
European Commission
ReInHerit
ReInHerit webinar
"Engaging Museum Visitors with Gamification Apps"
30 November 2022 | 3:00-3:45 pm (CET)
Marco Bertini - MICC Unifi

ReInHerit
Redefining the Future of Cultural Heritage

European Commission

Engaging Museum Visitors with Gamification Apps

How Strike-a-pose and Face-fit applications work

UNIVERSITÀ DEGLI STUDI FIRENZE
MICC Centro per la Comunicazione e l'Integrazione dei Media

MICC Media Integration and Communication Center

NEMECH NEW MEDIA FOR CULTURAL HERITAGE

THE REINHERIT TOOLKIT

The ReInHerit Toolkit

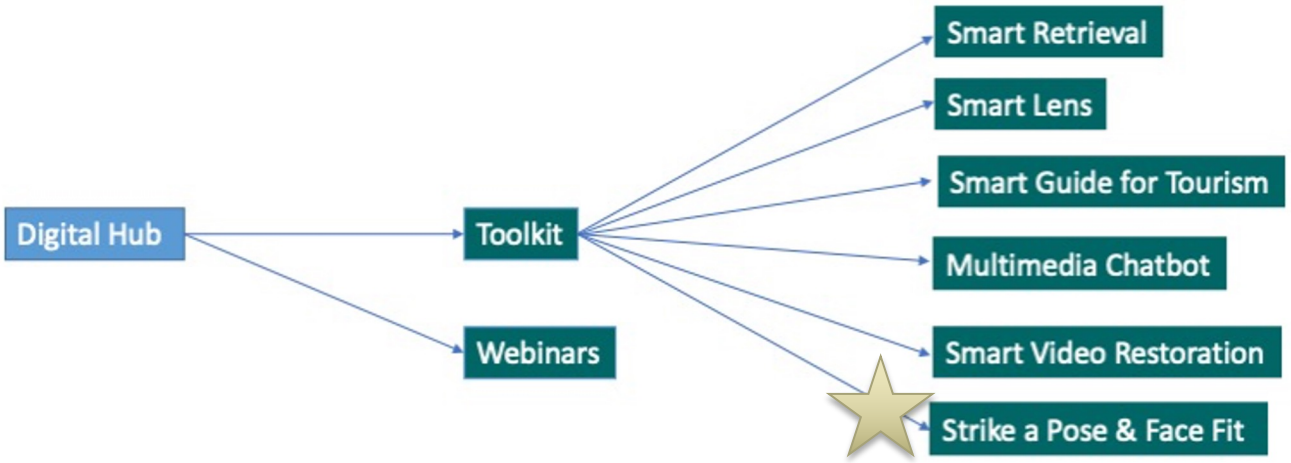
The goal of the ReInHerit Toolkit is to develop and deliver **digital apps and digital tools "based on existing, commercially available or open source,** core technologies and frameworks in the fields of **AI, IoT, webinars, and mobile development for CH management**"

The development process will result in a **series of (mobile) apps** for the ReInherit **Digital Hub.**

CH Professionals and visitors will use them to

1. **interact** with the performance environment
2. as **intelligent guidance tools** that adapt to the actions and interests of a museum or site visitor, understanding both the context of the visit and what the visitor is looking at;
3. as **gamification** and **learning-based tools**
4. as **tools for discovering relationships** and similarities between different objects in collections within the same museum/site and other collections
5. as tools for a **participatory** storytelling **experience**.

What is in the toolkit

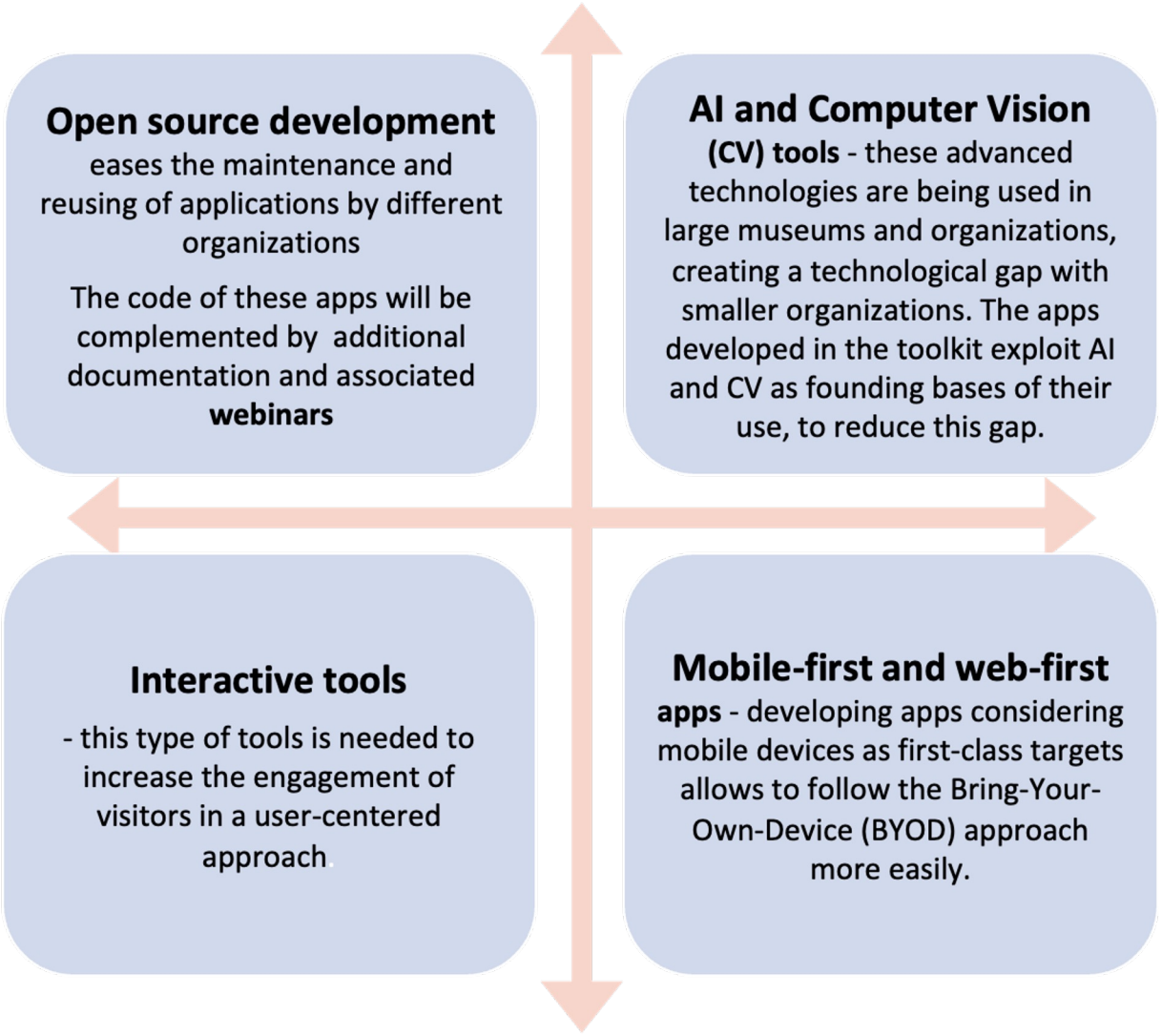


The ReInHerit Toolkit

The ReInHerit Toolkit is a set of **applications**, **instructions**, **webinars** that provide guidelines, prototypes for developing technology-assisted immersive performances, digital exhibitions, and educational and smart tourism applications.

Tree summary.
Highlighted in green are the parts related to Toolkit.

The toolkit development strategy



Inspired by AI tools in museums

Toolkit Strategy

- User/Human Centered Approach
- New points of view & perspectives about collections
- Interactive & Memorable Experiences
- Phygital Experiences
- Emotional Engagement for Learning Motivation
- Storytelling & Social Media Sharing
- Users Generated Narratives & Contents

Motivations

- Gamification is the process of exploiting strategies and game dynamics into scenarios that are not a game.

- It has already been proved to be useful to enhance skills and competences in a variety of domains such as marketing, industry training and entertainment.

Gamification for CH

- Cultural heritage can benefit from a gamification approach to engage visitors to museums content through the design of more entertaining, social and challenging digital learning scenarios.
- We want to help museums to move from the traditional “look and do not touch” toward a “play and interact” approach.
  - it has been observed that the availability of tools like gamified e-guides to visitors contributes to the sustainability of museums.

Gamification for CH

- In this webinar we present two applications designed for the cultural heritage domain that exploit gamification techniques in order to improve fruition and learning of museum artworks.

- The apps can be personalized to provide new types of interactions or have a different look and feel.

INSPIRATION

Mirror neurons

- Mirror neurons record actions executed by another in the observer's brain, do more than just visually register an observed action – they facilitate an understanding of that action.
- They allow us to understand others' actions, intentions, and feelings. The mirror neurons are in many areas of our brains, and they fire when we perform an action, and similarly we see others doing it.
- It has been proposed by the discoverers of such neurons, that mirror neurons form the biological basis of compassion and thereby of affective empathic experience.

AI for visitor engagement

Cleveland Museum of Art - US

ArtLens Exhibition
«Strike a Pose»
https://www.clevelandart.org/artlens-gallery/artlens-exhibition

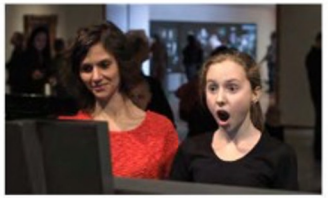
Visitors was asked to imitate the pose of a sculpture, and provided feedback relating to the accuracy of their pose. Visitors were able to share their poses and view others' poses, in addition to trying another pose.

AI for visitor engagement

Cleveland Museum of Art - US

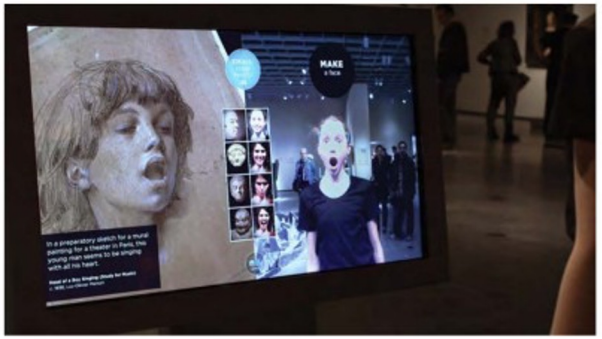
ArtLens APP
«Make a Face»

Facial recognition software matches visitors' facial expressions with one of artworks in the museum's collection. Visitors are shown a portrait to interpret the figure's emotion, then their facial expression is matched with another portrait. Visitors will see how meaning is created through facial expression in an artwork.



Visitors can "search" the collection through facial recognition, matching their own facial gesture to paintings and sculptures spanning centuries. This never before created interface connects visitors with the collection on a human and emotional level, creating snapshots that can be saved and shared through social media.

SEARCH THE COLLECTION BY
MAKING DIFFERENT FACES



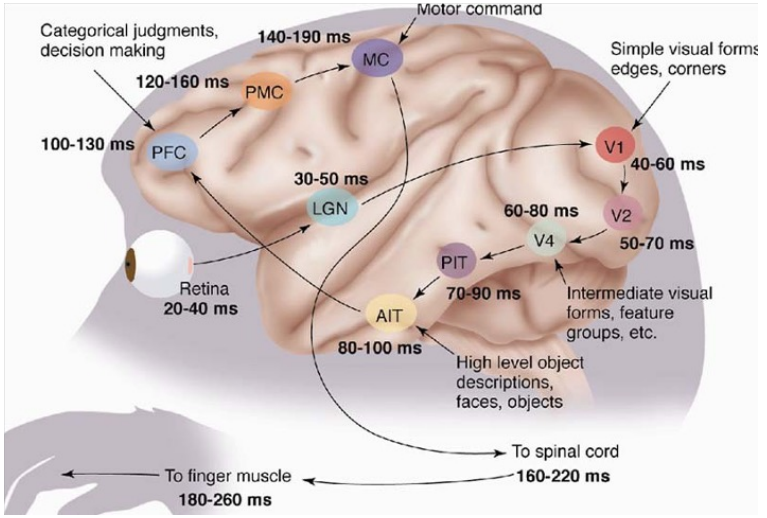
LOCAL
PROJECTS

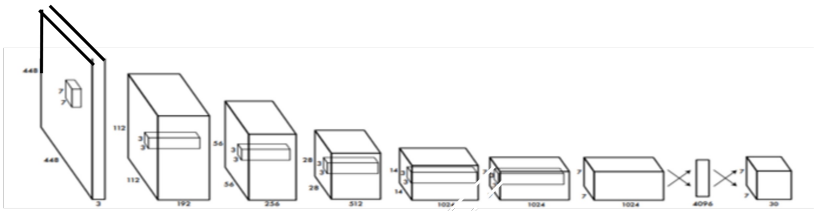
Our proposal

- In addition to exploit the empathic experience of replicating a pose or an expression we want to:
  - Implement the experience as a challenge, to increase the engagement while performing it;
  - Create user-generated media, to increase the engagement on social media;
  - Use state-of-the-art AI techniques that can run on mobile devices, to follow BYOD approach.

