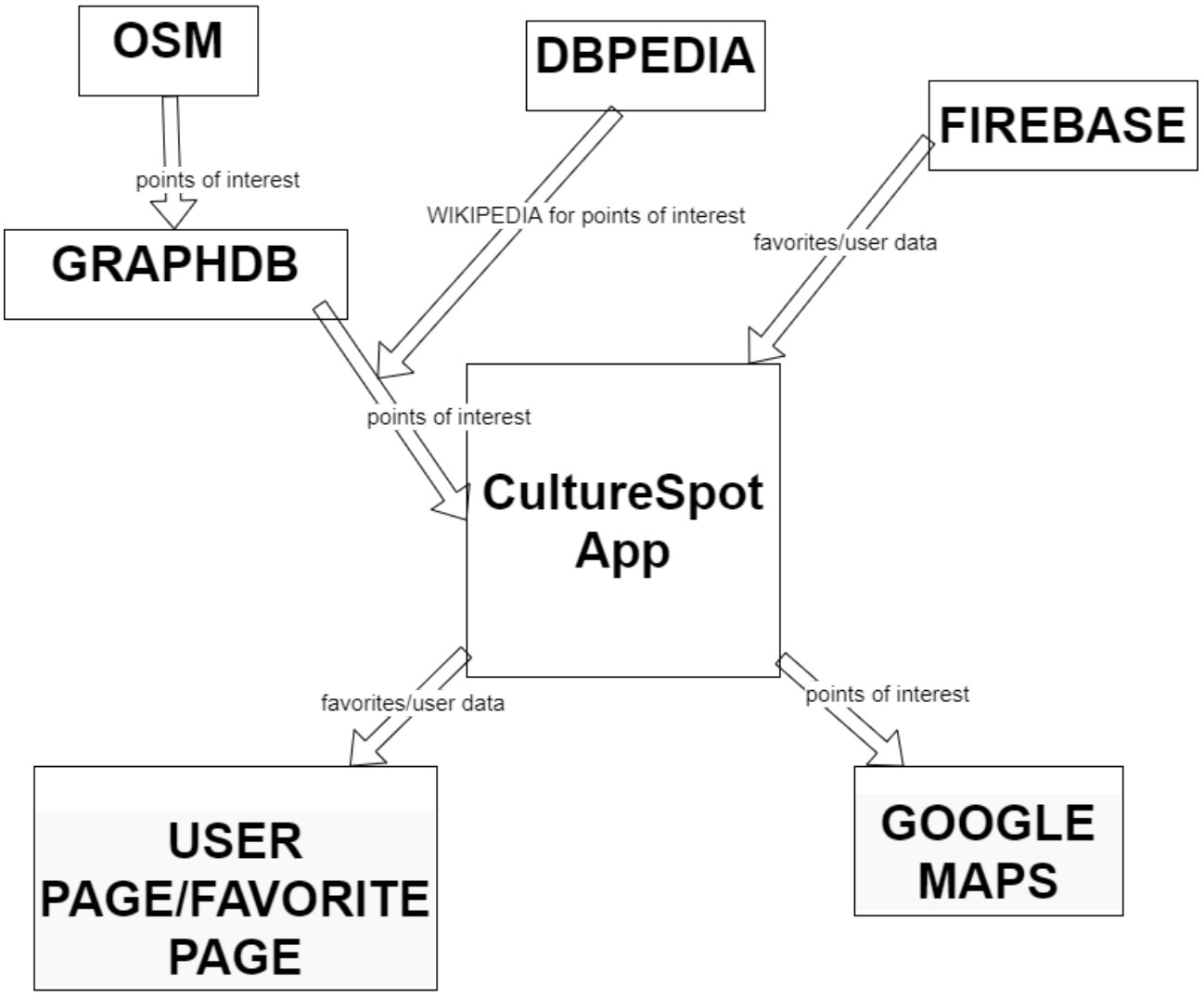


Figure 4 : CultureSpot Architecture

Main data for points of interest were taken from OSM , converted to RDF and uploaded to GraphDB. Using CultureSpot a query is sent to GraphDB for all or some points of interest depending on the parameters . The ones that do not have a wiki page are subject to another query to DBpedia in order to find theirs , if they do have. The results are shown to the Google Maps API .

In order to authenticate a user , register or even get his data there is a query to the Google's Firebase database , then the user can login/register or logout and even see his personal data , which includes a dedicated page for his favorite points of interest.

3.3 Technologies

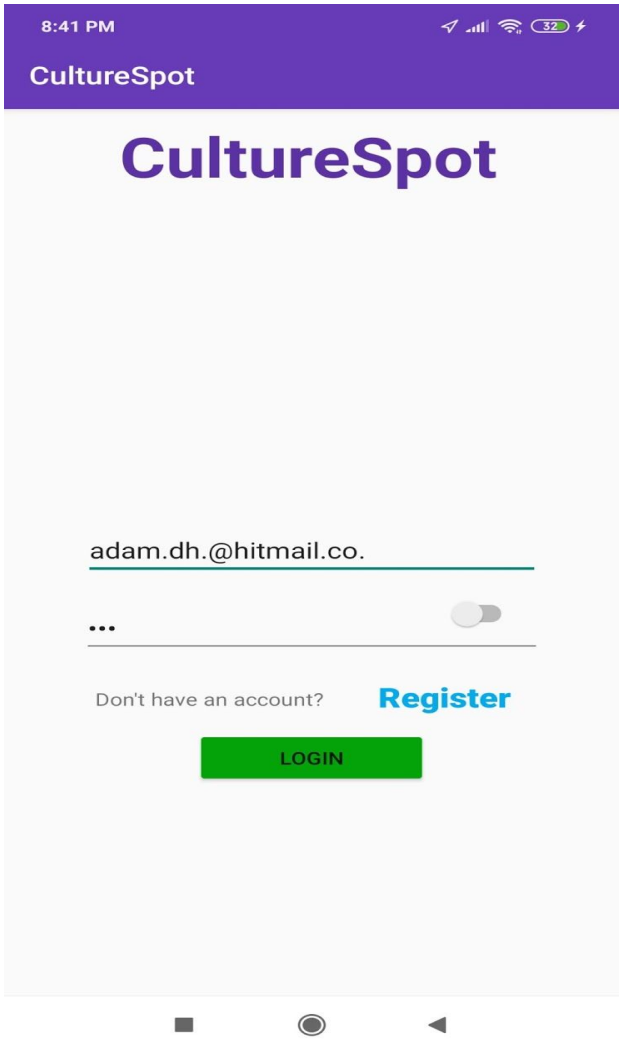
The app consists of four main technologies which are the following :

