



## Reconstruction and Practice of the Content and System of the Course "Automatic Control Principles" in Private Undergraduate Colleges Driven by the Demand of New Engineering

Xiaoling Zhou<sup>1,\*</sup>

<sup>1</sup> Mechanical and Electrical Engineering, Xi'an University of Architecture and Technology  
Huaqing College, Xi'an, 710043, Shaanxi, China

**SUMMARY:** *In order to explore the reconstruction and practical path of the course content and system of "Automatic Control Principles" in private undergraduate colleges under the guidance of new engineering demands, this paper proposes an improved Apriori algorithm for the course content and system management decision model of "Automatic Control Principles". Firstly, establish an evaluation system for the course "Principles of Automatic Control" in private undergraduate colleges based on teaching tasks and achievements, which includes both clear and quantifiable indicators as well as subjective evaluations. Secondly, the AHP method using a hierarchical model is used to calculate subjective weights, and the comprehensive weights obtained based on the combination weighting method are used to improve the traditional Apriori algorithm. The weighted Apriori algorithm is proposed to mine and analyze the association rules of the reconstruction and practical management decision-making of the course content and system of "Automatic Control Principles" in private undergraduate colleges. Finally, through case analysis, the effectiveness of the proposed association rule model in evaluating the content and system of the course "Principles of Automatic Control" in private undergraduate colleges was verified, which has guiding significance for the management and decision-making of the course "Principles of Automatic Control" in private undergraduate colleges.*

**KEYWORDS:** *private undergraduate colleges; Automatic control principle; Course content reconstruction; System management decision-making; AHP method; Apriori algorithm; Association rule mining*

## 1 Introduction

The "New Engineering" requires engineering graduates to have strong engineering practical and innovative abilities. Universities are reforming their education and teaching in response to this training concept, with a particular emphasis on rebuilding the professional course knowledge system [1, 2]. Principles of Automatic Control "is a core foundational course required for majors in Electrical Engineering and Automation, Electronic Information Science and Technology, and Mechanical Design, Manufacturing, and Automation. It requires teachers to organize various knowledge points from a macro perspective and form a complete and three-dimensional knowledge system. It is necessary for students to guide practice through the complete theoretical knowledge they have learned, and at the same time, to have a deeper understanding of theoretical knowledge in the practical process, which can achieve the expected

\*shuizhongyue202510@163.com  
<https://doi.org/10.65102/is20261116>

teaching effect well [3]. Constructing a three-dimensional knowledge system is essential for the teaching of automatic control principles course.

The 'new' of new engineering disciplines is an innovation in concepts, models, and practices that differs from traditional higher education. The reform of the new engineering disciplines is aimed at adapting to the new situation in China's economic and social development, industrial restructuring, technological innovation, international competition, and other fields. It is to meet the new needs of the educated population for higher-level self-development and self-improvement, and to support the new mission of "cultivating morality and talent" in China's higher education in the new era, as well as the new task of comprehensive development of "morality, intelligence, physical fitness, aesthetics, and labor". From the perspective of serving the country, society, and the people, when we re-examine the issue of the construction of new engineering disciplines, we will find that the so-called new engineering automation major does not simply refer to the establishment of certain new majors, but rather a comprehensive reform of China's engineering discipline construction and engineering education model. This means that all engineering disciplines, whether old or new, need to carry out new engineering reforms [4]. Considering the rapid development of China's social economy in the past 40 years, the rapid adjustment of industrial structure, the explosive growth of emerging technology industries, and the increasingly severe international competition in the industrial field, automation major, as one of the most fundamental, extensive, and traditional engineering majors supporting China's industrialization process, particularly requires comprehensive, systematic, breakthrough, and even disruptive new engineering reforms. The new generation of artificial intelligence technology wave objectively provides unprecedented opportunities and impetus for the knowledge system transformation and application technology innovation of automation major.

However, the new engineering reform that combines artificial intelligence and automation is different from the general "intelligence+X" reform model. In the conventional "Intelligent+X" type of new engineering automation majors, X is generally a major with obvious industry backgrounds such as machinery, materials, energy, construction, and automobiles [5]. Its new engineering reform mode is to use new technologies of artificial intelligence to solve industry problems or lead industry innovation, which is a combination of "methods" and "problems". This combination mode is not unfamiliar to most engineering majors. The last time this method was used for professional construction, the corresponding "intelligent" position was "automation", such as mechanical automation, electrical automation, chemical automation, etc. From this comparison, it can be seen that automation is essentially similar to artificial intelligence, both being universal methods for solving problems. Today's new generation of artificial intelligence is more like an upgraded version of automation with a wider range of applications, stronger driving force, and stronger innovation. This means that the combination of artificial intelligence and automation will involve the integration and evolution of knowledge systems at a deeper level, the substitution and transformation of technological methods in more fields, and the application and innovation of engineering practices on a larger scale. This also makes the construction of AI driven automation in new engineering disciplines a more challenging and valuable research topic.

This article will combine the exploration and practice of the new engineering reform in the automation major, and discuss, analyze, and explore the theory, methods, and practices of the course construction of "Automatic Control Principles" in the automation major of the new engineering major from the aspects of problem analysis, construction ideas, key measures, and application cases. The aim is to provide useful references for the continuous promotion and innovation of the new engineering automation major reform in China.

## 2 Related research

In recent years, the rapid development of data storage technology has enabled researchers to collect more data and greatly improve their ability to collect data. But people did not make good use of this data, thus failing to discover potential valuable information. With the development of advanced science and technology, researchers in various fields have begun to pay attention to potentially valuable massive data information to promote the development of this field. Researchers in the field of education are also paying more attention to the use of advanced technologies in educational research, which can be helpful for student learning and the management of educational administrators. In the field of new engineering, since the beginning of researching educational data, researchers have often used students' grades to evaluate their abilities and teaching effectiveness, ignoring the essence of the course "Principles of Automatic Control" and students' learning behavior, resulting in unsatisfactory evaluation results. Therefore, research in this field is becoming increasingly important. However, currently many studies focus on simple statistics of course evaluation data and student grades, while there is little research on in-depth analysis of course evaluation data and student online learning behavior data for "Principles of Automatic Control".

