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Mathematical Foundation of Big Data Analytics (SS 2019)
Neural Networks I

Ex. 1 Show that the following formulations are equivalent the minimization of the cross-entropy loss of the logistic activation function $f_L(z) = \frac{1}{1+\exp(-z)}$:

a)

$$\max_w \sum_{i=1}^n y_i w^T x_i - \ln(1 + \exp(w^T x_i)).$$

b)

$$\max_w \sum_{i=1}^n \ln\left(\frac{1}{1 + \exp(-y_i w^T x_i)}\right).$$

Ex. 2 You are given the following data of costumers:

	Costumer 1	Costumer 2	Costumer 3	Costumer 4
Age x_1	20	30	40	20
Income x_2	6	4	2	4
Number of former purchases x_3	1	0	3	1

You have designed a neural net without bias and with the logistic activation function, in order to analyze your costumers if advertising leads to purchases or not, indicated by $y \in \{1, 0\}$. You already trained your network and received the following weights:

$$w_1 = -0.1, \quad w_2 = 0.5, \quad w_3 = 1.$$

Calculate the probabilities, that your costumers will be prone for advertisements. Discuss the results.

Ex. 3 Show that the cross-entropy-loss is convex.