Research and Application of Knowledge Graph in Teaching: Take the database course as an example

Yuehua Qin¹, Han Cao¹* and Leyi Xue¹

¹ School of Computer Science, Shaanxi Normal University, Xi’an Shaanxi, 710119, China
caohan@snnu.edu.cn

Abstract. With the rapid development of technologies such as artificial intelligence and deep learning, education informatization has entered the 2.0 era with artificial intelligence as the main feature. As an important part of artificial intelligence technology, knowledge graph provides possibilities for smart education and promotes the innovation and development of smart education. At this stage, the core concepts and knowledge systems of some computer science disciplines need further clarification and improvement. Using a large amount of course-related information to construct an educational knowledge graph, processing and analyzing the knowledge points in the course, extracting the knowledge entities and effectively integrating them, can greatly help to clarify the knowledge system of the subject. The improvement of the teaching quality of this subject is of great significance. Therefore, this paper selects the construction of educational knowledge graph as research content, and uses database courses as examples of graph construction for research. The BIO tagging method is used to construct the database subject dataset, at the same time, it builds knowledge card based on educational knowledge graph to achieve database teaching wisdom, systematic teaching content, integration of knowledge fragments and improve the quality of learning.

1. Introduction
In recent years, the smart education model driven by big data analysis, artificial intelligence and other information technologies has not only become the trend of the development of educational information, but also become a hot research content in the academic community[1]. The inspiration of smart education mode comes from the view of "Smarter Planet", which is a new type of education information paradigm. It integrates modern education theory with big data analysis, artificial intelligence and other technologies, so as to improve the quality of teaching. In the "Education Informatization 2.0 Action Plan" released by the Ministry of Education in 2018, it was mentioned that China should actively conduct smart education innovation research and demonstration based on artificial intelligence, big data, Internet of Things and other emerging technologies, relying on various smart devices and networks, with the support of emerging technologies, we will vigorously promote the reform of educational models and ecological reconstruction[2]. In this development trend, the construction of educational knowledge graph has become an important driving force for the continuous progress of smart education.

Database has the function of large information resource storage and management, which is closely related to people's life. Therefore, the database course is a basic computer course generally offered in Colleges and universities, an important technical basis for the development and implementation of information system[3], and also a key discipline of computer related majors. With the continuous
progress of information technology and the times, the advantages and disadvantages of the learning effect of the subject of database have an increasingly obvious impact on whether students can better use and practice data theory and computer technology. Therefore, how to obtain the correct and effective subject knowledge and subject architecture from the massive information of database subject is the key to improve the learning efficiency, and make the database teaching become intelligent. The concept of knowledge graph has created a new way to solve this problem.

2. Related research

2.1. Knowledge graph
Driven by the current data and information, and the ever-changing technology, as the latest achievement of symbolism development and progress, knowledge graph is the key foundation of big data analysis and other information technologies[4], it is a graph-based data structure, composed of nodes and Edge composition, where nodes refer to each entity in the knowledge base, distinguished by category; and each edge refers to the logical association between entities. In fact, the knowledge graph can be regarded as a kind of relational network[5], which is a combination of knowledge between entities and a mapping of knowledge existing in the objective world. The prototype of the knowledge graph first appeared in a small company dedicated to the research of the Semantic Web. The company stores all kinds of data information of the entities in the objective world in the system, and establishes the relation between the data, thus developing a technology that is different from the previous keyword search. Google believes that this system has great development potential and broad development prospects. It acquired the company in 2010, and subsequently imported crowd-sourced structured knowledge data Wikidata[6], and put forward the view of knowledge graph to the public in 2012.

Knowledge graph is a technical means for iteratively extracting structured knowledge from a large amount of data of various structure types. The earliest Google company used it in the search engine function. With the continuous development of the industry, the knowledge graph can now be regarded as a display of knowledge visualization technology of structural relationships[7]. Its advantage lies in its ability to efficiently integrate multiple, redundant, and differently structured data and complete knowledge reasoning. After long-term research and development, knowledge graph has been applied to many examples of artificial intelligence application development, such as intelligent dialogue, semantic search engine, personalized recommendation system, etc. The continuous development of these applications not only changes people's traditional lifestyle, it also promotes the rapid advancement of various industries in a more intelligent direction.

