Pattern Analysis Spring 2008
Problem Set Four

Due Friday, April 24, 2008

1 Theory

Solve all the following problems:

1. Prove that the eigenvectors of a symmetric matrix associated with distinct eigenvalues are orthogonal. (This is a warm-up for the next problem.)

2. Show that the solutions $\psi^{(j)}$ to the generalized singular value problem are orthogonal in either of the following senses:

$$(\psi^{(i)})^T X^T X \psi^{(j)} = \lambda_i \delta_{ij}$$

and

$$(\psi^{(i)})^T Q^T Q \psi^{(j)} = \lambda_i \delta_{ij}$$

3. Using the result in Problem 2. show that the basis vectors in Signal Fraction Analysis

$$\phi^{(i)} = X \psi^{(i)}$$

are orthogonal with respect to the standard Euclidean inner product.

4. Describe (without actually implementing it) an algorithm that uses Canonical Correlation Analysis to solve a two-class classification problem.

2 Computing

Problem 1. This problem concerns applying Canonical Correlation Analysis to the Dogs and Cats data set. For each choice of the X-set and Y-set identified below compute the canonical vectors and canonical correlations. Use unvec and imagesc to display the pictures of the first canonical vectors in each case (for both the X-set and Y-set). Also plot the canonical correlations.

- X-set is taken as the set of 100 cat images and Y-set is taken as the set of 100 dog images.
- X-set is taken as the first 50 cat images and Y-Set is taken as the second 50 cat images.
- X-set is taken as the first 50 dog images and Y-Set is taken as the second 50 dog images.

Discuss your results.