In foreign countries, research on data-driven approaches began in the 1960s. In recent years, with the development of advanced science and technology, researchers in various fields have begun to use relevant field data to mine potential valuable information, promoting the progress and development of the field. More and more researchers are becoming interested in data in the field of education. For example, reference [6] provides a detailed description of relevant research on using data mining techniques to predict student performance. Reference [7] points out that not only academic performance has an impact on research ability, but also students' personality traits have a significant influence on their research ability. Reference [8] uses data-driven techniques to study student performance. Through extensive research abroad, advanced data mining methods are combined with educational data to promote the development of universities. Compared with foreign countries, China's higher education institutions started relatively late in the field of educational research and invested relatively little. However, with the increasing emphasis on higher education by the government and relevant education departments, more support has been given to research projects in the field of education. In recent years, many fields have introduced technologies such as machine learning, data mining, and artificial intelligence. Although machine learning technology and artificial intelligence have been applied in many fields, their development in the field of education has been slow, mainly due to different requirements for the application of educational data in various universities. Despite this, many researchers have analyzed and studied educational data according to different needs, and have made significant progress. Domestic scholars often use machine learning algorithms such as decision tree and naive Bayes when analyzing educational data, and have achieved good results. For example, reference [9] improved the frequent itemset generation of Apriori algorithm through views, analyzed teaching evaluation data, and found that education, professional title, and teaching experience affect course quality. Reference [10] analyzed teaching evaluation data using outlier detection algorithms to verify the feasibility of outlier detection algorithms in educational data research. Reference [11] filtered the strong rules generated by the Apriori algorithm by adding interest level, and analyzed the scores of different courses using the improved Apriori algorithm. It was found that there was a certain correlation between each course. Reference [12] analyzed the data of over 1000 students and 20 courses in its institution by constructing a data warehouse, and used decision tree algorithm to analyze which factors are related to students' grades. A relatively accurate analysis showed that factors such as course type and major have a significant impact on academic performance. Reference

[13] analyzed the academic performance of college students by establishing a data warehouse and found that there is a certain relationship between teaching effectiveness and the gender of teachers and students. When the gender of teachers and students is the same, most students have better grades. Reference [14] conducted mining, analysis, and research on the academic performance of college students. Through the overall distribution characteristics of grades, a preliminary understanding of grade data was obtained, and comprehensive influencing factors were identified. Based on decision trees, the main factors affecting college students' grades were analyzed. Reference [15] analyzed computer proficiency test scores by using Apriori algorithm and decision tree to establish a model, and used data from different years as training and testing sets. Finally, the results were compared with the actual results. The conclusion indicates that this method can effectively assist candidates in learning and identifying weak areas. Reference [16] analyzed the influencing factors of teaching evaluation results using the Apriori algorithm. In response to the high cost and large candidate item set of the Apriori algorithm, an improved ACM algorithm was used for analysis, further improving the efficiency of the algorithm. Reference [17] established an English score prediction model using the Naive Bayes algorithm, and trained the model using English CET-4 exam data from a certain school in different years as the training and testing sets. The results showed that this classification model had good performance. Reference [18] collected exam data from the past five years and analyzed it using the Apriori algorithm to study the reasons for the influence of international students learning Chinese. It was found that the prerequisite for learning Chinese well is to practice listening well.

Through studying the above literature, it can be seen that at present, the mining of higher education data mainly focuses on student grades, subject types, and teaching staff, neglecting the most important course essence in higher education. In most research, traditional machine learning algorithms are mainly used for mining, and many researchers have made certain improvements to the mining algorithms. Based on the data used in the mining process, most of the mining data comes from teacher and student data over the years, which cannot timely reflect the problems existing in the current course of "Principles of Automatic Control" and the actual learning situation of students at present.

### 3 Evaluation system

The construction of the new engineering automation major is a systematic teaching reform jointly promoted by teaching management units, professional construction organizations, and course teaching teams. Among them, the organization for the construction of automation majors (usually professional departments) is mainly responsible for the construction of the curriculum system; The teaching team is mainly responsible for the construction of course resources. These two tasks have a certain specificity, with significant differences between different majors, courses, and teams [19]. The teaching management unit of the course "Principles of Automatic Control" (usually a two-level teaching management organization at the school and college levels) is mainly responsible for organizing division of labor, resource allocation, and evaluation feedback. Its reform measures have certain universality and reference significance. Therefore, this section mainly discusses some typical reform measures that can be adopted by the teaching management unit of the course "Principles of Automatic Control".

#### 3.1 Organizational division of labor

The organizational structure of the construction of the new engineering automation major is designed around three elements: subject, division of labor, and relationship. At the college level,

the teaching management organization is the main body, and the college teaching guidance committee and teaching supervision group are established. The former is responsible for providing guidance based on the college's teaching management proposals, while the latter conducts quality evaluations based on teaching tasks; The automation department level is composed of professional construction working groups and professional teaching guidance committees established by professional departments. The former is responsible for the management and specific affairs of automation professional teaching and professional construction, while the latter is responsible for providing guiding opinions on automation professional teaching plans; The automation professional teaching team is responsible for the implementation of specific teaching activities and the construction of teaching resources, and is accountable to the automation professional construction working group, under the supervision of the college supervision group. From the college to the automation major department, then to the automation major construction working group, and finally to the teaching team, a top-down teaching organization and management backbone is formed. How to improve the organizational management efficiency between the upper and lower levels of the backbone is the biggest challenge faced by this organizational structure. Suggestion [20]: (1) Adopt a unified appointment mechanism of responsibility and rights between the college and the automation department; (2) Adopting a project approval system between the automation department and the working group; (3) In the construction work group and teaching team of the automation major, the main body is the overall allocation of teaching tasks, and the evaluation and resource allocation rights are coordinated for flexible control.

