Assignment 1: Computer Vision

DEADLINE: Friday 2023/11/17 at 17:00 (Stockholm time).

Overview

The objective of Assignment 1 is to test your knowledge of the skills learned in Lab 1:

1. Processing of image data using ImageIO and OpenCV.
2. Processing of face features using Py-Feat.

In this assignment, you will process and analyse a small dataset consisting of stock photos. You will create visualizations, process face features, and analyse which features are most likely to be important in order to predict an emotional state.

The Dataset

With this document, you should have also obtained the ZIP file `freepik_dataset.zip`, with the following structure:

```
dataset
├── annotations.csv
├── attribution.csv
└── images
    ├── arguing.jpg
    ├── back-off.jpg
        ...
```

The folder `images/` contains 20 stock pictures downloaded from Freepik, each containing one or more individuals expressing emotions. Each image has a corresponding entry in the CSV file `annotations.csv`, indicating if the picture's *valence* is `positive` or `negative`. For more information about the individual pictures, you can check `attribution.csv` on the dataset, or the **Attribution** section in this document.

Note: *If you use free resources from the internet, make sure you follow the terms and conditions! In this case, the images are explicitly designated as free to use, and the free license requires the user to give attribution to the original authors. Just because something shows up in Google Images, it doesn't mean you have a legal right to create derivative works or re-distribute it.*

Example images from the dataset.

Instructions

The assignment is graded pass or fail. You must submit a ZIP file with all the required contents through Studium before the deadline. See the **Deliverables** section for details on the structure and contents of the ZIP file.

Code

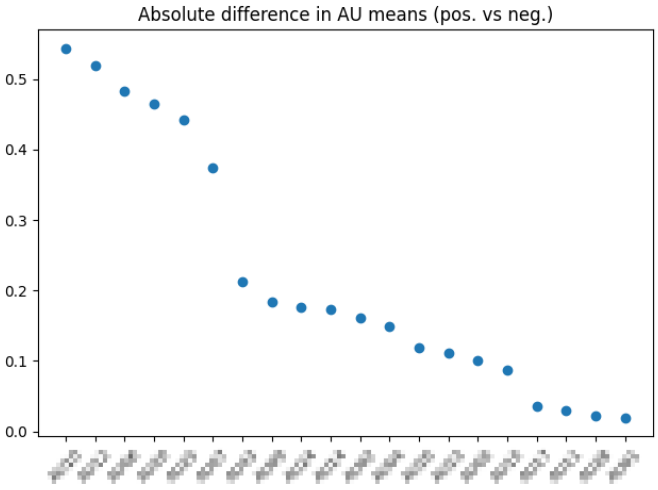
There is no code template for this assignment. You must write your own code that performs the following steps (note that this can be split among several scripts):

1. Use the Py-Feat detector to analyse every picture in the dataset.
    - Create a visualization of each image by overlaying information on top of the original image. You must show the face bounding boxes and the primary expressed emotion. Store the results in an output folder, with each visualization image named the same as the original picture.
    - Accumulate all the AU activations provided by Py-Feat for each face in each frame, and save them into a CSV file named `aus.csv`. The file must contain a column named `file` containing the name of the image each row corresponds to. It must also contain another column named `face` that acts as a sequential identifier for each face in the image (i.e., it goes up 0, 1, 2... for each face found in the same image).

Example visualizations like the ones your code should produce.

2. Analyse and visualize the extracted features.
    - Separate the AU data into the samples coming from the *positive condition* (valence of the image is positive, as given in `annotations.csv`) vs. the *negative condition* (valence is

negative).
- For each condition (positive vs. negative) and each AU (`AU01, AU02, AU04, ...`), calculate the mean value.
- For each AU, calculate the absolute difference between the positive mean and the negative mean (i.e. `|positive - negative|`, ignoring the sign).
- Sort the AUs from biggest absolute difference of means to smallest absolute difference of means.
- Display the sorted AUs as a graph. Save the graph as `au_visualization.png`.
  - The `x` axis must correspond to which AU is being plotted, in the sorted order. Each data point must be correctly labeled with the name of the AU.
  - The `y` axis must correspond to the absolute difference of means for that AU.
  - By default, `plt.plot()` connects all the points as if they belonged to a continuous function. Given the discrete nature of the `x` axis, we recommend using individual markers to display each data point (see [the PyPlot docs](https://matplotlib.org/stable/api/_as_gen/matplotlib.pyplot.plot.html)).



Example graph like the one your code should produce. The labels have been obscured, and a different dataset was used.

Reflections

Besides the code and its outputs, you must include a PDF file with your reflections on the following questions:

1. The Py-Feat detector has several stages. First it finds the faces in an image, and then it uses this information to extract other forms of data (AU activations, expressed emotion, ...).
   - Based on the visualization you produced, do you agree with all its predictions?
   - What seems to confuse the system when it fails?
   - Are there any cases that would be tricky for a human observer?
2. Based on the analysis of the AU data you have performed, suppose you need to choose a subset of the AUs as inputs for a predictive algorithm.
   - Which AUs would you choose, and why?
   - What's the problem with using *too many* features?

