Comprehensive Teaching Quality Assurance with Artificial Intelligence Applications

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Abstract. Establishing the teaching quality assurance system is a key aspect to realize the cultivation objectives of talents of higher education. This paper first discusses the composition, function and evaluation subjects of the comprehensive teaching quality assurance system. Secondly, the novel techniques of applying artificial intelligence to the diagnosis and mining of teaching state information is explored in detail, which constitutes scientific evidence for continual improvement of teaching.

1. Comprehensive Teaching Quality Assurance

Quality monitoring and continual improvement is the part of a comprehensive teaching quality assurance system (CTQAS) [1]. A valid CTQAS is characterized by synthesizing multiple evaluation observations from students, teaching supervisor, teaching assistants and managers, which focuses on establishing a sort of teaching quality evaluation pattern including mutually related aspects of all staff involvement, full course coverage and whole process supervision as well.

Generally speaking, information acquisition is conducted by means of routine teaching inspections, and special teaching inspections. Based on such traditional methods as regular meetings and releases on teaching, teaching status data has been properly processed, which is composed of classification, summary and feedback. Accordingly, a closed loop of teaching quality assurance is formed from information acquisition, processing, feedback to continuous improvement of teaching quality.

As far as the college framework in Chinese universities is concerned, the CTQAS mainly consists of three subsystems, which are administrative management subsystem, exploration & diagnosis subsystem and supervision subsystem, as illustrated in Figure 1. The mentioned three subsystems operate independently on one hand, and cooperatively on the other hand. There are different functions respectively for each subsystem.

The administrative management subsystem is mainly in charge of coordinating and dealing with all kinds of routine teaching activities, monitoring the enforcement of teaching related rules & regulations, and the confirmation of work specification of the teacher. Significantly, continuous improvement measures are also conscientiously implemented by the administrative management subsystem.

The undergraduate teaching steering committee of the exploration & diagnosis subsystem is engaged in the guidance and evaluation to the undergraduate teaching activities, especially focusing on the research and diagnosis of the teaching status information. Further suggestions are subsequently put forward to the party-government meeting decision-making mechanism of the college.

The supervision group of the supervision subsystem is devoted to multiple tasks of supervision and guidance, with emphasis on guidance. According to university guidelines and the detailed college enforcement plan, collegiate monitoring and evaluation on the undergraduate teaching level is put into practice.
Up to now, it is clear that a comprehensive teaching quality assurance system plays a key role in the talents cultivation of higher education. However, there are many inadequacies related to the CTQAS, especially the collegiate one. For example, the mechanism of quality evaluation and continuous improvement is not well established as to adapt to the demand of the cultivation of high-level professionals. It is not thorough and comprehensive that analyze the deep-rooted quality issues of the undergraduate teaching using teaching status data and evaluation results. Besides, quality evaluation feedback is limited to solving specific and formal problems, and the promotion of teaching quality cannot be prompt and effective.

For this purpose, it is essential strengthening the acquisition, statistic and analysis for teaching status data and evaluation results information. These acquired data are supposed to be holonomic and objective. For one thing, classroom evaluation results from both teaching supervision specialists and executives are proposed, for another, both peer review and student assessment are presented. In addition, resulting data and procedure information of teaching quality are explored. Pattern recognition techniques are then applied to these teaching status data mentioned above to form feasible comments and suggestions.

2. Applied Pattern Recognition Techniques

2.1. Hierarchical Decision Classifier
Hierarchical decision classifier is also called tree classifier or multi-classifier. It is an effective classification method for either multi-class or multi-modal distribution cases. Through the hierarchical decision classifier, a complex multi-class classification problem can be transformed into several simple classification problems. However the underlying classification of a complex multi-class set is not performed by using an algorithm and a decision rule. It is realized step by step in the form of hierarchical decision. A typical hierarchical decision classifier is the binary tree, in which each node has only two child nodes except the leaf node. At each node, the sample set is divided into two subsets. Such division is repeated until there is one class in the resulted subset. The structure of the binary tree is simple and intuitive. Diverse features can be extracted to, and diverse decision rules can be operated on corresponding nodes.
2.2. Empirical Mode Decomposition

Empirical mode decomposition [2] is based on N.E.Huang’s innovative assumptions, i.e., a complex data sequence can be regarded as the combination of a number of simple intrinsic mode function components, and each intrinsic mode function component can be linear or nonlinear. According to characteristic time scales of the data sequence, several intrinsic mode functions can be sifted one by one from the original data sequence. The decomposition procedure is formulated as follows.

- Search for local maxima and local minima of the original data sequence. Then, the upper envelope and the lower envelope is obtained by interpolating local maxima and local minima respectively.
- Perform averaging on the upper envelope and the lower envelope to obtain the instantaneous average of the upper and lower envelopes, \( m(t) \).
- Subtract \( m(t) \) from the original data sequence, a prototype function of the intrinsic mode function, \( h(t) \) is obtained.
- For \( h(t) \), repeat above steps, until the first intrinsic function component, \( c_1(t) \) is sifted.
- Subtract \( c_1(t) \) from the original data sequence to obtain the remainder, \( r_1(t) \). For \( r_1(t) \), repeat above sifting steps, and then the intrinsic mode function components \( c_2(t), c_3(t), \ldots, c_N(t) \) and the residual component \( r_N(t) \) are extracted successively.