In recent years, knowledge graph in many vertical fields have increasingly revealed its broad development prospects. For example, in the medical field, Dong Lili et al. combined the knowledge graph with deep learning and applied it to the initial diagnosis of disease types, which improved the diagnostic accuracy of various disease categories[8]. In the field of network security, Wang Lancheng et al. applied the knowledge graph to public opinion analysis and management, which simplifies the discovery process of focus events and improves the trend analysis capabilities of focus events, thereby enhancing the intelligence level of public opinion analysis management[9]. In the field of metal manufacturing, Duan Yang et al. Used knowledge graph to comprehensively integrate data related to metal cutting tasks, increasing the value density of the data, and providing favorable data support for the efficient completion of metal cutting tasks[10].

2.2. Educational knowledge graph
As the top priority of China's development and progress, the education industry has also introduced knowledge graph to reform and innovate the teaching model in recent years, and it is widely distributed in various disciplines. The progress of education and scientific research is also of positive and long-term significance in promoting the steady and healthy development of various disciplines.

As a new stage of educational informatization development, smart education should rely on big data analysis, Internet of Things, artificial intelligence, cloud computing and other scientific
technologies to support the construction of its ecosystem[11]. As an important part of artificial intelligence technology, knowledge graph can not only improve the interpretability of artificial intelligence, but also help to construct the framework of smart education system. With the help of educational knowledge graph, the knowledge entities can be extracted from the huge knowledge system, and at the same time, the massive fragmented knowledge can be effectively integrated to help learners connect the knowledge system intuitively and easily, and sort out the knowledge points relation, while providing people with high-quality personalized services such as intelligent question answering and search reasoning.

In the field of education, the most representative is the discipline knowledge graph[12], which is a huge semantic network, contains a lot of knowledge information, and there are interrelationships among knowledge points, knowledge points and learning materials. Discipline knowledge graph plays an important role in the application of smart education, such as linking learning materials, developing intelligent question answering system and personalized recommendation service of teaching materials.

2.3. Knowledge graph for Database subject
Applying the knowledge graph to the subject of database helps to clarify the knowledge system of the subject, greatly improve the efficiency of each work link in the teaching process of database courses, effectively shorten the working time of teachers, reduce the work tasks, and improve the students’ learning skills and efficiency.

Applying the knowledge graph to the database will help the teacher to acquire valuable knowledge and experience existing in a large amount of database course-related data, and help use the knowledge graph to build intelligent teaching materials. Due to the continuous development of database-related technologies, the subject knowledge of the database is also increasing, but it is difficult to update the knowledge in time for the paper version of the book, and it takes a long time from writing to publishing, and the intelligent textbook based on the knowledge graph can be effective to solve this problem, the knowledge graph can use the feedback mechanism to update and revise the existing static knowledge in time according to the development of database subject technology and knowledge, and continuously expand the scale of database subject intelligent teaching materials.

Applying the knowledge graph to the database can also provide support for teachers and students in education and learning, and effectively improve the teaching quality of the course. For example, teachers can improve the quality and efficiency of lesson preparation through knowledge graph. At the same time, the teacher establishes the small knowledge graph of the relevant knowledge points according to the teaching contents and tasks, so as to directly reflect the content of the learned knowledge points and the connection with other knowledge points to the students in the teaching, and help the teacher to form an index; Through this graph, teachers can detect the students' knowledge understanding at any time, and timely assess the learning status to grasp the students' learning trends; Through the knowledge map, students can not only find out and fill up the gaps through the knowledge detection results, but also mine relevant knowledge points and hidden knowledge for learning, which is helpful to enhance their understanding of learning content and flexible use, and constantly improve their learning effect.

