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: Neural Networks [7/30 Points]

With reference to a Feed-Forward Neural Network with J=4 hidden neurone, I=3 inputs, and one output, answer the following questions:

- Draw the network and write the analytical form of its output;
- Derive the weight decay error function and describe why it is used
- Derive the back-propagation formulas in case of weight decay.

Question 1.2: Recurrent Architecture [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]

Let assume we are interested in partitioning a cloud of N points, described by 3D coordinates, into 5 groups in such a way that the average distance of the points from the centroid of the group they belong to is minimized.

- 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 that can be extracted from these sentences:

- A car is a vehicle
- Vehicles can bring people from one place to another
- My car is black

Please, structure knowledge and, eventually, add knowledge elements enabling to write at least one rule to infer that my car can bring me from Milan to Como. Write the rule(s). General solutions will be more appreciated.

Question 2.2: Expert systems [2/30 Points]

Please, briefly describe the roles of the participants to a knowledge-based system design project.

Question 2.3: Fuzzy Systems [8/30 Points]

We would like to implement a fuzzy system to control the temperature of the air conditioning of a supermarket.

Please, consider the following aspects: time of the day, external temperature, internal temperature, desired internal temperature. The system should control the air conditioning system to match the desired internal temperature.

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.