



## 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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## Fisher Transform and Norms

**Exercise 1** In this exercise, we derive the Fisher transform for dimensionality reduction of feature vectors. The Fisher transform is a formulation of the LDA. In the training step, the class label for each pattern is known. The optimal projection axis  $\mathbf{a}^*$  for the Fisher transform is calculated according to the Rayleigh ratio:

$$\mathbf{a}^* = \operatorname{argmax}_{\mathbf{a}} \frac{\mathbf{a}^T \boldsymbol{\Sigma}_{\text{inter}} \mathbf{a}}{\mathbf{a}^T \boldsymbol{\Sigma}_{\text{intra}} \mathbf{a}}$$

The definitions for  $\boldsymbol{\Sigma}_{\text{inter}}$  and  $\boldsymbol{\Sigma}_{\text{intra}}$  can be found in the lecture slides. We are only interested in the 2 class problem.

- Describe the different quantities in the Rayleigh ratio.
- Reformulate the given (unconstrained) optimization problem to a constrained optimization problem using Lagrange multipliers.
- Solve the constrained problem to determine  $\mathbf{a}^*$ .  
Hint: derivatives w.r.t.  $\mathbf{a}$  must be 0. Use the Matrix Cookbook.

**Exercise 2** Implement a classification algorithm which classifies a new feature only by calculating the distance to the class prototypes (i.e., the mean of a class). Use the option to pass parameters to the classification function, and implement three approaches to calculate the distance:

- the L1-Norm
- the L2-Norm (= euclidean distance)
- the Mahalanobis distance, which incorporates the covariance matrices.