ML: Algo & Theory
SS 18

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

Assignment 3

(Abgabe am 08. Mai 2018)

Exercise 1

a.) Compute the derivative $\frac{\delta f}{\delta X}$, where $X = \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix}$:

$$f(X) = a^T X = \begin{bmatrix} 2 & -1 & 5 \end{bmatrix} \cdot \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} = 2x_1 - x_2 + 5x_3.$$

$\frac{\delta f}{\delta X} f(X) = \begin{bmatrix} \frac{\delta f}{\delta x_1} & \frac{\delta f}{\delta x_2} & \frac{\delta f}{\delta x_3} \end{bmatrix}$ with $\frac{\delta f}{\delta x_1} = 2$, $\frac{\delta f}{\delta x_2} = -1$, $\frac{\delta f}{\delta x_3} = 5$.
This leads to $\frac{\delta f}{\delta X} = \begin{bmatrix} 2 & -1 & 5 \end{bmatrix} = a^T$.

b.) Compute the derivative $\frac{\delta f}{\delta X}$, where $X = \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$:

$$f(X) = X^T A X = \begin{bmatrix} x_1 & x_2 \end{bmatrix} \cdot \begin{pmatrix} 1 & 2 \\ 5 & 3 \end{pmatrix} \cdot \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} = \begin{bmatrix} x_1 & x_2 \end{bmatrix} \cdot \begin{pmatrix} x_1 + 2x_2 \\ 5x_1 + 3x_2 \end{pmatrix} = x_1^2 + 3x_2^2 + 7x_1x_2.$$

$$\frac{\delta f}{\delta X} f(X) = \begin{bmatrix} \frac{\delta f}{\delta x_1} & \frac{\delta f}{\delta x_2} \end{bmatrix} = \begin{bmatrix} 2x_1 + 7x_2 & 7x_1 + 6x_2 \end{bmatrix} = \begin{bmatrix} x_1 & x_2 \end{bmatrix} \cdot \begin{pmatrix} 2 & 7 \\ 7 & 6 \end{pmatrix} = x^T \cdot (A + A^T).$$

Exercise 2