Design of Teacher Portrait System Based on Knowledge Graph

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***Abstract*—This paper takes the junior high school education administration system, human resource management system, student system and official website as the research object. Then the knowledge graph is used to study the multi-attribute teacher image. The system has intuitive material integration function, powerful interactive creation function, rich variable, function and program control function. The process line is used to connect each icon, which greatly improves the speed and quality of multimedia software development. The process of building the whole model is given in this paper. The image acquisition and analysis are completed. This paper extracts and generates feature entity and association information to generate portrait model. Finally, the design and implementation of the whole experiment are completed based on knowledge graph and Neo4j development environment. The joint recommendation method of knowledge graph based on multi-level structure is studied. The feature transformation matrix is removed during node updating in each level convolutional network, and its own connections are selectively maintained or removed. Through the real teaching data set, the analysis and application of teachers' teaching portraits are completed.**

***Keywords*—Knowledge graph, teacher teaching portrait, multi-feature, convolutional network recommendation algorithm**

I. INTRODUCTION

Massive data in teacher teaching, student behavior, course recommendation, precision teaching and school management have become an important basis for the construction of big data in junior high school. The teacher portrait is to realize the extraction of the whole image of the teacher through the "data" of the teacher's individual information. Constructing the image of junior high school teachers can provide big data support for the "teacher-student relationship" of school, provide decision support for schools, improve school management, and optimize social services [1]. Knowledge graph is a symbolic way to express various concepts in the real world and their relations, it is a kind of various types of graphics that can reflect the development process and structure of knowledge, and it expresses this knowledge and their internal relations in a visual way. Knowledge graph is an intuitive form of expression in teaching, which can show the structural connection between subject knowledge and help teachers and students to construct and think better about knowledge [2]. Some scholars regard it as a visual approach, and use systematic research methods to analyze its classification, application, and challenges. Some scholars have reviewed its connotation, technology and application based on multimodal information and combined with deep learning technology. User modeling is the foundation of big data services and key technologies. The core of user modeling is to explore labeled, abstract and semantic user modeling methods that can describe and predict user characteristics and behaviors from massive actual data. At present, there are few researches on teachers' teaching portraits based on user portraits, and the characteristic factors concerned are mostly single and difficult to guide teachers' teaching portraits effectively. Previous studies have summarized six steps from multimodal big data, laying the foundation for achieving high-quality precision education [3]. Some researchers have accurately depicted the whole process of teacher education from many levels by using the curriculum and management system of school online. Some scholars have conducted in-depth research on teacher continuous education under big data environment from different perspectives. Some scholars have put forward research ideas and approaches to construct primary school English curriculum images under the background of artificial intelligence. A knowledge map based on semantics is proposed. The graph convolutional network shows good performance in extracting graph data. In this project, the collaborative filtering method combining knowledge map and graph convolutional neural network is adopted to improve the recommendation effect. Although some researchers have used GCN to mine the higher-order neighborhood information of KG, and achieved good results in CF, it is found in practical application that the attribute transformation matrix in GCN can not only help CF algorithm complete, but also affect the recommendation effect of the model [4]. This paper takes the teaching administration system, human resource management system, student system and official website as the research object to study the multi-attribute teacher teaching image.

II. MULTI-FEATURE TEACHER PORTRAIT MODELING BASED ON KNOWLEDGE GRAPH

A. Overall model construction

This project takes the basic attributes of teachers as the main research object to establish a more accurate multidimensional teacher teaching portrait. Teachers' knowledge structure, accurate course selection, textbook reference, teaching evaluation, personalized teaching and other elements can be intuitively and visually displayed to improve its accuracy and richness [5]. From the perspective of "data acquisition - data preprocessing - feature entity extraction - teaching relationship generation - portrait model generation - model application", the whole model for teacher portrait is built. The overall model of multi-feature teacher teaching portrait based on knowledge graph is shown in Figure 1 (the picture is quoted in Information 2022, 13(2), 91).