### 3.2 Resource Allocation

Most of the work in the construction of the new engineering automation major belongs to incremental tasks, including the increase in workload of full-time teachers, the increase in resource investment, and the increase in organizational management costs. Therefore, there must be corresponding allocation of new resources to fully ensure the quality of the construction of the new engineering automation major. The resource allocation for the construction of the new engineering automation major mainly considers two aspects: resource acquisition and resource allocation. The main channels for obtaining external resources include tuition increment, school enterprise cooperation, joint education, government special projects, etc. The difficulty of obtaining the external resources mentioned above is high, and the increment is limited [21]. It is a relatively effective resource strategy to bind the construction of the new engineering automation major with landmark achievements such as the Strong Foundation Plan, Top notch Innovation Bases, National First Class Majors, Engineering Education Certification, Featured Majors, and International Education, in order to strive for internal resource allocation. However, in most cases, the increase in resources mentioned above is unpredictable and unsustainable. Therefore, the main resource allocation for the construction of the new engineering automation major comes from the reform of the resource redistribution mechanism within the college. The types of resources mainly include human resources, financial resources, and spatial resources, and the reform measures for allocation mechanisms mainly include two types [22]: coordinated and guided. The coordinated reform mainly optimizes and allocates existing resources directly through colleges and various professional departments, including teaching task allocation, space allocation, and fund allocation. Among them, fund allocation includes daily operating funds, basic education condition improvement funds, discipline construction funds, and other related special funds; Guiding reform measures mainly use certain scarce resources and evaluation feedback mechanisms as leverage to leverage other resource inputs, such as [23]: (1) using funding resources to guide human resource investment in the form of curriculum, textbooks, and other internal teaching reform projects; (2) Based on the

allocation of scarce spatial resources, guide the investment of research equipment funds in the construction of teaching and experimental platforms; (3) By adjusting the conditions for professional title evaluation and performance assessment, we aim to attract additional resources and funding to invest in the construction of new engineering disciplines.

### 3.3 Evaluation Feedback

Whether it is organizational division of labor or resource allocation, the core of the construction of the new engineering automation discipline is ultimately the teachers. Only by fully mobilizing the enthusiasm of teachers, regulating their teaching behavior, and guiding their energy investment can we effectively promote the reform of the new engineering discipline. The above work relies on the comprehensive and systematic reform of teaching evaluation and feedback mechanisms, and the specific evaluation and feedback system architecture is shown in Figure 1. This evaluation system is mainly aimed at teaching tasks and achievements in the field of automation, including teaching workload, construction tasks, teaching achievements, and teaching quality evaluation. It covers various aspects of work such as individuals, courses, textbooks, experiments, and professional construction. In form, it includes both clear and quantifiable indicators as well as subjective evaluations. The evaluation results need to be combined with the feedback system, using feedback channels such as performance evaluation, employment period evaluation, professional title evaluation, and resource allocation to create pressure and motivation for teachers to carry out high-quality teaching work through minimum class requirements, teaching GPA and teaching quality evaluation, teaching achievement evaluation, resource allocation, and project support.

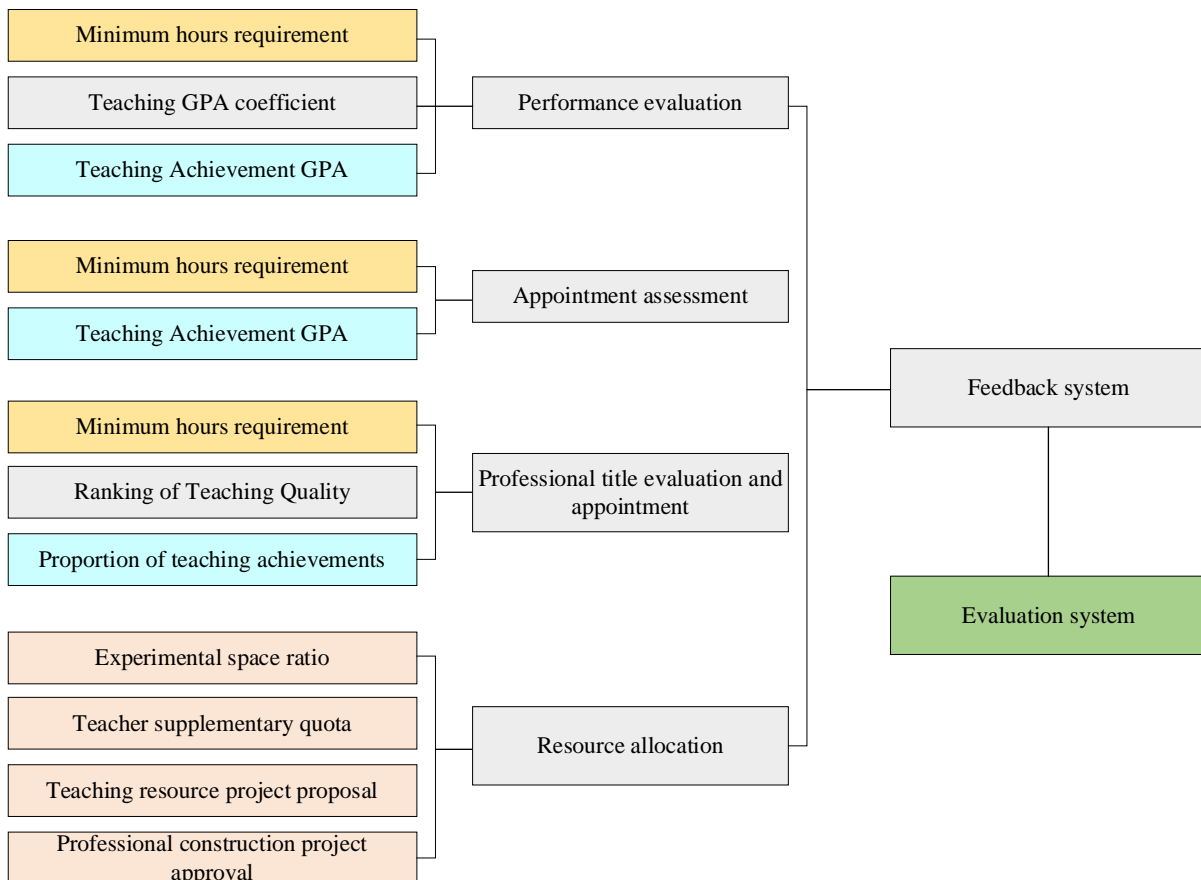


Figure 1: Evaluation Feedback System Architecture

## 4 Determination of indicator weights and mining of association rules

In the process of using the course content and system evaluation model of "Principles of Automatic Control", the weight of each evaluation index has a direct impact on the accuracy of the association rules of quality risk factors in the construction of automation professional disciplines [24]. The Analytic Hierarchy Process is a subjective weighting method, and the determined weights are easily influenced by personal preferences and insights, resulting in inaccurate and unscientific results; Although the objective weighting method uses mathematical calculation methods to calculate weight values, it cannot fully reflect the authenticity of weight calculation results due to the randomness of statistical data and limitations of calculation methods. In order to avoid the above-mentioned problems, this article adopts a combination weighting method that combines subjective and objective factors to determine the comprehensive weight of indicators, making the weight values of quality risk factors in the construction of automation disciplines more reasonable.

