

LIS-based Inspection Knowledge Graph Construction System

Fengyang Fu, Shuangling Sun, Yi Liu *

Chongqing Medical and Pharmaceutical College Chongqing 401331, China

* Corresponding Author

Abstract. In order to fill the lack of knowledge graph based on real experimental data from Laboratory Information System (LIS) in the field of medical testing, a method and system for constructing medical testing knowledge graph based on LIS is proposed. The problem of how to obtain rich and accurate literature resources of medical specialty from the real world is solved by building a database and tools such as reasoning machine. Using a large number of clinical laboratory specimens as a data source, data mining technology is used to analyze and process the massive information, so as to generate a high-quality visualization of the medical test knowledge graph. Doctors first do some pre-diagnostic preparations for patients, and then conduct a comprehensive and systematic physical examination. By building a medical test knowledge map, we have brought new possibilities for the application scenarios of LIS system.

Keywords: Lis; Medical Testing; Knowledge Graph; Relational Reasoning.

1. Introduction

Laboratory Information System (LIS) for collection, storage, transmission and retrieval, analysis and diagnosis of detectors, assisting detectors in pre-processing test forms and samples, and realizing the automatic collection and entry of test results. In recent years, with the rapid development of the Internet and computers, the degree of informatization of medical laboratories has been further enhanced. At present, the vast majority of medical institutions use manual entry of various test items and report contents, which is not only time-consuming and laborious, but also prone to errors. LIS system is a medical auxiliary equipment that can realize the entry of medical advice. Due to the lack of specialized professional workers, most hospitals use a manual method to manage all the information of specimens, including the review of the test report and the quality control records, etc. This traditional information management method is not only time-consuming, but also prone to mistakes. This traditional information management method is not only time-consuming and labor-intensive, but also ineffective and has many shortcomings. A large amount of medical test data can be observed in these data, for example, a patient's routine blood test results indicate low hemoglobin and red blood cell counts, which leads to anemia. If this value is detected then further work on other relevant data analysis is required to rule out the possibility that anemia may be present.

2. Related Work

2.1. Knowledge Graph

We examine medical issues from the patient's point of view and write medical texts from the patient's point of view. This paper analyzes the necessity of the use of artificial intelligence in medicine and explains its specific use in medicine. Using computer vision technology, artificial intelligence technology realizes a more accurate annotation method, thus improving the accuracy of annotation. However, the current artificial intelligence is still in a "weak" state, and researchers are not yet capable of giving powerful artificial intelligence services. With the continuous evolution of natural language technology, it is increasingly difficult to manually build a medical knowledge map, because the constant updating and change of medical knowledge makes the complexity of manual construction increasing, and it is difficult to meet the actual needs. With the deep intersection of artificial intelligence and computer technology, machine learning methods have been widely used in the

biomedical field. In these studies, the medical industry has constructed massive knowledge bases that are used to assist physicians in analyzing and predicting medical conditions.

2.2. Research Progress of LIS System in China

The first large-scale medical institution in Fushun, Liaoning Province, developed a more complete LIS in 1993, which is also the earliest LIS system in China. Since then, it has been widely used by hospitals at all levels and in all types of hospitals and has achieved success. At that time, the system was mainly used in outpatient charging and inpatient registration and statistics to promote the standardization and efficiency of medical services. Since the system had certain limitations in function and could not meet the clinical medical needs, it was soon adopted by other large hospitals. Since then, along with the rapid development of HIS, scientific research and development have also become more and more perfect, and a number of well-known enterprises represented by Tsinghua Zhifang, Haihui, Xinhe soon occupied most of the market of China's medical information system. In the 21st century, the LIS systems of major hospitals have been basically completed, laying a good foundation for future development.

3. Construction of LIS Knowledge Graph

3.1. Conceptual Design

When constructing a knowledge map in the field of medical testing, the first thing to do is to construct a conceptual schema layer as a way to obtain an overall conceptual template before proceeding to the next instance of learning. Since the medical testing discipline itself is highly intersectional and systematic, generalizing and organizing the relevant content within the field becomes an important part of constructing a medical knowledge map. With the advancement of biomedical testing technology, the scale of biomedical data will increase, and at the same time, the complexity of biomedical data will also increase. As the traditional methods based on keywords and rules and so on are difficult to meet the needs of complex medical specialty fields, while the existing medical information resources are not organized accordingly. Therefore, when constructing a knowledge map, designing the conceptual hierarchy is an indispensable task that can provide us with the required support and guidance. Based on the knowledge system model, this paper proposes a framework structure for the medical testing knowledge system model. On this basis, the key technical issues involved in the construction process of medical testing knowledge mapping and the solution methods are further discussed. Based on the actual information of the laboratory department of a tertiary-level hospital, this paper establishes a map of medical testing expertise with a model hierarchy and, on this basis, introduces the help of professionals and obtains international references to specialized terminology.