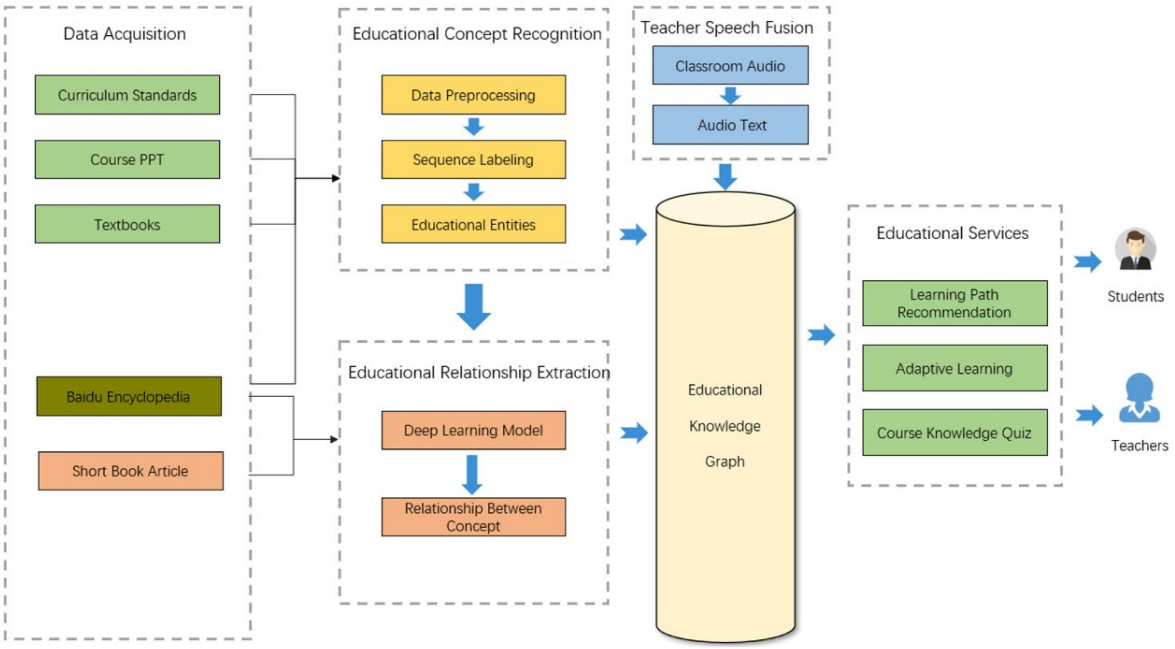

Fig. 1. The overall model of multi-element teacher teaching portrait based on knowledge graph

