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Research on Accurate Recommendation of Learning Resources based on Graph Neural Networks and Convolutional Algorithms

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Abstract: In response to the challenges of "learning confusion" and "information overload" in online learning, a personalized learning resource recommendation algorithm based on graph neural networks and convolution is proposed to address the cold start and data scarcity issues of existing traditional recommendation algorithms. Analyze the characteristics of the Knowledge graph of learners and curriculum resources in depth, use the graph Auto encoder to extract the auxiliary information and features in the Knowledge graph and establish the corresponding feature matrix, and use Convolutional neural network for classification and prediction. The experimental results show that this algorithm improves the performance of recommendation systems, improves learners' learning efficiency, and promotes personalized development.

Keywords: Convolutional algorithm; Personalized recommendation technology; Knowledge graph; learning resource.

1 Introduction

Lifelong learning is an effective way to enhance one's own abilities. The ways of acquiring knowledge are diverse and closely related to individual age. Before work, classroom teaching is the main approach, and after that, self-learning is the main approach. The massive learning resources in various application platforms not only provide convenience for learners, but also bring about the problem of information overload, wasting a lot of learners' time and energy, affecting their interest in learning, and thus reducing their enthusiasm for learning. Scholars have proposed personalized recommendation technology solutions to address such issues.

Personalized recommendation takes advantage of Big data, data mining, data analysis and other technical advantages to turn massive interference information data into treasure, mine effective information from it, provide users with the most suitable recommendation scheme, and improve economic efficiency. Recommendation technology mainly has two modes: user based and project based. User based Collaborative filtering algorithm was proposed in 1992, which was mainly used in email filtering system, and later was applied in various industries; This mode mainly consists of two steps: first, find a user cluster G with similar interests to the target, and recommend items that the user likes and the target user has not heard of to the target user in the set G. The recommendation system will have a continuous iterative process. In this process, as the user and recommended item levels continue to expand, the recommendation system also faces problems such as low accuracy, difficulty in going online, difficulty in multi-objective improvement, and weak user intent capture. From the perspective of users, in response to the dilemma of information overload, recommendation systems revolve around how users can efficiently obtain information of interest;

From the perspective of service providers, recommendation systems solve the problem of how to attract users, retain users, increase user stickiness, and improve user conversion rates to the greatest extent possible through products. Compared to search engines, users of recommendation systems are passive recipients of information, making it easier to achieve precise and efficient information filtering through personalized sorting and pushing. Therefore, it has become the main way to serve users of internet products with content as their main business.

According to the puzzling phenomenon of teaching resources in the online learning process, on the basis of neural network and Knowledge graph, a graph based neural network and Collaborative filtering algorithm is proposed. Autoencoder is introduced into the Knowledge graph to extract the map feature information, establish the learner's personalized feature parameters and curriculum Knowledge graph model matrix, effectively solve the problem of recommended cold start, and at the same time, use the deep learning of neural network to conduct data training, Reduce the data iteration process and improve the personalized recommendation efficiency of learning resources. Chapter 2 elaborates on the basic process of recommendation systems and analyzes the theoretical research achievements in the field of recommendation systems that have been achieved. Chapter 3 analyzes the algorithm model of this paper, including the collaborative recommendation module, graph feature extractor module, and connection unit design. Finally, relevant experimental simulation analysis is conducted to verify the recommendation performance and accuracy of this algorithm.

2 Problems existing in the current teaching design

According to different recommendation methods, recommendation systems can be divided into content based recommendation [1], Collaborative filtering based recommendation [2] and hybrid recommendation [3]. Different recommendation methods have different characteristics, such as content-based recommendations that are only related to products and have low relevance to users, and there is no "cold start" problem with recommendations. The recommendation based on Collaborative filtering is the most basic recommendation technology method. By analyzing the interaction history information of users and projects, and building user profiles respectively, mining the potential relevance between them, and then according to the context of users, find the project selected by similar users from the project matrix, and the project is not browsed by the target users. Relevant algorithms include item based Collaborative filtering algorithm [4], user based Collaborative filtering algorithm [5] and model-based Collaborative filtering algorithm [6]. Hybrid recommendation integrates and applies multiple recommendation technologies to obtain better recommendation results, usually to solve the cold start problem that Collaborative filtering cannot handle [7]. The personalized learning resource recommendation process is shown in Figure 1.

