



**NATIONAL AND KAPODISTRIAN UNIVERSITY OF ATHENS**

**SCHOOL OF SCIENCE  
DEPARTMENT OF INFORMATICS AND TELECOMMUNICATION**

**BSc THESIS**

**CultureSpot: an Android Application for navigation to Cultural  
Interest Areas, using Linked Open Data.**

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**ΕΘΝΙΚΟ ΚΑΙ ΚΑΠΟΔΙΣΤΡΙΑΚΟ ΠΑΝΕΠΙΣΤΗΜΙΟ ΑΘΗΝΩΝ**

**ΣΧΟΛΗ ΘΕΤΙΚΩΝ ΕΠΙΣΤΗΜΩΝ  
ΤΜΗΜΑ ΠΛΗΡΟΦΟΡΙΚΗΣ ΚΑΙ ΤΗΛΕΠΙΚΟΙΝΩΝΙΩΝ**

**ΠΤΥΧΙΑΚΗ ΕΡΓΑΣΙΑ**

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ενδιαφέροντος χρησιμοποιώντας συνδεδεμένα δεδομένα.**

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**ΑΘΗΝΑ**

**ΜΑΡΤΙΟΣ 2021**

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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 , useful information about multiple areas of interest (e.g museums, monuments ) was retrieved from datasets such as OpenStreetmap and DBpedia , which are huge centers of information for multiple things and are , of course , a small part of Linked Data.

User data is stored in Google's Firebase , which is a document-based database . Whenever a user wants to sign in , a request to authenticate him is sent to this database in order to check his credentials. Furthermore , in order to show his data we also have to retrieve it from Firebase.

To summarize , a user , in the application presented below , can signin/register to the application, get useful information and map directions for multiple areas of interest and make one or some of them favorites , which can be shown 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 ερωτημάτων. Με τη χρήση της διεπαφής χρήστη Android, αυτές οι πληροφορίες είναι εύκολα προσβάσιμες και εμφανίζονται στον χρήστη.

Ο σκοπός αυτού του project ήταν να εξοικειωθώ με τα συνδεδεμένα δεδομένα και την ανάπτυξη εφαρμογών Android. Στην εφαρμογή, ανακτήθηκαν χρήσιμες πληροφορίες σχετικά με πολλά σημεία ενδιαφέροντος (π.χ. μουσεία, μνημεία) από datasets όπως το OpenStreetmap και το DBpedia, τα οποία αποτελούν τεράστια κέντρα πληροφοριών για πολλά πράγματα και, φυσικά, είναι ένα μικρό μέρος των συνδεδεμένων δεδομένων.

Τα δεδομένα του εκάστοτε χρήστη αποθηκεύονται στο Firebase της Google, η οποία είναι μια βάση δεδομένων που βασίζεται σε έγγραφα. Κάθε φορά που ένας χρήστης θέλει να συνδεθεί, ένα αίτημα για τον έλεγχο ταυτότητας αποστέλλεται σε αυτήν τη βάση δεδομένων για να γίνει ταυτοποίηση. Επιπλέον, για να δείξουμε τα δεδομένα του, πρέπει επίσης να τα ανακτήσουμε από το Firebase.

Συνοψίζοντας, ένας χρήστης, στην εφαρμογή που παρουσιάζεται παρακάτω, μπορεί να συνδεθεί / εγγραφεί στην εφαρμογή, να λάβει χρήσιμες πληροφορίες και οδηγίες χάρτη για πολλαπλούς τομείς ενδιαφέροντος και να κάνει ένα ή μερικά από αυτά αγαπημένα, τα οποία μπορούν να εμφανιστούν στην προσωπική του σελίδα.

**ΘΕΜΑΤΙΚΗ ΠΕΡΙΟΧΗ:** Εφαρμογή android με συνδεδεμένα δεδομένα

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

## **ACKNOWLEDGMENTS**

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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

In this sub-unit Linked Data, RDF and SPARQL will be analyzed and explained thoroughly.

#### 2.1.1 Linked Data

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.[1]

Linked Open Data is a powerful blend of Linked Data and Open Data: it is both linked and uses open sources. One notable example of an LOD set is DBpedia – a crowd-sourced community effort to extract structured information from Wikipedia and make it available on the Web.[2]

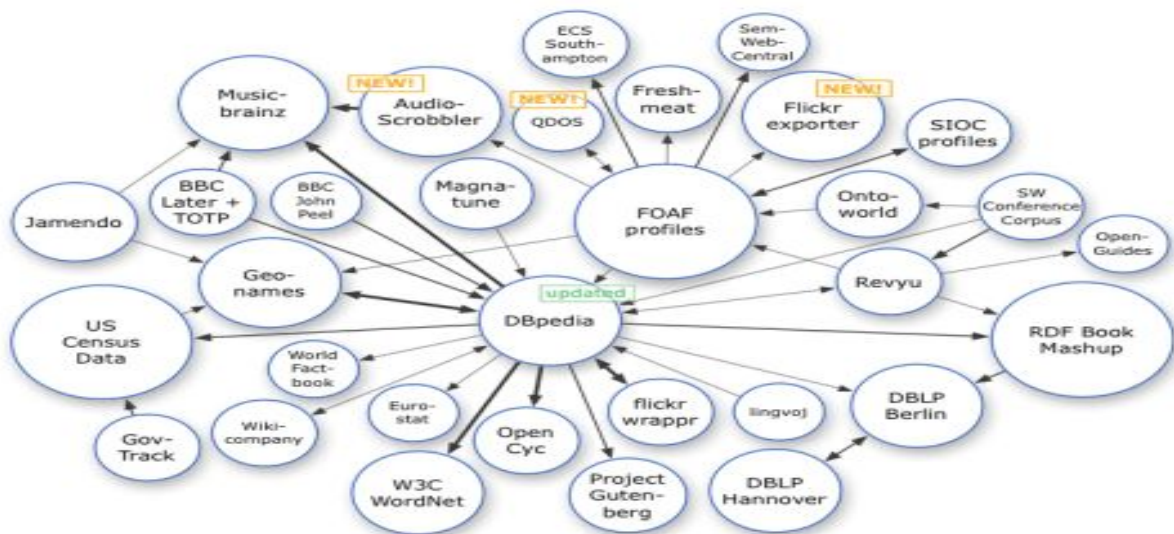
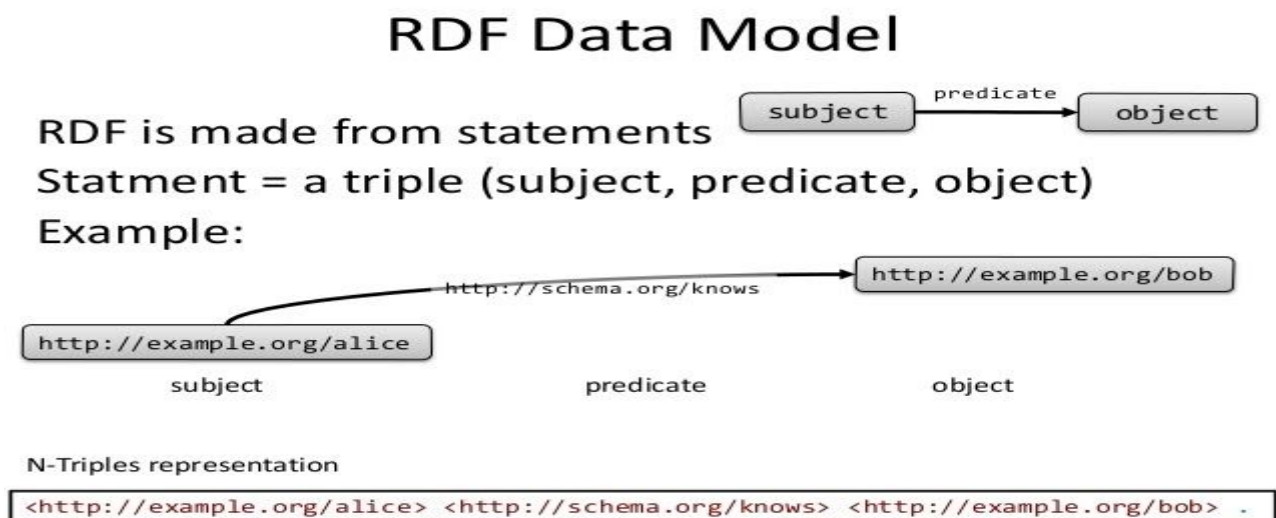


Figure 1 : Linked Data Example

### 2.1.2 RDF

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.RDF is built around the existing Web standards: XML and URL .



**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/knowns> (knows) is the predicate.
3. <http://example.org/bob> (Bob) is the object.

