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DESIGN AND IMPLEMENTATION OF SAAS ONLINE EDUCATION MANAGEMENT SYSTEM FOR EXPANDING LMS SYSTEM

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Abstract. The development of the education industry benefits from the continuous progress and updates of internet technology, and the organic integration of the two can further promote the emergence of the LMS (Learning Management System) system. Based on the application characteristics of the LMS system and the characteristics of the Software as a Service online education management system, a Software as a Service online education management system based on the extended LMS system was constructed. The service mode of the system was analysed, and a solution to the problem of paper formation and an analysis of the automatic paper formation algorithm in the system were provided. In addition, further research was conducted on the scores of the credibility evaluation of the system's services under different attribute parameters. Through the correlation analysis between different attributes and the credibility evaluation scores of the Software as a Service system, it can be seen that among the selected attribute parameters, Response Time and Latency show a negative correlation with the credibility evaluation, while other parameters show a positive correlation. The Software as a Service system constructed in this article provides relevant technical solutions, which have great practical application value and have reference significance for other similar applications. It provides more support for the application and promotion of the Software as a Service (SaaS) online education management system.

Key words: Expand LMS; Software as a Service system; service mode; credibility evaluation; correlation analysis.

1. Introduction. At present, the main users of the Learning Management System are usually schools and related enterprises. The main functions of the LMS system include basic information management, course management, learning record tracking, learning effectiveness evaluation, and various learning assistance functions (discussion, chat, quizzes, surveys, statistics, collaboration, voting). During the teaching process, teachers can use the LMS system to achieve functions such as online classes, homework assignments, uploading classroom materials, and social interaction [1-2]. Enterprises can use the LMS system for employee training, employee registration, progress tracking, and more. The business model of the LMS system is to charge fees for schools or corporate institutions, while providing free services to students and teachers.

With the innovation and development of internet technology, traditional LMS systems are no longer in line with the rapid iterative development model that prioritizes user experience in the context of the internet. Nowadays, most domestic LMS systems still remain in the traditional C/S mode. Alemayehu Fikru K et al.'s research shows that there is a certain degree of gap between China and advanced SaaS based architecture models abroad [3]. Studying the universal architecture of a SaaS based LMS system from a technical perspective, in order to continuously improve and optimize the performance of online education management systems, is one of the important issues currently faced, including the analysis and resolution of key details and encountered problems. Among them, the front-end includes how to use the latest single page architecture front-end framework to cooperate with traditional Java back-end technology, build reusable front-end components through the directive feature in angular.js, build unit testing and end-to-end testing for the front-end, and automate the front-end through construction tools. The backend section mainly includes how to achieve communication and routing between the client and backend, how to build the company's own modular framework based on the characteristics of JVM and Tomcat, and how to achieve isolation and mutual communication between modules, the company's backend storage framework, and the implementation of cache mechanism [4-6]. In addition, by analysing the key technologies of LMS system application in SaaS online education management system, we

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can refer to the implementation process of the system and build a SaaS based LMS system that has a good user experience, is stable, and is easy for the team to develop quickly [7].

Cloud computing and internet technology are also widely applied on LMS. In the field of LMS, currently the most advanced Blackboard company in foreign countries has adopted SaaS technology, serving LMS on the basis of AWS public cloud. Schools and educational institutions can pay as needed for the functions they need to activate, and there is no need to configure and install users' client and server sides. As long as users purchase LMS services, they can use the services anytime and anywhere [8-9].

At present, there is still a certain degree of lag in the domestic development status, and the development of LMS system is still insufficient. Technically, the traditional C/S architecture is still used, with limited scalability and the need for engineers to implement it on-site, resulting in poor user experience. In terms of functionality, it is also too simple, lacking a series of key functional points from the teacher creating the course to students completing their studies, achieving grades, and ending the course [10-11]. Customization and on-demand payment are also urgent issues for domestic LMS systems. Different schools and training institutions will have different ways of educational management, therefore, the demand for LMS is different. In traditional software systems, such systems can result in significant costs during implementation. With the increasing attention paid by the domestic education industry, the scale of users is increasing, and there are more and more course resources. The traditional LMS system in China is no longer able to meet the needs of users [12]. In order to provide users with more powerful functions and a better experience, there is an urgent need for a modern SaaS based online LMS system.

Based on the main problems faced above, this article introduces the solution of SaaS online education management system, and constructs a SaaS online education management system based on the extended LMS system. Based on the constructed system, the impact of service modes and different attribute changes on the credibility evaluation of its services was analysed, laying an important foundation for the application of the system in the education management industry.

2. LMS system and SaaS technology characteristics. Based on the development of the education industry and related technologies, the construction and experience optimization of an online design education knowledge service platform are achieved using a distributed SaaS model framework. Based on the analysis of typical users' needs in the online design education industry, relevant design goals and platform construction plan design process planning can be formulated for the design and improvement of the online design education knowledge service platform system [13-14].

