# *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]

Let consider the simple model on a neuron named Perceptron:

- Draw it and provide the analytical form of its output;
- Describe the learning algorithm for the perceptron;
- Perform 2 epochs of training for the XOR function (2 input)
- Why it is not straightforward to build a multi layer perceptron just connecting several basic perceptrons?

## Question 1.2: RBF [4/30 Points]

Draw an RBF, its analytical output and briefly describe the differences between RBF and classical Feed Forward Neural Network.

## Question 1.3: Genetic Algorithms [6/30 Points]

"Pomodoro click" is the new service of our company which delivers goods to our customers at home though a set of trucks. To reduce the delivery costs we want to develop a genetic algorithm that optimizes the routes of our trucks (each of them has limited capacity). In particular we have a set of delivery places (destinations) and we want to find the routes starting from the main store for each of the truck so that: they (all together) cover all possible destinations, minimize the overall length covered by the trucks, each of them does not deliver more than its capcity.

- Write the general schema of a genetic algorithm;
- Describe a possible coding and genetic operators for the problem;
- Which selection strategy should I use?
- Write a possible fitness function for the problem.

### *Question 2.1: Knowledge Representation [6/30 Points]*

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

- A computer is an electrical device

- Electrical devices need electricity to work

- My computer does not work

Please, structure knowledge and, eventually, add knowledge elements enabling to write at least one rule to obtain that

electrical connection to power for my computer might not be connected. Write the rule(s). General solutions will be more appreciated.

### *Question 2.2: Expert systems [2/30 Points]*

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

### *Question 2.3: Fuzzy Systems [8/30 Points]*

We would like to implement a fuzzy system to control the light intensity of a laptop screen.

Please, consider at least the following aspects: external light, power status (on battery or not and level of charge of the battery), desired light level, as stated by the user. The system should control the intensity of the screen light.

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.