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Research on Personalized Learning Resource Recommendation Based on Knowledge Graph Technology

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ABSTRACT

In the face of the dilemma of learners' "learning loss" and "information overload" in information resources, a personalized learning resource recommendation algorithm is proposed by conducting in-depth and extensive research on the knowledge graph. This algorithm relies on the similarity or correlation between learners' characteristics and course knowledge (learning resources) for recommendation. It analyzes learners' characteristics in depth from four aspects: data collection and processing, model construction, resource and path recommendation, and model application, and establishes a multi layered dynamic feature model for learners; Analyze the core elements of the curriculum knowledge graph, decompose the curriculum knowledge into nanoscale knowledge granularity, and construct a curriculum knowledge graph model. The experimental results indicate that this algorithm improves learners' learning efficiency and promotes their personalized development.

KEYWORDS

knowledge graph; Personalized recommendation technology; Learner characteristics; learning resource

1.INTRODUCTION

The standardized and large-scale training mode of traditional education is no longer suitable for the differentiated, diverse, and creative needs of talents in an information-based and innovative society. Individualized chemistry learning or individualized teaching is considered one of the effective ways to solve the current contradiction between supply and demand in talent cultivation, as it can recommend suitable learning resources, learning environments, and adaptive learning paths for learners based on their different personalized needs and characteristics. Providing personalized and adaptable services is one of the important tasks of China's educational informatization. Educational scholars advocate that education should support personalized and adaptive services, and propose to "strive to provide personalized and lifelong learning information environment and services for every student" [1]; The trend of global education development is to explore typical ways to achieve differentiated teaching and personalized learning under information technology conditions; Many educational scholars have proposed to integrate basic concepts such as lifelong learning, individualized teaching, and comprehensive development into educational reform, accelerate educational reform in the information age, achieve an organic combination of scale and personalized training, and comply with international educational development trends.

With the integration and development of

information technology in the education industry, it provides learners with abundant and massive learning resources. However, learners often encounter difficulties such as "learning loss" and "information overload" in the massive learning resources. How to efficiently and accurately recommend suitable learning resources and adaptive learning paths to learners has become an urgent problem to be solved in current educational informatization. Recommendation technology has been widely applied in various fields such as e-commerce, medical services, education, and movie recommendation; The recommendation system is known as the most popular information retrieval system in the era of big data, which can quickly and accurately push various required resources to users, and is highly expected to solve problems such as "learning lost" and "information overload". Therefore, this study is supported by technologies such as knowledge graph, big data, and data mining, and conducts research from aspects such as learner feature modeling, course knowledge graph model construction, and personalized learning resource recommendation. A personalized learning resource recommendation system based on knowledge graph is constructed and applied in practice, with the aim of improving learners' learning efficiency and promoting their personalized development.

2.PROBLEMS EXISTING IN THE CURRENT TEACHING DESIGN

With the rapid development of artificial intelligence, Knowledge Graph (KG) has gradually become one of the key technologies in recommendation systems and is widely applied in various research fields. In foreign countries, the concept of personalized recommendation was first proposed by Resnick [4]. Afterwards, there has been a wave of personalized recommendation technology research worldwide. The knowledge search product [5] Google Knowledge Graph, released by Google Technologies in May 2012, contributes to the semantic search quality of search engines and is an important milestone in the development of personalized recommendation technology. The personalized recommendation technology based on knowledge graph has been successfully applied in various fields such as biomedicine, business, information retrieval, intelligent transportation, etc., such as Amazon book recommendation, eBay, Netflix movie recommendation, etc. [6]. In the field of education, foreign scholars have explored and studied personalized learning resource recommendation methods and models, and have achieved good research results. For example, [7] proposed an adaptive personalized recommendation model that utilizes ontology based methods for semantic discovery, as well as preference and correlation based methods to rank learning objects, learning content, and the relevance of preferences, thereby providing learners with appropriate learning resources. [8] A service mining method based on semantic patterns and preference perception of user interest point recommendation is proposed, which recommends personalized services to learners based on learning behavior and trajectory sequence prediction. [9] A personalized adaptive learning model is constructed to analyze learners' navigation access data and behavior patterns, and provide personalized services based on their personalized characteristics.

