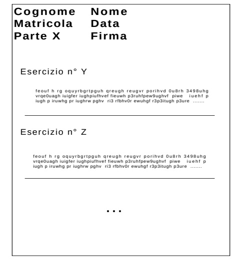
Soft Computing 28-06-2010



- Use only the answer sheets provided to you, write clearly on the top left hand corner (**like in the figure**) name, surname, enrolment number, date, part of the exam (Part 1 or Part 2) and signature
- Hand in the two parts in separate sheets
- Indicate the number of each exercise and separate each solution from each other clearly with a horizontal line
- Write CLEARLY by pen or pencil

Part 1

1.1. Fuzzy Design [7/32]

Design a fuzzy system able to control duration and number of activations of a home irrigation system. Single activation is performed at 10 PM, when two are selected another is added at 8 AM, in case of three another is added at 2 PM. The duration of each irrigation activity is proportional to the delivered water amount. The information available comes from a rainfall sensor that provides the amount of rainfall in the last 12 hours, and from a termometer providing maximum and minimum temperature in the just ended day. The decision is taken at 8 PM for the whole following day.

Select the input and the output variables of the fuzzy system, define the corresponding fuzzy sets, **justifying** shape and position, and at least 3 rules for modelling the problem.

Solution

Many solutions are possible. Here is one. The amount of water depends on the temperature, that makes water evaporating more or less quickly, and on the fact that if it rained enough, there is no need to put more water. Given this, we might consider either oth min and max temperature or the average temperature, together with the amount of water. For each of them we might have trapezoidal membership functions, justified by the fact that for more or less large intervals of the variable we will take the same decision. The output consists of two variables: the number of activations, and the amount of water (stated as the same for al activations). The first can be represented by singletons, and the variable will be defuzzyfied with the max operator, thus taking the decision that is more supported by the rules. The amount of water may also be represented by singletons since there are no special needs to have other shapes (thus giving more reative importance to lower matching values, and introducing potential problems to reach the extrema of the selected interval, due to the defuzzyfication, if done by the center of mass method). Rules may either consider all inputs and outputs together (e.g., if (AverageT is low) and (Rain is no) then (NActivations is one) and (AmountOfWater is few)) or consider separate, interacting subsystems (e.g., if (AverageT is low) then (AmountOfWater is few) and (NActivations is one); if (Rain is no) then (NActivations is two))

1.2. Neuro-Fuzzy Networks [2/32]

Describe the roles of the layers in neuro-fuzzy networks, w.r.t. the corresponding elements of a fuzzy rule-based system.

Solution

See slides or books. Neuro-fuzzy networks have layers associated to each conceptual component of fuzzy rules... Better to include also a picture

1.3. Reinforcement Learning [7/32]

Design a reinforcement learning system able to learn the behavior of a robot able to perceive close obstacles from 8 different directions, the amount of residual charge of the battery, and the distance from a light positiond on the charging station. The robot has two motors, one for each wheel, and has to move continuously in an environment where obstacles are present, maximizing the lenght of the run path in a period of time spanning three times the average duration of the battery.

Model the problem, specifying the **states**, the possible **actions** (**that enables the agent to pass from one state to another**), and a **reinforcement function**. Justify the choice of a reinforcement distribution algorithm for this application, on the basis of the selected model.

Solution

Also here many different solutions are possible. Here is one.

The state may be represented by eight boolean variables (to represent the presence of an obstacle in one of the given directions), one variable for the distance to the charging station (values: null, close, far), one variable for the state of the battery (values: full, low). It makes no sense to put values or variables for which there will not be a relation with possible actions (e.g., the "discharged value" for the state of the battery: in that case the robot is dead and cannot decide to do any action). The possible actions are represented by a single variable taking as values: forward, backward, left, right. The reinforcement function is proportional to the amount of movement done, w.r.t. the maximum possible (given by considering that the robot goes always forward). This can be given every 20 steps, so to have it distributed quite often, w.r.t. a reinforcement distribution at recharging time. This should be enough, but negative reinforcements can also be given when hitting an obstacle, and when finishing the battery