Machine Learning
Exercise Sheet 8

Prof. Dr. Dr. Lars Schmidt-Thieme, Rafael Rego Drumond
HiWi's: Khouloud Sallami, Maurício Camargo, Shayan Jawed, Sami Diaf
Information Systems and Machine Learning Lab
University of Hildesheim

Exercise 15: 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 $\beta = (1 \quad -1)^T$.

a) 3 points   Create a sketch of the data and the hyperplane! Which instances are wrongly classified?

b) 4 points   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?

c) 3 points   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 16: 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) 2 points Create a sketch of the data. Is it linearly separable? If so, draw a separating hyperplane.

b) 6 points Apply the mapping $g : \mathbb{R} \to \mathbb{R}^2$ 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 separable? If yes, find a separating hyperplane H_β, compute its parameters β and plot it.

c) 2 points For the hyperplane found in b), find all $x \in R$ such that $g(x) \in H_\beta$, i.e. all one dimensional points that map to this hyperplane using g. Does the resulting set separate the initial data points?