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

RDF statements state facts, relationships and data by linking resources of a different kind. With the help of an RDF statement, just about anything can be expressed by a uniform structure, consisting of three linked data pieces.[3]

### 2.1.3 SPARQL

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). [4]

A SPARQL query comprises, in order:

- Prefix declarations, for abbreviating URIs
- Dataset definition, stating what RDF graph(s) are being queried
- A result clause, identifying what information to return from the query
- The query pattern, specifying what to query for in the underlying dataset
- Query modifiers, slicing, ordering, and otherwise rearranging query results

# prefix declarations      PREFIX foo: <http://example.com/resources/>

# dataset definition      FROM ...

# result clause      SELECT ...

# query pattern      WHERE {}

# query modifiers      ORDER BY ...      [5]



## 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 Developers . [6]

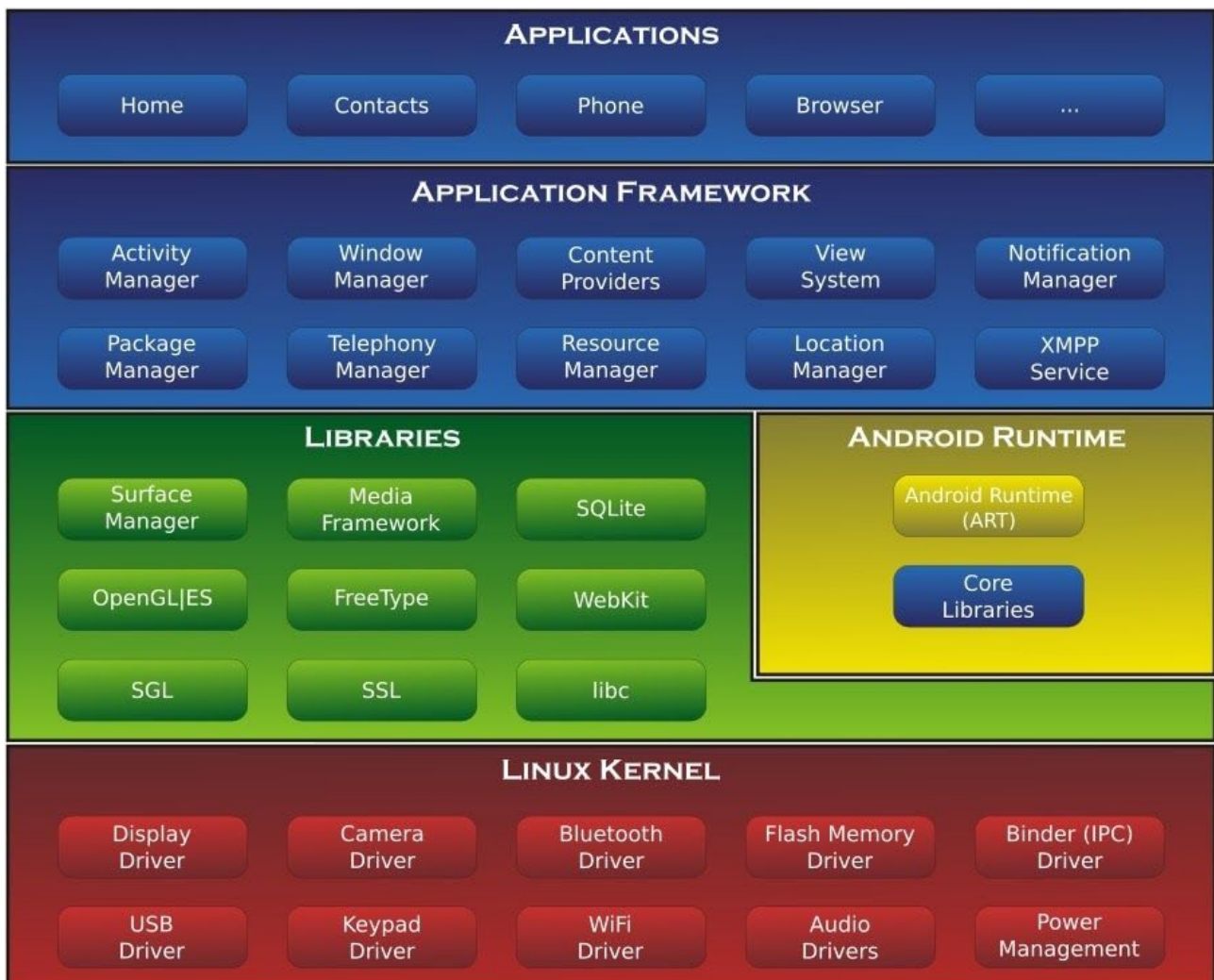


Figure 3 : Android System Architecture

## 2.3 Datasets

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

### 2.3.1 OverPass API OSM

The Overpass API is a read-only API that serves up custom selected parts of the OSM map data. It acts as a dataset over the web: the client sends a query to the API and gets back the data set that corresponds to the query.[8]

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[9]. This data was later saved to the GraphDB dataset, which will be analyzed in the sections below.

For each category of the places of interest we had to do a different query. For example for the museum category , we used this query :

```
node
```

```
[tourism=museum]
```

```
{{bbox}});
```

```
out;
```

where the box is the bounding box as mentioned above and the “tourism=museum” is set , so the category is specified .

### 2.3.2 DBpedia

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.[10]

DBpedia can be easily queried both with and without a deep knowledge of the DBpedia ontology. We can start building a query by searching on language-tagged literal values that are the objects of "rdfs:label" properties :

```
SELECT *
```

```
WHERE
```

```
{
    ?place rdfs:label "Acropolis Museum"@en
}
```

This will produce URIS , which labels are "Acropolis Museum" as an English-formatted text.[11]

The screenshot shows the 'SPARQL Query Editor' interface. At the top, there are tabs for 'About' and 'Tables'. On the right, there are links for 'Conductor', 'Facet Browser', and 'Permalink'. Below these, there are 'Extensions' (cmll, save to dav, sponge) and 'User: SPARQL'. The 'Default Data Set Name (Graph IRI)' field contains 'http://dbpedia.org'. The 'Query Text' area contains the query: 'select distinct ?Concept where {[[] a ?Concept} LIMIT 100'. At the bottom, there is a 'Results Format' dropdown set to 'HTML', and two buttons: 'Execute Query' and 'Reset'.