1. Data about the points of interest are saved in GraphDB , a database for RDF data. Whenever a user searches for specific points of interest a query to this database is sent in order to get the desired results (a HTTP GET query is also sent to DBpedia for some wiki page , but this is subject to change).
2. Autocomplete , a user can save time by getting a list of recommended results depending on the name he typed.The search for every name is done once when the map is loaded so there is no need to query GraphDB everytime there's a change to the search boxes.
3. User data , such as his credentials and his favorite points of interest , are saved to Firebase , a Google database.Whenever a user logins a query is sent to Firebase to check his credentials and if they are correct and then all of his data is provided to the app. The same applies whenever a user adds or deletes a favorite point of interest. Then the data is updated and re-uploaded to the database.
4. The main technology used is , of course , Google Maps API . Every result retrieved from GraphDB is shown to the map via clusters and markers making the search on the map as convenient as possible.The driving directions of a route is also shown there.

3.4 User Interface and Features

Image 1 : Splash Screen

Whenever a user opens the app he is shown the app's splash screen , until it is figured out if he has already logged in or not .If he is logged in he is redirected to the map screen , else he is redirected to the login screen shown below.



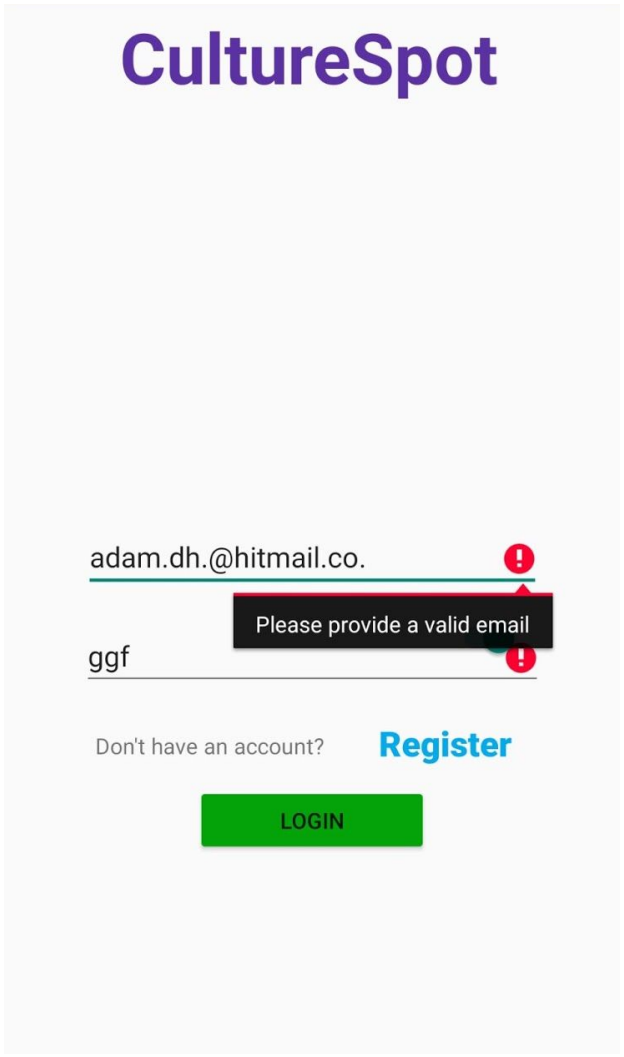


Image 2 : Login Screen **Image 3 : Login Screen Error and Show Password**

If he is not logged in he is redirected to the login activity where has to type his credentials to use the application.He can also (un)show his password by clicking on the check button right of the screen.As we can see in these screenshots there's a checking mechanism for errors.If the user clicks on the Register text he is redirected to the register activity shown below.If he signs in successfully he is redirected to the map screen shown 2 images below.