Computer Vision basics

Remind: if it's written in PowerPoint it's AI,
if it's written in Python it's Machine (or Deep) Learning.

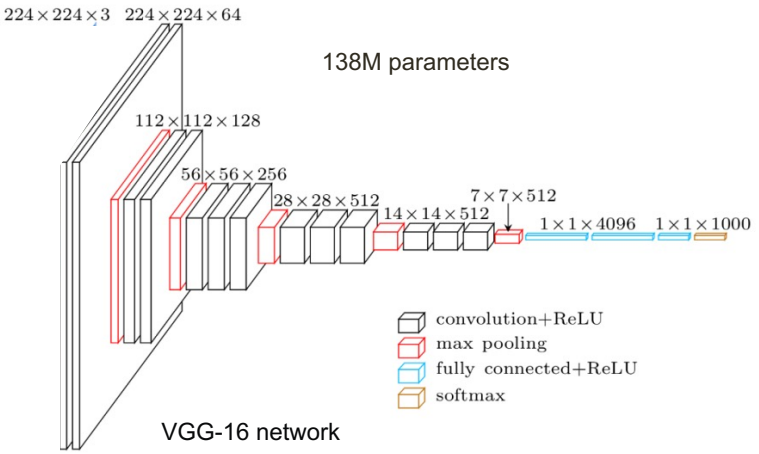


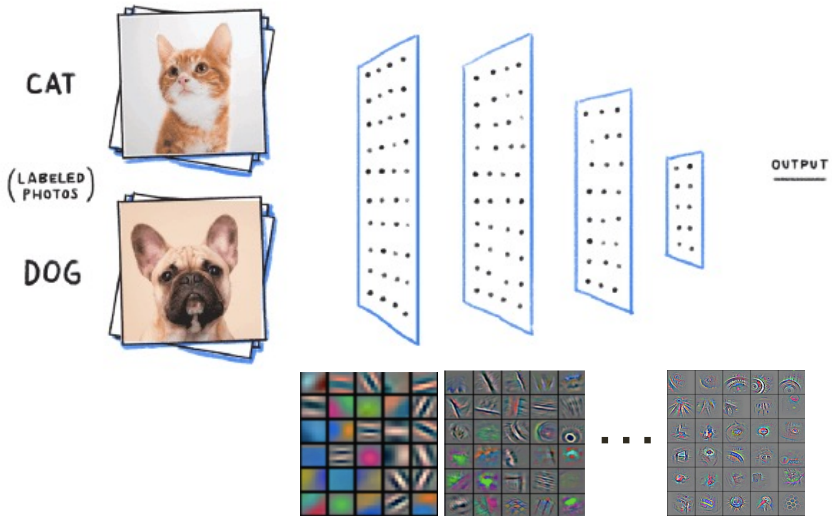


Machine Learning and Deep Learning

- *Machine Learning* technology could learn, categorize, and make predictions on data
- *Deep Neural Networks* are computing systems loosely modeled on the human brain
- The building blocks are filters that are used to extract the relevant features from the input using the *convolution* operation

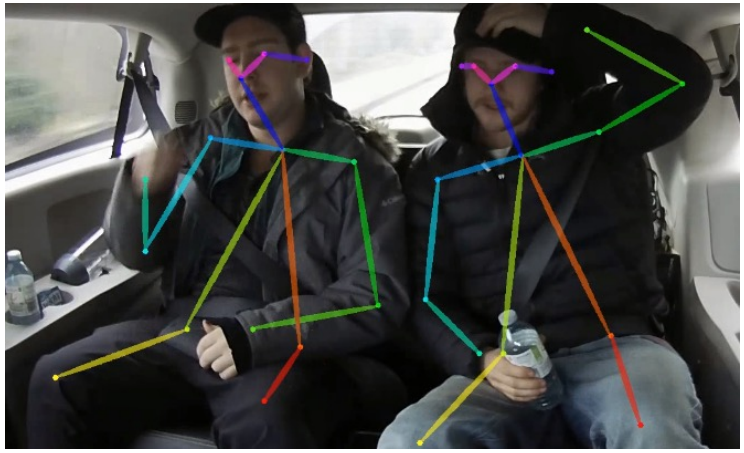
- The *deep* in deep learning stands for the idea of successive layers of representations.
  How many layers contribute to a model of the data is called the depth of the model.

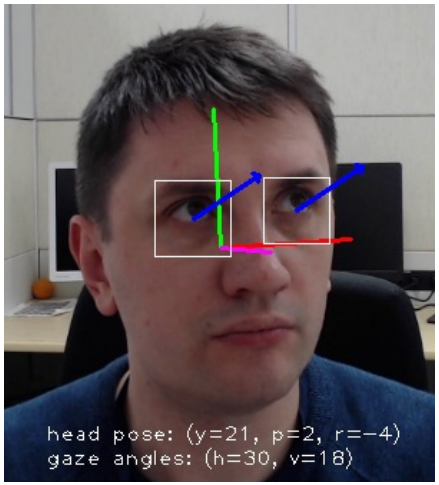




Pose recognition

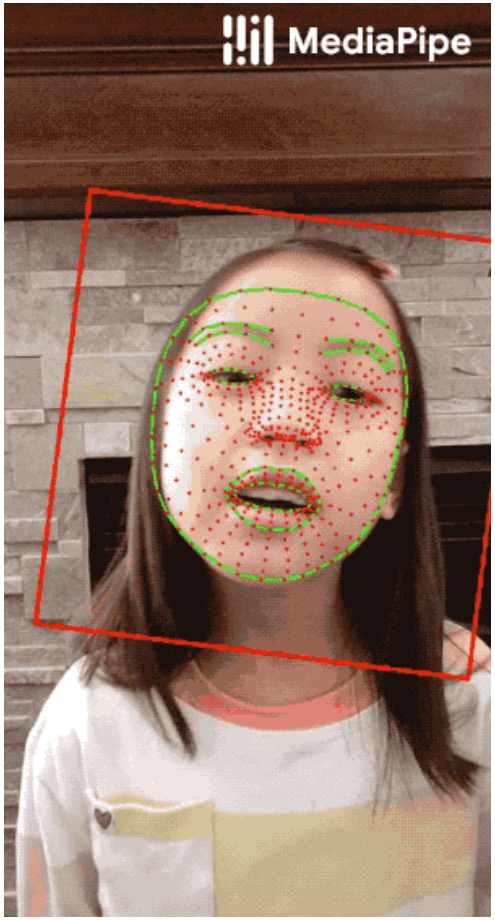
- Pose recognition can be performed on whole body o body parts, like head, hands or eyes





Face landmarks recognition

- Facial landmark recognition is a task akin to that of pose estimation, landmark points help to reconstruct the pose and expression of a face



Technical details

STRIKE-A-POSE

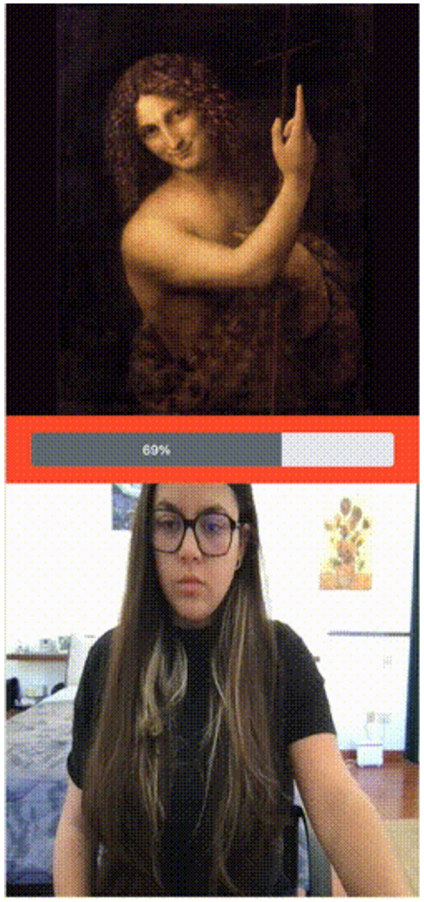
Strike-a-pose

- Strike-a-pose is a **web application** which performs analysis and evaluation of human poses compared to poses present in famous paintings or statues.
- Can be used on the **device of the visitor** (Bring your own device – BYOD approach) or as an **installation**.

- Once registered, the user is challenged to reproduce in sequence the poses of some artworks from the museum's collections.
- Once all the poses have been matched, the application allows the user to **generate a video** that can be saved for any **social sharing** and provide info on the artworks.

- The poses to be matched are organized in sets of challenges, e.g:
  - challenges to replicate poses using the whole body;
  - using only the torso (e.g. to allow also wheelchair users to interact);
  - based on thematic collections or other themes considered interesting by the museum curators.

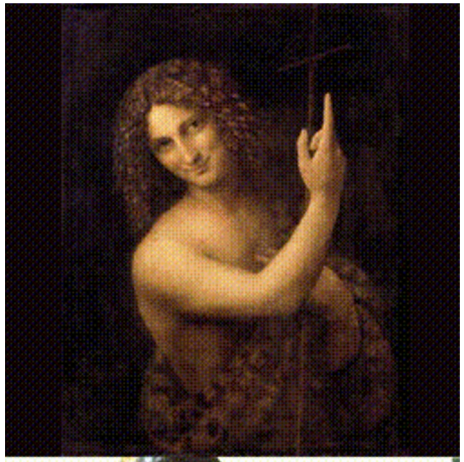
Strike-a-pose – mobile app

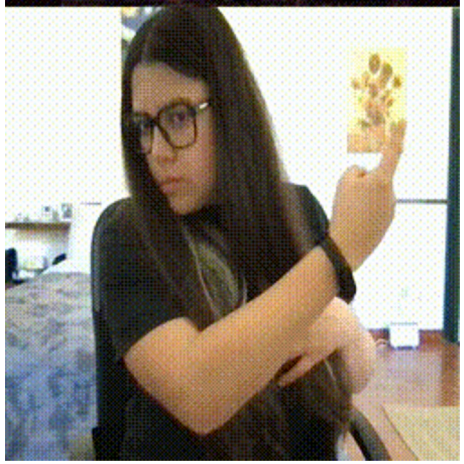


- The interface designed for smartphones uses a vertical layout, while the one for installations has a horizontal layout.

- The MoveNet model is used to obtain 17 keypoints . The model is used in the variant “Lightning” version, to run in real time (30+ FPS) on most of modern PCs and phones.
  The model runs completely client-side in the browser.

