Research on the Development Technology of B-Learning System Based on Web3.0

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Abstract:
With the continuous promotion of educational informatization, blended learning, which combines the advantages of traditional teaching and learning methods with the advantages of online learning, has become the core issue of education reform in the era of Web3.0. Based on the theory of constructivism and humanism, guided by the basic idea of B-learning, this paper constructs a blended learning support service system from five dimensions of subject-object support, community support, resource support, collaborative support and evaluation support according to the thought and technology of Web3.0. At the same time, according to the technical architecture, it analyzes the development technology for realizing B-Learning3.0 system, including PHP application development technology, Web database technology, x API monitoring technology, personalized recommendation technology, and Web3.0 technology, etc. and completes the basic work from system construction to technology implementation. In addition, we conducted two case studies: (1) Based on the Gradient Boosting Decision Tree (GBDT) model and two different educational data sets, the teaching quality is evaluated with the accuracy of 0.891 and 0.879 respectively. The experimental results show that our proposed model outperforms all the benchmark models; (2) To recommend a more accurate courses to students, a course recommendation algorithm is designed based on collaborative filtering, and achieved more than 80% accuracy.

Keywords: *Web3.0, B-learning, Educational technology, Collaborative filtering, Gradient Boosting Decision Tree*

1 INTRODUCTION

The Internet is a major revolution of human communication technology. In the information age, the traditional learning concepts and learning methods have undergone fundamental changes. With the iterative innovation of various information technologies, the emergence of Internet of things, machine learning, virtual reality technology, artificial intelligence, 5th generation mobile communication technology, blockchain and especially Web3.0 provide learners with newer and more means of acquiring knowledge. Future learning will highlight the morphological characteristics of individuation and adaptation. Zhou Zhiyue et al. developed an adaptive learning system based on negotiation, which can help learners adjust their help-seeking behavior [2]. Congressional research service in the United States proposes to build artificial intelligence enabled education to promote the realization of learners' personalized learning through artificial intelligence teaching applications such as adaptive testing, automated tasks and intelligent tutor system [3]. More and more people are no longer limited to the traditional Internet teaching mode, but adopt the way of human-machine collaboration to carry out modern learning.

2 OVERVIEW OF B-LEARNING LEARNING SYSTEM BASED ON WEB3.0

2.1 Web3.0

From the Web1.0 era of network interconnection based on a large number of static Web page information, to the Web2.0 era based on the emphasis on real-time communication between users, it is a revolution from core content to external applications again and again. The word Web3.0 contains multiple meanings. It is based on standard technologies such as Web Ontology Language, Resource Description Frame-work, Simple Protocol and RDF Query Language, represented by Semantic Web and Cloud Computing, and continues to develop on the basis of Web2.0 Technology.

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2.2 B-learning

In 1999, Jay Cross of the United States first applied E-learning to the two fields of enterprises and schools. With the rapid development of mobile Internet, m-learning, which obtains educational resources by means of wireless mobile communication devices and personal digital assistants, came into being. In spite of the fact that the portability, wireless and mobility of mobile learning devices enable learners to study in different purposes and different ways at any time without being confined to space, and due to the strong intelligent interaction and sharing of learning resources, it meets the individual learning needs of members. However, this highly fragmented learning state is vulnerable to interference due to the distraction of learners' attention and the limitations of mobile devices. Therefore, with the further development of educational technology theory and the re-examination of "constructivism" and "humanism", B-learning, which combines the advantages of traditional teaching and learning methods with the advantages of E-learning, has developed rapidly.

3 CONNOTATION ANALYSIS AND SYSTEM CONSTRUCTION OF B-LEARNING3.0 LEARNING SYSTEM

3.1 Further development of the con-notation of blended learning

Since 2020, affected by the COVID-19, about 1.5 billion students in 180 countries around the world need online learning. As the country with the largest number of MOOCs and students in the world, China still maintains a rapid growth trend. Although online education has the characteristics of rapidity, timeliness and repeatability, the problems encountered by learners in the learning process, such as resource dispersion, data incompatibility and non-standard management are promoting the further development of the research field of blended learning.

3.2 Architecture construction of learning support service in blended learning

The design of learning support services based on B-Learning is to provide learners with various learning support services combining online and offline around learning activities. Learning support service system based on B-learning3.0 is introduced in Figure 1.

