

# AusCare for the Indigo child!



Scuola di Ingegneria | Dipartimento di  
Ingegneria "Enzo Ferrari"



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MODENA E REGGIO EMILIA

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# 1. The Project



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# Autism

a different perspective of the world!



1 case for every 86 children  
(in Europe)

€ 5 to 6 million

(Average cost of treatment for a person with autism in a lifetime)

(Source: [EU MICHELANGELO project](#))

# The prevalence of autism is increasing!

(Source: [EU MICHELANGELO project](#))

It's a spectrum!



“



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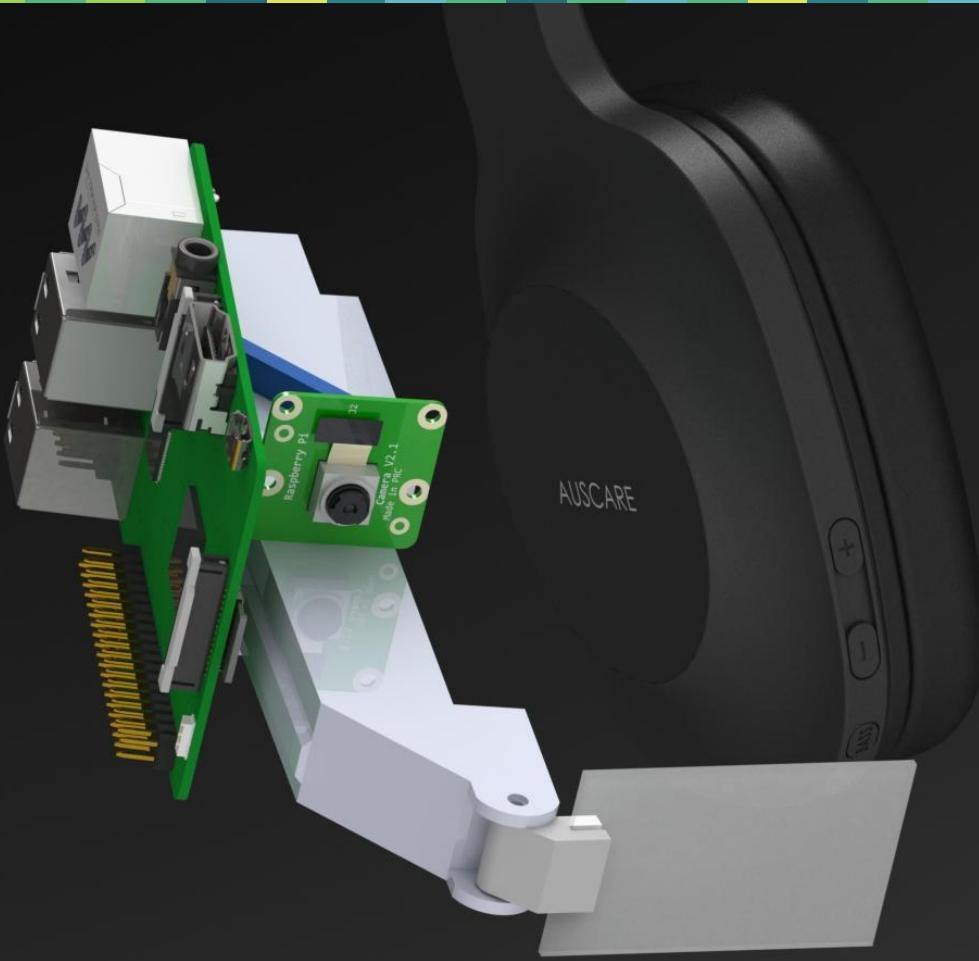
*We thought of making the therapy  
session more affordable and  
integrate smart analytics .....*

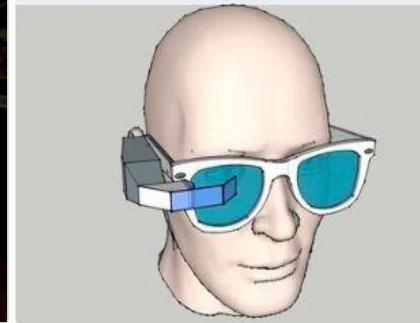
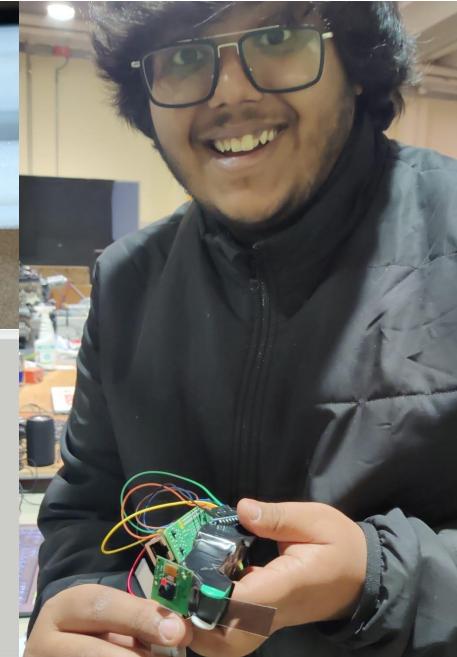
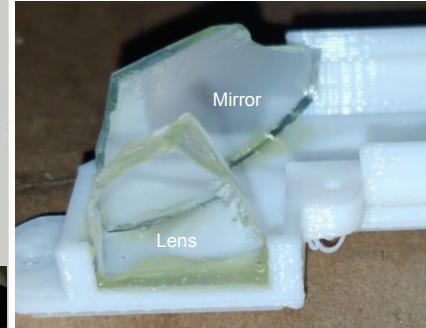
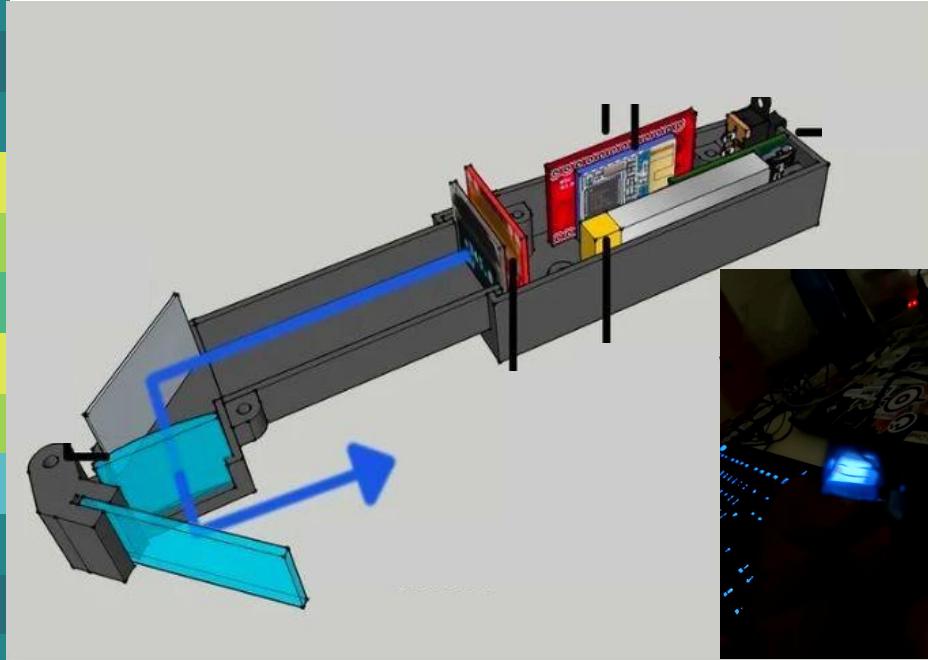
# AusCare

A raspberry pi based AR device to aid autistic children in therapy and enable their medical caretaker with a digital twin.

An assistive devices for the children on their therapeutic and training journey!

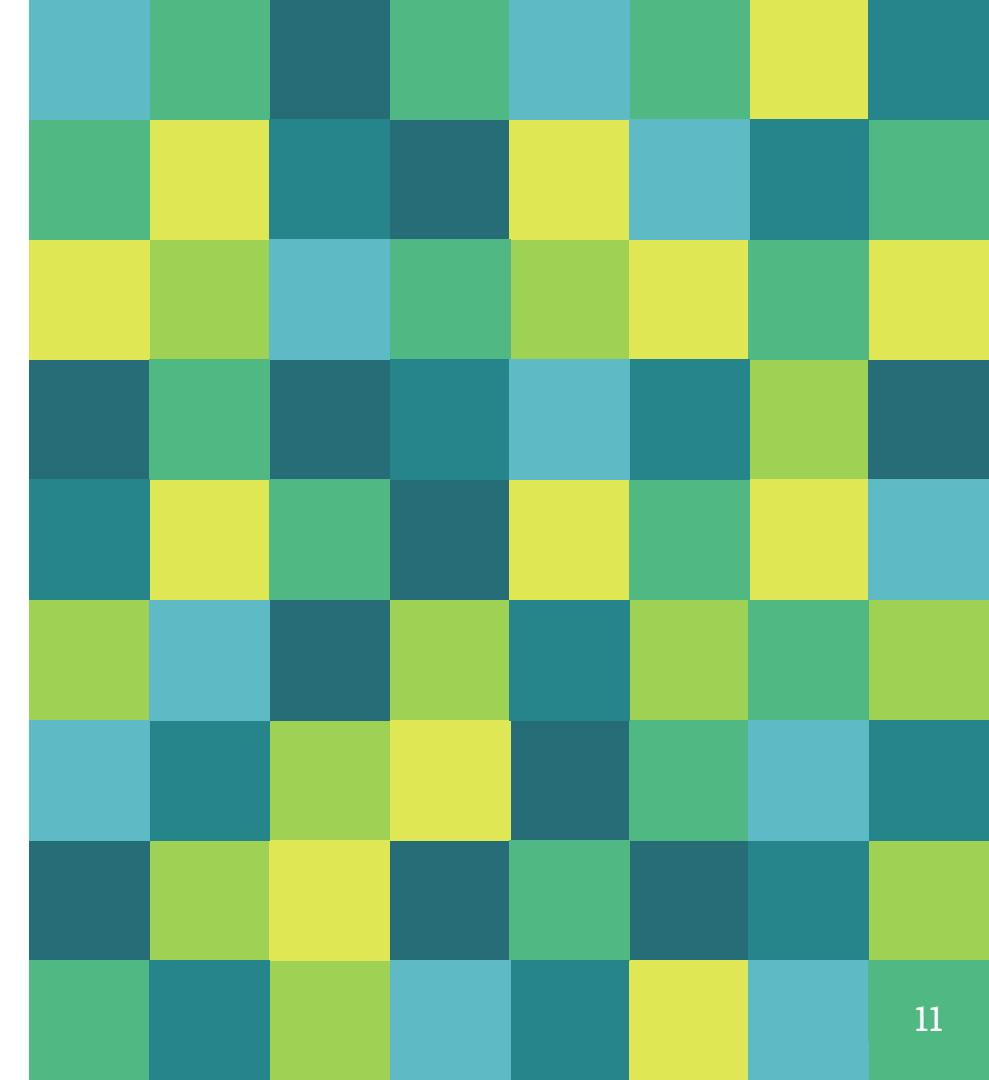






# 1.1.

## Emotion Recognition





Last login: Sat Feb 11 19:05:55 on ttys002

```
(base) miche@MacBook-Pro-2 ~ % cd /Users/miche/PycharmProjects/AusCare_IoT/
(base) miche@MacBook-Pro-2 AusCare_IoT % python3 /Users/miche/PycharmProjects/AusCare_IoT/experiments/emotion-detector-deployed/emotion_detect.py
{'request_id': '1676139116,8a250aee-9f55-4df0-ae7f-ea86bd0e867c', 'time_used': 111, 'faces': [{'face_token': 'd459fc0092192cccb94a482172381870', 'face_rectangle': {'top': 137, 'left': 56, 'width': 95, 'height': 95}, 'attributes': {'emotion': {'anger': 26.847, 'disgust': 0.107, 'fear': 47.019, 'happiness': 0.017, 'neutral': 25.95, 'sadness': 0.041, 'surprise': 0.019}}}], 'image_id': '5ThkSTd/BxbIHsrwzp0hDQ==', 'face_num': 1}
timestamp: 2023-02-11 19:11:56.961886, Emotion: fear, Emoji: 😰, FaceID: d459fc0092192cccb94a482172381870
^CStopping...
```

Ended.

