



General Information:

Exercises (1 SWS): Mo 12:15 – 13:30 (H10 lecture hall building) and Tue 08:45 – 10 (0.151-113)
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).

- What is the relationship between the SVD of a square matrix A and A^T .
- What is the relationship between the SVD of A and AA^T .
- Find a relationship between the singular values and the eigenvalues of a matrix $B = AA^T$.

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.

- Compute the LDA feature transform $\phi(\mathbf{x})$ during the training phase.
- In the classification step, use the following decision rule:

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

- What is the relationship between LDA classification and nearest neighbor classification?

Exercise 3 The exercise 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.

- Compute the principal component of your data, i.e. the unit vector \mathbf{w} such that the variance in its 1D subspace is maximized.
- Implement PCA to reduce the feature space to $d = 2$ using Singular Value Decomposition (SVD). Hint: De-mean the data.
- Visualize the reduced features in 2D.
- Reproject the reduced features into the original space and compute the mean absolute error.