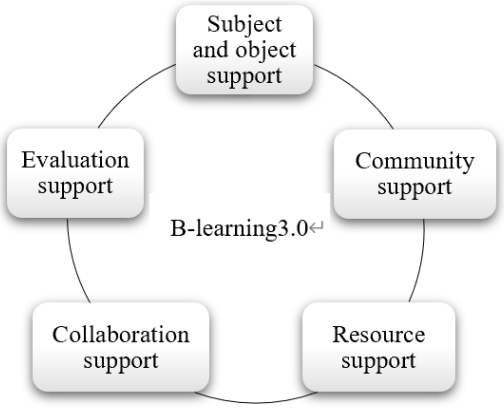

Figure 1: Learning support service system based on B-learning3.0.

3.2.1 Subject and object support

In blended learning activities, learners who participate in learning activities are subject. Learners in the blended learning environment have relatively flexible time and space, which requires learners to have strong self-regulation ability, as well as a strong sense of intrinsic motivation and self-efficacy [6]. In addition, due to the difference in personal information literacy and learning experience, learners' learning engagement will also vary. As the object of blended learning, the difficulty and relevance of learning content should conform to the existing cognitive rules of students. Studies have shown that when learning tasks are closely related to learning situations, learners will devote more time and effort into learning activities [5].

3.2.2 Community support

Learning community emphasizes the integration of element structure. Regarding as the traditional classroom environment, in order to complete the construction of knowledge, to communicate, cooperate or carry out a certain learning activity among team members with the same learning objectives. The traditional classroom environment is dominated by learners, while the blended learning activity should establish a learning community with multiple backgrounds and knowledge levels composed of teachers, assistants, administrators and social personnel. Many international open universities pay attention to personnel support services. For example, Acklinton Rosendale University in the United Kingdom provides personalized support services for each student, and answering questions within five working days [1].

3.2.3 Collaborative support

The traditional classroom communication between teachers and students is limited by time, with few opportunities and low participation. The learning system based on B-Learning3.0 needs the support of

collaborative learning activities. Through online and offline, real-time and non-real-time communication and collaboration, or group discussions based on the principle of heterogeneity in the same group, students can complement each other's advantages and develop critical thinking in the process of collaboration. Sharing materials through network communication tools such as social software or virtual communities can provide support for collaborative work of learners.

3.2.4 Evaluation support

The teaching evaluation of the blended learning model should firstly focus on the combination of process evaluation and result evaluation. Based on the big data analysis of learners' enthusiasm for independent exploration and collaborative learning, guide and encourage in time to provide more accurate personalized support services. Secondly, we should pay attention to the combination of self-evaluation and others' evaluation. The evaluation subjects should include teachers, peers, managers, social personnel and learners themselves, so as to realize the diversification of evaluation subjects and improve learners' metacognition and reflection ability. Finally, we should pay attention to the combination of scientific and comprehensive evaluation indicators. In addition to evaluating teaching content and teaching media, we should also evaluate learning support service platform and online learning resource platform. Figure 2 shows the research relationship on the keyword "education quality assessment", Each node is an academic paper related to the origin paper. Papers are arranged according to their similarity (this is not a citation tree). Node size is the number of citations. Node color is the publishing year. Similar papers have strong connecting lines and cluster together

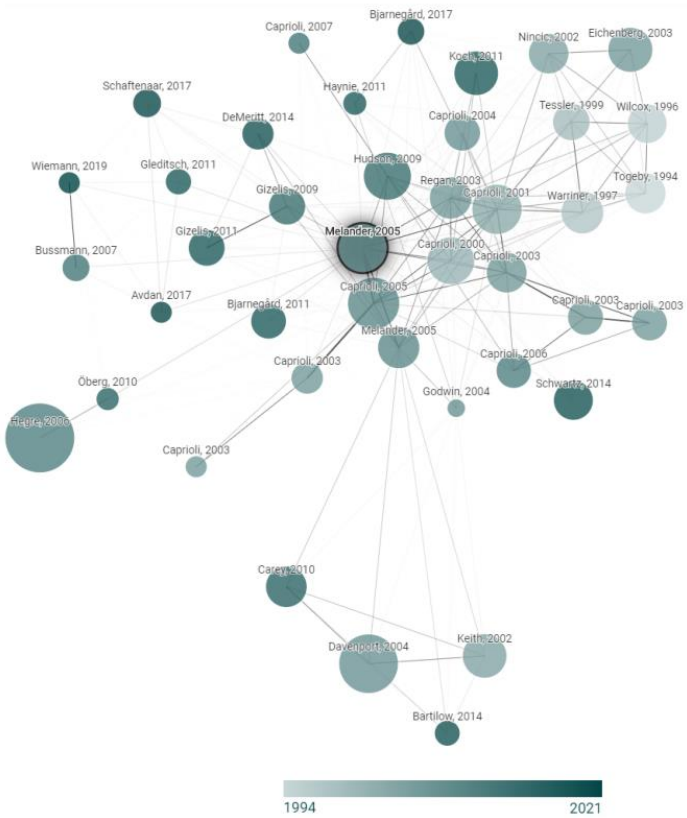

Figure 2: Research relationship.

