Knowledge Engineering

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Answer the following questions identifying the key aspects and try not to exceed the 1 page limit per question.

- Use only the sheets provided by the teacher
- Write Part I and Part II on separate sheets of paper
- Write your name and Student ID on each sheet you turn in
- English is the official language, however Italian is allowed
- Both pen and pencil are allowed, no other support is allowed

In case you have special needs (e.g., being graded within a given time) please write it on top of your assignment.

PART I

Question 1.1: Perceptron [6/30 Points]

Consider the classical schema for the single perceptron with two input:

- Draw it and write its output characteristic
- Define the formula for the weights update in the Perceptron
- Execute one epoch of training for the perceptron using the NAND (Not AND) function starting from the init conditions w0=0, w1=1/2 w2=1/2 and using a learning rate of 0.2 (+1 true values and -1 false values)
- Is a single perceptron able to learn the NOR function? Why?

Question 1.2: FF-NN [6/30 Points]

Consider the classical feed forward neural network schema having **I** input neurons, J hidden neurons and a single output:

- Draw the network and provide its analytical output
- Describe and discuss in details how learning is performed
- What is the overfitting issue in feed forward neural networks?

Question 1.3: Genetic Algorithms [4/30 Points]

Let assume we are interested in selecting the set of best publications, in terms of total number of citations, written by the researchers of Politecnico di Milano. We know the list of all publications made by people from Politecnico, the number of their citations and the list of authors. Only 3 publications are allowed for each employee and each publication can occur only once.

- Write the general schema of a genetic algorithm;
- Describe a possible coding and genetic operators for the problem;
- Write a possible fitness function for the problem;

PART II

Question 2.1: Knowledge Representation [6/30 Points]

Write the conceptual model (represented by "units") that can be extracted from these sentences:

- A cleaning robot is a mobile, autonomous electronic device
- Electronic devices need electrical power to work
- Mobile, autonomous electronic devices get power from batteries
- Roombas are cleaning robots
- Roombas' goal is to clean floors
- Chico is a Roomba

Please, structure knowledge and, eventually, add knowledge elements enabling to write at least one rule to understand when Chico needs to recharge its batteries. General solutions will be more appreciated.

Question 2.2: Expert systems [2/30 Points]

Please, briefly describe the main components of an expert system.

Question 2.3: Fuzzy Systems [8/30 Points]

We would like to implement a fuzzy system to control dynamically the speed of a mobile robot in presence of obstacles. In particular, we would like to approach obstacles at a reduced speed, while navigate at high speed if no obstacle is on our trajectory.

Please, select and model input and output variables of the system, define the corresponding fuzzy systems, select how to implement operators, write at least three of the rules implementing the fuzzy controller. Please, remember to **justify** all your choices, including shape and position of the membership functions.