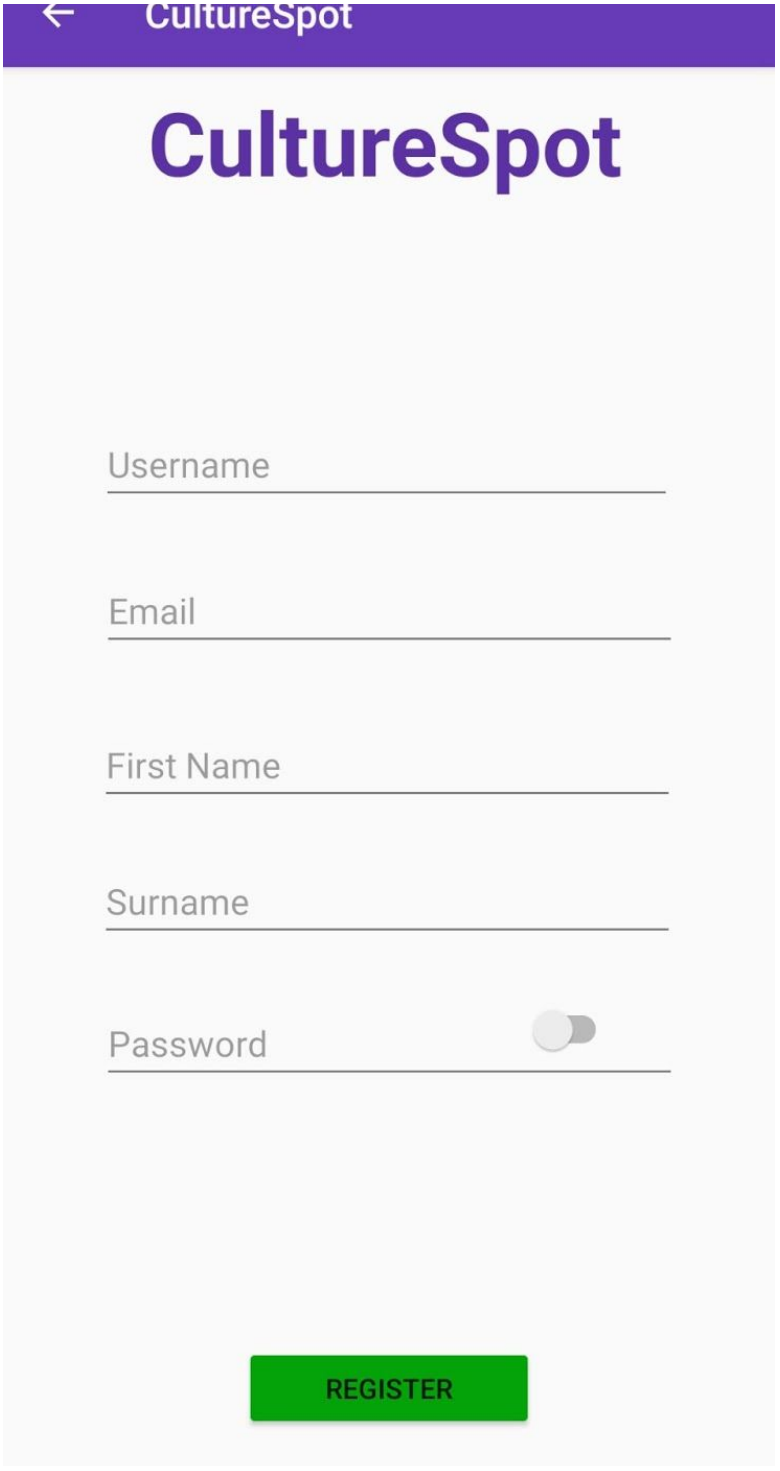


Image 4 : Register Screen

This is the register screen where the user has to type his desired credentials.There is of course the “(un)show password” mechanism as the mechanism for checking errors in the typing fields , as in the login screen . By pressing the back button on top-left of the screen he will be redirected to the login activity.If he registers successfully he is redirected to the map screen shown below.

