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Personalized learning model based on machine learning algorithms

Zhang Jin[1,2], Amirrudin Kamsin[3]
[1]Faculty of Information Technology, City University, Petaling Jaya, Malaysia
[2]School of Computer Information Engineering, Nanchang Institute of Technology, Nanchang, China
[3]Faculty of Computer Science and Information Technology, Universiti Malaya, Kuala Lumpur, Malaysia

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ABSTRACT

Machine learning algorithms have been widely applied in the field of personalized learning within educational information technology. By leveraging big data analysis and data mining techniques, machine learning can help identify patterns and trends in students' learning behaviors, preferences, and performance. This information can then be used to tailor educational resources and experiences to meet the individual needs and unique characteristics of each learner. Machine learning has made great progress and achievements in the teaching process of universities, but there are also some shortcomings. Such as data dependence, over-fitting and under-fitting, explanatory problems, need a lot of computing resources, data bias, sensitive to outliers, cannot solve all problems, and the challenge of data privacy, through the analysis of machine learning algorithm model, efforts to find ways to expand the dimension of personalized learning classroom, meet the students in learning objectives, learning content, learning methods of the special characteristics and unique needs, to guide students to actively explore and research, obtain innovation and appropriate learning results.

Corresponding Author:

Amirrudin Kamsin
Faculty of Computer Science and Information Technology, Univeristiti Malaya
50603 Kuala Lumpur, Malaysia
Email: amir@um.edu.my

1. INTRODUCTION

Probability theory, statistics, approximation theory, convex analysis, algorithm complexity theory, and other fields are all integral to the field of machine learning (ML). According to Tian [1], experts in the study of how machines can learn new information and abilities, as well as how to improve upon their current levels of efficiency and effectiveness by modelling human learning processes. It is the primary means by which intelligent machines can be created and thus the initial subset and core of artificial intelligence (AI). Many areas of AI can benefit from it, especially those that rely on induction and synthesis rather than deduction. At present, ML is mainly applied in fields such as data mining, network information services, robots and games, problem solving, image recognition, expert systems, and cognitive simulation [2]. As shown in Figure 1 [3], the ML algorithms can be classified into 6 categories: regression, classifcation, time series, clustering, association and oulier detection. In general, the fundamental of ML process is based on feedback iteration as illlustrated in Figure 2 [4], the process can be broken down into several steps: collection of data, clearning of data, selection and feature extraction, model evalation and deployment.

Personalized learning is the process of discovering and solving learning problems for specific children through comprehensive evaluation, tailoring learning strategies and methods that are different from

others, and enabling children to learn effectively [5]. Every child is unique, with their own unique talents, preferences, and innate strengths, as well as weaknesses that are different from others [6]. To solve children's learning problems, personalized methods should be used to adapt to learning requirements.

In today's rapidly evolving information, personalized learning has become an inevitable path for people to acquire new knowledge. The personalized needs first come from the needs of society, and has potential to convert the focus of education from teacher-centered to learner-centered environments [7]. In fact, global education systems are trending towards student-centered and more personalized education structure [8]. The rapid development of a modern and diversified society urgently requires the support of talents [9]. Only those with individuality, vitality, and creativity can keep up with and meet the rapid progress of society. Secondly, it is also the need for personal development and progress. Individual differentiation is reflected in different learning goals, pursuits in different regions, knowledge reserves, strengths, and hobbies. Therefore, individuals choose suitable learning methods, stimulate learning enthusiasm, and improve learning pertinence, resulting in significant learning outcomes and better integration of development needs. As shown in Figure 3, the diagram representes the elements of personalized learning, where the student-centered learning model is supported by personalized analysis, multiple evaluation, personalized guidance, multiple cognitive, and personalized teacher guidance, highlighting a customized educational approach.