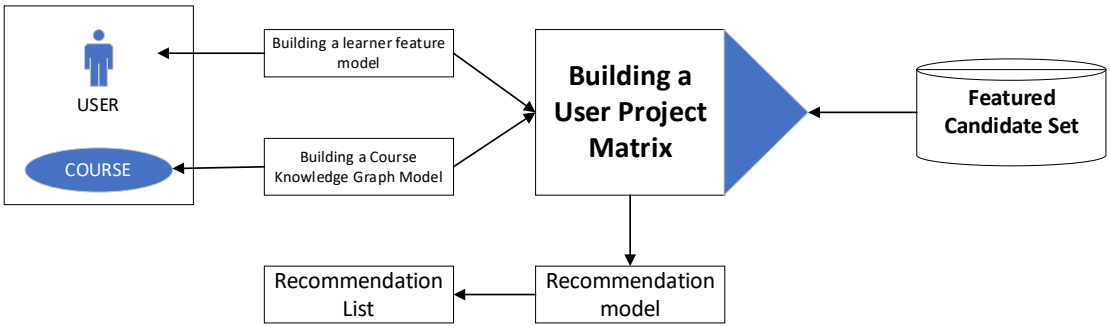

Figure 1 Recommendation system flowchart

With the rapid development of artificial intelligence, Knowledge graph (KG), with rich semantic information, has gradually become one of the key technologies of recommendation systems and is widely used in various research fields. The concept of personalized recommendation was first proposed by Resnick [8], and since then, there has been a wave of research on personalized recommendation technology worldwide. The knowledge search product 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 9] Apply Ripple Network water wave network principle to the recommendation system of Knowledge graph, simulate the propagation of water waves to automatically and iteratively expand users' potential interests, and effectively solve the limitations of knowledge map aware recommendation methods based on embedding and path. Some scholars also introduced deep learning into personalized learning resource recommendation algorithms, using DNN to model the learning of embedded vectors instead of complex Matrix decomposition, and achieved fruitful applications. The academic community is still exploring how to apply neural network forms that are more suitable for recommending data features to recommendation tasks, or how to find suitable data collection and processing methods to make cutting-edge mining tools available.

In the development process of artificial intelligence technology, deep learning has achieved unprecedented development, belonging to a machine learning method that can abstract and represent different levels of data [10], and has been deeply applied in the field of personalized recommendation. [11] The Collaborative filtering algorithm (RBM-CF) based on Restricted Boltzmann machine pushed it to the climax. [12] A framework of neural network algorithm and Collaborative filtering recommendation algorithm is designed to assist modeling with deep learning and improve the accuracy of recommendation results. In recent years, the deep learning method of Convolutional neural network has made breakthrough progress in speech recognition and other fields [13-15], and has been successfully applied to the reasoning field of Knowledge graph.

Through the analysis of relevant literature, the personalized recommendation technology based on the Knowledge graph has several problems. First, the computational efficiency. Compared with the traditional graph algorithm, the computation is complex and the scalability is poor; The second issue is data sparsity. During the process of creating the graph matrix, there is a high possibility of abnormal entities or relationships and a lack of corresponding algorithms to handle them, resulting in a decrease in computational

accuracy. Therefore, it is necessary to introduce deep learning algorithms such as Convolutional neural network into the recommendation technology of Knowledge graph to effectively solve problems such as cold start and improve the accuracy of recommendation.

3 Research contents

E-learning, as a learning method based on computer communication technology, can effectively utilize online teaching resources. Learners can choose a suitable place to connect to the network according to their own time and choose the learning resources that are suitable for them. As a resource provider, I hope to be chosen by learners and generate economic benefits. Recommendation algorithms serve as a bridge between learners and resources, and are the core of recommendation technology. This chapter proposes a graph neural network and convolutional algorithm (GNN-CA), which extracts auxiliary information and features in the Knowledge graph through the graph Auto encoder, trains together with the recommendation network based on deep learning, and improves the performance of the recommendation system.

3.1 Problem Definition

The main data in the recommendation system includes the user dataset $u \in U\{u_1, u_2, u_3 \cdots, u_m\}$ and the project dataset $v \in V\{v_1, v_2, v_3 \cdots, v_n\}$. There is an intersection between them, represented by $Y \in R_{m \times n}$, and its physical meaning is a matrix of $m \times n$, representing the rating records of n items by m users. If the data value is equal to 1, it indicates that there is interaction between the corresponding item and the user. Otherwise, there is no rating record. For this study, the goal of the recommendation system is to mine the hidden association rules between learners and learning resources based on the interaction between learners and learning resources by using Knowledge graph related algorithms, and match appropriate learning resources for target learners to improve the recommendation efficiency.

3.2 Algorithm Model Design

The overall framework of GNN-CFA is shown in Figure 2, which includes two main units: knowledge self encoding and embedding vector module. In the knowledge self coding module, the research objects include learners and courses. The key user graph features in the learner curriculum interaction graph are studied, and the user node information fused with the graph information is stored in the form of embedded vectors using the idea of graph representation learning. The Knowledge graph of learners and courses is reconstructed to obtain the corresponding interaction vector information, and the feature information is extracted using neural network technology, Build Knowledge graph feature matrix. The embedded vector model uses the connection unit based on convolution as the bridge, and the embedded vector of the Knowledge graph feature matrix data of the previous link as the convolution input signal to complete feature interaction.

