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GENERALIZED NET MODEL OF LECTURERS' EVALUATION OF STUDENT WORK WITH INTUITIONISTIC FUZZY ESTIMATIONS

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Abstract: A generalized net is used to construct a model which describes the process of evaluation by lecturers of the work of students. The evaluations utilize the theory of intuitionistic fuzzy sets.

Keywords: Generalized nets, Intuitionistic Fuzzy Sets, University, E-Learning.

Introduction

In a series of research papers, the authors have studied some of the most important processes of the functioning of universities (see [5]). In [4] the process of evaluation of the tasks solved by students is described by Generalized Nets (GNs, see [3]). In [6] describes the process of evaluation by lecturers of the tasks presented by students.

The evaluations corresponding to the students background about some theme are represented in intuitionistic fuzzy form (for the concept of Intuitionistic Fuzzy Set (IFS, see [1, 2]). The present paper a generalized net is used to construct a model which describes of the process of evaluation by lecturers.

Let us have n students. Let us also have m lecturers. The evaluations corresponding to the lecturers are represented by intuitionistic fuzzy estimations. They have the form $<\mu_j, \nu_j>$, μ_j and ν_j determine the degrees of strictness and non-strictness of the estimation of the j-th lecturer, $j = 1, 2,\ldots, m$.

1 Determine of the evaluations

Let s_i^j be the i-th student, who is taught by the j-th lecturer, $i = 1, 2,\ldots, n, j = 1, 2,\ldots, m$. The i-th student obtains average evaluations o_i^{avr}.

Of course, the way of evaluation of the different estimations will vary, but the authors consider that the evaluations of the lecturers of the tasks solved by students can be obtained, in general, by two ways:

Version 1.

The i-th student s_i^j obtains three estimations from three different lecturers. Let us note these estimations by $o^1_{s_i^j,j}$, $o^2_{s_i^j,j+1}$ and $o^3_{s_i^j,j+2}$, $i = 1, 2,\ldots, n, j = 1, 2,\ldots, m$.

The estimation process has the following steps:

1. Each lecturer estimates the results of all his/her students.

   As a consequence, the i-th student s_i^j obtains estimation $o^1_{s_i^j,j}$.

2. The first lecturer estimates the results of the students of the second lecturer, he – of the third one, etc., m-th lecturer – of the first lecturer's students.

   As a consequence, the i-th student s_i^j obtains estimation $o^2_{s_i^j,j+1}$.

3. The first lecturer estimates the results of the students of the third lecturer, he – of the fourth one, etc., $(m-1)$-th lecturer – of the first lecturer's students, m-th lecturer – of the second lecturer's students,

   As a consequence, the i-th student s_i^j obtains estimation $o^3_{s_i^j,j+2}$.

4. Order the estimations $o^1_{s_i^j,j}$, $o^2_{s_i^j,j+1}$ and $o^3_{s_i^j,j+2}$ of the i-th student following their order of strictness.

5. Averaging of the estimations $o^1_{s_i^j,j}$, $o^2_{s_i^j,j+1}$ и $o^3_{s_i^j,j+2}$ for the i-th student s_i^j and obtaining of the estimation o_i^{avr}:

$$o_i^{avr} = \frac{o^1_{s_i^j,j} + o^2_{s_i^j,j+1} + o^3_{s_i^j,j+2}}{3}.$$

6. Calculation of the intuitionistic fuzzy estimation for each lecturer on the basis of estimations $o^1_{s_i^j,j}$, $o^2_{s_i^j,j+1}$ and $o^3_{s_i^j,j+2}$ for i-th student s_i^j.

   In this case the evaluation of the j-th lecturer is

$$<\mu_j,\ \nu_j>=\left\langle \frac{x_j}{r_j}, \frac{y_j}{r_j} \right\rangle,$$

where:

x_j is the number of the estimations, given by the j-th lecturer, that are higher than the average estimation of the i-th student o_i^{avr};

y_j is the number of estimations, given by the j-th lecturer, hat are smaller than the average estimation of the i-th student o_i^{avr};

r_j is the number of the students estimated by the j-th lecturer.

Therefore, the degree of uncertainty here is determined by the number of the evaluations which are equal to the average estimation o_i^{avr} for the i-th student..

Version 2.

The i-th student s_i^j obtains m estimations from the m different lecturers. Let us mark them by $o_{s_i^j}^k$, where $i = 1, 2,\ldots, n,\ j = 1, 2,\ldots, m,\ k = 1, 2,\ldots, m$.

