

ECEN 649: Pattern Recognition

Homework 5

Assign date: Thursday November 12, 2020

Due date: Monday December 7, 2020 at noon

Reading assignment: Chapter 10 of the textbook and the original Viola-Jones paper

Computer Assignment

Problem 1 (AdaBoost for Face Recognition, 40 Points): The Viola-Jones face detection scheme is one of the most well-known applications of the AdaBoost algorithm. The detail of the detection scheme has been documented in the original Viola-Jones paper.

In this project, we offer you a dataset from CMU containing both face and non-face sub-images that have been pre-processed to have a uniform size of 19×19 . The dataset has been divided into a training set with 500 faces and 2000 non-faces and a test set with 472 faces and 2000 non-faces. Your goal is to use the training set to learn an AdaBoost predictor that predicts whether a given sub-image is a face or non-face and use the test set to test the accuracy of the learned predictor.

Your programming task can be divided into three main parts:

- 1) Extracting Haar features;
- 2) Implementing ERM for decision stumps;
- 3) Implementing AdaBoost predictor.

For this project, you can choose any programming language that you are comfortable with. However, you are *not* allowed to use any software packages that can directly help you to achieve any of the three programming tasks mentioned previously. The idea of this project is to ask you to get down to the algorithm and programming details, and in our experiences this is the best way for you to learn. Implementing ERM for decision stumps can be very time-consuming if not done properly. An *efficient* implementation of ERM for decision stumps can be found in Chapter 10.1.1 of the textbook.

For this project, you are asked to implement the AdaBoost predictor with 1, 3, 5, and 10 rounds. In your report, please provide:

- i) (10 Points) The top 10 features selected by AdaBoost. Your description of these features needs to be self-explanatory;

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- ii) (10 Points) The combined classifiers after running 1, 3, 5, and 10 boosting rounds. Again, your description of the combined classifiers needs to be self-explanatory.

- iii) (20 Points) The ROC curve of the combined classifiers after running 1, 3, 5, and 10 boosting rounds when applied to the test set. To obtain such curves, you need to manually adjust the thresholds in the combined classifiers to obtain various tradeoffs between the detection rate and the false positive rate. A general description of the ROC curve can be found in the following Wikipedia page: https://en.wikipedia.org/wiki/Receiver_operating_characteristic. Please carefully label your ROC curves in your report. How do the ROC curves change with the number of boosting rounds?
- iv) (Bonus points) Suggest how you may be able to improve the performance of the AdaBoost predictor in terms of accuracy and/or efficiency. Verify your suggestion using the given dataset.

When you submit your project report, please also include a copy of your source and executable codes and a readme file describing how to run your codes (including how to get the environment ready for running your codes).