This paper analyzes the construction process of the educational knowledge graph, and mines the relevant data information of the course. At the same time, combined with the knowledge graph representation technology, the construction and visualization of the educational knowledge graph is realized based on the database course, which provides the basis for the follow-up smart education applications (such as personality learning, precision teaching, recommendation of related knowledge points, etc.).

3. Design and construction of educational knowledge graph
Generally, the process of constructing a knowledge graph is periodic, and the methods for building a knowledge graph can be roughly divided into two categories, namely top-down construction and bottom-up construction. Among them, the former refers to a method based on ontology construction,
using websites with highly structured data as data sources, such as Wikipedia, etc. to extract the required ontology and rule constraints, and add it to the knowledge base; While the latter refers to use methods such as pattern recognition and writing rules to directly process the collected data, extract valuable information (such as entities, relations, etc.) needed to construct the graph from these vast data, and then add it to the knowledge graph.

This paper starts with acquiring knowledge in the database field, cleaning and preprocessing the collected data, and using a series of automatic or semi-automatic technical means to extract information, identify knowledge units from text datasets, and then extract the entities, attributes and relation. Finally, the extracted knowledge is stored in neo4j to realize the visualization of knowledge graph, thus forming an effective educational knowledge graph of database discipline to help smart education. The construction steps of the knowledge graph are shown in Figure 1.

![Knowledge graph construction steps](image)

**Figure 1. Knowledge graph construction steps**

### 3.1. The acquisition and tagging of dataset

Data is an important foundation for the construction of knowledge graph. This paper uses Python-based crawler technology to obtain question and answer knowledge of database disciplines on the Internet, such as Baidu Wenku. Since the establishment of domain knowledge graph attaches great importance to the accuracy of knowledge, especially in the field of education, the data source of knowledge graph must be accurate and unambiguous. Therefore, in view of the multiple sources of knowledge for Q&A, it is easy to cause data redundancy, irrelevant data, and data errors. In order to obtain high-quality datasets and ensure the accuracy of the database education knowledge graph, this paper preprocesses the collected data. The processing standards are as follows:

- Whether the terms are standardized, the words are used appropriately, and the reading is smooth and coherent.
- Whether the problem background is clear and specific, and the description content is reliable without ambiguity.
- No malicious or advertising content.
- Eliminate irrelevant and duplicate knowledge points.
- Check the correctness of the answer and modify the wrong answer.

Due to the lack of annotated datasets in the database field and the high accuracy of knowledge required for educational knowledge graph, the organized datasets are manually annotated. BIO, BIOE and BIOES are the tagging methods for the named entity recognition. In this paper, BIO tagging method is adopted to annotate four types of entities, which are terms, people, location names, and organization names. The BIO annotation is a word-level position tagging for each entity in the dataset. B represents the beginning of the named entity, I represents the interior of the named entity, and O
represents a word that does not belong to the named entity. Overall, we manually annotated 763 question and answer pairs, nearly 80,000 characters. The specific tagging method is shown in Table 1.

| Entity Type            | Entity Begin | Entity Interior |
|------------------------|--------------|-----------------|
| terms                  | B-TER        | I-TER           |
| person                 | B-PER        | I-PER           |
| location names         | B-LOC        | I-LOC           |
| organization names     | B-ORG        | I-ORG           |

3.2. Information extraction

Information extraction is a key step in the construction of knowledge graph. Its task is to identify and extract the required factual information from the document. The information is presented in a structured and easy-to-understand form to enable users to better query and use the knowledge graph[13]. Information extraction is also an important basis for artificial intelligence applications, such as intelligent question answering systems, information retrieval, and intelligent dialogues. Therefore, it has received extensive attention from academic circles in recent years. Information extraction includes many complex technologies, such as Named Entity Recognition (NER), Relation Extraction (RE), etc. Especially in the latter technology is extremely challenging.

3.2.1. Named entity recognition. Named entity recognition is a major task included in natural language processing tasks, and it is also a subfield of information extraction, which helps to convert text data of various structure types into structured data that can be read by computers[14-15] . The purpose of this task is to be able to accurately identify the information that exists in the text, such as the location name, organization name, meaningful date and so on[16], which can also be called entity extraction.

