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Student's performance evaluation by fuzzy logic

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Abstract

In connection with the spread of ICT in education there is an acute issue about getting a qualitative education. Therefore, various methods of determining the quality of education are developed and applied. In this paper, we propose a fuzzy model of performance evaluation of students through the establishment of performance. And we will try to prove the advantages of the use of fuzzy logic in the evaluation of students' knowledge.

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Keywords: Fuzzy logic; mamdani; fuzzy computing; students performance

1. Introduction

It is widely distributed technology of online training and assessment now. The aim of this method is a qualitative determination of the competence of students, without the use of formulas for the calculation of student performance. The electronic university tutors assign grades to students in performance magazines and on their transcripts. It provides data on the performance of each student to one request and is easy to calculate the average amount of progress for each student. It is necessary to properly take into account the type and value of the assessment, and the impact assessment on the performance in general. Table 1 shows the transfers to percentages, GPA and letters.

Types of estimates and their designation: Lecture evaluation – Lec; Practical evaluation – Pra; Laboratory evaluation – Lab; Studio evaluation – Stu; Seminar evaluation – Sem; Current control – CC; Medium control – MC; Rating – Rat; Rating admission – RA; Evaluation of the course work – Cou; Evaluation of project work – Pro; Summarizing the work rate – IP; Self work of learner – SWL; Self work of students – SWS; Self work of the student with the teacher – SWST; Self work of masters – SWM; Self work of the master with the teacher – SWMT; Self

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work of doctoral student – SWD; Self work of doctoral student with the teacher – SWDT; Final control – FC; Final evaluation – Fin; Automata evaluation – Aut.

Table 1 - Translation estimates in percentages, GPA and letters.

Evaluation of the traditional system	Evaluation of the credit system		
	The digital equivalent assessment	Literal equivalent assessment	Percentage
Excellent	4,0	A	95-100
	3,67	A-	90-94
Good	3,33	B+	85-89
	3,0	B	80-84
	2,67	B-	75-79
Satisfactorily	2,33	C+	70-74
	2,0	C	65-69
	1,67	C-	60-64
	1,33	D+	55-59
	1,0	D	50-54
Unsatisfactorily	0	F	0-49

Further work will be given 3 well-known method of calculating student performance, and we will offer the technique of calculating the student performance using fuzzy logic.

2. Methods of calculating student performance.

2.1. The methodology of calculation of performance by the arithmetic mean.

All methods used for calculating the input student performance data are given in Table 2. And also applies to the input data and FC. The methodology for calculating performance on the arithmetic mean summed up all the estimates and divided by the average count[1].

Table 2 - Input estimates.

Types of lessons	Week														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Lecture	100	50	100	100	100	100	100	76	90	100	50	0	50	100	100
Practical lesson	90	85	n/a	90	60	n/a	100	85	90	100	65	30	50	50	80
SWS	a/np	70	100	75	80	a/np	90	a/np	60	100	a/np	50	0	a/np	75

Here, a/np - assessment is not provided, n/a - student did not attend the session and FC = 80. Then the arithmetic mean score is: Fin = 72,46341.

2.2. The methodology for calculating performance at the universities of Kazakhstan[1]:

When calculating the final score monitoring accounted for the proportion of the weight on the occupations, they are displayed in Table 3.

Table 3 - Weighted share by type of occupation.

Types of lessons	Weight fraction						
Lecture	0,2	0,2	0,2	0,2	-	0,7	0,2
Practical lessons	0,5	0,2	-	-	0,7	-	0,2
Laboratory	-	0,3	0,5	-	-	-	-
Studio sessions	-	-	-	0,5	-	-	0,3
Self work of students	0,3	0,3	0,3	0,3	0,3	0,3	0,3
Total	1	1	1	1	1	1	1

Current control is determined by the weight fraction of the arithmetic means for each type of training. Tables 4-5 describe the input data for the calculation of performance.

Table 4 - Input estimates.