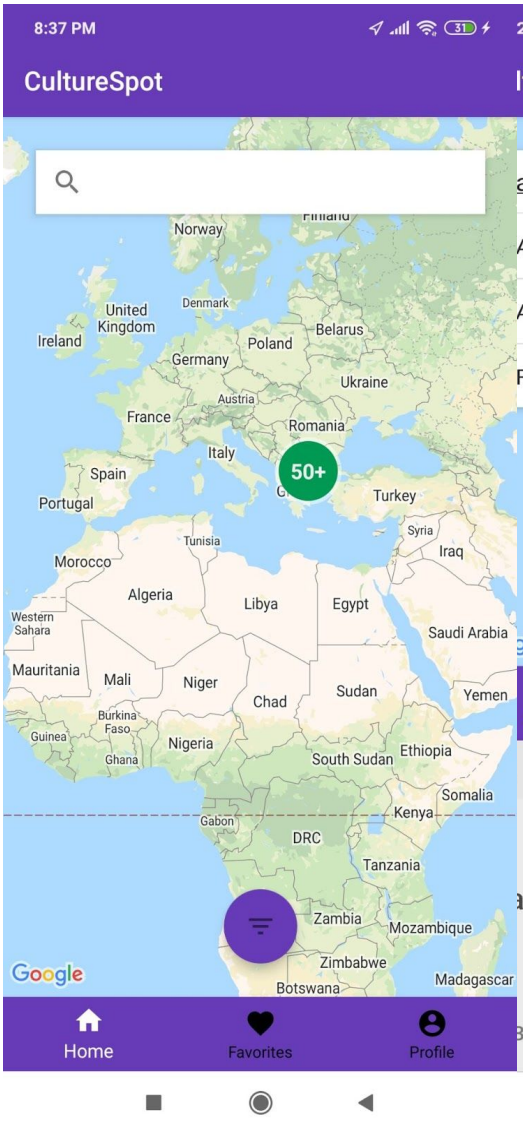


Image 5 : Defaut Map Screen

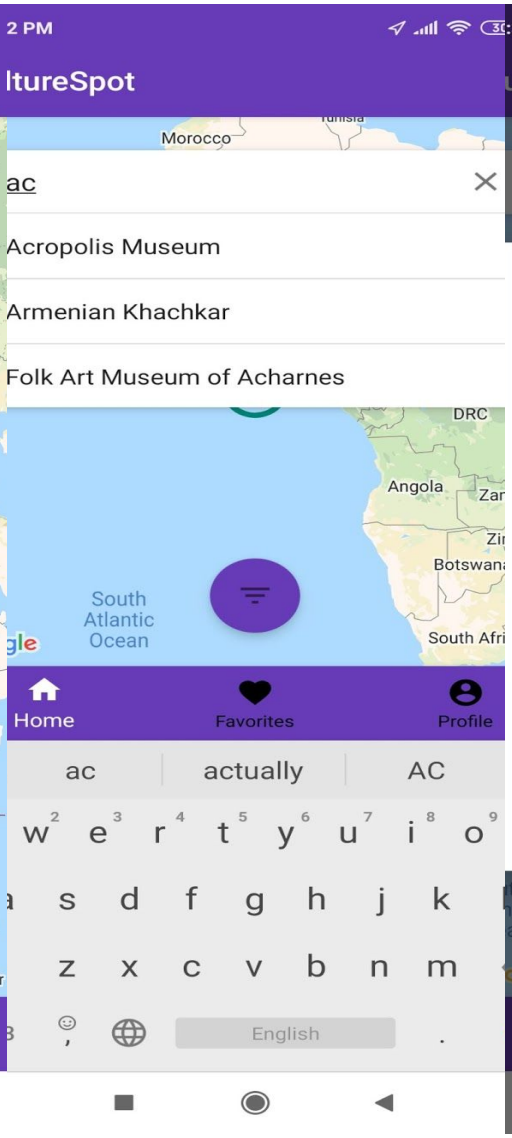


Image 6 : Search List Map Screen

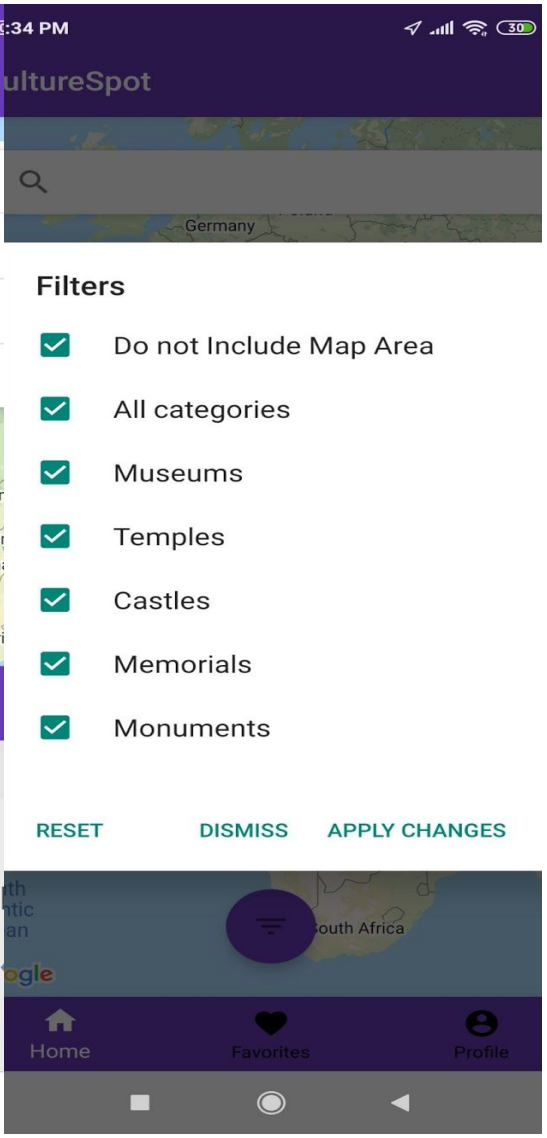


Image 7 : Filters List Map Screen

This is the default page of CultureSpot app.The user is shown all of the points of interest gathered on a cluster if he is zoomed out.By clicking on the floating button on the bottom of the screen he is shown the filters sections.There he has to choose at least on category,otherwise his options are not saved.He can also search for a name and a list of names will be shown to him.If he clicks on one of them directions to that place will be shown.On the bottom navigation, by clicking on favorites the user can see his favorite points of interest shown below and by clicking on the profile , he can check his credentials and logout from the app and be redirected to the login page shown above.