In the fields of education and business, the application of knowledge graphs is becoming increasingly important. For example, the Knowledge Factory Laboratory at Fudan University focuses on building large-scale knowledge graphs, and Baidu has also built a grand knowledge graph library. Domestic research mainly involves two aspects: personalized learning resource recommendation and learning path recommendation. (1) In terms of personalized recommendation, from the technical perspective, traditional recommendation mainly includes three categories: collaborative filtering based, content based and hybrid recommendation systems: collaborative filtering recommendation [10-11]. This method implements personalized recommendation based on the user's rating matrix for the project, but there are problems such as low recommendation accuracy and sparsity. Content based recommendation [12] involves calculating the similarity between project features and user interest models, which poses issues such as system cold start and the need to improve recommendation accuracy. Rule based recommendation [13] analyzes the relationship between users and interests based on user browsing history as recommendation opinions, and formulates corresponding recommendation rules. However, there is also a problem with system cold start. Hybrid recommendation [14], a new recommendation technology that combines the advantages of various recommendation technologies, has better usability compared to a single recommendation mode. In recent years, recommendation systems based on knowledge graphs have received increasing attention from industry and scholars. Knowledge graph based recommendation systems belong to hybrid recommendation systems. Knowledge graph recommendation systems utilize knowledge by first representing entities and relationships as knowledge representation vectors (known as knowledge graph representation learning, abbreviated as KGE), and then in putting them into deep neural network structures to calculate the matching score (recommendation probability) between target users and candidate items [15]. According to the design principles of recommendation methods, existing knowledge graph recommendation systems can be divided into two categories: feature representation based methods and graph structure based methods. Class 1: Method based on feature representation. By using the knowledge graph, the knowledge representation vector is first acquired, and then input into the recommendation module to produce satisfactory recommendation results. This type of model typically represents models such as TransE, TransD, TransR, TransH, etc. The second type of method based on graph structure: this type of model uses the topological structure of the graph to supervise the representation learning of knowledge features, and uses the architecture of Graph Neural Network (GNN) to learn entities and relationships; Typical models include RippleNet model, KGCN model, and KGAT model. (2) Research on learning path recommendation is mainly focused by domestic scholars on the influencing factors of learning path recommendation and the research on recommendation algorithms/mechanisms. In terms of research on the influencing factors of learning path recommendation, [16] explained the impact of situational perception factors on learning path selection. [17] The focus was on studying the impact of learners' learning ability factors on recommended paths, and a

personalized learning path generation framework was designed. [18] Utilize a knowledge graph and combine learning preferences, learning styles, and other factors to recommend learning paths to learners. In terms of algorithm or mechanism research, [19] designed a multi-agent based personalized recommendation system that utilizes genetic algorithm filtering strategies to generate learning paths.

Through reviewing domestic and foreign literature research, it has been found that personalized recommendation technology has received widespread attention and has been well applied in various industries; However, with the increasing complexity and diversity of personalized recommendation scenarios, recommendation systems are facing more and more challenges, including issues such as data sparsity, semantic mismatch, homogenization of recommendation results, the need to improve recommendation accuracy, and the lack of interpretability of recommendation results; Especially in the aspect of learning resource recommendation, there are few comprehensive studies on the relationship between learning process and learner characteristics, domain knowledge and learning behavior. Therefore, this study will comprehensively collect data from the entire learning process, supported by technologies such as big data. Based on the learner feature model and the establishment of course knowledge graph, a personalized learning resource recommendation model based on knowledge graph will be constructed to improve the quality and efficiency of personalized learning resource recommendation.