Strike-a-pose – mobile app



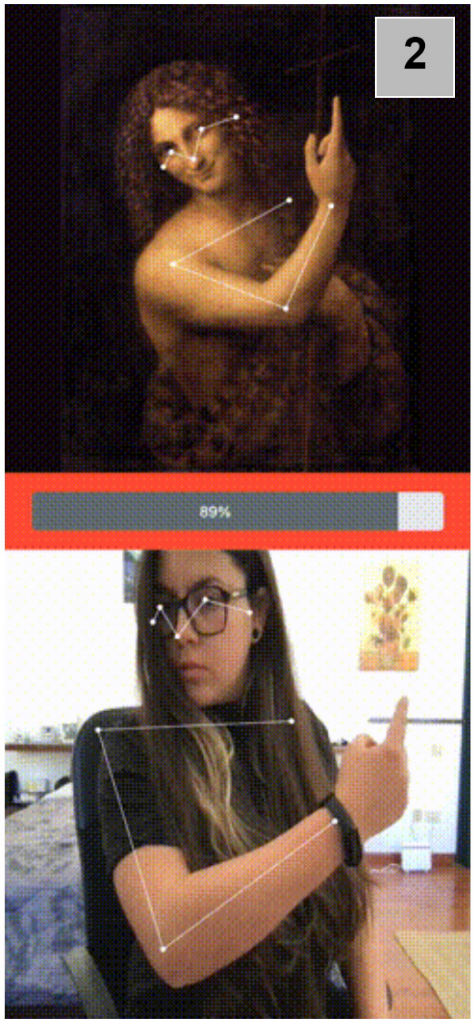


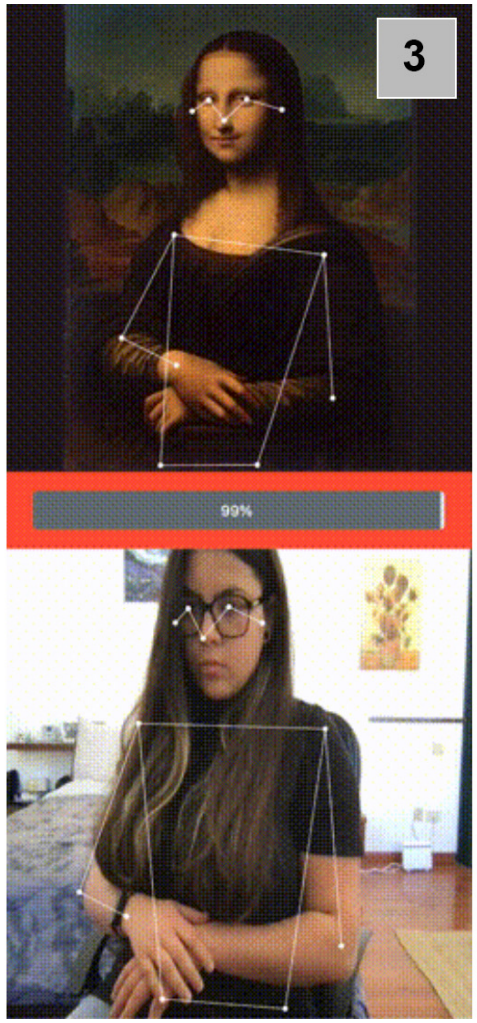
- Final video

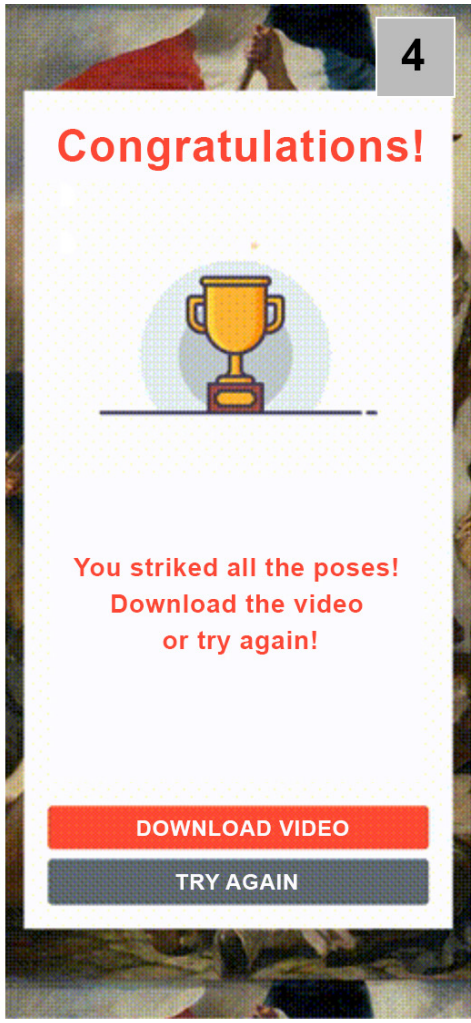
- Replicating poses unblocks the description of each artwork.

- Once a challenge is completed the user can download a video that shows the completion of the challenge, to share it on social networks.

Strike-a-pose – mobile app

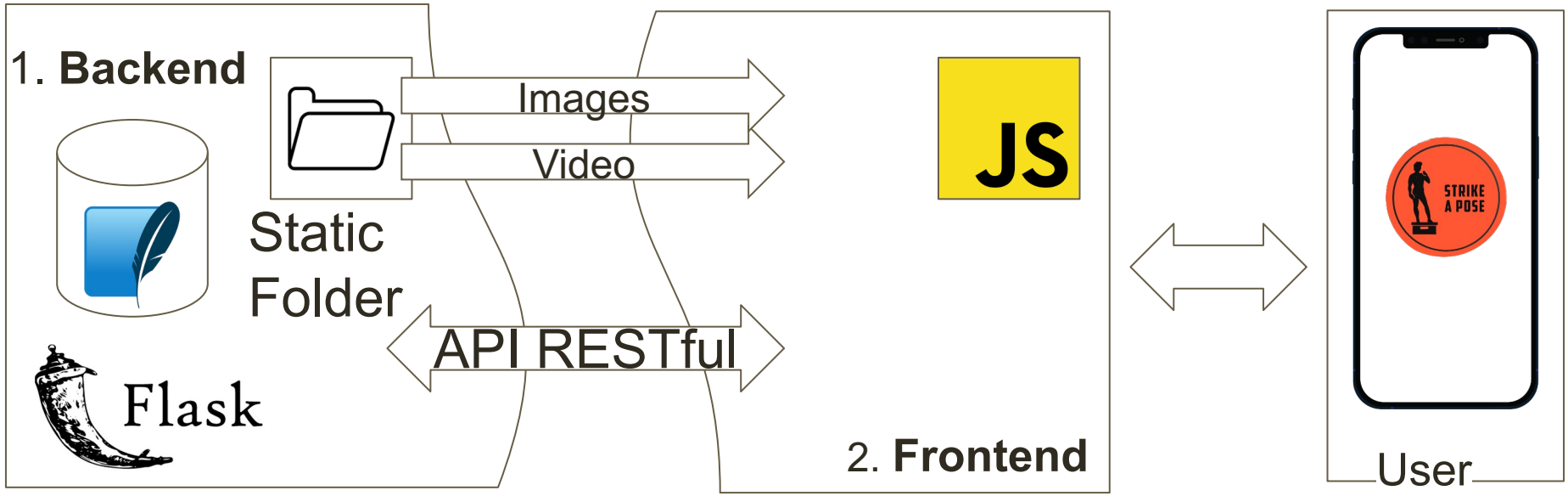




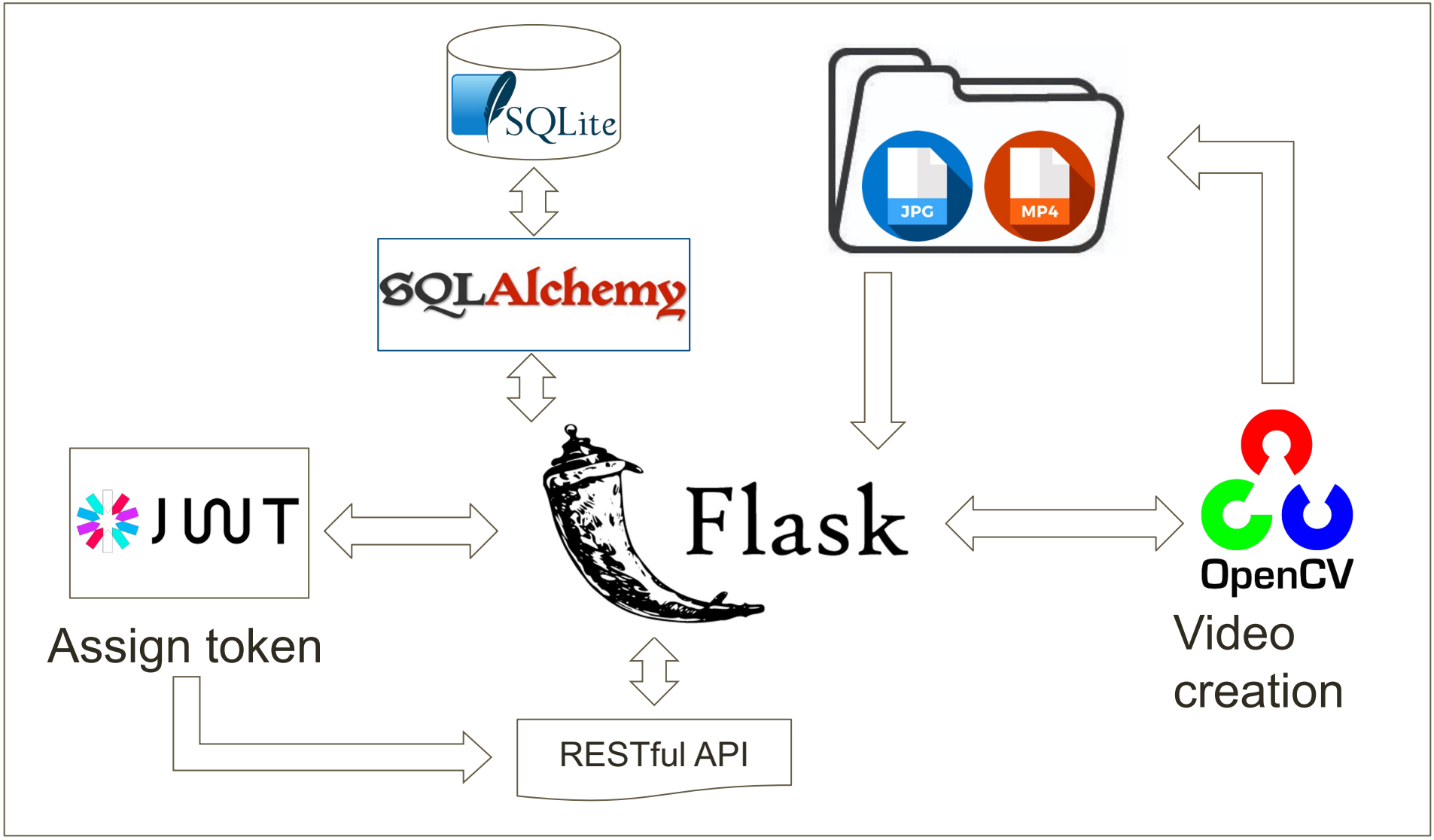


Architecture

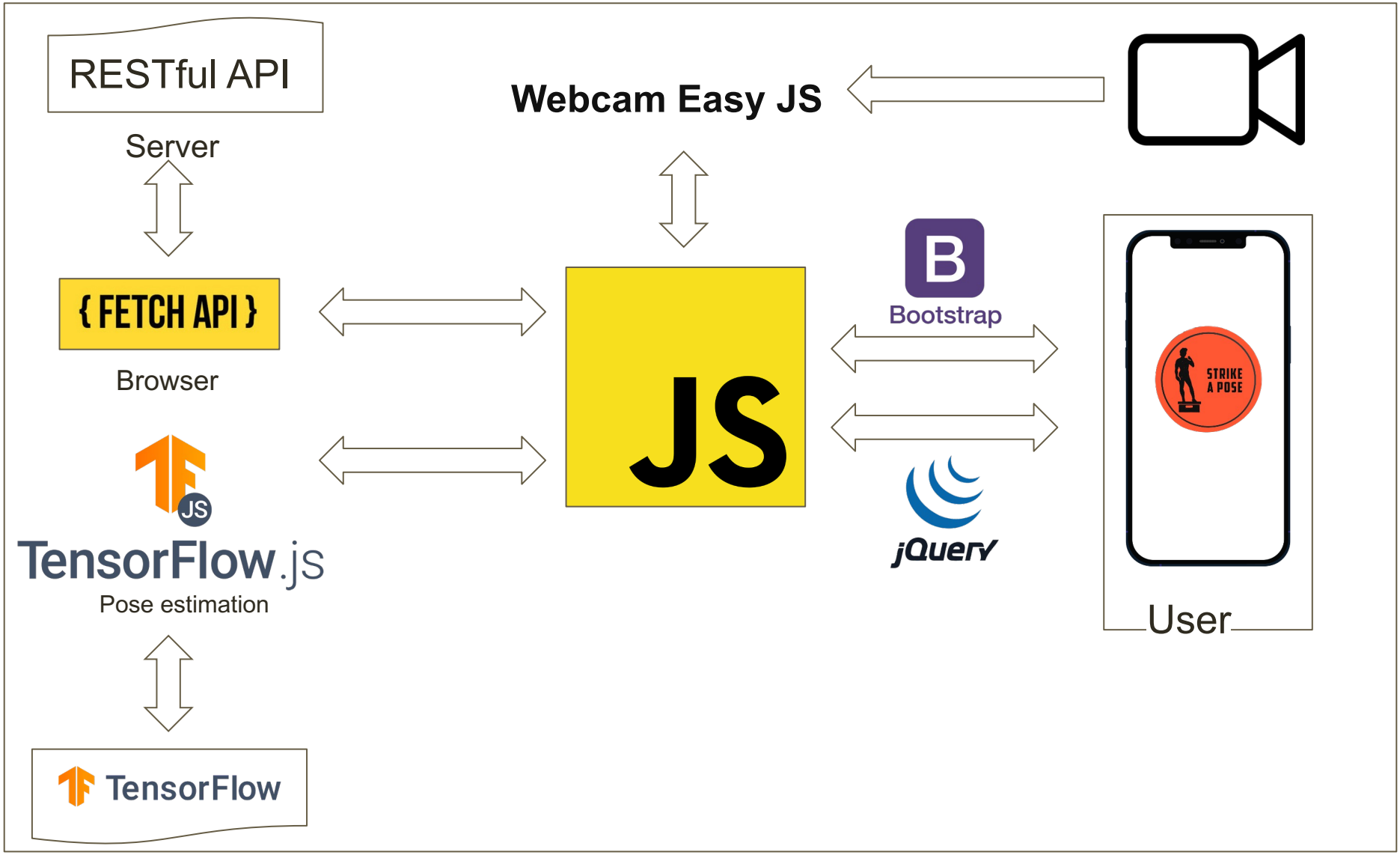
- The app is composed of two parts:
  - Backend: RESTful API implemented in Python using Flask
  - Frontend: implemented in JavaScript / HTML /CSS