### 4.1 Analytic Hierarchy Process

Analytic Hierarchy Process (AHP) is an application network system theory and multi-objective comprehensive evaluation method proposed by American operations researcher Sati in the early 1970s. It is a systematic analysis method that combines qualitative and quantitative analysis. This method divides a complex problem into several layers, each layer containing several factors. After in-depth analysis of the complex nature of things and related influencing factors, a clear hierarchical structure diagram is drawn. Then, a judgment matrix is established for each factor one by one. By calculating the eigenvalues and eigenvectors of the judgment matrix, the weights of different factors are obtained. Based on the size of the weight values, the evaluation results are selected and the best solution is chosen. The structure of the Analytic Hierarchy Process model is shown in Figure 2.

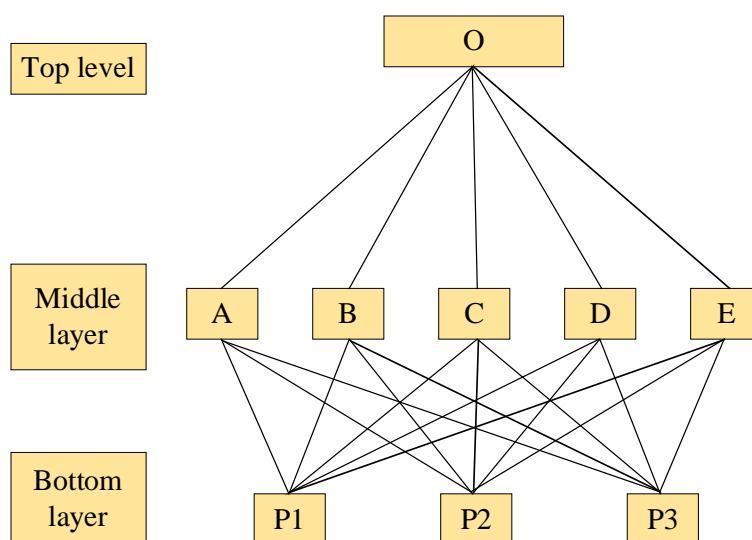


Figure 2: Analytic Hierarchy Process Model

The Analytic Hierarchy Process (AHP) has a clear train of thought, which enables logical, mathematical, and modeling thinking. It combines qualitative and quantitative methods, quickly and accurately identifies the key issues, and ranks the weights of influencing factors at each level. Suitable for decision analysis of complex problems with multiple criteria and objectives,

especially for scheme evaluation and decision-making. Due to its ability to combine qualitative and quantitative analysis, it has quickly been widely applied in many fields such as engineering, economics, energy, planning, safety, and more. The disadvantage is that there is a high degree of subjectivity, with empirical factors accounting for a large proportion, making it difficult to exclude personal factors of decision makers and convincing. Therefore, it is difficult to apply it to high-precision problem decision-making and evaluation.

The AHP method is relatively mature and widely used in both theory and application among various subjective weighting methods. The specific steps are as follows.

Step 1: Build a hierarchical analysis structure model. On the basis of a full understanding of the existing problems, establish a hierarchy, determine the research scope and influencing factors, clarify the logical hierarchical relationship of each factor, and establish an appropriate hierarchy. Depending on the specific situation, it can be divided into target layer (top layer), criterion layer (middle layer), scheme layer (bottom layer), etc.

The specific steps are to first conduct problem analysis, determine research objectives, and use them as target layer elements. Generally speaking, the research objective is unique; Identify various criteria that affect the goal, clarify their logical relationships, and use them as the criteria layer. Finally, find various measures for solving the problem and use them as the solution layer.

Step 2: Construct a judgment matrix. The contribution values of each factor to the previous layer are different. For example, the impact of each factor in the criterion layer on the target layer is different, and the impact of each factor in the scheme layer on the criterion layer is also different. Therefore, it is necessary to compare them pairwise and construct a judgment matrix based on the scale of contribution values. It is the fundamental basis for making decisions. The scale of importance can be evaluated using expert evaluation methods.

Step 3: Check the consistency of the judgment matrix. Generally, there are many judgment objects, and it is difficult to ensure that the constructed judgment matrix is completely consistent. The method of measuring pairwise consistency is to calculate the consistency index. Only when the calculated consistency index is verified to be qualified can the comprehensive calculation of AHP continue.

Step 4: Determine the best solution. Determine the overall ranking of each influencing factor in the selected evaluation index system, that is, calculate the weight of the relative importance of all elements at the same level to the previous level. This process is carried out layer by layer from the target level to the scheme level, and the importance of each influencing factor is determined by its weight.