The task of named entity recognition can be solved by a variety of technical methods. These technologies are usually divided into the following categories: dictionary-based, statistics-based, rule-based, deep learning, and hybrid technologies. Among them, the technology based on the combination of rules and dictionaries means that experts in the field manually establish the recognition rules of the corresponding text data to achieve the task of entity recognition. This method will have a higher accuracy and a faster recognition speed, but the disadvantage is that this method consumes a lot of human and material resources, is poorly portable, and has relatively large limitations. With the continuous progress and update of various information technologies, deep learning methods based on large-scale data have gradually become the mainstream of the current era. This method has better portability, low manual participation, and high efficiency. Eric Nichols et al. proposed to use a BILSTM-CNNs model structure to automatically detect character-level and word-level features in order to reduce the use of feature engineering[17]. Matthew E. Peters et al. proposed to use a large number of unannotated datasets to train a language model, and use this language model to obtain the word vectors that need to be annotated. Finally, the acquired vector is added as a feature to the original BIRNN-CRF neural network model, which greatly improves the effect of entity recognition[18]. In the medical field, Li Huilin et al. Constructed a neural network system model of BR-BiRNN and BR-BiLSTM-CRF based on block representation and applied it to medical texts, effectively improved the effect of named entity recognition in the medical field[19].

This paper defines four entity types and uses the BILSTM-CRF model to implement entity recognition tasks. It uses the jieba tool when segmenting words. It also defines a proprietary noun dictionary in the database field with 971 vocabularies. The dictionary implements the correction of words to ensure the accuracy of word segmentation results. Because the BILSTM-CRF model needs to encode the given text data, this paper uses the word2vec model to train the database subject related text data, from which the word vector representation of the text data to be recognized can be obtained.
Experiments show that this method has achieved good results in the entity recognition task in the field of database discipline. After the recognition results are aligned, 1386 entities are finally extracted.

3.2.2. Relation extraction. Extracting entity information from the dataset of database discipline is only to extract discipline knowledge points, and the educational knowledge graph formed is only a large number of isolated nodes. Therefore, it is also necessary to identify the relation between each knowledge point and the attribute of each knowledge point to enrich the educational knowledge graph, that is, it is necessary to construct the relation between entities and extract the attribute of each entity through the relation extraction, only then can we construct a complete network system.

Relation extraction is a basic task in natural language processing. It extracts entities, entity attributes and the relation between entities from many types of source text data, which is the key step to establish knowledge graph. The relation is the most critical feature of knowledge graph. Based on the relation, we can realize the interrelation of many affairs in the objective world, so as to support information retrieval, semantic understanding and other applications[20]. On the other hand, using relation extraction can help us reduce the cost of building knowledge graph. The better the effect of relation extraction, the more complete and larger the graph will be. The attributes of each entity in the knowledge graph and the mutual relation between the entities will also be richer. In this paper, "entity-relation-entity" and "entity-attribute -attribute value" triplets are used as the basic expressions of facts, and all the database course knowledge stored in the graph are connected with each other in the form of mesh to form a huge network knowledge system, so as to build the educational knowledge graph of database discipline, which can not only strengthen the correlation between knowledge points, but also further promote the communication and dissemination of knowledge points.

The main task of attribute extraction is to collect the attribute information of the entities in the database discipline from the dataset to construct the attribute list of the database entities, and then complete the graph to describe the entities in the database course system and enrich the information of each entity. In this paper, we define the rule set of all kinds of entity attributes, and implement the extraction of two kinds of entity attributes based on rules. They are terms and characters respectively. The term entity includes 12 types of attributes, and the character entity includes 10 types of attributes. The specific classification categories are shown in Table 2.

| Entity Type | Attribute category |
|-------------|--------------------|
| terms       | Concept, Category, Character, Constitute, distinction And Connection, function, method, significance, premise, responsibility, relative merits, other |
| person      | EnglishName, birthplace, birthday, School, synopsis, Life Of Characters, main Contributions, achievements And Honors, research Field, picture |

Relation extraction refers to extracting the relation between entities, such as the inclusion relationship between entities. This paper extracts three types of entity relations, which are include, correlation and research field, contains a total of 1003 inclusion categories, 113 correlation categories, and 6 research fields categories. Through these relations, a series of fragmented database entities are linked to form a networked knowledge structure, so as to make database subject knowledge more systematic.