Architecture - backend

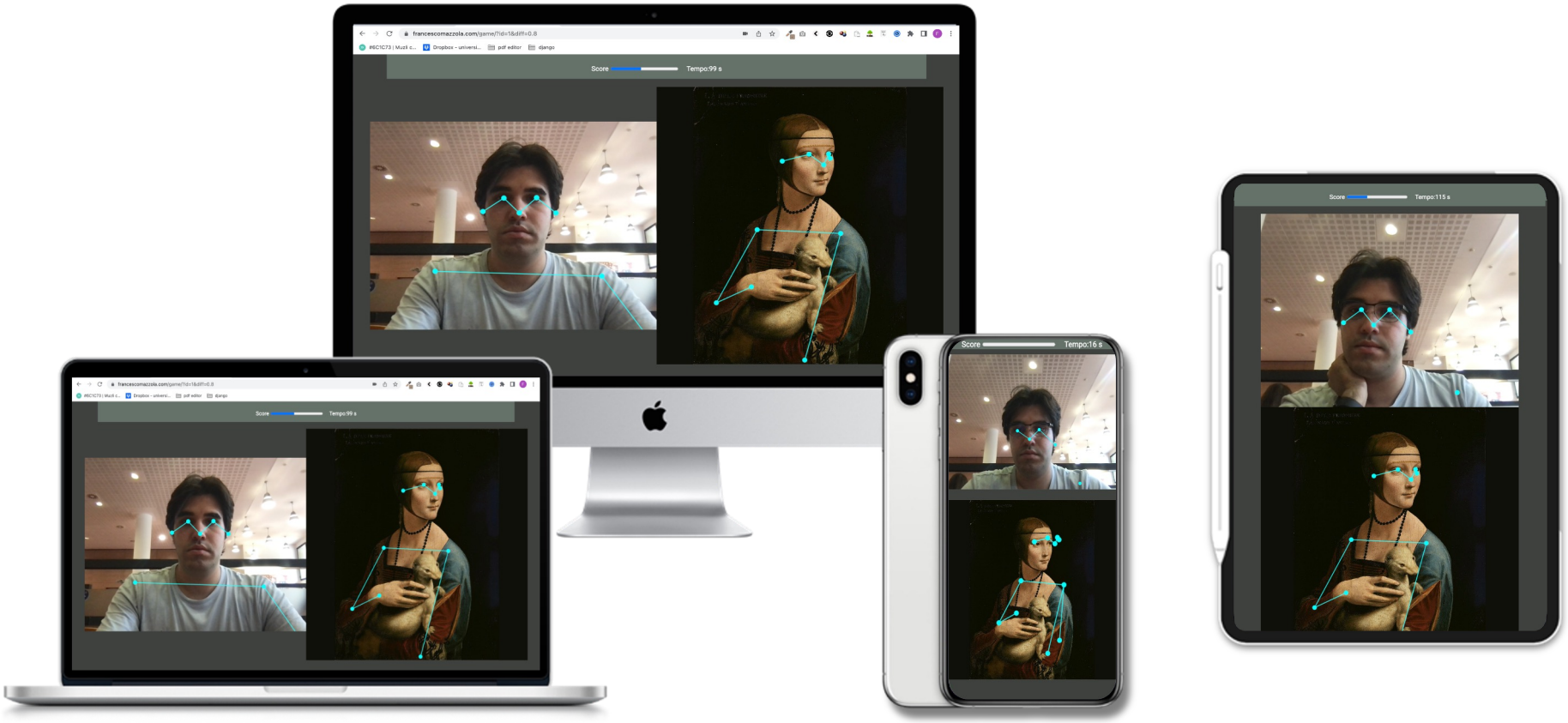


Architecture - frontend



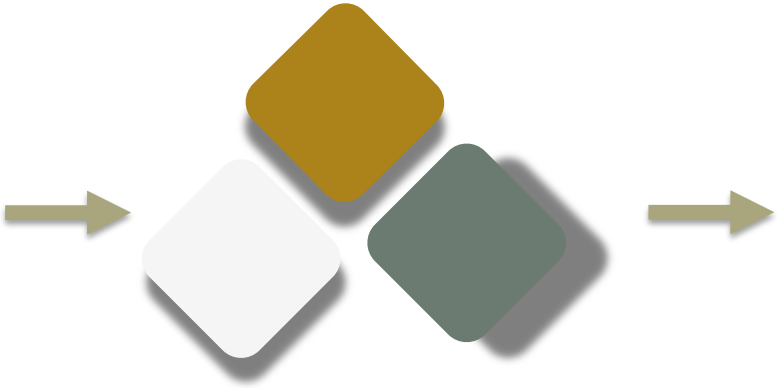
Responsive interface

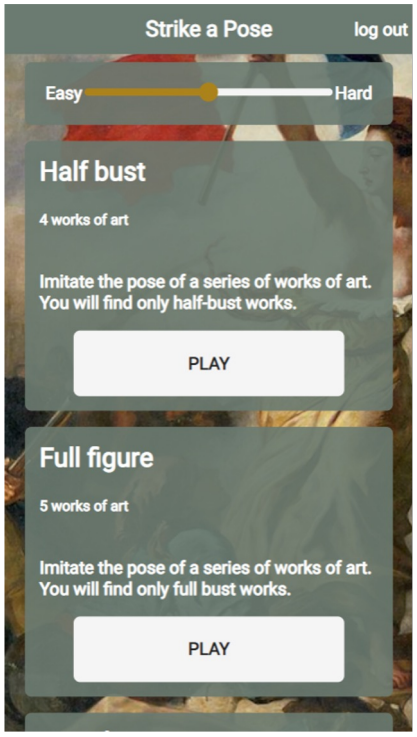
- The web interface is designed to be responsive and adapt to different devices

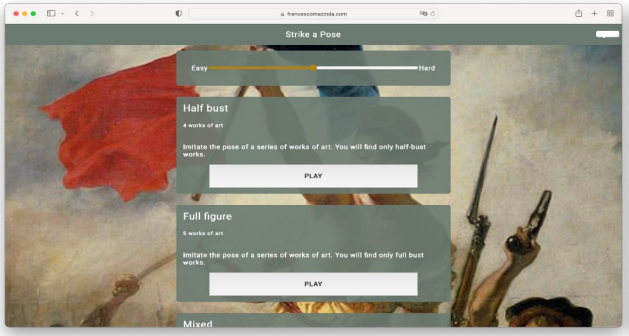


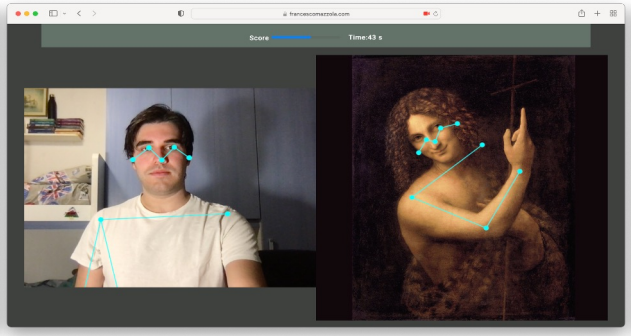
Interface adaptation

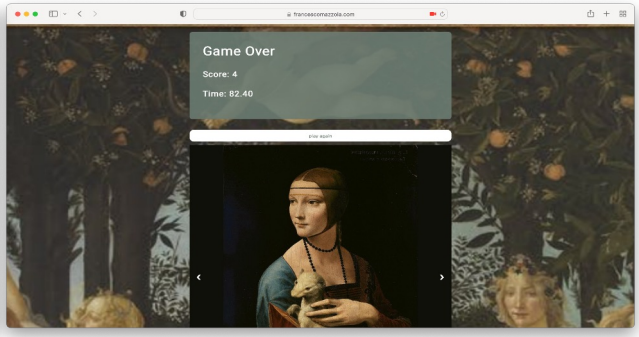
- Select color palettes to recall your organization or location
- Personalize the layout of the elements







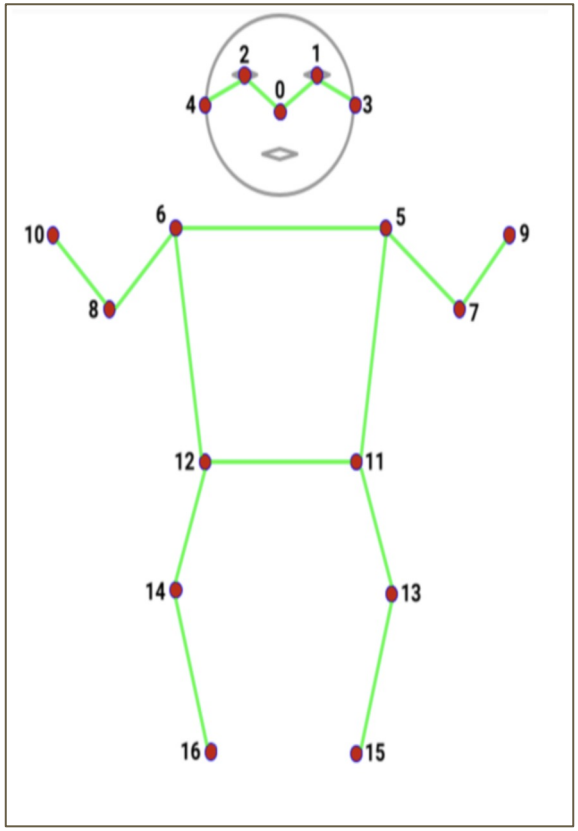




Pose estimation

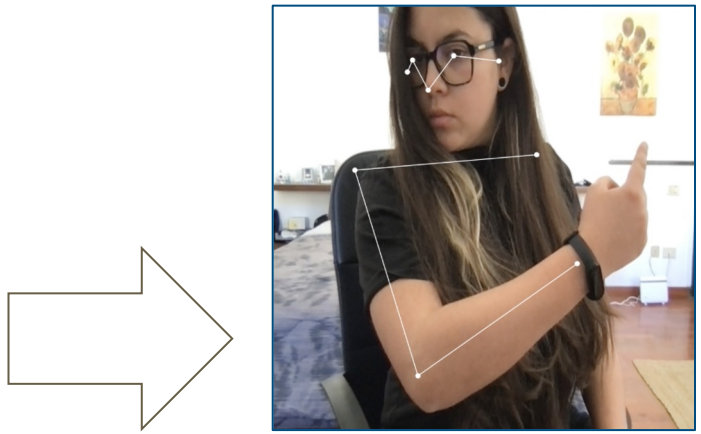
TensorFlow.js

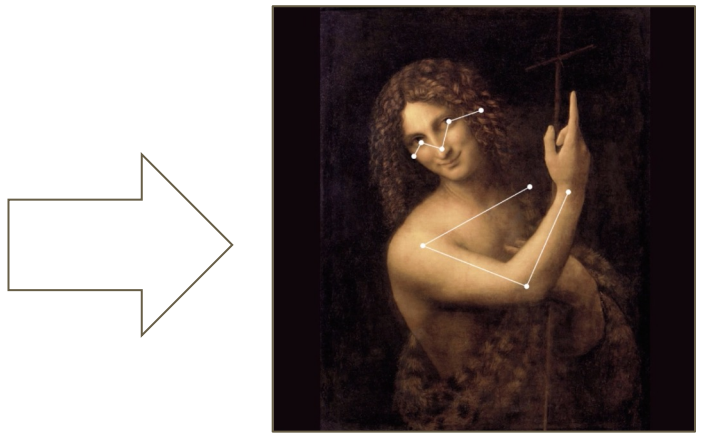
A neural network receives an image as input and outputs the position of the joints of a skeleton



Pose estimation

- We looked at neural network models that can be executed in TensorflowJS and have low requirements for computational capabilities
- We selected MoveNet, available in different “sizes”
- **MoveNet.Lightning** is smaller, faster but less accurate than the **Thunder** version.
- **MoveNet.Thunder** is the most accurate but also larger and slower version of **Lightning**.