The estimation process has the following steps:

1. Each lecturer estimates the results of all his/her own students.
   As a consequence, the i-th student s_i^j obtains estimation $o_{s_i^j}^k$, where $k = j$.
2. Each lecturer estimates the results of all students whom he/she does not teach.
   As a consequence, the i-th student s_i^j obtains m–1 new estimations $o_{s_i^j}^k$, where $k = 1, 2,\ldots, j-1, j+1,\ldots, m$.
3. Order the estimations (m in numbers) $o_{s_i^j}^1$, $o_{s_i^j}^2$,..., $o_{s_i^j}^m$ obtained from the different lecturers by the i-th student, following their order of strictness.
4. Averaging of the estimations $o_{s_i^j}^1$, $o_{s_i^j}^2$,..., $o_{s_i^j}^m$ from the i-th student s_i^j to obtain estimation o_i^{avr}:
$$o_i^{avr}=\frac{o_{s_i^j}^1+o_{s_i^j}^2+\ldots+o_{s_i^j}^m}{m}.$$
5. Calculation of the intuitionistic fuzzy estimation for each lecturer on the basis of estimations $o_{s_i^j}^1$, $o_{s_i^j}^2$,..., $o_{s_i^j}^m$ for the i-th student s_i^j.
   In this case the evaluation of the j-th lecturer is
$$<\mu_j,\ \nu_j>=\left\langle \frac{x_j}{n}, \frac{y_j}{n} \right\rangle,$$

where:

x_j is the number of the estimations, given by the j-th lecturer, that are higher than the average estimation of the i-th student o_i^{avr} ;
y_j is the number of estimations, given by the j-th lecturer, hat are smaller than the average estimation of the i-th student o_i^{avr} .

Therefore, the degree of uncertainty here is determined by the number of the evaluations which are equal to the average estimation o_i^{avr} for i-th student..

2 A GN-model

The GN-model (see Fig. 1) contains 7 transitions and 16 places, collected in two groups and related to the two types of the tokens that will enter respective types of places:
α - tokens and a-places represent the lecturers and their activities,
β - tokens and c-places represent the students and their solutions of the problems.

For brevity, we shall use the notation α- and β-tokens instead of α_i- and β_j-tokens, where i, j are numerations of the respective tokens.
In the beginning α- and β-tokens stay, respectively, in places a_3 and b_3 with initial characteristics:

x_0^{α} = "name, speciality and score of a lecturer",

x_0^{β} = "name, speciality and current evaluations of a student".

If we would like the model to be more detailed, the first and the latest characteristics can have, e.g., the following larger forms

x_0^{α} = "name, speciality and score of a lecturer
variant of evaluation that the lecturer uses",

x_0^{β} = "name, speciality and current evaluations of a student,
name of the student's lecturer who will give the problems and/or examine the student".

All α-tokens and all β-tokens have equal priorities, but the priority of α-tokens is higher than the priority of β-tokens.

The new lecturers and students enter the net via places a_1 and b_1 respectively.

The forms of the transitions are the following.

$$Z_1 = <\{a_1, a_3, a_9\}, \{a_2, a_3\},$$

where:

	a_2	a_3
a_1	*false*	*true*
a_3	$W_{3,2}^a$	$W_{3,3}^a$
a_9	*false*	*true*

>,

$W_{3,2}^a$ = "The lecturer must examine",
$W_{3,3}^a = \neg W_{3,2}^a$.
where ¬P is the negation of predicate P.

The α-tokens do not obtain any characteristic in place a_3 and they obtain the characteristic

"list of the problems that the student must solve"

in place a_2.