3.2.3. Storage and visualization. In terms of storage and visualization of knowledge graph, a large number of large-scale knowledge graphs have been successfully established, such as Knowledge Vault, WordNet[21], FlockDB, and linked open data(LOD) knowledge base, among which LOD includes YOGO, FreeBase, DBpedia[22], GraphDB, Wikidata[23], Neo4j and so on. This paper uses the Neo4j graph database to realize the storage and visualization of educational knowledge graph. The database subject entities extracted from the collated dataset and the associated batches extracted are imported into Neo4j. According to the different scenarios of knowledge use, the database problems are divided
into two categories: terms and person. In order to enhance the intuitiveness of the knowledge graph, a small amount of terms and characters were selected as demonstrations, as shown in Figures 2 and 3.

![Figure 2. Terms knowledge graph example.](image1)

![Figure 3. Person knowledge graph example.](image2)

4. Knowledge Card

In order to help users better understand and use the knowledge graph, Google uses knowledge card as its representation in the query. This paper provides a search interface similar to a common search engine. When a teacher or student enters an entity name, a knowledge card for that entity will be returned. The knowledge card feeds back systematically combed knowledge related to entities in the database discipline to teachers and students. Essentially, it is an entity search service that relies on the knowledge graph constructed by search engines[24]. Knowledge card provide users with more detailed structured information about the entities included in the search process or the answers returned. In a sense, it is also a knowledge graph for query specific[25].

Compared with searching the content of database courses in previous search engines, searching knowledge points based on educational knowledge graph can return more accurate query results for users, rather than many fuzzy query results or even simple sets of unrelated knowledge, so that the returned content Highly concentrated in this field, there will be no other irrelevant knowledge information. Moreover, the knowledge card divides the database courses into knowledge points, which enables the teacher to quickly obtain the necessary materials for the lesson preparation during the lesson preparation, improve the efficiency and quality of the lesson preparation, and enable the students to learn repeatedly according to their mastery of certain parts consolidate relevant knowledge points and improve learning quality. In the current era of mobile Internet information and fragmented learning, knowledge card is a kind of learning method that can continuously enhance the individual's learning of knowledge, improve learning efficiency, and implement visualization and systematization of teaching content. By querying entities and matching them in the educational knowledge graph, this paper returns the corresponding entities and their attribute values, and then carries out structured, graphical and logical memory for a single knowledge point or person in the database, so that learners can fully understand and learn each knowledge point after decomposition, strengthen memory, improve learning effect, and provides a solid foundation for the intelligent teaching of database subjects. The examples of term and character knowledge cards are shown in Figure 4 and figure 5 respectively.
Data
Concept: Data is the symbol record of describing things, and it is the basic object stored in the database. Such as digital, audio, graphics, text, image, language, video and other forms of expression. After digital processing, it is stored in the computer. Data is the symbol representation or carrier of information. Information is the connotation of data and the semantic interpretation of data.

Category: The types of data include text, graphics, images, audio, video, student records, cargo transportation, etc.

Premise: The main factors that need to be considered to determine the data storage location and storage structure are access time, storage space utilization and maintenance cost.

Method: Data model is used to abstract, represent and process data and information in real world in database. The methods of inserting data include (1) inserting tuples (2) inserting subquery results.

