

the index optimization of Teaching Quality Evaluation based on Boolean Matrix algorithm in Rough Set

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Abstract. The objective evaluation of teachers' teaching quality can stimulate teachers' teaching enthusiasm and improve teaching quality. In this paper we apply an algorithm based on Boolean matrix in rough set for data analysis on the evaluation of teachers' teaching quality, optimize the evaluation index and generate easy and valid decision rules. The correctness and effectiveness of the decision rules are verified by theoretical analysis and experiment simulation.

The quality of teaching is the life of colleges and universities, and the quality evaluation of the teachers' teaching is the means to encourage teachers to devote themselves to reform teaching and improve the teaching quality. The objective and fair evaluation of the teachers' teaching work, is a powerful tool of the school teaching management department for teaching quality control and management. At present, the evaluation of the teaching quality in colleges and universities is mainly based on expert evaluation, student evaluation and leader evaluation. Because of people's feeling and experience, the subjectivity of the evaluation is relatively large. It is very difficult to ensure the teaching quality objectively and fairly. Rough set can be used to handle fuzzy and imprecise problems. And it can mine potential, valuable knowledge objectively from the large numbers of data without any prior knowledge. So In this paper we propose an algorithm for the evaluation of teachers' teaching quality, based on Boolean matrix in rough set optimize the evaluation index and generate easy and valid decision rules. It can provide some guidance for the evaluation of teachers' teaching quality objective and fairly.

attribute reduction algorithm based on Boolean Matrix in Rough Set

basic theory Definition^[6]: information system $IS = (U, A, V, f)$, where U is a universe, and its partition is $X = (X_1, X_2, \dots, X_m)$ with attribute set $A = \{a_1, a_2, \dots, a_n\}$, there is only one number i for every set $(X_k, X_l) (1 \leq k < l \leq m)$,

$$i = (l - 1)(n - 1) - \frac{l(l-1)}{2} + (l - k) \quad (1)$$

One i is given to unique correspondence the set pair (X_k, X_l) .

Structure the Boolean Matrix $C_A = (c_{ij})_{m \times n}$, $c_{ij} = \begin{cases} 0 & f(X_k, a_j) = f(X_l, a_j) \\ 1 & f(X_k, a_j) \neq f(X_l, a_j) \end{cases}$, $(1 \leq k < l \leq m)$. the (X_k, X_l) unique correspondence the set pair of number i, j unique correspondence the number of attribute a_j .

Definition^[7]: information system $IS = (U, A, V, f)$, attribute set $R \subset A$, delete all lines which value of attribute of set R in this column is 1 from Boolean matrix C_A , called the rest of Boolean matrix C_A is $C_{A \setminus R}$.

Statement 1^[8] if there is only one 1 in some line in Boolean Matrix, the rest are 0, so the column which the 1 corresponding to the attribute is a part of the core. All attributes which 1 corresponding form the core of the information system; if there is no lines like this ,the core is null.

Statement 2 the relation of The core attributes and reduction is the following: $CORE(A) = \cap RED(A)$.

Theorem1^[6] information system $IS = (U, A, V, f)$, $A_1 \subseteq A$, if the non-zero line numbers of C_{A_1} and C_A are equal ,that is to say $IND(A_1) = IND(A)$

Theorem2^[6] information system $IS = (U, A, V, f)$, the sufficient and necessary condition of $A_1 \subseteq A$ being a reduction of A is that the following two conditions are founded:

(1)the non-zero line numbers of C_{A_1} and C_A are equal, that is to say ,the ability of the classification of A_1 and A is equal.

(2)if we delete any columns of C_{A_1} ,there will appear zero lines, C_{A_1} independence.

Inference 1 information system $IS = (U, A, V, f)$, in $C_{A \setminus CORE(A)}$, $A_1 \subseteq A - CORE(A)$, if the non-zero lines of A_1 and $C_{A \setminus CORE(A)}$ are equal, the non-zero lines of $C_{\{A_1, CORE(A)\}}$ and C_A are equal.

Prove:

According to the definition, all lines which the value of this column the attribute in $CORE(A)$ corresponding to is 1 are deleted from the boolean matrix, the rest is call $C_{A \setminus CORE(A)}$. So set of matrix $C_{A \setminus CORE(A)}$ is the set which $CORE(A)$ of information system IS can not distinguish, and The line numbers of $C_{A \setminus CORE(A)}$ is the line numbers which $CORE(A)$ can not distinguish. In $C_{A \setminus CORE(A)}$, if the non-zero line numbers of A_1 and $C_{A \setminus CORE(A)}$ are equal, A_1 can distinguish all sets of $C_{A \setminus CORE(A)}$, A_1 can distinguish all the sets which $CORE(A)$ can not distinguish. So, $\{A_1, CORE(A)\}$ can distinguish all sets of C_A , the non-zero line numbers of $C_{\{A_1, CORE(A)\}}$ and C_A are equal. That's all.

