

Multifactor method of teaching quality estimation at universities with intuitionistic fuzzy evaluation

M. Hristova¹, E. Sotirova^{2,3}

¹Higher School of Transport "Todor Kableshkov", Sofia, Bulgaria, e-mail: mhristova@vtu.bg

²Prof. Asen Zlatarov University, Bourgas-8000, Bulgaria, e-mail: esotirova@btu.bg

³CLBME - Bulgarian Academy of Sciences, Acad. G. Bonchev Str., Bl. 105, Sofia-1113, Bulgaria

Abstract: The paper is related to the algorithmization of multi-factor method used to estimate the teaching quality at universities. The evaluation methods and procedures suggested in the paper are intended to make experts' evaluations as objective as possible. The intuitionistic fuzzy estimation used to describe the process of evaluation.

Index Terms: Intuitionistic Fuzzy Sets, Modelling, Multifactor Method, Teaching Quality, E-learning.

1 Introduction

In the present paper the authors shall extend our previous research from [2]. In [2] we introduce a generalized net model of the multifactor method of teaching quality estimation at universities. Now, we construct a procedure that gives the possibility for the algorithmization of the multifactor method of teaching quality estimation represented by intuitionistic fuzzy form (for the concept of Intuitionistic Fuzzy Set (IFS, see [1]).

The evaluation of the quality of teaching at universities is very important process. It cannot be measured and assessed objectively, because objective evaluation factor has always been dominating (the teacher/lecturer/expert). What was mentioned refers not only to the particular individual (a pupil/student), but also the quality given by a university or a program or a subject.

Due to the specificity of education the subjective estimation cannot be avoid but should be made objective. That can be achieved by science-based quantitative methods using the instruments of subjective statistics.

The formal expert models have been applied in a number of papers on those problems [3, 4, 5, 6, 7].

Quality

$$Q = f_Q(k_1, k_2, \dots, k_n, K_1, K_2, \dots, K_n)$$

is examined [7] as a complex multi-measurement value quantitatively dependant on different criteria that not cover each other K_1, K_2, \dots, K_n (k_1, k_2, \dots, k_n are the weight coefficients of the criteria) that are correlatively connected with the quality indicators P_1, P_2, \dots, P_m

$$K_1 = f_1(b_{1,1}, b_{1,2}, \dots, b_{1,m}; P_1, P_2, \dots, P_m)$$

$$K_2 = f_2(b_{2,1}, b_{2,2}, \dots, b_{2,m}; P_1, P_2, \dots, P_m)$$

$$\dots$$

$$K_n = f_n(b_{n,1}, b_{n,2}, \dots, b_{n,m}; P_1, P_2, \dots, P_m),$$

where the coefficients of the indicator significance in the criteria value b_{ij} ($i=1, \dots, n, j=1, \dots, m$) are expert-defined.

To formulation and selection of indicators, the method of reduction by contents nearness or cluster method [8] is used.

This paper is a continuation of a series of research papers [9-14]. [9] and [10] describe Intuitionistic fuzzy interpretations of multi-person multi-criteria decision making. In [11, 12, 13, 14] intuitionistic fuzzy estimations are used for the evaluation of the e-learning assessment, students work, lecturers, etc.

2 Algorithmization of evaluation methods and procedures

According [2] the algorithmization of evaluation consists of nine steps:

- 1) Defining the expert staff;
- 2) Defining the experts' competence;
- 3) Models of indicator evaluation;
- 4) Values of teaching quality indicators according to experts and a check on the coordination of their opinions;
- 5) Averaged values of the indicators;
- 6) Relative weight of the indicators for each criterion;
- 7) Values of criteria;
- 8) The criteria significance in the summarized quality estimation;
- 9) Summarized quality estimation.

In the present paper we propose a different method for step 1) and step 2). We use the techniques of Intuitionistic Fuzzy Sets to describe the process of defining the expert staff and defining the experts' competence.

2.1. Defining the expert staff

Depending on the evaluation objective set, the corresponding academic body (the Dean, Head of department, Faculty Council, Department Council) determines the experts by name. Each of them can suggest changing of the staff that the academic authorities can take into account and define an expert group of initial membership n_0 . Initially we have the experts e_1, e_2, \dots, e_{n_0} .

Each expert have his current IFS estimation $\langle \mu_i, \nu_i \rangle \in [0, 1] \times [0, 1]$, $i = 1, 2, \dots, n_0$ (see [1]). The estimation reflects the degree of the acceptance of the expert (μ) and the non-acceptance of the expert (ν) from the other experts, and:

$$\mu_i = \frac{r_i}{n_0},$$

$$\nu_i = \frac{t_i}{n_0}$$

where:

r_i is the number of positive answers for the i -th expert form other experts,

t_i is the number of negative answers for the i -th expert form other experts,

n_0 is the total number of experts.

At the beginning, when still no information has been obtained, all estimations are given initial values of $\langle 0, 0 \rangle$.

The degree of uncertainty $\pi_i=1-\mu_i-v_i$ represents those cases where the experts did not engage with final opinion about the other experts.

To illustrate the estimation of the expert' acceptance, we will give the following example: a expert make 20 estimations for the other experts. The 10 of the answers is "yes", 5 of the answers is "no" and in the rest 5 cases he abstain from voting. That is why we determine his estimation as (0.5, 0.25).

The calculated estimation of the each expert reflects the coefficient of its mutual acceptance.

We compare the estimations with four threshold values: $M_{max}, M_{min}, N_{max}, N_{min}$.

If $(\mu_i < M_{min} \ \& \ v_i > N_{max})$, the expert e_i can't be included in the list of the expert' staff.

If $(\mu_i > M_{max} \ \& \ v_i < N_{min})$, the expert e_i can be included in the list of the expert' staff. In this case the experts are arranging in a descending rating.

