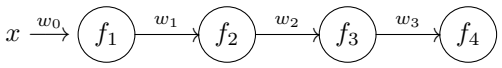
University of Helsinki
Department of Mathematics and Statistics
Neuronetworks February 2014
Exercises for week 3

1 Exercise. Let $n > 2$ be a natural number. Design a Hopfield network of n units where each unit is in a binary state (0 or 1) whose stable states are such that exactly 2 of the units are in the state 1 and all others are in the state 0.

2 Exercise. This is worth 3 exercises: Implement an algorithm which finds an (approximate) solution to the travelling salesman problem of 10 cities using the ideas described in 13.5.5. If you do this exercise, please send me the source code before the Tuesday lecture. Any programming language is accepted.

3 Exercise. Consider the following network:



Each function f_i is differentiable $\mathbb{R} \to \mathbb{R}$ function and w_i are real numbers. The input into the network is the real number x. The input into the first neuron is x multiplied by w_0. For the rest neurons the input is the output of the previous neuron multiplied by the weight of the incoming arrow. The output of neuron i is $f_i(t)$ where t is the input into that neuron.

(a) What is the function calculated by the network, i.e. write the output of the last neuron in terms of f_i's, w_i's and x.

(b) Denote that function by $\Phi(x, w_0, w_1, w_2, w_3)$. What is the derivative of Φ with respect to w_2?

(c) What is derivative of Φ with respect to x?

4 Exercise. Consider the network of the previous exercise. Suppose that given input 5 we would like to have output 1. The error is defined by

$$E = \frac{1}{2}|\Phi(5, \bar{w}) - 1|^2.$$

Write down the derivative of E with respect to w_2.

5 Exercise. (Chapter 5 exercise 4). Consider the algorithm 5.1.1. (discussed in the lecture on Thursday 20.02). If a vector w_i happens to be chosen far away from all clusters in an unfortunate way, it might happen that it is never updated. In this case, it is called a "dead unit". Propose two or three heuristics on how to eliminate such dead units.

6 Exercise. Worth 2 exercises. Find out about some application of Kohonen self-orginising maps (whatever you are interested in) and write an essay about it of length around one page of printed text. If you do this exercise, please e-mail me the essay before Tuesday 4pm.