

# Design of a Learning Path Recommendation System Based on a Knowledge Graph


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## ABSTRACT

Current learning platforms generally have problems such as fragmented knowledge, redundant information, and chaotic learning routes, which cannot meet learners' autonomous learning requirements. This paper designs a learning path recommendation system based on knowledge graphs by using the characteristics of knowledge graphs to structurally represent subject knowledge. The system uses the node centrality and node weight to expand the knowledge graph system, which can better express the structural relationship among knowledge. It applies the particle swarm fusion algorithm of multiple rounds of iterative simulated annealing to achieve the recommendation of learning paths. Furthermore, the system feeds back the students' learning situation to the teachers. Teachers check and fill in the gaps according to the performance of the learners in the teaching activities. Aiming at the weak links of students' knowledge points, the particle swarm intelligence algorithm is used to recommend learning paths and learning resources to fill in the gaps in a targeted manner.

## KEYWORDS

Knowledge Graph, Learning Path, Learning Recommendation System, Node Centrality

## INTRODUCTION

With the development of information technology, China's education has entered the stage of intelligence (Qinghua et al., 2019), demonstrated by knowledge, openness, and synergy. The Implementation Plan for Accelerating Educational Modernization (2018 – 2022) (Xinhua News Agency., 2019) pointed out that educational development relies on the promotion of the informatization of education, speeding

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up smart education, encouraging learners to conduct autonomous learning, and taking feedback on teaching. The New Generation Artificial Intelligence Development Plan noted that the construction of a knowledge graph is the key analysis and reasoning technology. Thus, the learner-centered education platform should be built through a knowledge graph.

Current learning platforms tend to have problems related to resource overload, redundant information, and chaotic learning routes. These cannot meet individualized learning requirements, fail to provide timely feedback between teachers and students, and leave learners and teachers dissatisfied with self-learning methods. There is, therefore, a need for structured teaching and learning. Thus, the use of knowledge graphs for reasonable learning path recommendation has become an urgent problem.

The learning knowledge and nation system designed via the knowledge graph can accurately identify learning paths, eliminate knowledge fragmentation and information redundancy, form structured knowledge, and clarify the relationship between predecessors and successors of knowledge. Therefore, recommending learning paths can make students' learning more scientific and reasonable.

The concept of a knowledge graph was first proposed by Google in 2012 as it accelerated and optimized its search engine capabilities. In 2013, it was popularized in academia, becoming a key technology in the field of artificial intelligence (AI). Zhen et al. (2019) proposed the construction method of a knowledge graph in the adaptive learning system of human-computer collaboration, which expresses the application of a knowledge graph in an adaptive learning system from the dimensions of resource integration and adaptive learning. Hang (Hang Z., 2020) proposed using a knowledge graph to evaluate the mathematics lesson plan, reduce the complexity, obtain key indicators, and supplement the evaluation of knowledge points, abnormal knowledge points, and knowledge point spans. Ye et al. (2021) proposed the basic concept and construction of a multimodal knowledge graph, analyzing key technologies and related application scenarios. Ang et al. (2022) used reinforcement learning to solve the problems of data labeling, noise, and reasoning interpretability and reliability. They introduced its application to practical fields like intelligent recommendation. Aidan et al. (2021) illustrated how to represent and extract knowledge in knowledge graphs using a combination of deductive and inductive techniques. Padia et al. (2019) proposed a method for embedding knowledge graphs into real-valued tensors and a linear tensor decomposition algorithm with provable convergence. These proved the effectiveness of the proposed model on knowledge graph prediction. Kwa et al. (2020) proposed a schema-based iterative knowledge graph completion method, solving the problem of consistency of the ontology schema between the extended knowledge graph and initial knowledge graph.

Learning path recommendation aims to recommend reasonable paths to learners in support of comprehensive, reliable learning. Guangquan (2018) designed and proposed a method for recommending learning resources and exercise resources according to learners' personalities. Yue (2019) proposed improving the binary particle swarm algorithm to improve the efficiency and accuracy of personalized learning path recommendation. Menghua (2020) achieved personalized learning path recommendation by constructing a course knowledge graph and showing the relationship between knowledge points. Zhuang Chen (Zhuang., 2020) proposed a learning path generation algorithm based on clustering and an improved learning path recommendation algorithm based on a long short-term memory network, realizing a better adaptive and more accurate path recommendation scheme. Hanlin (2021) proposed an effective scheme to transform learning resources into learning paths by using learner portrait technology in the environment of semi-supervised learning. Ronghai and Changdong (2021) proposed a hin-def model that combined tensor decomposition, a heterogeneous information network, and deep learning triple technology. They solved the problem of sparse data and improved the accuracy of the recommendation system. Seghroucheni et al. (2014) proposed an adaptive learning system model based on a recommender system, helping learners who encounter difficulties in learning evaluation to correct the learning path. Nguyen and Tran (2021) proposed embedding career goals into knowledge graphs to form a new knowledge graph architecture to achieve specific classification of learners and make the semantic relationship between subjects clearer and more relevant. Niknam and Thulasiraman (2020) proposed a bionic intelligent learning path recommendation scheme based

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