## 4.2 Determining indicator weights based on variable weight theory

The variable weight comprehensive evaluation method is a comprehensive decision-making approach proposed by WANG in 1990. This method can more objectively determine the weight of indicators, reduce the influence of subjective factors, and avoid the problem of "state imbalance" when calculating constant weight indicators. This article cites the variable weight comprehensive evaluation method from reference [25], which introduces a local penalty incentive variable weight function based on the variable weight theory. The formula for variable weight is as follows:

$$w_i^1 = \frac{w_i^0 S(x_i)}{\sum_{i=1}^n w_i^0 S(x_i)}, (i, j = 1, 2, \dots, n) \quad (1)$$

where,  $w_i^0$  is the constant weight calculated by the AHP method,  $w_i^1$  is the variable weight, and  $s(x_i)$  is the penalty incentive variable weight function.

$$S(x_i) = \begin{cases} 1, & x_i = 0 \\ \frac{d_2 - d_1}{\beta - \alpha} \alpha \ln \frac{\alpha}{x_i} + d_2, & 0 < x_i \leq \alpha \\ -\frac{d_2 - d_1}{\beta - \alpha} x_i + \frac{d_2 \beta - d_1 \alpha}{\beta - \alpha}, & \alpha < x_i \leq \beta \\ d_0 + \frac{d_2 - d_1}{2(\beta - \alpha)(\gamma - \beta)} (\gamma - x_i)^2, & \beta < x_i \leq \gamma \\ d_0, & \gamma < x_i \leq \delta \\ c(1 - \delta) \ln \frac{1 - \delta}{1 - x_i} + d_0, & \delta < x_i < 1 \\ 1, & x_i = 1 \end{cases} \quad (2)$$

where,  $0 < \alpha < \beta < \gamma < \delta < 1, 0 < d_0 < d_1 < d_2 < 1$ ;  $\gamma$  is the punishment level,  $\delta$  is the incentive level;  $d_0$ ,  $d_1$ , and  $d_2$  are evaluation strategies;  $C$  is the adjustment coefficient;  $x_i$  is the evaluation value for the  $i$ -th indicator.

The calculation formula for the comprehensive weight  $w_i$  of each indicator is as follows:

$$w_i = \varepsilon w_i^0 + (1 - \varepsilon) w_i^1 \quad (3)$$

where,  $\varepsilon$  is the compromise coefficient. The larger the  $\varepsilon$ , the greater the impact of the weight values determined by the Analytic Hierarchy Process on the comprehensive weights; On the contrary, the weight values determined by the theory of variable weights have a greater impact on the overall weight. To make the results more balanced, we take  $\varepsilon=0.5$  here.

### 4.3 Association Rule Mining

Assuming a database is  $D$ , and the set of all data in  $D$  is denoted as  $Item = \{I_1, I_2, \dots, I_k\}$ , the association rule mining process includes two steps [26]: (1) finding frequent itemsets. Scan database  $D$  and calculate the support frequency corresponding to each transaction. When the frequency of a certain itemset reaches a certain level, it is called a frequent itemset. (2) Mining association rules. The itemsets  $I_i$  and  $I_s$  are any combination of all transactions, and the association rules are usually referred to as  $I_i \Rightarrow I_s$ . There are three important indicators for evaluating the strength of association rules, namely support (Wsup), confidence (Wconf), and improvement (Wlft). The higher the support and confidence, the stronger the rule; The higher the degree of improvement value, the more effective the rule provides. The Apriori algorithm is the most widely used association rule mining algorithm, which uses a layer by layer iterative approach to search for frequent itemsets and mine association rules. Usually, the algorithm needs to be implemented through the following process: (1) connection, with the aim of finding the maximum frequent itemset; (2) Pruning aims to narrow down the search space of the candidate item set  $c_i$ ; (3) Generate strong association rules.

The traditional Apriori algorithm uses the same level of support when conducting data mining, assuming that the risk factors in the database are independent of each other and have no difference in importance. However, in reality, there is a distinction between primary and secondary risk factors [27]. The traditional Apriori algorithm can only obtain association results by scanning high-frequency risk factors in the database, making it difficult to reflect the impact of low-frequency but highly important risk factors on association rules. To this end, weight data is introduced to improve the support degree to weighted support degree, and to mine the association rules of quality risk in the construction of automation professional disciplines.

The weighting methods for Apriori algorithm support are mainly divided into three types:

horizontal weighting, vertical weighting, and mixed weighting. Where, Horizontal weighted association rules reflect the importance of different risk factors to a project by setting differentiated weights for them. The purpose of this study is to explore the association rules between risk factors with different weights, therefore, a horizontal weighting method is adopted to improve the support degree. The comprehensive weight is the result obtained by weighting the subjective and objective weights, and the data is more scientific and in line with the actual situation. The weighted support formula is as follows [28, 29]:

$$Wsuph(X) = \max\{w_1, w_2, \dots, w_n\} \times Wsup(X) \quad (4)$$

where,  $X$  is the itemset,  $\max\{w_1, w_2, \dots, w_n\}$  is the term with the highest horizontal weight for  $X$ , and  $Wsup(X)$  is the support for  $X$ .

The improved algorithm is the same as the traditional Apriori algorithm, which is implemented in two steps: connection and pruning. The definition of horizontal weighting makes the pruning step slightly different from the traditional algorithm, and can only be judged by the unique horizontal weighted support degree.

## 5 Experimental analysis

### 5.1 Dataset Collection and Cleaning

At present, the main way to collect evaluation data for the course "Principles of Automatic Control" in the automation major is through questionnaire surveys. Traditional paper survey questionnaires waste manpower and resources, and the collection and statistics of survey questionnaires are difficult. In response to these shortcomings, the data used in this chapter will be obtained through a questionnaire survey system to obtain evaluation data for the course "Principles of Automatic Control". The obtained data inevitably has some missing and subjective issues. Before analysis, it is necessary to first organize and delete dirty data and other preprocessing work to ensure the accuracy of data analysis conclusions and predictions.

The 417 pieces of data used for analysis were collected from a questionnaire survey of undergraduate students in the course of "Principles of Automatic Control" at a certain university, targeting four groups of people: students, teachers, peer experts, and teaching supervision groups. They were collected through a course evaluation questionnaire survey system designed with course evaluation indicators, and the data structure is shown in Table 1. After integration, each record includes 12 attributes from four dimensions: teaching team, teaching content, teaching resources, teaching methods and means.