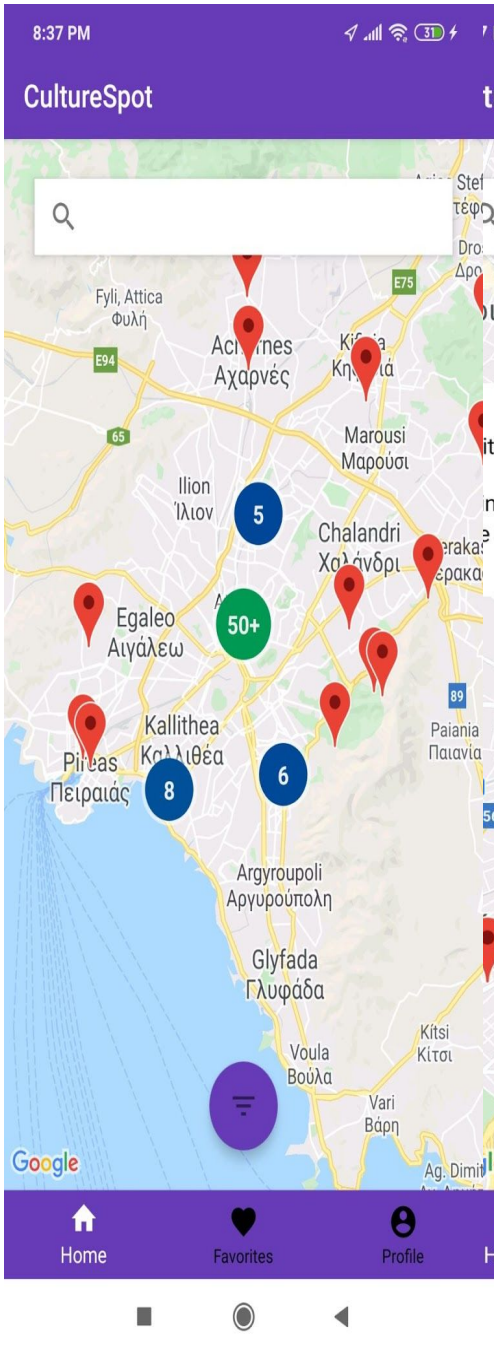


Image 8 : Clusters and Markers Map Screen

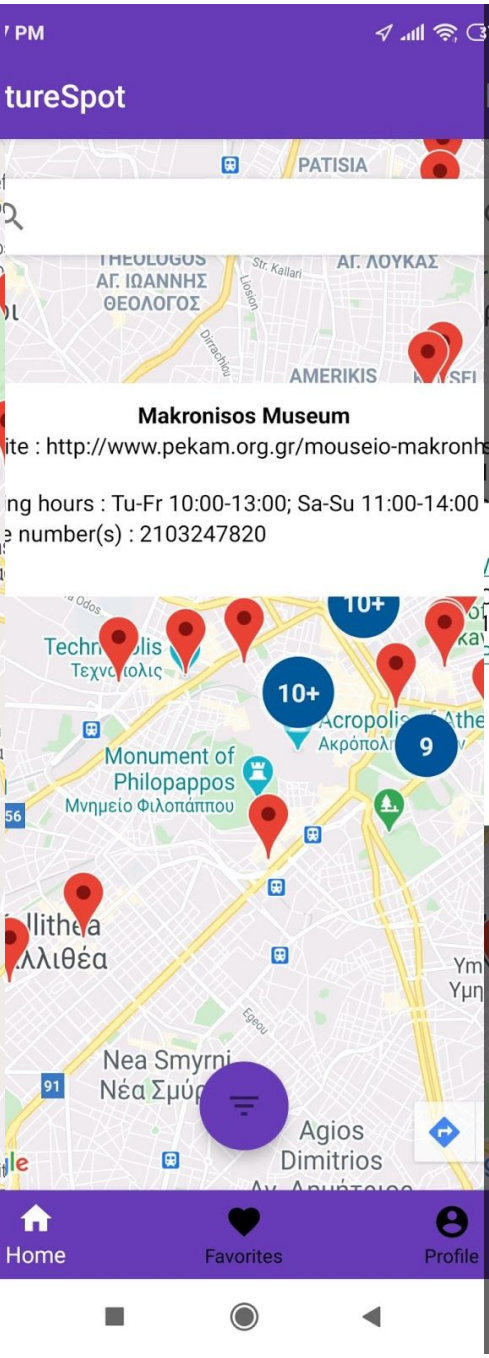


Image 9 : Info Window of Marker Map Screen

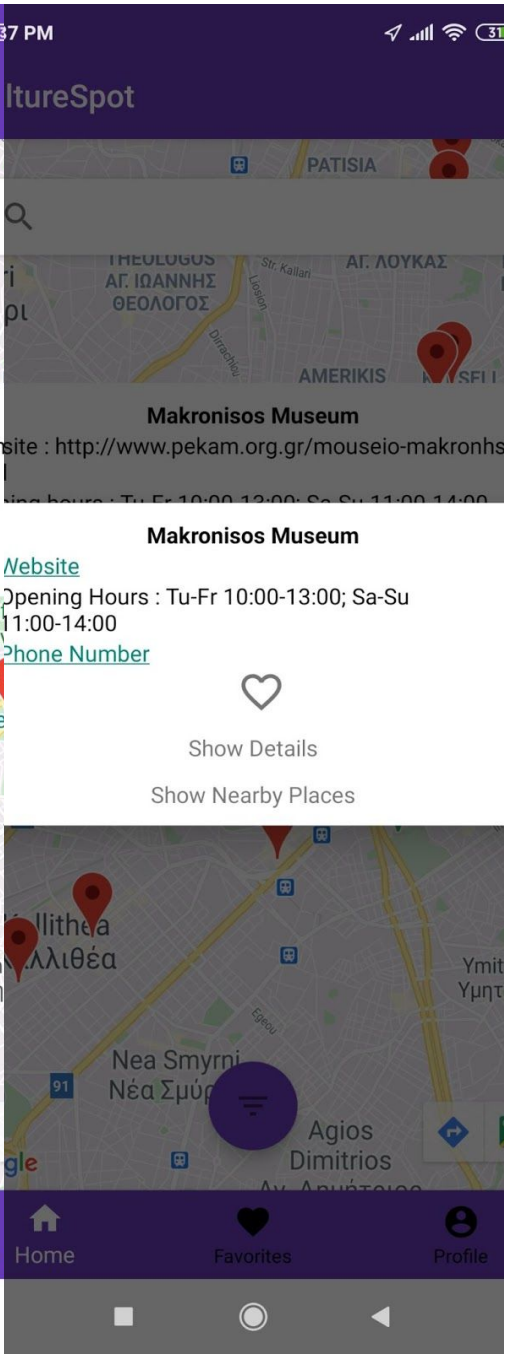
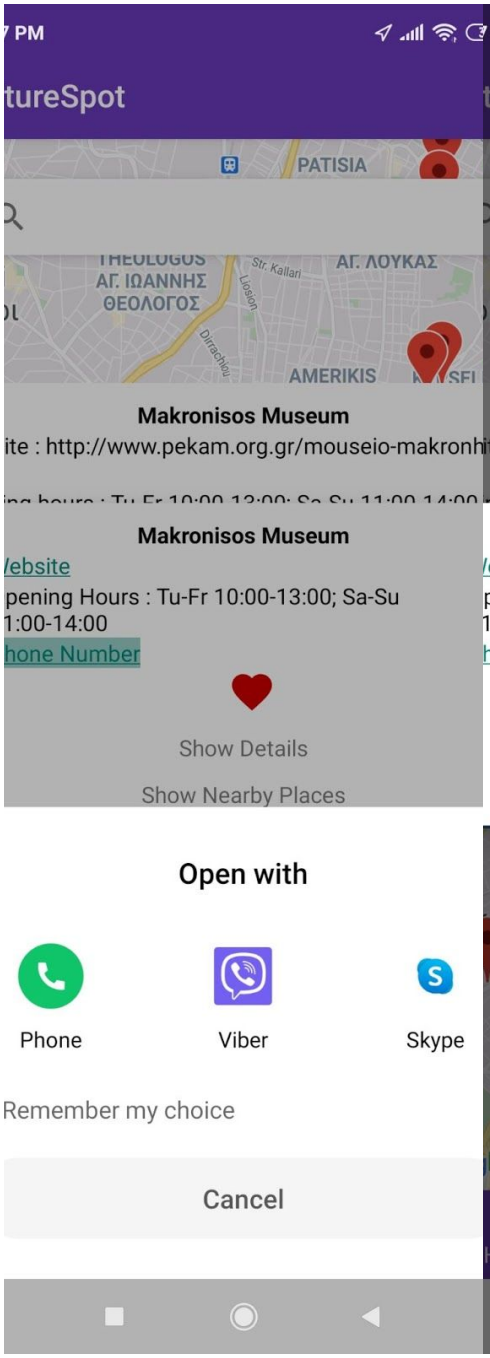
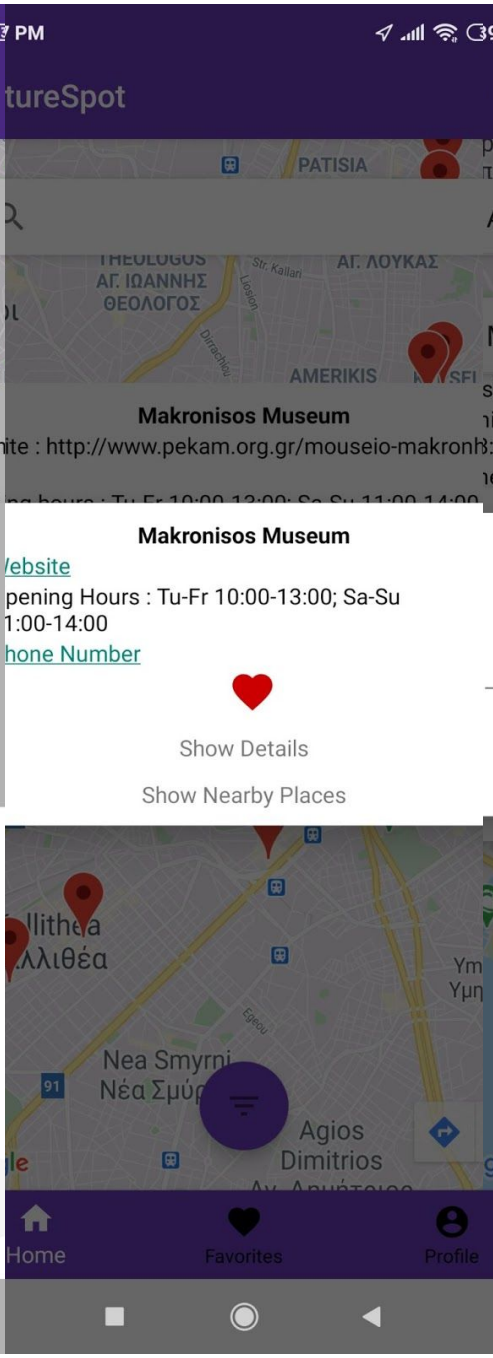