Time of execution: 0.013 s



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Activities Google Chrome ▾ Feb 8 18:58

41a5-151-34-214-66.eu.ngrok.io/emore

Homepage Emotion Recognition Activities Metrics Settings Logout

Update 3

## AusCare

### Emotion Recognition

Start / Stop (Emotion Detector)



data UNIMORE Term\_1 IoT AusCare-IoT-UniMoRe website static emojis ▾

anger.png



disgust.png



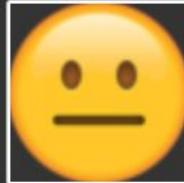
fear.png



happiness.png



neutral.png



sadness.png



surprise.png



Activities Google Chrome ▾ Feb 8 18:59

IoT Project Course Pl StampaC growupb Getting (4) What AusCare AusCare Home-b AusCare Groups a Activities + - Update

Homepage Emotion Recognition Activities Metrics Settings Logout

# AusCare

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## User Activities

Timestamp	Photo	Emotion	Emoji	People Encountered
2023-02-08 18:58:08.244594		happiness	😊	23
2023-02-08 18:58:00.339049		happiness	😊	22
2023-02-08 18:57:52.086010		disgust	呕	21
2023-02-08 18:57:43.580498		disgust	呕	20
2023-02-08 18:57:35.526726		neutral	😐	19
2023-02-08 18:57:27.306232		happiness	😊	18
2023-02-08 11:03:17.602251		happiness	😊	17
2023-02-08 11:02:57.662695		disgust	呕	16

Activities Google Chrome ▾

Feb 8 18:59

IoT Project Course Pl StampaC growupb Getting (4) What AusCare AusCare Home-b AusCare Groups a Metrics + - Update

Homepage Emotion Recognition Activities Metrics Settings Logout



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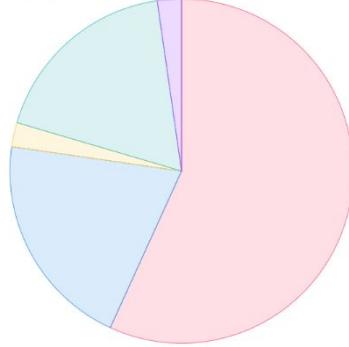
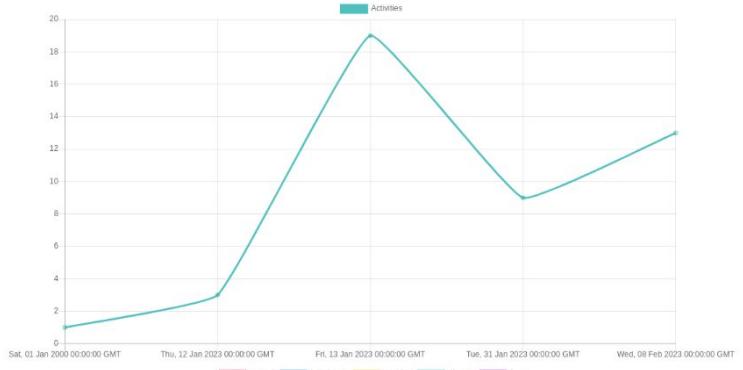
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## AusCare

### Metrics for Shankho Boron Ghosh



# Collaboration with Medical Professionals

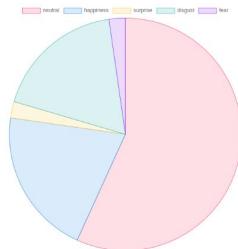
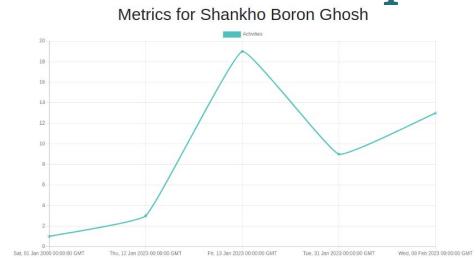
The proposed device is just a mere tool. To enhance it even better, we will collaborate with various field experts to enhance the experience even further.





# Data Analysis (digital twin)

The digital twin data is a time series data. Medical professionals can track and personalize the focus of treatment and obtain quantitative metrics of the effects.



Eventually with enough data points, it is possible to use AI techniques (like LSTM) which infers treatment methods and tracks for the enhanced learning.



# Financial Incentive

Average therapy session for autism costs around € 50-100.

whereas

Our prototype is under € 250 (one time cost) which can be decreased even further once into production!

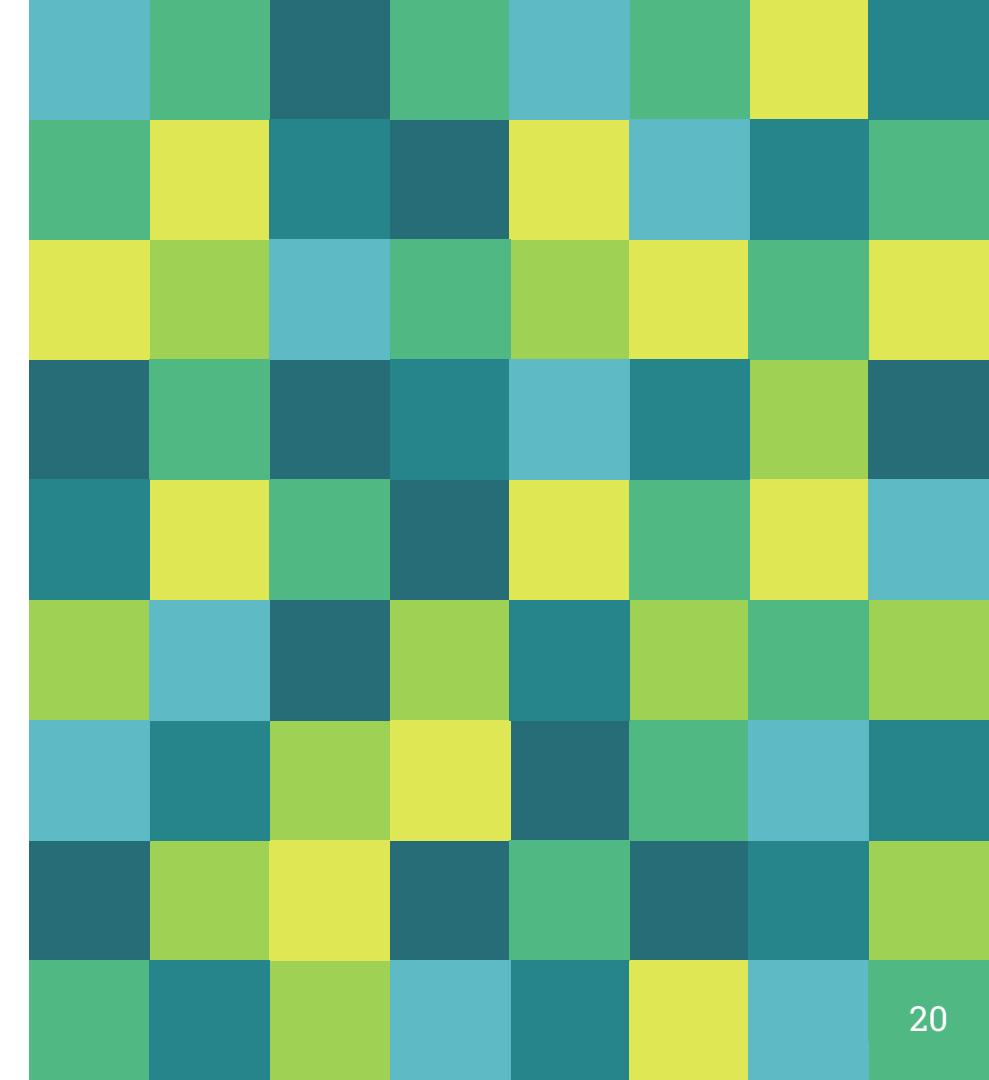
This will also make **online therapy** possible for children on the spectrum!

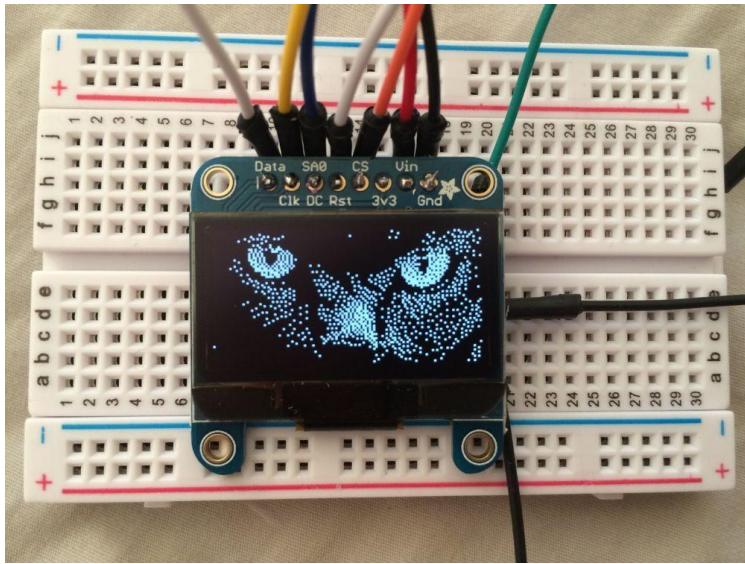
# Future Prospects

# 1.2.

(future prospects)

