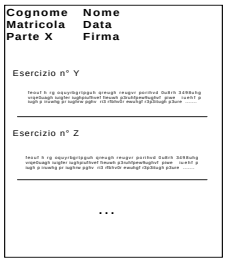
Soft Computing 28-06-2010

- 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.

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.

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.

Part 2

2.1 Neural Networks [Score 8/32]

Lets consider the feedforwd topology model with I input, J hidden neurons, and 1 output; you should answer the following questions:

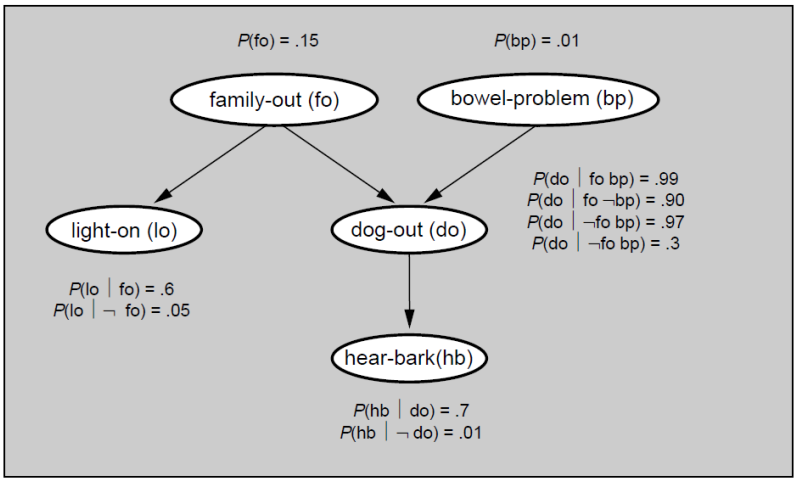
- What is overfitting? Does this model of network suffer this issue? In case the answer is positive, describe the two techniques to reduce its effects described during lectures
- Derive the backpropagation equation when using the *weight decay* technique ... double check indexes in summations ;-)
- Which activation functions should we use in case we want to use this network for regression? What about classification? Why?

2.2 Bayesian Networks [Score 8/32]

> *Suppose when I go home at night, I want to know if my family is home before I try the doors. (Perhaps the most convenient door to enter is double locked when nobody is home.) Now, often when my wife leaves the house, she turns on an outdoor light. However, she sometimes turns on this light if she is expecting a guest. Also, we have a dog. When nobody is home, the dog is put in the back yard. The same is true if the dog has bowel troubles. Finally, if the dog is in the backyard, I will probably hear her barking (or what I think is her barking), but sometimes I can be confused by other dogs barking.*

This situation can be modele by using the Bayesian network in the figure
With reference to that network, answer the following questions:

- Identify at least 2 independent nodes, 2 nodes conditionally independent (stating with respect to qhich conditioning node/s), 2 nodes suffering for the “explaining away” phenomenon.
- Compute the exact probability of dog-out given light-on
- Compute the previous probability by monte carlo simulation using the provided random numbers
- How does *likelihood weighting* work? Why it is used instead of monte carlo? Is it possible to use the message passing method with this network? Why?



Random numbers: 0.7937, 0.9992, 0.1102, 0.6226, 0.1326, 0.3100, 0.1348, 0.2233, 0.3965, 0.1351, 0.2411, 0.9275, 0.3911, 0.5113, 0.0929, 0.0217, 0.1595, 0.8445, 0.8792, 0.1870, 0.9913, 0.7120, 0.8714, 0.4796, 0.4960, 0.2875, 0.0609, 0.2625, 0.1863, 0.9171, 0.4869, 0.8175, 0.6416, 0.3063, 0.6609, 0.3580, 0.9382, 0.4877, 0.0910, 0.6738, 0.5149, 0.2216, 0.7250, 0.0682, 0.9641, 0.2077, 0.1611, 0.6382, 0.0002, 0.3356, 0.2751, 0.0445, 0.0939, 0.4100, 0.8169, 0.8705, 0.0226, 0.7272, 0.8480, 0.7286.