1 Exercise

If possible read up chapter 4.1.4 in the aforementioned Bishop Book (p.186)!

1.1 (3P) Subtask

Show that maximization of the class separation criterion \( m_2 - m_1 = \vec{w}^t(\vec{m}_2 - \vec{m}_1) \) with respect to \( \vec{w} \), using a Lagrange multiplier to enforce the constraint \( \vec{w}^t\vec{w} = 1 \), leads to the result that \( \vec{w} \) is proportional to \( \vec{m}_2 - \vec{m}_1 \). (see exercise 4.4. in Bishop).

1.2 (3P) Subtask

By making use of
\[
y_i = \vec{w}^t\vec{x}_i, \quad m_2 - m_1 = \vec{w}^t(\vec{m}_2 - \vec{m}_1)
\]
and
\[
s_k^2 = \sum_{n \in C_k} (y_n - m_k)^2
\]
show that the Fisher criterion
\[
J(\vec{w}) = \frac{(m_2 - m_1)^2}{s_1^2 + s_2^2}
\]
can be written in the form
\[
J(\vec{w}) = \frac{\vec{w}^tS_B\vec{w}}{\vec{w}^tS_W\vec{w}}.
\]
(see exercise 4.5. in Bishop)

2 (6P) Exercise

In this exercise you will analyse the linear predictive coding (LPC) algorithm.

2.1 (1P) Subtask

Read the documentation of the Matlab command \texttt{lpc} and explain the parameters.
2.2 (2P) Subtask

Implement a Matlab function which computes the estimated signal

\[ \hat{x}(n) = \sum_{k=1}^{P} a_k x(n-k) \]  

(1)

and the error-signal

\[ e(n) = x(n) - \hat{x}(n) \]  

(2)

based on the LPC-coefficients \( a_k \).

2.3 (3P) Subtask

There are 4 .wav-files on our homepage which contains the phonems s, p, l and i.

1. Perform an LPC-analysis on these files by setting \( P = 4 \) and using the first 512 samples of each signal.
   Generate a plot of \( x \), \( \hat{x} \) and \( e \) for each phonem. (4 plots)

2. Explain the different results for the different phonems.

\[ ^{1} \text{You can use the Matlab-function 'lpc' and 'filter'} \]