3.1.1. Physical Design for Medical Testing

The uniqueness of E as an entity in the field of medical testing lies in its ability to be recognized as the only entity in the field of medical testing; its qualities are unique and distinctive; the entity is uniquely identifiable. It is one of the most important components of the medical testing system, as well as an indispensable part of the entire medical testing process, and is closely linked to clinical care activities. The laboratory serves a specific medical research organization that is representative and complete. Therefore, we can work with this entity as one of the main operations of the medical unit. The four concepts covered by the medical testing entity E include: the entity that performs physical tests on patients, the entity that provides basic information, the entity that performs pre-diagnosis, and the entity that performs tests. Morphological testing is the preparation of a variety of stained specimens, observation of its morphological characteristics, and then use the principles and methods of histochemistry to study a class of testing methods, including histopathological examination, histochemical examination, microbiological examination, immunohistochemical examination. The term "test" covers a wide range of meanings, including all kinds of examinations

or experiments on the human body, test results, judgment methods, and other clinically relevant content. Figure 1 presents a schematic that synthesises a tree of entity concepts.

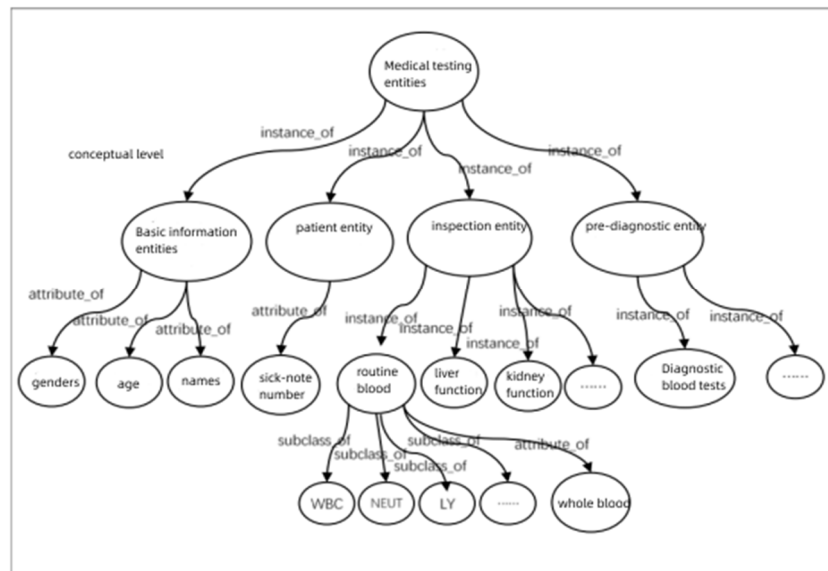


Figure 1. Conceptual layer design of the medical testing knowledge graph

3.1.2. Medical Testing Entity Relationship Design

There is a clear functional division of labor between testing entities, including sample collection, testing and detection, report issuance and other responsibilities. Based on this definition, this paper establishes a unified conceptual system of medical testing entities. Second, we propose an ontology-based approach for describing the relationships of medical testing entities. Once again, we establish a relational database system model for medical test entities. In this check, there exists an interrelated test fact between different medical test entities, i.e., $R\{E_i, E_j\}$, where E_i and E_j represent medical test entities. What the medical test entity relational database model describes is the data storage and operation relationship between the entities, which is extremely useful. In addition, by expanding the attributes of the medical test entity relational database model, the model is able to enhance its ability to support different sources of medical test entity relational databases. Based on this model, a medical test entity-relationship database system is constructed, which includes entity classes and relationship classes. Each medical fact relationship is given unique identifying characteristics to ensure its uniqueness. Based on the data in the LIS system, this paper analyzes the following different clinical medical testing efforts including.

