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Neural network for defining intuitionistic fuzzy sets in e-learning

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Abstract
The paper presents a neural network that evaluates the students' answers based on defined set criterions. To be involved in practice there are used evaluation in intuitionistic fuzzy form about the students' knowledge. This is proper to be used as a basic element for e-learning systems' building.

Key words: Intuitionistic Fuzzy Sets, Neural networks, e-Learning, Digital University.

Introduction

Within the context of e-learning, the information exchange between the education and training system and the student is performed electronically. The student obtains information on a given topic at his/her local machine. After this the student's acquisition of knowledge can be rated by asking appropriate questions and problems, in order to pass on to the next topic of training.

In a series of research, the authors study some of the most important processes of functioning of universities ([5, 6, 7, 8, 9, 10]). Generalized Nets (GNs, see [12, 13]) are used to describe the process of student assessment [5, 9, 10]). The evaluations to cope with the varying student background on different themes are represented in intuitionistic fuzzy form; (for the concept of Intuitionistic Fuzzy Set (IFS, see [1]).

In [5] the process of evaluation of the problems solved by students is described by Generalized Nets. The paper [8] describes the process of evaluation by lecturers of the tasks presented by students. In [9] a generalized net is used to construct a model which describes of the process of evaluation by lecturers. In [10] is constructed a generalized net that corresponds to a model which describes the standardization of the process of evaluation by lecturers. In [11] the process of evaluation of student's course is described. The evaluation of student's course is a function of the student's evaluations from examination of the course.

The aim of the present paper is to use the techniques of neural networks to model the process of e-learning within the digital university and to assess the students' knowledge on relevant topics in intuitionistic fuzzy form. The students fill in the closed tests with *m* questions (with tree possible answers for the each question: a; b or c). The evaluation is formed on the basis of these answers.

These assessments, which estimate the degree of the assimilation (μ) and the non-assimilation (ν) of the information obtained, are represented by ordered pairs $<\mu, \nu>$ of real numbers from the set $[0,1]\times[0,1]$.

The degree of uncertainty π=1-μ-ν represents those cases where the student is currently unable to answer the question asked and needs additional information. Everywhere the ordered pairs have been defined in the sense of intuitionistic fuzzy sets.

Neural network

In works [2, 3, 4] are described different types of neural networks. Many of them are used for image recognizing (symbols, classes, knowledge etc.). Neural network can be used for obtaining intuitionistic fuzzy evaluation. In the present paper we use Feed-forward neural network with structure from Fig.1. In the inputs of the neural network are the students' answers and the positive criterions for evaluation the respective question (the true answers for it).

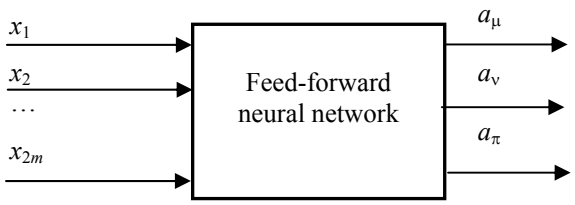

Fig. 1. Nodes of the neural network

On the inputs x_1, … x_m are students' answers of the questions from the test. On the inputs x_{m+1}, … x_{2m} are correct answers of the questions from the test.

Outputs a_μ , a_ν and a_π obtain intuitionistic fuzzy evaluations. The first output gives the degree of the assimilation of the information μ; the second - degree of a non assimilation of the information ν, and the third - degree of uncertainty π = 1-μ-ν.

For the realization of our purpose was used two-layer feed-forward neural network. The P_{20x1} vector was fed at the input, and the T_{3x1} was produced at the output. The input layer consisted of 8 neurons as the standard logic function (logsig) was used as a transfer function. The output of the second layer was defined by the equation a^1=logsig(pw^1+b). The output layer was with a linear transfer function and was defined by the equation a^2=purelin ((logsig (pw^1+b^1)w^2+b^2).