Image 10 :Popup Window of Marker Map Screen

If a marker is clicked an info window is shown with all of the information available for this point of interest.If the info window is clicked then we get the popup of Image 10.There the user can make the place of interest a favorite one(this will make the heart red,indicating that is a favorite point of interest).He can click to show nearby places to show another popup , he can click on show details which will have the same results as a clicking a name from the search list mentioned above.He can also click to links to redirect to another app.





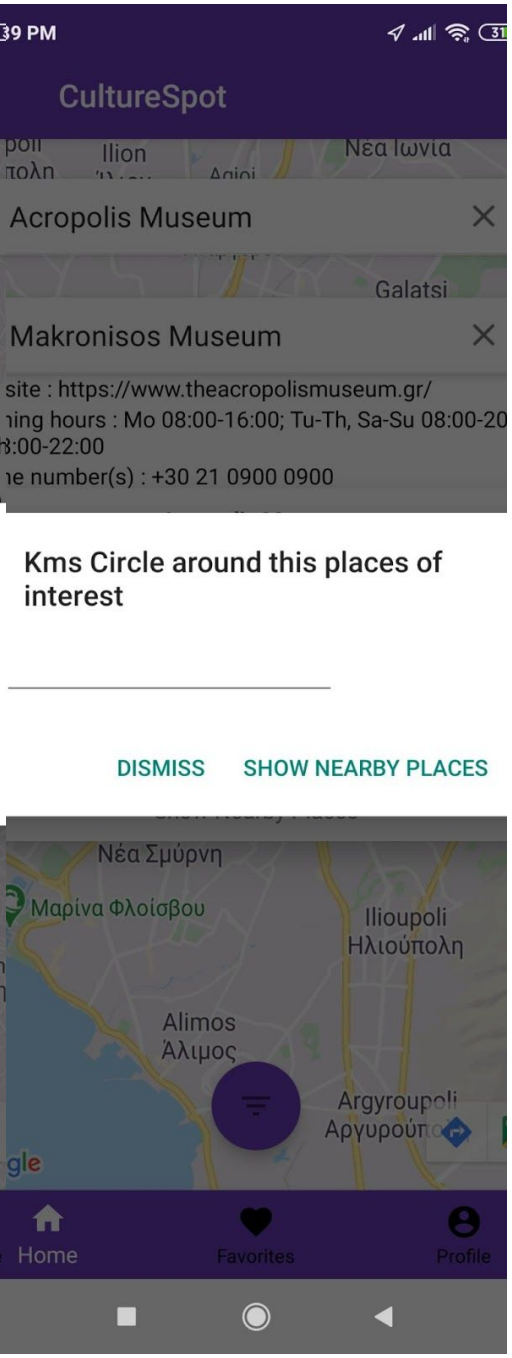


Image 11 : Redirect to App Map Screen

Image 12 : Favorite Point of Interest Map Screen

Image 13 :Search Nearby Places Map Screen

If the user clicks for example on a telephone he is redirected to the dialer app(same for links to browsers) if clicks on the heart this place is now a favorite one(this would already red if it was already a favorite one).If he clicks for nearby places he will be prompted to add Kms radius to show nearby places(it would be the same ,as the clusters on Image 8)