- (1) subclassof relationship: used to describe the subordination between A and B.
- (2) instanceof relationship: refers to an instance link between entity A and entity B individuals.
- (3) attributeof relationship: refers to the value of an attribute which represents an entity A as an entity B.
- (4) diagnosis relationship: represents a diagnosis entity B held by patient entity A.
- (5) There exists a disease association such that a DISEASES association is formed between the disease name entity A and the patient entity B.
- (6) An association of DETECT is presented between Entity A and Patient Entity B, which indicates that there is a strong examination link between them.

Figure 2 It shows a patient-focused entity that is closely linked to the basic information entity, the test entity, and the pre-diagnostic entity, all of which are closely linked.

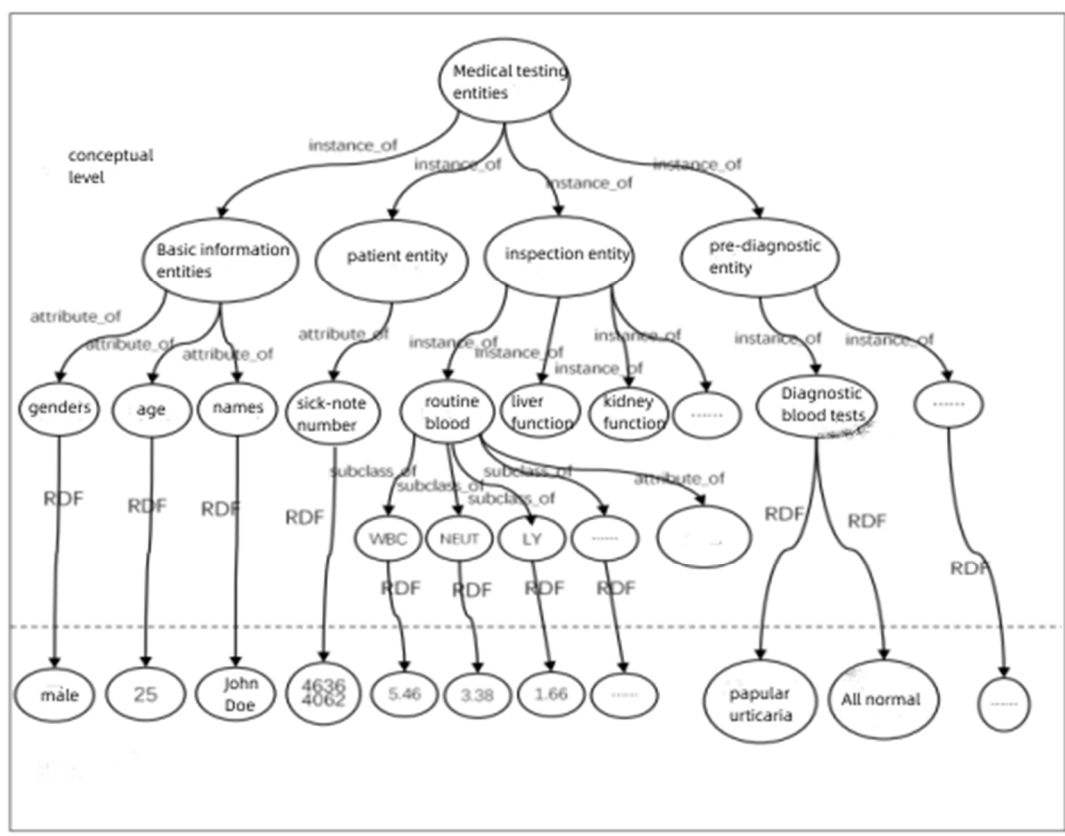


Figure 2. Hierarchical structure of medical testing knowledge map

3.2. Instance Level Design

Instantiation technique refers to the use of database or data warehousing techniques to deeply mine and analyze the information in the database. LIS is a huge and complex system that is responsible for managing every single thing that happens in a hospital. After analyzing various data, they can be summarized into some simple rules. Database data formats are rich and varied, including XML, RDF, JSON, etc. These formats contain a lot of structured data, such as thesis, books, etc. The data can be analyzed in a variety of ways. For semi-structured data, the length of some of these fields or words is adjusted to realize the corresponding extraction method. When a check item is extracted, entity extraction must be performed to obtain the check item. The attribute values of the set of check items are sorted in a certain order and then inserted into the corresponding candidate set in order, and a table is generated according to this order, and finally the table is uploaded to the background server. In order to handle unstructured textual data, such as pre-diagnostic conclusions, it is necessary to use NPL for knowledge extraction rule manipulation because of its high level of format flexibility.