The concept of user experience is explained from a qualitative perspective, which describes how a product is directly or indirectly associated with the outside world and the emotional cognition and subjective feelings that arise when it interacts with it. Simply put, when describing the user experience of a product, what needs to be asked is whether it is convenient and fast to use. Describing the determining factors of user experience in a structured manner can be divided into the following five elements: strategic layer, scope layer, structural layer, framework layer, and presentation layer [15-16]. The strategic layer determines the product design goals from the perspective of the school or enterprise, as well as the core demands from the user perspective; The scope determines the list of product requirements and the segmented needs of various types of users from which; The structural layer determines the information exchange structure framework of the product; The framework layer determines the roommate process and interactive page layout of the product; The presentation layer determines the visual style and style of the product. As shown in Figure 2.1, the design objectives of an online education management system based on user experience elements are presented.

2.1. LMS system. For common LMS systems, there are three main modes used: LAN mode, C/S mode, and B/S mode. The local area network (LAN) method was the earliest used, mainly running through LAN protocols. The advantage of this system is that it is easy to develop, but its security and stability are poor, so it has been basically phased out. The C/S mode is implemented jointly by the client software and the server, and the application software needs to be installed on the user's machine [17]. The C/S model is built on the basis of a local area network, which has certain limitations and is not conducive to expansion, and updates and upgrades are not flexible enough. The B/S mode, also known as the browser server mode, adopts popular internet technology and is more user-friendly, making installation, deployment, and version updates more convenient. With the rise of cloud computing in recent years, SaaS, as a way to implement cloud computing, has been

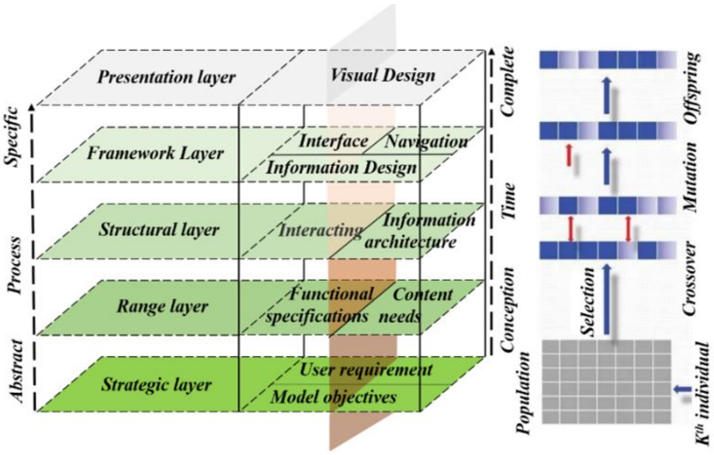

Fig. 2.1: Design Objectives of Online Education Management System Based on User Experience Elements

welcomed by schools or enterprise level applications. SaaS allows users to rent software by purchasing services, and applications can be paid on demand based on customized functions. Users only need to log in to the browser using the purchased account to enjoy customized services. Under the background of cloud computing, LMS systems are gradually evolving towards SaaS based services to provide a better user experience [18-19].

2.2. Advantages of SaaS technology in LMS systems. Both abroad and domestically, SaaS service software has gained great development opportunities. In addition to the precise judgment of customer needs by SaaS service providers, the most crucial aspect is the advantages of SaaS software itself. It appears at an appropriate time to adapt to the development of the times and people's consumption needs, in order to gain a clear advantage in competition with traditional software. This is also the reason why this article uses the SaaS model for online teaching system design [20].

1. Advantages on the user side
   Ready to use: For users, using SaaS software is a simple task. As long as you can connect to the internet, you can start using SaaS software, without the complex installation and configuration process of traditional software. The SaaS software was already installed on the network server of the software supplier before its launch, and the installation and configuration of the software are independent of the user. If there is a problem, you don't need to solve it yourself. You only need to provide feedback to the service provider to solve the problem, which is convenient and fast.
   No maintenance required: A software or product cannot be perfect, and there may be some issues during use. No matter what the problem is, the traditional software model leaves it to users to solve, which is both time-consuming and a waste of energy; The maintenance of SaaS software is the responsibility of the provider, and users do not need to consider these issues [21].
   Cost reduction: An important consideration factor for whether software is worth consuming is the price of the software. In the past, traditional software users bought just as they did, but if there were problems, they couldn't help it even after the shelf life; When SaaS software users need the software, they pay according to the time, and buy it as soon as they use it; If you feel it's not suitable, you can no longer pay for the rental.
   Congenital antivirus: The client of SaaS software is usually a browser or other tool software. Even if the client's system is infected with a virus, it only needs to reinstall tools and software such as the system and browser, without the need to install and restore application software one by one. Moreover, it is difficult for viruses on the client side to spread to the server, as the client and server mainly communicate through protocol-based data, making it difficult for viruses to penetrate. Users do not need to overly consider security and other issues [22].