**Figure 4 : DBpedia SPARQL Endpoint**

### 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 and 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

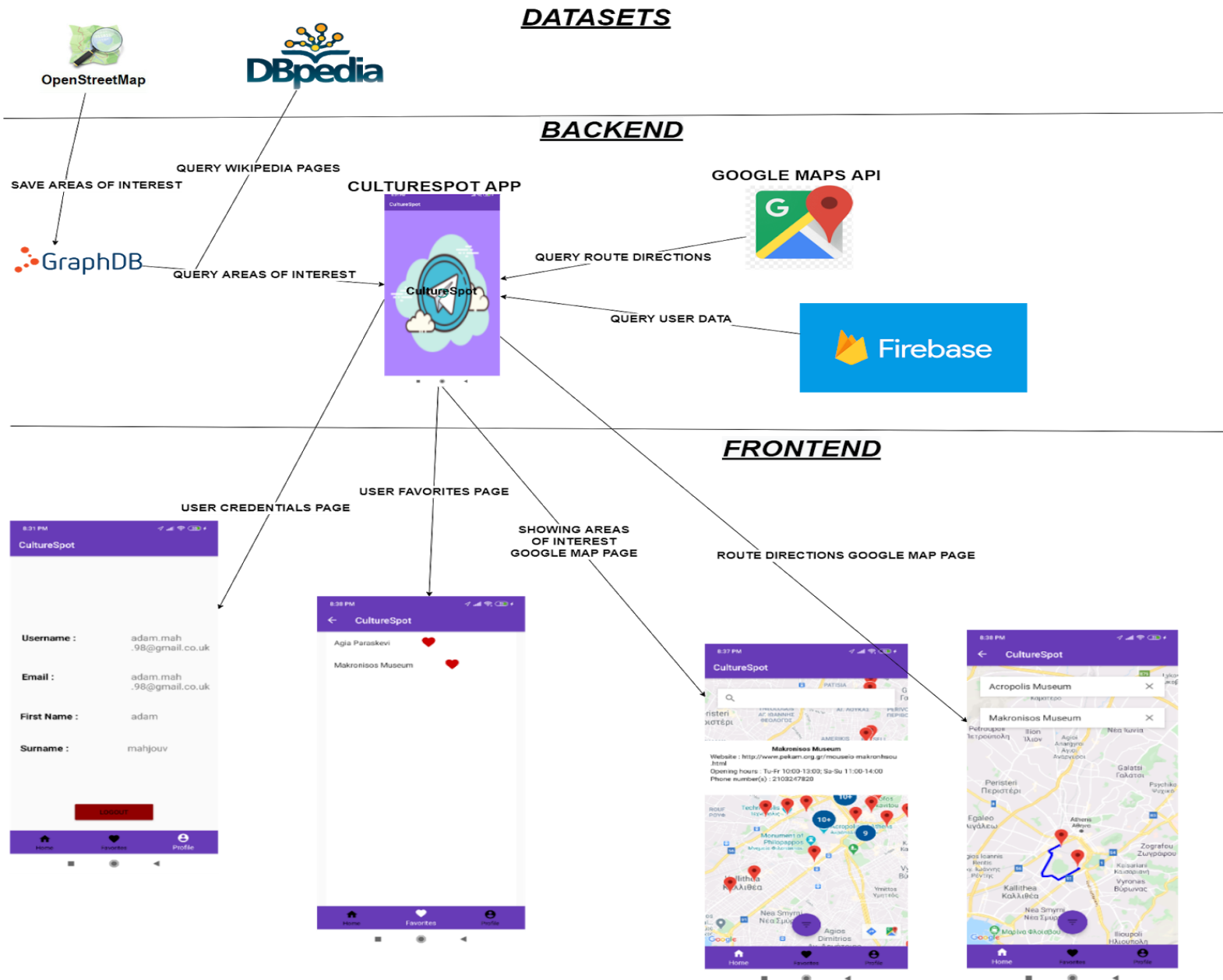


Figure 5 : CultureSpot Architecture

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 five main technologies , Geotriples , GraphDB , Firebase , Android Studio and Google Maps API. All of them will be analyzed in the sections below

#### 3.3.1 Geotriples

In order to transform the CSV files from OSM Overpass API to RDF,Geotriples was used.

GeoTriples allows the transformation of geospatial data stored in raw files (shapefiles, CSV, KML, XML, GML and GeoJSON) and spatially-enabled RDBMS (PostGIS and MonetDB) into RDF graphs using well-known vocabularies like GeoSPARQL and stSPARQL, but without being tightly coupled to a specific vocabulary.[9]

Geotriples was used in a docker pack called KR-Suite-docker,which includes all the linked data tools developed by the KRR&A team of the National and Kapodistrian University of Athens.[12]

#### 3.3.2 GraphDB

All of the data acquired from the Geotriples app was stored in GraphDB, Ontotext's database for RDF data.[13]

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).

Furthermore,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.

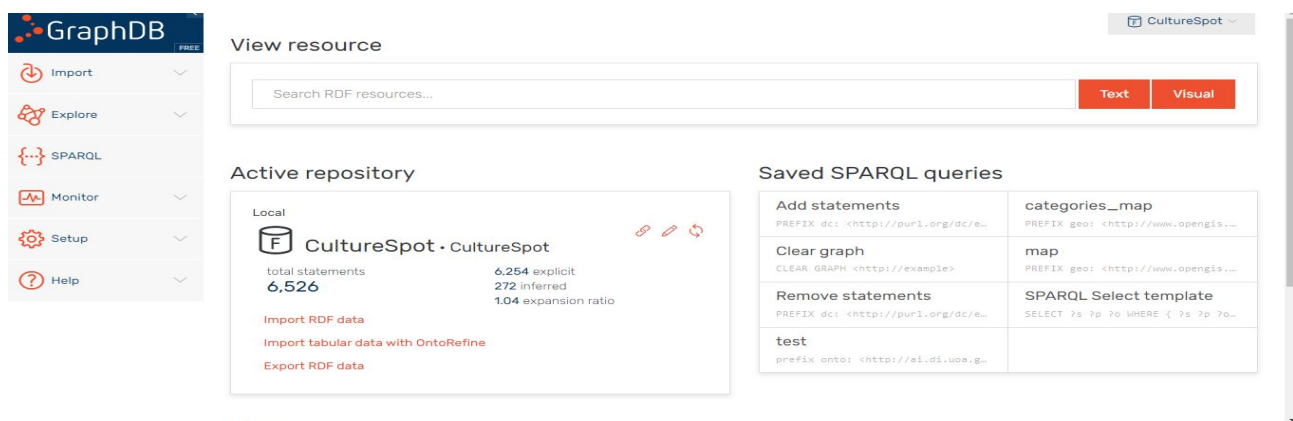


Figure 6 : GraphDB Dashboard

### 3.3.3 Firebase

Each user's data , such as his credentials and his favorite points of interest , are saved to Firebase , a Google database. Whenever a user logs in 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. [14]

Whenever a user wants to access his data a request is sent to Firebase with his id and all of his data , including his favorite areas of interest , are shown to him. 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.

In the image below you can see the database of our app which in its current state [22/3/20] has only one document "Users" , where every user's data is saved. In the Authentication we can also be shown the credentials of every user (email and encrypted password).

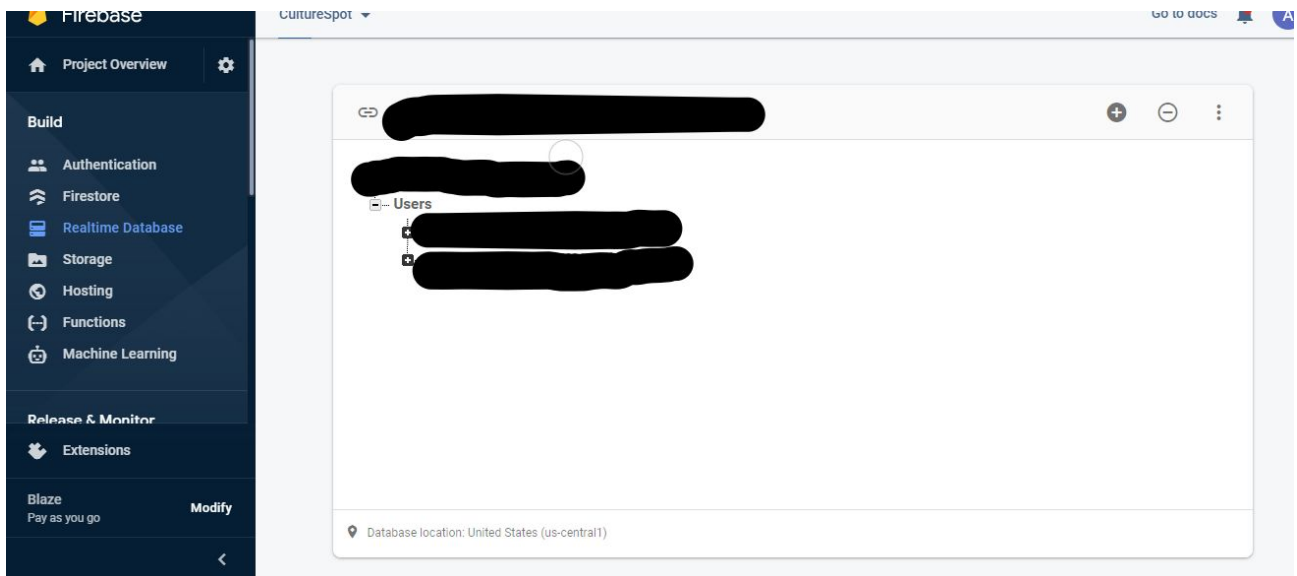


Figure 7 : Firebase Dashboard



### 3.3.4 Google Maps

The main technology used is , of course , Google Maps API . Every result retrieved from GraphDB is shown on this map.

Android applications are well-coordinated with this API as both are developed and maintained by the same company , Google. The functionalities are multiple and can vary a lot. In CultureSpot , marker clustering and Directions API was used in order to show the necessary information that was wanted.[15]

The SDK supports the Java programming language and provides additional libraries and extensions for advanced features and programming techniques.

In order to use this API , a key must be generated ( see Future Work section).

General Information about the areas of interest and their position is given by using the marker clustering API, via clusters, markers and info windows making the search on the map as convenient as possible.

The driving directions of a route between two points is shown by using the Directions API , via an HTTP-GET request with the right parameters.