The method is an improved entity identifier recognition method, which is optimized on the basis of existing ontologies to obtain more accurate recognition results. The method is not only effective in improving the accuracy and recall of entity descriptions, but also has good scalability. First, we will associate entities in LIS at the conceptual level to establish the instance level. Secondly, the semantic relationship table associated with this instance and the rule set related to it will then be established based on this instance. By carefully analyzing the patient Zhang San (the patient name in the LIS), we have successfully realized the instantiation of his admission diagnosis, admission disease process, laboratory test index data, and admission condition analysis process. Secondly, using rule-based knowledge discovery technology and data mining technology, combined with patient information, we extract effective features from a large number of structured or semi-structured data sets within the medical domain to form a medical knowledge base required by users. By adopting this method, doctors can diagnose and treat a particular disease more conveniently, thus improving work efficiency. In order to realize the instantiation of the patient, the attribute value of the patient "Zhang San" with

the medical record number "46364062" corresponds to the patient entity class, which improves the efficiency and accuracy of diagnosis. Through the method of data synchronization to achieve the medical information system information integration and data integration, the conceptual map of medical testing is realized. Through instantiation, the time required for clinicians to assess the quality of medical writing can be significantly reduced, thus improving diagnostic efficiency and accuracy. In addition, this study utilizes data mining techniques to provide physicians with a decision support tool based on knowledge-based reasoning.

Table 1. List of Medical Testing Entity Terms

Type of entity	Category marking	Number of entities
Type of inspection	test	58
Medical testing program	examination_item	1874
Test item reference value	threshold_value	3748
Specimen type	specimens	4
Pre-diagnosis	disease	1134
Inspection record	record	32108

