

# Machine Learning

## Exercise Sheet 9

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Submission until January 16th, 13.00 via learnweb!

### Exercise 17: Perceptron (10 Points)

Given is the following data set:

$x_1$	$x_2$	$y$
1	1	1
3	1	1
1	3	-1
3	3	-1

and a hyperplane given by  $\beta_0 = -1$  and  $\beta = (1 \quad -1)^\top$ .

- Create a sketch of the data and the hyperplane! Which instances are wrongly classified?
- Perform the perceptron learning algorithm that was shown in the lecture on the training data with the given hyperplane. Use as step size  $\alpha = 1$ . In order to make results comparable, perform the updates **in the order the data is given (top to bottom)**. After how many single instance updates does the algorithm terminate?
- What happens if we apply the perceptron learning algorithm to the following data?

$x_1$	$x_2$	$y$
1	1	1
1	-1	-1
-1	-1	1
-1	1	-1

## Exercise 18: Linear Seperability (10 Points)

Given is following data set:

$x$	$y$
-3	-1
-2	-1
-1	1
0	1
1	1
2	-1
3	-1

a) Create a scetch of the data. Is it linearly seperable? If so, draw a separating hyperplane.

b) Apply the mapping  $g : \mathbb{R} \rightarrow \mathbb{R}^2$  defined by

$$g(x) = \begin{pmatrix} x \\ x^2 \end{pmatrix}$$

on all the data points to create the transformed data set and create a plot of it. Is the transformed data set linearly seperable? If yes, find a seperating hyperplane  $H_\beta$ , compute its parameters  $\beta$  and plot it.

c) For the hyperplane found in b), find all  $x \in \mathbb{R}$  such that  $g(x) \in H_\beta$ , i.e. all one dimensional points that map to this hyperplane using  $g$ . Does the resulting set seperate the initial data points?