3.RESEARCH CONTENTS

This study will comprehensively collect data from the entire learning process, supported by technologies such as big data, and knowledge graph, big data, and data mining. It will conduct research from aspects such as learner feature modeling, course knowledge graph model construction, and personalized learning resource recommendation. A personalized learning resource recommendation system based on knowledge graph will be constructed and applied in practice, with the aim of improving learners' learning efficiency and promoting their personalized development. Conduct research from the following aspects

(1) The Basic Framework Design of Personalized Learning Resource Recommendation System

Design a basic framework for personalized learning resource recommendation from three dimensions: learner feature model, course knowledge graph model (i.e. learning recommendation object model), and personalized learning resource recommendation.

(2) Construction of learner feature models

1) Modeling of learner models.

Accurately describing and quantifying learners' feature information is the foundation of personalized recommendation. Learner characteristics include personalized parameter content such as learner basic information, cognitive foundation, learning style, learning preferences, cognitive level, emotional state, learning behavior, learning needs, learning history, etc. The project utilizes next-generation information technology to collect learners' online/offline learning process and result data, and establishes a dynamic feature model for multiple and multi-level learners.

2) Extract personalized feature parameter information from learners.

(3) Construction of Curriculum Knowledge Graph Model

1) The course knowledge model is a prerequisite for knowledge visualization and learning path recommendation. Determine the core elements of the course knowledge model and design a framework for the course knowledge model.

2) Perform a nanoscale knowledge granularity decomposition of course knowledge.

3) Provide automatic or semi-automatic semantic feature descriptions of course knowledge points to ensure that the features extracted from course knowledge points match the personalized feature parameters of learners.

4) Using the Beautiful Soup framework to crawl the concepts related to course knowledge entities, analyze the structural hierarchy and knowledge point relationships of course content; Annotate knowledge points and their correlation relationships to form a knowledge point structure diagram.

5) The knowledge points are represented by domain ontology and described by ontology language OWL.

6) Build a course knowledge graph model.

(4) Personalized learning resource recommendation

Personalized learning resource recommendation is implemented based on learner feature models and learning recommendation object models (course knowledge models). The recommendation of personalized learning resources relies on the similarity or correlation between learner characteristics and course knowledge (learning resources) for recommendation.

1) Design personalized learning resource recommendation algorithms.

By utilizing the deep recommendation strategy of knowledge graph correlation, the similarity and centrality between knowledge points are calculated, and combined with learners' cognitive level and learning style, the target knowledge points are mapped into the knowledge graph.

2) Rank recommendations based on relevant relationships and similarity of knowledge points.

3) The breadth recommendation strategy based on the mixed relationship of knowledge graphs generates a learning path based on learners' mastery of knowledge points and the priority of the correlation between knowledge points.

4) Based on learners' learning logs, test results, learning behavior sequence analysis results, and other comprehensive judgments of their learning progress and status, and then recommend learning resources or paths to them.

4.SYSTEM ARCHITECTURE DESIGN

The system architecture design mainly includes four aspects: data collection and processing, model construction, resource and path recommendation, and model application, as shown in Figure 1.

Data acquisition and processing: basic data of learners, teachers' and students' behaviors, teaching evaluation and other data are obtained through IOT perception, education information platform and other channels. Data processing is carried out using new generation information technologies such as log analysis, text analysis, semantic analysis, etc. Through data cleaning, data integration, protocol, format conversion and other links, a preliminary standard format is obtained.

Model construction: Utilize scientific theoretical knowledge such as artificial intelligence, educational measurement, and cognitive space to construct models for learner characteristics and course knowledge graphs.

Resource and Path Recommendation: Utilizing learning analysis, clustering analysis, sequence pattern mining and other related algorithms to form deep recommendation strategies based on knowledge graph correlation and breadth recommendation strategies based on knowledge graph hybrid relationships, providing learners with corresponding personalized chemical learning resources.

