

No any material or calculator allowed – use pen or pencil. Return the exam question.

You may answer in English or Finnish. I use the minimum description length principle in evaluation. That is a good answer is very compact and very correct. Respectively, a long and incorrect answer is worse than a short and incorrect answer. You need 4 points to pass the exam and 12 points for the best grade.

1. Answer shortly to all questions:

(a) Explain where and why reinforcement learning is useful.

(b) If you have  $N$  samples  $\{[x_1, x_2]\}_n$  of binary variables  $x_1$  and  $x_2$  (all values equally probable) and you run the k-means clustering algorithm with  $k=4$ , then how would it converge?

(c) Define the k-Nearest-Neighbor algorithm

(d) Draw a single perception (a neuron) that solves the logical XOR problem as well as possible. How many times (if equal input distribution assumed) would it fail on average?

(e) How do you know whether a trained neural network suffers from over-fitting?

(f) If a neural network training suffers from over-fitting, then how can you avoid it?

(g) Draw a picture of four rooms with any configuration and doors between the rooms such that all rooms can be reached. Draw a robot in one room and its goal to the most distant room from the robot. Define immediate rewards for moving one room to another.

(h) Give at least two undesirable properties of the nearest neighbor learning.

(4 points)

2. Self-organising map (SOM)

You have one dimensional SOM of four nodes where the node 1 has the neighbor node 2, the node 2 has 1 and 3, and the node 4 only 3. The initial values are  $I$ : 1.2; 2.3; 6.4; 3. The learning parameter (learning rate) is  $a=1$  for the best matching unit and  $a=1/2$  for its neighbors. Draw the real number line and nodes on the real line. Then re-draw the new configurations of nodes after the following inputs: 1, 2, 1, 2

3. Concept learning vs Decision trees

Training examples are given in Table1. Find all concept learning concepts consistent with the data. By decision tree learning, form the decision tree for the data. Which one is better and why?

Table 1: Training examples.

Col	BP	OverW	Diabets
High	High	Sign	Yes
High	High	No	Yes
Moder	High	Sign	Yes
High	Moder	Sign	Yes
Moder	Moder	No	No
Moder	Moder	Sign	Yes