Deliverables

Abbreviating from Wikipedia: *"A deliverable is a good produced as a result of a project that is intended to be delivered to a customer."*

The *deliverables* for this assignment (i.e., the things you're expected to submit for grading) must be packed as a ZIP file containing the following folder structure:

```
<zip file>
├── processed
│   ├── au_visualization.png
│   ├── aus.csv
│   └── images
│       ├── arguing.jpg
│       ├── back-off.jpg
│       └── ...
└── scripts
    └── ...
```

- The folder `scripts/` must contain all the code you used to complete this assignment. We should be able to run it from the top-level folder.
- The folder `processed/` must contain the outputs from said scripts. In particular:
  - The subfolder `processed/images/` must contain the visualization for each image in the dataset. Note that we use the same name for the visualization as for the original image.
  - The file `processed/aus.csv` must contain the full set of AU activations (as returned by Py-Feat) for each face detected in each image. Each row must contain two index columns: `file` (with the name of the image this row corresponds to) and `face` (sequential per image, starting at 0 for the first face in the image).
  - The file `processed/au_visualization.png` must be an image rendered in PyPlot, showing the absolute difference in means between the positive and negative sample sets for each AU, ordered from the biggest difference to the smallest difference.

Attribution

Name	Link	Creator
thumbs-up	https://www.freepik.com/free-photo/portrait-fair-haired-beautiful-female-woman-with-broad-smile-thumbs-up_9116647.htm	cookie_studio
sad-man	https://www.freepik.com/free-photo/depressed-young-spanish-male-sitting-chair-leaning-his-head-against-wall_22860234.htm	wirestock
claws	https://www.freepik.com/free-photo/young-beautiful-woman-wearing-casual-clothes-doing-claw-gesture-as-cat_14265327.htm	azerbaijan_stockers
laughing-couple	https://www.freepik.com/free-photo/young-couple-wearing-blank-shirt_23992148.htm	Freepik

Name	Link	Creator
by-the-sea	https://www.freepik.com/free-photo/sad-couple-sitting-together-outdoors_47698002.htm	Freepik
arguing	https://www.freepik.com/free-photo/young-couple-having-argument-conflict-bad-relationships-angry-fury-woman-angry-young-couple-sit-couch-living-room-having-family-fight-quarrel-suffer-from-misunderstanding_28871200.htm	stefamerpik
enjoying-the-sun	https://www.freepik.com/free-photo/carefree-asian-girl-laughing-dancing-park-enjoying-summer-sunny-day-raising-hands-up-brea_34636189.htm	benzoix
piggyback	https://www.freepik.com/free-photo/excited-man-black-denim-jacket-chilling-with-girlfriend-outdoor-portrait-happy-couple-exploring-city_12152891.htm	lookstudio
back-off	https://www.freepik.com/free-photo/young-hispanic-woman-working-small-business-ecommerce-moving-away-hands-palms-showing-refusal-denial-with-afraid-disgusting-expression-stop-forbidden_39467467.htm	krakenimages.com
handshake	https://www.freepik.com/free-photo/happy-coworkes-shaking-hands-after-business-presentation-office_26390827.htm	Drazen Zigic
tablet	https://www.freepik.com/free-photo/young-hispanic-woman-using-touchpad-sitting-table-night-depressed-worry-distress-crying-angry-afraid-sad-expression_60413697.htm	krakenimages.com
happy-man	https://www.freepik.com/free-photo/portrait-smiling-african-man-living-room_17293810.htm	gpointstudio
sad-woman	https://www.freepik.com/free-photo/young-depressed-adult-home_29973199.htm	Freepik
business	https://www.freepik.com/free-photo/working-businessman_5633753.htm	pressfoto
pain	https://www.freepik.com/free-photo/young-annoyed-blonde-office-worker-man-headphones-sits-desk-with-office-tools-using-laptop-holds-his-back-looking-up-isolated-white-background-with-copy-space_13321390.htm	stockking
students	https://www.freepik.com/free-photo/group-young-college-students-smart-casual-wear-campus-friends-brainstorming-meeting-talking-discussing-work-ideas-new-design-project-modern-office-coworker-teamwork-startup-concept_10075812.htm	tirachardz

Name	Link	Creator
bills	https://www.freepik.com/free-photo/young-asian-pregnant-couple-records-income-expenses-home-mom-worried-serious-stress-while-record-budget-tax-financial-document-working-living-room-home_6141954.htm	tirachardz
bullied	https://www.freepik.com/free-photo/front-view-boy-being-bullied-by-colleague_32519170.htm	Freepik
disagreement	https://www.freepik.com/free-photo/young-colleagues-communicating-during-business-brake-office_7838570.htm	cookie_studio
grandparents	https://www.freepik.com/free-photo/cheerful-grandparents-granddaughter-having-fun-together-home_26634291.htm	Drazen Zigic