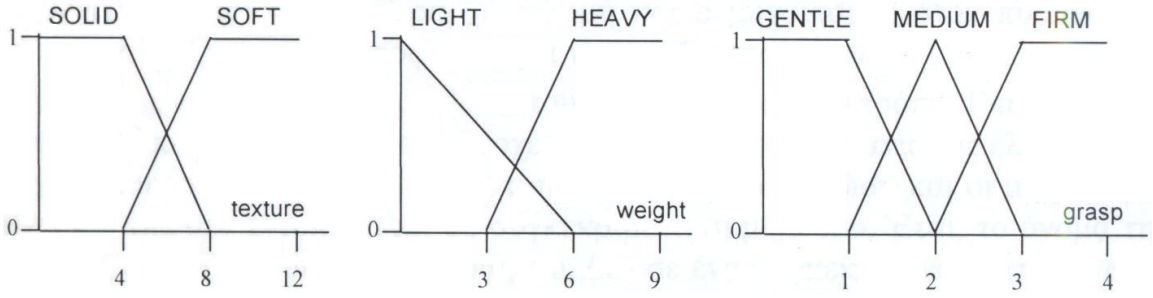
Fuzzy Systems Assignments

(Only 80% of the marks for the first two assignments)

1. We have a robotic arm and we want to create a Fuzzy inference System (FIS) that will control the grip of the robotic arm. Input data for the FIS are the texture of the object and its weight. The output is the force that has to be exercised by the grip of the robotic arm (grasp). The rules that control the system are:
   - if texture is SOLID and weight is HEAVY then apply FIRM grasp
   - if texture is SOLID and weight is LIGHT then apply MEDIUM grasp
   - if texture is SOFT and weight is HEAVY then apply MEDIUM grasp
   - if texture is SOFT and weight is LIGHT then apply GENTLE grasp

   The membership functions of the linguistic terms for the fuzzy variable texture, weight and grasp are given in the following diagrams:



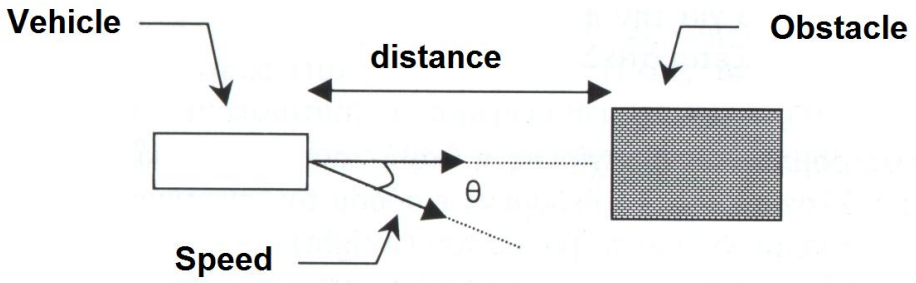
   After creating the FIS, you have to use it to:

   a) Compute the value of the force that has to be exercised by the grip (grasp) when the input data are: texture=5 (in some texture scale) and weight=7 (in a weight scale).

   Solve the same problem diagrammatically. The value of grasp must be approximately calculated from the diagram.

2. We want to create a Fuzzy inference System (FIS) that will control a vehicle in avoiding an obstacle. The input variables are the speed of the car, and its distance from the obstacle. The output variable is the angle that the vehicle has to turn in order to avoid the obstacle. You have

to define the linguistic terms of the three variables (eg. Speed = {Low, Medium, High}), the corresponding membership functions, and the rules that will produce the result for the angle θ.



3. Non-linear system identification with neuro-fuzzy systems. We have a non-linear system with two (2) inputs and one (1) output that is described by the following nonlinear equation:

$$y = (1 + x_1^{-1.5} + 3x_2^2) \qquad (1)$$

Each $x_i \,|\, i = 1,2,3$ is random real number in the interval [1,5]

Design and train a T-S-K (Takagi-Sugeno-Kang) neuro-fuzzy system that identifies the nonlinear system with the smallest possible error.

You can use the free fuzzy system development environment **Xfuzzy** (http://www2.imse-cnm.csic.es/Xfuzzy/), or the ANFIS of the MATLAB fuzzy toolbox.

The manual of the Matlab fuzzy toolbox is accessible from the home page of the class.

4. Pattern classification with neuro-fuzzy systems. Iris flowers are classified into three (3) categories depending on the length and width of the sepals and petals of each iris. We have 150 measurements, that we'll use in order to automatically classify the iris, in the following form:

A/A	Sepal-length	Petal-length	Sepal-width	Petal-width	Category
1	5	3.5	1.3	0.3	1
2	5.6	3	4.1	1.3	2
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
150	6.8	3.2	5.9	2.3	3

Table: Format of the input-output patterns for IRIS

Design and train a T-S-K (Takagi-Sugeno-Kang) neuro-fuzzy system which will operate as a classifier. Use the first 75 patterns in order to train the classifier and the rest 75 patterns in order to check the correct classification ability of the system.

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