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: Feedforward [7/30 Points]

Consider the classical feed forward neural network architecture with I input neurons, J hidden neurons and 1 output neuron:

- Draw it and write its output characteristic
- Define the general formula for the weights update
- Derive the backpropagation formulas for the 2 layers of the network in the case of sum of squares error function
- Describe the issue of overfitting in feedforward neural networks and the 2 methods to face it

Question 1.2: Recurrent Architectures [3/30 Points]

Draw and briefly describe the kind of neural network topologies that could be used for time series prediction.

Question 1.3: Genetic Algorithms [6/30 Points]

We are interested in designing the best color palette to be used for a graphical project. The palette is a subset of 10 out of 256 possible colors. Each palette can be evaluated by a team of graphic designers.

- 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 computer is an electronic device
- Electronic devices may suffer from electroshock
- Electronic devices are protected against electroshock by a fuse
- When a fuse is burnt its electronic device has no power
- Ciccio is Johnny's computer

Please, structure knowledge and, eventually, add knowledge elements enabling to write at least one rule to detect that the fact that a computer like Ciccio is not working is possibly due to electroshock. General solutions will be more appreciated.

Question 2.2: Expert systems [2/30 Points]

Please, briefly describe what are the roles of the members of a knowledge based system development team.

Question 2.3: Fuzzy Systems [8/30 Points]

We would like to implement a fuzzy system to control the position of a ball on a plan that can rotate around two perpendicular axes, parallel to the plan. The movements are actuated by two motors and appropriate leverage.

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.