If the original data sequence is the teaching status data, the combination form, \( \sum_{i=1}^{N} c_i(t) \) reflects the fluctuations of the teaching quality status, and the residual component, \( r_N(t) \) represent the changing trend.

2.3. Fuzzy Inductive Reasoning

Fuzzy Inductive Reasoning (FIR) is a modeling and simulation method that generates the qualitative input-output model from real-valued observation data of physical variables [3]. A fuzzy inductive reasoning system consists of four functional modules, namely, fuzzification module, qualitative modeling engine, qualitative simulation engine and defuzzification module (Figure 2).

Fuzzification is to map quantitative real-valued variables into qualitative triples, which are a discrete class value, a fuzzy membership value and a side value.

Qualitative modeling is to identify the relationship among the fuzzied class values as determined as possible, which is encoded in the expression of mask.

Qualitative simulation is to predict the m-output corresponding to current m-input. To this end, masking operation is performed on class value vector, membership value vector and side value vector respectively using the optimal mask obtained by exhaustive search to construct the corresponding m-input/output matrix, which is followed by forming behavior matrices using observed states and their probabilities of occurrence. Through class value, membership value and side value based behavior matrices, an entire qualitative triple is predicted.

Defuzzification is the inverse operation of fuzzification. Provided that membership functions are known, the quantitative data can be reconstructed uniformly by qualitative triples without any information loss.
2.4. Artificial Neural Networks Classifier

Traditional pattern recognition methods are presented in condition of stationarity and time-invariance of samples. However, samples in many cases such as teaching status data are generally nonstationary and time-varying. So the recognition performances of traditional methods are not satisfying. As an adaptive, non-parametric and nonlinear classifier, the artificial neural networks are insensitive to stationarity and time-invariance intrinsic to samples, and thus, it has constituted a new approach to the pattern recognition.

There are diverse kinds of neural networks classifiers such as hierarchical neural networks or interconnected neural networks according to topology, and feedforward neural networks or feedback neural networks. In the case of small sample, Neural networks with supervised training are optimal for pattern recognition of teaching status data. Multilayer perceptron (MLP) [4] is the most commonly used and representative feedforward neural network with supervised training. A multilayer perceptron classifier includes one input layer, one output layer and at least one hidden layer, which is capable of generalizing, nonlinear mapping and fault-tolerating. In case of large sample, convolutional neural networks (CNN) [5] are appropriate to the recognition of teaching status data. In general, the basic structure of convolutional neural networks is represented by two layers. One of them is the feature extraction layer, where the input of each neuron is connected to a local receptive field in the previous layer and features of that region are extracted. Once a local feature is extracted, the position relationship between the local feature and other features is also determined. The other layer is the feature mapping layer. Each computing layer of the network consists of several feature mappings and each feature mapping is a plane on which all neurons are with equal weights. Since the deep learning algorithm of feature detection layer of CNN operates on the training data, it avoids the explicit feature extraction from the training data when using CNN. Significantly, Due to the same weights of neurons on the same feature mapping plane, learning in parallel is available for the CNN. Figure 3 is a CNN recognition approach of teaching status data with random forest classification decision.

![Figure 3. CNN recognition with random forest classification decision](image)

3. Feedback and Continuous Improvement

As far as the automation major of Beijing institute of fashion technology is considered, feedback is performed on the practical teaching system to achieve continuous improvement. To meet professional development objectives, including students' engineering development capabilities, practical innovation capabilities and scientific research capabilities, evaluation results of teaching quality are contributed to promote the construction of multi-element, multi-module and multi-level practical teaching system, which is characterized by realizing combinations of theory and practice, expertise and textile &
garment industry, integrated design and engineering application, traditional technology and cutting-edge technology.

Dynamics of teaching quality related to the core modules of automation major of Beijing institute of fashion technology are shown in Figure 4-6. Degree of accomplishment is the weighted evaluation observations from students, teaching supervisor, teaching assistants and managers.

![Figure 4. Experiments of computer control system](image1)

![Figure 5. Integrated experiments of automation specialty](image2)

![Figure 6. Professional course design](image3)

4. Conclusions

The comprehensive teaching quality assurance system is with total factor and whole process, which is well versed in teaching sessions [6]. Its highly effective operation is determined by integrated factors interacting and affecting each other. First of all, the student-centered philosophy is supposed to be emphasized, and it is essential to guide students to participate in the management of teaching quality assurance. And then, supervisory experts are supposed totally to be responsible for learning supervision, teaching supervision and management supervision as well. Finally, Currently emerging requirements are bound to facilitate the applications of artificial intelligence technology to acquisition, classification, diagnosis and mining of the teaching status data.
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6. References
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