The Ternary-Encoded Fuzzy-Neural Networks

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Abstract – **When combining fuzzy logic and neural networks it is possible to get a hybrid system that can process uncertain values and can be trained. Fuzzy logic elements can be regarded as fuzzy-neural networks. In order to present a set of fuzzy values the ternary encoding is used.**

Keywords - **ternary, fuzzy, neural, minimum, maximum.**

I. Introduction

Artificial neural networks are physical cellular systems which can acquire, store and utilize experiential knowledge. Fuzzy systems can process uncertain, vague values and provide the most accurate control action. Combining these intelligent technologies it is possible to get a hybrid system that can process uncertain values and can be learned [1].

So, we propose to build up fuzzy minimum and maximum element as neural networks.

II. The ternary encoding of fuzzy values

Fuzzy minimum operation is performed so:

$$z = x \wedge y = \min(x, y) .$$

Fuzzy maximum operation is performed so:

$$z = x \vee y = \max(x, y) .$$

In the practical case we often deal not with the ideal fuzzy logic, but with an almost fuzzy, multivalued one.

That is why, so called ternary encoding is used in order to present a membership function, which is of a singleton-type (fig.1). In [2] the {-1, 0, +1} ternary logic is proposed, but we propose to use the {0, 1, 2} ternary logic.

So, let fuzzy logical zero correspond to ternary 000 and fuzzy logical one correspond to ternary 222. Instead of [0, 1] logic we have [000, 222] logic.

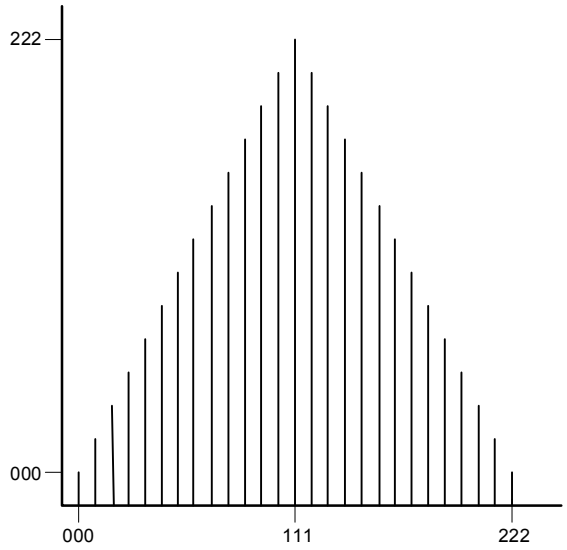

Fig.1 A membership function as a set of singletons

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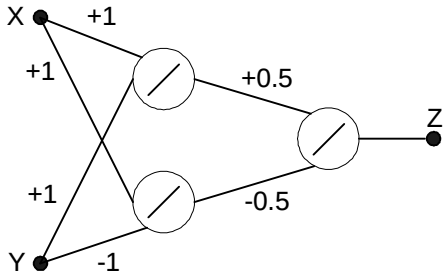
III. The neural networks

The neural network performing the minimum operation is presented at fig. 2, where



$$f(net_1) = net_1 = x \cdot (+1) + y \cdot (-1) ,$$

$$f(net_2) = net_2 = x \cdot (+1) + y \cdot (-1) ,$$

$$f(net_3) = net_3 = net_1 \cdot (+0,5) + net_2 \cdot (-0,5)$$

Fig.2 The minimum neural network

The neural network performing the maximum operation is presented at fig. 3, where:

$$f(net_1) = net_1 = x \cdot (+1) + y \cdot (-1) ,$$

$$f(net_2) = net_2 = x \cdot (+1) + y \cdot (-1) ,$$

$$f(net_3) = net_3 = net_1 \cdot (+0,5) + net_2 \cdot (+0,5) .$$

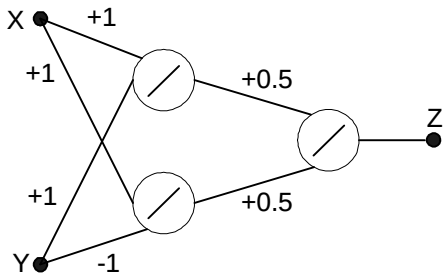


Fig.3 The maximum neural network

These neural networks perform the fuzzy minimum and maximum operations, thus they can be used in fuzzy controllers with ternary information presentation.

IV. Conclusion

So, we have proposed two neural networks on linear neurons. The first operates as a fuzzy minimum element, the second does as a fuzzy maximum element. Ternary encoding is used in order to present a set of fuzzy values.

References

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