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 and **tell it to the teacher!**

PART I

Question 1.1: FF-NN [6/30 Points]

Consider the classical schema for the feed forward neural network having **I** input neurons, **J** hidden neurons and a single output:

- Draw it and write its output characteristic
- <u>Derive</u> the weight decay error function for this network
- Define the backpropagation formulas under weight decay
- Why is weight decay used? How γ is chosen?

Question 1.2: Neural Networks for Time Series [4/30 Points]

Assuming we are interested in using a neural network to predict the future values for a time series.

- What kind of models we could use for that?
- How do we train those models?

Question 1.3: Genetic Algorithms [6/30 Points]

We are interested in merging the outcome of queries made on different web search engines. Assume each search engine returns a (possibly different) list of items (identified by unique ids), with some (possibly different) order, and assume you are interested in finding out the best ranking which minimizes the number of inversions with respect to the search engine results.

- 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;

Question 2.1: Knowledge Representation [6/30 Points]

Write the conceptual model (represented by "units") that can be extracted from these sentences:
- An elephant is a mammal
- A mammal is an animal
- Elephants have large ears and a trunk
- Dumbo is an elephant with large ears

Please, structure knowledge and, eventually, *add knowledge elements* enabling to write at least one rule to deduce that, since Dumbo is a mammal, he has taken in his life some milk from his mother Jumbo. General solutions will be more appreciated.

Question 2.2: Expert systems [2/30 Points]

Please, briefly describe the role of the components of the team that develops an expert system.

Question 2.3: Fuzzy Systems [8/30 Points]

We would like to implement a fuzzy system to control the speed of a grinder which can be used for different materials: dry bread, parmisan cheese, persil, coffee, etc. The controller should control the speed according to the resistance (measured as current absorbed by the engine) of material to be ground and the current speed.

Please, select and model input and output variables of the system, define the corresponding fuzzy sets, 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.