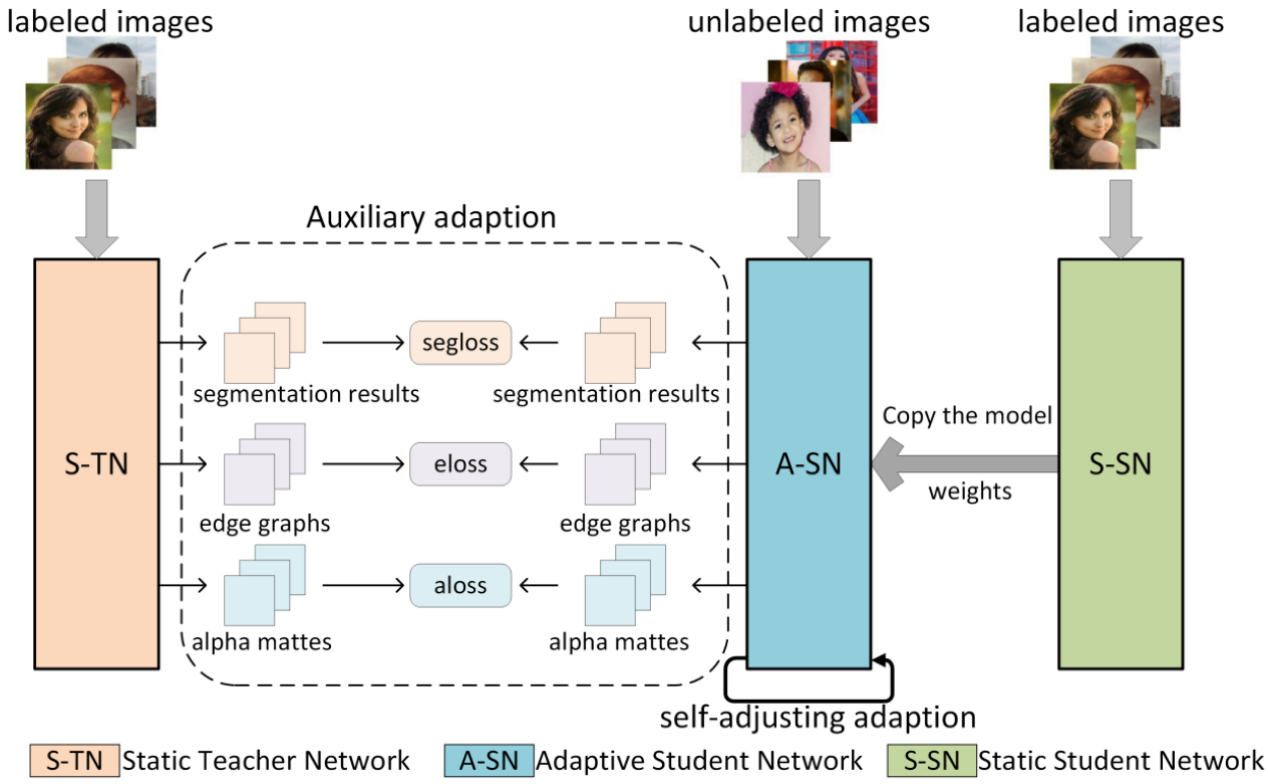

Fig. 2. Teacher user portrait collection process

B. Data Collection

The teaching image of teachers includes five aspects: the basic characteristics of teachers, the characteristics of curriculum content, the characteristics of curriculum teaching, the characteristics of professional and the characteristics of teaching results [6]. The research of this paper is not only based on a single teacher data source, but also includes the training program in the education process, the educational administration system, the staff management system of the human resources department, the student engineering system, the teaching organization on the official website of the school and the style of teachers. Then the original feature data, desensitization data and fitting data are collected and processed. Six basic elements are proposed. (1) Teachers' personal information: name, gender, age, department, home address, political status, contact information, etc. (2) Teacher information: teaching subjects, subject categories, teaching schools, classes, majors, etc. (3) Initial education information: graduation school, education level, diploma, major, etc. (4) Basic seniority level information: school category, position, title, title, teaching

years, social part-time jobs, teaching achievements, etc. (5) Information about the basic characteristics of the course: course name, selection of textbooks, codes, credits, etc. (6) Specialty characteristics: specialty name, specialty number, specialty code, training plan, etc. The data acquisition process is shown in Figure 2 (image cited in Electronics 2022, 11(24), 4080).

C. Feature entity extraction and relationship generation

The acquired data is integrated, and entities in the established knowledge map are extracted and associated. The purpose of this paper is to help teachers make teaching plans, choose teaching materials, make teaching plans, optimize training programs and realize personalized teaching [7]. In this paper, the machine learning method is used to make statistics on the original characteristic data and generate the characteristic entity.

D. User portrait model generation

Considering the factors such as time, curriculum, major, teaching materials, and region, the multi-level, multi-granularity and multi-angle multi-feature spatial segmentation of teachers' portraits is carried out. The basic attribute model of multi-attribute teacher teaching portrait, teacher characteristic portrait, curriculum characteristic portrait and teaching ability portrait are constructed [8]. Teacher characteristics description module includes: teacher's curriculum schedule, school, curriculum relations and so on. The portrait model of curriculum characteristics is to describe the selected teaching material, teacher's profession and class relationship. The analysis model of teachers' teaching quality is a kind of image of teachers' teaching content and teaching behavior. The teacher teaching portrait model generated in this paper is shown in Figure 3 (the picture is quoted in The Educational Game "Indonesian Tribes" for the Kindergarten Students).

