

AS-74.3115 NEURO-FUZZY Computing in Automation
Exam 9.5.2008
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All questions are of equal value.

Use of books or lecture notes is not allowed.

1)

- Define a fuzzy set.
- Who is considered the inventor of fuzzy logic?
Mention one other person that has been influential in developing basic ideas of fuzzy logic.
- In fuzzy logic T-norm is defined as a map
 $T : [0,1] \times [0,1] \rightarrow [0,1]$. Let a, b, c , and d be real numbers belonging to a closed unit interval.

T-norm satisfies the following criteria:

$$T(a,b) = T(b,a) \quad \text{commutativity}$$

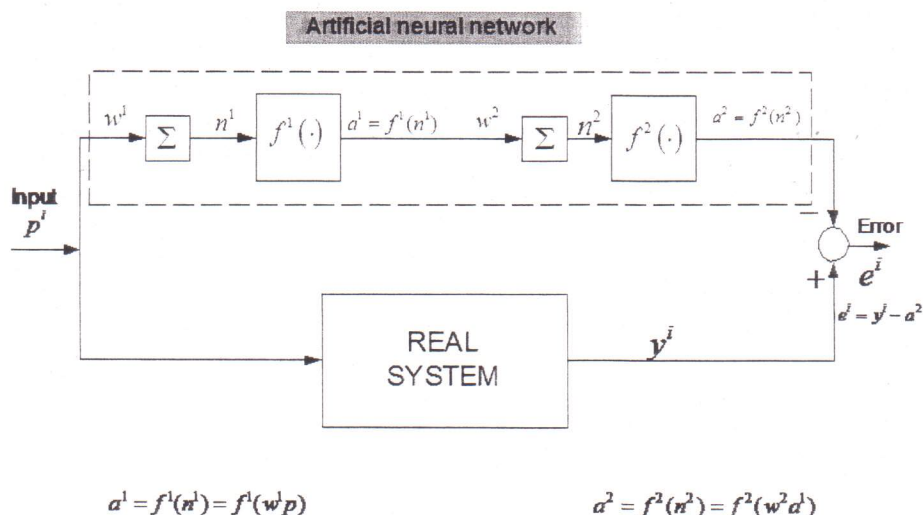
$$T(T(a,b),c) = T(a,T(b,c)) \quad \text{associativity}$$

$$T(a,b) \leq T(c,d), \text{ if } a \leq c \text{ and } b \leq d \quad \text{nondecreasing}$$

$$T(a,1) = T(1,a) = a, \quad T(0,0) = 0 \quad \text{boundary}$$

Give an example of T-norm and show that it satisfies the above requirements.

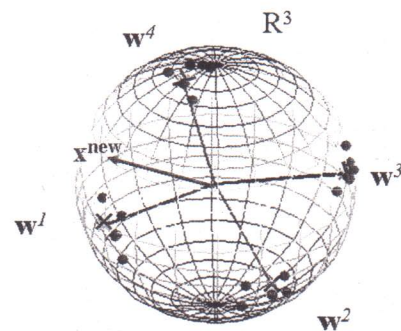
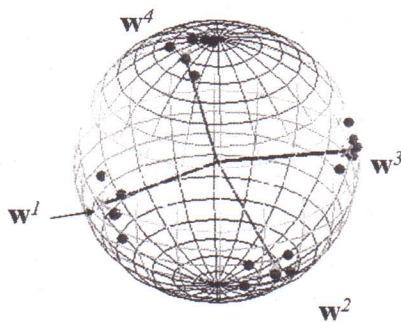
- Give two ways how fuzzy logic can be used in fuzzy control. Draw a block diagram of each.
 - Draw the basic block diagram of a fuzzy system. Explain what the task of each block is.
- 3) The figure below shows a simple two-layer perceptron network, where notation is given in the figure.
- Explain how backpropagation algorithm works.
 - Compute the updating algorithm of the first phase of backpropagation (one layer is enough).



Hint: Gradient algorithm

$$\mathbf{w}_{k+1} = \mathbf{w}_k - \alpha_k \left(\frac{\partial J}{\partial \mathbf{w}} \right) \Big|_{\mathbf{w}_k}$$

- 4). a) Suppose you have four weight vectors of unit length $\mathbf{w}^j = [w_1^j, w_2^j, w_3^j]$, $j = 1, \dots, 4$ as shown in the figure (left).



A new input vector \mathbf{x}^{new} is introduced (Figure on the right). Explain how competitive learning works.

b) How does Kohonen Self-Organizing Map differ from competitive learning.

- 5) a) What are the main objectives in system monitoring? Draw a block diagram of system monitoring showing the different phases.
b) Explain the basic Genetic Algorithm cycle.