# 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 [8/30 Points]*

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

- Draw it and write its output characteristic
- Define the general formula for the weights update according to backpropagation
- What are the two main limits of backpropagation being it a basic gradient descent technique? How to face those limits?
- Derive the error function to be used in case of classification (i.e., the error model is a Bernulli distribution with the neural neural output being the Bernulli parameter)
- What should be the activation functions of the network in case of classification? What if we have more than 2 classes?
- Describe the issue of overfitting and list the standard techniques used to face it in neural networks?

## *Question 1.3: Genetic Algorithms [8/30 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.
- Describe the possible selection schema for the algorithm

**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 robot is a mechanical device
- Mechanical devices have moving parts
- A mobile robot may have either wheels or legs
- Moving parts can be blocked by dust
- Annie is Johnny's mobile robot

Please, structure knowledge and, eventually, add knowledge elements enabling to write at least one rule to detect that the fact that a robot like Annie that a leg of annie may not move due to excessive dust. General solutions will be more appreciated.

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

Please, briefly describe what are the main parts of a classical knowledge based system.

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

We would like to implement a fuzzy system to control the speed of a car. Given a reference speed, known when starting the system, the car should run at that speed. Available data are current speed, reference speed, and acceleration. The control is on gas and brake.

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.