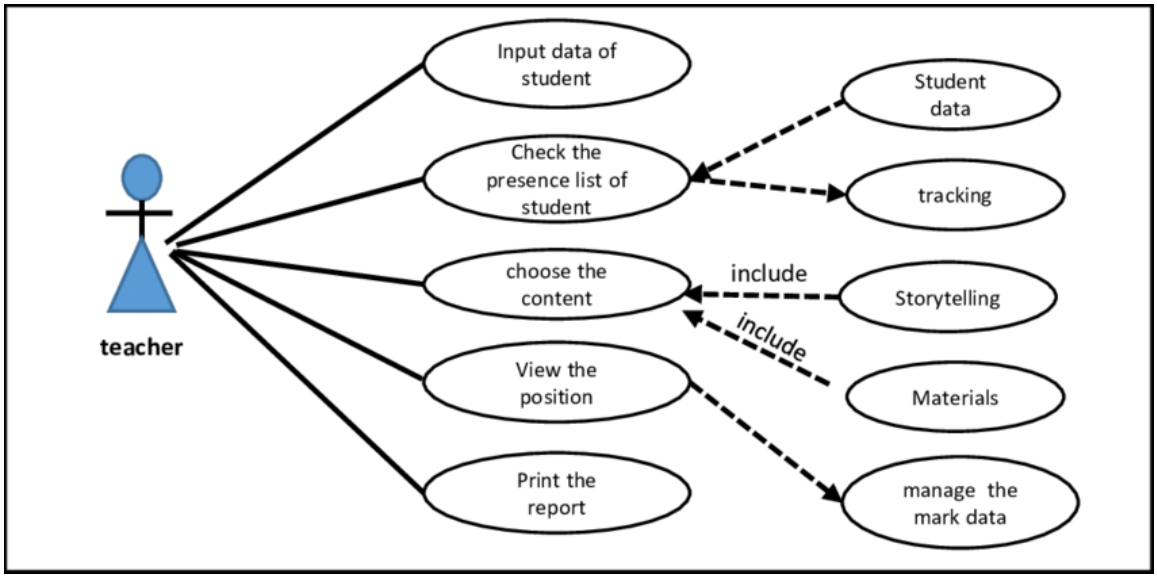

Fig. 3. Teaching portrait model

III. HIGHER-ORDER KNOWLEDGE GRAPH CONVOLUTIONAL NETWORKS

In knowledge graph H, $s_{u,v}$ represents the relationship between entity u and entity v, and the inner product function h is used to calculate the score between the user and the relationship:

$$\xi_s^a = h(a,s) \tag{1}$$

Where $a \in \mathbb{R}^c$ is the vector representation of user a, $s \in \mathbb{R}^c$ is the vector representation of relation s, and c represents the dimension of the vector. ξ_s^a reflects the importance of relationship s influence on user a preferences [9]. Linear aggregation of the $k-1$ nearest neighbor representation of b is required to obtain the k nearest neighbor representation of item b:

$$b_{R(e_b)}^{a(k)} = \sum_{e \in R(e_b)} \tilde{\xi}_{s_{e_b,e}}^a e^{(k-1)} \tag{2}$$

Where $e \in \mathbb{R}^c$ is the vector representation of entity e, and $\tilde{\xi}_{s_{b,e}}^a$ is the normalized user relationship score:

$$\tilde{\xi}_{s_{e_b,e}}^a = \frac{\exp(\xi_{s_{e_b,e}}^a)}{\sum_{e \in R(e_b)} \exp(\xi_{s_{e_b,e}}^a)} \tag{3}$$

The update operation get the k level representation of item b:

$$b^{a(k)} = \varphi\left(b^{a(k-1)} + b_{R(e_b)}^{a(k)}\right) \tag{4}$$

$$b^{a(k)} = \varphi\left(b^{a(k)}_{R(e_b)}\right) \tag{5}$$

Where φ is a nonlinear function. The difference between equation (4) and equation (5) is that the $k-1$ order representation of item b is added to the k order representation of item b, which is called adding a self-join. The discussion of self-connection will be discussed in the experimental section.

