FACIAL FEATURES DETECTION

DS 303 - Introduction to Machine Learning Course Project

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Contribution of each member

- Bhavya Kohli: 20d070021

  Worked on both the ML stages.

- Amruta Parulekar: 20d070009

  Made the PPT and worked on the first ML stage and code commenting.

- Tanmay Joshi: 200070027

  Worked on both the ML stages.

- Sameep Chattopadhyay: 20d070067

  Worked on the second ML stage and helped in the PPT and code commenting.

Problem Definition and Relevance

In the modern age, facial recognition has several applications. It can be used for-

- Organising photos
- Identity validation
- Tracking criminals and missing persons

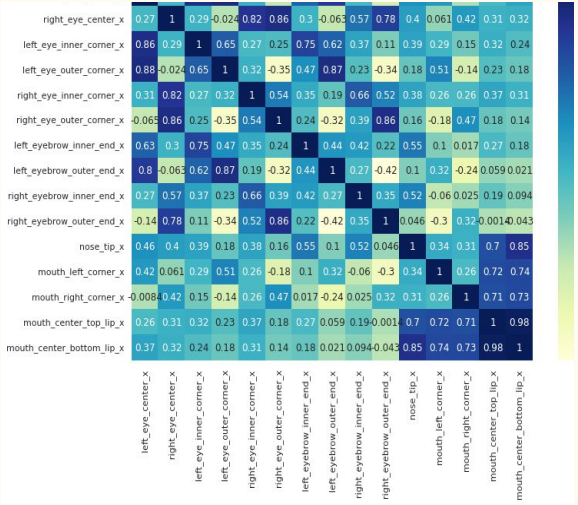
In this project, we aim to demonstrate the usage of the *fastai* library as a faster and more efficient computational tool for feature extraction in order to perform facial recognition and detect whether any two given images belong to the same person or not

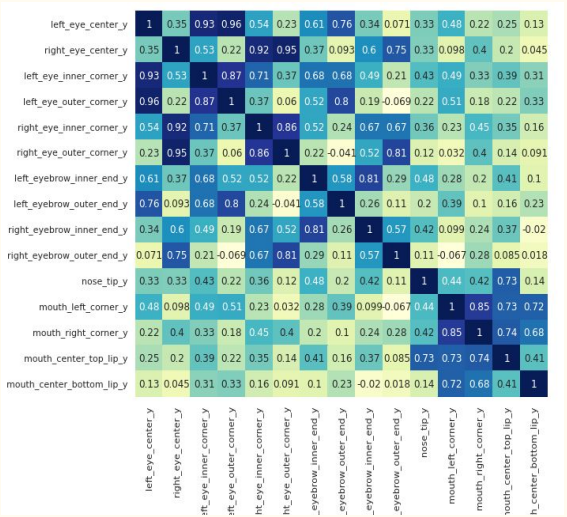
Proposed solution

- For the facial recognition, we are implementing a two stage algorithm.
- Firstly, we perform facial detection on the given image and crop the face portion in order to extract certain facial features.
- We extract 15 points from each face, including the locations of the centres and corners of the eyes, nose and mouth using fastai.
- Then these 15 points are used to compare the facial features of any two images and return a single value, 0 or 1, which predicts whether the images belong to the same person or not
- We have used convolutional neural networks for our project- the cnn_learner method.

Step 1: Exploratory Data Analysis

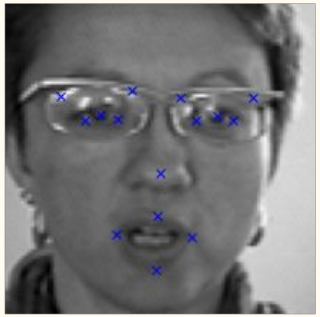
- The data was thoroughly analysed and various attributes of the variables printed.
- Heatmaps of the x coordinates and y coordinates of different features were made.
- Other plots were made to see the general location of important points like the centres of eyes and the tip of the nose.



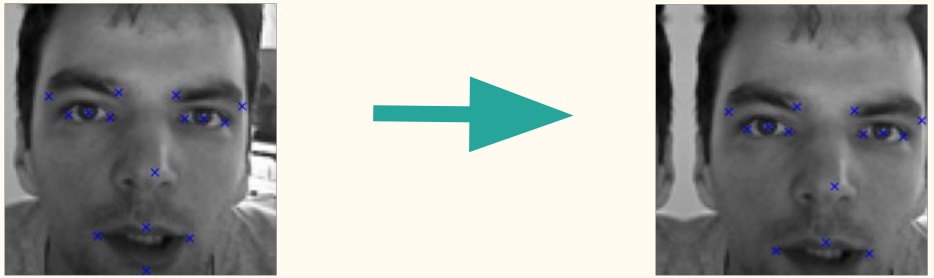


Step 2: Feature extraction and image augmentation

15 Facial features such as nose tip, centres & corners of eyes and mouth are detected from the images from the given dataset as shown below-