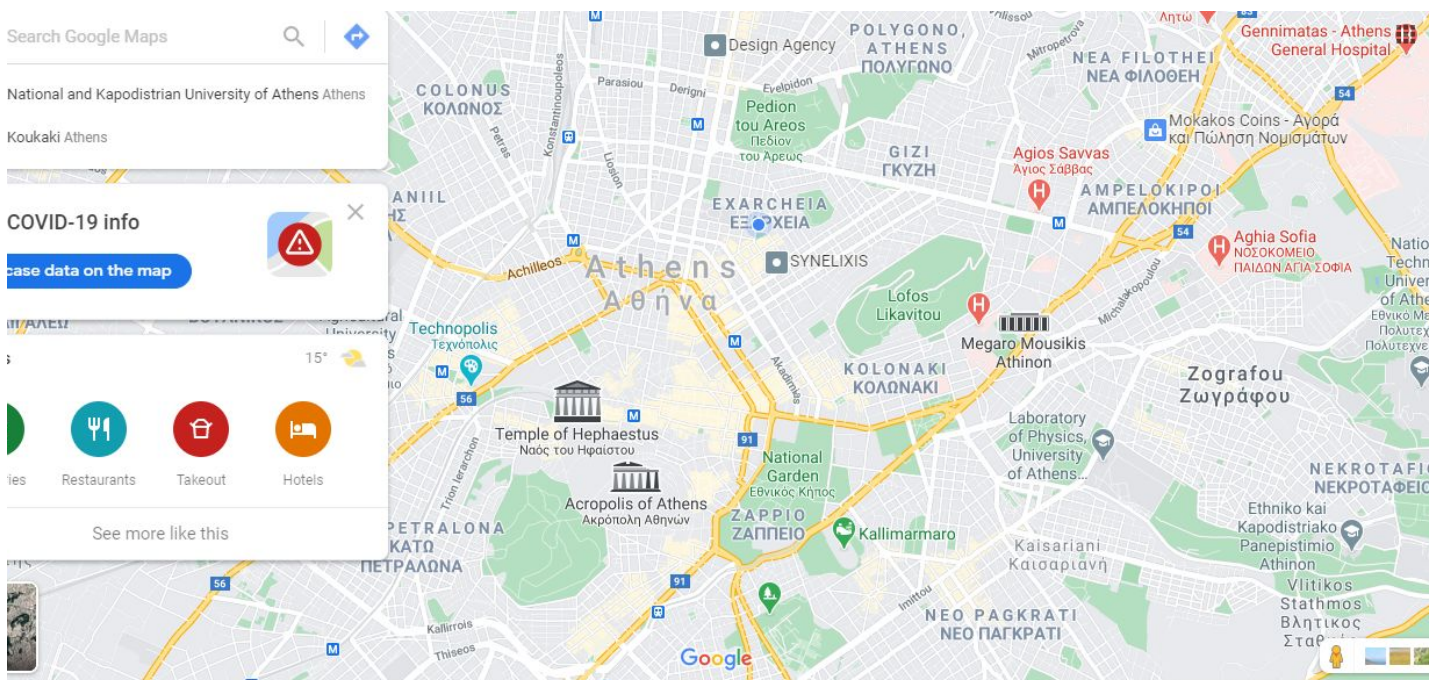


Figure 8: Google Maps Example



### 3.3.5 Android Studio

In order to write the code necessary for this project Android Studio IDE was used. It is the most well-known IDE for android applications, as it comes with various tools that will make the development the easiest possible.

In order to create the screens of the applications Android Studio provides a Visual layout editor (the code for the layout is written in XML format), with multiple configurations that are available in the menu.

In the backend Java was used as the programming language. Using Android Studio's code autocomplete, we were able to write better code in a faster and more productive manner.

Among the various tools which were available, the Firebase and the Google Maps ones were the most useful as there was no need to write extra code. All of the features were available with the click of a button.

Finally, Android Studio comes with emulator of Android smartphone to test applications, so there is no need to own an android smartphone. [16]

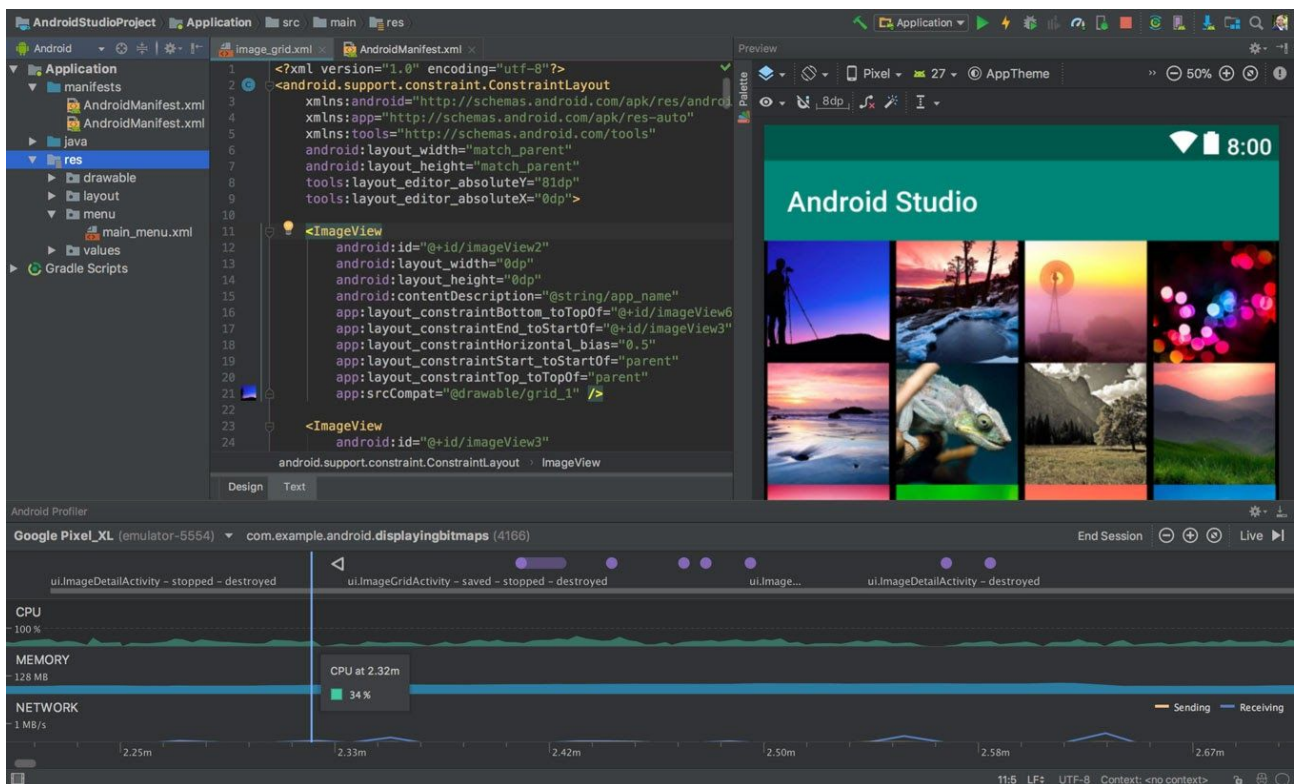


Figure 9 : Android Studio Homepage

### 3.4 User Interface and Features

In this subsection we will analyze how the app works by showing the screens of the app as well as explaining them.

#### 3.4.1 Splash Screen



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.