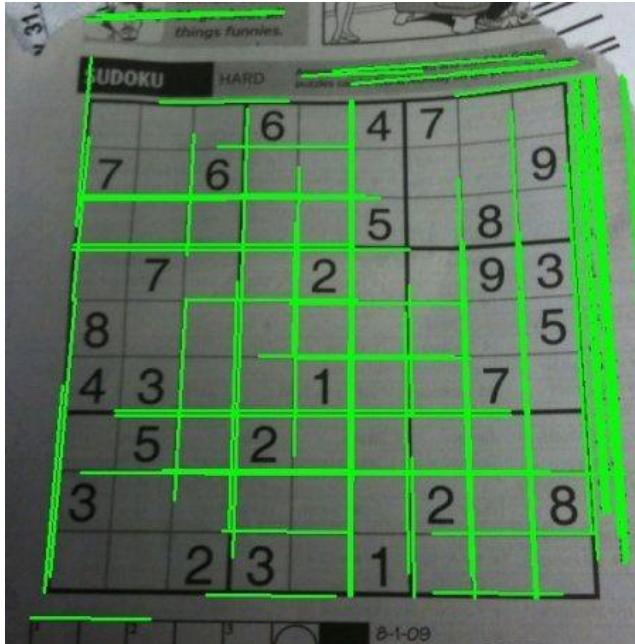
## Stencil practice





**A B C D E F G**  
**H I J K L M N**  
**O P Q R S T U**  
**V W X Y Z**

# Attention Tracking for optimal training



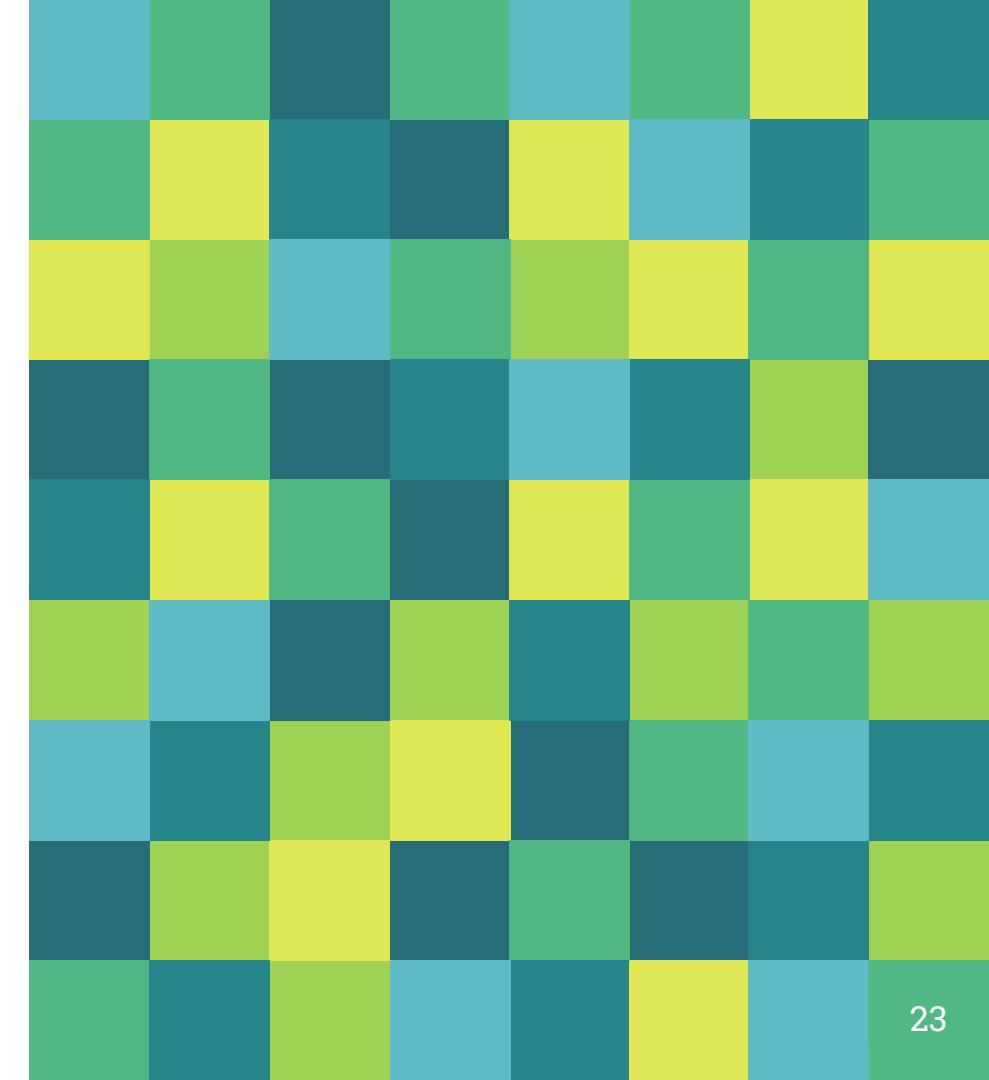
Hough's Transform

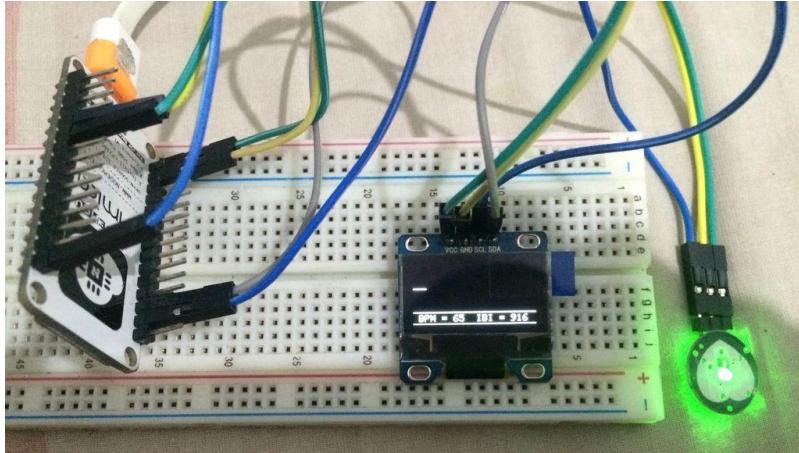
```
[  
 {  
   "session": "writing",  
   "time": 120,  
   "heartrate": [],  
   "Attention%": 57  
 },  
 {  
   "session": "drawing",  
   "time": 45,  
   "heartrate": [],  
   "Attention%": 45  
 },  
 {  
   "session": "playing",  
   "time": 67,  
   "heartrate": [],  
   "Attention%": 53  
 }]
```

# 1.3.

(future prospects)

## Binaural beats (via panic tracking)



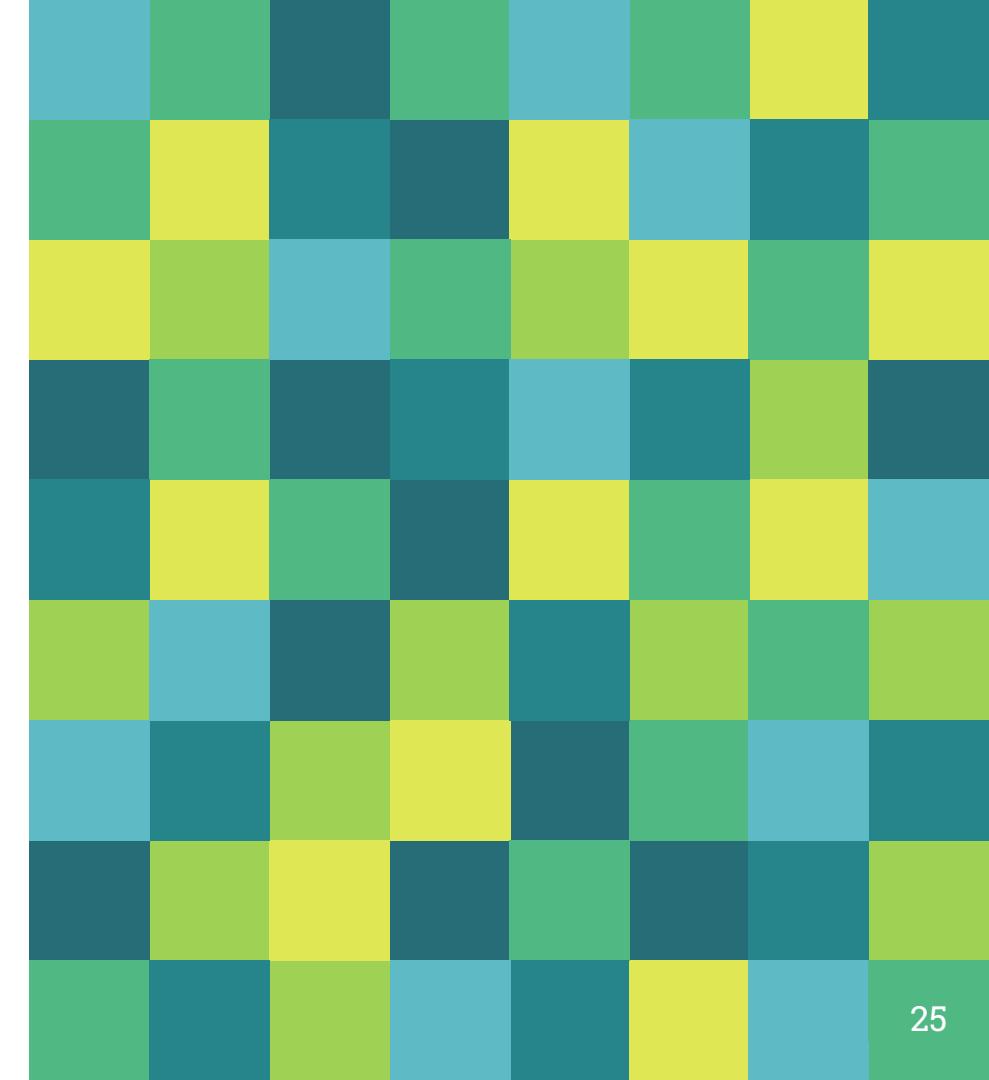


GET /emotirecog/start	200 OK
GET /training/Abc/stop	200 OK
GET /training/Abc/stop	200 OK
GET /training/Abc/start	200 OK
GET /beats/stop	200 OK
GET /beats/start	200 OK
GET /beats/start	200 OK
GET /emotirecog/start	200 OK
GET /play/start	200 OK
GET /beats/stop	200 OK

# 1.4.

(future prospects)

