DIPARTIMENTO DI INGEGNERIA DELL'INFORMAZIONE

GROUP 4

HUMAN "EMOTION TRACKING" MOBILE APP

885II 22/23 - Mobile And Social Sensing System

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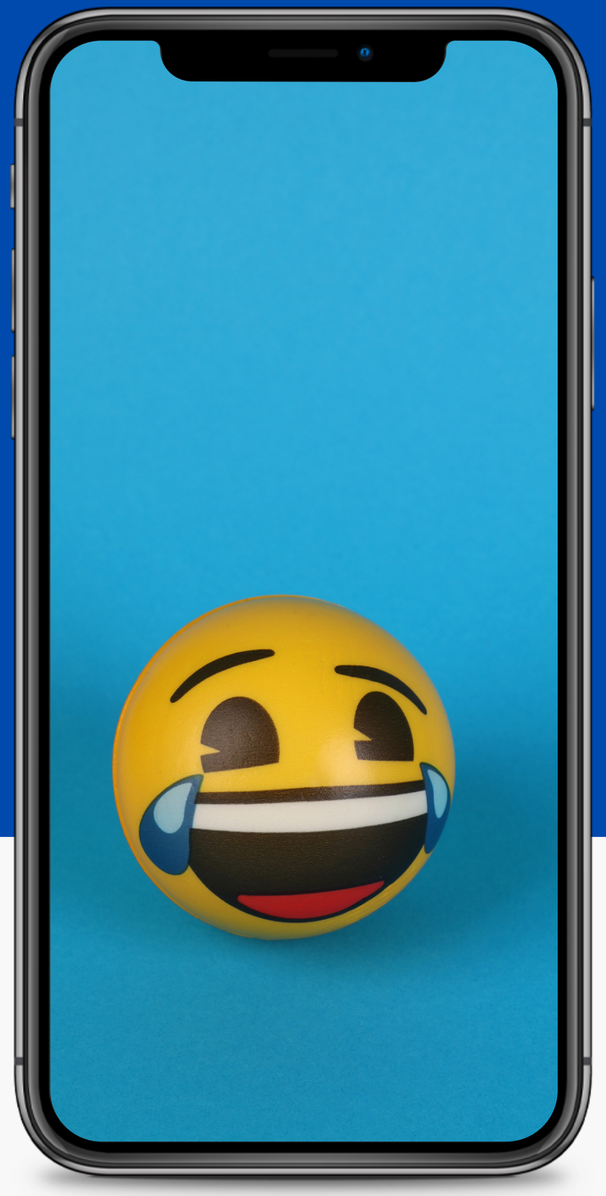


INTRODUCTION

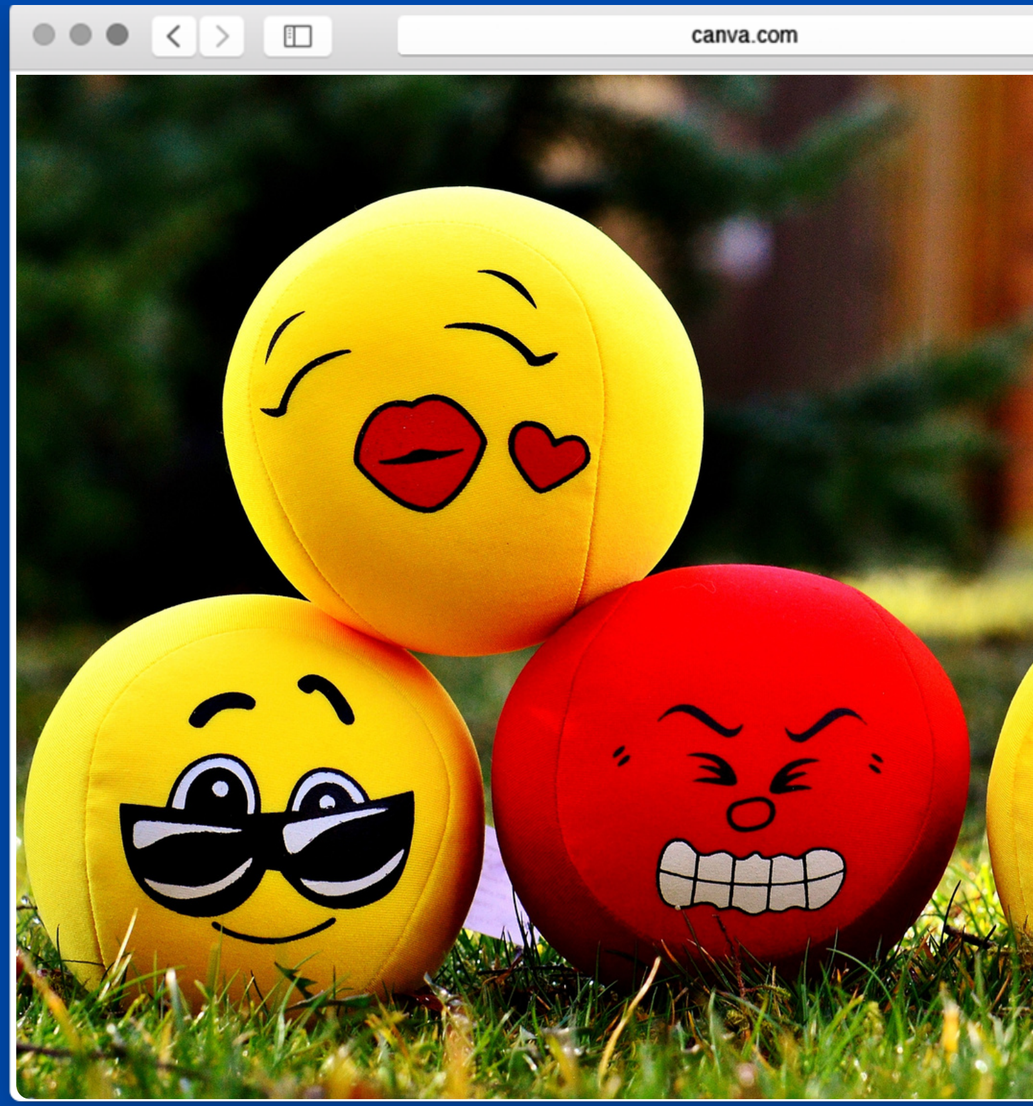
- Why Emotion tracking?
- Challenges
- Goals of the project
- Techs and Tools Used

WHY EMOTION TRACKING?