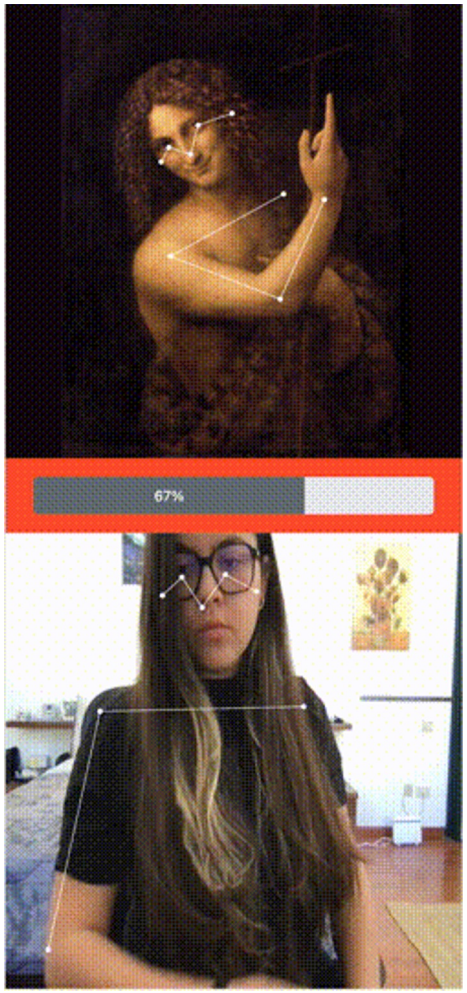




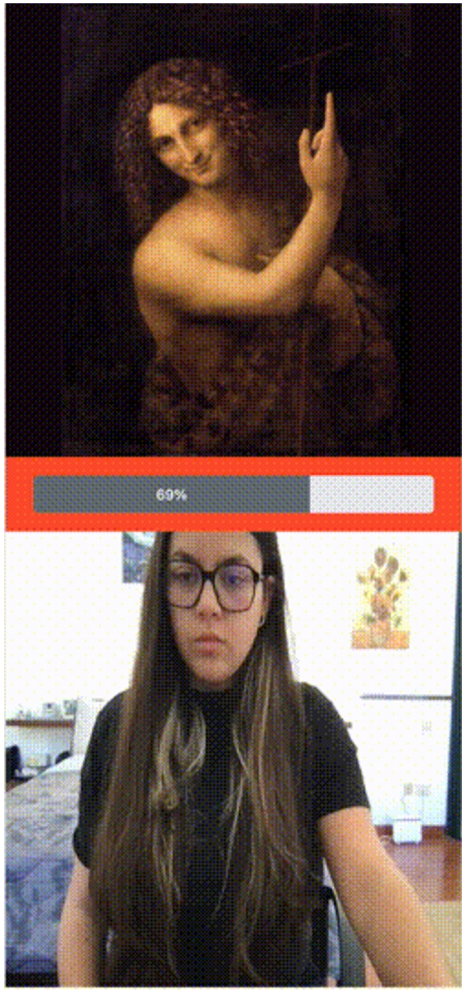
Pose comparison

- Normalization
  - We compute the average position of all the detected keypoints and normalize the position according to the average
  - We need it to compare similar poses in different parts of the image
- We compare the distances of the normalized keypoints between reference image (artwork) and webcam image
  - It must be a game: allow for some “generous” overall distance
- Provide a feedback to the user

Pose comparison



Easy mode: show skeleton

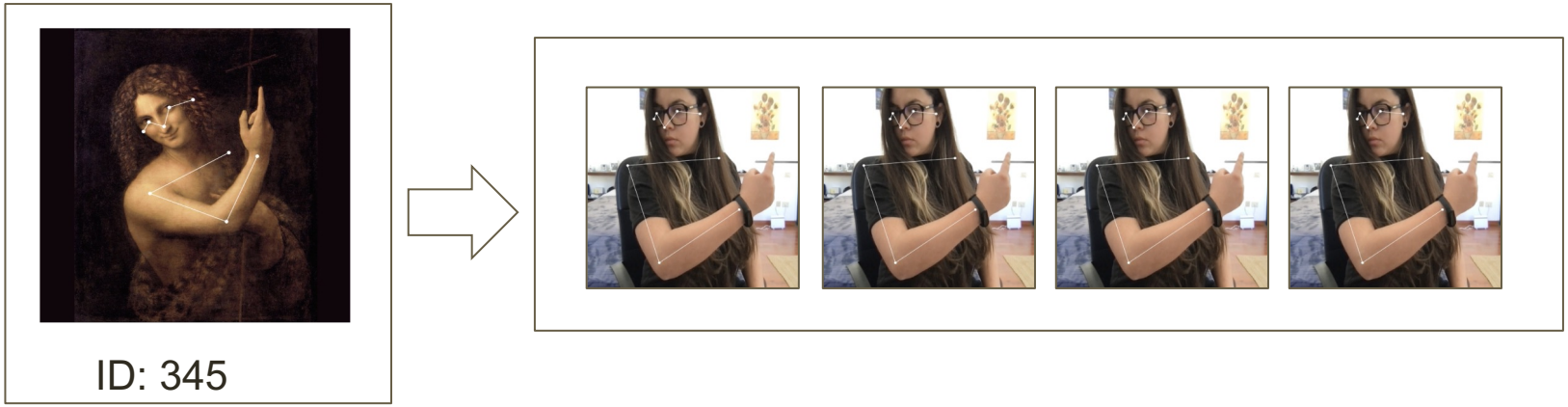


Hard mode: no skeleton

Video creation

- We store in the backend the acquired frames obtained by the webcam and use the frames immediately before and after the pose match to create a video

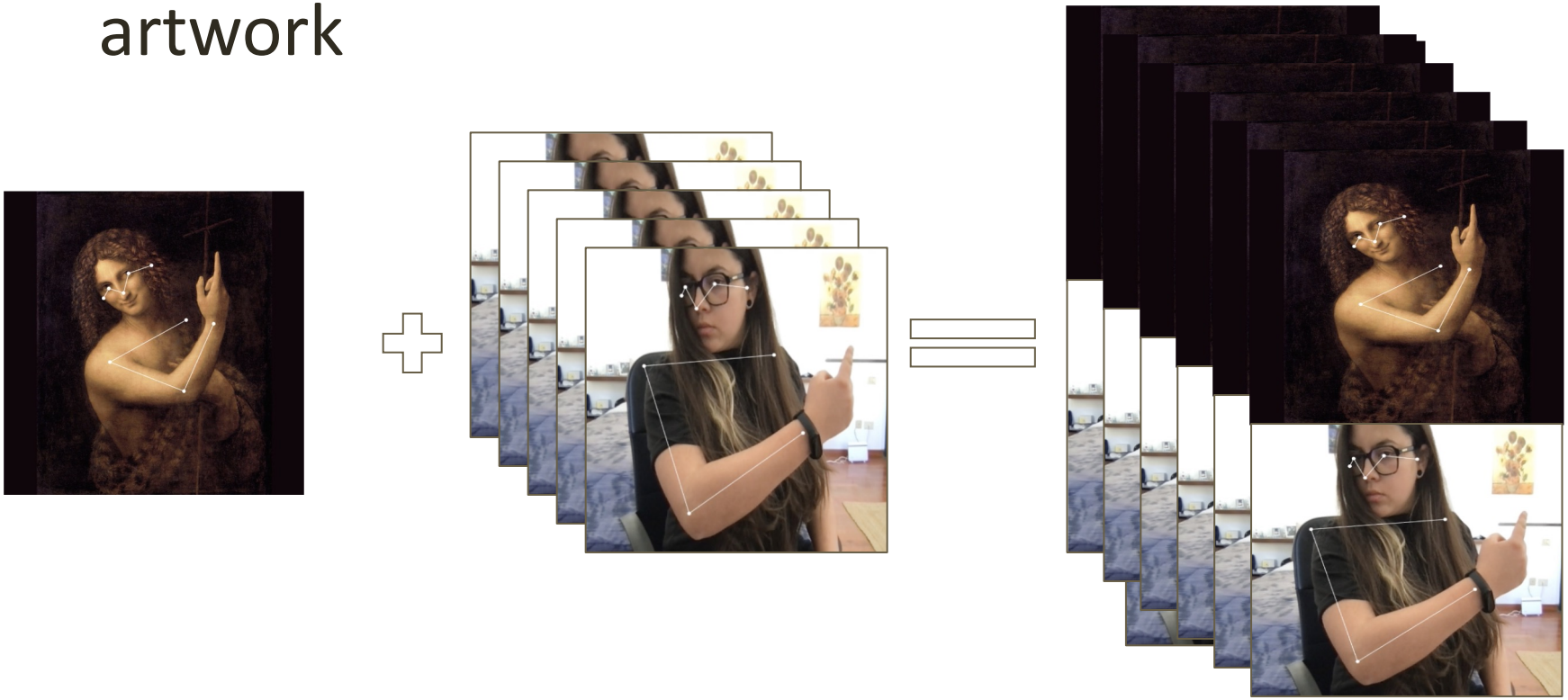
. . .



. . .

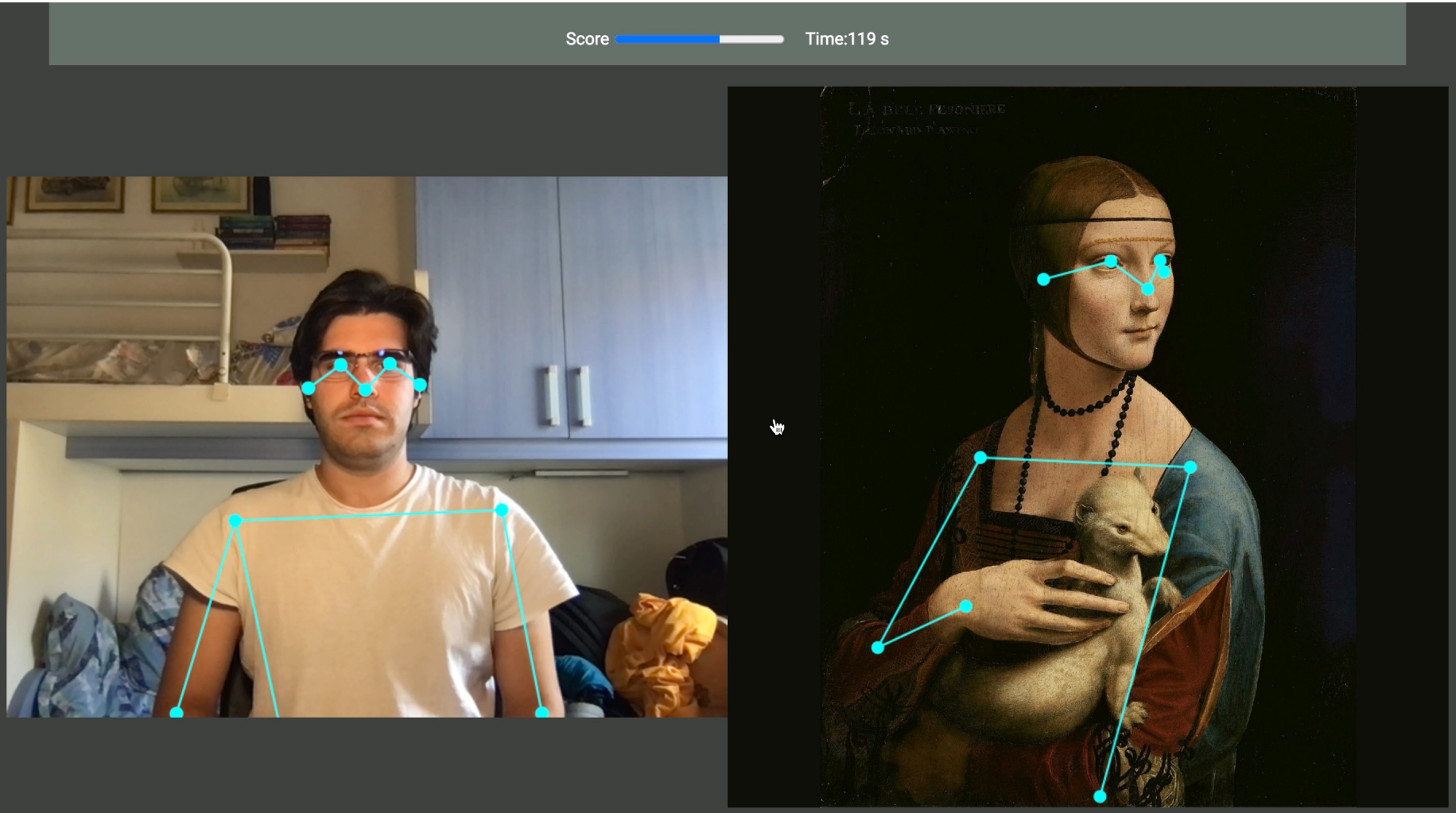
Video creation

- We are living in a “vertical video” world… compose the video of the action with the artwork