# Educational Training





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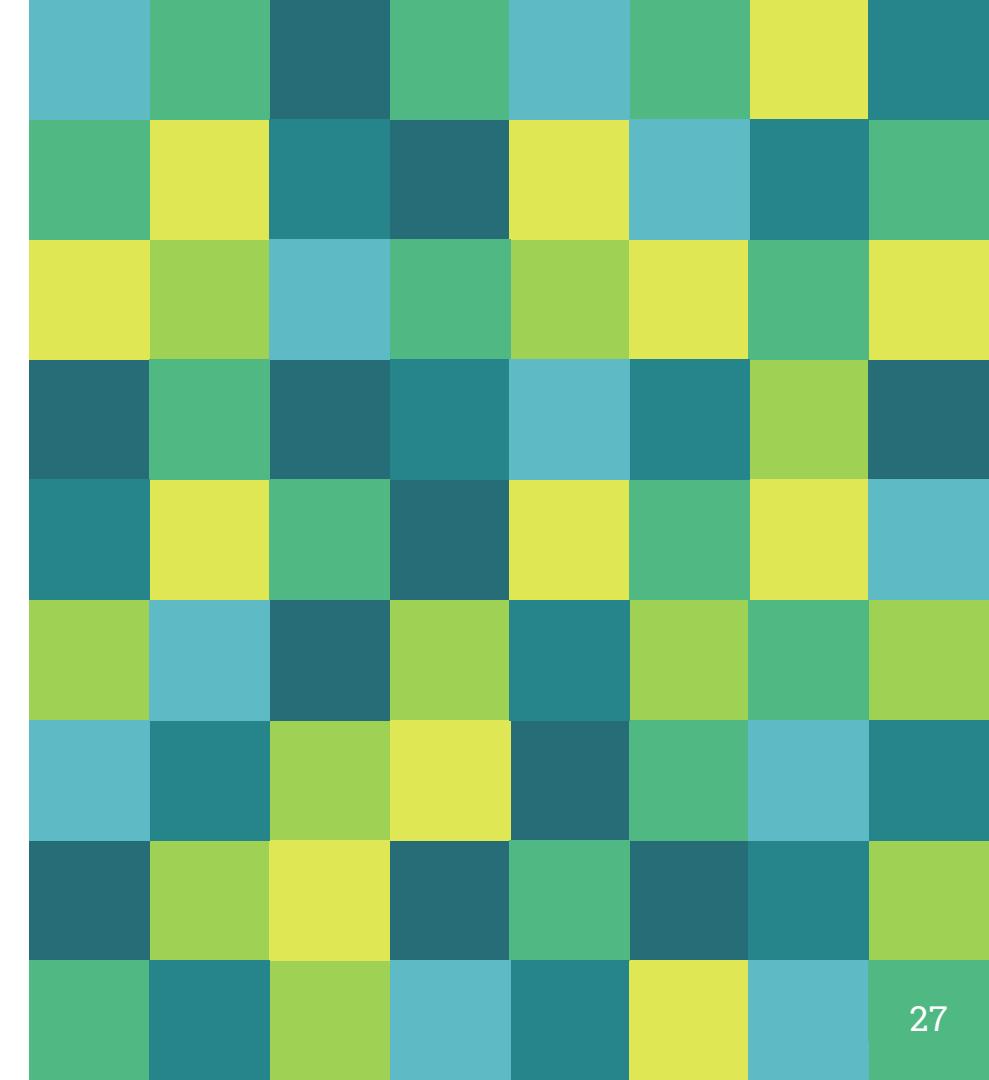
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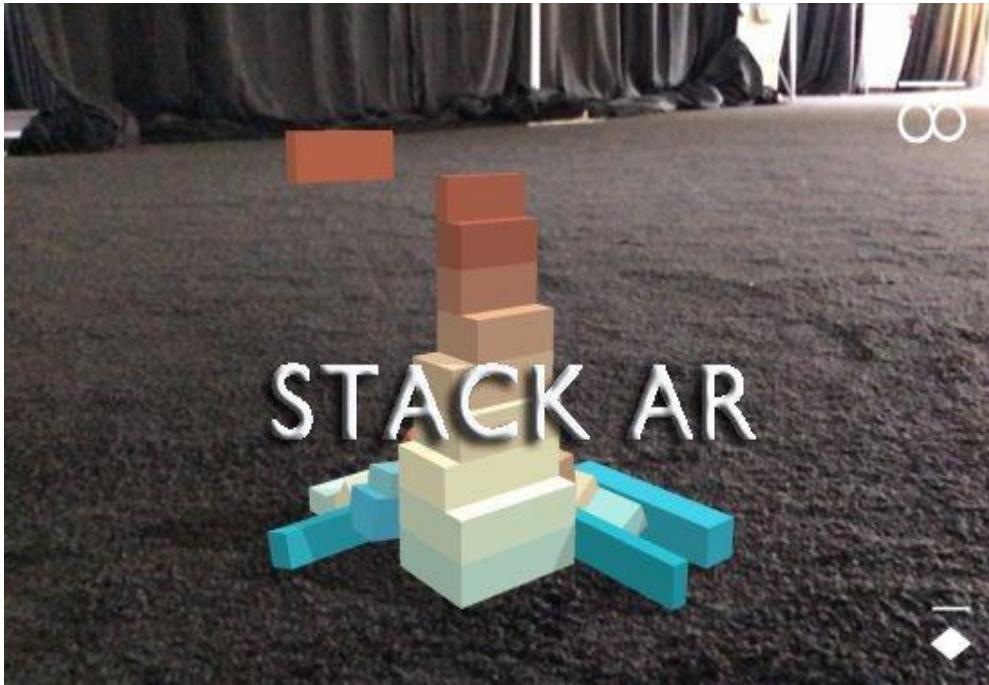
# 1.5.

(future prospects)

## AR Games



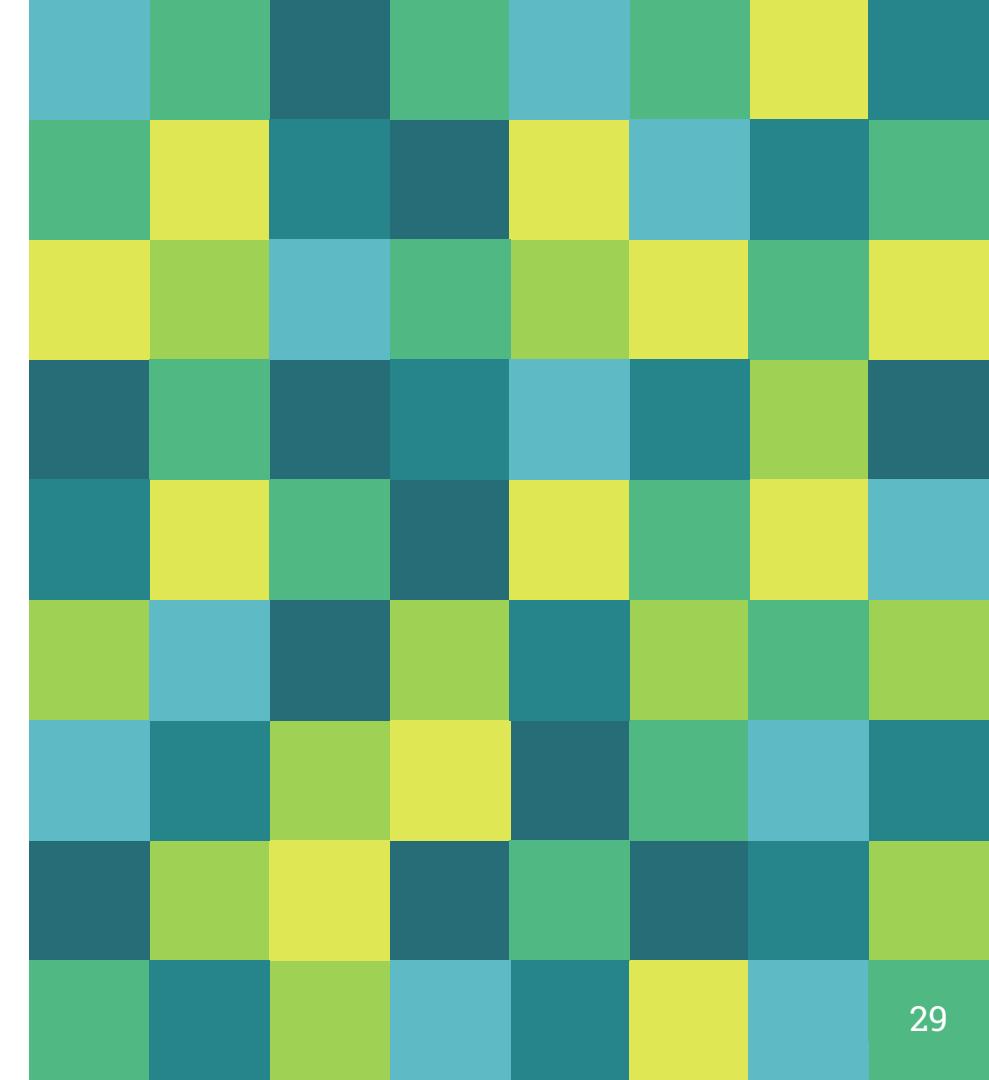
Development of simple AR basic games, to aid and increase the understanding of complex tasks!



# 1.6.

(future prospects)

## Non invasive EEG addition



Non invasive EEG device/headset can be easily added to analyse the brain patterns and suggest for better and enhanced learning tracks.



# The PoC and future on the spectrum!



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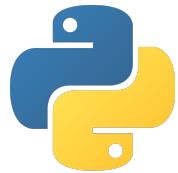
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# 2. Architecture

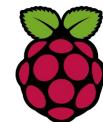
(of the prototype)

# Technology Stack

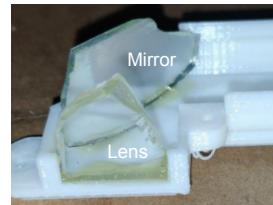
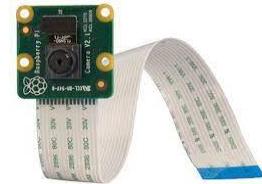
## SOFTWARE



