FUZZY LOGIC NEURAL NETWORK

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Abstract: A complex neural network is analized and synthetised by means of fuzzy logic.

1. Introduction.

In [1] fuzzy logic model of a single neuron has been introduced. We intend to analyse and synthesize a complex neural network using theory outlined in [1].

2. Static fuzzy neural network.

Consider a static fuzzy neural network depicted in Figure 1.

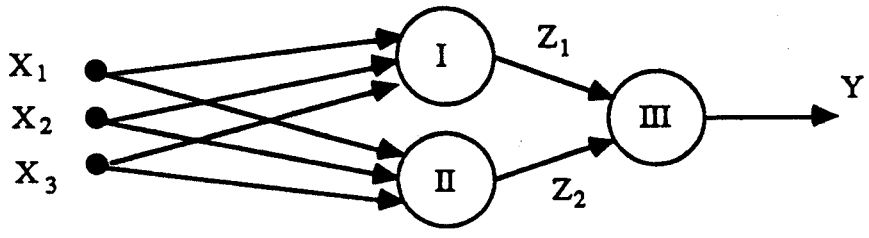

Figure 1 Static fuzzy neural network

Let neurons constituting the network be shaped by the following

For neuron No. I

$$\left\{ \text{IF } X_{1(i)} \text{ AND } X_{2(i)} \text{ AND } X_{3(i)} \text{ THEN } Z_{1(i)}, \text{ ALSO} \right\}$$

$$i = 1, 2, 3, \ldots, I$$

$$Z_1 = X_1 \circ R_1^I \Delta X_2 \circ R_2^I \Delta X_3 \circ R_3^I \tag{1}$$

For neuron No. II

$$\left\{ \text{IF } X_{1(i)} \text{ AND } X_{2(i)} \text{ AND } X_{3(i)} \text{ THEN } Z_{2(i)}, \text{ ALSO} \right\}$$

$$Z_2 = X_1 \circ R_1^{II} \Delta X_2 \circ R_2^{II} \Delta X_3 \circ R_2^{II} \tag{2}$$

For neuron No. III

$$\{\text{IF } Z_{1(i)} \text{ AND } Z_{2(i)} \text{ THEN } Y_{(i)}, \text{ ALSO}\}$$

$$Y = Z_1 \circ R_1^{III} \Delta Z_2 \circ R_2^{III} \tag{3}$$

Using (1), (2) and (3) an input-output model of the network could be stated as

$$Y = [X_1\ X_2\ X_3] * \begin{bmatrix} R_1^I \circ R_1^{III} \Delta R_1^{II} \circ R_2^{III} \\ R_2^I \circ R_1^{III} \Delta R_2^{II} \circ R_2^{III} \\ R_3^I \circ R_1^{III} \Delta R_3^{II} \circ R_2^{III} \end{bmatrix} \tag{4}$$

where * stands for $(\circ, \Delta)$-composition. Formula (4) constitutes fuzzy logic model of the considered network. An idea outlined here may be imposed on any type of neural networks.

3. Dynamic fuzzy neural network.

Let us consider dynamic fuzzy neural network depicted in Figure 2.

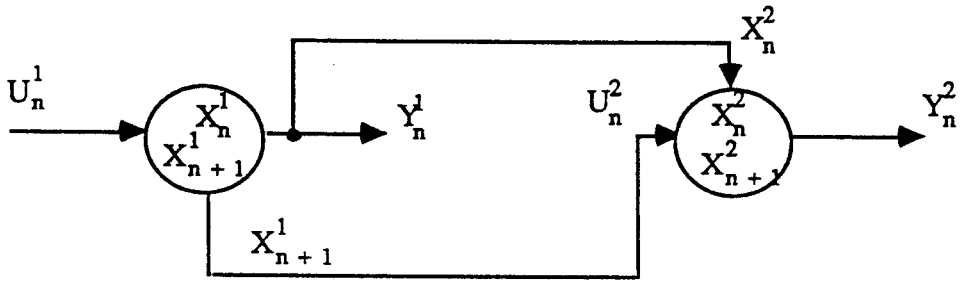

Figure 2 Dynamic fuzzy neural network

Using denotation of [1], Chapter 3, we get the following dynamic model of neuron No. I

$$\begin{bmatrix} X^1_{n+1} \\ Y^1_n \end{bmatrix} = \begin{bmatrix} X^1_n & U^1_n \end{bmatrix} * \begin{bmatrix} A^1 & B^1 \\ C^1 & D^1 \end{bmatrix} \tag{5}$$

and for neuron No. II

$$\begin{bmatrix} X^2_{n+1} \\ Y^2_n \end{bmatrix} = \begin{bmatrix} X^2_n & U^2_n \end{bmatrix} * \begin{bmatrix} A^2 & B^2 \\ C^2 & D^2 \end{bmatrix} \tag{6}$$

In the presence of a series connection of the above network we note that

$U^2_n = X^1_{n+1}$ and $X^2_n = Y^1_n$

Combining Equations (5) and (6) we get dynamic model for network in Figure 2.

$$\begin{bmatrix} X^2_{n+1} \\ Y^2_n \end{bmatrix} = \begin{bmatrix} X^1_n & U^1_n \end{bmatrix} * \begin{bmatrix} A & B \\ C & D \end{bmatrix} \tag{7}$$

where

$A = B^1 \circ A^2 \Delta A^1 \circ C^2$

$B = D^1 \circ A^2 \Delta C^1 \circ C^2$

$C = B^1 \circ B^2 \Delta A^2 \circ D^2$

$D = D^1 \circ B^2 \Delta C^1 \circ D^2$

The above procedure could be extended to any type of dynamic neural network.

Solution of Equation (7) had been discussed in [1].

4. Summary.

The theory of fuzzy logic neuron has been applied to investigate a complex neural network.

References.

[1] J.B. Kiszka, and M.M. Gupta, Fuzzy logic model of simple neuron, BUSEFAL, 1989.