ECE 763 Project-3 Adaptive Boosting for Face Detection

Introduction:

The aim is to obtain a strong face detector using a group of weak classifiers by the method of AdaBoost (Adaptive Boosting). This method identifies and weighs a set of weak classifiers whose combination provides much larger accuracy than any of the individual classifiers.

Input:

- The data used for this program is obtained from the FDDB face dataset.
- The dataset consists of positive-Face and negative-Nonface data. Face data is extracted from images using the annotation provided and Non-Face images have been cropped from the background.
- Training Data: 1000 Face + 1000 Non-Face images
  (All images resized to 20X20 Greyscale)
- The input data is labelled +1 for face and -1 for non-face.
- The input also consists of a large set of week classifiers. This program uses Haar features as the weak classifiers.

Haar Features:

- A Haar-like feature considers adjacent rectangular regions at a specific location in a detection window, sums up the pixel intensities in each region and calculates the difference between these sums.

- The Haar feature uses the different edge like characteristics in the face which leads to transitions from dark to light regions in the grayscale image.
- This difference in intensities distinguishes a face image from nonface images.
- This classification is done based on a threshold.
- There are many Haar features available based on the type of edges and intensity variation.
- The following 4 are used in this program.

  Edge Feature 2-x(intensity variation along x direction)

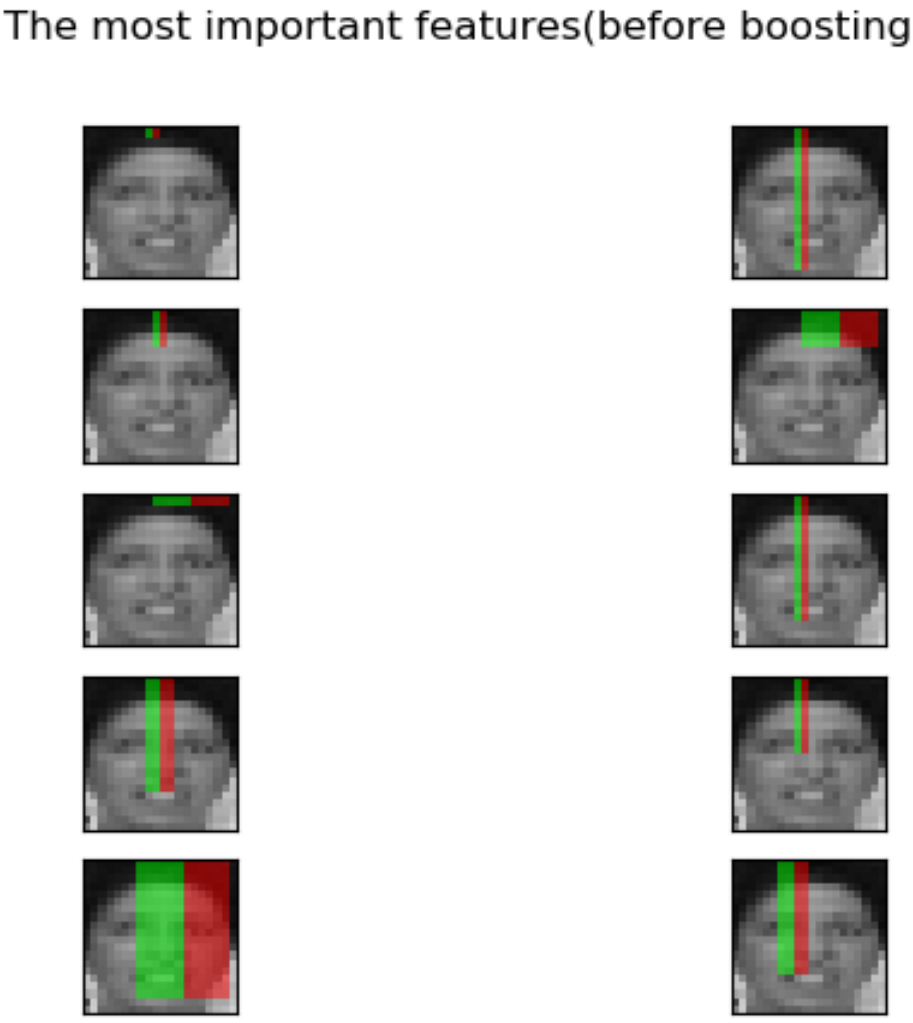
  Edge Feature 2-y(intensity variation along y direction)

  Line Feature 3-x(intensity varying twice along x direction)

  Line Feature 3-y(intensity varying twice along y direction)

- All possible Features of above 4 types are extracted for each of the images.
- The mean of each of the feature across 100 face and nonface image is used as the threshold of classification of the weak classifiers.

