Mini-Project: Eigenfaces

Goals of the Mini-Project

Each mini-project proposes to examine in deep one of the statistical signal and data processing tools seen in class.

The goals of the mini project are:

- Implement one (or more) of the tools seen in class;
- Explore more advanced / specific tools related to the tools seen in class, via scientific literature and numerical implementation;
- Present the tools to the class with a demo and a performance comparison.

Such goals are achieved via specific tasks:

- Work as a team (everyone must contribute and be aware of every detail of the accomplished work);
- Implement the assigned tool seen in class (Python or Matlab);
- Test it on simulated and real data (real data will be provided);
- Submit a report on the test of the tool on simulated and real data (**Assignment #1**);
- Explore other advanced tools, not presented in class, outperforming the assigned tool (start from the suggested literature, and pursue the research of information on additional papers & books);
- Submit a report on the advanced tools (**Assignment #2**);
- Implement the new tools (Python or Matlab);
- Prepare a demo (on simulated and real data) comparing the tools;
- Prepare about 5 slides to present to your colleagues the tools, their comparison, a demo, and your conclusions.
- Submit the demo (with instructions), the presentation, and a short report (min 6 pages, max 10 page) on the mini-project (**Assignment #3**);

You will be evaluated on these tasks, on the quality of problem solutions, on the quality of your implementation, on the quality of the presented demo & results.

Description of the Mini-Project

PCA (or singular value decomposition) can be used as data dimensionality reduction method in various applications, including in complex data sets as photos of human faces. If the dimensionality reduction is done well, classification of data can be then achieved with a simple linear classifier.

For this mini-project, it is interesting to

- Using PCA, reduce the dimensionality of the data set of human face photos.
- Implement a linear classifier applied to the data set of human faces dimensionality reduced using PCA.

- Analyse its performance, consider discarding first few faces.
- Using the Fisherfaces method, reduce the dimensionality of the data set of human face photos.
- Implement a linear classifier applied to the data set of human faces dimensionality reduced using Fisherfaces method.

Note: the goal of this exercise is to use a linear classifier, that you can obtain by solving an appropriate system of equations. If you want, you can of course play with different classifiers (SVMs are used in the Scikit example) or training methods, but no points will be awarded for that.

Note: we recommend using Extended Yale Face Database B (cropped).

References:

- Scikit-learn *Faces recognition example using eigenfaces and SVMs*
- Belhumeur, Peter N., João P. Hespanha, and David J. Kriegman. *Eigenfaces vs. fisherfaces: Recognition using class specific linear projection.* IEEE Transactions on pattern analysis and machine intelligence 19.7 (1997): 711-720.
- Generalized Eigenvalue Problem on Wikipedia
- Extended Yale Face Database B (B+) http://vision.ucsd.edu/content/extended-yale-face-database-b-b
- Huang, Gary B., et al. *Labeled faces in the wild: A database forstudying face recognition in unconstrained environments.* 2008, link
- List of datasets: https://www.face-rec.org/databases/.