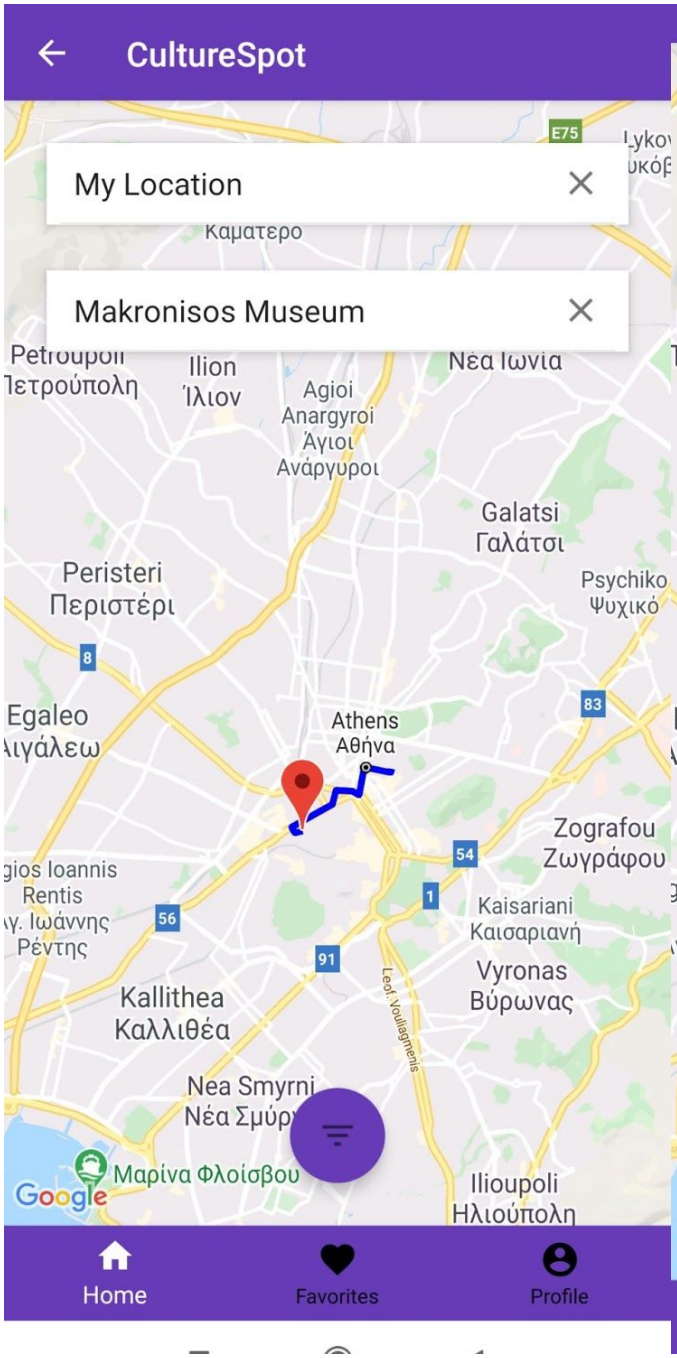


Image 14 : Route Directions from My Location Map Screen

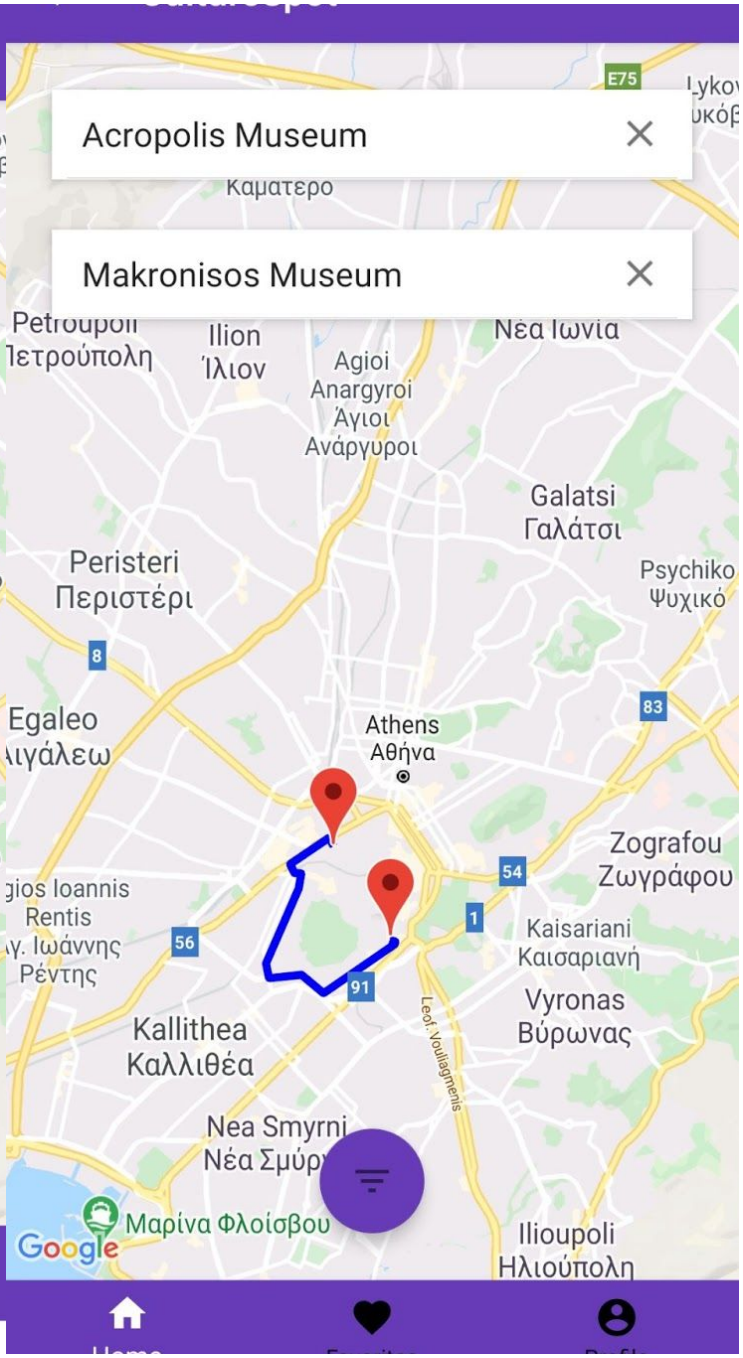


Image 15 : Route Directions between two Points of Interest Map Screen

Here we can see the route directions fetched from Google Maps Api .If the back button is pressed then we research for points of interest depending on the filters.We can also search for two points of interest to get their route(My location included.)

Note : A place must be clicked from the list in order to show the directions.

