Face Detection Using Adaboost

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1 Implement AdaBoost

(a). Haar filters

Implement AdaBoost for T=100. In each iteration, return the Haar filter with lowest weighted error from the filters pools, we display the first 20 Haar filters as below. By the shape of filters, we can see different filters can detect different parts of the faces.

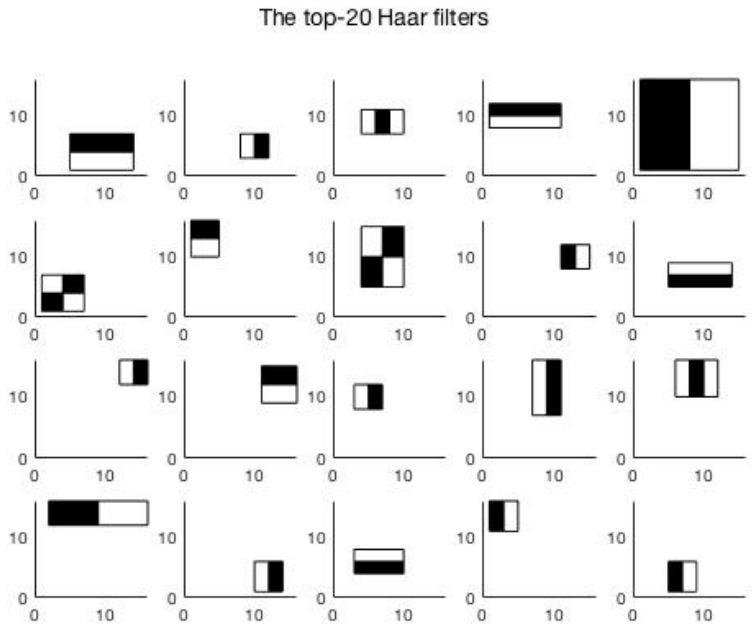

Figure 1: Top-20 Haar filters for AdaBoost

(b). Training error of strong classifier

As the number of weak classifiers T increasing, we can see the graph below that the training error of strong classifier keep going down, which means the

performance of model become better and better, and the boosting process really works.

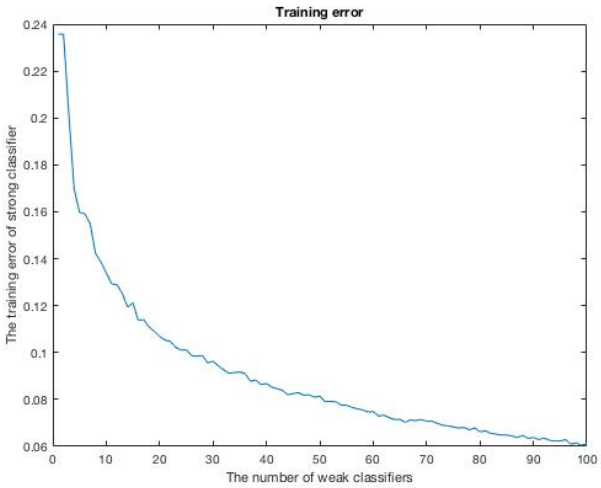

Figure 2: AdaBoost Training Error

(c). Traning errors of weak classifiers

From the graph of weak error below, we can see as number of weak classifiers T increasing, the weak error become larger. I think the reason is we keep decrease the weights of right classification and increase the weights of wrong classification, and those wrong classifications are hard to classify in nature, which results the performance of weak classifier become worse. Besides, we can see during one iteration, the error also keep going up.

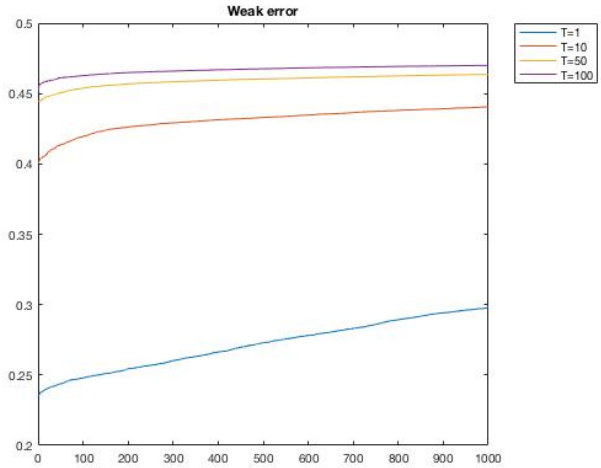

Figure 3: AdaBoost Error of weak classfiers

(d). Histograms

From the histograms of AdaBoost at T=10,T=50 and T=100, we can know as the T increasing, the ditributions of faces and non-faces become more and more separatble, which means the performance of our model become better and better.

