Machine Learning 2
Exercise Sheet 5

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Submission until May 24th, 8:00 AM by learnweb.
Please put your name in all filenames.
Non-pdf submissions for non-programming exercises will not be graded.

Exercise 9: Basic Network Topologies(10 Points)

a) 2 points Consider the binary linear regression model

$$\hat{y} := \sigma(\beta^T x)$$

, where σ is the logistic sigmoid. Show how this model is equivalent to a simple neural network.
What kind of topology does this network have? (e.g. Recurrent, Feed-Forward, Hopfield)
(Bonus point if you can illustrate the connection of this model to GLMs)

b) 5 points Let w_1 and w_2 be the weights of a perceptron (i.e. simple neural network) with two inputs x_1 and x_2. Let $AND(x_1, x_2)$ be the "logical and" function, let $OR(x_1, x_2)$ be the "logical or" function.
Design two single-layer perceptrons which correspond to the logical AND and OR functions.

x_1	x_2	y
0	0	0
0	1	0
1	0	0
1	1	1

Table 1: AND function

x_1	x_2	y
0	0	0
0	1	1
1	0	1
1	1	1

Table 2: OR function

c) 3 points Consider the $XOR(x_1, x_2)$ function, which models the behavior of the logical Exclusive Or. For two inputs we have

x_1	x_2	y
0	0	0
0	1	1
1	0	1
1	1	0

Table 3: OR function

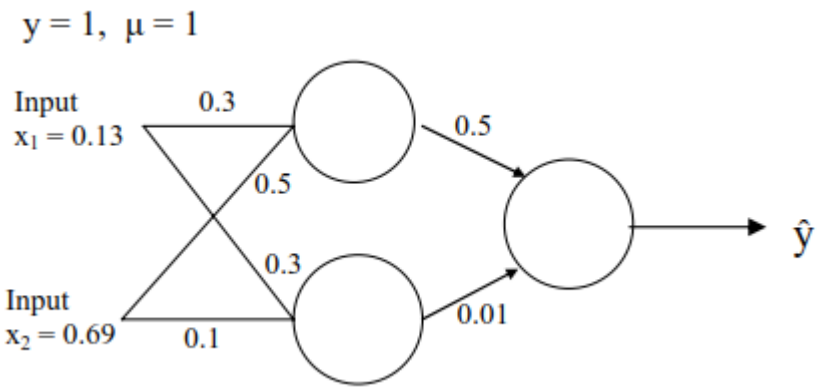
Show that a single-layer model cannot correctly model the XOR function, and then design a multi-layer perceptron does correctly model the function.

Exercise 10: Back-Propogation (10 Points)

For this question, it will help immensely if you go through the worked example on page 20 of this tutorial PDF `https://www.fer.unizg.hr/_download/repository/BP_chapter3_-_bp.pdf`.

a) 2 points Briefly describe the steps involved in backpropogation for multi-layer neural networks.

b) 6 points Suppose you have been given the following single-layer network



- Perform a forward pass on the network.
- Perform a reverse pass with (y = 1.0).
- Perform a further forward pass and comment on the result.

c) 2 points Identify two potential pitfalls with the Backprogation algorithm, and suggest solutions which can remedy those problems.

1 Bonus 5: Implementing Recurrent Neural Networks

a) 10 points Do exercise 16.1 from Murphy chapter 16.
Doing only part C will earn you 6 points.