Institut for Matematik og Datalogi
Syddansk Universitet

November 16, 2004
JFB

Introduction to Computer Science
E04 – Lecture 11

Lecture, November 15

We will begin on the theory of computation from chapter 11, covering 11.1 through 11.4 and MergeSort from section 11.5.

Lecture, November 22

Klaus Meer will introduce some basic questions related to neural networks. He will explain how neural networks in principle could be used for tasks such as pattern recognition. We shall deal with a most basic example of a one-layer, feedforward network called perceptron (or McCulloch-Pitts network). A few ideas behind the famous Perceptron Learning Algorithm will be explained. Notes will be handed out at lecture.

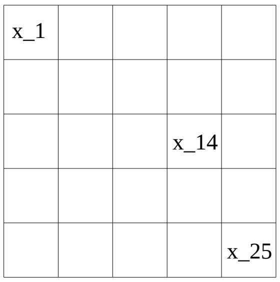
Lecture, November 29

Jørgen Bang-Jensen will lecture on graph problems and heuristics. There will be notes.

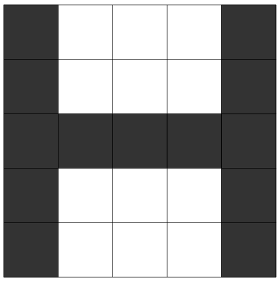
Discussion section: week 48

Discuss the following problems in groups of three or four.

In both problems we are going to construct a network that will recognize specific (simple) patterns. Our basic model for an image is a 5×5 grid whose different positions are numbered from 1 to 25. Thus, we can think about these positions as 25 input values to our network, denoted by $x_1, \ldots, x_{25}$. These inputs can take the values 0 or 1, only. A 0 value corresponds to a white grid point, a 1 value codes a black grid point.

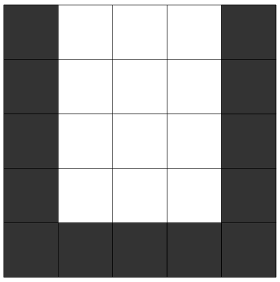


Problem 1: Construct a perceptron taking the 25 input values $x_1, \ldots, x_{25} \in \{0,1\}$ that precisely recognizes the following pattern of the latter **H**:



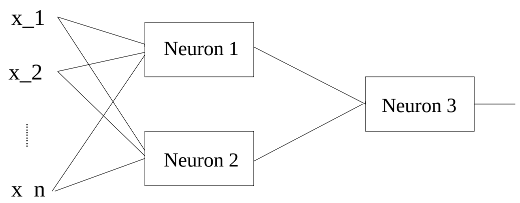
Here, to construct means that you should find suitable real values $w_1, \ldots, w_{25}$ and b such that the resulting perceptron network gives output 1 if and only if the inputted values $x_1, \ldots, x_{25}$ precisely represent the above pattern.

Problem 2: Now we consider a second pattern. We would like to build a network that is able to recognize the letter **H** from before and the letter **U**:



a) Why is it impossible to solve that problem by just using a single perceptron network? In your answer, suppose that a perceptron network exists that solves the problem. Then argue about how that network has to arrange its weights in order to accept the two above patterns but not any other pattern.

b) Solve the above pattern recognition problem by using a more advanced network structure. The network should still consist of perceptron neurons. However, now there is a first layer with two perceptrons in it each of which is connected to the 25 inputs and having its own set of weights and an own threshold. Then, the results of these two perceptron neurons are connected in a second layer by a third perceptron neuron, again taking new weight values that linearly combine the results of the first two neurons and computing its result using a third threshold value.



All edges in the above network get their own (may be similar) weight values.

Assignment due 8:15, November 30

Late assignments will not be accepted. Working together is not allowed. (You may write this either in English or Danish, but write clearly if you do it by hand.) Show your work where it is relevant.

- Do problem 31 on page 451.