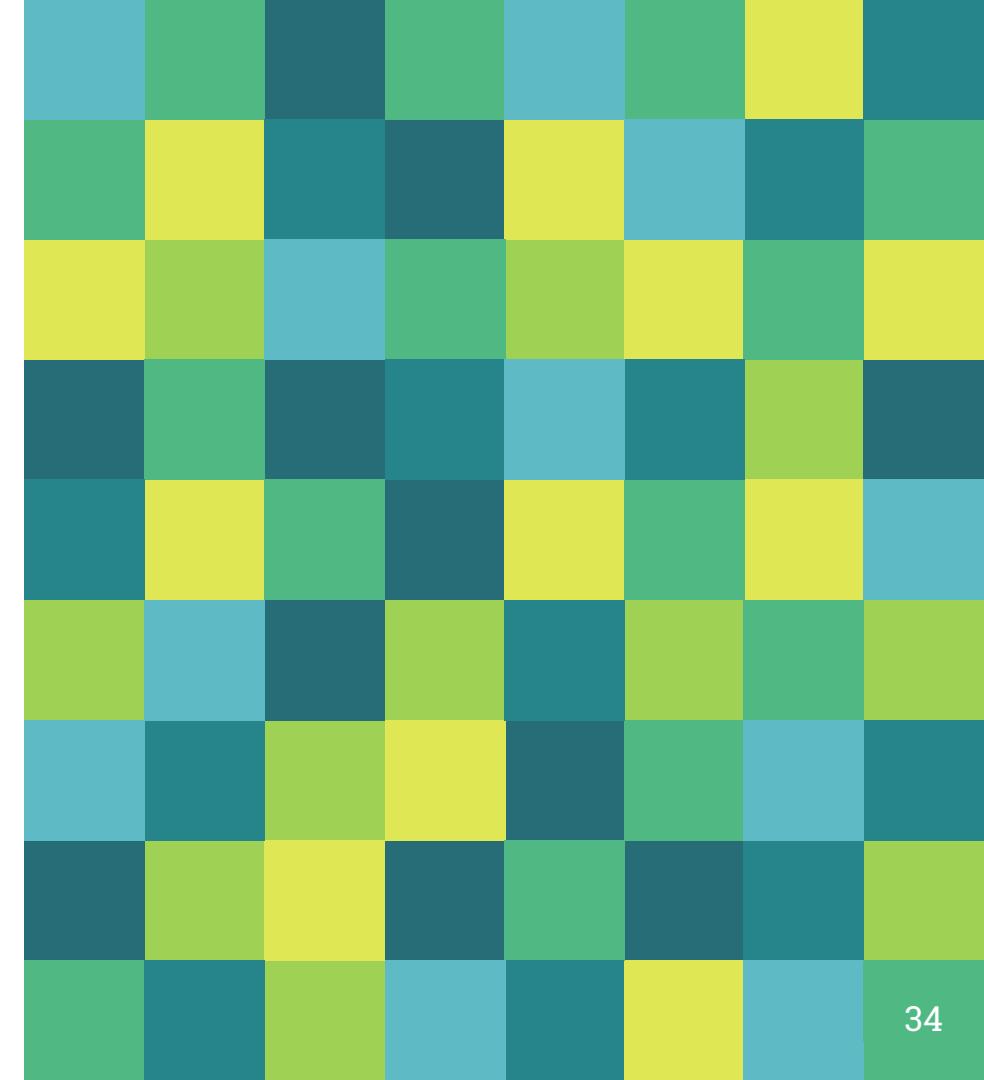
## HARDWARE

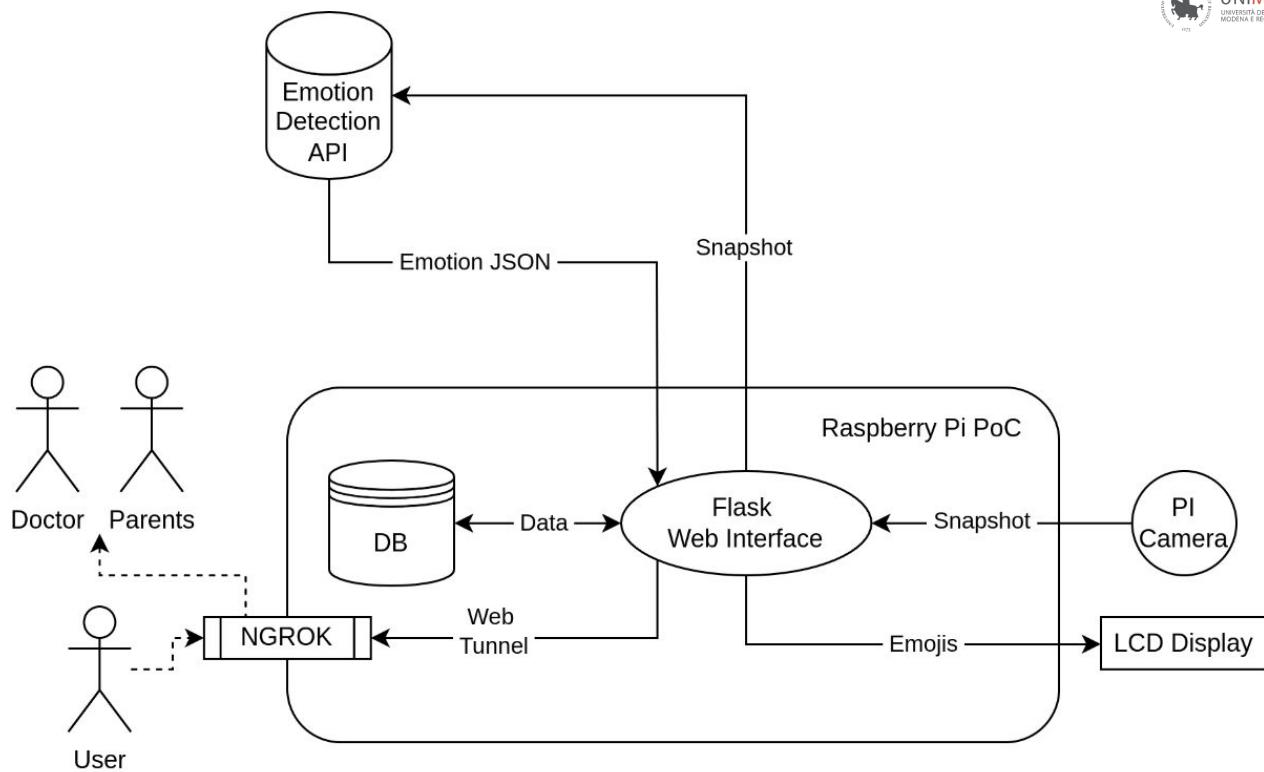


Raspberry Pi



# Proof of Concept (Prototype)

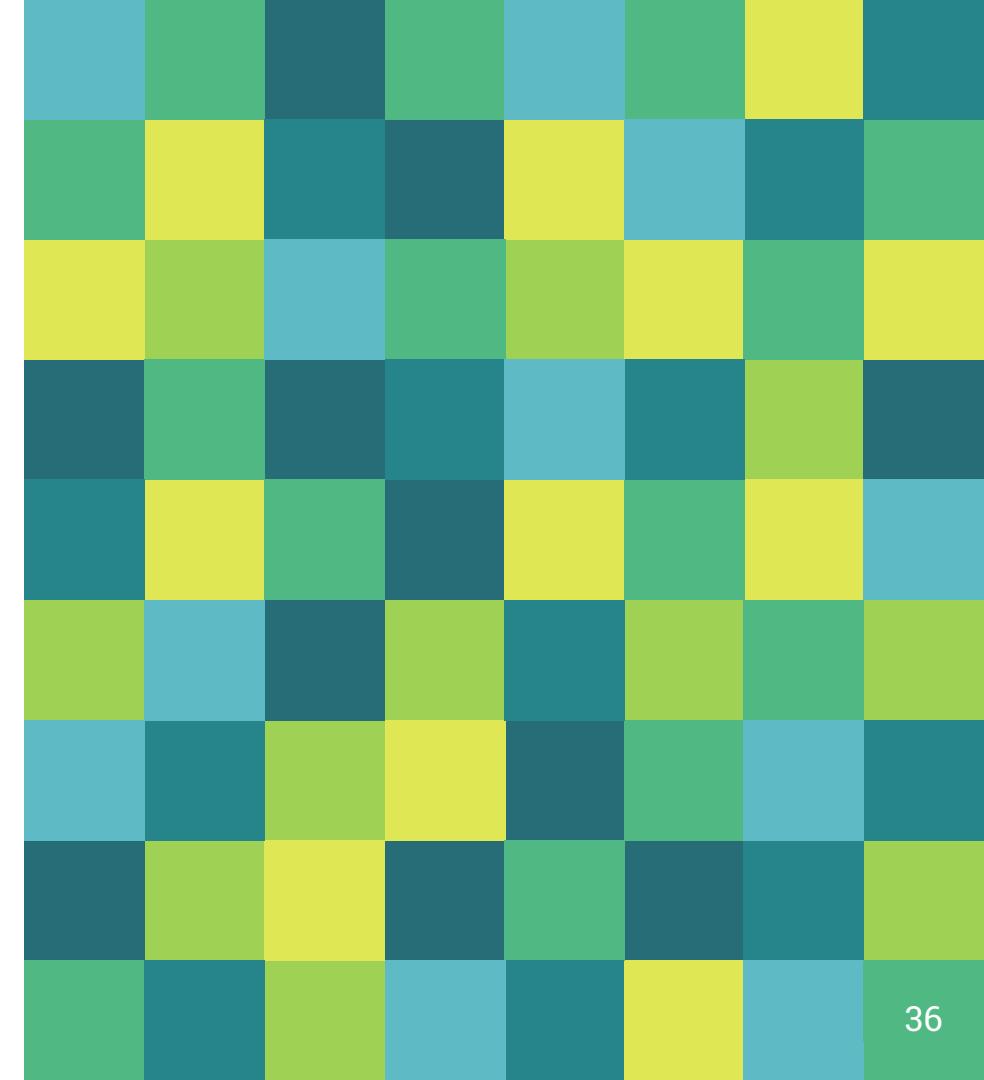


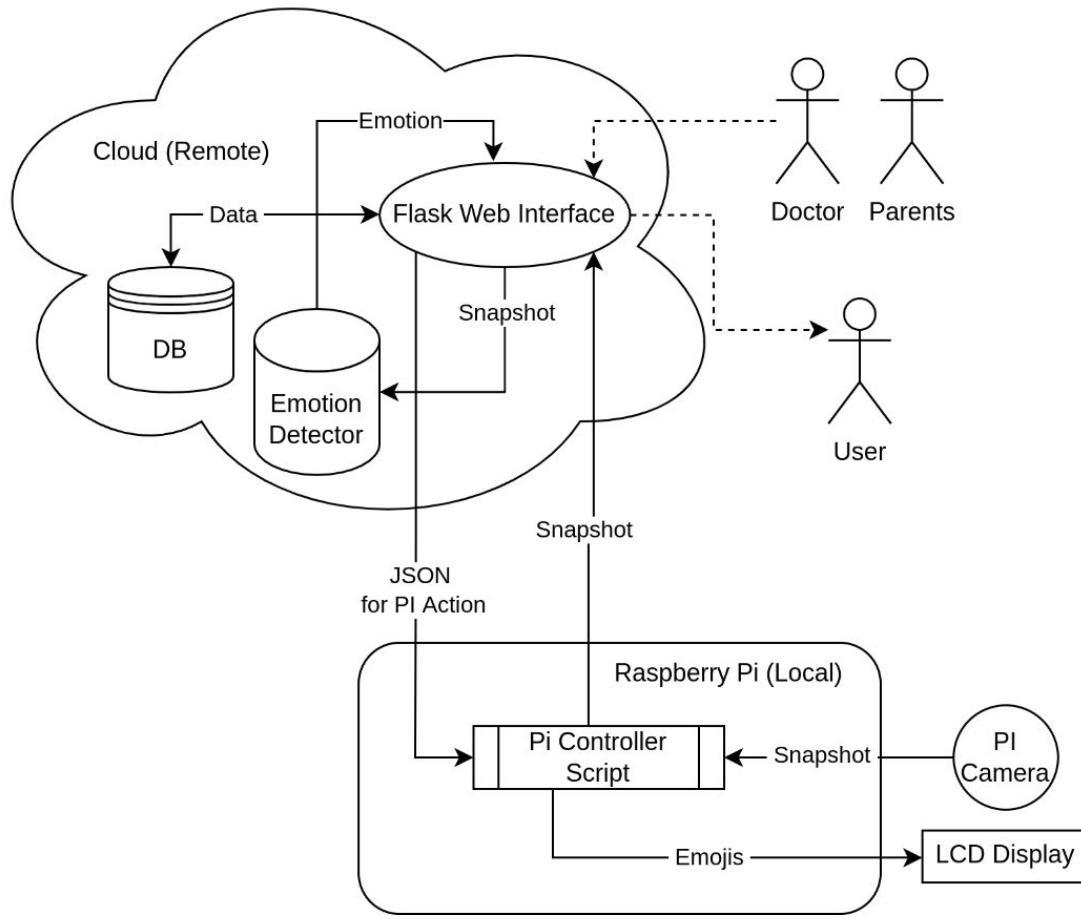


The diagram shows the architecture we designed for the proof of concept of the AusCare device.

For the today's demo, most of the software and hardware components of the system are integrated in the Raspberry Pi.

# Scalable Solution (Product)





The scalable version would be decoupling our system and moving some of the components to the cloud.

The most appropriate changes would concern the emotion recognition mechanism, the web interface and the database.