*Table 1: Data Structure*

Field name	meaning	Data type	Length
id	ID	varchar	64
type	Course Type	int	1
leader_lecturer	Course leader and main lecturer	varchar	1
structure_quality	Teaching team structure and overall quality	varchar	1
reform_research	Teaching Reform and Research	varchar	1
course_content	Course content	varchar	1
design	instructional design	varchar	1
practice	Course Practice	varchar	1
materials	Textbooks and related materials	varchar	1
environment	Practical teaching conditions	varchar	1
net_resource	Online teaching resources	varchar	1
teaching_idea	Teaching Philosophy	varchar	1
teaching_methods	The use and effectiveness of multiple teaching methods	varchar	1
information_technology	Application of Information Technology	varchar	1

When using the questionnaire survey system to obtain raw data, due to extreme human intervention situations such as all positive evaluations or all negative evaluations, the relevant data has been excluded. During the data collection process using the questionnaire survey system, some indicators were not successfully collected due to the comprehensive influence of the system's own characteristics and human operations. Considering the size and completeness of the dataset, it is not appropriate to directly delete these missing data items. After in-depth analysis, it was found that the presentation frequency of some options exceeded 50% of the total sample size. Based on this, this chapter has decided to use pattern filling to handle missing data. After completing data processing, the final number of records was determined to be 408, accounting for 97.54% of the total sample data.

The Apriori algorithm typically focuses on one-dimensional attribute value data. From another perspective, the representation of attribute values in such data can be simply understood as only involving the presence or absence of a certain element *a*. However, in real-world scenarios, data generally presents multidimensional features, making it difficult for Apriori algorithm to be directly applied to association rule mining. Based on the national quality course evaluation standards and the specific needs of educational reform, a first level evaluation index system has been carefully constructed for the "Automatic Control Principles" course in the automation major, which covers key aspects such as teaching team, teaching content, and teaching conditions. In order to present the connotation of primary indicators in a more systematic and detailed manner, it is necessary to further refine the design of secondary indicators within the framework of primary indicators. Specifically, these secondary indicators cover the relevant situation of the person in charge and lecturer of the "Automatic Control Principles" course in the automation major, the composition structure and overall literacy level of the teaching team, and the reform measures and research progress in the teaching field. However, due to the multidimensional nature of the data collected for course evaluation indicators, their data structure and correlation relationships are complex, making it impossible to directly apply the Apriori association rule algorithm for effective analysis of such data.

## 5.2 Result Analysis

Conduct rule extraction experiments using traditional Apriori algorithm, probability based Apriori algorithm, and improved algorithm under different conditions to investigate the filtering effect of the improved Apriori algorithm on extracting interesting rules. Figures 3 to 5 show the changes in the number of association rules extracted by the three algorithms under different combination conditions. Figures 3 to 5 show that within the respective set ranges of parameter combinations such as support, confidence, and interest, the number of extracted rules decreases with increasing support, confidence, and interest.

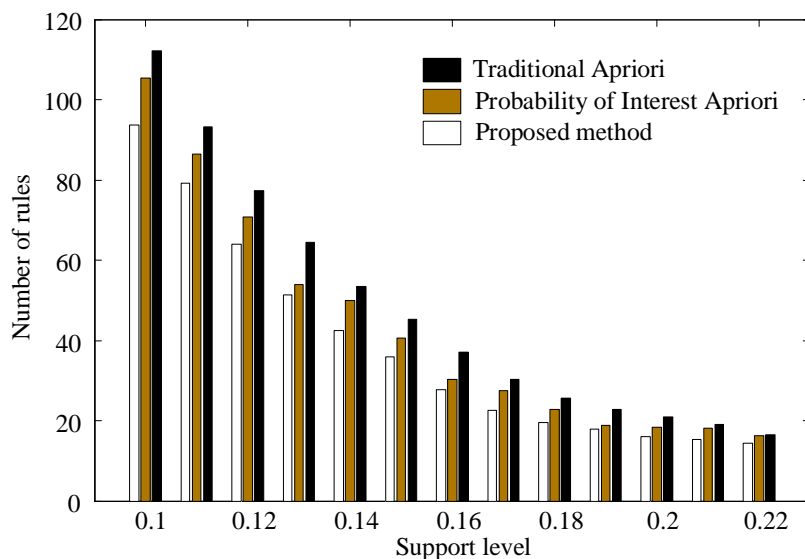


Figure 3: Comparison of the number of extracted rules by three algorithms under different support levels

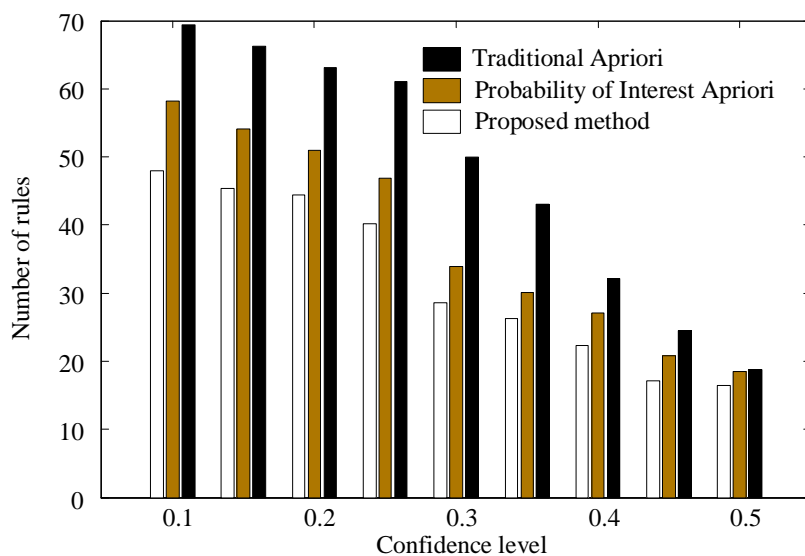


Figure 4: Comparison of the number of extracted rules by three algorithms under different confidence levels