Types of lessons	Weight fraction	Week							CC	MC*	Rat1
		1	2	3	4	5	6	7			
Lecture*	0,2	100	50	100	100	100	100	100	92,86		
Practical lesson	0,5	90	85	n/a	90	60	n/a	100	60,71	75	74,41
SWS*	0,3	a/np	70	100	75	80	a/np	90	83		
Total	1								73,83		

Table 5 - Input estimates.

Types of lessons	Weight fraction	Week								CC	MC*	Rat2
		8	9	10	11	12	13	14	15			
Lecture*	0,2	76	90	100	50	0	50	100	100	70,75		
Practical lesson	0,5	85	90	100	65	30	50	50	80	68,75	90	78
SWS *	0,3	a/np	60	100	a/np	50	0	a/np	75	57		
Total	1									65,63		

* – put the estimate by the teacher who lectures.

Current control on lectures, practical classes, SWS is calculated by the arithmetic mean.
CC=73,85=92,86*0,2+60,71*0,5+83*0,3
Rating Rat1 (Rat2) is determined in accordance with the monitoring points (CC) and the boundary control (MC):
Rat1(Rat2)=(CC+MC)/2; Rat1=74,41=(73,85+75)/2
Rating tolerance for the discipline:
RA=(Rat1+Rat2)/2=(74,41+78)/2=76,2
The final grade for the discipline is calculated as follows:
(FC=80): Fin=RA*0,6+FC*0,4=76,2*0,6+80*0,4=45,72+32=77,72

2.3. The methodology of calculation of performance in the University of Liverpool Grading Scheme for Masters Programmes.

Grades for assignments are awarded on a six-point scale: A*, A, B, C, D and F. Each grade has a numerical value from 0 to 84. Table 6 shows the grading assessments.

Table 6 - Gradation estimates.

Grade	Numerical Value
A*	84
A	74
B	64
C	54
D	44
F	0

The table 7 shows how the end-of-module grade is calculated for a student who has performed well during module one of their programme. We have translated the input data (similar to those used above) in the University of Liverpool's grading system, and the table below shows their numeric values for their system. This was done because they score from 0 to 84 in 6 positions. Table 8 displays the output data.

Table 7 - Input estimates.

Types of lessons	Week														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Lecture*	A*	D	A*	A*	A*	A*	A*	B	A	A*	D	F	D	A*	A*
Practical lesson	A	B	F	A	C	F	A*	B	A	A*	C	F	D	D	B
SWS*		C	A*	B	D		A		C	A*		D	F		B
Types of lessons	Week														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Lecture*	84	44	84	84	84	84	84	64	74	84	44	0	44	84	84
Practical lesson	74	64	0	74	54	0	84	64	74	84	54	0	44	44	64
SWS*		54	84	64	44		74		54	84		44	0		64

Table 8 - Output ratings.

Types of lessons	Average component mark	Weight	Component's contribution to End-of-Module Grade
Lecture*	68,4	50%	34,2
Practical lesson	51,86667	25%	12,96667
SWS*	56,6	5%	2,83
FC	80	20%	16
Total		100%	65,99667

As we can see on the score 65.99667 University of Liverpool's grading system is **B**. In our system, grading **B** estimates that about 80-84 points out of 100.

Fin = 80 (around eyes).

As we can see in 3 different evaluation systems go different. We now offer a method of assessment based on fuzzy logic.

2.4. The methodology of calculation of performance evaluation by fuzzy logic[2-5].

As input data we took the average scores in Tables 1 and 2, which are represented in table 9.

Table 9 - Input estimates.

Types of lessons	Average mark
Lec	81,06667
Pra	65
SWS	70
FC	80

We used the method of Mamdani implemented Matlab to build Fuzzy computing. Relevant Fuzzy computing is presented in Figure 1.