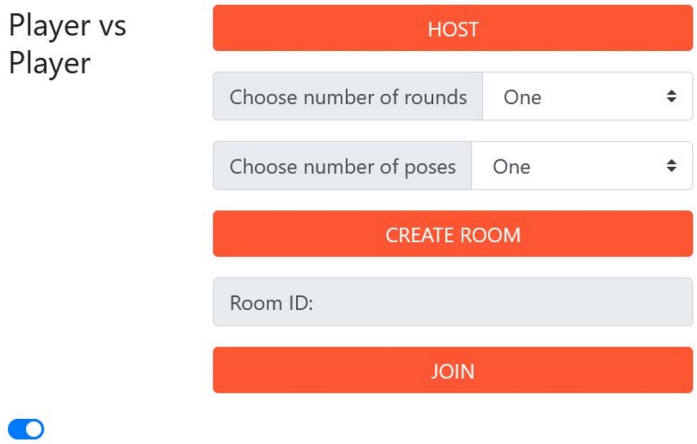
Video creation

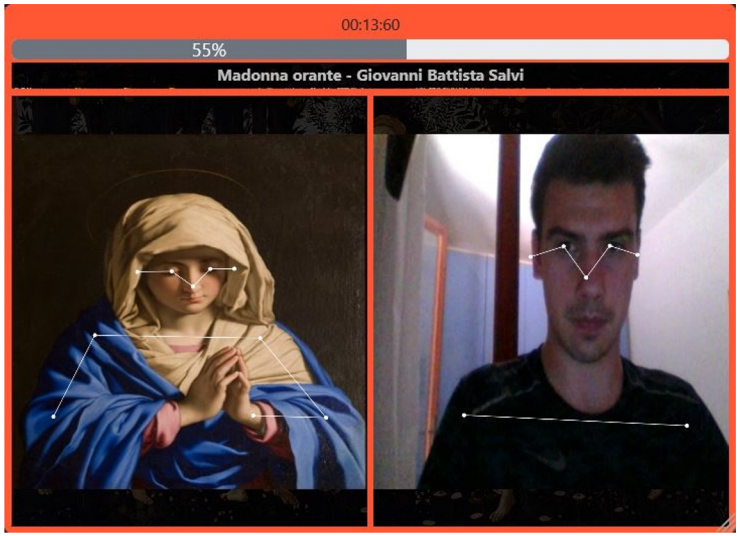
Video creation



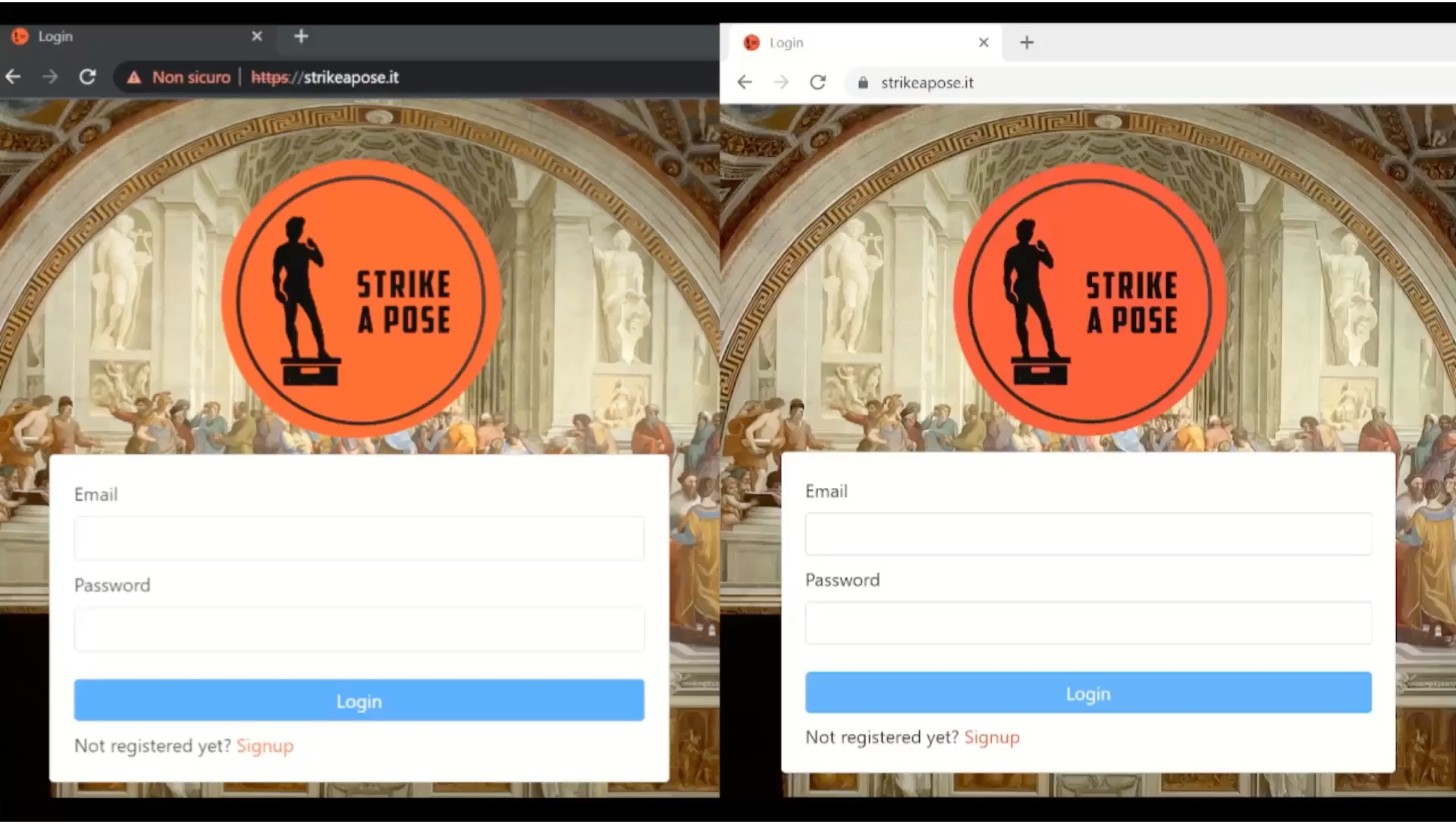
Variations

- The basic version of the game can be extended, e.g. adding a 1 vs 1 mode
- This requires to add some functions in the backend to allow to create virtual rooms where friends can compete
  - The API manages the message passing of the web clients to determine the winner and show the final results



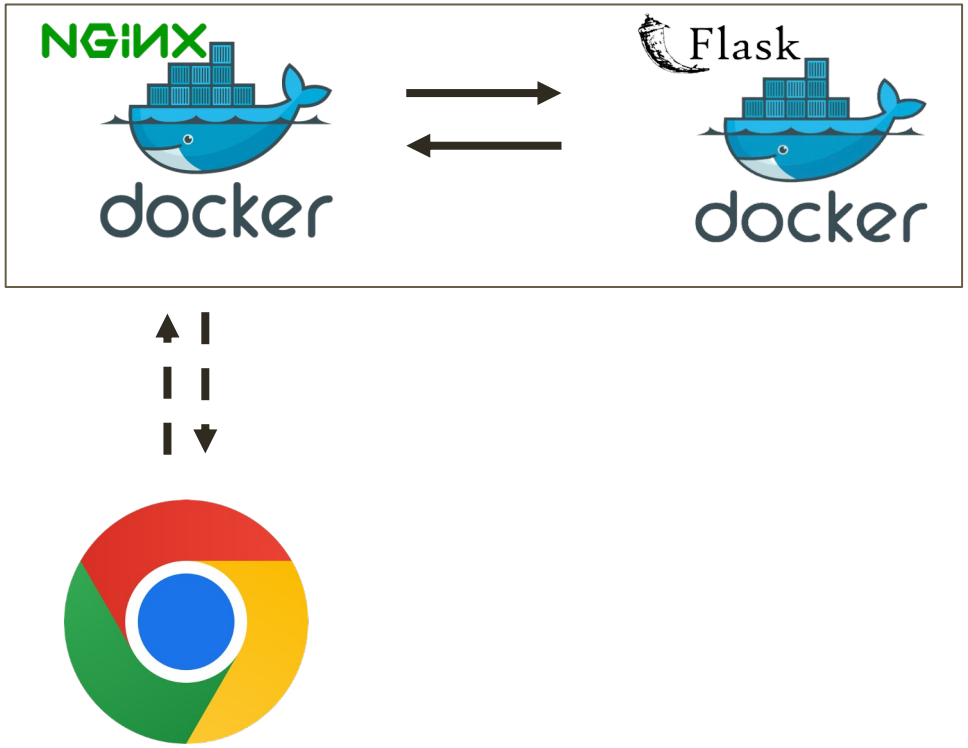


1 vs 1


Login
Non sicuro | https://strikeapose.it
STRIKE A POSE
Email
Password
Login
Not registered yet? Signup
Login
strikeapose.it
STRIKE A POSE
Email
Password
Login
Not registered yet? Signup

Deploy

- To ease testing the app is Docker-ized
  - Use Docker Compose to activate the nginx and flask containers



Technical details

FACE-FIT

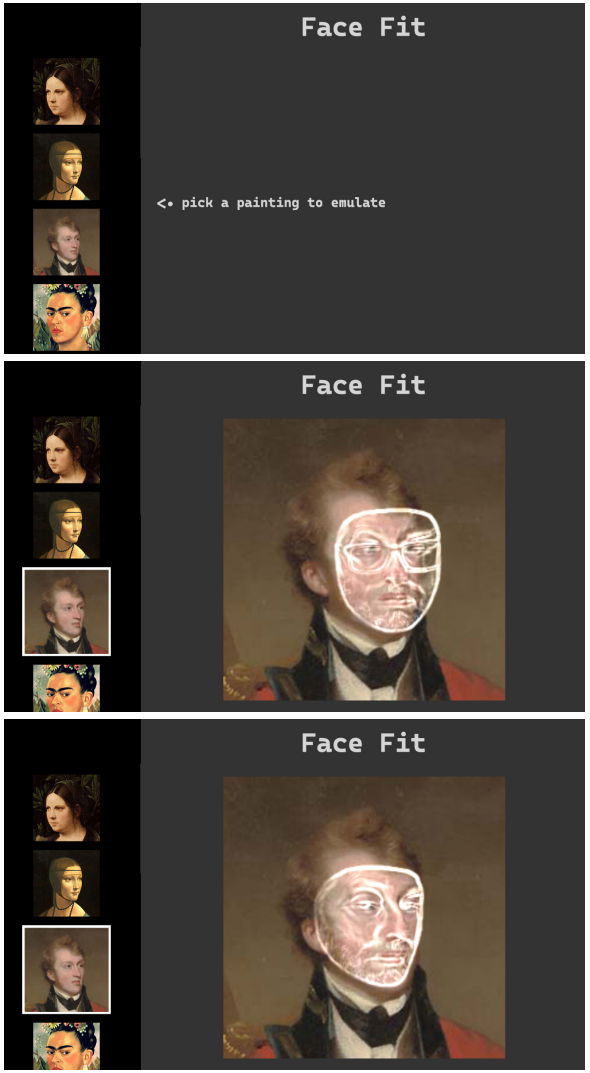
Face-fit

- Face-Fit is an application which provides gamification and personalization on painting, in particular portraits, adapting their visual content.

- The application designed both **for smartphone** and desktop (**for museum installation**) allows to replicate the pose of the head and the expression of some portraits by famous painters and transfer the face of the user on the artworks, **generating a new image**.

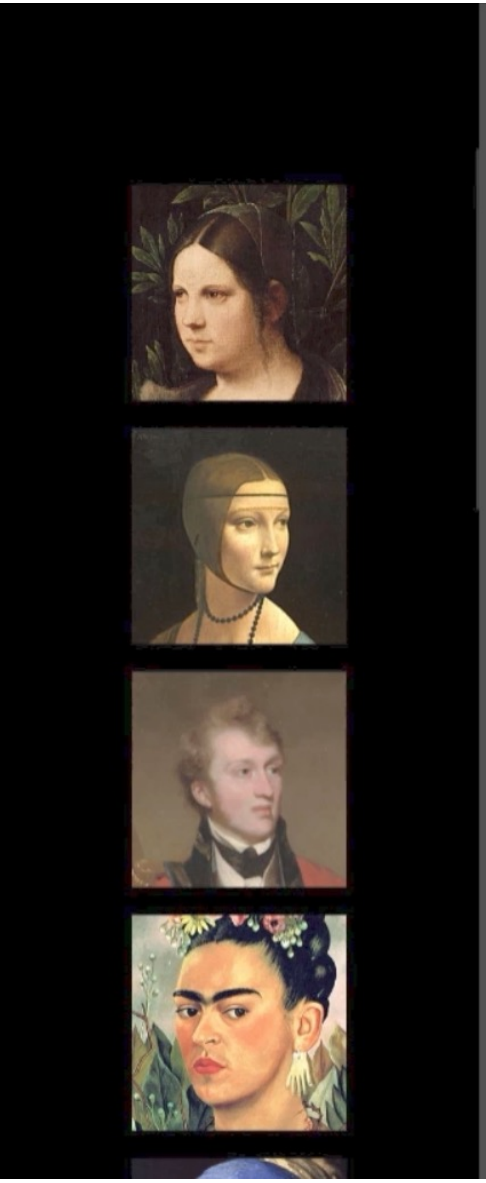
- Once the pose is matched the user obtains information on the artwork and can download the generated images for **sharing on social networks**.