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# 3. Implementation

(of the prototype)

# Repository

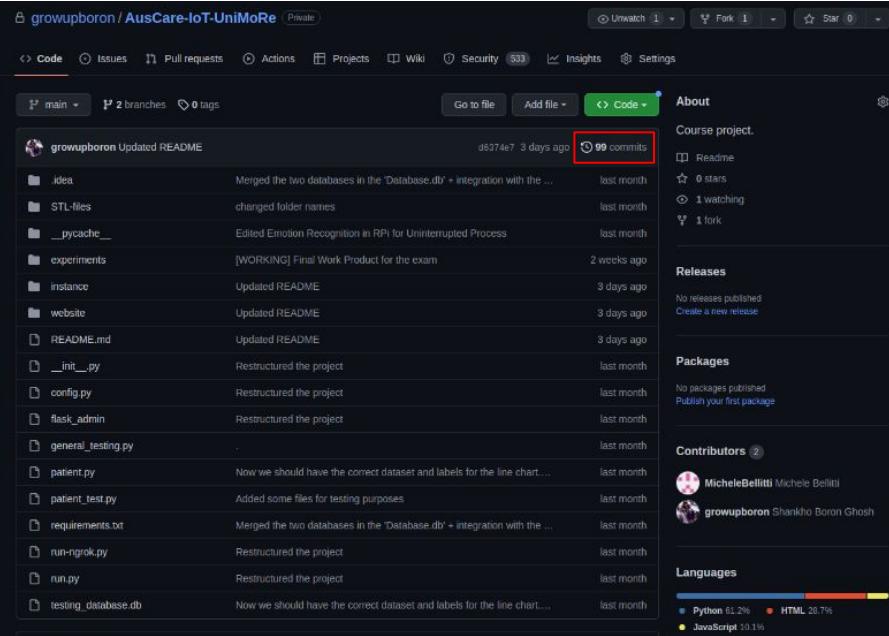
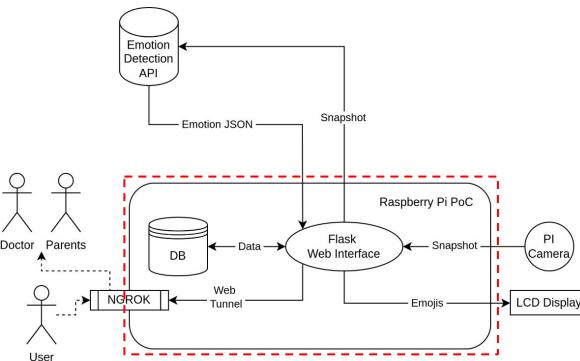
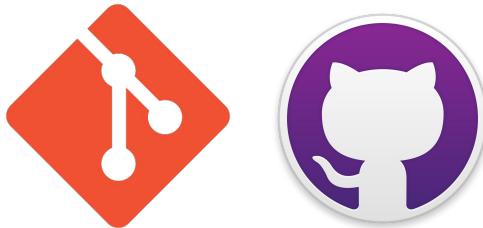
Auscare-IoT-UniMoRe (<https://github.com/growupboron/AusCare-IoT-UniMoRe>)

```

experiments
  - Azure_API
  - Emotion-Detection-TF
  - emotion-detector-deployed
  - face++_API
  - Face-Info

STL-files

instance
  - database.db
  - requirements.txt
  - run-ngrk.py
  - run.py
  - website
    - auth.py
    - config.py
    - emotion_detect.py
    - __init__.py
    - models.py
    - patient.py
    - static
      - emojis
      - images
    - templates
      - Activities.html
      - base.html
      - dashboard.html
      - Emorec.html
      - Evaluate.html
      - home.html
      - login.html
      - Metrics.html
      - Settings.html
      - sign_up.html
    - views.py
  
```

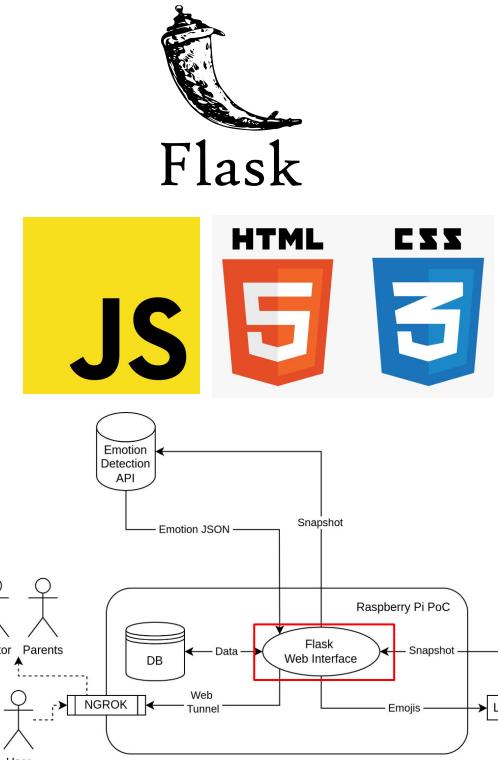



# Web Interface (Flask)

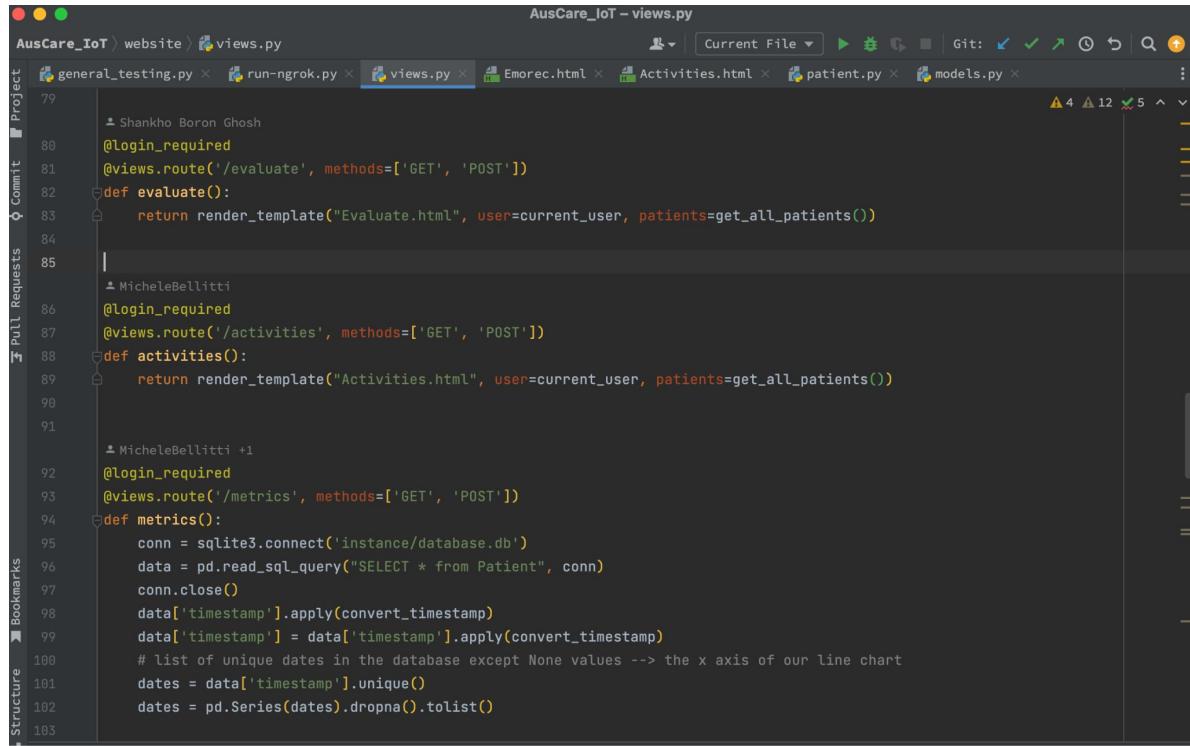
Flask is a micro web framework for the python language.

We used Flask to develop the **backend** of our web interface. The core of it is a script (*views.py*) which defines the different **routes** our website will have.

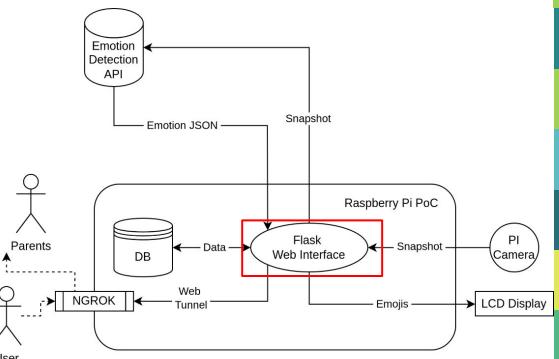
For the **frontend**, we use a mix of HTML (CSS) and JavaScript components.



# Web Interface (Flask)



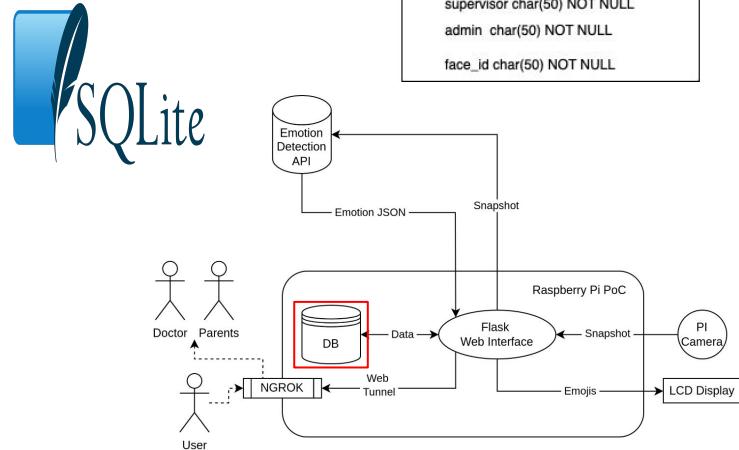
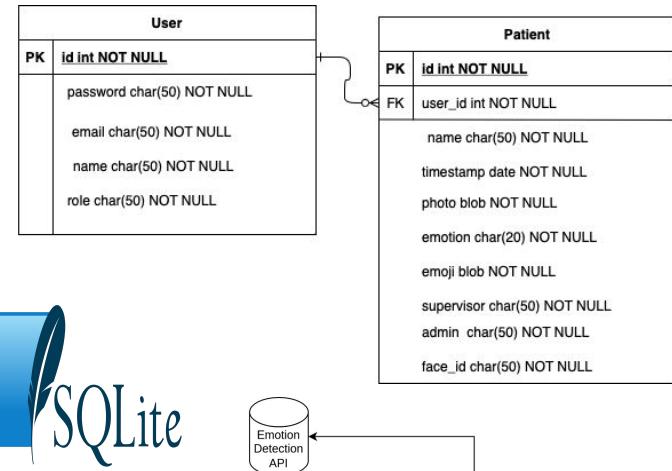
```
AusCare_IoT > website > views.py
AusCare_IoT > website > general_testing.py > run_ngrok.py > views.py > Emorec.html > Activities.html > patient.py > models.py > ...
79
80     @Shankho Boron Ghosh
81     @login_required
82     @views.route('/evaluate', methods=['GET', 'POST'])
83     def evaluate():
84         return render_template("Evaluate.html", user=current_user, patients=get_all_patients())
85
86     @MicheleBellitti
87     @login_required
88     @views.route('/activities', methods=['GET', 'POST'])
89     def activities():
90         return render_template("Activities.html", user=current_user, patients=get_all_patients())
91
92     @MicheleBellitti +1
93     @login_required
94     @views.route('/metrics', methods=['GET', 'POST'])
95     def metrics():
96         conn = sqlite3.connect('instance/database.db')
97         data = pd.read_sql_query("SELECT * from Patient", conn)
98         conn.close()
99         data['timestamp'].apply(convert_timestamp)
100        data['timestamp'] = data['timestamp'].apply(convert_timestamp)
101        # list of unique dates in the database except None values --> the x axis of our line chart
102        dates = data['timestamp'].unique()
103        dates = pd.Series(dates).dropna().tolist()
```



# Database (SQLite)

We make use of a **SQLite** database to store and retrieve informations about **patients** and **users** of the web interface.

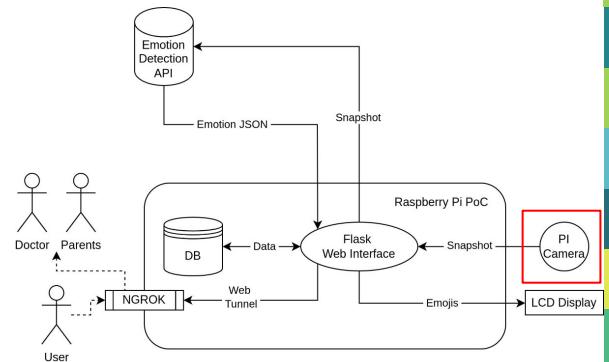
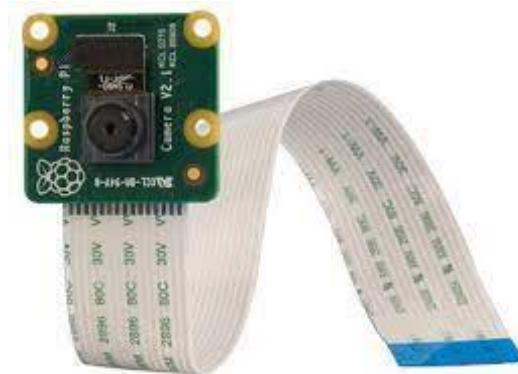
We use **SQLAlchemy** to access the database in Python.