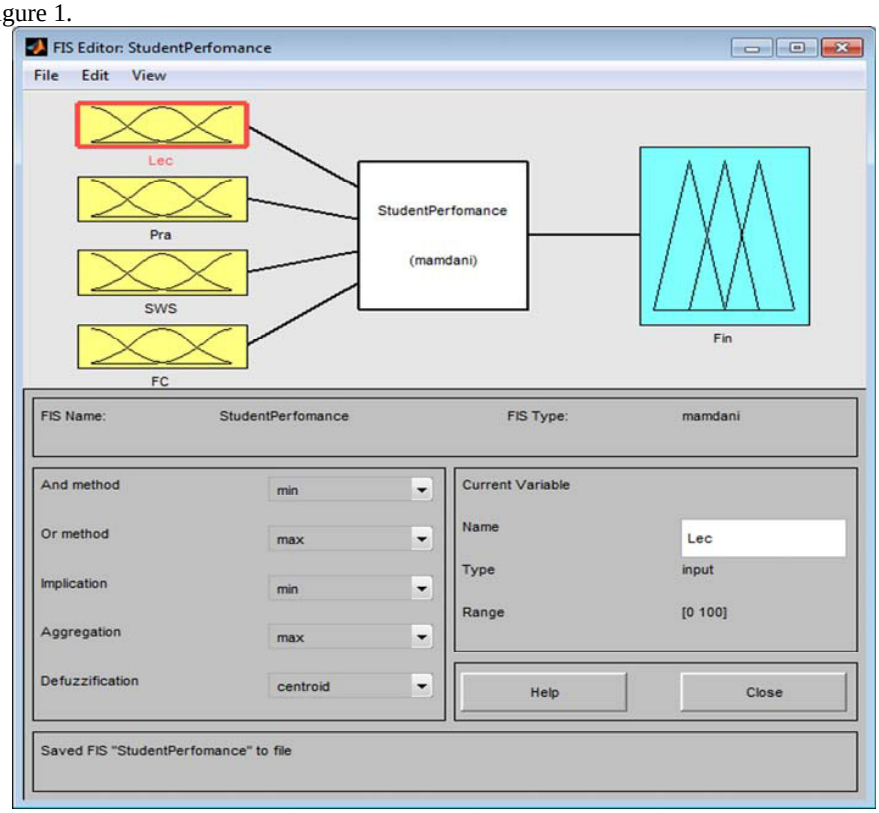

Fig. 1. student Performance by Fuzzy computing.

Description Fuzzy computing is given below:

[System]
Name='StudentPerformance'; Type='mamdani'; Version=2.0; NumInputs=4; NumOutputs=1; NumRules=10; AndMethod='min'; OrMethod='max'; ImpMethod='min'; AggMethod='max'; DefuzzMethod='centroid';
[Input1]
Name='Lec'; Range=[0 100]; NumMFs=4; MF1='Unsatisfactorily': 'trapmf', [0 0 49 59]; MF2 = 'Satisfactorily': 'trapmf', [40 50 74 84]; MF3='Good': 'trapmf', [65 75 89 99]; MF4='Excellent': 'trapmf', [80 90 100 100];
[Input2]
Name='Pra'; Range=[0 100]; NumMFs=4; MF1='Unsatisfactorily':'trapmf',[0 0 49 59]; MF2 = 'Satisfactorily': 'trapmf',[40 50 74 84]; MF3='Good':'trapmf',[65 75 89 99]; MF4='Excellent':'trapmf',[80 90 100 100];
[Input3]
Name='SWS'; Range=[0 100]; NumMFs=4; MF1='Unsatisfactorily':'trapmf',[0 0 49 59]; MF2= 'Satisfactorily': 'trapmf',[40 50 74 84]; MF3='Good':'trapmf',[65 75 89 99]; MF4='Excellent':'trapmf',[80 90 100 100];
[Input4]
Name='FC'; Range=[0 100]; NumMFs=4; MF1='Unsatisfactorily':'trapmf',[0 0 49 59]; MF2='Satisfactorily': 'trapmf',[40 50 74 84]; MF3='Good':'trapmf',[65 75 89 99]; MF4='Excellent':'trapmf',[80 90 100 100];
[Output1]
Name='Fin'; Range=[0 100]; NumMFs=4; MF1='Unsatisfactorily':'trapmf',[0 0 49 59]; MF2='Satisfactorily': 'trapmf',[40 50 74 84]; MF3='Good':'trapmf',[65 75 89 99]; MF4='Excellent':'trapmf',[80 90 100 100]
[Rules]
1 1 1 1, 1 (1) : 1
2 2 2 2, 2 (1) : 1
3 3 3 3, 3 (1) : 1
4 4 4 4, 4 (1) : 1
4 3 3 4, 4 (1) : 1
3 2 2 3, 3 (1) : 1
3 4 4 3, 3 (1) : 1
4 2 2 4, 3 (1) : 1
2 3 3 2, 2 (1) : 1
2 4 4 2, 2 (1) : 1

