Neural Networks 2018
Homework 1
The TLU

General instructions

Print your report and put it in the box of Neural Networks near 216 in the Bernoulliborg. Also send the pdf by e-mail to neuralnets2018@gmail.com. The assignment is due on Monday, April the 23rd at 11:00 am. You should e-mail just one archive file containing your report, so the easiest way of doing this is just to archive all of your files at once. Name it as follows:
s1234567_DonaldTrump_s7654321_SantaClaus.zip.

1   Logical functions (5 pt.)

In this assignment you will get familiar with threshold logic units (TLU) and how to implement simple logical functions with them. Note that the TLUs will be introduced in the second lecture.

For each logical function, we need one figure from you that shows the structure of the TLU network, and one table in which you enumerate all possible input values, the corresponding output values, and the values of each parameter of your network (weights and biases). You also need to specify whether the function is linearly separable or not. Take note that multiple weight/bias combinations may lead to a correct result.

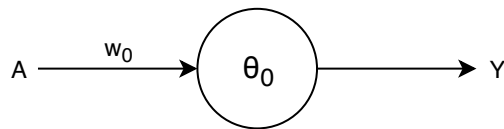The following is an example solution for the logical function $\neg A$:

Figure 1:
A network graph.
This function is linearly separable.

A	w_0	θ_0	Y
0	-0.5	1	1
1			0

Table 1:
A table indicating all possible values

For each of the following logical functions use one or multiple TLUs to implement the function. Take care to use as few TLUs as possible. You should never use more than one hidden layer to solve the exercises. For each problem indicate whether the function is linearly separable or not ($\oplus$ is XOR), give a figure of the network as shown above and give a table indicating all possible input and output values, as well as the weights and biases.

1. $A \wedge B$

2. $A \vee B$

3. $A \oplus B$

4. $\neg(A \vee B)$

5. $A \oplus B \oplus C$

2 Decision boundary (2 pt.)

The data set in Table 2 contains output values for a 2D input $\mathbf{x} = [x_1, x_2]$. Using TLUs, make a network that will classify the data points into their appropriate outputs.

- Make a plot showing the data points

- In the plot, draw the weight vector(s) of your TLUs and draw their corresponding decision lines

- Indicate the value of each weight component and bias (Hint: look at end of chapter 3 of the booklet)

$\mathbf{x}_1$	$\mathbf{x}_2$	output
-0.75	0.75	1
0	0.75	0
-0.25	0.25	1
0.25	0.25	1
0.5	0.5	0
1	0.25	0
-0.75	0	0
0.25	-0.25	1
-0.5	-0.5	0
0.25	-0.75	0
0.75	-0.5	1

Table 2: Labelled data set

3 Essay (2 pt.)

How TLUs are inspired by biological neurons? Explain which elements of a TLU correspond to which aspects of a biological neuron. Limit your answer to 200 words.