

Machine Learning and Adaptive Systems (ECE656)

Computer Assignment 5 (Manifold Learning and Pattern Classification)

The purpose of this computer assignment is to use the Laplacian Eigenmaps (LE) manifold learning method as a nonlinear feature extraction method for pattern classification applications. The database to use for this computer assignment is ORL face dataset <https://cam-orl.co.uk/facedatabase.html>. This dataset contains 400 facial images of 40 individuals. For every individual, there are 10 images each of size 92 x 112 pixels. The images were taken at different times, varying the lighting conditions, facial expressions (open-closed eyes, smiling-not smiling) and facial details (glasses-no glasses). All the images were taken against a dark homogeneous background with the subjects in an upright, frontal position (with tolerance for some side movement). In this computer assignment, we choose only 50% of this database for 20 different individuals.

1. One image from each subject should be randomly selected for testing, while the rest of the images are used for training of the standard LE to generate the sub-manifold in low dimensional space. Try two different sub-manifold dimensions e.g., $M=50$ and 100 . Repeat this experiment 10 times so that every image of each subject can serve as the testing sample once. The testing images should be learned (embedded) incrementally by the algorithm covered in the lecture 26.
2. Use a k-nearest neighbor (KNN) classifier for $k=7$ to perform classification of the testing dataset for 20 classes (different individuals) based upon their low dimensional features in the sub-manifold domain. Provide the classification results using a confusion matrix and comment on the performance of (a) the incremental sample embedding method, and (b) the K-NN classifier that used the low dimensional features for decision-making.
3. **Bonus Points (20%):** Provide a comparison of the incremental learning with the batch LE in terms of the ability to embed points in the sub-manifold space and capture the intrinsic structural information of the input manifold as well as the classification results using the K-NN classifier.
4. Provide a detail discussion on your results and point out the advantages/disadvantages of the manifold-based features in a brief report.