# Pi Camera

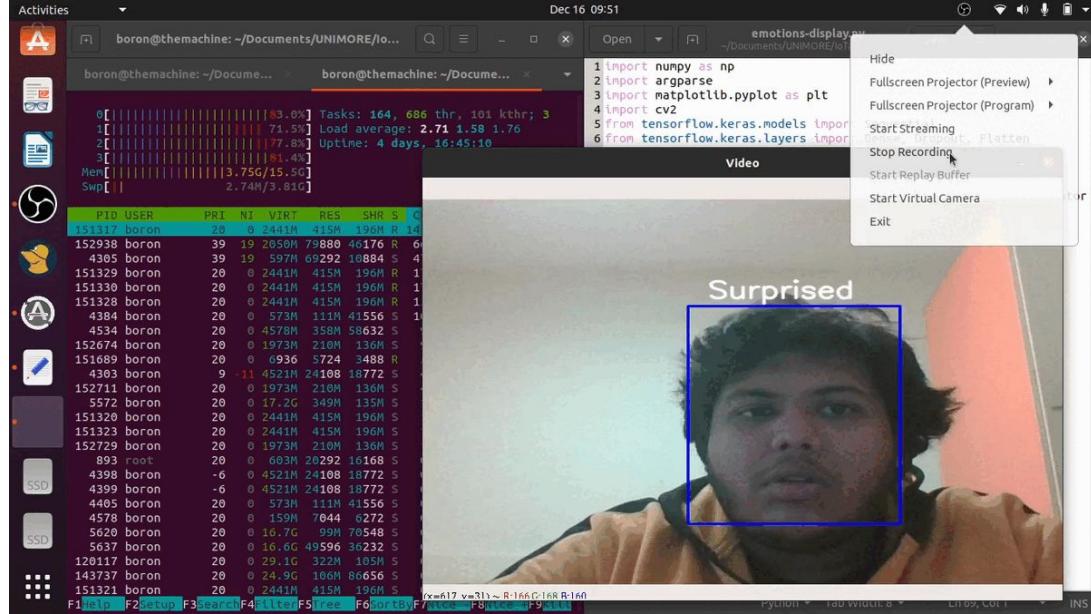
The picamera python library is used to capture snapshots, the orientation and capture resolution of the camera is also defined here.

```
website > emotion_detect.py > {} base64
27
28 def take_photo():
29     # take a photo with the camera
30     camera = PiCamera()
31     camera.vflip = True # vertically flipping image as PiCam is mounted invertly
32     camera.resolution = (640, 480) # need a well lit room
33     #camera.start_preview()
34     time.sleep(1)
35     camera.capture('website/static/images/face.jpeg')
36     #camera.stop_preview()
37     camera.close()
38
```



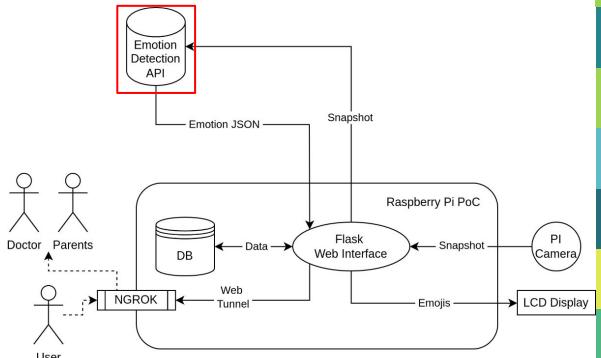
# Emotion detection

We initially experimented with onboard face detection, but decided not to proceed.



pandas NumPy Keras

Matplotlib OpenCV TensorFlow

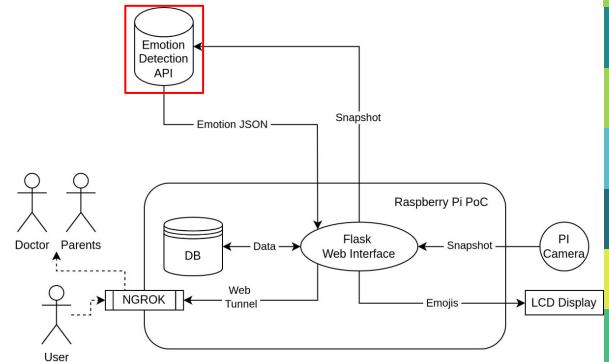
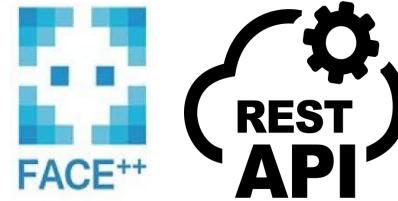


# Emotion detection

We decided to implement the emotion detector using an API service called **Face++**.

Face++, a product of MEGVII, is one of the world's largest computer vision platforms.

Captured snapshots are sent from the Pi Camera and correspondingly JSON is received, which on parsing provides functionality to our code.



# Emotion detection

Here's a sample output of a response call to the Face++ API:

```
Last login: Sat Feb 11 19:05:55 on ttys002
(base) miche@MacBook-Pro-2 ~ % cd /Users/miche/PycharmProjects/AusCare_IoT/
(base) miche@MacBook-Pro-2 AusCare_IoT % python3 /Users/miche/PycharmProjects/AusCare_IoT/experiments/emotion-detector-deployed/emotion_detect.py
{"request_id": "1676139116_8a250aee-9f55-4df0-ae7f-ea86bd0e867c", "time_used": 111, "faces": [{"face_token": "d459fc0092192cccb94a482172381870", "face_rectangle": {"top": 137, "left": 56, "width": 95, "height": 95}, "attributes": {"emotion": {"anger": 26.847, "disgust": 0.107, "fear": 47.019, "happiness": 0.017, "neutral": 25.95, "sadness": 0.041, "surprise": 0.019}}}], "image_id": "5ThkSTd/BxbIHsrwzp0hDQ==", "face_num": 1}
timestamp: 2023-02-11 19:11:56.961886, Emotion: fear, Emoji: 😰, FaceID: d459fc0092192cccb94a482172381870
^CStopping...

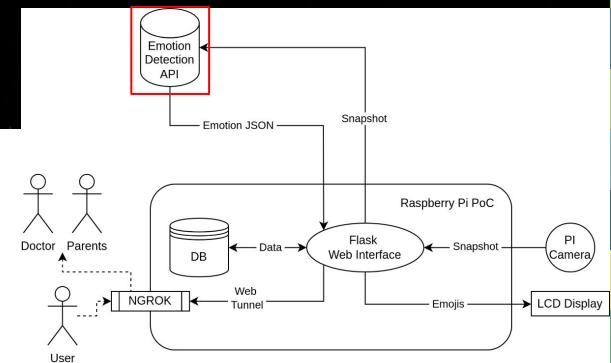
Ended.
Time of execution: 0.013 s
```

After parsing, the emotion with the highest confidence score is selected.



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1923

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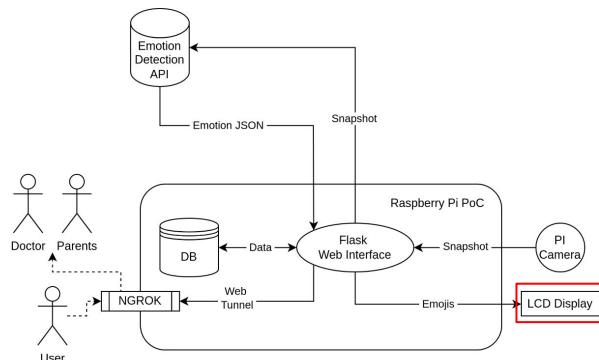


# Display

```
website > patient.py > {} datetime
77
78     def mapper(self, emotion):
79         self.people_counter += 1
80         timestamp = datetime.datetime.now()
81         emoji = ''
82         # driver code for st7735 display
83         disp = ST7735.ST7735(port=0, cs=0, dc=24, backlight=None, rst=25, width=80, height=160, rotation=90, invert=True) # Comment if not
84         #on RPi
85         WIDTH = disp.width      # Comment if not on RPi
86         HEIGHT = disp.height    # Comment if not on RPi
87
88         if emotion == "happiness":
89             emoji = '😊'
90             img = Image.open("website/static/emojis/happiness.png")
91         elif emotion == "sadness":
92             emoji = '😢'
93             img = Image.open("website/static/emojis/sadness.png")
94         elif emotion == "anger":
95             emoji = '😡'
96             img = Image.open("website/static/emojis/anger.png")
97         elif emotion == "surprise":
98             emoji = '😮'
99             img = Image.open("website/static/emojis/surprise.png")
100        elif emotion == "disgust":
101            emoji = '🤢'
102            img = Image.open("website/static/emojis/disgust.png")
103        elif emotion == "fear":
104            emoji = '😱'
105            img = Image.open("website/static/emojis/fear.png")
106        elif emotion == "neutral":
107            emoji = '😐'
108            img = Image.open("website/static/emojis/neutral.png")
109
110        img = img.resize((WIDTH, HEIGHT)) # Comment if not on RPi
111        #img.show()
112        disp.display(img) # Comment if not on RPi
113        img.save("website/static/images/lastemotion.png")
114        #self.update(emotion, timestamp)
115        time.sleep(1)
116        #img.close()
117        img = Image.open("website/static/emojis/off.png")
118        disp.display(img)      # Comment if not on RPi
119
120        return timestamp, emoji
```



Once the IPS display (0.96", 80×160, ST7735) is connected.  
It communicates with RPi through I2C protocol using the ST7735 python library.