2. Advantages of software vendors
 Saving sales costs: Software products produced under traditional software models require a series of investment, development, sales, and marketing efforts. When users purchase a product, they often focus most on its usability and durability, whether the product can be applied in multiple aspects, and whether it can withstand the test of time. Based on these considerations, users may have difficulty making decisions when purchasing a product. But for software products under the SaaS service model, service providers only need to do a good job in market promotion. For product quality, users can first spend a small amount of money on product trials, and then decide whether to continue purchasing product services based on the level of experience.
 Saving maintenance costs: Through previous analysis of SaaS mode services, it can be concluded that in traditional software service modes, when encountering major software problems, software service providers may need to dispatch specialized technical maintenance personnel for on-site software maintenance, which will greatly consume the service provider's maintenance costs. If multiple users encounter problems, the service provider will need to spend a lot of money on software maintenance [23-24]; But in the SaaS service mode, no matter how many users encounter problems at the same time, users only need to feedback the problem to the service provider. On the one hand, software maintenance is carried out on the servers purchased by the service provider themselves, and on the other hand, software maintenance technicians will be very familiar with their own servers and deployment environment, and can quickly locate the problem and solve the user's problem. Based on this advantage, software maintenance costs can be greatly reduced [25].

3. Design and Implementation of SaaS Online Education Management System Expanding LMS System. Taking online education models and platform learning and platform user experience as research objects, highlighting the professional attributes of design disciplines. In addition, it was emphasized that optimizing and researching the experience design of the platform, as well as building online platforms, should be the focus of design practice. In the context of the experience economy era, the quality of user experience evaluation in online education is no longer limited to the visual effects and functional richness of the product, but includes the comprehensive impact of other factors such as the entire process of service backend management, organizational operation, information access, acquisition and feedback, and student learning effects on users, Therefore, through comprehensive analysis of online design education and training scenarios and deep exploration of needs, a better platform user experience optimization has been achieved.

Based on the above introduction of typical trust models or frameworks in cloud computing environments, combined with the 3D cloud service credibility evaluation system, this article analyses the comprehensive evaluation indicators of service credibility in order to evaluate the comprehensive performance of the system used in the education field before proceeding with system design. Through relevant analysis, this article proposes a third-party based comprehensive evaluation reference model for the credibility of SaaS services, based on the constructed SaaS online education management system based on the LMS system. As shown in Figure 3.1, a third-party based comprehensive evaluation reference model for SaaS service credibility is provided. As shown in the figure, the system is based on the basic framework of cloud services and forms the basic part of the system through relevant data collection, processing, and feedback. In addition, further combining with the consumer needs of cloud services and achieving data feedback, promoting system updates and improvements, and reflecting the overall functionality of the system, ultimately forming a comprehensive evaluation reference model for SaaS service credibility.

3.1. Service Model of SaaS Online Education Management System. The core of SaaS software services is to transform traditional software industry sales products into sales services, treating software as a service rather than a sold product [26]. The basic theory of SaaS holds that the essence of software is services. From the perspective of users, what they are more concerned about is whether a software product is easy to operate and does not encounter significant problems. Even if a software product requires a large amount of money to purchase, as long as the functionality is convenient and there are no subsequent usage issues, most users are willing to purchase it. Users value the service of a product more than the price. SaaS software is able to gradually establish a foothold in the field of software services by meeting the needs of users [27].

From the perspective of modern economics, regardless of the business model, the establishment of the model

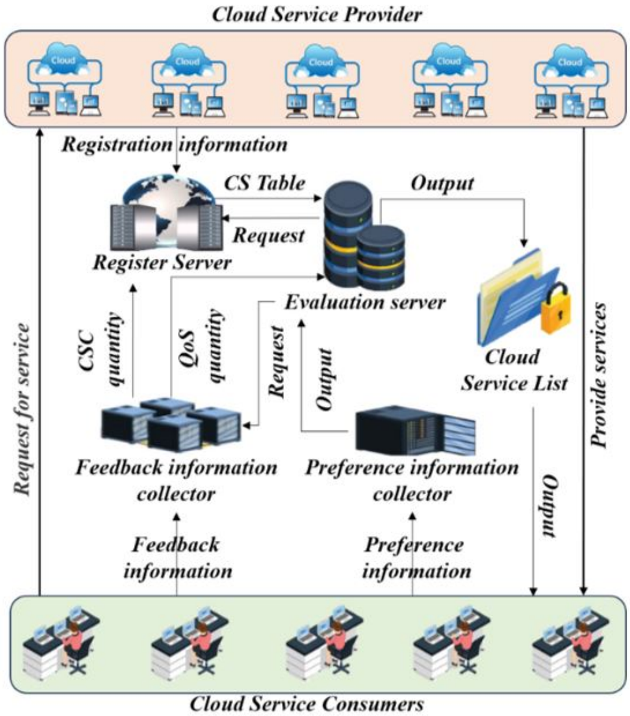

Fig. 3.1: Reference Model for Comprehensive Evaluation of SaaS Service Credibility Based on a Third Party

requires a clear supply-demand relationship to support this business model, that is, whether the product's functions can meet the needs of users. The biggest difference between traditional software business models and SaaS software business models lies in their different definitions of software [28]. The traditional software business model regards software as a product, which is customized according to user needs based on market research. When user needs change, the existing functions of the software product may not necessarily meet user needs; The SaaS software business model views software as a service that sells services to users. Even if users' needs change, service providers can make changes to their services in a short period of time, in line with the supply-demand relationship in economics.

