1 Data: Images of Cats and Dogs

The following data are available on the course website.

1. PatternRecData.mat which contains two variables: the 198-by-198 matrix KLDATA.mat and a row vector sub-labels of length 160. The data matrix KLDATA contains distinct images of cats and dogs in the reduced space (courtesy of Dave Bolme and Dr. Ross J. Beveridge, Department of Computer Science, Colorado State University) in its columns. There are 99 of each animal and they are randomly placed in the columns of KLDATA. The vector sub-labels gives you the identity (with cat = 1 and dog = 0) of the first 160 patterns.

2. TIFFtraining.zip which contains TIFF images for the first 160 patterns in KLDATA. There is a little glitch to the file Dog96.tif, which is a $64 \times 64 \times 2$ matrix instead of simply 64×64. The first layer is what you would need.

2 Project Assignment

Use the data given above to build different pattern recognition architectures from the methods that you learned in class over the semester or methods you acquired elsewhere that are relevant to the problem.

Submit a write-up that that are coherent to the format described in the syllabus. Once you are satisfied with your pattern recognition routine on the known data, classify the last 38 unknown columns in KLDATA as either cats or dogs. Save the result as a row vector of zeros (= dogs) and ones (= cats) and email it to me by the end of the semester. Alternatively, if you wish to classify the raw data (instead of the KL data), you would design your classifier to take in either a 4096-by-1 column vector or a 4096-by-38 matrix and output their class labels as either cats or dogs.

Your final write-up will be sure to include the following items.

1. Classification errors as a 2-by-2 confusion matrix (dogs classified as dogs, dogs classified as cats, cats classified as cats, cats classified as dogs). You can accomplish this by splitting the data into testing and training and provide classification errors on the testing set.

2. Description of the classification method and details about how the classifier is constructed.

3. Predicted class membership for the 38 unlabeled data.

4. Codes used in the exploration process. These codes can be inserted wherever they fit or shuffled all the way at the end of the report depending on your writing style.

3 Suggestions for Possible Approaches

The following list is by no means complete. The purpose is to provide you with some initial directions.

1. Determine the covariance matrix of the cats and the covariance matrix of the dogs and construct optimal bases for each using maximum noise fraction. Project new samples onto the cat basis and dog basis and see which gives a better representation.

2. Use vector quantization, e..g, Kohonen's self-organizing map on a 2D lattice. Neural Network.

3. Use eigen-cats and eigen-dogs and the Principal Component Analysis (PCA) on the raw data.
4. 2D Discrete Wavelet Analysis (DWT) or Fourier Analysis on the raw data for frequency content information.
5. Radial Basis Function (map cats to ones and dogs to zeros). Support Vector Machines with various kernels.
6. Fisher's Linear Discriminant Analysis (LDA).
7. Kernel Linear Discriminant Analysis (KLDA).
8. Labeled Voronoi cell classification.
9. One-sided or two-sided tangent distances.
10. Set-to-set comparison with principal angles and Grassmannian distances.
11. Neural networks or convolution neural networks.
12. Deep learning.
13. A combination of any of the methods above with weights.