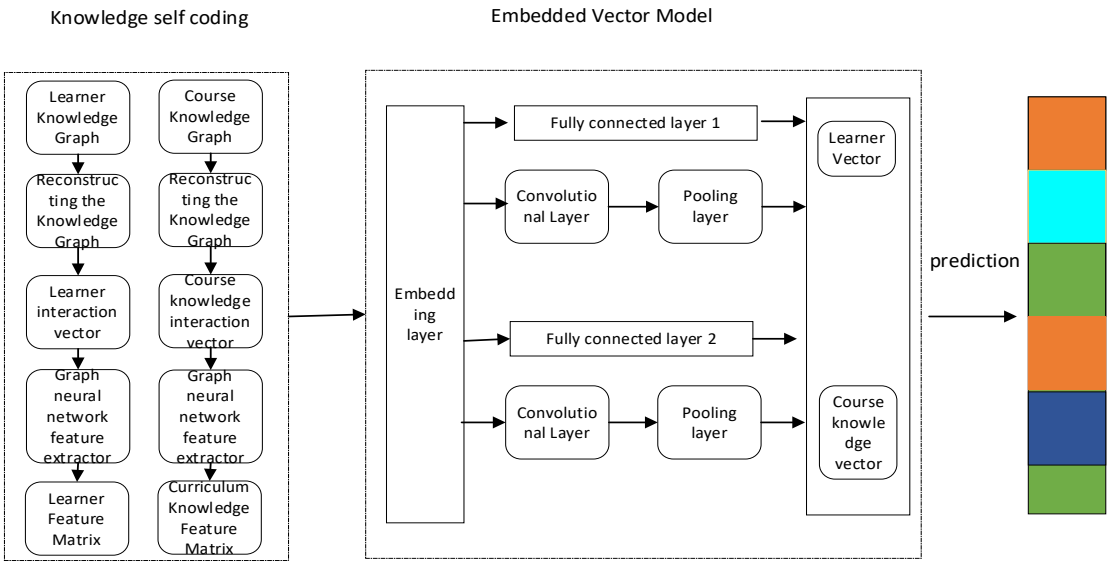

Figure 2 GNN-CA Algorithm framework

1) Figure feature extractor module

The Autoencoder model consists of two parts, the encoder and the decoder. It works unsupervised, encoding the input data into intermediate variables, and then decoding the intermediate variables into output data to reconstruct the input data. The Figure Autoencoder in Figure 2 uses the Figure Neural Network as the encoder to learn the implicit features of input data such as learners and courses. It uses the Figure Network feature processing method to extract new features and obtain reduced dimension data. It uses dot product as the decoder to return the encoded data and obtain high-quality output data feature matrix. From the design perspective of GNN-CA Algorithm, the core of graph feature extractor of graph Autoencoder is not only whether it can effectively use the feature information contained in nodes, but also whether it can effectively learn the representation of graph structure information of nodes, such as whether the vectors of nodes with the same structure are similar in the embedded space.

2) Embedded Vector Module

In the personalized recommendation system, Word embedding are embedded into low dimensional Vector space through some methods and technologies of Autoencoder and presentation learning. On the premise of maintaining the syntactic and semantic relationship of words, the object mapping from high-dimensional space to low dimensional space is realized, which improves the generalization ability of the model and reduces data storage and computing costs. Convolutional neural network is a kind of deep learning neural network structure, which has the feature of automatically learning input parameters, and can effectively improve the efficiency and accuracy of recommendation. It is mainly composed of convolutional layer, pooling layer, fully connected layer and Activation function. Among them, the convolutional layer is the core layer of CNN, which extracts the features of the input vector through convolution operations and serves as the input for the next layer. The pooling layer plays a role in downsampling, reducing the size of the feature vectors output by the convolutional layer, thereby reducing network parameters and computational complexity. The fully connected layer is used to connect the outputs of the convolutional layer and the pooling layer, forming a vector of learner and

course knowledge for final classification and prediction.

4 Conclusion

Information overload affects people's access to learning resources, reducing learners' enthusiasm and interest in learning. Recommendation systems can recommend suitable learning resources to users based on the implicit relationship between users and projects. Traditional recommendation methods have the problems of cold start and data sparsity. Under this background, this paper proposes an accurate recommendation model of learning resources based on graph neural network and convolution algorithm, reconstructs the Knowledge graph of learners and courses, and uses the algorithm advantages of Convolutional neural network to conduct in-depth learning training, thus improving the recommendation efficiency and recommendation accuracy.

Acknowledgments

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