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 NOR (Not OR) 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: RBF && FF-NN [4/30 Points]
Let compare Feed-Forward Neural Networks (FFNN) and Radial Basis Functions (RBF):
- Draw the two architectures and provide their analytical output
- Describe and discuss in details how learning is performed in both (no derivations required)

Question 1.3: Genetic Algorithms [6/30 Points]

Let assume we have the urban map of Milan represented by a graph of E links between V nodes and we are interested in finding the shortest path between an origin node and a destination node.

- 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;
- Is a genetic algorithm the best solution for this problem?

Note: very simple inefficient solutions can be found; they are ok for me ...

Question 2.1: Knowledge Representation [6/30 Points]

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

- A horse is an equine

- Equines need grass to eat

- The horse Abigail is lazy

Please, structure knowledge and, eventually, add knowledge elements enabling to write at least one rule to obtain that possibly Abigail needs grass to eat. Write the rule(s). General solutions will be more appreciated.

Question 2.2: Expert systems [2/30 Points]

Please, briefly describe the main participants to an expert system development team

Question 2.3: Fuzzy Systems [8/30 Points]

We would like to implement a fuzzy system to control dynamically the amplification of a hearing aid.

Please, consider at least the following aspects: external noise, external signal and desired audio level, as stated by the user. Consider that the system is able to provide distinct values for the intensity of the interesting signal (e.g., a person speaking to the user) and the intensity of background "noise".

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.