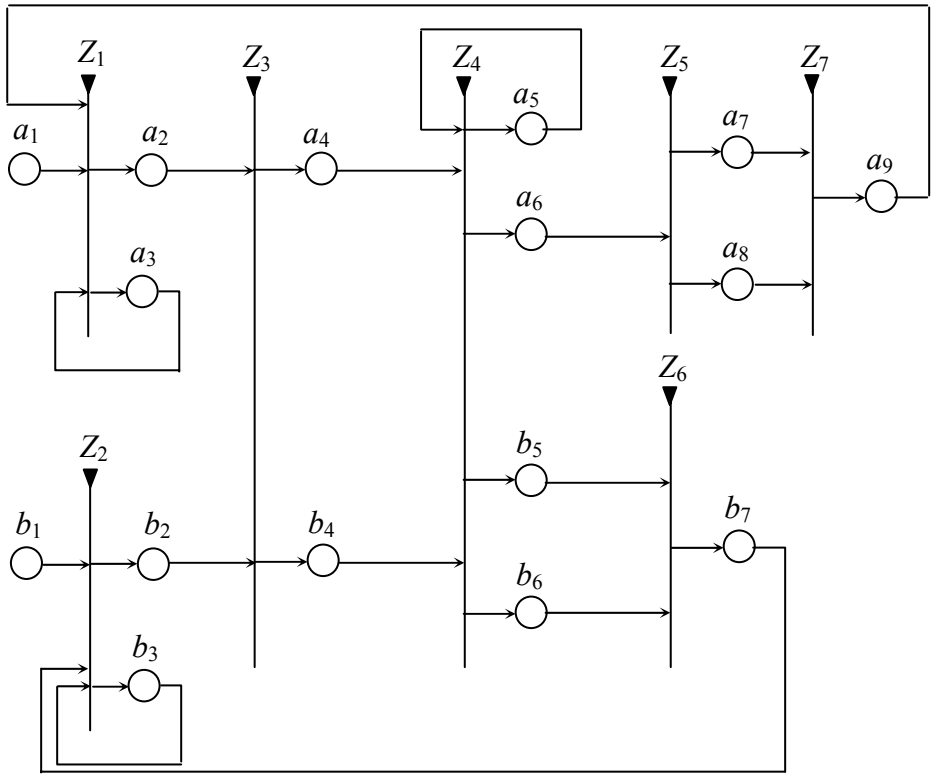

Fig. 1.

$$Z_2 = <\{ b_1, b_3, b_7\}, \{b_2, b_3\},$$

	b_2	b_3
b_1	*false*	*true*
b_3	$W^b_{3,2}$	$W^b_{3,3}$
b_7	*false*	*true*

$>$,

where:

$W^b_{3,2}$ = “The student must have examination”,

$W^b_{3,3} = \neg W^b_{3,2}$.

The β-tokens do not obtain any characteristic in places b_2 and b_3.

$$Z_3 = <\{a_2, b_3\}, \{a_4, b_5\},$$

	a_4	b_4
a_2	*true*	*false*
b_2	*false*	*true*

$>$.

The α-tokens do not obtain any characteristic in place a_4, while β-tokens obtain characteristic “student's solutions of the problems”

in place b_4.

$$Z_4 = <\{a_4, a_5, b_4\}, \{a_5, a_6, b_5, b_6\},$$

	a_5	a_6	b_5	b_6
a_4	$W^{\alpha}_{4,5}$	$W^{\alpha}_{4,6}$	*false*	*false*
a_5	$W^{\alpha}_{5,5}$	$W^{\alpha}_{5,6}$	*false*	*false*
b_4	*false*	*false*	$W^{b}_{4,5}$	$W^{b}_{4,6}$

>,

where:

$W^{\alpha}_{4,5} = W^{\alpha}_{5,5}$ = "There are students whose research must be evaluated by the current lecturer",

$W^{\alpha}_{4,6} = W^{\alpha}_{5,6} = \neg W^{\alpha}_{4,5}$,

$W^{b}_{4,5}$ = "The lecturer that will examine the present research prefers First way for evaluation",

$W^{b}_{4,6}$ = "The lecturer that will examine the present research prefers Second way for evaluation".

The α-tokens do not obtain any characteristic in places a_5 and a_6.

The β-tokens enter one of the output places b_5 or b_6 of transition Z_4 obtaining characteristic

"estimation of the current student's problems".

$$Z_5 = <\{ a_6 \}, \{a_7, a_8\},$$

	a_7	a_8
a_6	$W^{a}_{6,7}$	$W^{a}_{6,8}$

>,

where:

$W^{a}_{6,7}$ = "Calculation of the intuitionistic fuzzy estimation for the lecturer prefers First way for evaluation",

$W^{a}_{6,8}$ = "Calculation of the intuitionistic fuzzy estimation for the lecturer prefers Second way for evaluation".

The α-tokens enter one of the two output places of transition Z_5 obtaining characteristic

"estimation of the lecturer's score for the current examination".

This estimation for the j-th lecturer can be obtained in the following intuitionistic fuzzy form

$$<\mu_j,\ \nu_j> = \left\langle \frac{x_j}{r_j}, \frac{y_j}{r_j} \right\rangle,$$

in place a_7

and

$$<\mu_j,\ \nu_j> = \left\langle \frac{x_j}{n}, \frac{y_j}{n} \right\rangle,$$

in place a_8,

where:

x_j is the number of the estimations, given by the j-th lecturer, that are higher than the average estimation of the i-th student;

y_j is the number of estimations, given by the j-th lecturer, hat are smaller than the average estimation of the i-th student;
r_j is the number of the students estimated by the j-th lecturer.

$$Z_6 = <\{ b_5, b_6 \}, \{b_7\},$$

	b_7
b_5	*true*
b_6	*true*

>.

The β-tokens obtain characteristic

"average estimation of the student"

in place b_7.

$$Z_7 = <\{ a_7, a_8 \}, \{a_9\},$$

	a_9
a_7	*true*
a_8	*true*

>.

The α-tokens do not obtain any characteristic in place a_9.

3 Conclusion

The paper describes a way of analyzing the estimations of the lecturer's strictness since this is a personal characteristic which can be difficult to measure by traditional means. Having in mind the personal criteria of the lecturers, we can obtain more objective estimations of the students' results, thus altering the lecturers' estimations with the to accommodate their level of strictness. The present model is an element of a more general model describing different processes, flowing in a university.

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