### 3.4.2 Login Screen

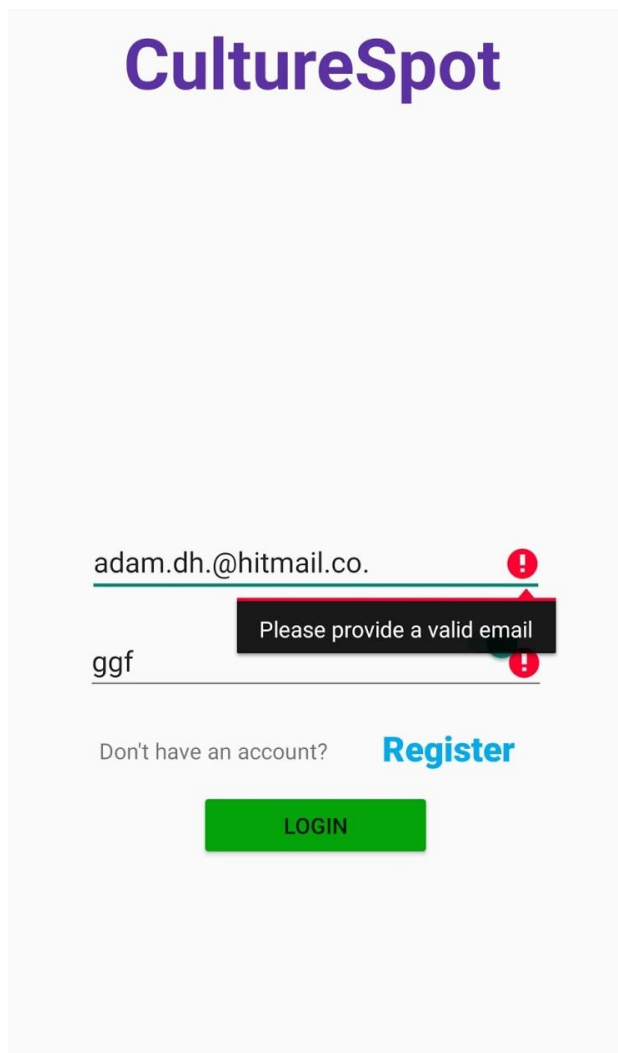


Image 2 : Login Screen

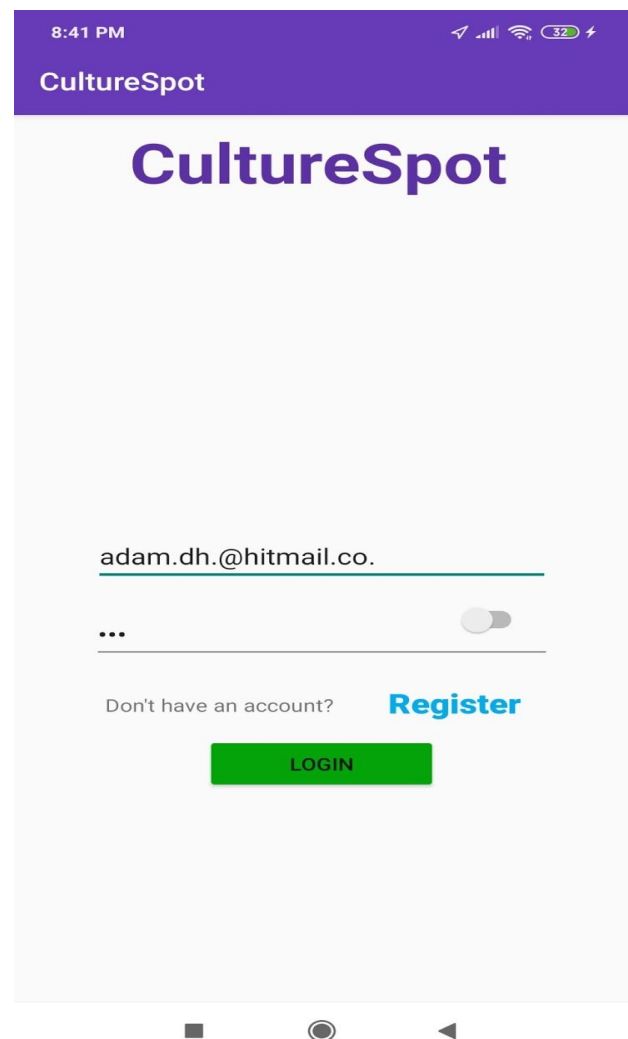
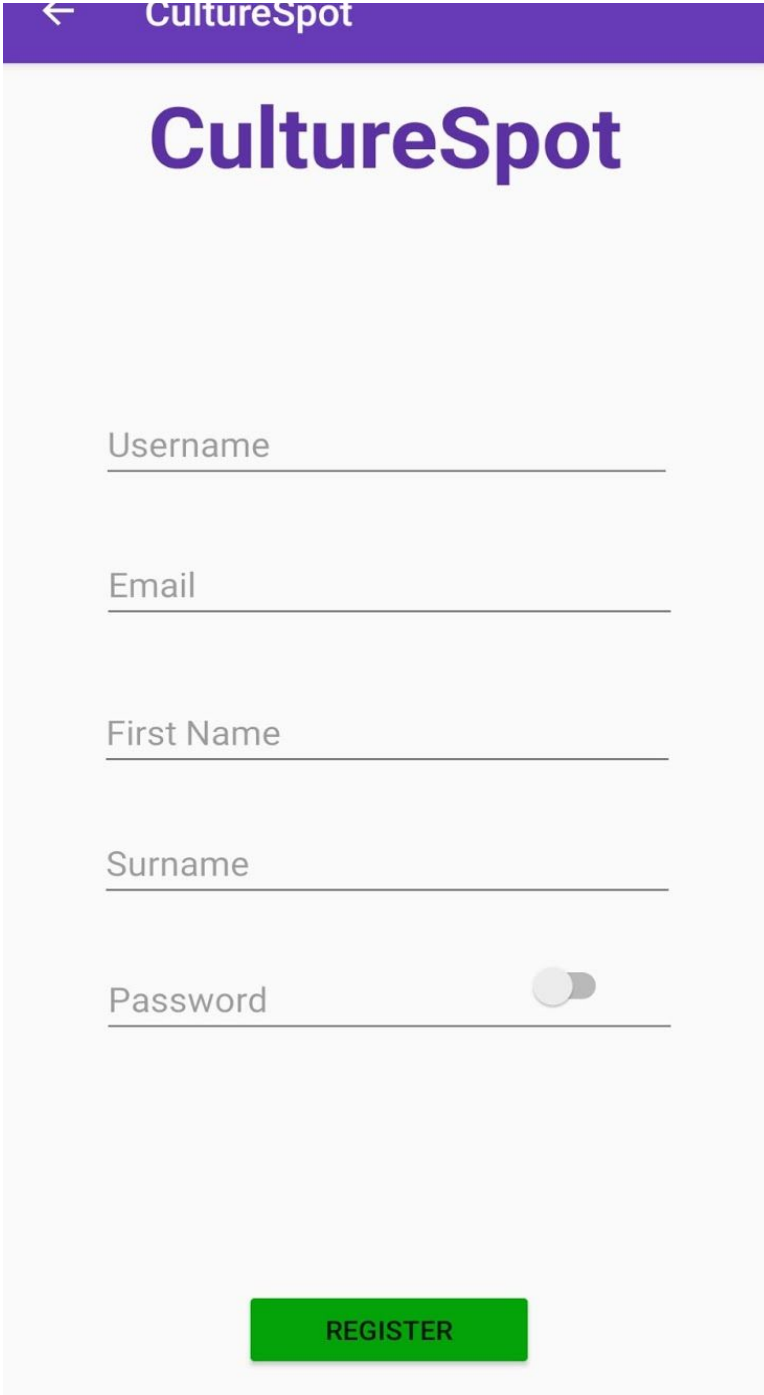


Image 3 : Login Screen Error and  
Show Password

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.

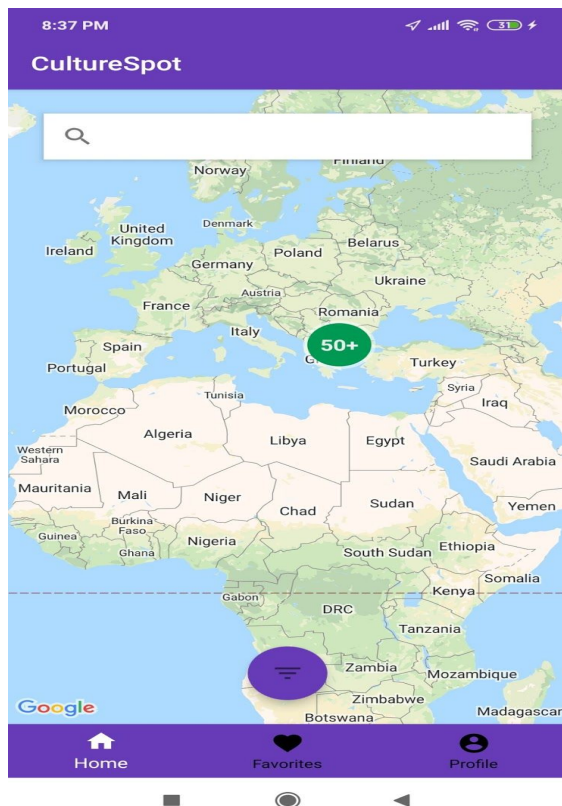
### 3.4.3 Register Screen

The image shows a mobile application screen for registering a new user. At the top, there is a purple header bar with a white back arrow on the left and the text "CultureSpot" in white. Below the header, the word "CultureSpot" is displayed in a large, bold, purple font. The registration form consists of five input fields, each with a label above it: "Username", "Email", "First Name", "Surname", and "Password". The "Password" field has a toggle switch to its right, currently in the "off" position. At the bottom of the form, there is a green rectangular button with the word "REGISTER" in white capital letters.

