Techniques of Artificial Intelligence

Exercises – Neural Networks

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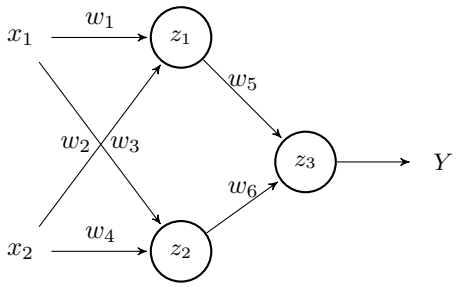
1. **Neural networks**



Consider the neural network shown above. Suppose it is a linear neural network, such that the output value of each node is the weighted some of the inputs. (No activation function).

Give an equation for the values of the three output nodes.

Design a perceptron which will provide exactly the same output as the linear neural network above. Show that the output equation of the perceptron is the same as the one of the neural net shown above.

2. **Perceptrons** (exercise 4.5 in the course book)
Derive a gradient descent training rule for a single unit with output o, where:
$O = w_0 + w_1 x_1 + w_1 x_1^2 + ... + w_n x_n + w_n x_n^2$ when using the loss function $J = \frac{1}{2} \sum_{d \in D} (y_d - o_d)^2$.

3. **Back-propagation algorithm and chain rule**

Consider the neural network of question 1 but now using the sigmoid function as activation function for each neurons: $a_i = \frac{1}{1+e^{-z_i}}$. This neural network can be trained to perform a binary classification using the cross entropy loss function:

$$J(a_3, y) = -ylog(a_3) - (1-y)log(1-a_3) \tag{1}$$

Using the chain rule of derivation, compute the derivatives of the loss function with respect to the parameters w_i.