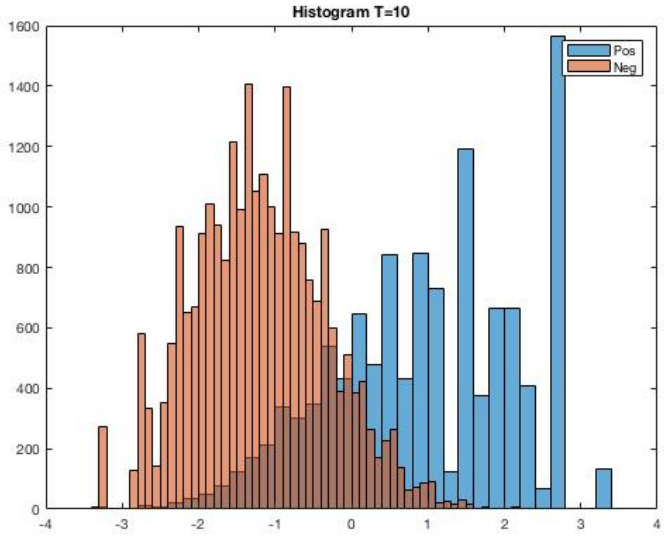

Figure 4: AdaBoost histogram for T=10

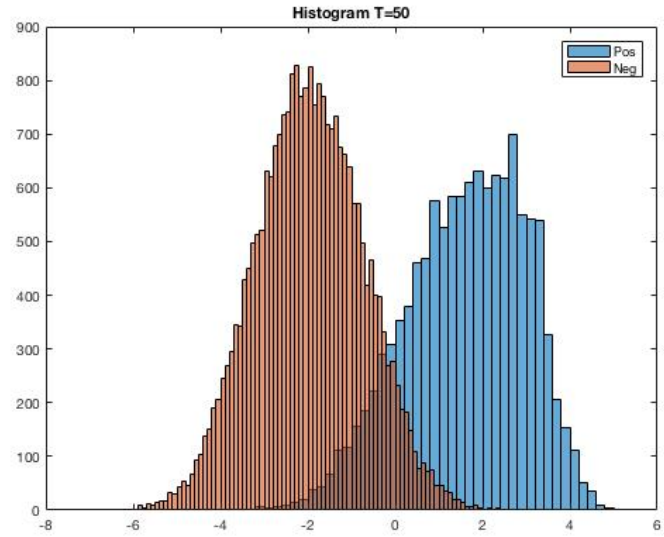

Figure 5: AdaBoost histogram for T=50

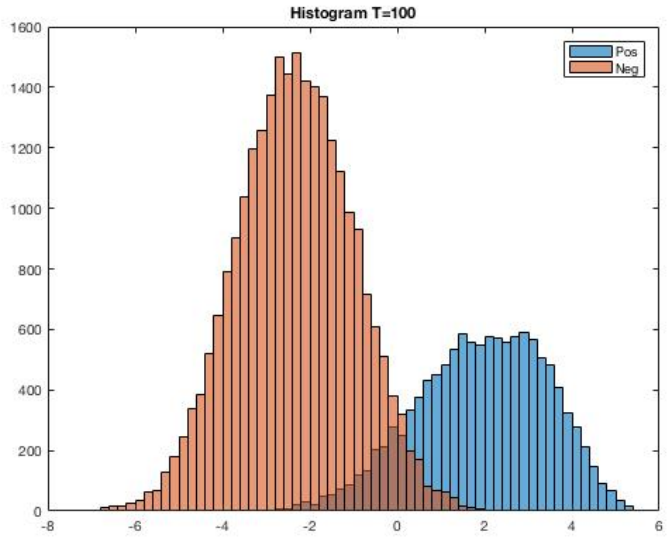

Figure 6: AdaBoost histogram for T=100

(e). ROC Curve

The ROC Curve is a graphical plot that illustrates the diagnostic ability of a binary classifier system as its discrimination threshold is varied, and more to the upper left corner more better. From the Figure 7 below, we can see as the number of weak classifiers T increasing, the performance of our model becomes better and better.