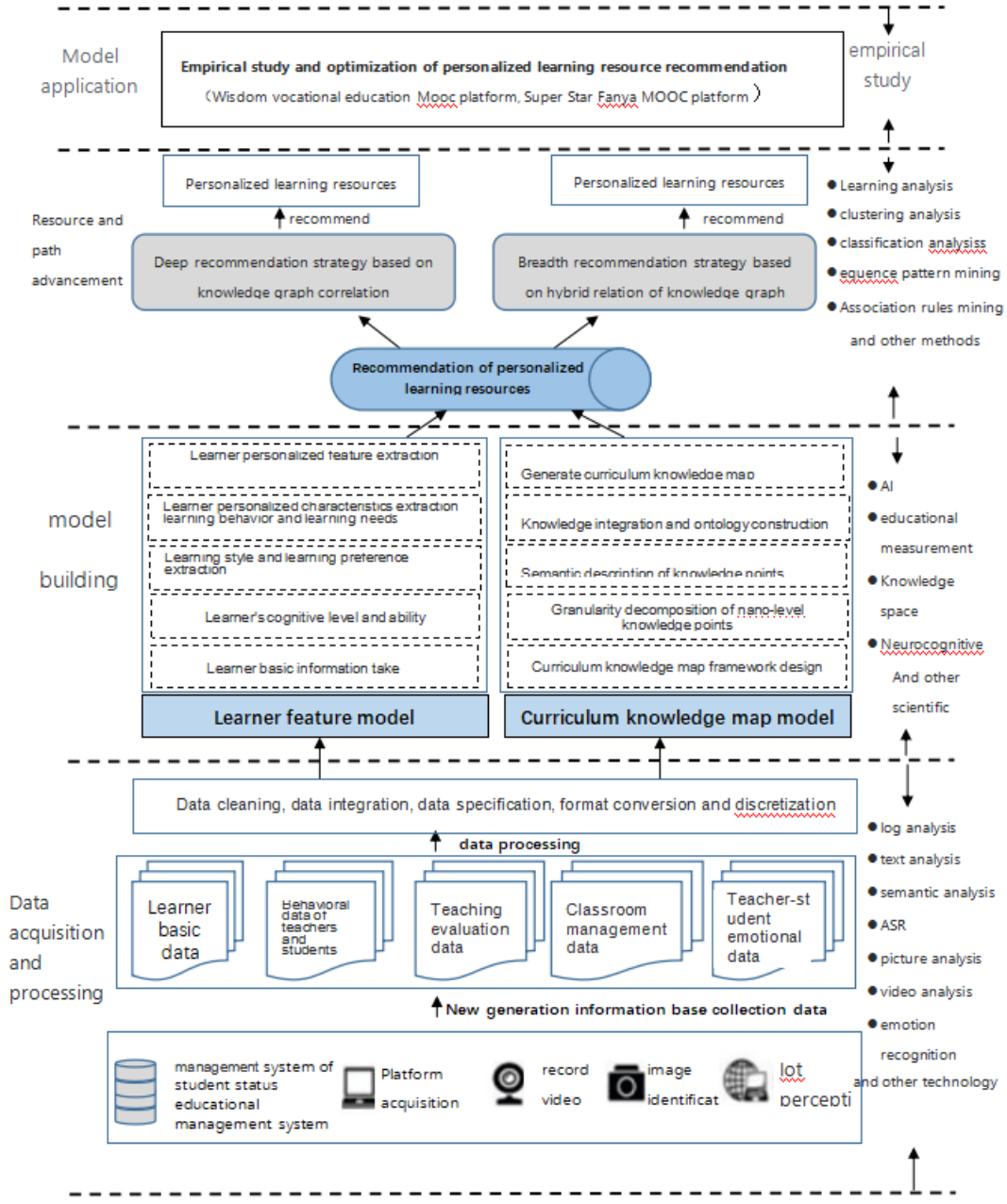

Figure 1 Recommendation system structure diagram

5.CONCLUSION

This article analyzes the feature information of learners and course resources in the teaching

process, collects and analyzes learner behavior data using new generation information technology, constructs a learner feature model and a learning recommendation object model (course knowledge model), uses mining and other technical means, integrates knowledge graph technology, and proposes recommendation strategies that are both broad and deep, effectively improving the efficiency of learning resource recommendation.

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