Research on Formative Evaluation Algorithm of Teaching Process Based on Algebraic Feature Analysis Model

Mu Yang[a], Yanmei Hu[b,*]

Chengdu Medical College, Chengdu, Sichuan, 610083, China

[a] udjtrt@126.com, [b] 13965808@qq.com

*The corresponding author

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Abstract: In this paper, an analysis model for formative evaluation which based on fusion algebraic features from singular value decomposition and KL projection is constructed in the evaluation mechanism of teaching process. Firstly, the formative evaluation vector is used to describe the process of formative evaluation, and singular value decomposition (SVD) and KL transform are performed on the vectors. Then the transformed eigenvectors are linearly fused to form a new feature classification vector, which is used as the criterion of formative evaluation. The test results show that the method eliminates the influence of interference information in the evaluation process on the classification accuracy of final evaluation, and greatly improves the accuracy of formative evaluation in the teaching process.

1. Introduction

Formative evaluation, also known as process evaluation, is an evaluation conducted in the teaching process. It is an evaluation of students'learning results and teachers' teaching effects in order to guide the teaching process forward correctly and perfectly. Formative assessment is to discover the potential of each student, strengthen and improve students'learning, and provide feedback for teachers. Practical experience shows that information about teaching process is often provided to teachers and students, so that students and teachers can make effective use of this information and take appropriate corrective measures to make teaching a "self-correcting system".

Formative evaluation has the following remarkable characteristics:

1) Definite and feasible goals: The key to formative assessment is to help students identify the learning goals they need to achieve. This goal must be challenging, and students can only achieve it through hard work.

2) Specific and effective criteria: Formative evaluation belongs to standard reference evaluation, and the key is to formulate specific and effective criteria. The criteria can be discussed and decided by both teachers and students. The process of setting standards is also a process of self-identification and self-evaluation for students.

3) Timely and frequent feedback: formative assessment emphasizes the monitoring of students'acquisition of knowledge and skills in the process of educational activities, that is, in the process of students' knowledge, skills and attitudes formation. This kind of evaluation gives teachers the opportunity to understand and guide students'behavior in a variety of learning environments over time, not just to obtain students' performance in a specific space-time or environment.

Formative evaluation information is formed in the process of teaching activities, and with the accumulation and enrichment of teaching activities, formative evaluation indicators often include: autonomous learning time, classroom participation, usual practice results, project completion, mid-term and final examination results. We can describe it with a set of vectors.

Let the formative evaluation index vector be:

$$A= [A_1, A_2 ,A_3 ,... A_n] , A_i = (a_0,a_1,\ldots,a_n)$$

Thereinto, $a_0,a_1,\ldots,a_n$ is indicators of formative assessment.

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2. Formative Evaluation of Teaching Process Based on Algebraic Characteristic Analysis Model

In recent years, the combination of algebraic features to improve the accuracy of pattern recognition has become a research hotspot. There are many systems that use different features and different classifiers to combine each other, and their classification performance has been greatly improved. Singular value decomposition (SVD) is an effective algebraic feature extraction method. Because of the stability of the singular value feature in classifying objects, and its important properties such as transposition invariance and mirror transformation invariance, the singular value feature can be used as an effective algebraic feature description of the object to be classified.

In practice, to further strengthen the classification features of describing objects, the principal component features are obvious after K-L projection of the vector to be classified, which is conducive to improving the accuracy of classification and recognition. In the process of teaching evaluation, it is helpful to improve the accuracy of classification and evaluation by comprehensively utilizing the SVD characteristics of the evaluation object and the principal component characteristics of the evaluation object after KL projection to evaluate and classify the learning effect of the students in the teaching process.

3. Singular Value Decomposition and KL Projection of Evaluation Vector and Classification Method in Teaching Process Evaluation

3.1 Singular Value Decomposition of Teaching Evaluation Vector.

Assuming $A \in Rm \times n$, then there is Orthogonal matrix

$$U = [u_0, u_1, \cdots u_{r-1}] \in R^{m \times n},$$

$$V = [v_0, v_1, \cdots v_{r-1}] \in R^{m \times n}$$

$$\text{Let } A = \begin{pmatrix} \Sigma & 0 \\ 0 & 0 \end{pmatrix} V^T = \sum_{i=1}^{r} \sigma_i u_i v_i^T$$

Among above, $\sum = diag[\sigma 1, \sigma 2, \ldots, \sigma r]$ and $\sigma 1 \geq \sigma 2 \geq \ldots \geq \sigma r. > 0$, $\sigma 1, \ldots, \sigma r$ is the singular value of the matrix A, r=rank(A) is rank of a matrix A.