The result of calculations Fin = 75,4 is shown in Figure 2.

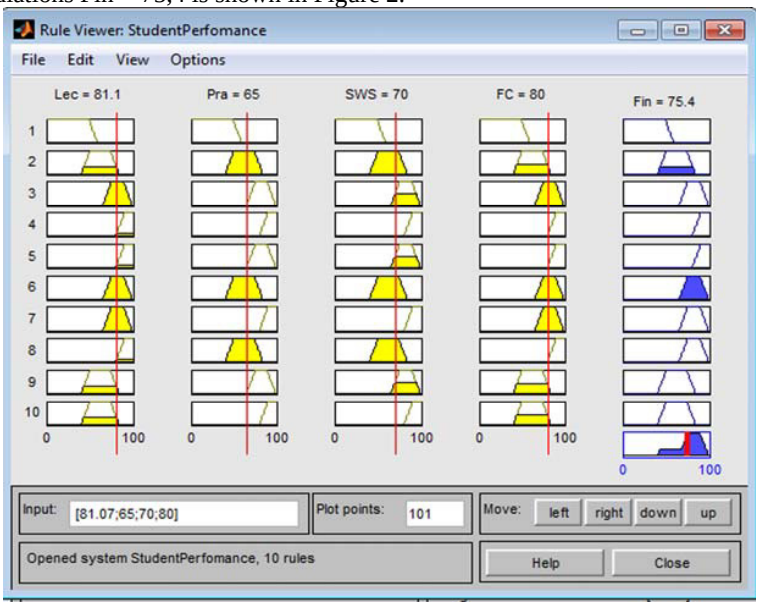

Fig. 2. the result of the calculation Fin = 75,4.

3. Experiments.

For the experiment, we took a group of 13 students, which is undergoing "Three-dimensional graphics." Estimates for the lectures, practical classes and independent work are recorded in an electronic log of the teacher, which is shown in Figure 3.

Estimates for the lecture course "The three-dimensional graphics" are displayed in Table 10.

Table 10 – UOG 3317-3-L Three-dimensional graphics (UOG 3317) Group: B3-60200-01.

#	Weeks								MC1	Weeks							MC2
	1	2	3	4	5	6	7	8		9	10	11	12	13	14	15	
	a/np	90	n/a	90	90	90	90	90		a/np	a/np	90	90	90	a/np	90	
	a/np	90	90	90	90	90	90	90	93	a/np	a/np	90	90	90	a/np	90	91
	a/np	90	90	90	90	90	90	90	85	a/np	a/np	90	90	90	a/np	90	89
	a/np	90	90	90	90	90	90	90	90	a/np	a/np	90	90	90	a/np	90	88
	a/np	90	90	90	90	90	90	90	89	a/np	a/np	90	90	90	a/np	90	77
	a/np	90	90	90	90	90	90	90	90	a/np	a/np	90	90	90	a/np	90	91
	a/np	90	90	90	90	90	90	90	88	a/np	a/np	90	90	90	a/np	90	86
	a/np	90	90	90	90	90	90	90	80	a/np	a/np	90	90	90	a/np	90	80
	a/np	n/a	n/a	90	90	90	90	90	60	a/np	a/np	90	90	90	a/np	90	70
	a/np	90	n/a	90	90	90	90	90	88	a/np	a/np	90	90	90	a/np	90	91
	a/np	100	100	90	90	90	90	90	92	a/np	a/np	90	90	90	a/np	90	90
	a/np	80	90	90	90	90	90	90	60	a/np	a/np	90	90	90	a/np	90	80
	a/np	90	n/a	90	90	90	90	90	70	a/np	a/np	90	90	90	a/np	90	81

