ML: Algo & Theory
SS 18

1	2	3	$\sum$

Florence Lopez (3878792),
florence.lopez@student.uni-tuebingen.de
Jennifer Them (3837649),
jennifer.them@student.uni-tuebingen.de

Assignment 6

(Abgabe am 05. Juni 2018)

Exercise 2

d.) A support vector is a vector, whose Lagrangian multipliers are non-zero. In the case of a hard-margin SVM the support vectors lie on the margin. In the case of a soft-margin SVM the support vectors can lie either on the margin, inside the margin or on the wrong side of the hyperplane.

Exercise 3

a.) The primal problem is: minimize$_{x\in\mathbb{R}} f(x) = x^4 - 10x^2 + x$ subject to $g(x) = x^2 - 2x - 3 \leq 0$. The feasible set of this problem can be computed by trying out. One can see that for $x \in [-1, 3], g(x)$ stays ≤ 0, since for $x = -2, g(x) = 5$ and for $x = 4, g(x) = 5$, too, which is both > 0.
To solve the primal, one has to compute: $\frac{\delta f(x)}{\delta x} = 4x^3 - 20x + 1 \overset{!}{=} 0$. We solved this using WolframAlpha and got the following results:

b.) The Langrangian to this problem is:
$L(x, \alpha) = f(x) + \alpha g(x) = x^4 - 10x^2 + x + \alpha x^2 - 2\alpha x - 3\alpha$. The derivative with respect to x is: $\frac{\delta L(x,\alpha)}{\delta x} = x^3 - 20x + 1 + 2\alpha - 2\alpha = x^3 - 20x + 1$.
The dual function can be computed by: $h(\alpha) = \inf_x L(x, \alpha) = \inf_x x^4 - 10x^2 + x + \alpha x^2 - 2\alpha x - 3\alpha$. We know from the exercise that the dual function $h(\alpha)$ is optimal for $\alpha = 0.5$. Therefore we can calculate the optimal solution of the dual function:
$h(\alpha) = h(0.5) = \inf_x x^4 - 10x^2 + x + \frac{1}{2}x^2 - x - \frac{3}{2} = x^4 - \frac{19}{2}x^2 - \frac{3}{2}$. To get the value of the infimum, we have to set the derivative of $h(0.5)$ to zero:
$\frac{\delta h(0.5)}{\delta x} = 4x^3 - 19x \overset{!}{=} 0 \Leftrightarrow 4x^3 = 19x \Leftrightarrow x^2 = \frac{19}{4} \Leftrightarrow x = .$