- Emotions are one of the most important parts of our daily life, and we found it reasonable to work on this area.
- Facial Expressions play their role in a non-verbal communications and also helps to identify the current state of the person we are communicating with.
- Face being one of the exposed part of the human body allows for the use of different ML techniques, especially using the camera, to analyze and recognize the emotions of an individual.

CHALLENGES

- Develop a DL model for real time face detection to calculate happiness index.
- Accessing the location of the User
- Store the information in a safe place like remote FirebaseDB
- Do a clustering for a deeper understanding of user emotions and their spatial distribution.



GOALS OF THE SYSTEM

The goal of this project is to develop a solution that can collect the emotional status of the end user through the front camera and create a happiness map on the **openstreetmap**.

The sensor data, the location and the happiness level, is collected in real-time for calculating the emotions of the user through a smartphone app named as 'Emotoion Tracker'.

It requires the end user to give acces to their front camera, to switch-on the GPS to access their location where the application is being utilized.

TECH AND TOOLS USED

Prepocessed FER2013 DataSet

Binary CNN

TensorFlow Lite

Clustering

DBSCAN

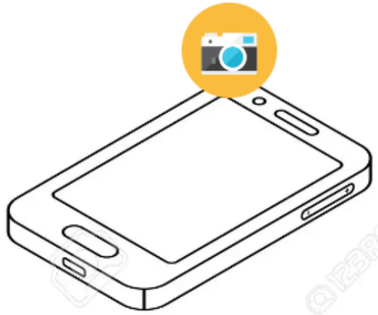
Firebase

EMOTION RECOGNITION

1. Handling data from the smartphone
2. The face detection module
3. The emotion recognizer module
4. Training details
5. Overall processing pipeline

HANDLING DATA FROM THE SMARTPHONE

- **Goal:**
  - Estimate the degree of happiness of the user in a specific location, using smartphone's sensors
- **Method:**
  - Get video streaming from the smartphone, process frames to obtain an estimate of the user emotion over time using facial expressions
  - Use GPS to get location information, periodically send sensed location and estimated happiness to the database



THE FACE DETECTION MODULE

The face detection module is implemented through the MLKIT face detection API, available in Android.

INPUT

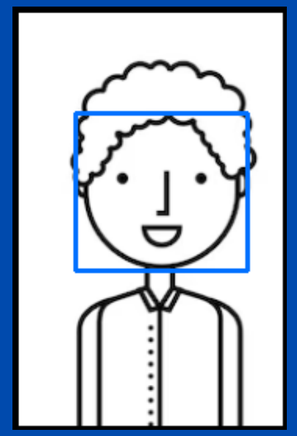
Frame from the front camera

PROCESS

Detect faces in the frame, if any

OUTPUT

Bounding boxes information for the detected faces



THE EMOTION RECOGNIZER MODULE

The emotion recognizer is a custom CNN developed in Tensorflow. The CNN has been trained using a modified version of the FER2013 dataset on a binary classification problem (happy/unhappy)