3.1.1. Analysis of Paper Formation Problems. In the education industry, the problem of generating test papers is one of the important issues that most online education management systems face. Similarly, for the SaaS online education management system that expands the LMS system, the paper generation problem is essentially a combinatorial optimization problem with multiple constraints, which can be defined as a combination of a set of constraint conditions and an objective function. In order to assess students' mastery of knowledge, each test question is mainly set with the following attributes: a) test question number; b) Question score; c) Question type; d) Difficulty coefficient; e) Knowledge points, the range of knowledge levels to which the test questions belong; f) Cognitive classification, reflecting the level of requirements for the teaching content of the question; g) Differentiation, reflecting the degree to which the question identifies and distinguishes the candidate's level of knowledge and ability; h) Estimated answer time.

In automatic test paper generation, for each test question, the above 8 indicators need to be determined. For each test paper, a matrix Sg determined by $8\times m$ is shown in formula (3.1). Among them, m is the number of test questions included in the test paper.

$$Sg = \begin{bmatrix} a_{11} & a_{12} & ... & a_{18} \\ a_{21} & a_{22} & ... & a_{28} \\ ... & ... & ... & ... \\ a_{m1} & a_{m2} & ... & a_{m8} \end{bmatrix} \tag{3.1}$$

The objective matrix should meet the following constraints as much as possible: The total score of the test paper is approximately given by formula (3.2):

$$P = \sum_{i=1}^{m} a_{i2} \tag{3.2}$$

In the formula, P represents the total score of the test paper, and a_{i2} is the score of the *i-th* test question. In addition, for the difficulty constraints of the test paper, formula (3.3) needs to be met:

$$ND = \frac{\sum_{i=1}^{m} a_{i2}a_{i4}}{100} \tag{3.3}$$

In the above formula, ND is the difficulty of the test paper, and a_{i4} is the difficulty coefficient of the *i-th* test question. In the process of education management, not only the above two links need to be constrained, but also the knowledge points need to be constrained. The specific constraint conditions are given by formula (3.4):

$$\sum_{i=1}^{m} c_{1i} \times a_{i2} = z_h c_{1i} = \begin{cases} 1, IFa_{i5} = 0 \\ 0, IFa_{i5} \neq 0 \end{cases} \tag{3.4}$$

In the formula, a_{i5} is the knowledge point number of the *i-th* test question, and h_z is the score of the *h-th* knowledge point. For the constraints of cognitive classification, formula (3.5) can provide:

$$\sum_{i=1}^{m} c_{2i} \times a_{i2} = P_k c_{2i} = \begin{cases} 1, IFa_{i6} = k \\ 0, IFa_{i6} \neq k \end{cases} \tag{3.5}$$

For the above formula, a_{i6} is the cognitive classification number of the *i-th* question, and Pk is the score of the *k-th* cognitive classification. The constraint of question type also has an important impact on the analysis of paper formation problems. In this model, the constraint conditions of the question type can be described using formula (3.6):

$$\sum_{i=1}^{m} c_{3i} \times a_{i2} = q_d c_{3i} = \begin{cases} 1, IFa_{i3} = d \\ 0, IFa_{i3} \neq d \end{cases} \tag{3.6}$$

In addition, constraints on time and overall differentiation are important components of ensuring overall quality, as shown in formulas (3.7) and (3.8), which provide constraints on time and overall differentiation:

$$T = \sum_{i=1}^{m} a_{i8} (i = 1, 2, ..., m) \tag{3.7}$$

$$D = \frac{1}{P} \sum_{i=1}^{m} a_{i2}a_{i7} \tag{3.8}$$

In addition to the constraints of the above individual items, other indicators such as expected value, extraction frequency, etc. can also be specified. However, based on our experience, having too many indicators can increase the difficulty of paper formation and reduce the efficiency of paper formation.

3.1.2. Automatic test paper generation algorithm. Through the analysis of the paper generation problem in the SaaS online education management system, it can be seen that the efficiency of automatic paper generation and the good performance of generating test papers mainly depend on the design of the algorithm. Here, we will introduce an improved genetic algorithm based on segmented integer code coding. According to the adaptive crossover probability P_c, each question type segment is crossed separately. The crossover method is as follows: randomly select two crossover points within a certain question type segment, and then exchange the middle segment between the two points to determine the non-duplication of each gene in the generated child. If duplicate genes appear, they are re crossed or replaced with randomly generated genes until all genes are different [29-30]. Adopting adaptive crossover probability not only performs well in the later stage of evolution, but also improves the crossover rate of individuals with excellent performance in the early stage of evolution, so that they do not stay in a state of approximate stagnation, reducing the possibility of evolution towards local optimal solutions. The adaptive crossover probability P_c is determined by formula (3.9):

$$P_{\mathrm{c}1} = \begin{cases} P_{\mathrm{c}1} - \frac{(P_{c1}-P_{c2})\times(f^{'}-f_{max})}{f_{max}-f_{avg}}, f^{'} \geq f_{max} \\ P_{\mathrm{c}1} f^{'} f_{max} \end{cases} \tag{3.9}$$

In the above equation, f 'is the larger fitness value between the two strings to be crossed; f_{max} and f_{avg} are the maximum fitness values of individuals in the previous generation population and the average fitness values of the population; P_{c1}=0.9, P_{c2}=0.6.

