Machine Learning
Exercise Sheet 8

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Exercise 15: Perceptron (6 Points)

a)

x_1	x_2	x_3	class
4	3	7	negative
2	-3	3	positive
1	0	-3	positive
4	2	3	negative

Apply the perceptron learning algorithm until convergence on the given data. Use a step length $\alpha = 1$ and start with $\beta = 0$, $\beta_0 = 1$. Use the algorithm with a small difference: choose the training instances sequentially instead randomly (line 6).

b)

x_1	x_2	class
1	1	positive
1	-1	negative
-1	-1	positive
-1	1	negative

Show that the problem given in the table above cannot be solved with a single perceptron. No graphical solutions.

Hint: Use a perceptron with the same settings as in part a).

Exercise 16: SVM (4 Points)

D	a	b	c	d	e	f	g	h	i
x	-3	-2	-1	-0.5	0	0.5	1	2	3
Class	-1	-1	+1	+1	+1	+1	+1	-1	-1

a)

1. Which shape does a hyperplane have in the 1-dimensional space? Which in the 2-dimensional, which in the 3-dimensional space?
2. Plot the data D.
3. Is the data D linear separable? If it is linear separable add a separating hyperplane to your plot.

b) Given is the mapping function $h : \mathbb{R} \rightarrow \mathbb{R}^2$:

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

1. Apply h to the data D.
2. Plot the transformed data.
3. Add a separating hyperplane to the plot to show that the data is linear separable in the transformed space.
4. Add the separating hyperplane of the transformed space to the plot in a). Explain how you estimated it.