In this paper, we use GBDT algorithm to evaluate the quality of education as a sample, figure 3 introduces the algorithm flow of GBDT.

Require:
Training set: $\{(x_i, y_i)\}_{i=1}^{n}$; number of iterations: m
Loss function: $L(y, F(x))$; learning rate: v
Ensure: The predict model: $F(x)$
1. $F_0(x) = 0$;
2. for $t = 1 \rightarrow m$ **do**
3. $y_i' = -[\frac{\partial L(y_i, F(x_i))}{\partial F(x_i)}] F(x) = F_{t-1}(x), \quad i = 1, 2, \ldots, n$;
4. Train a new tree $h_t(x)$ according to $\{(x_i, y_i')\}_{i=1}^{n}$
5. $\rho_t = \arg \min_{\rho} \sum_{i=1}^{n} L(y_i, F_{t-1}(x) + \rho * h_t(x))$;
6. $F_t(x) = F_{t-1}(x) + v^* \rho_t{}^* h_t(x)$;
7. **end for**
8. **return** $F_m(x)$;

Figure 3: Algorithm flow of the GBDT model.

Table 1 shows the classical model including the k-Nearest Neighbor, Decision Tree, CART, Artificial neural network, Naive Bayes, Support Vector Machine, Logistic, and Random Forest, and the advantage and disadvantage are also listed.

Table 1 Introduction of the benchmark models.

Method	Advantage	Disadvantage
KNN	Learning cost is 0; No parameter	Algorithm performance depends on data dimension
DT	Very flexible; Easy to understand	Prone to bias and over-adaptation
CT	Flexible and easy to understand; No parameter	Excessive adapt
ANN	Efficient	Easy to over-fit
NB	The probability of predicting the category can be obtained	Assume that all the characteristic conditions are independent
SVM	Not easy to over-adapt	Difficulty in kernel selection
Logistic	Can know the logical probability of the model	Cannot handle Multiple col-linear problems
RF	Not easy to over-fit	Erratic results

Compared with these model, Gradient Boosting Decision Tree (GBDT) based on regression tree, GBDT has high prediction accuracy, it can deal with nonlinear data, and it can flexibly deal with various types of data, including continuous and discrete values [4]. Regression tree generation algorithm can be expressed as follows:

Input: Training data set D:

Output: regression tree $f(x)$.

In the input space where the training data set is located, each region is recursively divided into two sub-regions and the output value on each sub-region is determined to build a binary decision tree:

(1) Select the optimal segmentation variable j and the segmentation point s, and solve:

$$\min_{j,s}[\min_{c_1} \sum_{x_i \in R_1(j,s)} (y_i - c_1)^2 + \min_{c_2} \sum_{x_i \in R_2(j,s)} (y_i - c_2)^2] \quad (1)$$

The variable j is traversed, the fixed segmentation variable j is scanned at the segmentation point (j,s), and the pair A that minimizes the above formula is selected

(2) Divide regions with selected pair A and determine corresponding output values:

$$R_1(j,s) = x \mid x^{(j)} \le s, R_2(j,s) = x \mid x^{(j)} > s \quad (2)$$

$$c_m^{\wedge} = \frac{1}{N} \sum_{x_1 \in R_m(j,s)} y_i, x \in R_m, m = 1,2 \quad (3)$$

(3) Continue to call steps (1) and (2) on the two sub-regions until the stop condition is met.

(4) Divide the input space into M regions $R_1, R_2, \ldots R_M$. Generate decision tree:

$$f(x) = \sum_{m=1}^{M} \hat{c}_m I(x \in R_m) \quad (4)$$

We use two public data sets to evaluate the teaching quality. Table 2 shows the experimental results. We can find that the prediction accuracy of our proposed model (GBDT) outperformed than the all benchmark models.

Table 2 Experimental results of the benchmark models.