4. Applications of the LIS Knowledge Graph

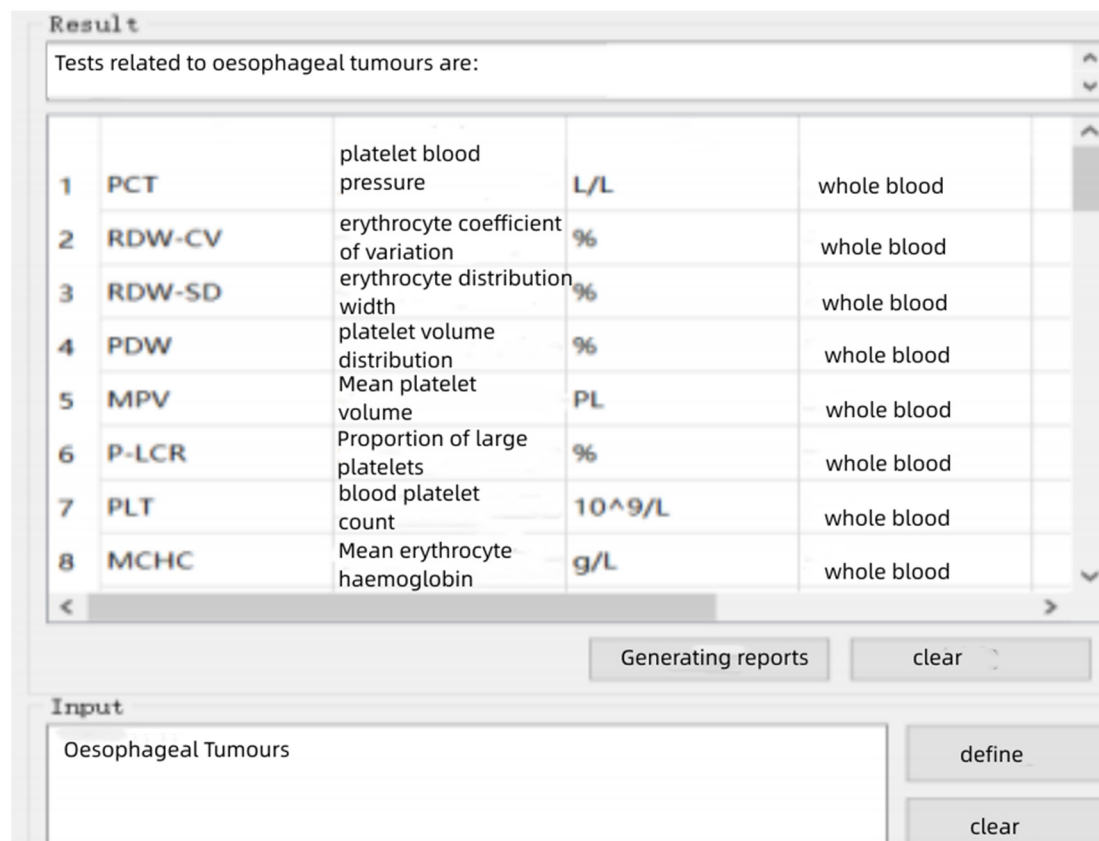


Figure 3. Query application of medical testing knowledge

In order to deeply explore the usefulness and value of LIS Knowledge Graphs, we will study how they are presented in practical applications. It is worth pondering that the storage method used in traditional knowledge mapping is limited to keywords without considering the interrelationships

between entities. For example, branching plot unfolding method can be used. In the process of building LIS knowledge graph, recognizing entities and relationships is an indispensable step, while the reasoning ability of LIS knowledge graph is reflected in the two aspects of inspection query and reasonable inspection in practical application. Inspection query is a type of big data analytics, where specific information can be parsed from large data sets by using statistical tests and parsing functions. By optimizing the search results, users can obtain higher information retrieval efficiency and accuracy, thus enhancing their experience. Esophageal tumors mainly include esophageal smooth muscle tumors and papillomas. Figure 5 presents the pre-diagnostic entities and specimen entities of esophageal tumors, in addition to further presenting the attributes and values of the pre-diagnostic entities of esophageal tumors, which provides readers with a more in-depth understanding of the LIS Knowledge Map, a method that can assist physicians in cross-checking multiple examination items to obtain more reasonable examination results. By modeling the patient's disease information as well as various testing index datasets as input variables, more accurate prediction conclusions can be obtained. On this basis, we constructed a knowledge base and reasoning machine for an intelligent assisted decision-making system to improve the intelligence of decision-making. PLT, the acronym for white blood cells in the human body, stands for the number of white blood cells in the blood.

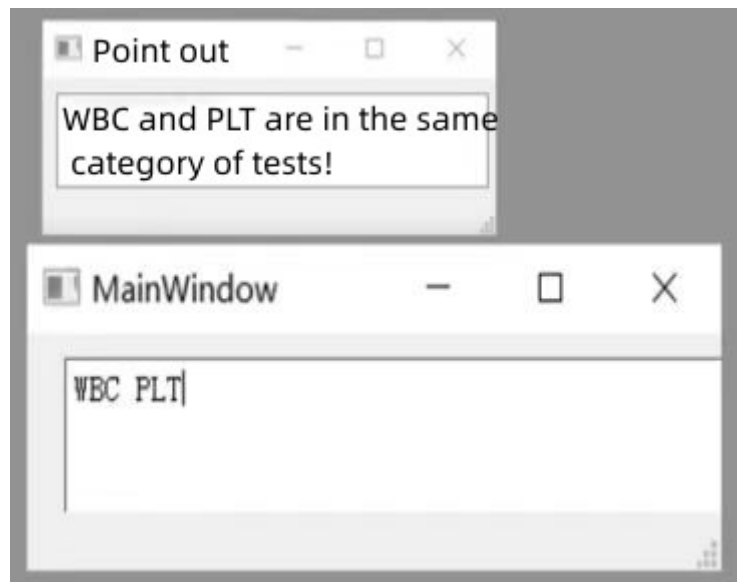


Figure 4. Rational Testing Application of Medical Testing Knowledge

5. Conclusion

On this basis, this study establishes a knowledge graph that combines the real LIS records of the laboratory department with expert assistance and applies it to the field of medical testing. We propose a method that combines the actual LIS records of the laboratory department, expert assistance and international clinical terminology references in order to construct and apply a medical testing knowledge graph. This knowledge graph can be used to help physicians make correct judgments about patient diseases. Rule-based reasoning is a way of representing knowledge using a form of structured rules. The field of medical testing is highly specialized. Semantic web graphs constructed using ontology technology can also enable the mining of potential associations between disease data, which in turn can help to provide a deeper understanding of disease diagnosis and treatment methods. In the medical field, knowledge graph is widely used in test query and rational test, providing an efficient auxiliary query tool for doctors, and also bringing new possibilities for the application scenarios of LIS system.

Acknowledgments

The project was supported by the fund of Chongqing Higher, