AI2 Module 3
Tutorial 3

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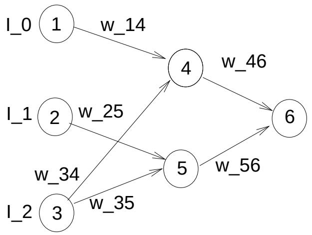
In this tutorial you will simulate learning algorithms for neural networks.
We consider learning the logical OR function using the examples A, B, C, D given in the table below. The inputs are denoted I_1 and I_2, and as usual we shall use a "bias" unit I_0 whose value is always -1 to function as the *threshold*.

Example	I_0	I_1	I_2	T
A	-1	0	0	0
B	-1	0	1	1
C	-1	1	0	1
D	-1	1	1	1

1. Simulate the Perceptron Learning Algorithm (PLA) on these examples. Start with the weight vector $(W_0, W_1, W_2) = (0, 0, 1)$, and use the learning rate $\eta = 1$. Repeatedly, go over A, B , C, D, updating the weights every time an example is classified incorrectly. Recall that the update rule of the (threshold) PLA is: $W_i \leftarrow W_i + \eta I_i(T - O)$.

   While performing the simulation, sketch the I_1-I_2 plane, draw the positions of the four training examples, and draw the decision boundary as W it is updated.

2. (do as much as time permits) Simulate one step of the Backpropagation algorithm for the following network:



   The update rules for backpropagation are

$$
\begin{aligned}
W_{ji} &\leftarrow W_{ji} + \eta a_j \Delta_i \\
\Delta_i &= g'(in_i)(T - a_i) && \text{for output units} \\
\Delta_i &= g'(in_i) \sum_k W_{ik} \Delta_k && \text{for hidden units}
\end{aligned}
$$

   where for hidden units k in the sum ranges over all other nodes connected to i's output.

   Start with $W_{ji} = 1$ for all i, j, use $\eta = 1$ and the sigmoid function. Recall that the sigmoid function is $g(z) = \frac{1}{1+e^{-z}}$ and that $g'(z) = g(z)(1 - g(z))$.

In particular, you should compute the output on example B and modify the weights as appropriate. To may want to compute things in the following order: first compute the values in_i, and a_i for all nodes. Then compute the Δ_i for each node and finally compute the updates of weights.

You may need the following values in your computation: $\frac{1}{1+e^{-0}} = 0.5$, $\frac{1}{1+e^{-1}} = 0.73$, $\frac{1}{1+e^{-1.23}} = 0.77$.