Face-fit

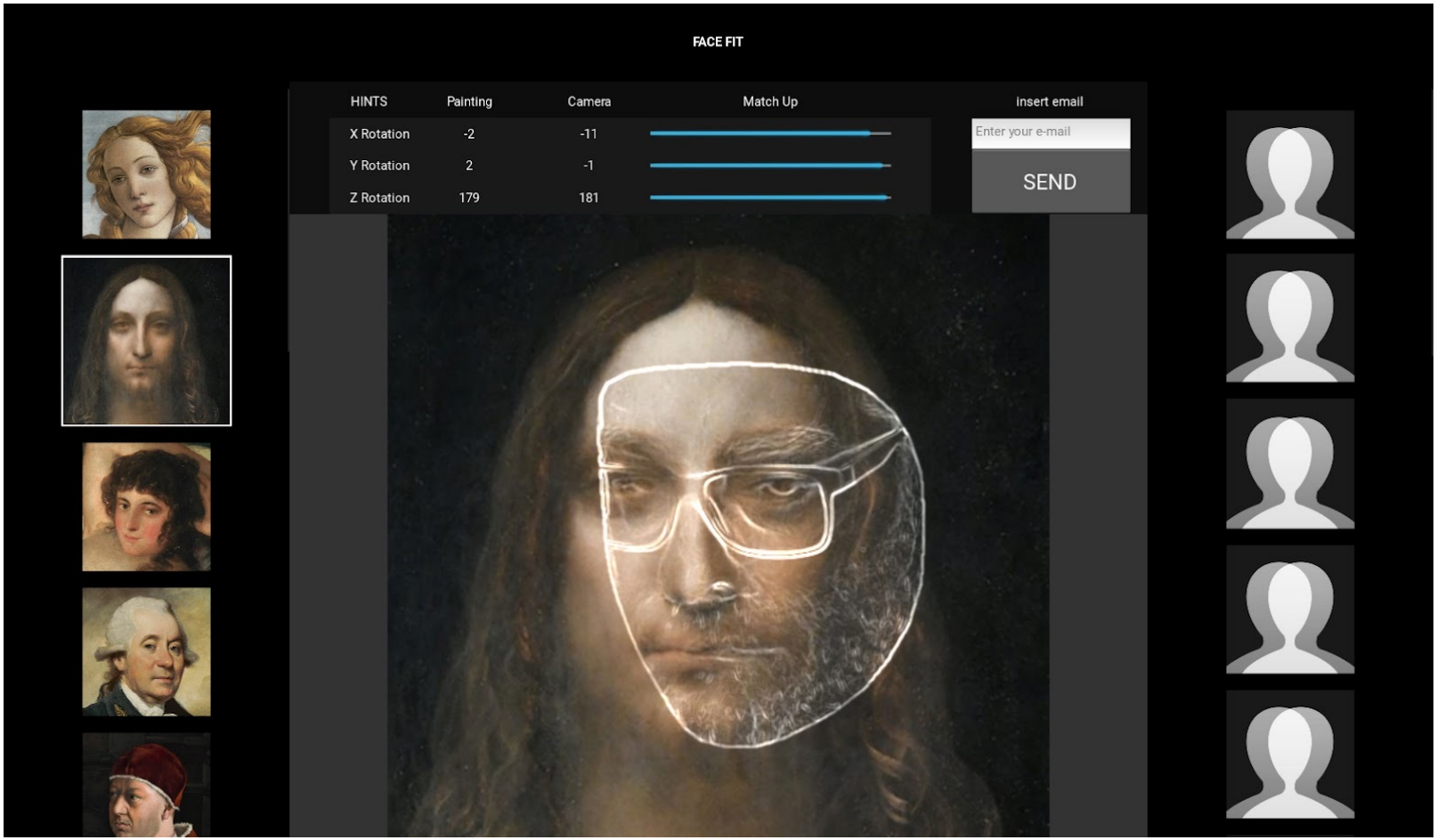


- A faster than real-time face mesh prediction network is used to obtain 468 3D points for each face, also when using mobile phones.
- The points are used to compute the pose of the whole face.
- Once the pose is matched the position of eyes, eyebrows and mouth is matched.
- When both pose and facial expression match the face of the user is substituted to that of the painting and the description of the artwork is provided

Face-fit



Face-fit



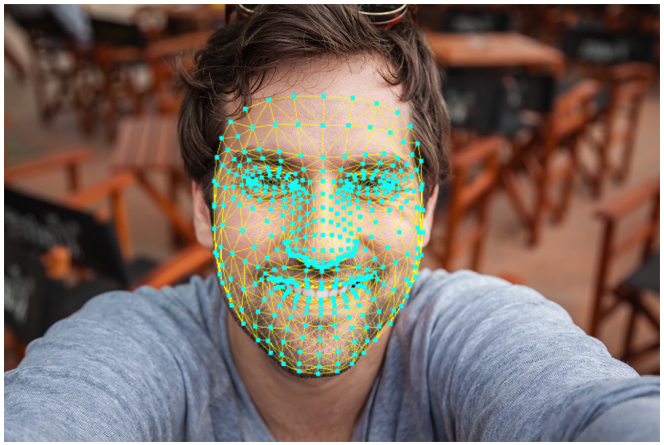
How to give a feedback to the user ?
Our solution: ”ghost” face + sliders

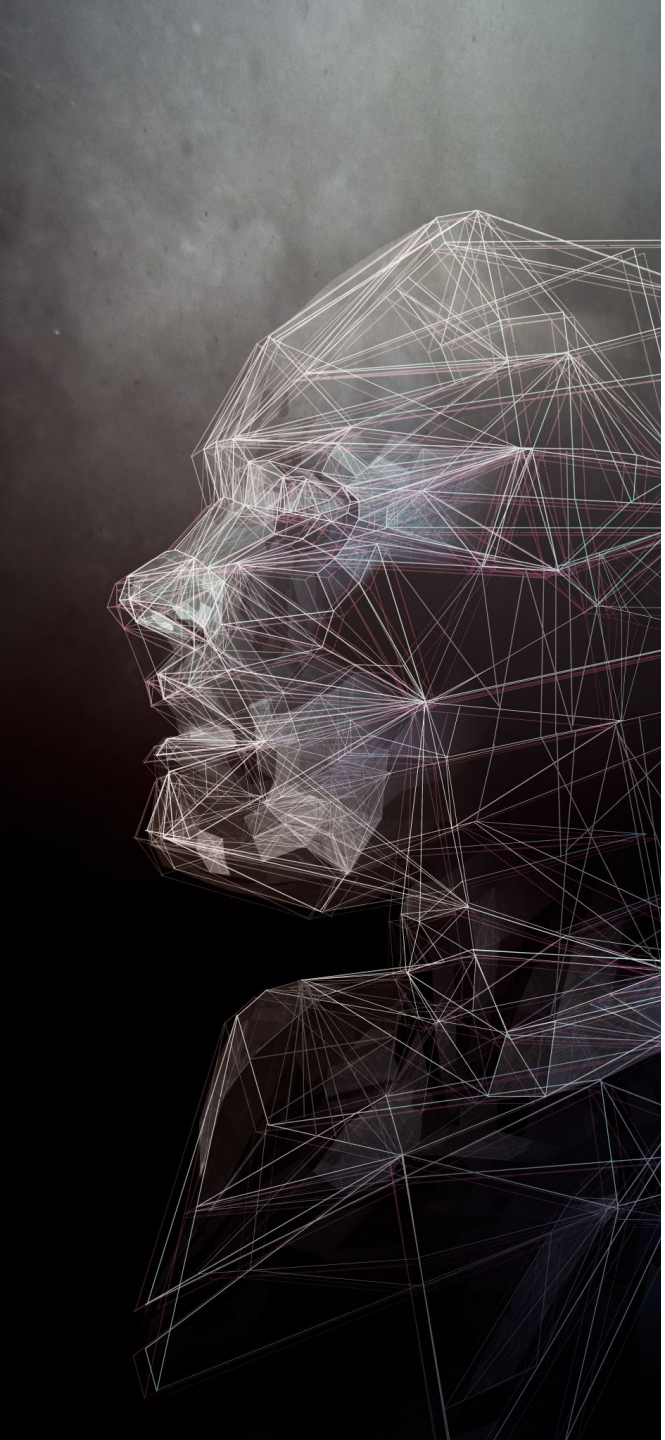
Architecture

- The app is divided in two codebases:
  - A monolithic desktop app in Python for installations
    - GUI in Kivy, Tensorflow + OpenCV for computer vision
  - A web app for mobile devices
    - Frontend: Javascript + TensorflowJS
    - Backend: Flask + OpenCV
- In general web apps may have reduced advanced capabilities and need to rely on backend, try to keep as much as possible in frontend to reduce latency !

From face to points

- We use a specialized neural network for real-time 3D mesh representation of human faces.
- An image (webcam or artwork) is processed to extract 468 3D vertices





Face matching: pose

- A human face can rotate along three axes
  - Looking up/down
  - Looking right/left
  - Turning toward one shoulder or the other
- If the distance of the computed axes is within an interval w.r.t. that of the artwork the pose is matched
- The rotation axis are computed from the face mesh

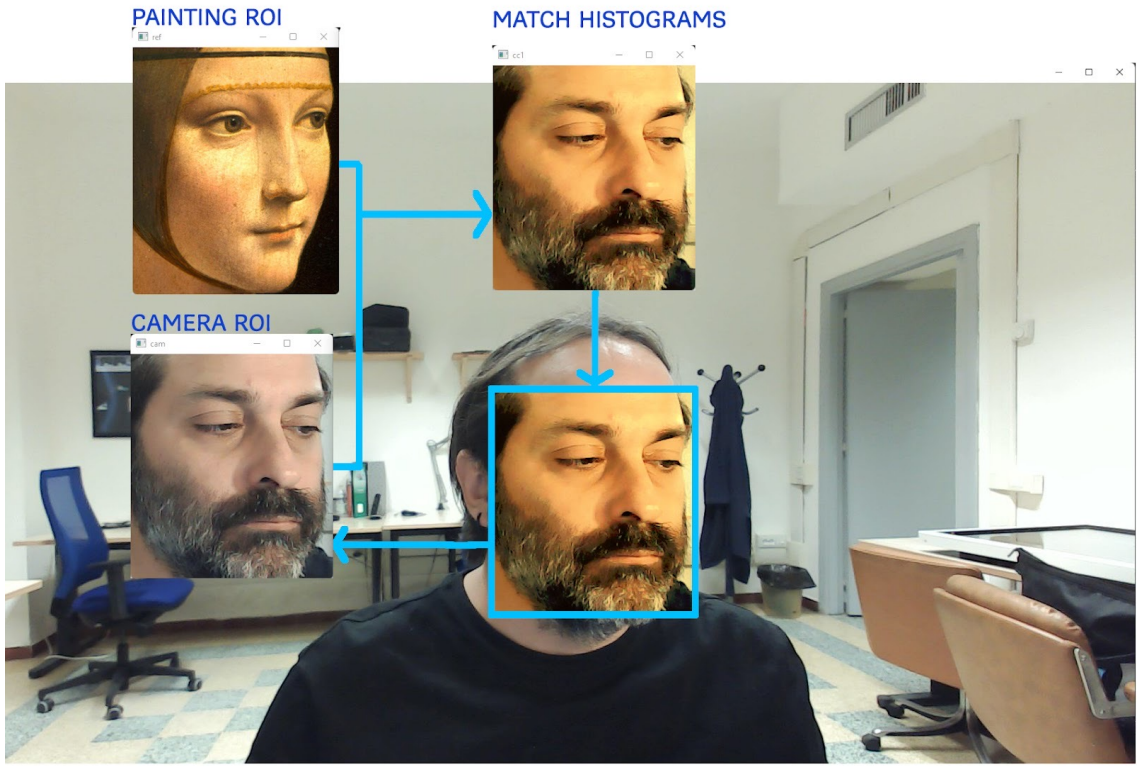
Face matching: expression

- The expression is evaluated according to the open/closed status of mouth and eyes and is evaluated once the pose is matched

- Pose and expression matching can be computed on mobile devices, so the web app version runs these operations without delay on the user device