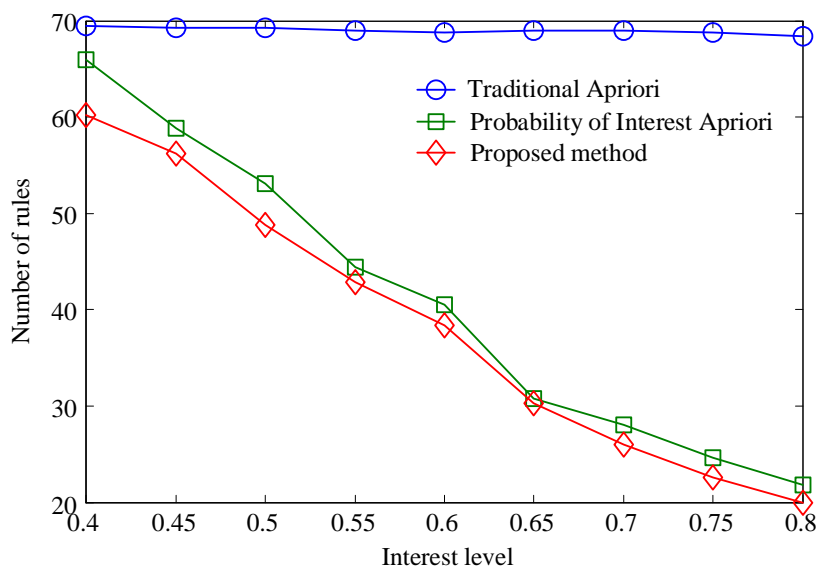


Figure 5: Comparison of the number of extracted rules by three algorithms under different levels of interest

Under the conditions of pre-set confidence and interest parameters, experimental observations were conducted. As the support gradually increased, compared to using traditional algorithms, the number of rules extracted by the improved Apriori algorithm showed a significant decrease in the initial stage, while the gap between the two gradually narrowed until it approached. Although the number of rules extracted by the improved Apriori algorithm is slightly higher than that of the Apriori method based on probabilistic interests, the overall trend is still lower than that extracted by the probabilistic interest algorithm. This phenomenon clearly indicates that the Apriori algorithm incorporating interest factors can effectively reduce the probability of misleading rules, and Apriori algorithms with different levels of interest settings have better performance in reducing misleading rules. After setting the support and interest parameters, relevant tests were conducted. As the confidence level continued to increase, the number of rules generated by the improved Apriori algorithm was significantly reduced compared to the traditional Apriori algorithm in the initial stage. Subsequently, the difference in the number of rules generated by the two gradually narrowed and approached. However, the overall trend of the number of rules generated by the improved Apriori algorithm is less than that of the probabilistic interest Apriori algorithm, indicating that introducing interest can reduce the number of misleading rules generated, and the improved Apriori algorithm can better reduce the generation of misleading rules. Under the premise of setting support and confidence parameters and introducing interest in the Apriori algorithm, as the interest level increases, the number of rules extracted by the probabilistic Apriori algorithm and the improved Apriori algorithm gradually decreases. From the overall trend observation, the number of rules generated by the improved Apriori algorithm is less than that of the probabilistic Apriori algorithm. Compared with it, using the traditional Apriori algorithm for mining did not change the number of extracted rules, indicating that introducing interest can reduce the generation of misleading rules. The improved Apriori algorithm is more effective in reducing the generation of misleading rules. In summary, the algorithm proposed in this article extracts fewer rules compared to traditional Apriori and probabilistic Apriori algorithms, effectively suppressing the generation of meaningless and misleading association rules, and improving the efficiency of data mining and the accuracy of implicit knowledge in the data.

## 6 Conclusion

Driven by the demand for new engineering disciplines, the reconstruction and practice of the content and system of the course "Principles of Automatic Control" in private undergraduate colleges have become the key to improving the quality of engineering education and cultivating talents with engineering practical and innovative abilities. This article proposes a course content and system management decision model based on an improved Apriori algorithm, providing strong support for optimizing course content and improving the system. Firstly, an evaluation system for the course "Principles of Automatic Control" in private undergraduate colleges has been established, which not only covers quantifiable teaching indicators but also incorporates subjective evaluation to comprehensively reflect the teaching effectiveness of the course. Secondly, the subjective weights were calculated using the Analytic Hierarchy Process (AHP) of the hierarchical model, and combined with the comprehensive weights obtained by the combination weighting method, the traditional Apriori algorithm was improved and a weighted Apriori algorithm was proposed. This article elaborates on the reform measures for the construction of the new engineering automation major from three aspects: organizational division of labor, resource allocation, and evaluation feedback. By clarifying the responsibilities of teaching management institutions at all levels, optimizing resource allocation, and establishing a comprehensive and systematic evaluation and feedback mechanism, the teaching reform of the course "Principles of Automatic Control" has been effectively promoted. At the same time, the weighted Apriori algorithm was used to conduct in-depth analysis of course evaluation data, uncovering key factors and their associated rules that affect course quality, providing data support for optimizing course content and improving the system. Through case analysis, this article verifies the effectiveness of the proposed association rule model.

However, curriculum restructuring and practice in the context of new engineering disciplines is a continuous process that requires constant exploration and improvement. Future research can further expand data sources and incorporate more dimensions of evaluation indicators to improve the accuracy and applicability of the model. Meanwhile, it is possible to explore the application of advanced technologies such as machine learning and deep learning in the analysis of course evaluation data, in order to discover deeper association rules and potential value. In addition, strengthening cooperation and communication with other universities and enterprises to jointly promote curriculum reconstruction and practice under the background of new engineering disciplines is also an important direction for future research.

## Funding

This research was supported by First-Class Course Construction Project for "Principles of Automatic Control" at Huaqing College, Xi'an University of Architecture and Technology.

This research was supported by Sponsored Project of the Third Teacher Teaching Innovation Competition at Huaqing College, Xi'an University of Architecture and Technology.

This research was supported by the Doctoral Development Fund of Xi'an University of Architecture and Technology Huaqing College (2026DDF-NS-M 10) (CN)

## About The Author

Xiaoling Zhou was born in Yuncheng City, Shaanxi Province, China in 1988. She earned her Master's degree from Xi'an University of Technology, majoring in Electrical Engineering and Automation. She is currently employed at Huaqing College, Xi'an University of Architecture

and Technology, where she serves as the Director of the Electrical Engineering Teaching and Research Office. Her primary research focuses on microgrids and smart grids.