In the remaining cases when $(M_{min} < \mu_i < M_{max} \ \& \ N_{min} < v_i < N_{max})$ we can't make decision for the expert e_i .

Lets n_1 in number experts are included in the list, and the necessary total number of experts is n . If $n_1 \geq n$ the experts who have the lowest μ_i are dropped from the list until the approved number become n .

If $n_1 < n$ the new evaluation for the experts whit estimations $\langle \mu_i, v_i \rangle$, where $(M_{min} < \mu_i < M_{max} \ \& \ N_{min} < v_i < N_{max})$ must be implemented.

2.2. Defining the experts' competence

Now we describe the determination of the expert's competence.

After the defining the expert staff there be n experts: e_1, e_2, \dots, e_n . Let each expert have his current estimation $\langle \varepsilon_i, \delta_i \rangle \in [0, 1] \times [0, 1]$. The score reflect the degree of the competence of the expert (ε) and the non-competence (δ).

The degree of uncertainty $\pi=1-\varepsilon-\delta$ represents those cases where the experts did not engage with final opinion about the other expert's competence.

At the beginning, when still no information has been obtained, all estimations are given initial values of $\langle 0, 0 \rangle$.

Expert's scores can be interpreted, e.g., as

$$\varepsilon_i = \frac{\sum_{j=1}^n \varepsilon_{i,j}}{n}, \delta_i = \frac{\sum_{j=1}^n \delta_{i,j}}{n}, i = 1, 2, \dots, n,$$

where:

$\varepsilon_{i,j}$ is the estimation of the j -th expert for the competence of the i -th expert,

$\delta_{i,j}$ is the estimation of the j -th expert for the non competence of the i -th expert,

and $\varepsilon_{i,j}, \delta_{i,j} \in [0, 1], \varepsilon_{i,j} + \delta_{i,j} \leq 1$.

3 Conclusions

The present paper we construct a procedure that gives the possibility for the algorithmization of the multifactor method of teaching quality estimation represented by

intuitionistic fuzzy estimations. The suggested evaluation methods and procedures are intended to make experts' evaluations as objective as possible.

References

- [1] K. Atanassov, *Intuitionistic Fuzzy Sets*, Springer Physica-Verlag, Berlin, 1999.
- [2] M. Hristova, E. Sotirova, Generalized net model of the Multifactor method of teaching quality estimation at universities. *IEEE-IS'08*, (in press)
- [3] Berestneva, O.G., Maroukhina, O.V., Sharopin, K.A., "Evaluation of quality education on the basis of modern information technologies". *IEEE International Conference on Artificial Intelligence Systems ICAIS 2002*, Divnomorskoe, Russia, 5-10 September, pp. 441-443, 2002.
- [4] Jaap Scheerens, Cees Glas, Sally M. Thomas, "Educational Evaluation, Assessment and Monitoring: A Systemic Approach", Swets & Zeitlinger, 2003.
- [5] Feng, Chu, "Quantitative evaluation of university teaching quality - an application of fuzzy set and approximate reasoning", Publisher Elsevier North-Holland, Inc., Amsterdam, The Netherlands, Volume 37, Issue 1, p.1-11, August 1990.
- [6] Ho, William, Prasanta K. Dey, Helen E. Higson, Multiple criteria decision-making techniques in higher education. *International Journal of Educational Management*, (20), 5, pp.319- 337, 2006
- [7] Hristova, M, Quantitative methods for evaluation and control of university education quality, PhD Thesis, Sofia, Bulgaria, 2007
- [8] Hristova, M., Methods for forming and reduction of the criteria for evaluation and control the quality of education, Mechanical engineering and Mechanics knowledge, Economics and management series, TU Varna, pp.37-45, 2007
- [9] Atanassov, K., G. Pasi and R. Yager. Intuitionistic fuzzy interpretations of multi-criteria multi-person and multi-measurement tool decision making. *International Journal of Systems Science*, Vol. 36, 2005, No. 14, 859-868.
- [10] Yager, R. R., Non-numeric multi-criteria multi-person decision making, "International Journal of Group Decision Making and Negotiation 2, 81-93, 1993.
- [11] Shannon, A., D. Langova-Orozova, E. Sotirova, K. Atanassov, P. Melo-Pinto, T. Kim, Generalized Net Model for Adaptive Electronic Assessment, Using Intuitionistic Fuzzy Estimations, *Computational Intelligence, Theory and Applications*, Univ. of Dortmund, Germany, Computer Science I, Springer, 2005, 291-297.
- [12] Melo-Pinto, P., T. Kim, K. Atanassov, E. Sotirova, A. Shannon and M. Krawczak, Generalized net model of e-learning evaluation with intuitionistic fuzzy estimations, *Issues in the Representation and Processing of Uncertain and Imprecise Information*, Warszawa, 2005, 241-249.
- [13] Shannon, A., E. Sotirova, I. Petrounias, K. Atanassov, M. Krawczak, P. Melo-Pinto, T. Kim, Intuitionistic fuzzy estimations of teacher's evaluation of student work, *First International Workshop on Intuitionistic fuzzy sets, Generalized nets and Knowledge Engineering*, Univ. of Westminster, London, UK, 2-6 September, 2006, 45-48.
- [14] Shannon A., E. Sotirova, K. Atanassov, M. Krawczak, P. Melo-Pinto and T. Kim. Generalized net model of lecturers' evaluation of student work with intuitionistic fuzzy estimations. *Second International Workshop on IFSs*, Banska Bystrica, Slovakia, 3 Dec. 2006. In: -Notes on Intuitionistic Fuzzy Sets, Vol. 12, 2006, No. 4, 22-28.