Inference 2 if there is only one 1 in every line of $C_{A \setminus CORE(A)}$, and the attribute set the matrix corresponding to is called $A_1 \subseteq A - CORE(A)$, so $\{A_1, CORE(A)\}$ must be a attribute reduction of IS .

Prove:

(1) In $C_{A \setminus CORE(A)}$, if there is one 1 in every line, this is to say A_1 can distinguish all sets in matrix $C_{A \setminus CORE(A)}$, according to inference1, the non-zero line numbers of $C_{\{A_1, CORE(A)\}}$ and C_A are equal.

(2) In $C_{A \setminus CORE(A)}$, if there is only one 1 in every line, this is to say, there is only one attribute that can distinguish this set. If the attribute is deleted, there must be appeared zero lines and no attribute can distinguish this set. The non-zero line numbers of $C_{\{A_1 - \{a\}, CORE(A)\}}$ is 1 less than C_A . So $C_{\{A_1, CORE(A)\}}$ is independent.

According to Theorem 2, attribute set $\{A_1, CORE(A)\}$ must be attribute reduction of IS , that's all.

Algorithm description Firstly, lines can be processed, core attribute can be found and core attribute is added directly to the attribute reduction set R , then $C_{A \setminus R}$ is got through computing. Secondly, the matrix is decomposed into the matrix in which there is only one 1 line. Attribute sets every matrix corresponding to and core attribute constitute the attribute reduction set.

Input: information system $IS = (U, A, V, f)$

Output: all attribute reduction sets R of information system IS .

Step1: structure all attribute sets R according to information system.

Step2: initialize the attribute reduction sets $R = \emptyset$.

Step3: the sum of every line in the Boolean matrix C_A is computed, add the attribute which the column whose value is 1 in these lines corresponding to is added into attribute reduction set R . $R = R \cup \{a\}$, then $C_{A \setminus R}$ is got through computing. If there is no lines whose sum is 1, go step5.

Step 4: $C_{A \setminus R}$ is decomposed into some matrix in which there is 1 in very line and there are not all 1 in very column. And then the attribute whose column is 1 is added into $R = R \cup \{a\}$, R is the result. The matrix numbers after decomposing is the attribute reduction numbers of the information system IS .

Step5: output R , the end.

examples of algorithm application

According to the actual situation of our college, the quality evaluation index system of the teaching quality is formulated, Including: expert evaluation, student assessment. According to the courses, it is also divided into theoretical and practical evaluation index. Due to space reasons, we only introduce expert evaluation index, including fifteen index, as shown in table 1.

Table 1 evaluation index of teachers' teaching quality

Serial number	Evaluation index
1	Teaching preparation
2	The teaching goal is clear , accords with the standard of curriculum and is suitable for students' characteristics
3	Substantial content and appropriate information
4	Accurate lecturing and strict logic
5	Pay attention to basic concepts, basic principles, and basic skills training
6	Carry out creative restructuring of teaching content, and embody the inner relationship of knowledge
7	Pay Attention to the introduction of knowledge into teaching reasonably
8	Pay attention to connecting theory to practice and to the training of students ability
9	Encourage students to explore, think, question, and be good at inspiring thinking
10	Stimulate learning interest, create a harmonious and interactive teaching atmosphere
11	Appropriate use of various teaching methods to enhance teaching effect
12	Language, gesture and text are infectious
13	Hard work and dedication, rigorous scholarship
14	Pay attention to the students' ideological situation , strict at students, teaching while educating people
15	The teacher has a good moral character and a good teacher's image

rough set is employed in index optimization of these index. Firstly 10 samples is extracted randomly though analytic study from 366 samples of teaching evaluation base at the second term of 2014. U_1 presents sample 1, U_2 presents sample 2. a_1 presents evaluation index 1- Teaching preparation; a_2 Present evaluation index 2- The teaching goal is clear , accords with the standard of curriculum and is suitable for students' characteristics. And so on, this system decision table is built, as shown in table 2.