## References

- [1] Stockheim J, Perrakis A, Sabel B A, et al. RoCS: robotic curriculum for young surgeons[J]. *Journal of Robotic Surgery*, 2023, 17(2): 495-507.
- [2] Abichandani P, Sivakumar V, Lobo D, et al. Internet-of-things curriculum, pedagogy, and assessment for stem education: A review of literature[J]. *IEEE Access*, 2022, 10: 38351-38369.
- [3] Mamvuto A, Mannathoko M C. The changing African art and design curriculum: narratives from teacher education[J]. *Arts education policy review*, 2023, 124(3): 149-156.
- [4] Kusmawan A, Rahman R, Anis N, et al. The relationship between teacher involvement in curriculum development and student learning outcomes[J]. *International Journal of Educatio Elementaria and Psychologia*, 2025, 2(1): 1-12.
- [5] Mohanty A, Alam A, Sarkar R, et al. Design and development of digital game-based learning software for incorporation into school syllabus and curriculum transaction[J]. *Design Engineering*, 2021, 8(1): 4864-4900.
- [6] Williams R, Ali S, Devasia N, et al. AI+ ethics curricula for middle school youth: Lessons learned from three project-based curricula[J]. *International Journal of Artificial Intelligence in Education*, 2023, 33(2): 325-383.
- [7] Harcher E, Fakolade A, Gordon D, et al. Design and implementation of a health systems science curriculum at a large teaching hospital[J]. *BMC Medical Education*, 2022, 22(1): 643.
- [8] Hays R B. Purposeful design in health professions' curriculum development[J]. *Medical Teacher*, 2024, 46(12): 1532-1538.
- [9] Murad D F, Hassan R, Heryadi Y, et al. Recommendation system based on recognition of prior learning to support curriculum design in online higher education[C]//2021 International Conference on Information Management and Technology (ICIMTech). IEEE, 2021, 1: 413-417.
- [10] Hall D M, Čustović I, Sriram R, et al. Teaching generative construction scheduling: Proposed curriculum design and analysis of student learning for the Tri-Constraint Method[J]. *Advanced engineering informatics*, 2022, 51: 101455.
- [11] Widiaty I, Achdiani Y, Widaningsih L, et al. Fuzzy AHP for performance analysis: mapping green curriculum and developing blue curriculum framework[J]. *J Eng Sci Technol*, 2024, 19(4): 80-8.
- [12] Syarnubi S, Syarifuddin A, Sukirman S. Curriculum Design for the Islamic Religious Education Study Program in the Era of the Industrial Revolution 4.0[J]. *Al-Ishlah: Jurnal*

- Pendidikan, 2023, 15(4): 6333-6341.
- [13] George A S. Preparing students for an AI-driven world: Rethinking curriculum and pedagogy in the age of artificial intelligence[J]. Partners Universal Innovative Research Publication, 2023, 1(2): 112-136.
- [14] Hadi A, Marniati M, Ngindana R, et al. New paradigm of merdeka belajar curriculum in schools[J]. Al-Ishlah: Jurnal Pendidikan, 2023, 15(2): 1497-1510.
- [15] Eguia R E. Collective knowledge and skills of planning and executing future-proof curriculum design of outcomes-based graduate education[J]. International Journal of Multidisciplinary: Applied Business and Education Research, 2022, 3(1): 56-65.
- [16] McEneaney J, Morsink P. Curriculum Modelling and Learner Simulation as a Tool in Curriculum (Re) Design[J]. Journal of Learning Analytics, 2022, 9(2): 161-178.
- [17] Pepin B. Connectivity in support of student co-design of innovative mathematics curriculum trajectories[J]. ZDM–Mathematics Education, 2021, 53(6): 1221-1232.
- [18] Day E L, Petritis S J, McFall-Boegeman H, et al. A framework for the integration of green and sustainable chemistry into the undergraduate curriculum: greening our practice with scientific and engineering practices[J]. Journal of Chemical Education, 2024, 101(5): 1847-1857.
- [19] Supriani Y, Meliani F, Supriyadi A, et al. The Process of Curriculum Innovation: Dimensions, Models, Stages, and Affecting Factors[J]. Nazhruna: Jurnal Pendidikan Islam, 2022, 5(2): 485-500.
- [20] Jurado C A, Tsujimoto A, Punj A, et al. Successful development and implementation of a digital dentistry curriculum at a US dental school[J]. Journal of oral science, 2021, 63(4): 358-360.
- [21] Sajja R, Sermet Y, Cwiertny D, et al. Platform-independent and curriculum-oriented intelligent assistant for higher education[J]. International journal of educational technology in higher education, 2023, 20(1): 42.
- [22] Cahyadi D, Faturahman A, Haryani H, et al. Bcs: Blockchain smart curriculum system for verification student accreditation[J]. International Journal of Cyber and IT Service Management, 2021, 1(1): 65-83.
- [23] Trinter C P, Hughes H E. Teachers as curriculum designers: Inviting teachers into the productive struggle[J]. RMLE online, 2021, 44(3): 1-16.
- [24] Chimbunde P, Moreeng B B. The sustainability of curriculum reform and implementation through teacher participation: Evidence from social studies teachers[J]. Journal of Curriculum Studies Research, 2024, 6(1): 83-98.
- [25] Bellas F, Guerreiro-Santalla S, Naya M, et al. AI curriculum for European high schools: An embedded intelligence approach[J]. International Journal of Artificial Intelligence in Education, 2023, 33(2): 399-426.

- [26] Qasim A, El Refae G A, Eletter S. Embracing emerging technologies and artificial intelligence into the undergraduate accounting curriculum: Reflections from the UAE[J]. *Journal of Emerging Technologies in Accounting*, 2022, 19(2): 155-169.
- [27] Rathore A A, Sultana N, Zareen S J, et al. Artificial intelligence and curriculum prospects for elementary school[J]. *Pakistan Journal of Humanities and Social Sciences*, 2023, 11(4): 4635-4644.
- [28] Alam A. A digital game based learning approach for effective curriculum transaction for teaching-learning of artificial intelligence and machine learning[C]//2022 international conference on sustainable computing and data communication systems (ICSCDS). IEEE, 2022: 69-74.
- [29] Miller E C, Severance S, Krajcik J. Motivating teaching, sustaining change in practice: Design principles for teacher learning in project-based learning contexts[J]. *Journal of Science Teacher Education*, 2021, 32(7): 757-779.