3.2 KL Projection and Principal Component Feature Extraction of Evaluation Vector.

KL expansion of evaluation vectors is an optimal orthogonal transformation to compress teaching evaluation vectors. Through KL projection, the algebraic principal component features of teaching evaluation vectors are obtained, which forms the basis of subspace pattern recognition. The method takes the total dispersion matrix of training sample set as the generating matrix, namely

$$S_t = E\{(x-m)(x-m)^T\} \quad x \in \forall \omega, \qquad i=0,1,\ldots,P-1$$

or

$$\hat{S}_t = \frac{1}{M} \sum_{i=0}^{M-1} (x_i - m)(x_i - m)^T$$

Among them, X_i is the ith of the training samples of the teaching evaluation vector, m is the average vector of the training sample set of the teaching evaluation, and M is the total number of training samples. After KL transformation, a set of corresponding feature vectors can be obtained, which can be called "evaluation vector feature set". With such a reduced-dimension subspace composed of the feature set of evaluation vectors, any teaching evaluation vector can be projected to it and a set of projection vectors can be obtained. These vectors indicate the position of the image in the subspace, thus they can be used as the classification basis of formative evaluation of teaching.

In this paper, the class scatter matrix of the training sample set is used as the generation matrix of

the K-L transform, namely

$$s_b = \sum_{i=0}^{p-1} p(\omega_i)(m_i - m)(m_i - m)^T$$

Classification criteria of KL projection and SVD is showed as the figure 1.

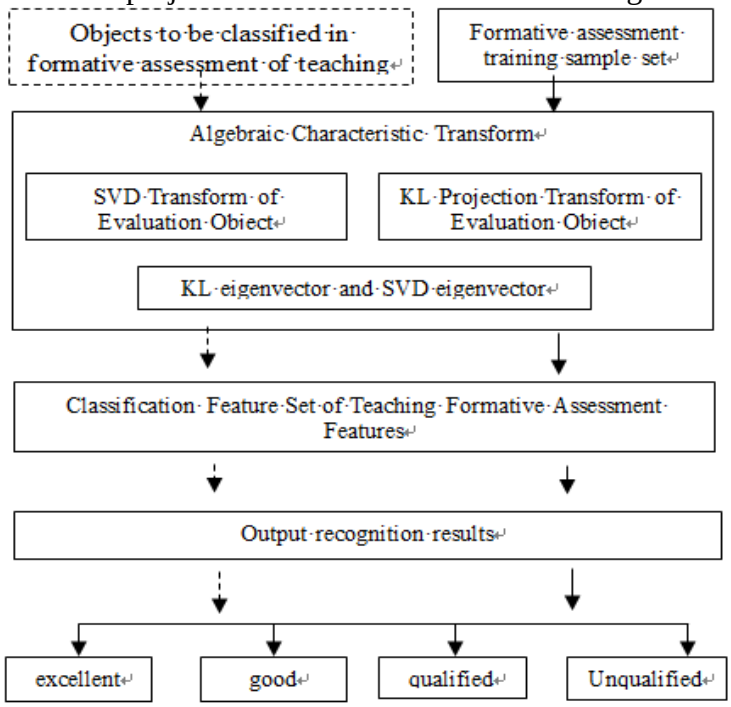

Figure. 1 KL Projection and Singular Value Decomposition for Classification and Discrimination

3.3 Classification and Discrimination Method in Formative Assessment of Teaching.

Classification and discrimination in formative evaluation of teaching is an important part of the final result. There are many methods of feature combination in pattern recognition. In this paper, linear weighting method is used to fuse features, and projection transformation vector is used comprehensively.

Let the principal component characteristic vector of the KL projection is:

$$X = [\, x1, x2, x3, \ldots xn \,] \quad xi = (\, x0, x1, \ldots, xn)$$

And SVD feature vector is:

$$Y = [\, y1, y2, y3, \ldots yn \,] \quad yi = (\, y0, y1, \ldots, yn)$$

Let the fusion feature vector is: $Z = AX + BY$

Thereinto,A, B is the weight coefficient, it is mainly based on the specific circumstances of the training samples to determine, fusion feature vector is showed as the figure 2.

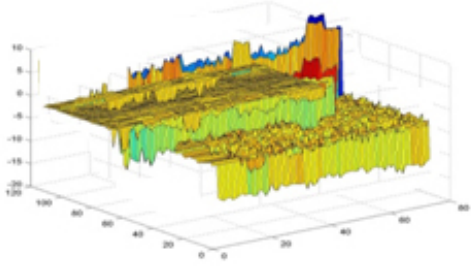

Figure. 2 Fusion Feature Vector

Euclidean distance is chosen as the classification method of formative assessment of teaching in the specific discriminant operation. Its definition is as follows :

$$d(i,j)=\sqrt{\left|x_{i1}-x_{j1}\right|^2+\left|x_{i2}-x_{j2}\right|^2+\cdots+\left|x_{ip}-x_{jp}\right|^2}$$

The square of Euclidean can be used to compare the differences in the process of vectors, which is helpful to distinguish the similar objects to be classified.