According to the adaptive mutation probability Pm, the mutation is performed separately in each question type segment. The mutation method is as follows: randomly select a mutation site within a certain question type segment, and then randomly generate a gene. If the gene is the same as the mutation site gene, the mutation is repeated until a different gene appears. By adopting adaptive mutation probability, mutation can perform well in both the early and late stages of evolution. The adaptive mutation probability Pm is determined by the following equation:

$$P_m = \begin{cases} P_{m1} - \frac{(P_{m1}-P_{m2})\times(f_{max}-f)}{f_{max}-f_{avg}}, f \geq f_{avg} \\ P_{m1} f^{'} f_{avg} \end{cases} \tag{3.10}$$

In the formula, fmax and f_{avg} are the maximum fitness values of individuals in the previous generation population and the average fitness values of the population; F is the fitness value of the individual to be mutated; P_{m1}=0.1, P_{m2}=0.001.

3.2. Construction of SaaS Online Education Management System Based on Extended LMS System. In the actual process of expanding the SaaS online education management system of the LMS system, a total of three ports were designed for the online design education knowledge service platform, as shown in Figure 3.2. The PC user webpage display environment is usually the port where students and teachers enter the knowledge service platform for related learning or teaching activities in home and office settings; The H5 mobile end is usually used in mobile scenarios, where students can access the platform anytime and anywhere for knowledge learning. Teachers can also view course and student information for knowledge teaching at any time. In addition, teaching scenarios also break the limitations of time and space; The backend management end is used for unified management of platform systems. As shown in the figure, the design of the online design education knowledge service platform includes three main parts. At the same time, it combines feedback data from students and teachers to achieve multi-dimensional data sharing. Through relevant data processing techniques, it breaks through the data barriers in common systems and provides necessary guarantees for the implementation of the system's performance.

In addition, based on the functional design of the online design education platform knowledge service platform system mentioned above, through the design analysis experiment of the information framework, the experimental plan for designing the information framework for three ports was obtained.

Based on the above analysis, in the construction process of expanding the SaaS online education management system of LMS system, the characteristics of simple form and easy modelling of linear models can be fully

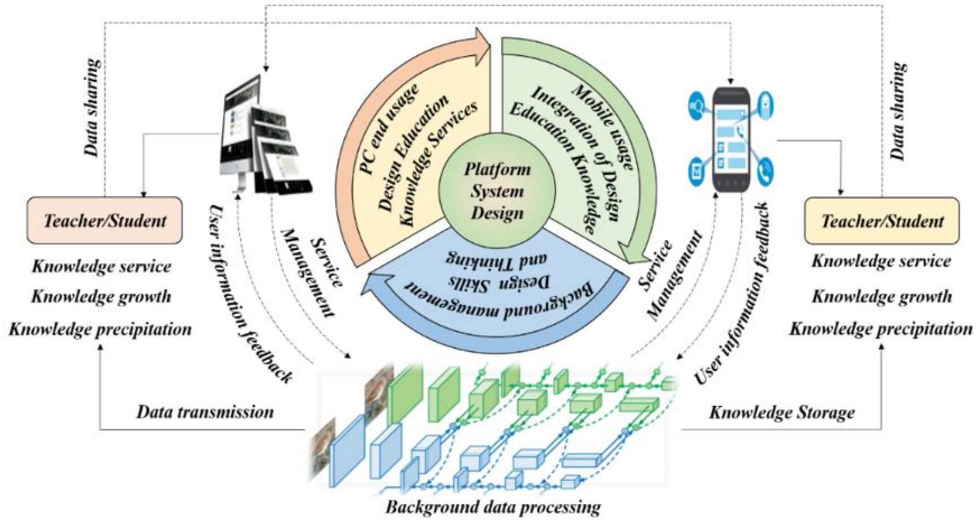

Fig. 3.2: Framework Construction of Online Design Education Knowledge Service Platform System

utilized. Given a sample set described by n attributes, namely n-dimensional eigenvectors $x\leq(x_1,x_2,...,x_n)$, and using n-dimensional eigenvectors $w\leq(w_1,w_2,...,w_n)$ to represent the weights corresponding to each attribute, the linear model of the sample set can be expressed in the form of a quantization matrix as formula (3.11):

$$f(\overrightarrow{w},x,b)=\overrightarrow{w}^T\overrightarrow{x}+b \tag{3.11}$$

In the formula, $f\in R$, the value range is the entire real number field, and b is the non-zero intercept. After learning $\overrightarrow{w}$ and b, the model can be determined. Due to the intuitive expression of the importance of each attribute in prediction by $\overrightarrow{w}$, this linear model has good interpretability.