INPUT

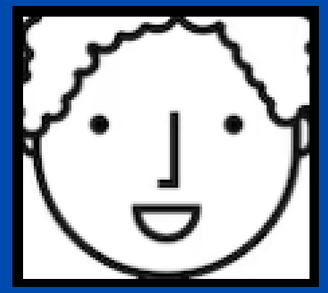
Cropped frame representing a face

PROCESS

Evaluate happiness of the represented face

OUTPUT

Probability that the represented face is happy



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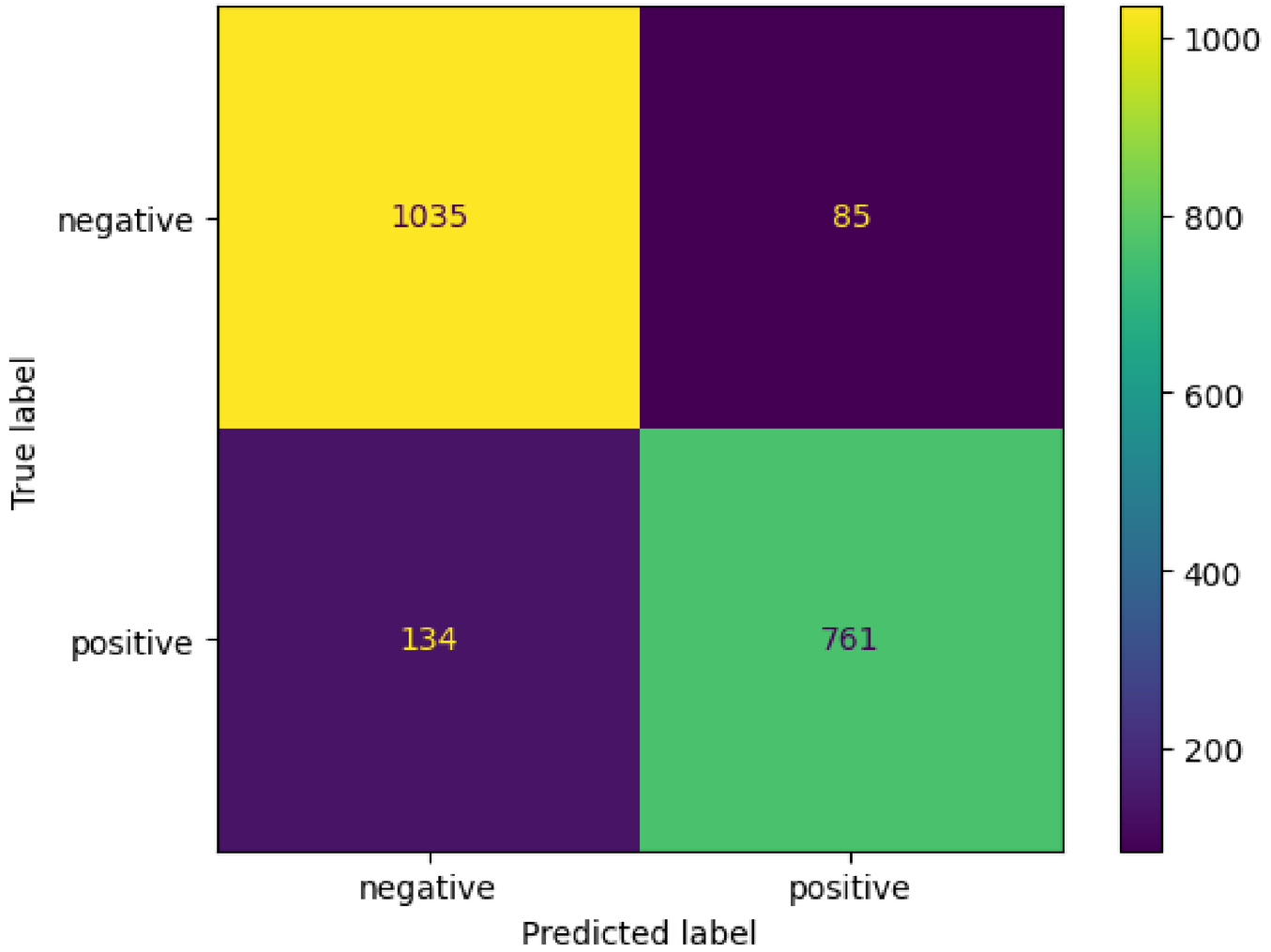
THE EMOTION RECOGNIZER MODULE (TRAINING DETAILS)

Emotion	Training set	Test set
Anger	3995	958
Disgust	436	111
Fear	4097	1024
Happiness	7215	1774
Neutral	4954	1233
Sad	4830	1247
Surprise	3171	831

Emotion	Training set	Test set
Happy	7215	1774
Unhappy	8825	2205

	Training set	Validation set	Test set
Accuracy	91.63 %	89.26%	89.13 %
Loss	0.225	0.313	0.315