4. Design, Implementation and Performance Testing of Teaching Formative Assessment Algorithms Based on Algebraic Characteristic Analysis Model

In order to test and verify the formative evaluation algorithm based on the algebraic feature analysis model, we construct a mobile terminal-based classroom teaching assistant platform. The formative evaluation algorithm based on the algebraic feature analysis model provides a real-time interactive classroom teaching assistant tool for teachers. The platform can record the formative evaluation index of teaching in real time, which provides a carrier for the verification and practice of the algorithm. The login interface and function interface of the platform are shown in the following figure 3. The Trend Map of Achievement in Teaching Formative Assessment System is shown in the following figure 4.

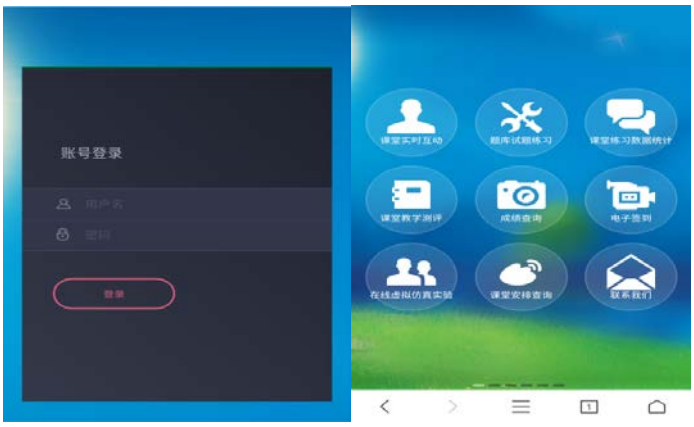

Figure. 3 The Login Interface and Function Interface

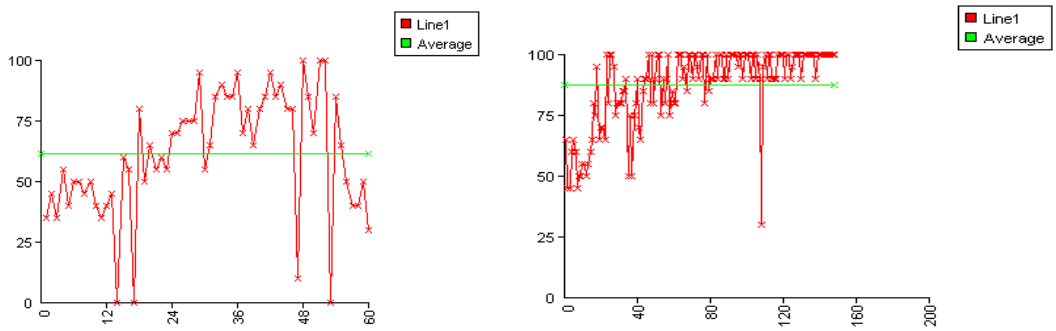

Figure. 4 The Trend Map of Achievement in Teaching Formative Assessment System

324 students were evaluated and analyzed systematically. We selected 10 students who are known to be excellent, good, qualified and unqualified in learning evaluation to construct training sample library, and constructed projection vector library by using the teaching formative evaluation algorithm of algebraic feature analysis model. Then we projected and calculated the formative indexes of other classmates who are not classified.

When the input sample is a trained formative evaluation vector, the system can output classification information accurately, and the classification accuracy is 100%. Experiments on untrained test samples show that the system can output classification matching information.

The algorithm has been tested repeatedly with this system. From the experimental results, it can be seen that the recognition rate increases gradually as the number of training samples increases. This is consistent with people's own visual recognition ability. The system can quickly and uniquely classify

all trained formative evaluation information to be classified. The untrained vector to be classified can also be used to classify and discriminate accurately. The experimental results of different test methods are compared as shown in Table 1.

Table 1 Comparison of test results

Test method	Total number of test samples	Test accuracy number	Test accuracy (%)
Traditional KL Projection Method	324	292	90．1
SVD Projection Method	324	289	89．2
A Fusion Method Based on KL Projection and SVD	324	318	98．1

5. Conclusions

The research of formative evaluation algorithm based on algebraic feature analysis model can make full use of all kinds of evaluation information in formative evaluation process. It can greatly reduce the dimension of original feature space and has a higher recognition accuracy when classifying information. Therefore, formative evaluation using this algorithm is a better classification and evaluation method.

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