In traditional GCN, the final representation of the item $b^{a(k)} = \varphi\left(E^{(k)} \cdot \left(b^{a(k-1)} + b^{a(k)}_{R(e_b)}\right) + \varepsilon^{(k)}\right)$, where $E^{(k)}$ is the trainable feature transformation matrix of layer k and $\varepsilon^{(k)}$ is the offset term of layer k. Compared with the original GCN, the feature transformation matrix and bias used in the k order update are removed, and self-join is selectively removed according to data sparsity. The paper will test whether the feature transformation matrix exists. The LMCR is modeled by introducing the most commonly used mutual entropy loss function and assuming a high prediction of it under positive or negative interactions (Figure 4 cited in Review article: Design and evaluation of weather index insurance for multi-hazard resilience and food insecurity). The loss function is as follows:

$$\ell = -\sum_{a \in U}\left(\sum_{b_i : y_{ab_i}=1} T(y_{ab_i}, \hat{y}_{ab_i}) - \sum_{b_j : y_{ab_j}=0} T(y_{ab_j}, \hat{y}_{ab_j})\right) + \zeta \| \phi \|_2^2 \tag{6}$$

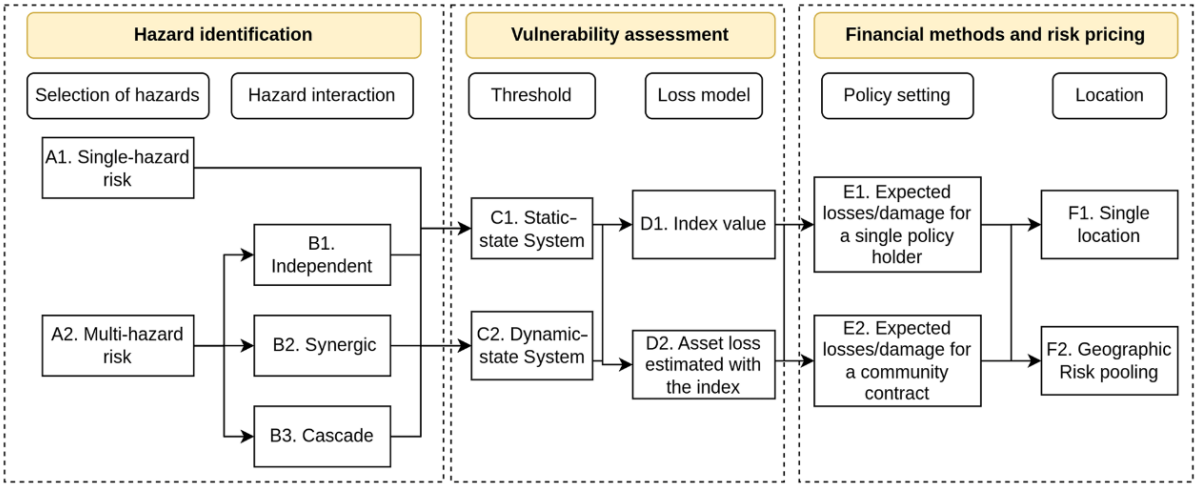

Fig. 4. LMCR algorithm flow

Where T is the cross-entropy function. $b_i : y_{ab_i} = 1$ means that C interacts positively with the current user a, $b_j : y_{ab_j} = 0$ means that b_j interacts negatively with the current user a, and $\left|\left\{b_i : y_{ab_i} = 1\right\}\right| = \left|\left\{b_j : y_{ab_j} = 0\right\}\right|$; ζ is L2 regularization coefficient.

IV. System Inspection

A. Experimental design

This study takes Junior high school's educational administration system. More than 500 teachers' data were obtained by means of data collection. Test system: Windows 10. The development environment is: Neo4j, Python3.8pycharm.

B. Data Preprocessing

However, the characteristic data obtained in this project come from multiple system libraries. The methods used are also different, resulting in differences between the form and code of the raw feature data collected from the data. In order to solve the problems in the establishment of knowledge map, this project uses a variety of data preprocessing methods such as rule representation and "data cleaning", "data mapping", "data integration" and "data reduction". And carry on the "teacher's teaching portrait" entity relationship model design.