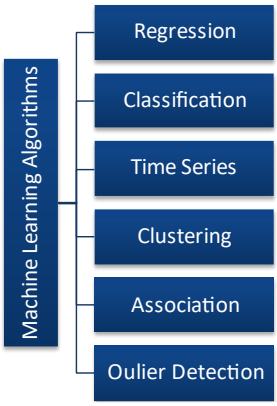

Figure 1. Machine learning algorithm classification [3]

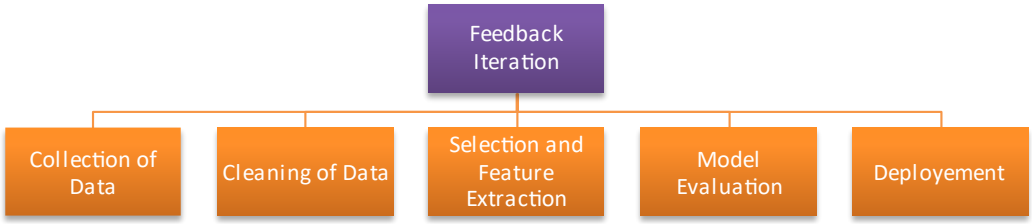

Figure 2. Machine learning process [4]

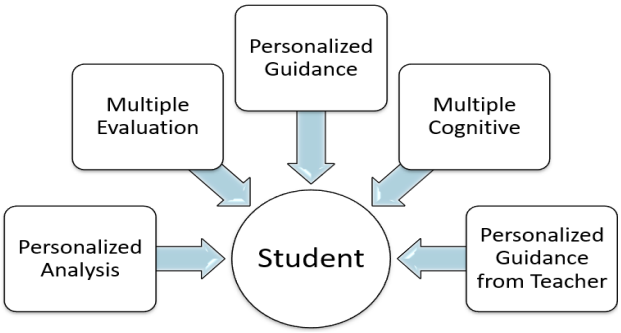

Figure 3. Elements of personalized learning

2. THE DRIVING EFFECT OF MACHINE LEARNING ALGORITHMS ON PERSONALIZED LEARNING

2.1. Personalized learning and analysis

Learners based on their own personalized needs and learning situation, in the process of obtaining learning resources by using various big data search engines or platforms [10]. With the help of data analysis by ML algorithms and algorithmic model calculation, can clearly analyze the relevant data of students' personalized learning. This includes students' personalized needs analysis, that is, by collecting students' learning history records, learning interest, subject level and other data, identify students' learning characteristics and personality needs. Personalization of teaching content: based on the personalized needs of learners, combining the educational knowledge base and cutting-edge technology, customize the most suitable teaching content and learning resources for students [11]. Through the data collection and analysis of the students' learning process, timely feedback of students' learning situation and problems, promote students' learning, growth and progress [12]. In particular, the learning rules, habits, abilities, interests and progress, under the calculation of the algorithm, analyze the massive data, eliminate the false, eliminate the rough and select the fine, find out the authoritative, reliable, applicable, with the personalized, timeliness and unique information and transform into their own knowledge [13].

2.2. Personalized learning recommendation

ML algorithms can generate learning recommendations based on learning data and students' personal information to meet students' learning needs and interests [14]. The personalized learning system can provide a specialized learning path and learning content for each student. Personalized learning content recommendation is the key to improve the quality of learners 'personalized learning, and establish a personalized learning content recommendation model to improve learners' personalized learning satisfaction. Through the analysis of learners 'personalized labels, the monitoring index system of learners' learning status is constructed to improve the efficiency and quality of learners' personalized learning. On this basis, the personalized knowledge graph generation rules are obtained with the generation framework of learners' personalized learning content, and finally the personalized learning content [15]. The proposed personalized learning algorithm based on learning state is compared with the traditional algorithm, and the results show that the personalized learning content obtained by the personalized learning algorithm based on learning state monitoring can greatly improve the satisfaction of learners with personalized learning. The personalized learning content obtained by the personalized learning algorithm based on learning state monitoring is more targeted, which has certain reference value for improving the personalized learning quality of learners [16].

2.3. Learning evaluation and feedback

ML algorithms can monitor students' progress and provide feedback from teachers and students. In addition, the ML algorithms can also adjust the learning recommendations according to the evaluation results to optimize the students' learning results [17]. Personalized learning evaluation and feedback is the compass of personalized learning, it is based on the learners learning goals to take all feasible methods, such as set aside, cross validation and self-help method bootstrapping (put back resampling) [18], to the learning process, learning results to integrity and accuracy comprehensive judgment. Through a comprehensive evaluation of personalized learning, students can learn results and expected learning goals, learning learners attitude to the learning process, learning methods, problem ability processing skills, communication skills with others as a kind of feedback, provide the system, help learners with its learning behavior, target quality consistent series of information data, from the information data, learners according to need to adjust the learning method, strategy. Similarities exist between predictive modelling and education in e-mental health, where machine learning can offer personalized interventions [19].