**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.

### 3.4.4 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 one 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 5 : Default Map Screen

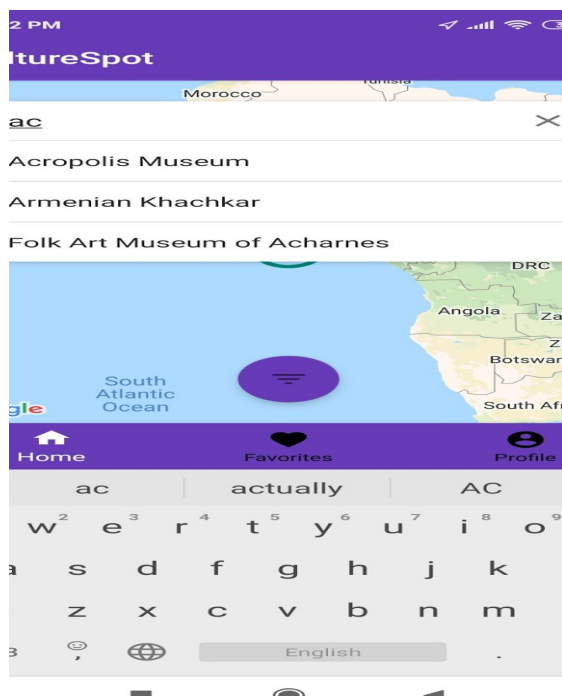


Image 6 : Search List Map Screen

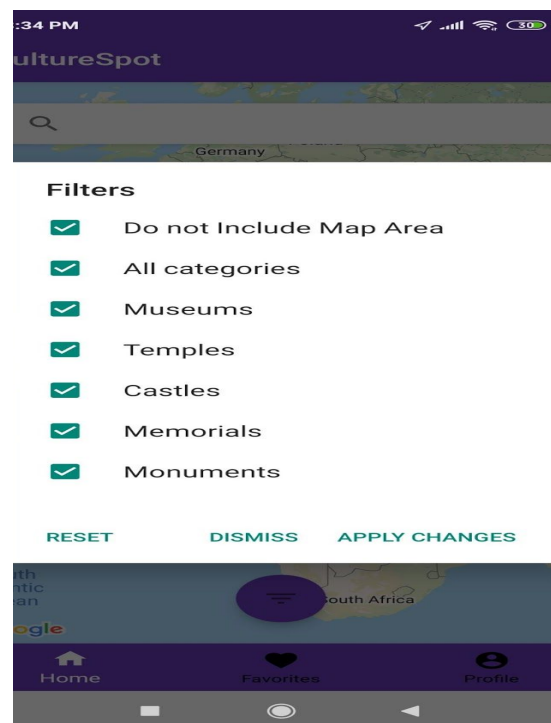


Image 7 : Filters List Map Screen



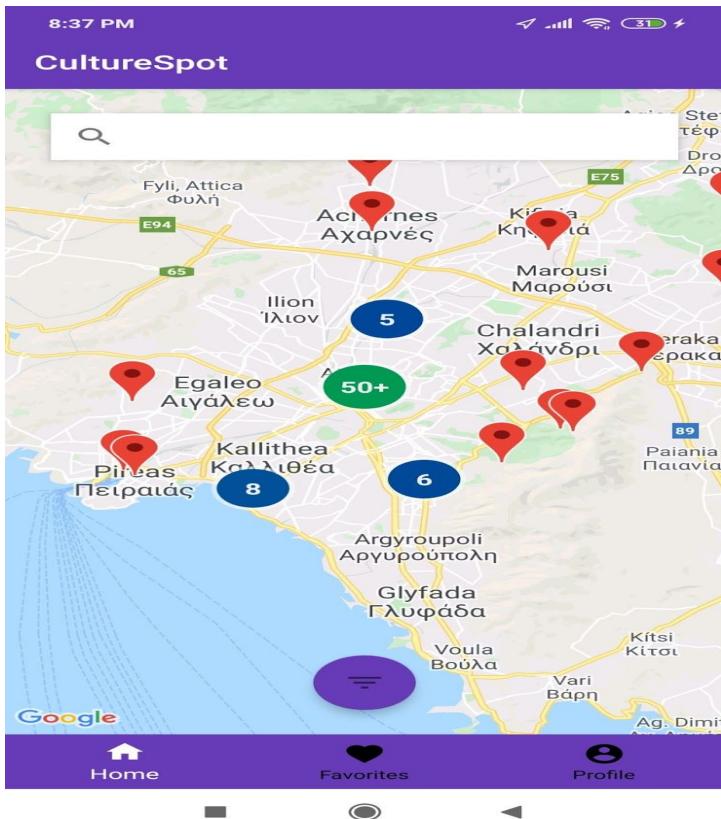


Image 8 : Clusters and Markers

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.

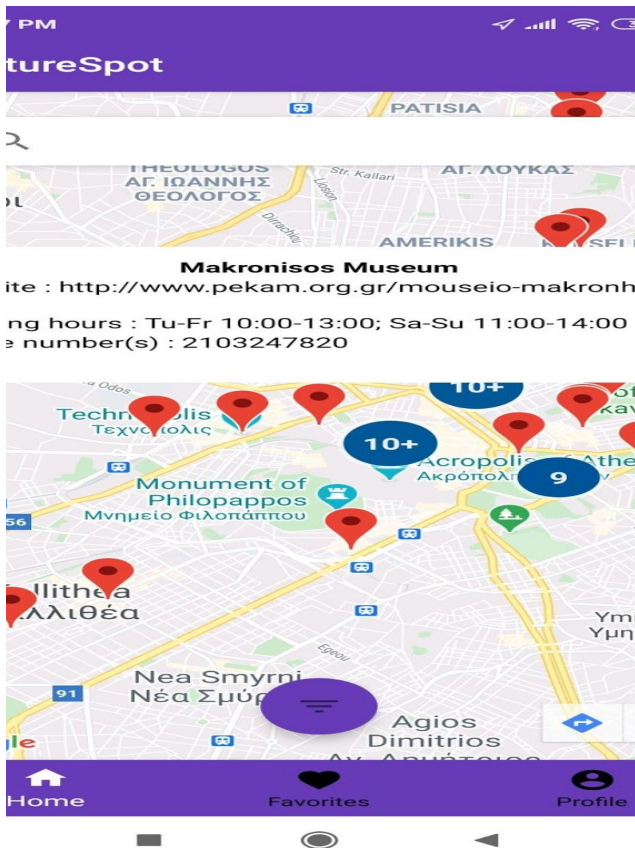


Image 9 : Info Window of Marker Map Screen

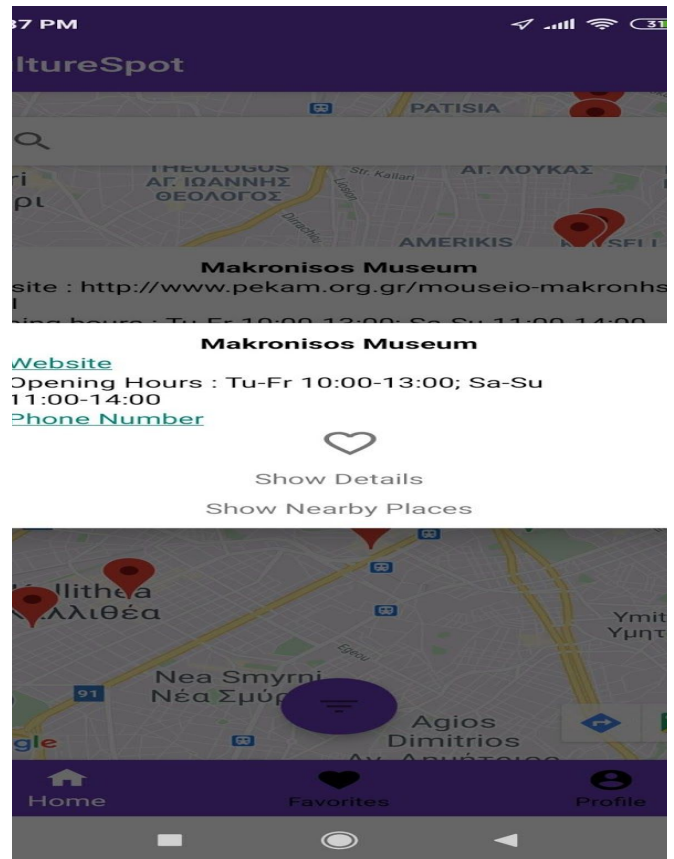
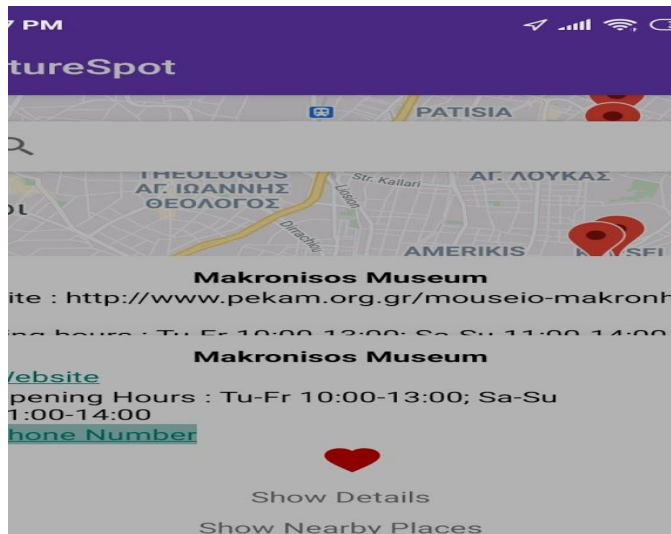


Image 10 : Popup Window of Marker Map Screen



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)