CONFUSION MATRIX ON TEST

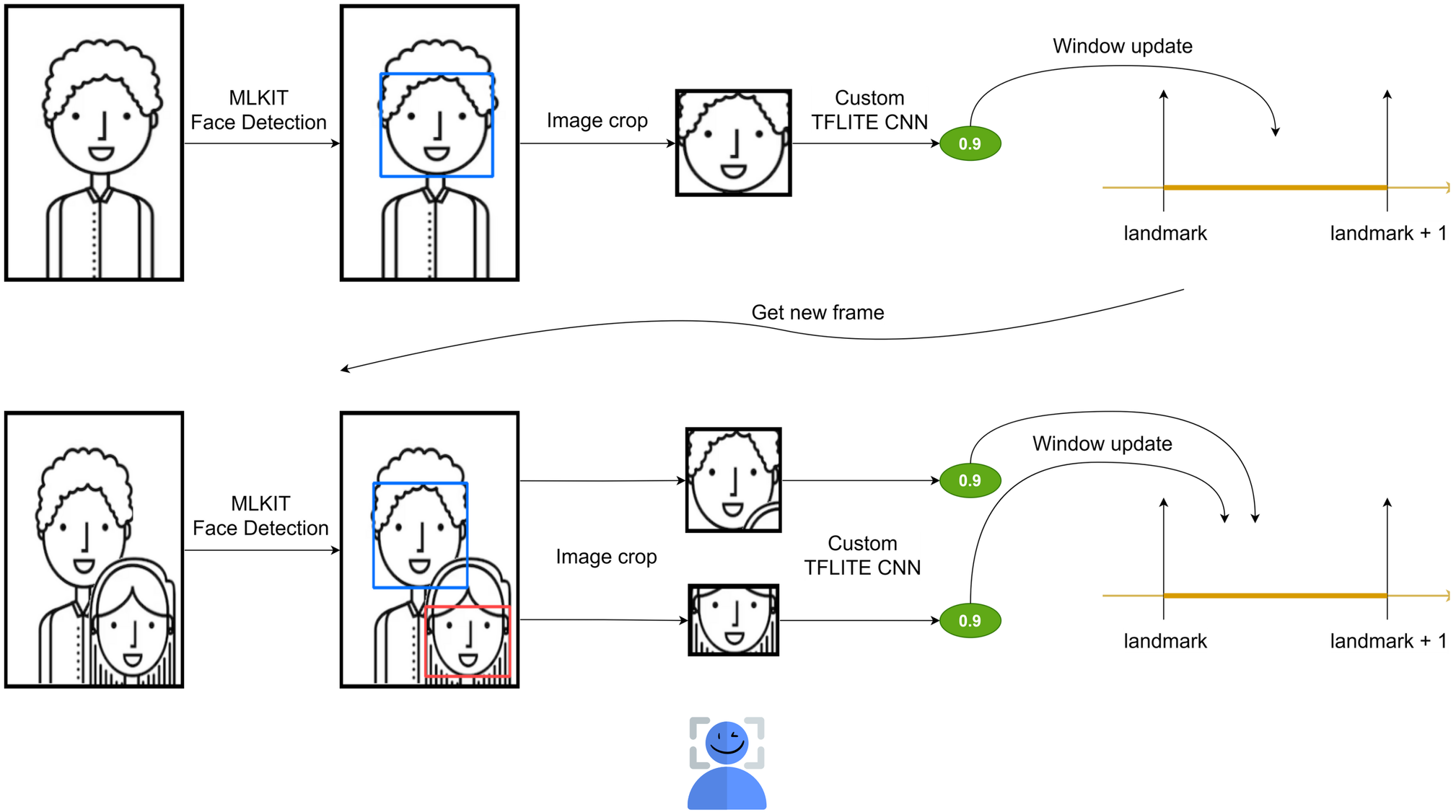


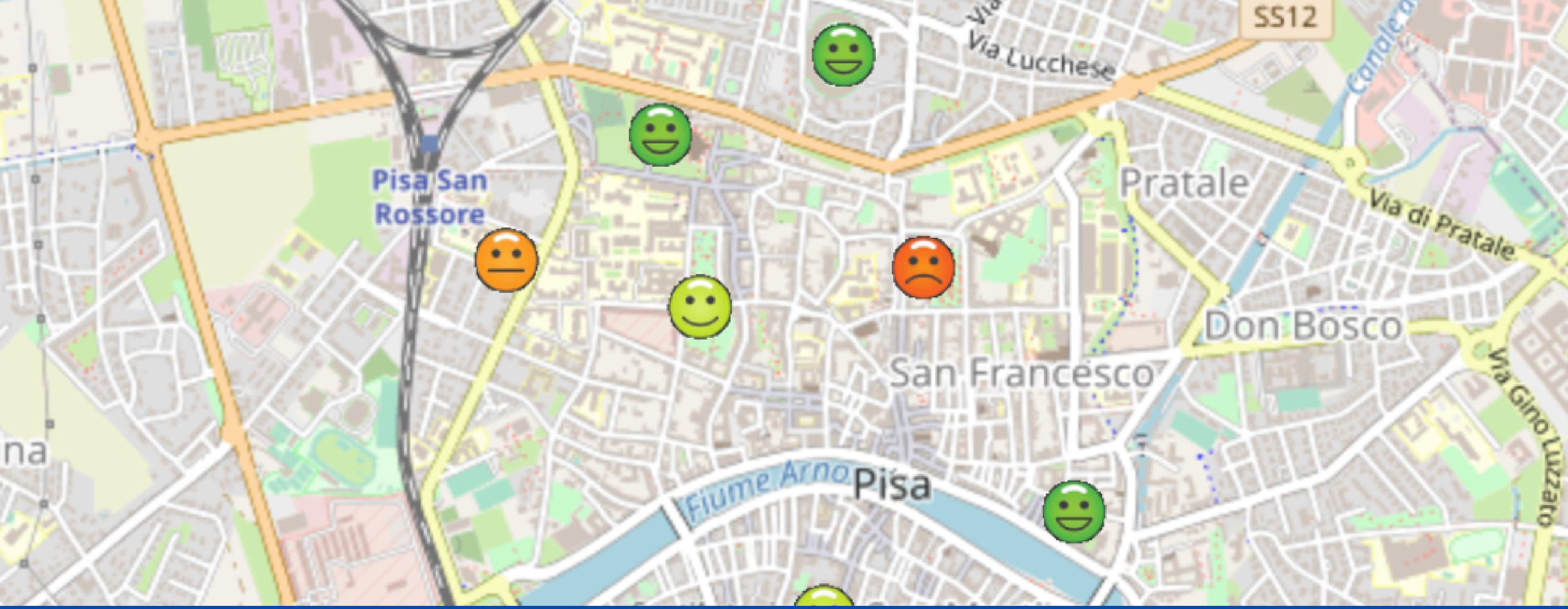
OVERALL PROCESSING PIPELINE

Landmark window model:

- When the app is being used (and if the user gave the necessary permissions), the processing of the video streaming starts.
- The predictions from the CNN are accumulated, along with the number of predictions.
- Each 10 seconds, the location of the smartphone is obtained and the average happiness in the last 10 seconds is computed (using the accumulators updated above). This information is sent to the DB.
- Accumulators are reset and a new window begins.

OVERALL PROCESSING PIPELINE




SS12
Via Lucchese
Pisa San
Rossore
Pratale
Via di Pratale
Don Bosco
San Francesco
Via Gino Luzzato
Fiume Arno
Pisa

CLUSTERING

WHY CLUSTERING?

One of the fundamental components of our application is the clustering stage, aimed at identifying the happiest places within the city

WHY DBSCAN?