3. PERSONALIZED LEARNING MODE BASED ON MACHINE LEARNING ALGORITHMS

Personalized learning is a learning mode under the background of the information age, which can fully reflect the different characteristics of students and promote their personalized development. In the context of personalized learning, the previous teaching model has changed and developed to be data-oriented [20]. Based on the support of a series of technologies such as big data, data is used to track the situation related to students, such as learning ability, learning status, and conduct a comprehensive study based on various data. With the help of data analysis, the students comprehensively evaluated and found the problems; meanwhile, they implemented the personalized learning method to achieve considerable teaching results and improve the teaching efficiency. The personalized learning model is shown in Figure 4.

3.1. Build personalized data resources

To accomplish personalised learning, which involves using ML algorithms to select learning content that suits the features and styles of learners and satisfy tailored demands, a personal data resource library is a crucial first step. This includes both the structured and the unstructured forms of data. The organisation and cleanliness of structurally structured data (often quantitative data) makes it a natural target for ML techniques. IBM's structured query language (SQL) was created in 1974 as a database management system (DBMS) language. The speed with which business users may enter, search, and manipulate structured data is greatly enhanced by the usage of a relational (SQL) database [21]. Things like the date, your name, your address, your phone number, and your credit card number. Using structured data makes working with and querying ML data easier, and does not necessitate a thorough familiarity with the various forms of data and how they function. Users can gain access to and make sense of the data with only an elementary knowledge of the topics involved. Tools for using and analysing structured data are more developed and widespread than those for unstructured data. Data with established structures are useful exclusively for their intended purposes, reducing their versatility and accessibility; meanwhile, adapting to shifting data needs necessitates updating all structured data, a time- and resource-intensive process.

Then, traditional data tools and methodologies are unable to process and evaluate unstructured data, which is typically categorised as qualitative data. For this reason, a non-relational (NoSQL) database is the optimal storage medium for unstructured data. The data lake provides an alternative to traditional database storage for storing and managing unstructured data. The value of unstructured information is rising dramatically. More than 80% of all enterprise data is expected to be unstructured in the near future, and yet 95% of businesses place a high value on unstructured data management. Data from the internet of things (IoT) includes but is not limited to texts, mobile activity, social media posts, and sensor data. Because of its flexibility, more file types can be stored in the database, providing data scientists with more information from which to draw. Data collection is simplified when there is no need to acquire any predefined information. On the storage side of things, it enables huge storage and pay-per-use pricing, cutting costs and making scaling easier. However, due to its undefined/unformatted character, unstructured data preparation and analysis necessitates knowledge of data science. This is great news for data analysts, but it will likely turn off business users who aren't analysts and who aren't trained to deal with complex data. Learners can pick and choose the knowledge points they wish to acquire, or pick and choose the information they need from the many online courses, and then enhance the effectiveness of resource selection and the quality of resource selection with the help of some relevant technologies. ML algorithms provide the ideal setting for the implementation of individualised education, which has become increasingly important as new ideas like big data gain traction.

Figure 4. The personalized learning model

3.2. Analysis report of calculating personalized needs

Under the calculation of the ML algorithm, the learning resources obtained by the learners are organized and arranged according to their learning characteristics, cognition and preferences [22]. In general, it can be divided into linear type, tree type and network type, and it can also be divided into linear structure and nonlinear structure. Learners will have different learning types, knowledge status and cognitive levels, and they will also acquire different learning content. Usually, the computer learns the law from the given data, that is, seeks the law from the observed data (sample), establishes the model, and uses the learned law (model) to predict the unknown or unobservable data. Thus, the collected learning data will be analyzed to timely obtain the learning situation of learners. Organize, summarize and analyze these data, and optimize the unrelated data or unrecognizable data again, so as to obtain accurate analysis conclusions. After data screening and comparison, the data is transformed into a mode that can be operated, producing valuable and meaningful data, and forming a visual analysis report, to provide a strong reference for learners to formulate scientific and reasonable strategies. The basic ML process is shown in Figure 5. Hybrid machine learning models have demonstrated optimal performance in predicting student academic performance in personalized learning environments [23].