In order to use the linear model above to handle the binary classification problem, it is necessary to use the function shown in formula (3.11) to map $f\in R$ to (0,1), and obtain formula (3.12):

$$y(z)=\frac{1}{1+e^{-z}} \tag{3.12}$$

If $y(z)$ is considered as the possibility of the sample being a positive example, then (1-y) is the possibility of its negative example. If y is considered as the class posterior probability $P(y=1\,|x)$ and combined with formula (3.12), formula (3.13) can be obtained:

$$\ln\frac{p(y=1\,|x)}{p(y=0\,|x)}=\overrightarrow{w}\overrightarrow{x}+b \tag{3.13}$$

Due to $p(y=1\,|x)+p(y=0\,|x)=1$, further formula (3.14) can be obtained:

$$\begin{cases} p(y=1\,|x)=\frac{e^{\overrightarrow{w}^T\overrightarrow{x}+b}}{1+e^{\overrightarrow{w}^T\overrightarrow{x}+b}} \\ p(y=0\,|x)=\frac{1}{1+e^{\overrightarrow{w}^T\overrightarrow{x}+b}} \end{cases} \tag{3.14}$$

When using the feature vectors $\overrightarrow{X}=(\overrightarrow{x^1},\overrightarrow{x^2},...,\overrightarrow{x^m})$ of a set of m training samples and their corresponding classification target variable $\overrightarrow{Y}=(\overrightarrow{y^1},\overrightarrow{y^2},...,\overrightarrow{y^m})$, we hope that the regression algorithm can achieve the maximum probability $L(\overrightarrow{w,b})$ on this set of training samples. At this point, the maximum likelihood method can be used to estimate the values of $\overrightarrow{w}$ and b, as described in formula (3.15):

$$\underset{\overrightarrow{w},b}{\arg\max}L(\overrightarrow{w},b)=\underset{\overrightarrow{w},b}{\arg\max}\prod_{i=1}^{m}p(y^i\left|\overrightarrow{x^i}\right.,\overrightarrow{w},b) \tag{3.15}$$

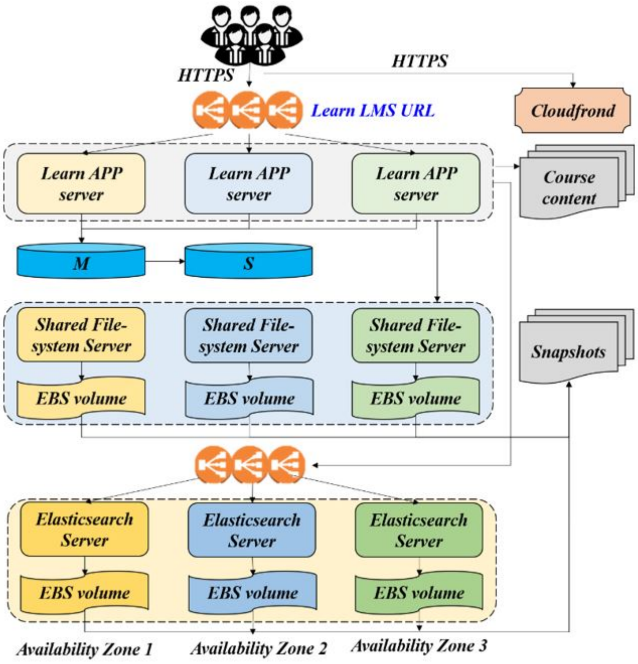

Fig. 3.3: SaaS Deployment Diagram of Learn System

It is not difficult to see from the above analysis that the regression analysis is used to study the relationship between a categorical dependent variable and a set of independent variables, namely characteristic variables. The binary evaluation results of the service credibility, including CSP reputation, of the SaaS online education management system based on the extended LMS system are truly applicable, as the dependent variables only have two values: 1 and 0 [31].

The deployment of SaaS systems is distributed across multiple AWS availability zones, and the overall architecture of the system is designed to withstand failures in one to two availability zones, and can run in any service interruption situation. Figure 3.3 summarizes the distribution of the logical components of this system in the availability zones of AWS, and the system is deployed using three or more availability zones.

3.3. Database Table Design. The system has designed multiple database tables based on functional requirements. This section mainly introduces the tables related to core functions based on the E-R diagram.

1. User Information Table
   The user information table records the information of registered users, including fields such as user ID, phone number, nickname, avatar, gender, age, etc. The user information table is shown in Table 3.1.
2. Teacher Information Form
   The teacher table records the information of the certified teacher, including teacher ID, avatar, mobile phone number, ID card number, hand-held ID card photo and other fields. Among them, is user user_id, institution organization_id is foreign key, and teacher information
3. Institutional Information Table
   The institution information table records the information of the institution, including the institution ID, institution name, organization type, institution contact phone number, institution introduction, and other fields, mainly displaying some important fields.
4. Course Information Table
   The course information table records the information of the course, including course ID, associated teacher, course name, cover background, limited number of trial sessions, limited number of registrations, and other fields. It mainly displays some important fields.