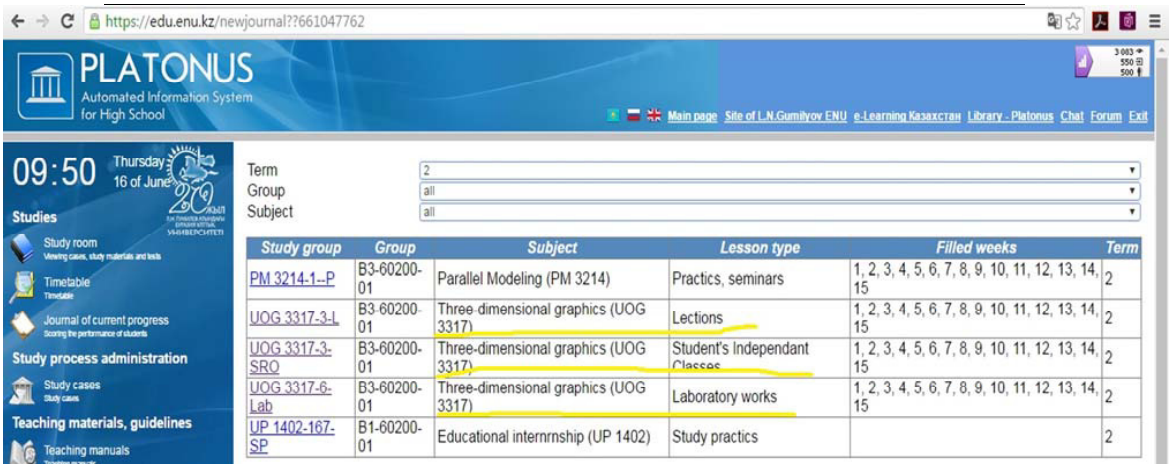

Fig. 3. Electronic journal of the teacher.

Estimates for the practical training course "Three-dimensional graphics" shown in Table 11.

Table 11 – UOG 3317-6-Lab Three-dimensional graphics (UOG 3317) Group: B3-60200-01.

#	Weeks														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	a/np	90	95	95	80	90	90	100	a/np	90	90	93	95	95	90
2	a/np	90	95	95	100	95	90	95	a/np	95	90	90	95	95	90
3	a/np	90	90	90	90	90	n/a	90	a/np	90	88	90	95	90	90
4	a/np	85	90	90	90	90	85	90	a/np	90	88	90	85	90	90
5	a/np	90	85	90	90	90	80	90	a/np	85	50	90	80	n/a	90

6	a/np	85	95	90	80	90	95	95	a/np	95	95	90	95	90	90
7	a/np	75	85	85	80	90	90	90	a/np	85	80	90	80	90	90
8	a/np	65	85	80	80	90	n/a	90	a/np	85	75	50	80	80	90
9	a/np	n/a	n/a	n/a	n/a	10	50	50	a/np	70	10	75	60	90	90
10	a/np	80	90	90	75	90	90	90	a/np	90	85	90	90	100	90
11	a/np	90	90	90	95	90	90	95	a/np	95	90	90	90	90	90
12	a/np	80	85	80	75	10	10	50	a/np	80	65	85	75	90	90
13	a/np	80	90	85	80	85	50	50	a/np	75	75	80	75	90	90

Estimates for independent work "Three-dimensional graphics" course and estimates for the exam of the course "Three-dimensional graphics" are shown in Table 12.