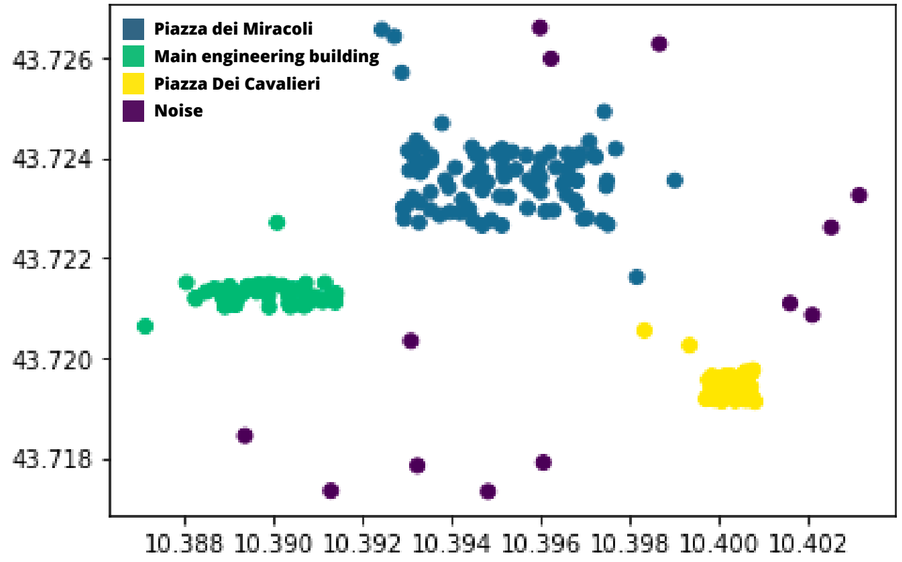
Clusters emerge naturally from regions of high data density, allowing for the detection of clusters of varying sizes and shapes
Not need to specify the number of clusters to be found a priori

CLUSTERING

VALUATE BEST PARAMETERS

min_samples	eps	silhouette_coefficient
5.0	0.0015	0.636463
8.0	0.0015	0.632234
6.0	0.0015	0.632234
9.0	0.0015	0.632234
7.0	0.0015	0.632234
4.0	0.0015	0.631169
9.0	0.001	0.612066
6.0	0.001	0.612066
4.0	0.001	0.612066
7.0	0.001	0.612066