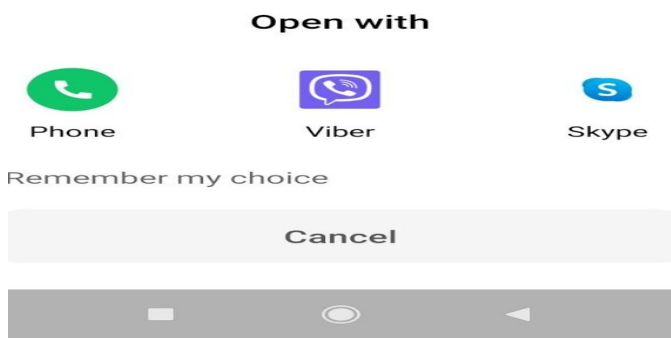


Image 11 : Redirect to App Map Screen

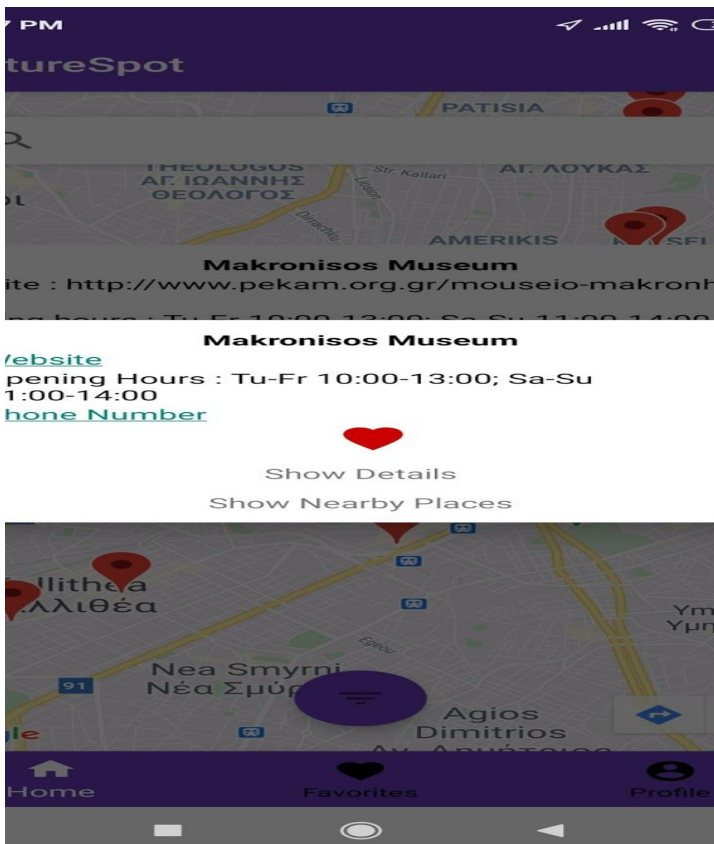


Image 12 : Favorite Point of Interest

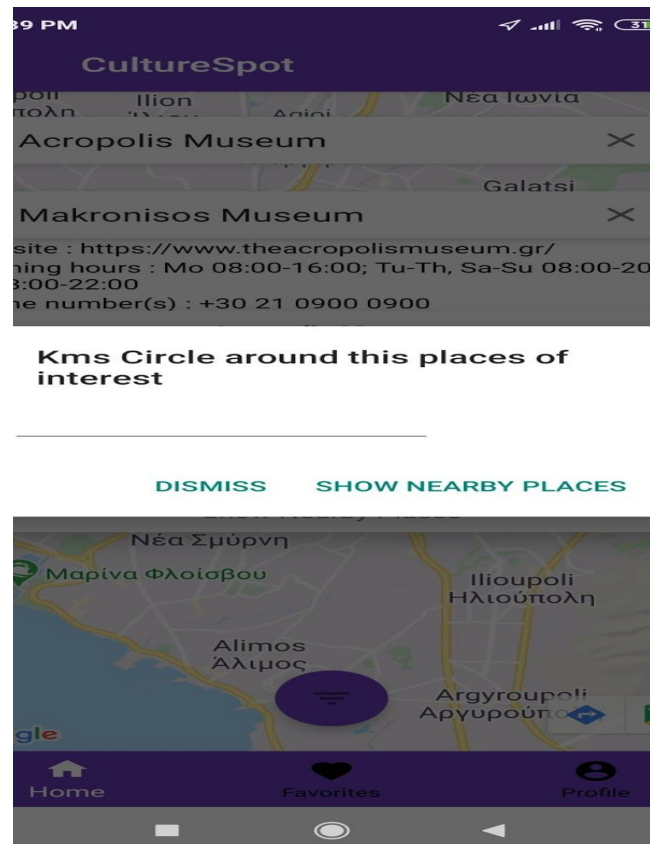
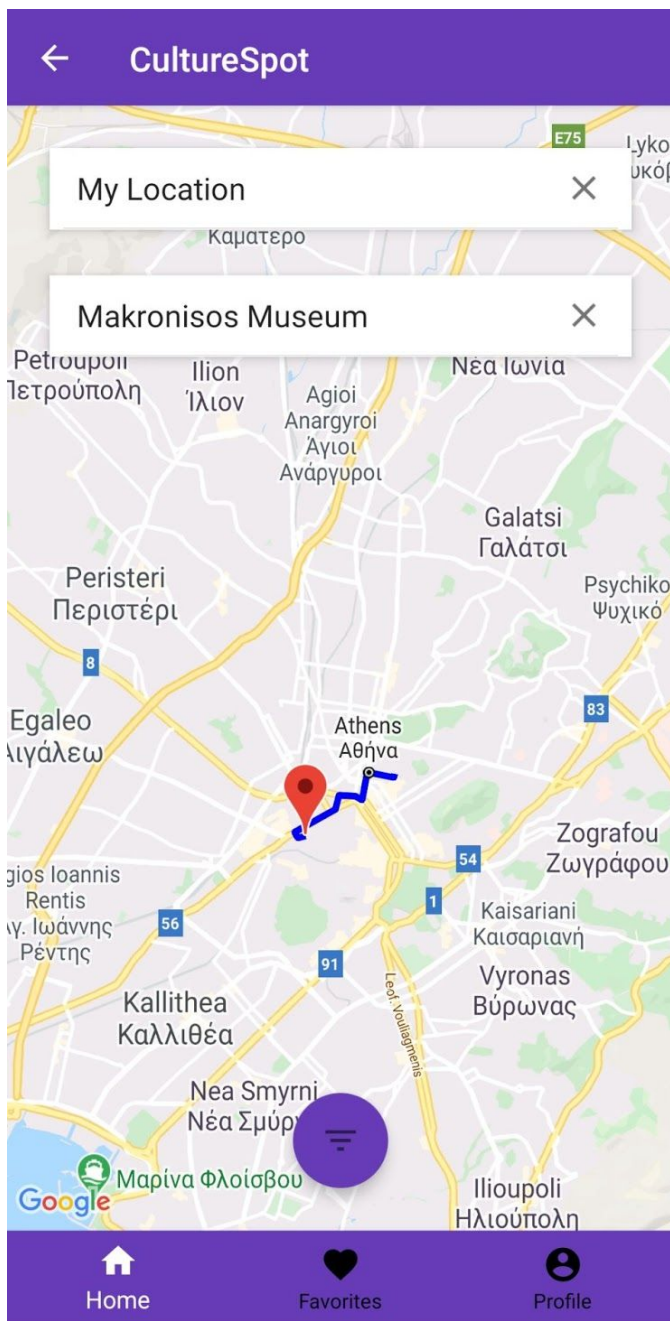
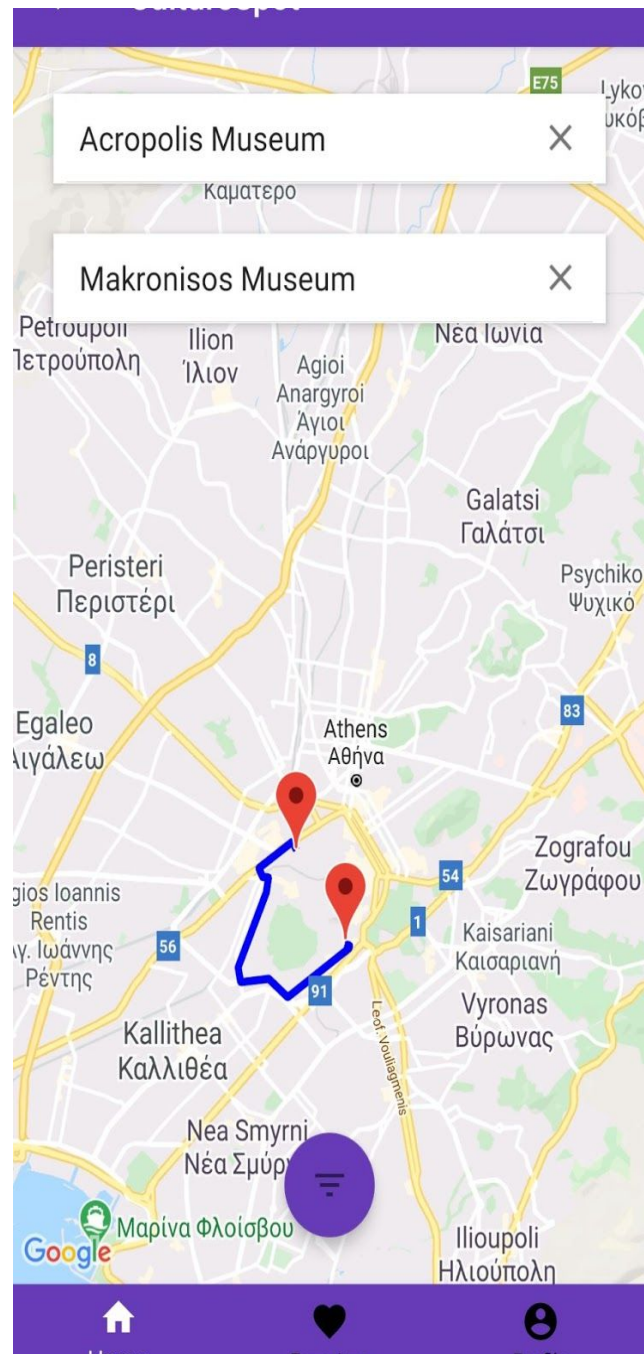