3.3. Evaluation of personalized learning

Personalized learning evaluation is the vane of the implementation of personalized learning, which is a comprehensive judgment of the learning process and learning results according to the learning objectives. As a kind of feedback to the system operation, evaluation can provide comprehensive monitoring data related to the quality of learners' learning behavior [24]. Based on these information data, learners can timely adjust their own learning methods and strategies. The credibility and effectiveness of evaluation are the indicators to measure the quality of personalized learning evaluation. Learning evaluation with high credibility and strong effectiveness has a good guiding and motivating function for learners, and otherwise it may convey false or wrong information to learners, resulting in learners being unable to achieve their learning goals or even deviate from the direction.

First, the personalized learning evaluation should be comprehensive and systematic. The evaluation of personalized learning is not only the evaluation of learning results, but also an important part of the evaluation. While evaluating whether the learning results reach the expected learning goals, the learners' learning attitude, the way to deal with problems, the ability to use the calculation and so on should also be evaluated. The second is to evaluate all participants in personalized learning. In the traditional learning evaluation, it often only targets the teachers, but ignores the learners themselves and their parents. Learning education is a comprehensive and comprehensive behavior. Taking comprehensive factors as the evaluation object improves the authenticity of evaluation and can evaluate the effect of learning in a deeper level.

Third, the technical means of evaluation should be diversified. Not just tests, questionnaires, so there are many interpersonal factors, the results of evaluation are often untrue [25]. Big data technology can fully combine network evaluation with entity evaluation, so that the evaluation is true, objective and has more reference value.

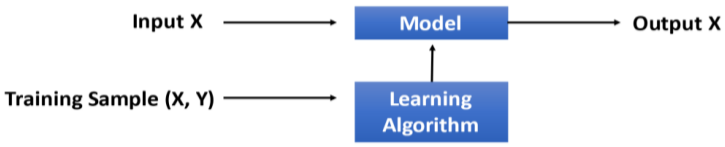

Figure 5. Basic process of machine learning

4. CONCLUSION

In the era of big data, ML algorithms will play a pivotal role in the globalisation of education. Using these algorithms to create tailored learning modes has the potential to vastly improve classroom instruction. ML algorithms, which take advantage of massive data processing and analysis, can personalise their teaching methods and materials to each student. By taking this route, teachers can provide students with individualised and dynamic lessons that improve retention and proficiency.

Data sources, such as student performance, preferences, and learning patterns, are no match for the processing power of ML algorithms. Students gain a more thorough comprehension of the content and are motivated to learn independently when instructors use this data to craft individualised learning routes, suggest relevant resources, and offer instantaneous feedback. Teaching staff can more effectively intervene on behalf of students who are having difficulty learning thanks to the use of ML. Data-driven insights can be used to enhance both course materials and classroom activities, leading to better education overall.

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BIOGRAPHIES OF AUTHORS

Zhang Jin an associate professor at Nanchang Institute of Technology. He received his master's degree in Computer Technology from Jiangxi University of Finance and Economics in 2015. He is now studying for his doctor's degree in information Technology from City University of Malaysia. Has guided students to participate in the Jiangxi college students electronic computer contest won the first prize, Jiangxi ninth college students art performance scientific research paper selection second prize, the 15th challenge cup national college students extracurricular academic science and technology works competition won Jiang Jiang undergraduate group third prize, Jiangxi college students entrepreneurship competition business plan competition, the 15th blue bridge cup national software and information technology professional talent competition national finals Python group B program design university, the 15th blue bridge cup national software and information technology professional talent competition national finals C/C ++ program design university group B third prize, he was rated as an excellent instructor. His main research interests focus on artificial intelligence, optimization algorithms, information retrieval, feature selection, combination problems, data mining, and text mining. He can reach him by email: 2003062@nut.edu.cn.

Associate Professor Dr Amirrudin Kamsin is a Senior Lecturer at the Department Computer System & Technology, Faculty of Computer Science and Information Technology, Universiti Malaya, Malaysia. He was Acting Director of Universiti Malaya Centre for Continuing Education (UMCCed) 2019 - 2022. He was also Acting Director at the Universiti Malaya Professional Development and Leadership Centre (UM-LEAD) 2022 - 2023 and Deputy Director (ODL) at UMCCed 2017 – 2022. He received his BIT (Management) in 2001 and MSc in Computer Animation in 2002 from Universiti Malaya and Bournemouth University, UK respectively. He obtained his PhD in Computer Science from University College London (UCL) in 2014. His research areas include human-computer interaction (HCI), authentication systems, e-learning, mobile applications, serious game, augmented reality and mobile health services. He can reach him by email: amir@um.edu.my.