Table 12 – UOG 3317-3-SRO Three-dimensional graphics (UOG 3317) Group: B3-60200-01. UOG 3317-3-Exa Three-dimensional graphics (UOG 3317) Group: B3-60200-01.

#	Weeks															Exam
	1	80	3	4	5	6	7	8	9	10	11	12	13	14	15	
1	a/np	80	a/np	90	100	a/np	a/np	90	a/np	a/np	80	85	90	a/np	90	80
2	a/np	80	a/np	95	100	a/np	a/np	90	a/np	a/np	80	90	90	a/np	90	75
3	a/np	80	a/np	90	100	a/np	a/np	90	a/np	a/np	80	85	90	a/np	90	95
4	a/np	80	a/np	90	100	a/np	a/np	90	a/np	a/np	80	85	90	a/np	90	99
5	a/np	80	a/np	90	100	a/np	a/np	90	a/np	a/np	80	85	90	a/np	90	100
6	a/np	80	a/np	90	100	a/np	a/np	90	a/np	a/np	85	90	90	a/np	90	70
7	a/np	80	a/np	90	100	a/np	a/np	90	a/np	a/np	80	85	90	a/np	90	100
8	a/np	80	a/np	90	100	a/np	a/np	90	a/np	a/np	75	75	90	a/np	90	82
9	a/np	80	a/np	n/a	n/a	a/np	a/np	90	a/np	a/np	30	65	70	a/np	75	90
10	a/np	80	a/np	90	100	a/np	a/np	90	a/np	a/np	80	85	90	a/np	90	92
11	a/np	80	a/np	90	100	a/np	a/np	90	a/np	a/np	85	90	90	a/np	90	78
12	a/np	80	a/np	90	90	a/np	a/np	90	a/np	a/np	75	75	80	a/np	75	80
13	a/np	80	a/np	90	100	a/np	a/np	90	a/np	a/np	75	75	80	a/np	75	96

Using the data, carry out calculation 4 methods (arithmetic mean, Kazakhstan, Liverpool, fuzzy). The calculation results are shown in Table 13. For Liverpool evaluation system will translate into the appropriate format. Please translate input data into letter format. Then translate the letter format in 0-84 format. The results are transferred to the usual format of 0-100.

Table 13 - Results.

№	Avg	KZ	Liv	Fuz
1	87,21	83,925	84	76,2
2	90,76	83,12	90	82
3	87,06	91,215	70	87,5
4	89,30	93,705	92	92,5
5	85	90,015	89	92,5
6	89,7	80,345	85	82
7	88,03	91,125	91	92,5
8	82,18	80,765	83	82,4
9	55	73,465	66	50
10	86,27	89,625	85	82,4
11	90,54	84,55	87	82
12	78,48	75,62	82	82
13	80,789	85,07	85	82,8

4. The discussion of the results.

Correlation of the results to find out how strong the relationship between the values of the results. The most known Pearson correlation coefficient[6], that means the level of line dependence between variables. Table 14 reflects the type of relationship between the variables.

Table 14 - Correlation.

Variables	Value	Correlation type
avg-kz	0,64168	Low positive linear relation
avg-liv	0,723127	Almost Strong positive linear relation
avg-fuz	0,835344	*Strong positive linear relation*
kz-liv	0,46714	Very Low linear relation
kz-fuz	0,762188	*Strong positive linear relation*
liv-fuz	0,70705	*Almost Strong positive linear relation*

As we see the method for calculating the performance by Fuzzy computing has other methods has Strong positive linear relation. We have proved that the evaluation student performance by Fuzzy computing more palatable, since the arithmetic mean, Kazakh, Liverpool systems use formulas other variations not, and to change the final assessment, simply change the formula for calculating the evaluation and Fuzzy computing based on logical inference rules. In addition, Fuzzy computing is an internationally proven a powerful mathematical tool, and it should be used everywhere.

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