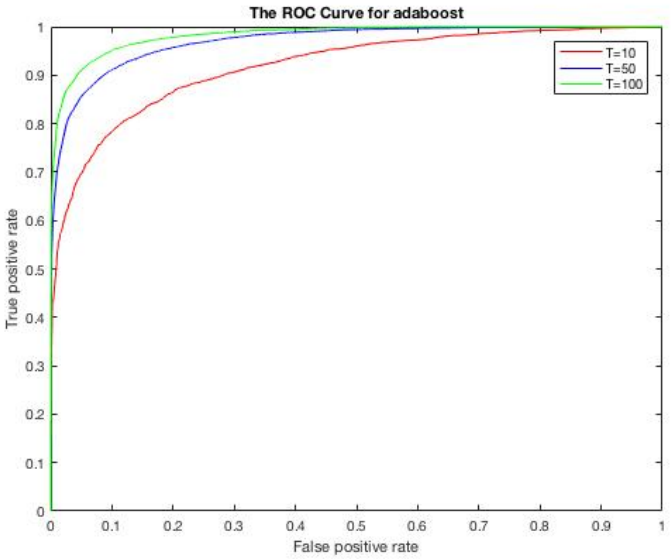

Figure 7: ROC curve for adaboost

(f). Detections

We use our training strong classifer to detect faces on the 3 provided testing images, in order to make our picture clear to see, we only display detection whose vote score is more than 1.2, and we can see our detection results before hard negative mining are very meanningful.

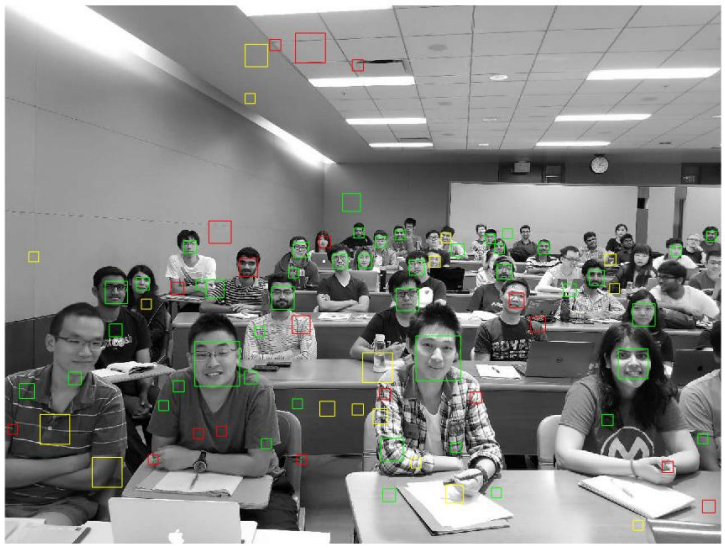

Figure 8: Detection image 1 before hard negative mining

Figure 9: Detection image 2 before hard negative mining

Figure 10: Detection image 3 before hard negative mining

(g). Hard negative mining

Although the detections above are meaningful, we can see some background are detected to be faces. In order to reduce the chance to detect background as faces, we take those misclassifications from the 3 non-face testing images, and put them into our non-face training data, and retrain our model (for computing speed, we reduce some original non-face training data). From the picture below, we can see the detection results after hard negative mining become clean and better, which means our approach really works.

Figure 11: Detection image 1 after hard negative mining

Figure 12: Detection image 2 after hard negative mining

Figure 13: Detection image 3 after hard negative mining

2 Implement RealBoost

From above process, we know that AdaBoost works well on face detection. However, in AdaBoost, each weak classifier is limited to a step function of one parameter, and we think we can extent to more general form; thus, we implement RealBoost algorithm on the 100 filters chosen in step (c).

(a). Histograms

From the graphs below, we can see as number of weak classifers T increasing, the face and non-face distribution become more and more separatable. I think the distributions separate better than those corresponding in AdaBoost process.