Method	Acc (Foreign language class)	Acc (Math class)
KNN	0.834	0.812
DT	0.823	0.801
CT	0.841	0.825
ANN	0.887	0.867
NB	0.867	0.846
SVM	0.832	0.814
Logistic	0.817	0.804

RF	0.882	0.864
GBDT (proposed)	**0.891**	**0.879**

4 ANALYSIS ON THE IMPLEMENTATION TECHNOLOGY OF B-LEARNING3.0 LEARNING SYSTEM

4.1 Web Technology

4.1.1 Hypertext Preprocessor Technology

PHP is a widely used open source multi-purpose scripting language, which can be embedded in HTML, especially suitable for web program development. Famous PHP programs include Mambo, phpBB, MediaWiki, etc. PHP can run on various operating systems such as Unix, Linux and Windows. It supports common web servers such as Apache, IIs, Netscape or iPlanet. Because of its cross-platform characteristics, portability and expansibility, high efficiency and wide application range, the development of web applications with PHP provides a convenient and quick technical basis for the development and popularization of B-Learning3.0.

4.1.2 Web Database Technology

Web database technology refers to a database technology that is based on Web mode and takes B/S mode as the structure, integrates the client into a unified Web browser, and provides Internet users with easy-to-use and content-rich services. Common database management systems include SQL Server, MySQL, Oracle, DB2, Sybase, etc. As a real multi-threaded and multi-user database management system, MySQL is the most widely used in PHP Web development. This simple and easy way of manipulating the database further guarantees the realization of the B-learning3.0 learning system.

4.1.3 Experience Application Programming Interface Monitoring Technology

X API is a new learning technology specification. It is a set of standard tools and rules for automatically recording student activities by collecting and analyzing individual learning behavior data and customizing teaching content and learning methods. Yee King MJ uses the x API data standard to collect informal learning behavior records of members and analyze their learning behavior, aiming to improve the learning effect of learners [8].

In B-learning3.0, the learning experience of learners on the web platform are recorded by x API. The application sends the statement to the Learning Record Store (LRS) in the form of "noun+verb+object", and the LRS authorizes the Learning Record Consumer (LRC) to view and use the learning records, as shown in Figure 4. LRS can share these statements with other LRS, or exist alone or in the learning management system [7].

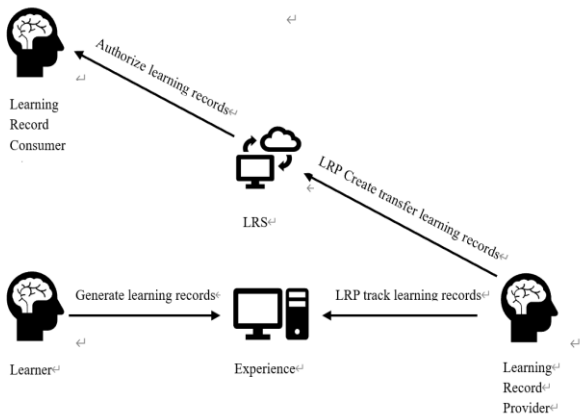

Figure 4: Tracking process of learners' online learning experience based on x API.

4.1.4 Personalized Recommendation Technology

Personalized recommendation technology is a product of the development of e-commerce and the Internet. In the era of big data, personalized recommendation technology can also be applied to the field of education. According to Berners Lee, the father of the web, the semantic web is divided into seven hierarchies, as shown in Figure 5. URI and Unicode are used as the base layer to identify resources. Languages such as XML, NS, and XML Schema are used as information markers to represent the content and structure of data. RDF+RDF Schema and ontology layer, as data interoperability layer, provide explicit formal language to truly achieve the purpose of human-computer interaction. Logic layer, proof layer and trust layer locate, coordinate, analyze, verify and establish trust relationship for user information. According to different algorithms, the commonly used recommendation technologies include: recommendation technology based on user's product bipartite graph network structure, content filtering technology based on text correlation, and collaborative filtering technology.

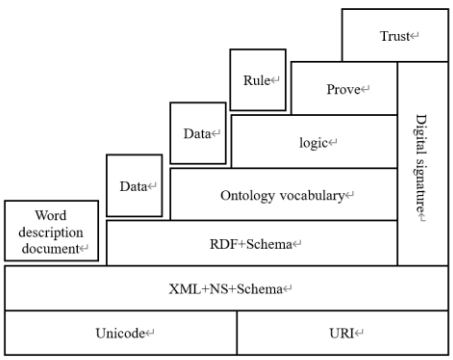

Figure 5: Hierarchy of semantic web.

This article will introduce an example based collaborative filtering recommendation algorithm as follows: In order to recommend a more accurate courses to students, this system to establish the evaluation matrix, the evaluation matrix can influence on the students in the course selection process by element analysis, such as students' professional level, degree of learning, interests, and course notes, through the analysis of the information and to establish a corresponding to the students, comparing it with the items in the evaluation matrix to find out the course selection record with the highest similarity, so as to complete the course recommendation for students. The design of college course selection and recommendation system mainly includes three steps:

Step 1. Establishing evaluation Matrix

The evaluation matrix collects historical course selection data of students through major selection, interests and hobbies, learning level and course selection records. If it needs to be extracted from the educational administration system, attention should be paid to the corresponding processing of the data, so that the data can meet the structure of the evaluation matrix of students' course selection, which is shown in Table 3.