Table 2 information system

	a ₁	a ₂	a ₃	a ₄	a ₅	a ₆	a ₇	a ₈	a ₉	a ₁₀	a ₁₁	a ₁₂	a ₁₃	a ₁₄	a ₁₅
U ₁	10	9.5	10	9.5	9	8	8	8.5	9.5	9	9	9	10	8.5	10
U ₂	10	10	9.5	10	10	9	8	9	10	10	9.5	9.5	9.5	9	10
U ₃	8.5	8	8.5	8.5	8	8	8.5	8	8	7	8	7.5	8	8	8
U ₄	8.5	8	8	9.5	8	8.5	8	8	10	10	9	8	8.5	8	8
U ₅	10	8.5	9.5	8.5	10	8.5	9.5	9	9	9	9	9	9	9	9.5
U ₆	9	9	7.5	8	8.5	8.5	8	8	8.5	8.5	7.5	7.5	8.5	8.5	8.5
U ₇	9.5	9	9	9	9.5	8.5	8.5	9	8.5	8.5	8.5	9	9.5	9	9
U ₈	9	8.5	8	7	7	6.5	7.5	8.5	7.5	6.5	7.5	7	8.5	8.5	9.5
U ₉	10	9.5	9.5	9.5	9.5	8	8.5	9	8.5	8	8.5	8.5	9.5	9.5	9.5
U ₁₀	10	9.5	9.5	9.5	9.5	8	8.5	9	6.25	8	8.5	8.5	9.5	9.5	9.5

Secondly, the Boolean matrix is structured, after attribute reduction using this algorithm of this paper, First, core attribute a₉ is got, d(a₉,R)=41, R={a₉}, C_{A/R} is got through

$$111111010011111$$

computing, C_{A/R} =

$$101110110011111$$

$$111111110111111$$

$$111101000101011$$

Then C_{A/R} is decomposed, as long as there is 1 in every line. Through this matrix, all of the attribute a₁,a₃,a₄,a₁₂,a₁₄,a₁₅ can distinguish the rest samples by themselves. So they are deleted from the matrix, and constitute attribute reduction with core attribute separately. They are: {a₁,a₉}, {a₃,a₉}, {a₄,a₉}, {a₉,a₁₂}, {a₉,a₁₄}, {a₉,a₁₅}, and the matrix becomes

$$010011010010100$$

C_{A/R} =

$$000010110010100$$

$$010011110110100$$

$$010001000100000$$

through C_{A/R}, the distinguish ability of a₅,a₈,a₁₁,and a₁₃ is equal, the

distinguish ability of a₂ and a₆ is equal. So attribute reduction is obtained by a₅ and a₂ :

{a₂,a₅,a₉}, {a₂,a₇,a₉}, {a₅,a₁₀,a₉}. The attribute reduction sets are:

{a₁,a₉}, {a₃,a₉}, {a₄,a₉}, {a₉,a₁₂}, {a₉,a₁₄}, {a₉,a₁₅}, {a₂,a₅,a₉}, {a₂,a₇,a₉}, {a₅,a₁₀,a₉}, {a₂,a₈,a₉}, {a₈,a₁₀,a₉},

{a₂,a₁₁,a₉}, {a₁₁,a₁₀,a₉}, {a₂,a₁₃,a₉}, {a₁₃,a₁₀,a₉}, {a₆,a₅,a₉}, {a₆,a₇,a₉}.

The attribute importance of these fifteen attributes are shown in table 3.

Table 3 attribute importance value

attribute	a ₁	a ₂	a ₃	a ₄	a ₅	a ₆	a ₇	a ₈	a ₉	a ₁₀	a ₁₁	a ₁₂	a ₁₃	a ₁₄	a ₁₅
importance	5.95	7.02	6.85	6.85	7.21	5.77	5.95	5.59	7.39	7.39	6.85	7.21	6.67	6.49	6.85

In this sample data, importance of every attribute is shown in table 3. We the biggest attribute importance {a₅,a₁₀,a₉} is chose, and decision rules are got as shown in table 4.

Table 4 decision rules

	range	result
$\frac{a_5 + a_9 + a_{10}}{3}$	[9,10]	excellent
	[8,9)	good
	[7,8)	middle
	[6,7)	qualified

The decision rules are verified by 366 sample data in 2014, and there are 42 samples which do not comply with the decision rules and the rest do. The success rate is 88.52%.

Conclusion

In this paper an algorithm is employed based on Boolean matrix in rough set for data analysis of the evaluation of teachers' teaching quality of our college in 2014 and finally a new attribute reduction is got, generate decision rules are got and verified. Compared with old method of evaluation of teachers'

teaching quality, this evaluation system of teachers' teaching quality established by rough set overcome subjectivity and inefficiency , It can evaluate teachers' teaching quality more objectively, more easily and more efficiently. It has a strong practical value.

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