Table 3.1: User Information Table

Field Name	Type	Field Constraint	Annotation
ID	bigint(20)	NOT NULL	Unique ID identification (primary key)
phone	varchar(12)	NOT NULL	Mobile phone number
nickname	varchar(128)	DEFAULT NULL	nickname
avatar	varchar(255)	DEFAULT NULL	Avatar
gender	tinyint(4)	DEFAULT NULL	Gender
age	int(11)	DEFAULT NULL	Age
birth	date	DEFAULT NULL	birthday
is_auth	tinyint(4)	NOT NULL	Is it certified
auth_type	tinyint(4)	DEFAULT NULL	Certification type
auth_time	datetime	DEFAULT NULL	Certification time
is_enabled	tinyint(4)	NOT NULL	Is it enabled
is_deleted	tinyint(4)	NOT NULL	Do you want to delete it

Table 4.1: Correlation Analysis Between Attribute Changes and Model Evaluation Scores

Attribute	Attribute Description	Correlation
Response Time(RT)	Time it takes to send a request and receive a response	Negative correlation
Availability (Ava)	Successful calls/total calls	Positive correlation
Throughput (TP)	Total number of calls (or times) within a given period of time	Positive correlation
Success ability (Suc)	Number of response messages/number of request messages	Positive correlation
Compliance(Com)	Degree to which a WSDL document complies with the WSDL spec	Positive correlation
Latency (Lat)	Time the server takes to process a given request	Negative correlation
Reliability (Rel)	Ratio of error messages to total messages	Positive correlation
Best Practices (BP)	Degree to which web services comply with WS-I basic configuration files	Positive correlation
Documentation(Doc)	Proportion of document detection in WSDLs	Positive correlation

5. Course Registration Form
   The course registration form records the student ID and course ID when students register for course selection.
6. Course User Check in Record Form
   The course user check-in record table records the information of course user check-in records, where course check-in course_sign_in_id and user user_id are foreign keys.

4. Analysis of system credibility evaluation results. In the SaaS online education management system model based on the extended LMS system, research was conducted on the credibility evaluation score of the selected parameter attribute changes in the SaaS model. In order to further analyse the correlation between different attributes and the credibility scores of SaaS online education management system services in expanding the LMS system, as shown in Figure 4.1, four attributes, namely Availability, Reliability, Response Time, and Latency, were selected as examples to perform a regression analysis relationship between the attributes and the credibility evaluation scores of the system services. As shown in the figure, both Availability and Reliability show a positive correlation with the system service credibility evaluation score; The Response Time and Latency attributes show a negative correlation with the credibility score of SaaS system services.

This article summarizes and analyses the attributes related to the credibility evaluation of SaaS online education management system, as shown in Table 1. The correlation analysis between different attributes and the credibility evaluation score of SaaS online education management system is provided.

Due to the absence of missing values in the dataset, no corresponding processing is required. Based on the previous classification processing, the dataset is divided into a test set and a training set by 3:7. The comparison between the boxplot of the 7 datasets before partitioning and the boxplot of the training dataset after partitioning is shown in Figure 4.2. It can be seen that there are some obvious outliers in the RT and Lat attributes. In addition, it can also be seen that Ava, TP, and RelBP also have a few outliers. Considering that the WOE transformation used later can eliminate outliers to a certain extent, it will not be dealt with here.

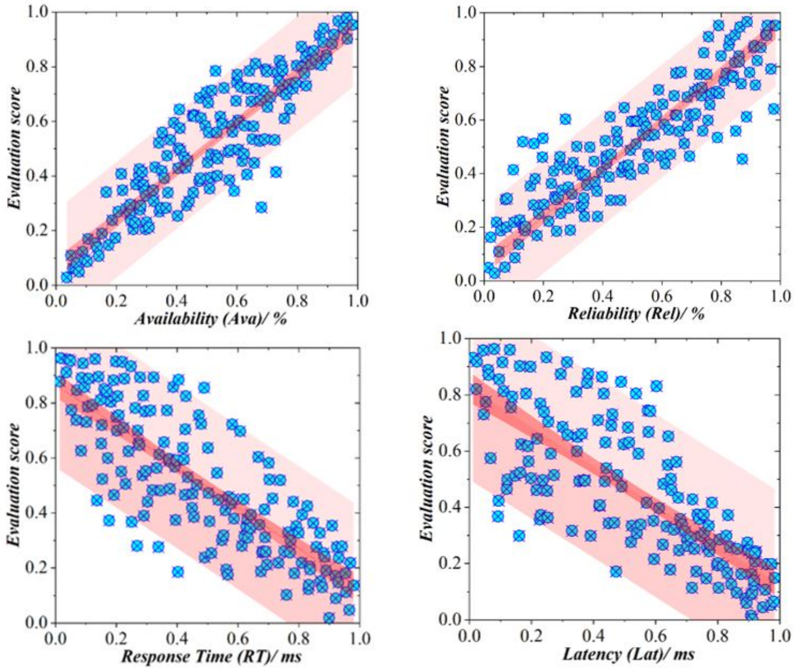

Fig. 4.1: Correlation Analysis Between Various Attributes and Evaluation Scores in SaaS Online Education Management System

In addition, in order to further compare the distribution of provinces in different geographical regions more intuitively, as shown in Figure 4.1, the distribution and division of provinces in each region are presented. From the figure, the determination of provinces involved in analysing the environmental performance and measurement of smart city power supply is a comprehensive consideration of their geographical location and economic development.

