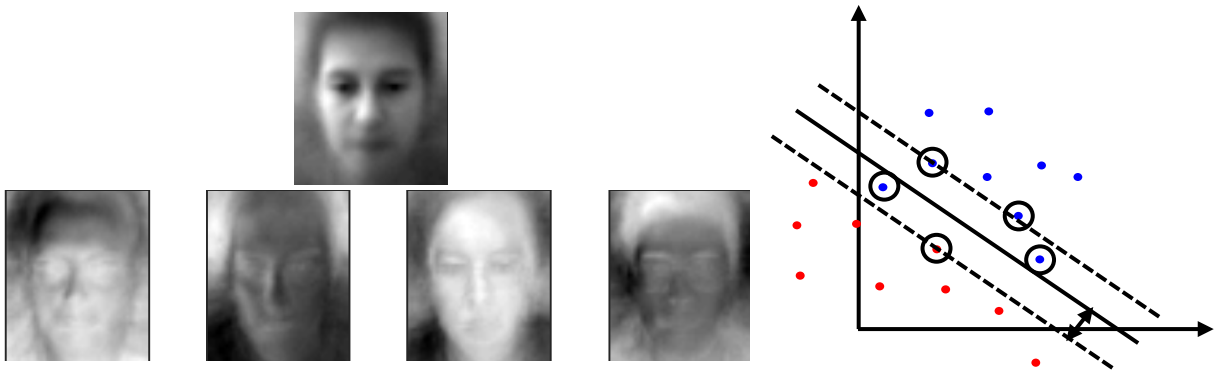
EE468/EE9SO29/EE9CS729

Pattern Recognition

Coursework on PCA and SVM for face recognition [50% mark]



Release on 11 Nov 2016, the report due on 20 Dec 2016 (midnight)

The course work requires Matlab programming. Use the provided face data (face.mat). In all questions, you can use any existing toolbox/code, unless specified. Some suggestions are below.

Submission instructions:

One joint report by each pair

Page limit: 4-6 A4 pages per report with 10 font size (use the IEEE standard double column paper format, either in MS word or latex).

http://www.pamitc.org/cvpr16/files/egpaper_for_review.pdf

http://www.pamitc.org/cvpr16/files/cvpr2016AuthorKit.zip

Give insights, discussions, and reasons behind your answers, on the scope of lectures. ***Quality and completeness of discussions within the page limit*** will be marked.

Source code is not mandatory, unless specified: optionally, this can go to appendices, which do not count for the page limit.

Submit the report **in pdf** through the Blackboard system. No hard copy is needed. Write your full names and CID numbers on the first page.

If you have questions, please contact

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Useful toolboxes:

You may use the statistical pattern recognition toolbox (STPR) or LibSVM, which is downloadable at

http://cmp.felk.cvut.cz/cmp/software/stprtool/

https://www.csie.ntu.edu.tw/~cjlin/libsvm/

If you encounter any trouble in using the STPR toolbox in college machines, please contact g.garcia-hernando@imperial.ac.uk.

Q1. [10] Eigenfaces

a. Partition the provided face data into your training and testing data, in a way you choose. Explain briefly the way you partitioned. Apply PCA to your training data, by computing the eigenvectors and eigenvalues of the data covariance matrix $S=(1/N)AA^T$ directly. Show and discuss the results, including: the eigenvectors, the eigenvalues, and the mean image, how many eigenvectors with non-zero eigenvalues are obtained and how many eigenvectors are to be used for face recognition. Give insights and reasons behind your answers.

b. Apply PCA to your training data, using the eigenvectors and eigenvalues of $(1/N)A^TA$. Show and discuss the results in comparison to the above, including: if the eigenvectors and eigenvalues obtained are identical, what are the pros/cons of each method. Show respective measurements for your answers.

Q2. [15] Applications of Eigenfaces

Hereinafter, we use a more efficient PCA technique among the two methods discussed in Q1. Use the data partition, which you used in Q1, into training and testing.

a. Perform the face image reconstruction using the PCA bases learnt. Show and discuss the results, while varying the number of bases to use, including: if the reconstruction error (or the distortion measure) obtained is same as in the theory, how good the reconstruction results are for at least 3 images of your choice (e.g. from both the training and testing dataset).

b. Perform the PCA-based face recognition by either the NN classification method or alternative method learnt in the PCA lecture. Report and discuss, including: the recognition accuracy (success rates), example success and failure cases, the confusion matrices,

time/memory (and any other aspects you observe), by varying the parameter values/experimental settings you used. Give insights and reasons behind your answers.

Q3. [25] Multi-class SVM for Face Recognition

Use the provided face data, and the same data partition into training and testing as in Q1.

Feature vectors **x** are the raw-intensity vectors (obtained by raster-scanning pixel values of face images) or PCA coefficients. Try both and compare the results below.

Train and test multi-class SVM using the feature vectors **x**. You can use any existing toolbox for two-class (or binary-class) SVMs. Note, write your own lines of code for the multi-class extensions of SVM (both one-versus-the-rest and one-versus-one), and provide your code in an appendix of your report. Compare the results of the two multi-class extensions of SVM.

Show, measure and discuss the results, including:

- setting the SVM parameters, i.e. kernel type, kernel parameters, C (underfitting/overfitting),
- recognition accuracy and confusion matrix
- time-efficiency of SVM training/testing
- examples of support vectors and success/failure images
- margin etc.

Discuss the results in comparison to those of **Q2**.

Give insights and reasons behind all your answers.

(Optional) LDA and Ensemble learning

This part carries no mark, should go to an appendix of your report.

Try LDA and Ensemble learning, along with PCA, SVM and NN classifier. Compare and discuss face recognition results by different combinatorial methods.