For purpose of comparison, we have obtained the top 10 features based on classification error of each with respect to 1000 face and nonface training data. These 10 features before boosting are as follows:



Training and Adaptive Boosting:

The Ada-boost algorithm is as follows

- Initially all the Training data are given an equal weight of 1/(number of training images). The following steps are performed iteratively.

1. Compute the weighted error for each of the weak classifiers based on the weights of each data and the number of wrong classifications of each classifier across all training data.
2. The feature with the least error from previous step is added to the final list contributing to the final strong classifier. The weightage of this classifier with respect to the final list of classifiers in the strong classifier is calculated based on the error obtained in previous step.
3. The weights of all data points are altered based on the selected feature and its weightage from previous step.

- This procedure is performed repeatedly for M iterations. In this project, Number of iterations=100. This means that there are 100 weak classifiers in the final classifier.

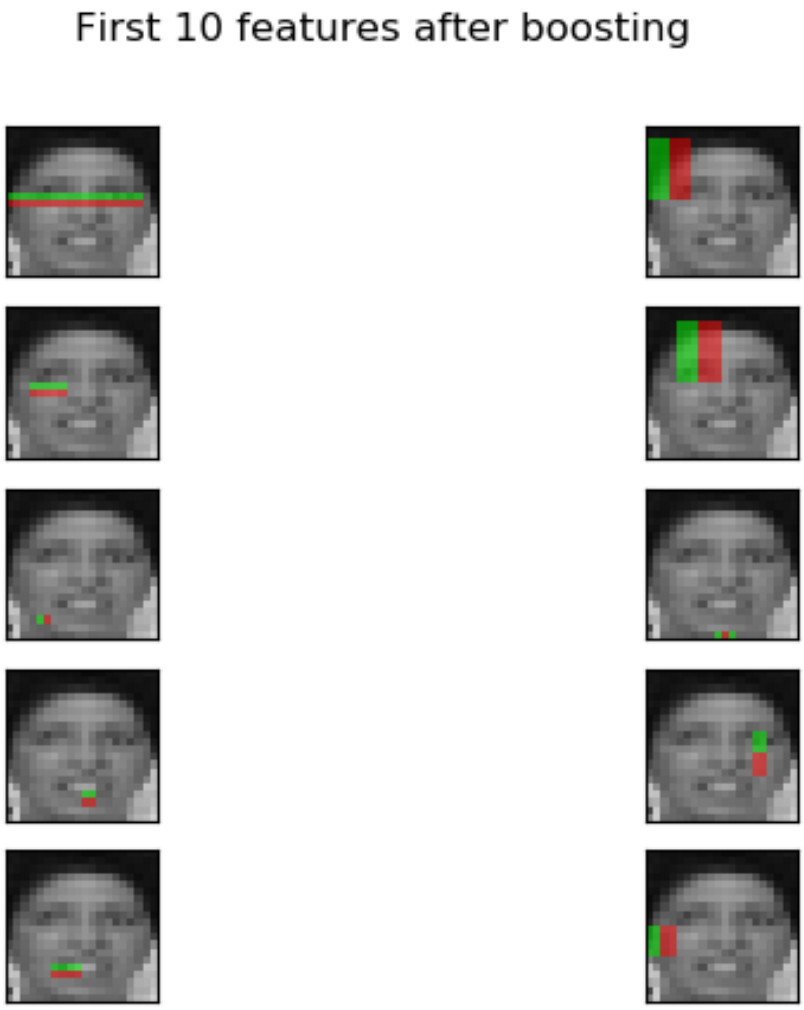
Output of Algorithm:

The algorithm outputs a strong classifier as follows,

$$H(x) = sign\left(\sum_{i=1}^{M} \alpha_i h_i(x)\right)$$

Where, H – Strong classifier
x – input image
M – Number of weak classifiers selected by Adaptive boosting
h_i – i^{th} weak classifier
α_i – weight corresponding to h_i

- The first 10 features (out of 100) in the strong classifier as chosen by the Ada boost algorithm is as shown below:



(It is seen that this is much different from the ones before boosting)

Testing Results:

- Training data used: 100 Face + 100 Nonface images
  (also obtained from FDDB dataset).

- Using the final strong classifiers, the results obtained are as follows (for a total of 200 images). Accuracy=91%

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number of True Positives= 84
number of True Negatives= 98
number of False Positives= 16
number of False Negatives= 2
accuracy 91.0
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- The ROC curve is as given below.