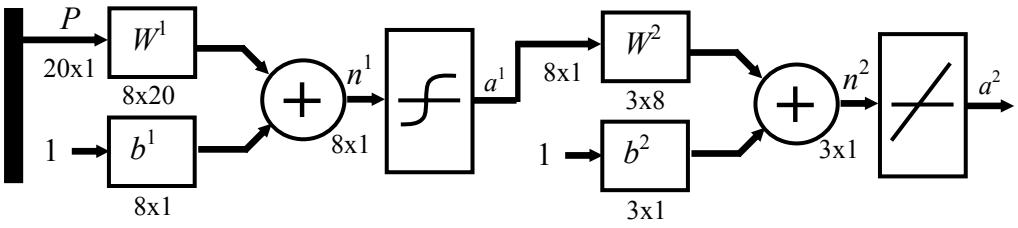

Fig. 2. Neural network structure

The network learning was performed in a MATLAB environment by means of the Levenberg-Marquardt algorithm with a set mean square error of 1.10^{-5}.

At the beginning is done a statistics of the students' answers and after that is learned the neural network. Initially when still no information has been obtained, all estimations are given initial values of <0, 0>. When $k \geq 0$, the current (k+1)-st estimation is calculated on the basis of the previous estimations according to the recurrence relation

$$<\mu_{k+1}, \nu_{k+1}> = <\frac{\mu_k k + m}{k+1}, \frac{\nu_k k + n}{k+1}>,$$

where $<\mu_k, \nu_k>$ is the previous estimation, and <μ, ν> is the estimation of the latest measurement, for m, $n \in [0, 1]$ and $m + n \leq 1$. These values are used for training of neural network (Fig.3).

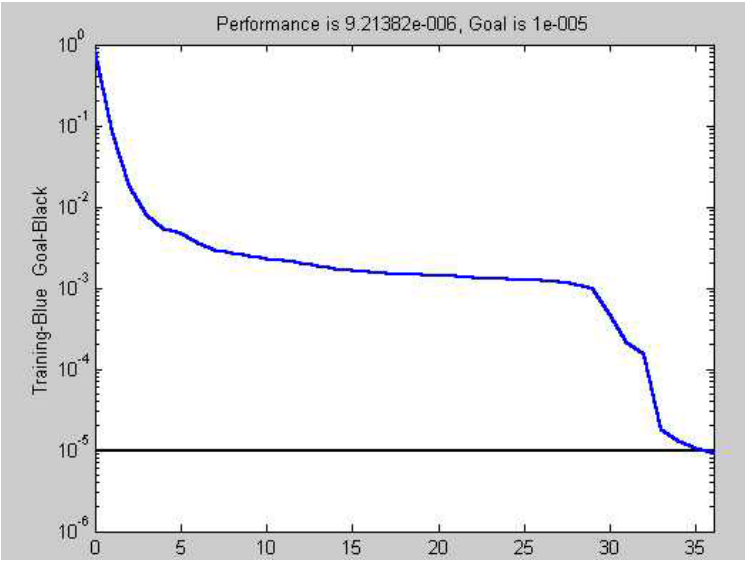

Fig. 3. Training of the neural network

During the neural network's test not only correct answers are given but and different of them (Table 1). The table consist true (T), false (F) answers and questions without answers (blank).

Table 1

№	The answers of each different question										μ	ν	π
1	T	T	T	T	T	T	T	T	T	T	0.9978	0.0001	0.0002
2	T		T	T	T	T	T	T	F	F	0.7999	0.1002	0.0983
3	F	F	T			T	F	T	T	T	0.6008	0.2991	0.1038
4	T	T	F		T	T	T		T	F	0.7998	0.1001	0.0995
5	T	T	T	F			T	T	F	T	0.8010	0.0998	0.1016
6	F	F	T	F	F		T	F	T		0.3886	0.5093	0.1024
7	T		T	T	T	T	F	F	F	T	0.5992	0.2988	0.0997

Inferences

- When on the neural network's input is given correct answer (that coincides with precursory set criterion), the degree of assimilation of the information μ is 1, and the degree of non assimilation of the information ν is 0.
- When a student gives correct answers for the half of questions in the test then the final evaluation has $\mu > 0.5$.
- When a student gives incorrect answers for the half of questions in the test then the final evaluation has $\nu > 0.5$.

- The examinee needs additional learning when the degree of the non assimilation of the information ν is ≥ 0.5 or uncertainty π is ≥ 0.5 (row 6 of Table1).

Conclusion

The presented neural network determine the degree of assimilation, non assimilation and uncertainty in the students answers' evaluation. The evaluation is based on defined set criterions. The network could be used for the evaluation of the students' answers in the closed tests in e-learning. This is proper to be used as a basic element for e-learning systems' building.

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