In fact, based on the above analysis results, it can be seen that the distribution of attributes *RT* and *Lat* is very close. Similarly, from Figure 4.3, it can be seen that the distribution of *Suc* and *Rel* is the closest. In addition, after dividing the dataset into test and training sets in a 3:7 ratio, the number of samples in the training set is 282, and the number of samples in the test set is 120. From the comparison of the box plot, it can be seen that the distribution pattern of the divided training set and the sample population before the partition is consistent, indicating that the partition of the dataset has a certain representativeness. For the convenience of the experiment, this section is mainly based on the training set data for analysis.

Based on the correlation analysis results of different attributes, four feature attributes were selected to generate histograms, as shown in Figure 4.3. From the figure, it can be seen that there are certain differences in the distribution of different attributes, which basically exhibit a normal distribution or F-distribution. For the attributes *Best Practices* and *Reliability*, their distribution is closer to a normal distribution.

5. Conclusions . Internet technology has laid the foundation for the development of online education management systems. Based on the characteristics of LMS systems, this article proposes a Software as a Service online education management system that extends LMS systems. It analyses and studies the self-service mode, discusses the credibility evaluation score of the system, and further studies the correlation between different attributes and credibility evaluation scores, as well as the comparison of attribute distribution histograms. The main conclusions are as follows:

1. Based on the basic characteristics of the LMS system, the Software as a Service online education management system, which expands the LMS system, can achieve more comprehensive functional

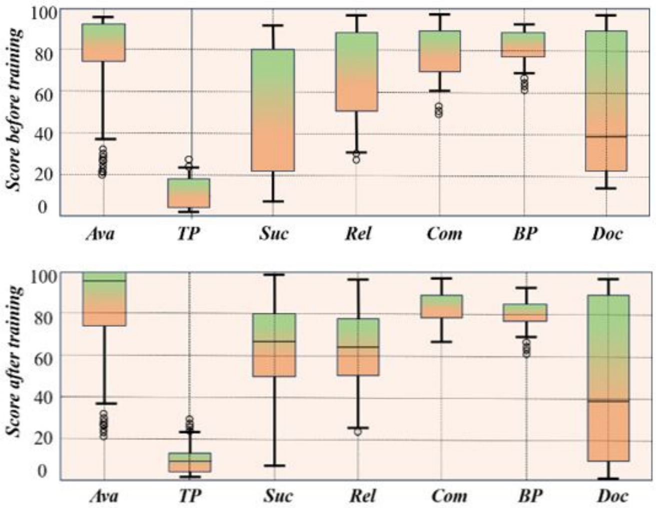

Fig. 4.2: Statistical Description of Regional Efficiency Scores at Different Stages

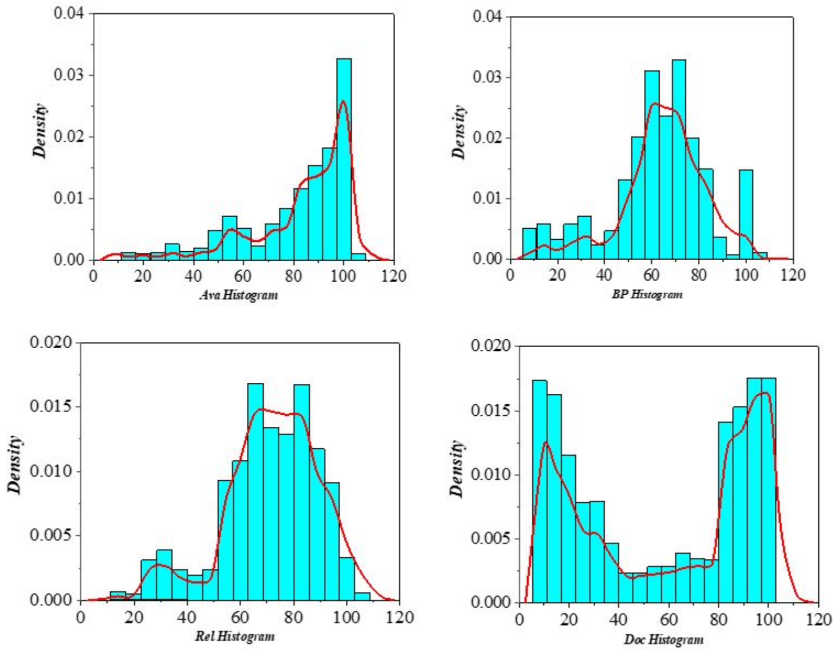

Fig. 4.3: Histogram Comparison of Four Feature Attributes in Training Set

service modules, further improve the service mode of the online education management system, and achieve innate defence functions with lower operation and maintenance costs, higher stability, and virus threat. This lays the foundation for the development of the online education management system and the comprehensive improvement of application performance.

2. In the Software as a Service online education management system constructed in this article, there are certain differences in the impact of different attribute parameters on the credibility evaluation

score of the system. Among the 7 analysed attributes, Response Time and Latency show a negative correlation with credibility evaluation, while other attributes show a positive correlation; Histograms with different attributes mostly exhibit features of normal distribution and F-distribution; The proposed credibility evaluation method can also be applied to other types of online education management systems, providing more research methods for evaluation and analysis of different systems.

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