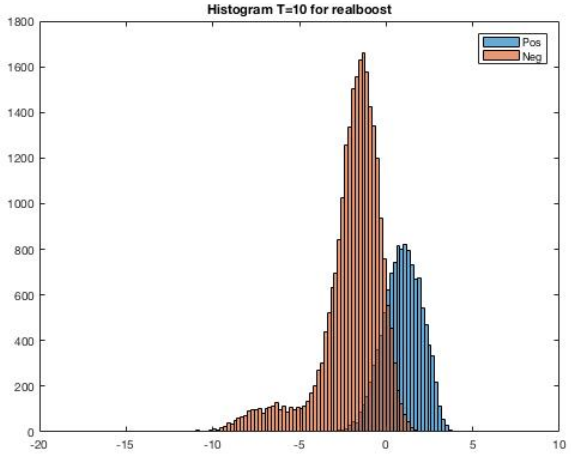

Figure 14: RealBoost histogram for T=10

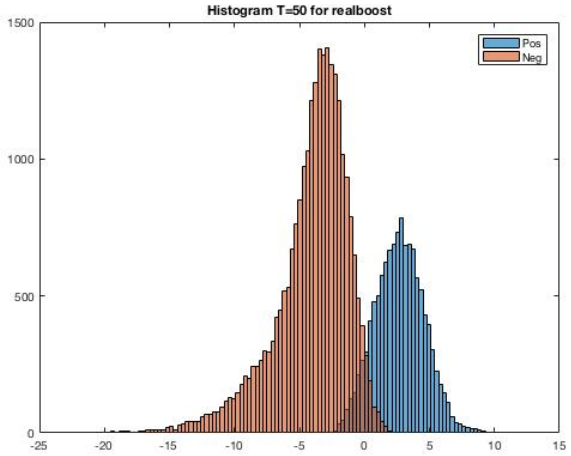

Figure 15: RealBoost histogram for T=50

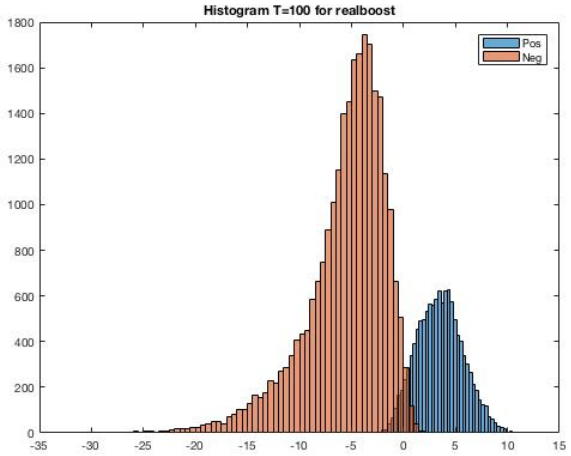

Figure 16: RealBoost histogram for T=100

(b). ROC Curve

From the ROC curve of RealBoost, we know as number of weak classifiers T increasing, the performance of RealBoost becomes better and better. Comparing to the corresponding ROC curve of AdaBoost in Figure 7, we can see the position of RealBoost ROC curve locates more to the upper left corner, which means the performance of RealBoost exceeds the perfomance of AdaBoost in our experiment.

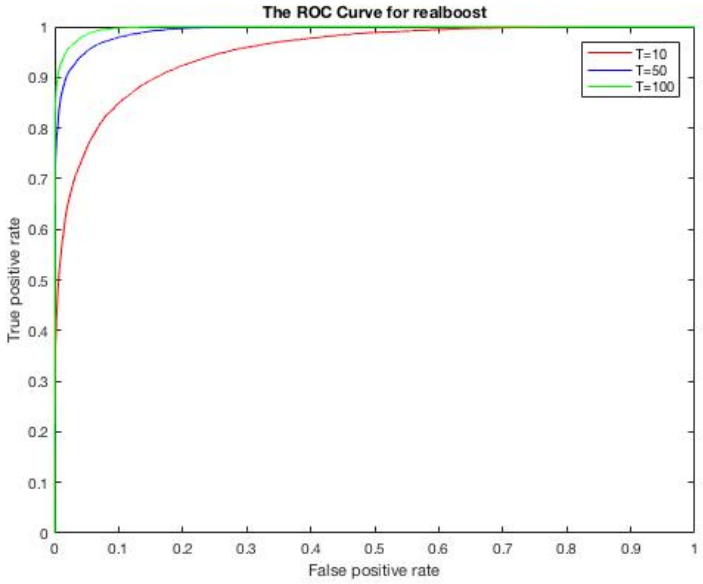

Figure 17: ROC curve for realboost