Table 3 Student course selection evaluation matrix of collaborative filtering algorithm.

	Item1	...	Item n
Student A	3	...	1
...	...	R_{ij}	...
Student N	2	...	5

Step 2. Search for nearest neighbors

This step compares the similarity between the students in the evaluation matrix and the target students, finds out the group of students with the highest similarity, and establishes the nearest neighbor set. The similarity algorithm is shown in the following formula: Common similarity measurement methods include Pearson correlation coefficient formula (5) and cosine correlation formula (6). Pearson correlation coefficient is used in this paper.

$$\sin(a,i)=\frac{y\in\sum_{R_a\cap R_i}(R_{a,y}-\overline{R}_a)(R_{i,y}-\overline{R}_a)}{\sqrt{\sigma_a\sigma_i}} \quad (5)$$

$$\sin(a,i)=\cos(a,i)=\frac{\overline{a}\times\overline{i}}{\|\overline{a}\|\ \|\overline{i}\|} \quad (6)$$

Where, $R_{a,y}$ and $R_{i,y}$ respectively represent student a and student i evaluation of the course y; $\overline{R}_a$, $\overline{R}_i$ respectively represent the evaluation mean values of student a and i, and in the formula y are student a and i jointly evaluated courses. In cosine similarity calculation of Equation (6), the score set of student a and i sum is regarded as a vector.

Step 3. Generate recommendations.

At this stage, the target students are recommended according to the evaluation value of the most recent neighbor set. The general prediction formula for students' scoring is as follows:

$$P_{a,y}=\frac{\sum_{u,y\in v_u}w(a,u)v_{u,y}}{\sum_{u,y\in v_u}|w(a,u)|} \quad (7)$$

Table 4 Comparative analysis of different algorithms.

Algorithm	Acc	Recall rate
Pearson correlation coefficient	81.52%	76.51%
Cosine correlation	82.45%	79.61%

Table 4 shows the comparative analysis of different algorithms, and the subject of this experiment consists of 50 students' evaluation of 5 courses.

5 CONCLUSIONS

Blended learning will become a major trend of e-learning in the future. Personalized teaching will be carried out through teachers or technical support, and more student-centered learning activities will be carried out. It truly realizes the explicitation of invisible knowledge, the systematization of explicit knowledge, the digitization of systematic knowledge and the internalization of digital knowledge. Based on the theory of constructivism, guided by the basic idea of B-Learning, supported by web technology and artificial intelligence technology, this paper constructs the system of B-Learning3.0 learning system support services according to the ideology and technology of Web3.0. At the same time, according to the technical architecture, this paper analyzes the development technology of B-learning3.0 system, hoping to provide some help to the users who develop the network learning system based on Web3.0.

REFERENCES

[1] Bai, Q., Zhang, S.Y. (2017). Exploring “Integration of Teachinng” of Visual Culture English Course. J. Modern Distance Education. (02), 83-88.

[2] Chou, C.Y., Lai, K.R., Chao, P.Y., Tseng, S.F., &Liao, T.Y. (2018). A negotiation-based adaptive learning system for regulating help-seeking

behaviors. J. Computers& Education.126(7), 115-128.

[3] CRS. (2018). Artificial Intelligence (AI) and Education. https://fas.org/sgp/crs/misc/IF 10937.pdf.

[4] Deng S, Wang C, Wang M, et al. A gradient boosting decision tree approach for insider trading identification: An empirical model evaluation of China stock market [J]. Applied Soft Computing, 2019, 83:105652.

[5] Henrie, C.R., Bodily, R., Manwaring, K.C.et al. (2015). Exploring intensive longitudinal measures of student engagement in blended learning. J. International Review of Research in Open and Distributed Learning.16(3),131-155.

[6] Wei, Y., Wang, J., Yang, H.et al.(2019). An Investigation of Academic Self-Efficacy, Intrinsic Motivation and Connected Classroom Climate on College Students' Engagement in Blended Learning.C.2019 International Symposium on Educational Technology (ISET). IEEE.160-164.

[7] X API.(2022).https://xapi.com/overview/.

[8] YEE, K.M.J., RIERSON, M.et al. (2017). Evidencing the value of inquiry based: constructionist learning for student coders. J. International Journal of Engineering Pedagogy.7(3), 109-129.