AdaBoost for Face Detection

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AdaBoost stands for **Ada**ptive **Boosting**, which builds a strong classifier from many individually weak learners.

AdaBoost

AdaBoost is a method for face detection which uses many simple classifiers. The weak learner makes a simple binary decision for a single feature

$$h_1(x) \in \{-1, 1\} \ldots h_T(x) \in \{-1, 1\}$$

For all the T features, we have a simple classifier which makes a decision that's better than a random decision. Then, if we take a weighted sum of the simple classifiers, we can get a strong classifier. [1]

$$H_T(x) = \text{sign}(\sum_{t=1}^{T} \alpha_t h_t(x))$$

[1] In this formula, the α value is the weight of the classifier.

AdaBoost Process

We first assume a uniform distribution and choose a classifier with a minimal weighted error. Then we increase the weight of the misclassified elements and thus make our decision for the next round.

Then we repeat the step, and choose the classifier with the minimal weighted error. Since in the previous step we increased the weights of the misclassified points, this will "pull" the classifier line towards those elements. After the second iteration we again increase the weights of the misclassified elements.

The main objective of AdaBoost is to find the model h_t which classifies correctly at the highest rate. We also want to find the highest **margin** between the decision boundary and the data points. We do this by using the negative exponent of α.

For face detection, we sometimes use a **sliding window**, where we have a window of a set size and we pan it across an image to test for possible faces. However, we have comparatively few faces in an image, and scanning that many pixels can be quite demanding.Since we have so many possible places for there to be a face, we can't spend that much time on any one individually, since that will increase our computation.

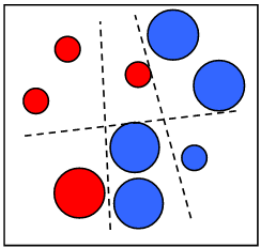

Figure 1: The three dashed lines are individually weak classifiers, since they all mislabel a couple of data points. However, if our model $H(x)$ uses all three classifers, the combined results will be quite strong.

Viola and Jones' Face Detector

This face detector is quite influential and is the model used in real-time applications. Its training phase is slow but the actual face detection is quite fast. We have four types of rectangle features, which whose difference should let us know if it's likely for there to be a face in the image.

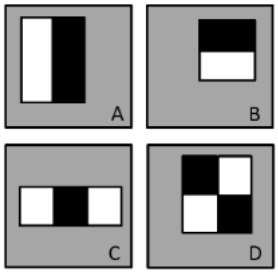

Figure 2: To quickly determine the possiblity of a face, we take the difference of the white and black areas over a region of an image. These patterns roughly correspond to facial features.