Distinction And Connection: The reason of realizing the real structure of data in database is that a) the structure of data is described by data model without program definition and explanation b) the data can be lengthened c) the minimum access unit of data is data item. The database management system can provide control functions for data with (1) data security protection. Protect data to prevent data leakage and damage caused by illegal use. (2) Data integrity check. Control the data in an effective range, or ensure that the data meet a certain relationship. (3) Concurrency control. To control and coordinate multi-user concurrent operations, and to prevent mutual interference and get wrong results. (4) Database recovery. Recover the database from an error state to a known correct state. Comparing information with data, data is a form or record form of information existence. After data is interpreted and given a certain meaning, it becomes information.

Figure 4. Terms knowledge card example.

Name: James Nicholas Gray
Birth Place: America
Birthday: 1994
School: University of California
Research Field: database, transaction processing
Synopsis: James Nicholas gray, American Information Engineer. He has successively worked in Bell Laboratories, IBM, tandem, Dec and other companies, and his research direction has shifted to the field of database. During IBM, he participated in and presided over the development of IMS, system R, SQL / DS, DB2 and other projects. During tandem, gray improved and expanded the company’s main database product encompass, and participated in the development of system dictionary, parallel sorting, distributed SQL, nonstop SQL and other projects. He won the software system award and Turing Award.

Life Of Characters: James Nicholas gray, American Information Engineer. He studied at the University of California, Berkeley. He received a bachelor’s degree in Engineering Mathematics in 1966 and a doctor’s degree in Computer Science in 1969. He worked for IBM, Tandem computer company and digital. He became a Microsoft researcher in 1995. He has developed a database and transaction processing system including IBM’s system R, Microsoft’s terraserver and skyserver. He put forward the concept of data block and lock particle. He also has a share in developing Windows Live box. In 2002, he sailed alone to Fala Lun island to scatter his mother’s ashes. On January 28th, his ship disappeared. On February 1, digital globe scanned the area and produced thousands of images. The image is put on Amazon Mechanical Turk, hoping that people can work together to find out his ship. On February 16th his family called for the search operation to be cancelled.

Figure 5. Person knowledge card example.
5. Conclusions
At present, the development direction of educational informatization in China has gradually transformed into smart education driven by big data, artificial intelligence and other information technologies. This paper takes the database as an example to construct and visualize the educational knowledge graph, and create a knowledge card on the basis of the knowledge graph, which is conducive to the construction of a smart education system framework for database disciplines. The educational knowledge graph can more fully show the relationship between the knowledge points of the database disciplines, which is conducive to students' knowledge association when learning knowledge points, so that teachers and students can effectively integrate the distributed learning resources in the process of teaching, link the fragmented knowledge, and then make the knowledge points more structured and integrated, so the teaching level has been improved to a certain level. In the future research work, the graph can be gradually applied to knowledge snapshot, knowledge Q&A, knowledge association query, course knowledge resource recommendation and other aspects, and applied to smart education, continuously providing knowledge drive for smart education, so as to better realize the database intelligent education and improve the teaching quality.