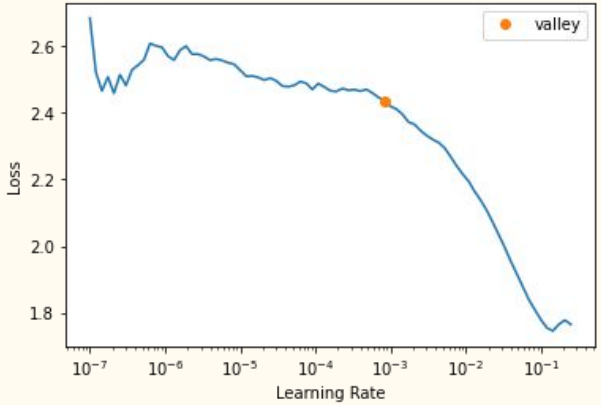
The images were augmented (Shifted and/or rotated) in order to make the model more generalised and capable of identifying faces that are not straight.



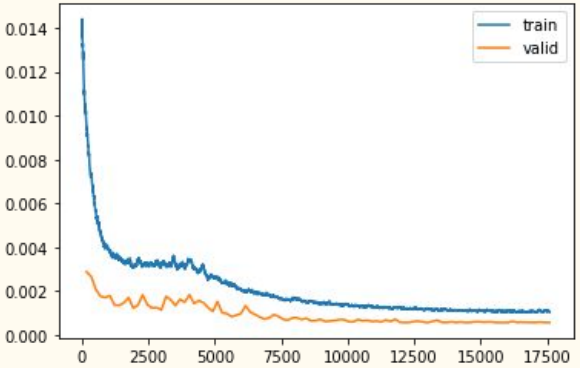
Step 3: Learner model (Using cnn_learner method in fastai)

- A loss function was defined for the learner model, using mean square error on the flattened image. We made sure to deal with the *nan* values in places where augmentation removed points from the image.
- Transfer learning is a technique where you use a model trained on a very large dataset and then adapt it to your own dataset. We have used Resnet18 for our model.
- We used the *cnn_learner* method in *fastai* and initialized it with *resnet18* and our *data loader*.
- The model summary and model details were printed.
- We used a learning rate finder, which plots lr vs loss relationship for a Learner and helps pick a good starting learning rate.
- We also plotted the loss with every iteration and observe how it is reduced

Step 4: Analysis and predictions

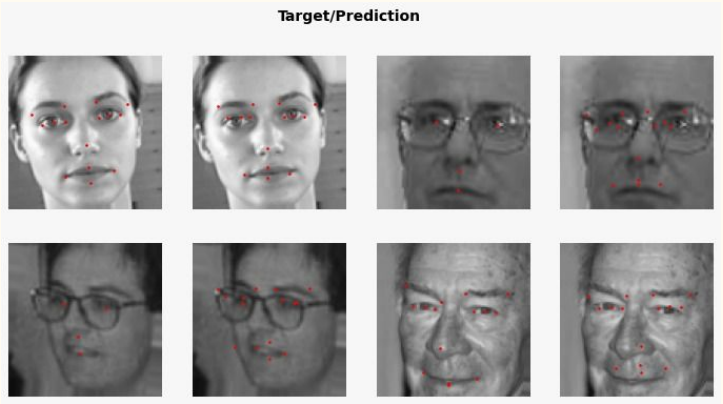


Plot of learning rate vs loss to find good starting learning rate



Plot of Loss function of Learner with iterations

A sample of the training images along with their points (red dots), after augmentation



The actual points on the training images, along with the predicted points

Step 5: Feature comparison

- We have used the LFW dataset of Massachusetts university for the second stage of our project
- The images of the dataset are first cropped and preprocessed in order to just have the faces, and stage 1 step are applied to obtain feature points
- Then we feed 13 points to a function that calculates the distances between each possible pair of these 13 points eg- distance between eyes, length of lips etc.
- Now, for any pair of training images of the same person, the l_2 norm of every such corresponding distance pair was calculated.

- The root mean square of these norms was calculated for every image pair.
- The RMS values of the norm were used to set a threshold value
- Now for the test images, if the root mean square value is more than the threshold value, the image is not a match and otherwise it is a match
- The testing was done on 1000 pairs of images and the accuracy was calculated

Conclusion

- Finally, we have successfully created a model that compares two images and identifies whether they belong to the same person or not.
- Obtained Accuracy of the model -
- There is possibility of further improvement in the model by training the model on images of people of different ages and ethnicities
- We can use this model in making face locks, locating people in crowds etc
- Similar methods can be used for facial emotion recognition, age recognition and many other such cases.

Citations

Face Cropping - https://stackoverflow.com/questions/13211745/detect-face-then-autocrop-pictures

Feature Detection-

https://www.kaggle.com/code/chr9843/myfacialkeypointsnb/notebook

Labeled Faces in Wild Dataset (University of Massachusetts- Amherst) -

http://vis-www.cs.umass.edu/lfw/