VALUATE BEST PARAMETERS

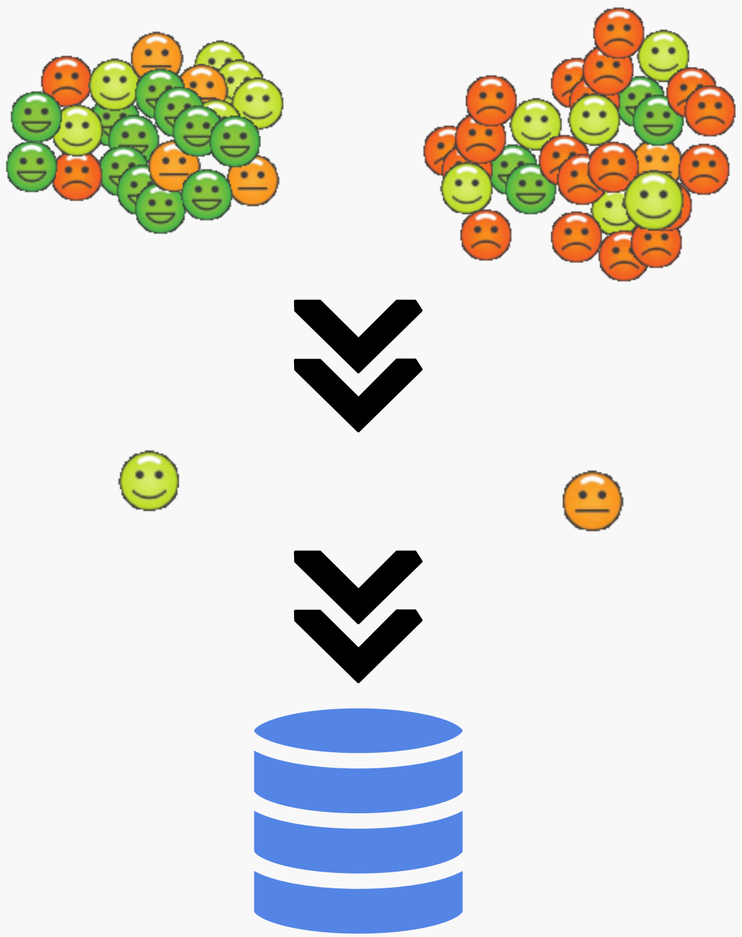


SMILE LIBRARY

```
import smile.clustering.DBSCAN
```

We use the SMILE library for perform DBSCAN locally

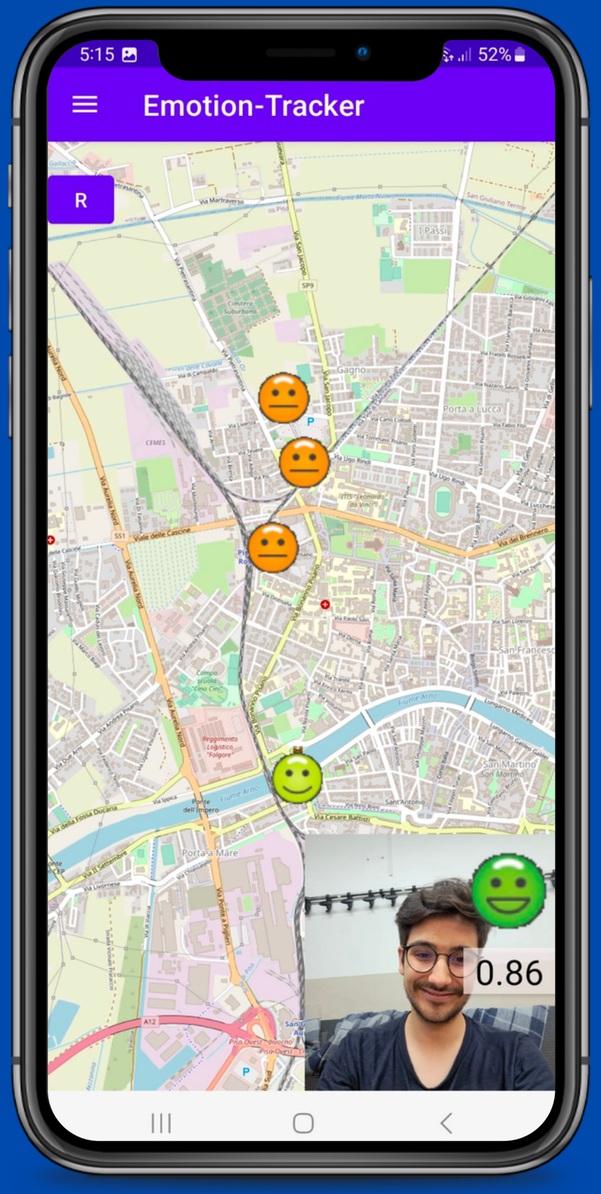
ANDROID SERVICE



For the implementation of the cluster phase we leveraged a built-in Android service to perform the clustering process in the background.

Once the clusters are computed, they are summarized by a single representative point known as the centroid, that are the mean of all the points within the cluster.

The service clears the collection of clusters for the current user and replaces it with the newly computed clusters.