References
[1] Zheng Q H, Dong B, Qian B Y, Tian F, Wei B F, Zhang W Z, Liu J. The State of the Art and Future Tendency of Smart Education[J]. Journal of Computer Research and Development,2019,56(01):209-224.
[2] Ministry of Education of the People's Republic of China. Notice of the Ministry of Education on Issuing the "Action Plan for Education Informatization 2.0" [EB/OL],[2019-04-28].http://www.moe.gov.cn/srcsite/A16/s3342/201804/t20180425_334188.html.
[3] Geng Y, Bai T, Xu W. Research on SPOC teaching model based on Five-Star Teaching Principle: An example based on database courses in medical colleges[J].China Medical Education Technology,2019,33(02):186-191.
[4] Wang X, Zou L, Wang C K, Peng P, Feng Z Y. Research on knowledge graph data management: A survey. Ruan Jian Xue Bao/Journal of Software, 2019,30(7):2139-2174(in Chinese). http://www.jos.org.cn/1000-9825/5841.html
[5] Yu S W, Fan H, Wang F, Xu L. Research on intelligent medicine based on knowledge graph[J].Chinese Medical Equipment Journal,2017,38(3):109.
[6] BOLLACKER K, EVANS C, PARITOS H P, et al. Free-base: A collaboratively created graph database for structuring human knowledge[C]//Proceedings of 2008 ACM SIGMOD International Conference on Management of Data.2008: 1247-1250.
[7] Chen Z Y, Shang Y, Qian D M. Research on intelligent question answering system based on knowledge graph[J].Computer Applications and Software,2018,35(02):178-182.
[8] Dong L L, Cheng J, Zhang X, Ye N. Research on Disease Diagnosis Method Combining Knowledge Graph and Deep Learning [J]. Journal of Frontiers of Computer Science and Technology, 2020,14(05):815-824.
[9] Wang L C, Lou G Z. A Summary of Research on the Methods and Practice of Network Public Opinion Management on Knowledge Graph [J/OL].Information Studies: Theory & Application:1-7[2020-04-15].http://kns.cnki.net/kcms/detail/11.1762.G3.20191223.0858.002.html.
[10] Duan Y, Hou L, Leng S. Building and application of metal cutting knowledge graph [J/OL]. Journal of Jilin University (Engineering and Technology Edition):1-12[2020-04-15].https://doi.org/10.13229/j.cnki.jdxbgyxh20190948.
[11] LEI Y, UREN V, MOTTA E. SemSearch:a search engine for the semantic web[J].Lecture notes in computer science, 2006, (10) :238-245.
[12] Li Y Y, Zhang X L, Li X, Du J. Construction and Innovative Application of Discipline Knowledge Graph Oriented to Smart Education[J]. e-Education Research, 2019, 40(08):60-69.

[13] Guo X Y, He T T. Survey about Research on Information Extraction[J]. Computer Science, 2015, 42(2):14-17.

[14] MEYSTRE S M, SAVOVA G K, KIPPER-SCHULER K C, HURDLE J F. Extracting information from textual documents in the electronic health record: a review of recent research.[J]. Yearbook of medical informatics, 2008.

[15] Wu Y H, Jiang M, Xu J, Zhi D G, Xu H. Clinical Named Entity Recognition Using Deep Learning Models.[J]. AMIA Symposium, 2017;2017:1812-1819.

[16] LENAT D B. CYC: a large-scale investment in knowledge infrastructure. Communications of the ACM, 1995, 38(11), 33–38 (1995). https://doi.org/10.1145/219717.219745

[17] CHIU J P C, NICHOLS E. Named entity recognition with bidirectional LSTM-CNNs[J]. Transactions of the Association for Computational Linguistics, 2016, 4:357-370

[18] PETERS M E, AMMAR W, BHAGAVATULA C, POWER P. Semi-supervised sequence tagging with bidirectional language models[C]. Proceedings of the 55th Annual Meeting of the Association for Computational Linguistics, 2017:1756-1765.

[19] Li H L, Chai Y M, Sun M Z. Deep Network Model for Text Named Entity Recognition[J]. Journal of Chinese Computer Systems, 2019, 40(01):50-57.

[20] Guo Y F, Han L, Li P H, et al. Application of knowledge mapping in big data[J]. Telecom Technology, 2015, 1(6): 25-29.

[21] MILLER G A. WordNet: a lexical database for English[J]. Communications of the ACM, 1995, 38(11): 39-41.

[22] LEHMANN J, ISELE R, JAKOB M, et al. DBpedia-a large-scale, multilingual knowledge base extracted from Wikipedia[J]. Semantic Web, 2015, 6(2): 167-195.

[23] VRANDECIC D, KRTOETZSCH M. Wikidata: A Free Collaborative Knowledgebase[J]. Communications of the ACM, 2014, 57(10):78-85.

[24] Zhao Y M, Gao X H, Li Q, Liang S B. Evaluation and Comparative Study on Knowledge Card of Web Search Engines [J]. Documentation, Information & Knowledge, 2019(06):84-92+101.

[25] Xu J H, Kang Q, Song Z Q, et al. Applications of Mobile Social Media: WeChat Among Academic Libraries in China[J]. The Journal of Academic Librarianship, 2015, 41(1):21-30.