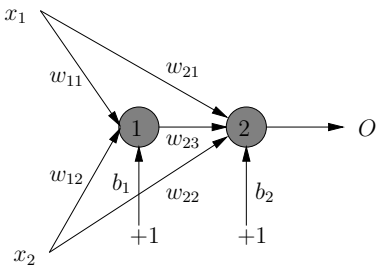
Aprendizagem Automática Avançada
(2º ciclo de Informática)

Backpropagation exercises

Problem 1 (adapted from Haykin, 2009 - problem 4.1)
Consider the following NN. Assume a McCulloch-Pitts model with a step function and inputs and output in $\{0, 1\}$.



Suppose weights are:

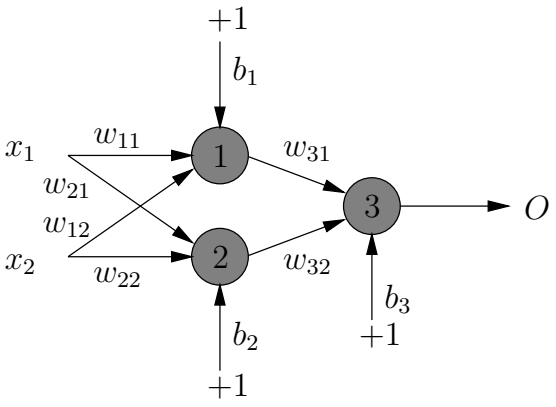
$$w_{11} = w_{12} = w_{21} = w_{22} = +1; w_{23} = -2; b_1 = -1.5; b_2 = -0.5$$

a) Determine the separation planes.

b) Obtain a truth table for the NN.

c) Consider now that the activation function is a sigmoid with parameter $a = 1$. Calculate 1 iteration of the error backpropagation algorithm.

Problem 2 (adapted from Haykin, 2009 - problem 4.2)
Consider the following NN with logistic functions of parameter $a = 1$ in the three neurons:



a) Run an implementation of the backpropagation algorithm over this model to learn the XOR problem. Experiment with and without momentum, and with logistic, $\tanh$ and ReLU.

b) Run also the algorithm over the NN of Problem 1 and compare results.

there is more...

Next two problems adapted from
`https://edoras.sdsu.edu/doc/matlab/toolbox/nnet/backpr13.html`

Problem 3 (simple function approximation)
Generate 200 points of one period of the sin function. From that data set produce a training set a test set and a validation set. Design an adequate MLP to solve it and train it with backpropagation.

Problem 4 (simple pattern recognition)
Design and train with backpropagation an MLP to solve a seven bit parity problem. If the number of bits in the input is odd the output should be one, otherwise minus one (this is called even parity: in the eight bits, seven inputs plus the output, the number of ones is always even).
Note: You may want to start by solving the easier version of three input bits, to get an idea of the difficulty of the problem.