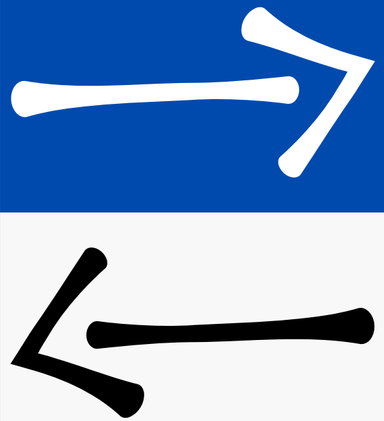


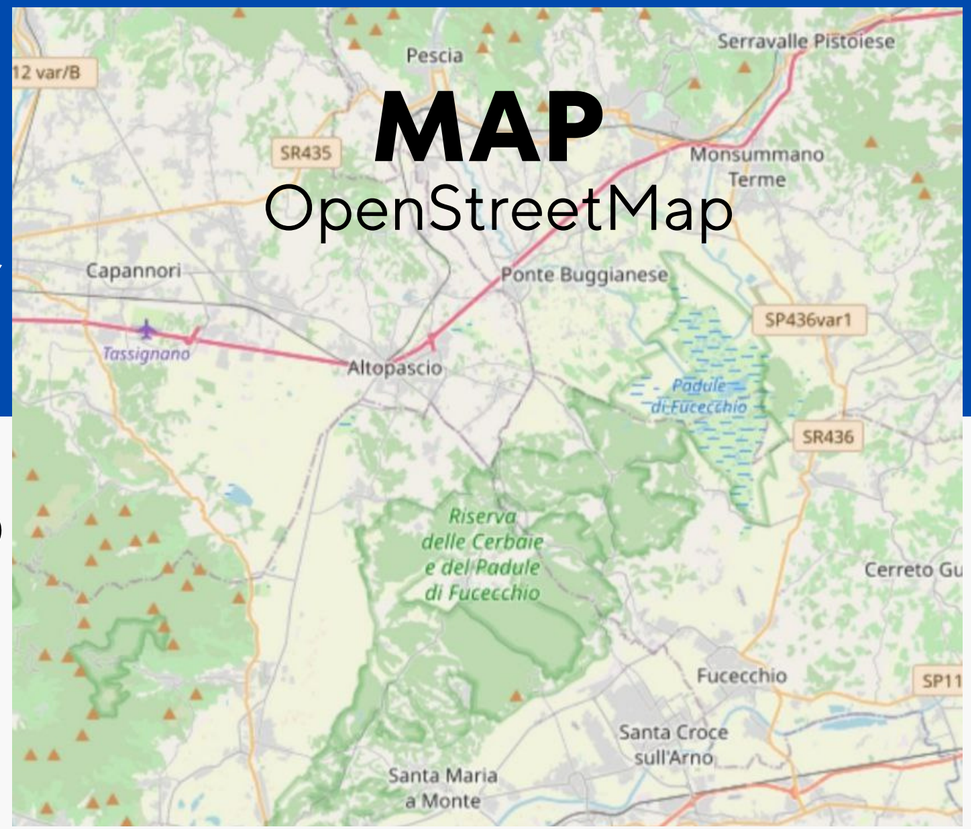
TEST

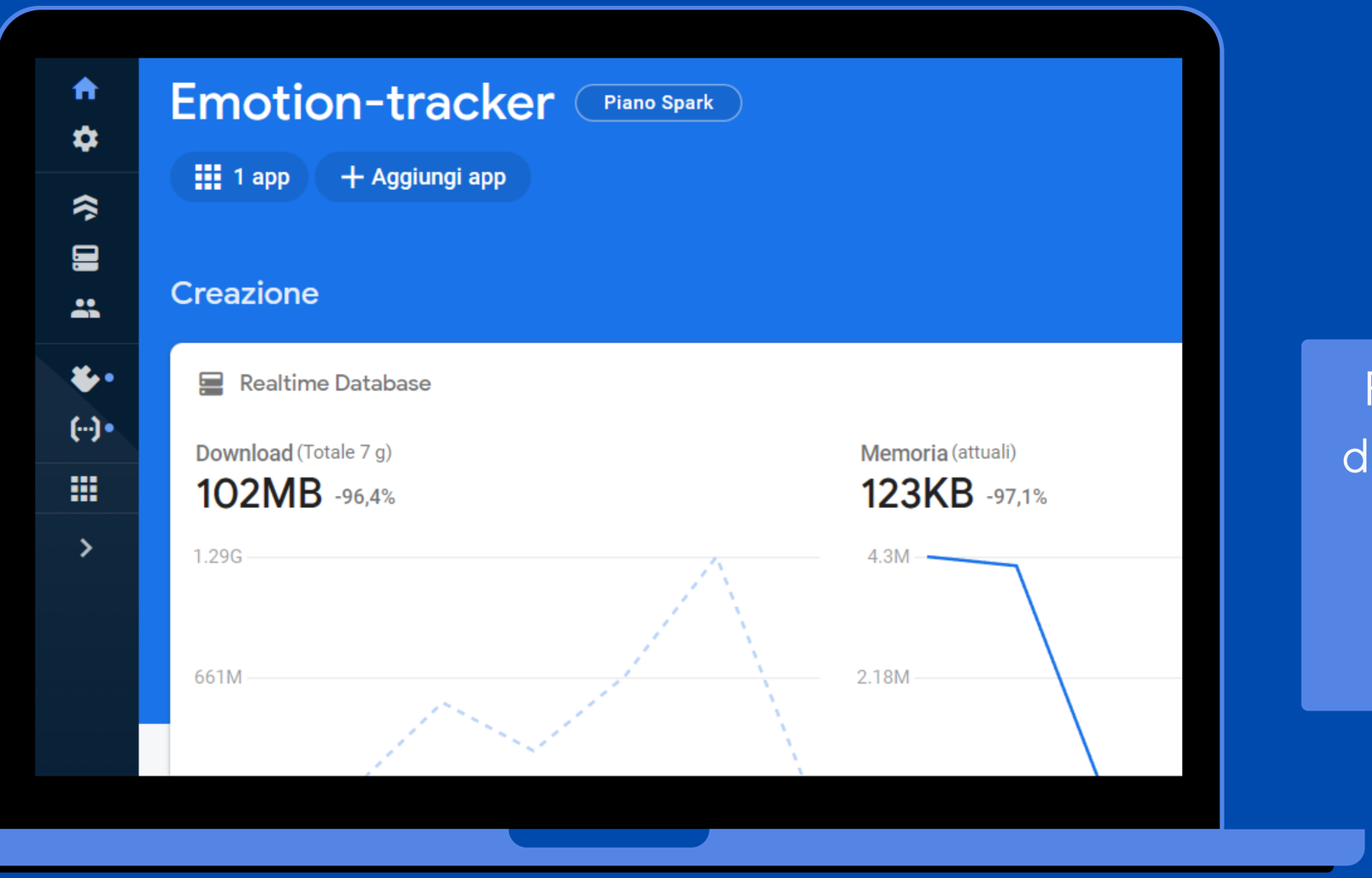
- We retrieve real world data, testing the app.
- We successfully uncovered clusters representing distinct areas within the city
- Even with a relatively small number of data points