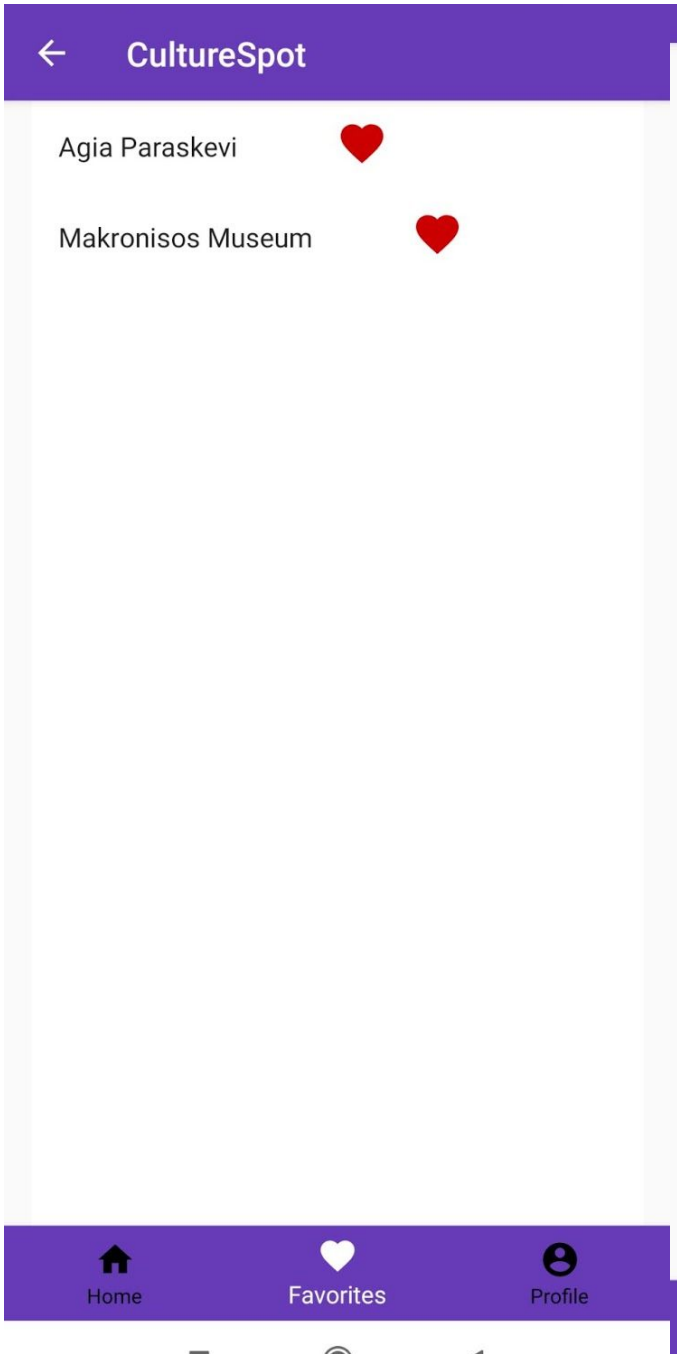


Image 16 : Favorites List Screen

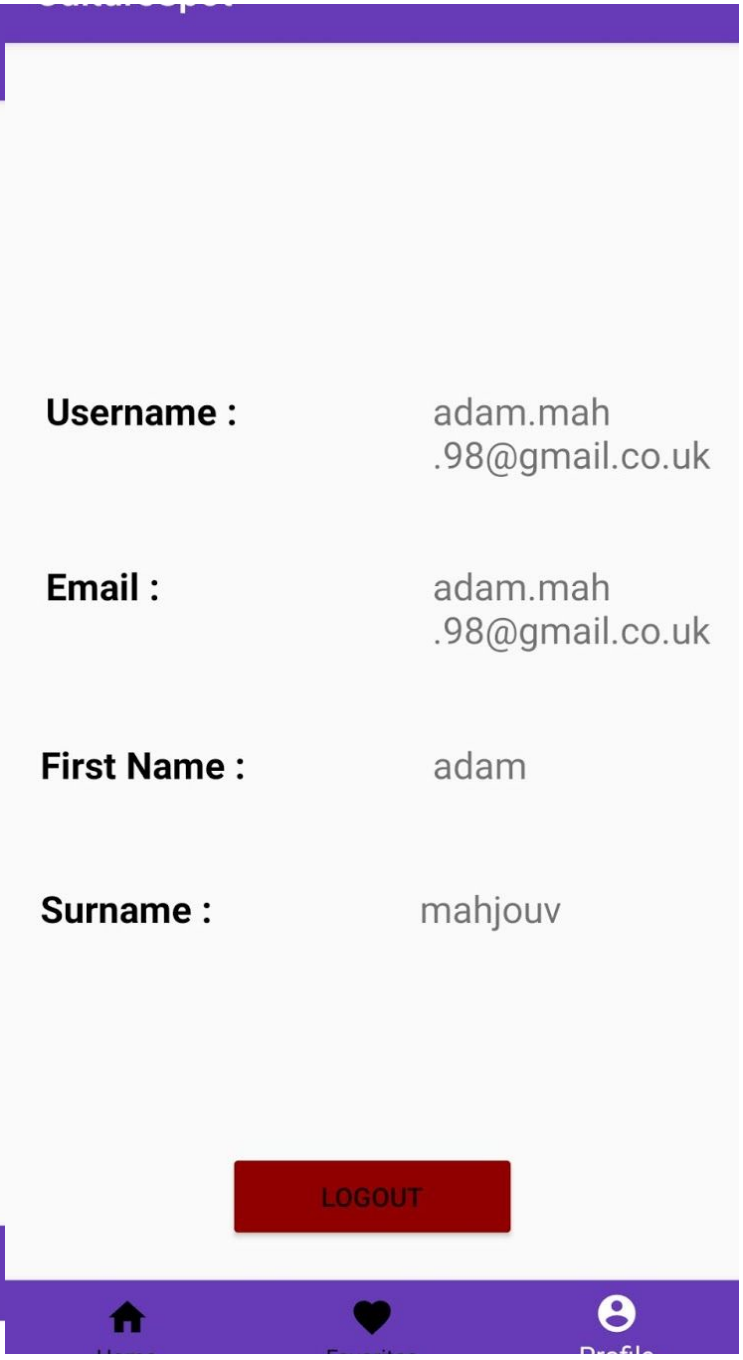


Image 17 : Profile Screen

Here we can see the Favorites list page where a user can see his favorites.If he clicks on the heart then he deletes this place from the page.In the other is the profile page where the user can see his credentials and press logout to be redirected to the login screen

4. FUTURE WORK

CultureSpot is a well structured application that has the base to create a more well-rounded app.There are some future extensions that could make the app better. These are the following :

- Bypass the DBpedia query by incoporating its data to GraphDB.
- Get written route directions , so the user can have better experience when searching the route.
- Create a review section for points of interest where multiple users can share their experience
- Create a chat so users can have personal conversations.

I believe these four extensions could make the app even better and would make it a true choice for the market of tourist information applications .

5. APPENDICES

The code for the application,plus the information on how to install it are found in here.

ABBREVIATIONS - ACRONYMS

RDF	Resource Description Framework
SPARQL	SPARQL Protocol and RDF Query Language
SDK	Android software development kit
OSM	OpenStreetMap
UI	User Interface
XML	Extensible Markup Language
W3C	World Wide Web Consortium
CSV	Comma Separated Values
HTML	HyperText Markup Language
HTTP	HyperText Transfer Protocol
JSON	JavaScript Object Notation
API	Application Program Interface

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