Creating the merged image

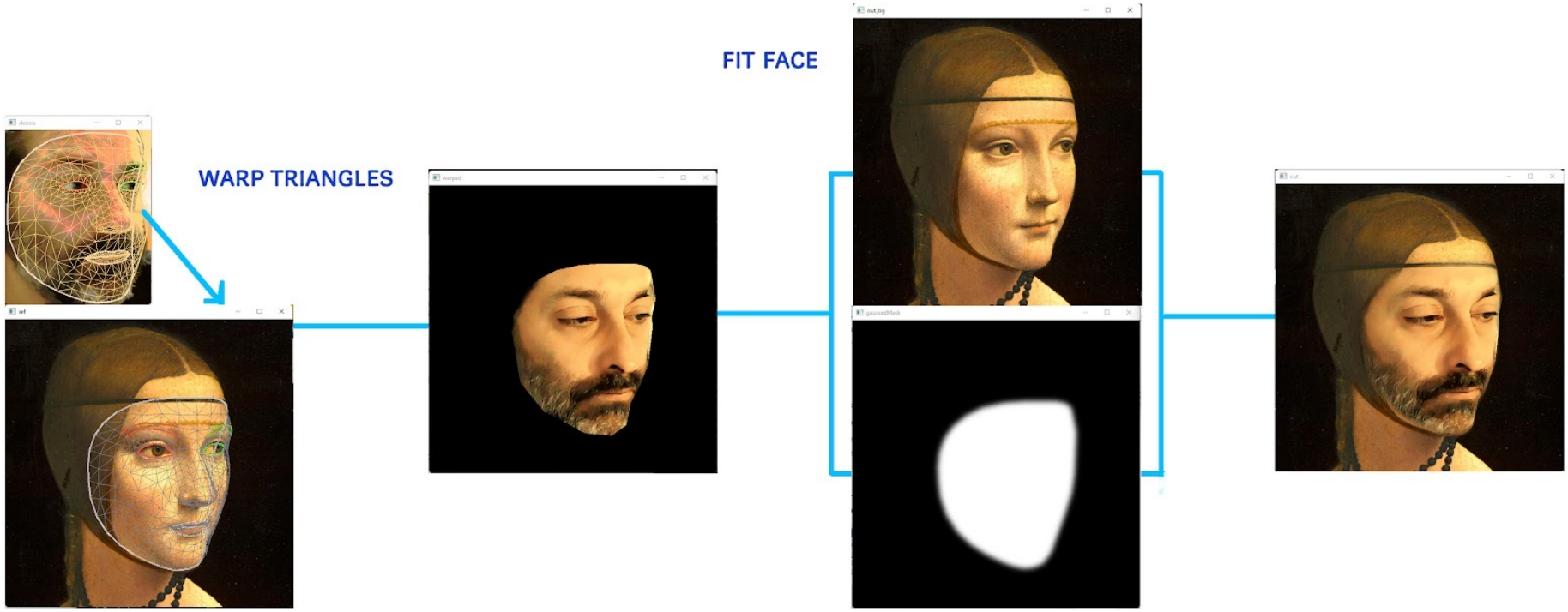
- Merging the image of a webcam in the content of the artwork is more complex and requires to:
  - Compute image noise of the artwork
  - Match the color palette of the artwork and apply it to the webcam image – it's a kind of color correction



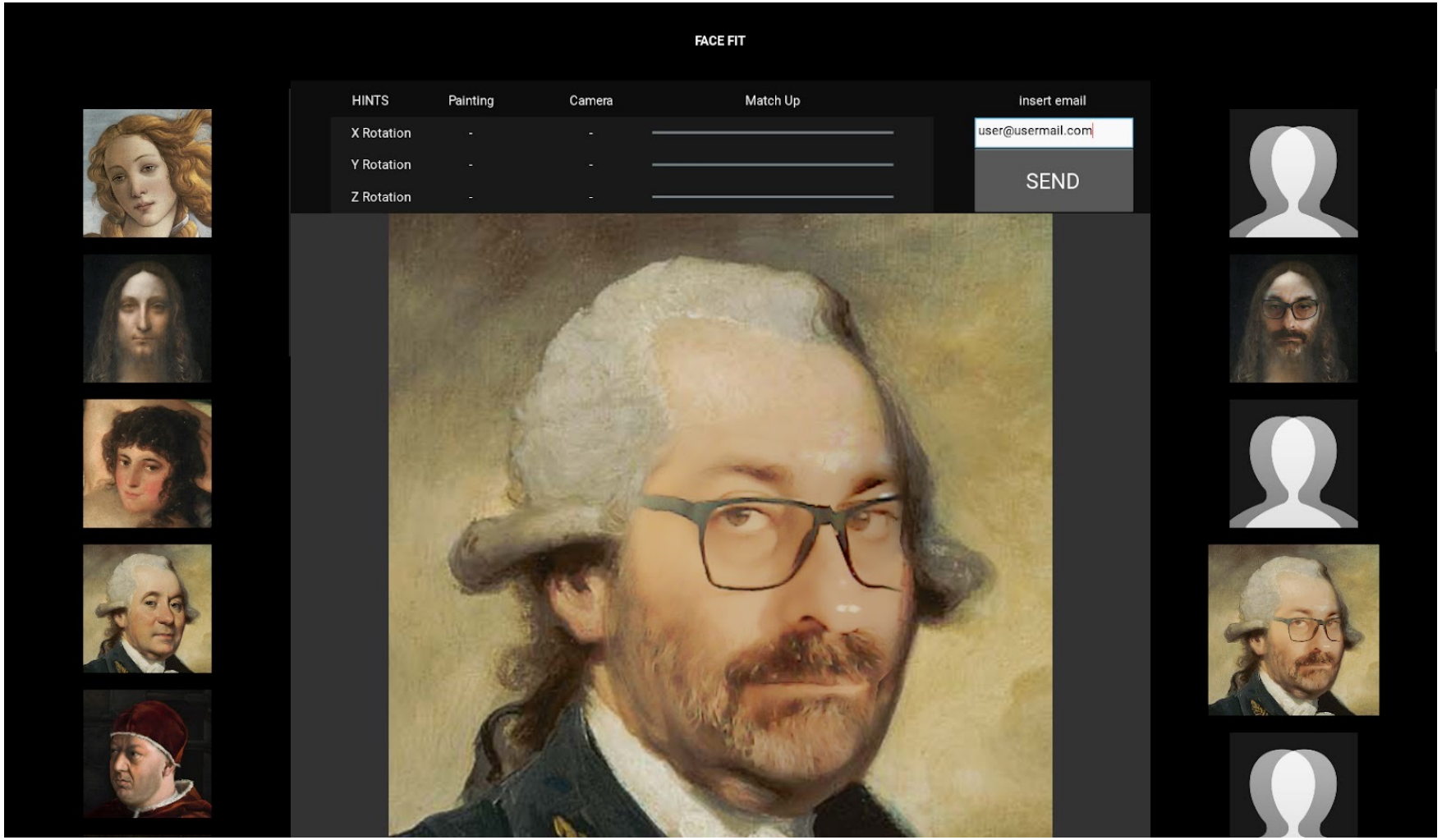
Morphing meshes

- The neural network allows to compute a 3D mesh, and each triangle of the mesh of the webcam image is transformed using an affine transformation to the triangle of the artwork
- The resulting image is masked on the painting (adding some image processing to better merge it)
  - The mask is computed as concave hull to avoid including background elements
- The noise computed on the artwork is applied to the masked face (sort of transferring the style of the painting to the face of the user)

Morphing faces



Morphing face



Images and info for users

Your Face-Fit Images ! Inbox ×

fitface.unifi@gmail.com
to me

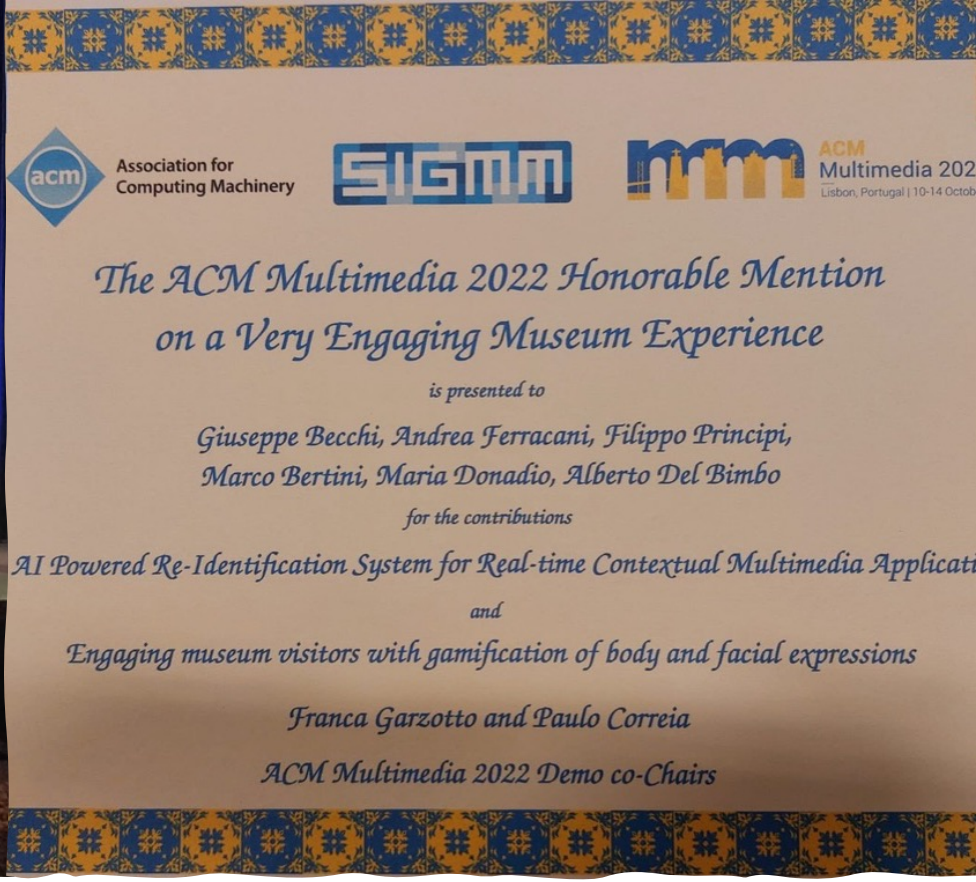
Hello,
Face-Fit App here. These are the results of your matches.
The characters in which you impersonated yourself are:

- Jesus Christ of the painting Salvator Mundi attributed in whole or in part to the Italian High Renaissance artist Leonardo da Vinci.
- the gentleman portrayed in Portrait of a gentleman, bust-length, in East India Company uniform painted by George Romney
- Cecilia Gallerani, subject of the painting Lady with an Ermine, widely attributed to the Italian Renaissance artist Leonardo da Vinci.
  Curiosity: it is the second of only four surviving portraits of women painted by Leonardo.
- Frida Kahlo, in the Self Portrait with Bonito
- Bacchus, subject of the Young Sick Bacchus by Italian Baroque master Michelangelo Merisi da Caravaggio.
  Curiosity: the painting is also known as the Self-Portrait as Bacchus.
- the farmer in the painting American Gothic by Grant Wood.
  Curiosity: American Gothic is one of the most familiar images of 20th-century American art and has been widely parodied in American popular culture.
- Joseph Benedikt Withalm, a master builder in Graz, subject of the portraid painted by Josef Schladerer.
- Jonas von Wilferstorf, an Austrian baron, portrayed by an unknown painter at the age of 26.

8 Attachments • Scanned by Gmail ⓘ

ReInHerit Digital Hub

FANTASTIC APPS FOR VISITORS ENGAGEMENT AND WHERE TO FIND THEM



ACM Multimedia 2022 Award

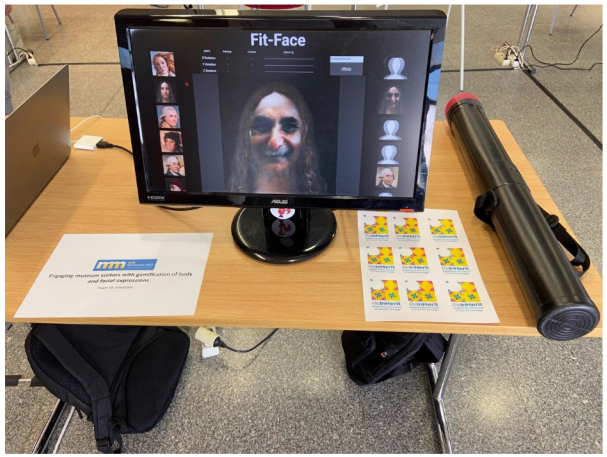
- ACM Multimedia is the foremost international conference on multimedia
- Strike-a-pose and Face-fit where demoed to the attendees of the conferences

ACM Multimedia 2022 demos

ACM Multimedia 2022 demos








Open Source Apps

- Full source code of the two systems will be made available on the digital hub of the EU ReInHerit project (https://www.reinherit.eu) to ease the adoption of gamified e-guides by small museums that can not afford the full development of such applications.
- Discuss the apps on the ReInHerit forum !
- Neep help or suggestions ? Contact us !

Open Source Apps

- On the ReInHerit Digital Hub (https://reinherit-hub.eu) you'll find:
  - Links to the Github repositories of the apps
  - Documents describing how to use them
  - Examples of use
  - The ACM Multimedia 2022 demo paper
  - Link to the ReInHerit forum to discuss the apps

Want more info ?

- Interested in these apps ? Have more questions ?

- Contact me at marco.bertini@unifi.it