Project II: Human face detection by Boosting techniques

Due on Nov 9

1. Objectives.

Boosting is a general method for improving the accuracy of any given learning algorithm. Specially, one can use it to combine simple "rules" (or weak learner), each performing only slightly better than random guess, to form an arbitrarily good hypothesis.

In this project, you are required to implement an AdaBoost and RealBoost algorithms for frontal human face detection, but cascade is not required.

2. The project includes the following steps.

2.1. Construction of weak classifiers

Design a few types of features as we discussed in class, and vary their size and location to generate about 10^5 features. For each feature calculate the histograms for the positive and negative populations. Determine the threshold. Each feature corresponds to a weak classifier, and is also called a tree-stump.   [Note that as the samples change their weights over time, the histogram and threshold will change.]

2.2. AdaBoosting

Implement the Adaboost algorithm to boost the weak classifiers you got in (2.1).
   i) Display the best ten features as images (after boosting);
   ii) At steps T=0, 10, 50, 100 respectively, plot the curve for the training errors of top 1000 weak classifiers among the pool of weak classifiers in increasing order.
      Compare these four curves and see how many weak classifiers have errors close to 1/2;
      iii) Plot the histograms of the positive and negative populations over the F(x) axis, for T=10, 50, 100 respectively.
      From the three histograms, you plot their corresponding ROC curves.
   [Note: You can continue to T= 200, or 500 as long as its performance keeps improving.]

2.3. RealBoosting

   Implement RealBoosting algorithm using the top T=10, 50, 100 features you have chosen at Adaboosting step 2.2.
      (iv) Plot the histograms of the positive and negative populations over the F(x) axis, for T=10, 50, 100 respectively.
      (v) Plot the three ROC curves and comparing them against the ROC's in 2.2.

3. Datasets

Training data: Face dataset and Non-face dataset in the size of 16x16 pixels are given to you.
   [Warning: The training of Boosting code takes a long time, so use a small number of examples when you test your codes, and then run the full dataset after you verify your code.]

Test data: Two class photos are given. [Note that you need to scale the image into a few scales so that the faces at the fron and back are 16x16 pixels in one of the scaled image].   Run you code and do some non-maximum suppression, i.e. when two positive detection overlaps significantly, choose the one has higher score.

Hard negative mining. 3 background images are taken without faces, you can run your detector on these images. Any "faces" detected by your code are called "hard negatives". Add them to the training set and re-train (don't start over, just add them at the end of where you stopped).