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 **tell it to the teacher!**

PART I

Question 1.1: Perceptron [5/30 Points]

Consider the classical Perceptron model <u>but use **3** Input and **1** Output</u> in this exercise:

- Draw it and write its output characteristic
- Describe the training algorithm for the Perceptron
- Perform an epoch of training for the XOR function (the output is 1 if and only if only 1 input is 1)
- Can this modified Perceptron solve the XOR problem?

Question 1.2: Radial Basis Functions [5/30 Points]

Let consider the Radial Basis Functions neural model:

- Draw a Radial Basis Function with 4 hidden neurons and 1 output neurons together with its output characteristics

- What are the differences between the RBF model and a classical feed forward architecture?

- Describe the training algorithm for the Radial Basis Functions

- How can we place the hidden units of a Radial Basis Function? How can we decide about how many of them?

Question 1.3: Genetic Algorithms [6/30 Points]

We have to design a system for the optimization of a painting robot trajectory. The trajectory is defined by a given set of N points defined by their 3D coordinates and the 3D vector applied to those points orthogonal to the surface to be painted. This trajectory could be not executable by the robot because of some constrain being violated.

The result of the optimization process should be a modified trajectory with all constraints satisfied but modified as little as possible.

- 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;

<div align="right">**PART II**</div>

Question 2.1: Knowledge Representation [6/30 Points]

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

- A soccer robot is a mobile, autonomous electronic device
- Electronic devices need electrical power to work
- Mobile, autonomous electronic devices get power from batteries
- Rakataa is a soccer robot
- Rakataa role is "mid-field"
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Please, structure knowledge and, eventually, add knowledge elements enabling to write at least one rule to understand when Rakataa 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 soccer robot in proximity to a ball. In particular, we would like to rush on the ball at high speed, but approach the ball at a reduced speed, and navigate at high speed when controlling the ball.

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 **motivate** all your choices, including shape and position of the membership functions.