C. Portrait analysis and application

A pattern extraction algorithm for semantic analysis is proposed. First, he won the support of all teachers. Map the attribute codes in the Entity-Teacher basic data table to other tables. Different physical entities such as subject, curriculum, textbook, classroom, department have been established. Finally, each generated entity is put into the Neo4j library to generate the nodes of the knowledge map. The relation between each form is extracted from the corresponding corpus to obtain the semantic information of each form. The connection between each node is established in the Neo4j database. A total of 695 associations were established. The created teacher teaching portrait graph relationship is shown in Figure 5.

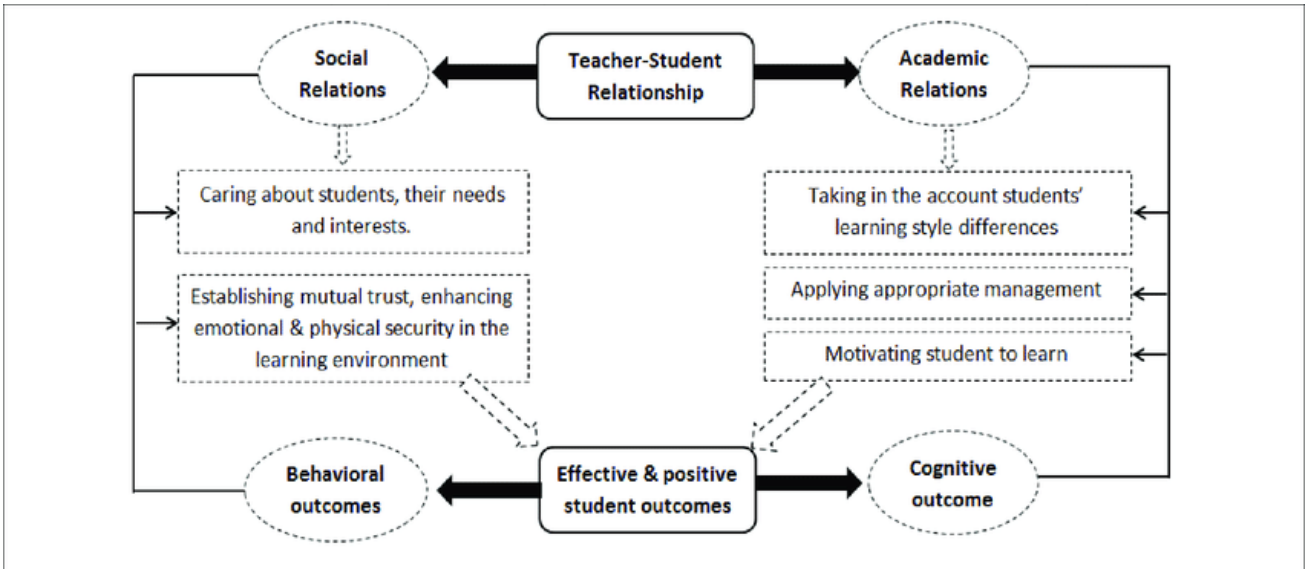

Fig. 5. Teacher teaching portrait map relationship diagram

The methods of Cypher, python and visualization are used to search and analyze the teachers' basic information, teaching materials, course materials, similar courses, related courses, professional classes, etc. Through the deep mining of big data, it is applied to the teaching management system of course scheduling, course checking, teachers' teaching evaluation, professional training program optimization, teachers' personalized course selection and so on.

V. Conclusion

A multi-attribute-oriented teacher education image model is proposed. It includes data acquisition, data preprocessing, feature entity extraction, relationship generation, portrait modeling, portrait analysis and application. This paper completes an application example for junior high school network on Neo4j platform. The results show that the algorithm is effective. This project lays a foundation for the practical application of teaching evaluation, training program optimization, personalized course selection, personalized teaching, and other fields.

Acknowledgments

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