Exercises for
Pattern Recognition
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General Information:

Exercises (1 SWS):	Tue 12:15 – 13:45 (0.154-115) and Fri 08:15 – 09:45 (0.151-115)
Certificate:	Oral exam at the end of the semester
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Feature Transforms

Exercise 1 In this exercise we will refresh your knowledge of the Singular Value Decomposition (SVD).

(a) What is the relationship between the SVD of a square matrix A and A^T.

(b) What is the relationship between the SVD of A and AA^T.

(c) Find a relationship between the singular values and the eigenvalues of a matrix $\boldsymbol{B} = \boldsymbol{A}\boldsymbol{A}^{\boldsymbol{T}}$.

Exercise 2 Linear discriminant analysis (LDA) is used to transform features such that two classes can be discriminated by a linear decision boundary. Use LDA for classification in the MATLAB Classification toolbox.

(a) Compute the LDA feature transform $\phi(\boldsymbol{x})$ during the training phase.

(b) In the classification step, use the following decision rule:

$$y^* = \underset{y}{\operatorname{argmin}} \left\{ \frac{1}{2} \|\phi(\boldsymbol{x}) - \phi(\boldsymbol{\mu}_y)\|^2 - \log(p_y) \right\}$$

(c) What is the relationship between LDA classification and nearest neighbor classification?

Exercise 3 The excersise addresses the Principal Component Analysis (PCA) for dimensionality reduction. On the course website you can find a short Matlab script to create a set of random points in 3-space. Your goal is to find a linear projection into 2-space, such that the original points can be reconstructed with minimal error.

(a) Compute the pricipal component of your data, i.e. the unit vector $\boldsymbol{w}$ such that the variance in its 1D subspace is maximized.

(b) Implement PCA to reduce the feature space to $d = 2$ using Singular Value Decomposition (SVD). Hint: De-mean the data.

(c) Visualize the reduced features in 2D.

(d) Reproject the reduced features into the original space and compute the mean absolute error.