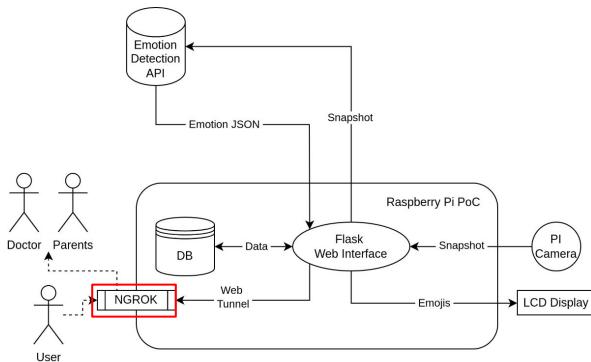
# ngrok



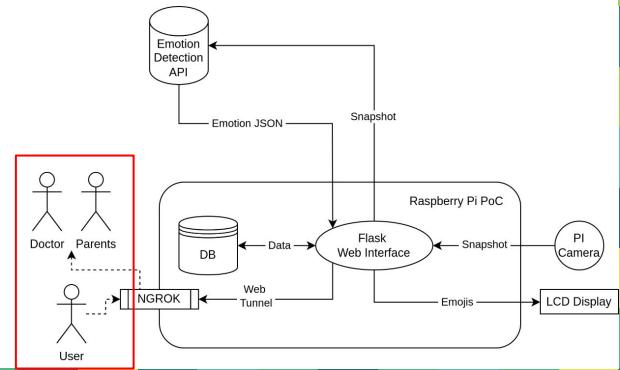
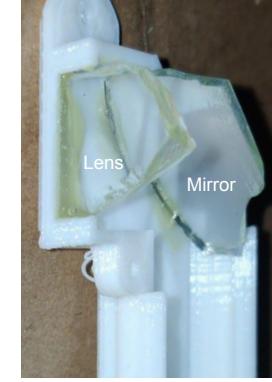
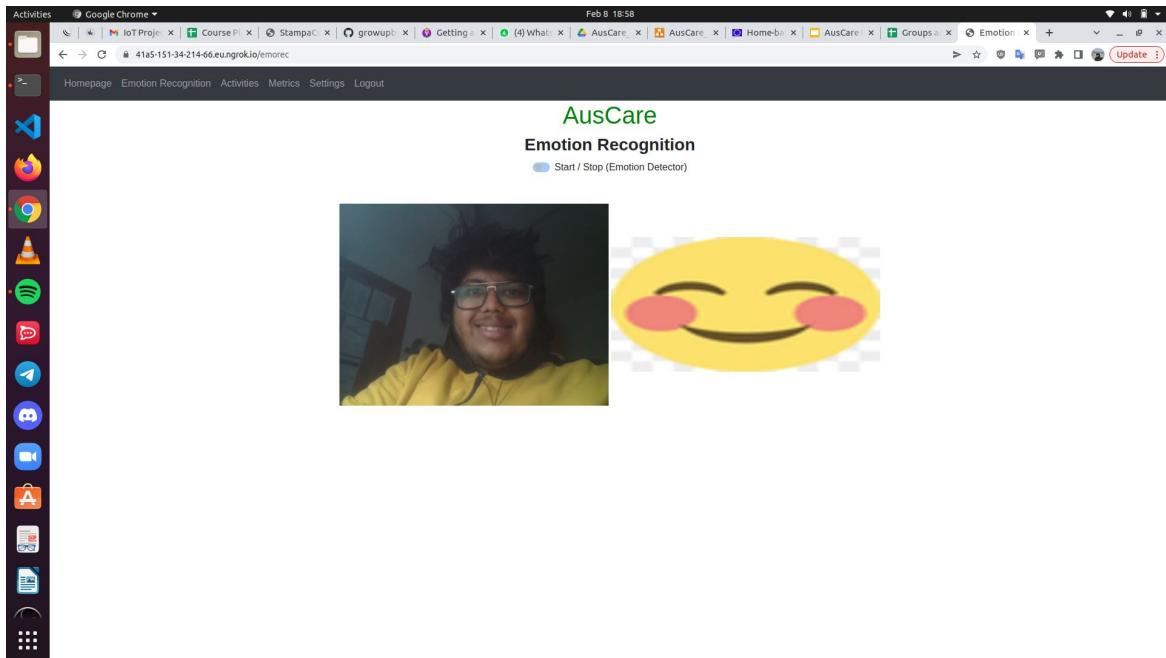
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```
run-ngrok.py > ...
1   from website import create_app
2   from flask_ngrok2 import run_with_ngrok
3
4   app = create_app()
5   run_with_ngrok(app)
6
7   print(__name__)
8
9   if __name__ == '__main__':
10      app.run(debug=True, port=5000)
```

```
ngrok
Join us in the ngrok community @ https://ngrok.com/slack
Session Status      online
Account            Shankho Boron Ghosh (Plan: Free)
Version             3.1.0
Region              Europe (eu)
Latency
Web Interface      http://127.0.0.1:4040
Forwarding          [https://23564-5-144-189-173.eu.ngrok.io] -> http://localhost:5000
```



# Output (Emotion)



# Output (Activities)

Google Chrome ▾

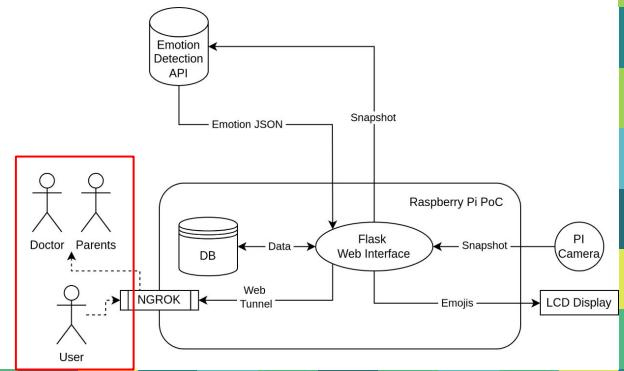
41a5-151-34-214-66.eu.ngrok.io/activities

Homepage Emotion Recognition Activities Metrics Settings Logout

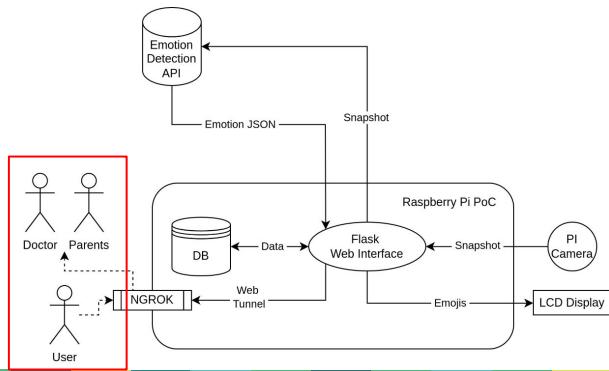
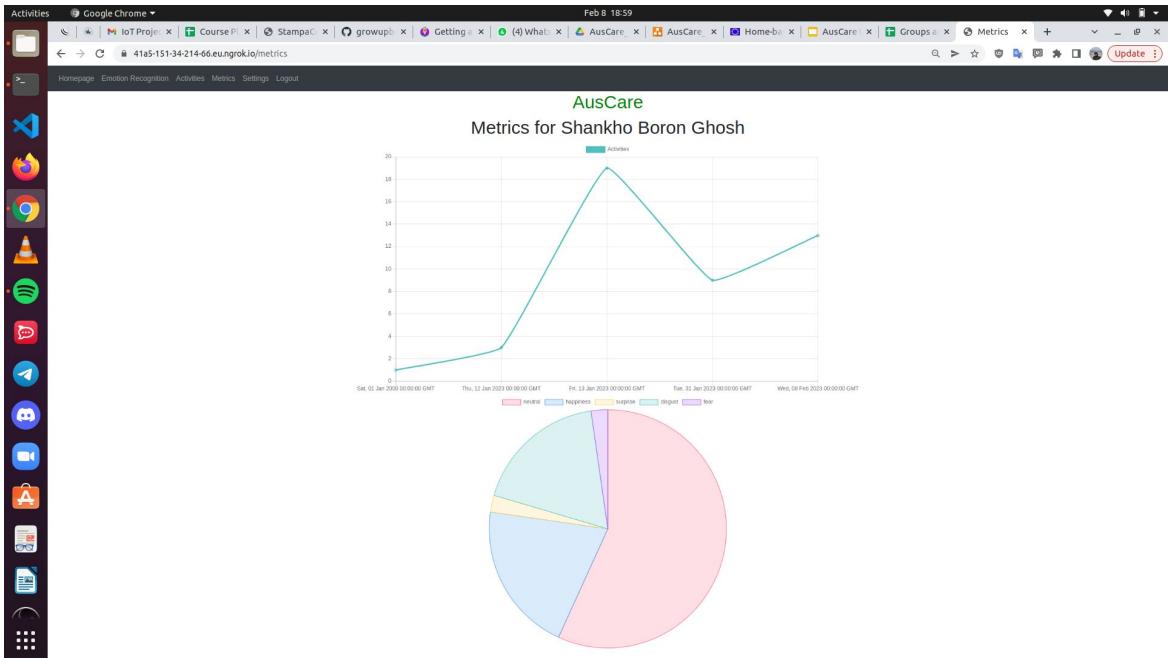
AusCare

### User Activities

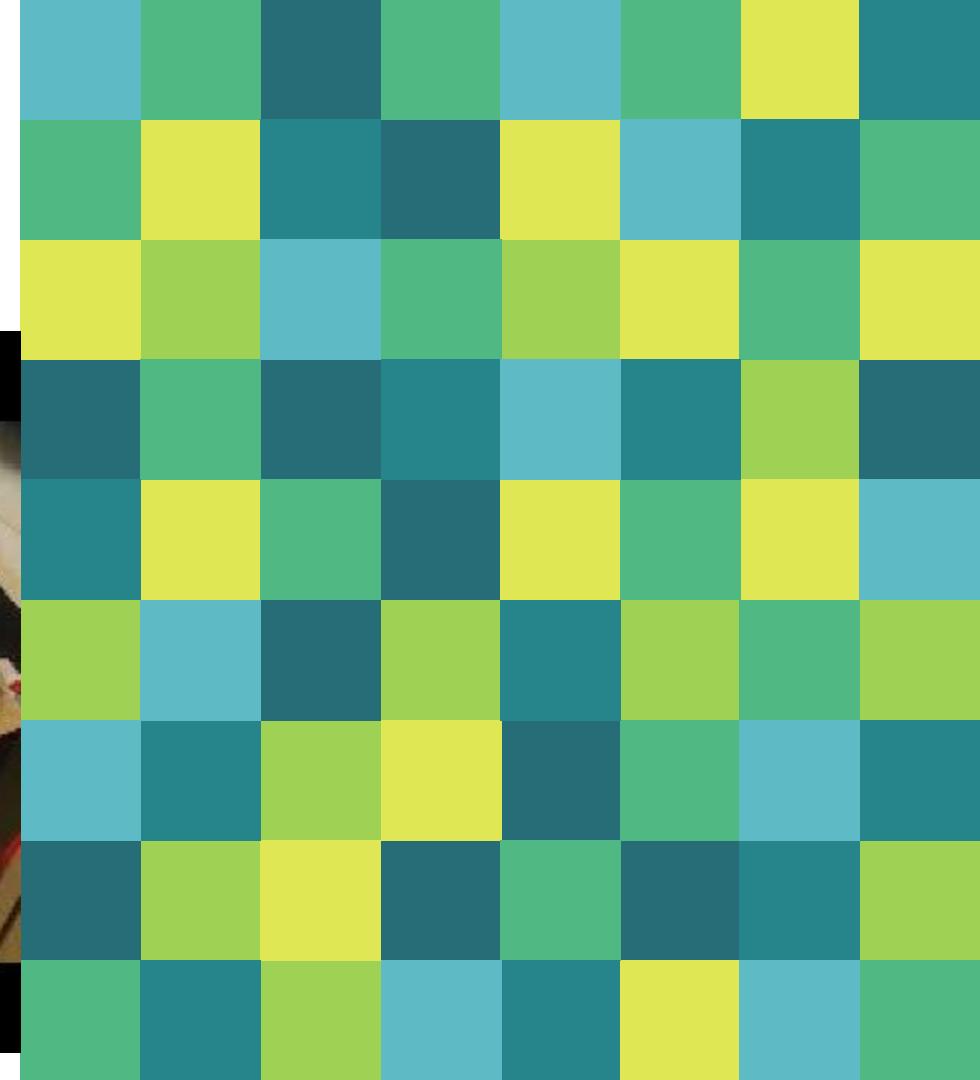
Timestamp	Photo	Emotion	Emoji	People Encountered
2023-02-08 18:58:08.244594		happiness	:)	23
2023-02-08 18:58:00.339049		happiness	:)	22
2023-02-08 18:57:52.086010		disgust	:o	21
2023-02-08 18:57:43.580498		disgust	:o	20
2023-02-08 18:57:35.526726		neutral	:	19
2023-02-08 18:57:27.306232		happiness	:)	18
2023-02-08 11:03:17.602251		happiness	:)	17
2023-02-08 11:02:57.662695		disgust	:o	16



# Output (Metrics)



# Demo





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# Thank You!

Project for IoT [IIM-63]

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