UNIVERSITY OF OULU
Department of Computer Science and Engineering
Dr. Tapio Seppänen

Pattern Recognition and Neural Networks (521497S, 5 cp / 3 cu)
Examination 13.12.2011

NEITHER PROGRAMMABLE/GRAPHICAL CALCULATORS NOR COURSE MATERIAL ARE ALLOWED IN THE EXAM!

1. *Structure of Pattern Recognition Systems*

   In general, a pattern recognition system can be partitioned into several components. Describe what kinds of components there usually are and what the tasks of these components are! (6p)

2. *Bayes Decision Rule*

   You have one real-valued feature x that can attain values in the range $[0,4]$. Within this range, the class-conditional density functions for classes c_1 and c_2 are

   $$p(x|c_1) = \frac{1}{2} - \frac{1}{8}x \qquad \text{and} \qquad p(x|c_2) = \begin{cases} \frac{2}{9}x & \text{when } x \leq 3 \\ 0 & \text{when } x > 3 \end{cases}.$$

   In accordance with the Bayes decision rule, derive a classifier when the a priori probabilities for the classes are $P(c_1) = \frac{2}{5}$, and $P(c_2) = \frac{3}{5}$! (6p)

3. *Estimating Distributions*

   In Bayesian classification, it is essential to know the distributions. What are the differences between parametric and non-parametric density estimation techniques and when should one use the former or the latter method (pros and cons)? To make a case in point, give a short description of one parametric and one non-parametric technique! (6p)

4. *Perceptrons*

   Figure 1 below shows a two Perceptron network with weights and bias values. The output y of the net can attain either the value 0 or 1 when the features x_1 and x_2 are real-valued. Determine the decision regions in the feature space (x_1,x_2), i.e. calculate what feature values lead to the output being 0 or 1! (6p)

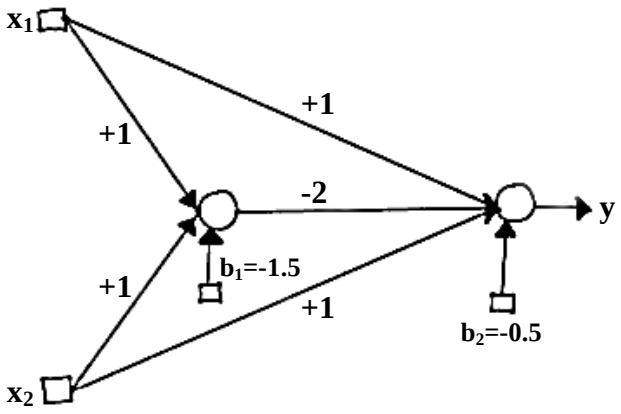

Figure 1. Multilayer Perceptron for the Question 4.