DATABASE

Firebase Realtime Database



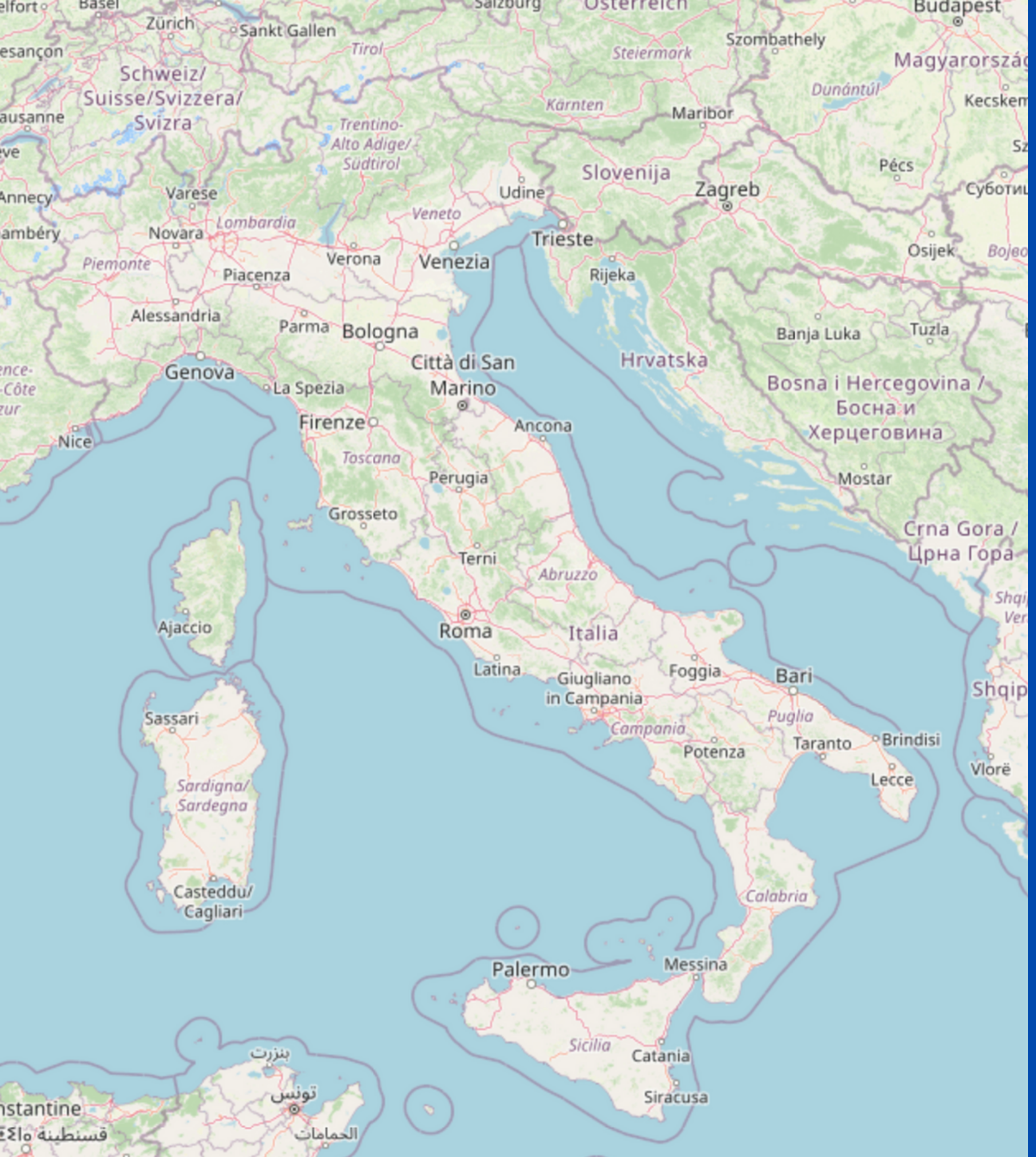




DATABASE

Firebase Realtime Database

Firebase Realtime Database is a database hosted in the cloud. The data is stored as JSON and synchronized in real time with each connected client



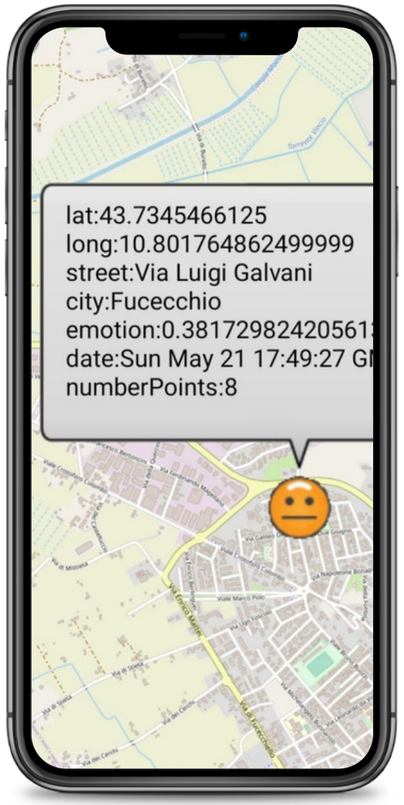
OPENSTREETMAP

OpenStreetMap is a free, editable map of the whole world that is being built by volunteers largely from scratch and released under an open-content license

SMARTPHONE'S GPS AND OSMDROID LIBRARY

Marker

GeoPoint



FIREBASE COLLECTION

Users

```
-NVOJkWkAD6lxpk2QdVW
    date_of_birth: "1999/10/10"
    password: "26ef33af3f99c756154f03b275c8ee4244ddd82cf0fb046dd84b7b9f0242e9fa"
    username: "fabio"
```

Users locations

```
position_emotion
    -NVV-9I5G4UwLFVNhqu6
        city: "San Giuliano Terme"
        emotion: 0.09200962697013892
        latitude: 43.714107
        longitude: 10.4960106
        street: "Via G. Toniolo"
        timestamp: 1684164091335
        username: "tess"
```

Clusters

```
clusters_matteo
    -NW-BizOweOKvRPNgn8W
        city: "San Giuliano Terme"
        emotion: 0.450482117240514
        latitude: 43.71410727631581
        longitude: 10.496014452631577
        numberOfPoints: 38
        street: "Via G. Toniolo"
        timestampDate: 1684483323683
```

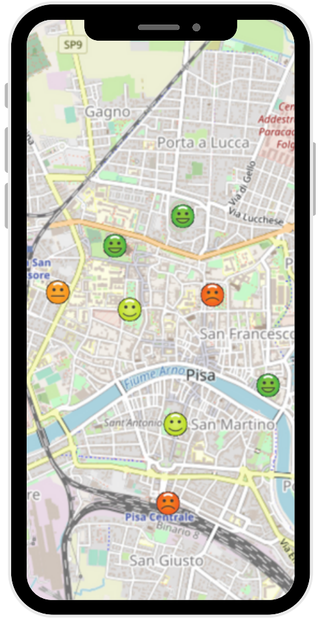
MAP-DB INTERACTION

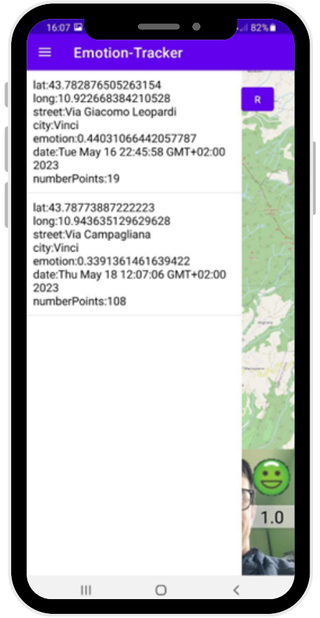
Clustering

Clusters

Query on Latitude and Longitude

Results





CONCLUSION

EMOTION RECOGNITION SYSTEM

In this work we presented a Binary CNN classifier that takes the pre-processed FER2013 dataset for creating a happiness map.

BINARY CLASSIFICATION PROBLEM

According to the CNN model we got a high accuracy on the test data showing that using a binary approach is a valuable option to analyze the happiness level.

FUTURE WORK

For the future we recommend using a multimodal approach to recognize facial emotions with the associated geographic locations.

QUESTION SESSION

If you have any questions, feel free to ask