Image 13 :Search Nearby Map Screen





**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.



### 3.4.5 Favorites and User Credential Screens



Image 16 : Favorites List Screen

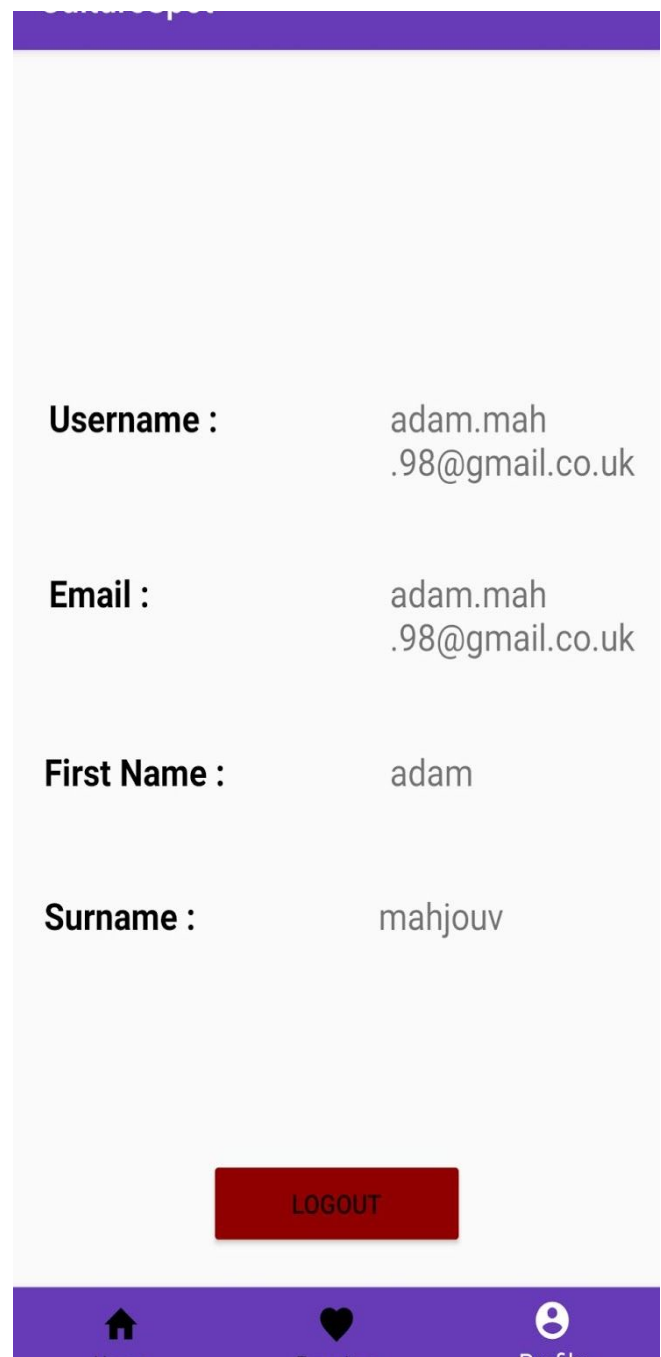


Image 17 : Profile Screen

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 mentioned below.

Our first goal is to bypass the DBpedia query by incorporating its data to GraphDB. This will minimize the backend time to query both DBpedia and GraphDB. If we take into consideration that from time to time it takes a lot of seconds (sometimes even minutes) to query DBpedia, then we can safely assume that the query time will be just 1 to 2 seconds.

Secondly, we could get written route directions, so the user can have a better experience when searching a route between two map points. This will of course help him navigate to an unknown city and it will decrease his time spent, because he will not have to use Google Maps application, but use CultureSpot from the beginning to the end.

Furthermore, a review section for points of interest, where multiple users can share their experience, must be created. This will help the users decide which cultural spots are worth visiting and will also make their opinion on a museum or monument valuable.

Finally, if a chat is created, users can have personal conversations that are not allowed in a review section. This will make the experience of our app much more personalized, in which users have the opportunity to exchange thoughts and experiences with one another.

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](#).

Instructions on how to use the application :

Download the CultureSpot folder and open it with Android Studio , which you have to download.

Connect Firebase with the project through Android Studio Tools.

Change the GraphDB\_URL in MapFragment.java:89(file:line) to your GraphDB url found in the dashboard of the GraphDB application , which you have to download.

Put your Google API keys in MapFragment:841 google\_maps\_api:19(src/debug and src/release/res/values) AndroidManifest.xml:33 google-services.json:23. This key can be created in Google Cloud Console (google account is needed).

Load the rdf-ttl files to your GraphDb database (First Setup->Repositories->Create a new Repository and then Import->RDF to load the files).

Run the code from Android Studio.

## 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
IDEA	Integrated Development Enviroment

## REFERENCES

- [1] W3 , Linked Data ; <https://www.w3.org/wiki/LinkedData> [Accessed 17/3/20]
- [2] Ontotext, Linked Data and Linked Open Data ; <https://www.ontotext.com/knowledgehub/fundamentals/linked-data-linked-open-data/> [Accessed 22/3/20]
- [3] Ontotext , What is RDF ; <https://www.ontotext.com/knowledgehub/fundamentals/what-is-rdf> [Accessed 17/3/20]
- [4] Ontotext , What is SPARQL; <https://www.ontotext.com/knowledgehub/fundamentals/what-is-sparql/> [Accessed 17/3/20]
- [5] W3 , SPARQL By Example ; <https://www.w3.org/2009/Talks/0615-qbe/> [Accessed 22/3/20]
- [6] Wikipedia, Android software development ; [https://en.wikipedia.org/wiki/Android\\_software\\_development](https://en.wikipedia.org/wiki/Android_software_development) [Accessed 18/3/20]
- [7] Wikipedia , Android(operating\_system) ; [https://en.wikipedia.org/wiki/Android\\_\(operating\\_system\)](https://en.wikipedia.org/wiki/Android_(operating_system)) [Accessed 19/3/20]
- [8] Wiki OpenStreetMap , OverPass API ; [https://wiki.openstreetmap.org/wiki/Overpass\\_API](https://wiki.openstreetmap.org/wiki/Overpass_API) [Accessed 19/3/20]
- [9] Github , GeoTriples ; <https://github.com/LinkedEOData/GeoTriples> [Accessed 22/3/20]
- [10] DBpedia Wiki , DBpedia ; <https://wiki.dbpedia.org/OnlineAccess> [Accessed 22/3/20]
- [11] Medium , Running Basic SPARQL Queries Against DBpedia ; <https://medium.com/virtuoso-blog/dbpedia-basic-queries-bc1ac172cc09> [Accessed 22/3/20]
- [12] Github , KR-Suite-docker ; <https://github.com/GiorgosMandi/KR-Suite-docker> [Accessed 22/3/20]
- [13] Ontotext , GraphDB ; <https://www.ontotext.com/products/graphdb/> [Accessed 22/3/20]
- [14] Google , Firebase ; <https://console.firebase.google.com/u/0/> [Accessed 22/3/20]
- [15] Google , Google Maps Platform ; <https://developers.google.com/maps> [Accessed 22/3/20]
- [16] Android , Android Studio ; <https://developer.android.com/studio> [Accessed 22/3/20]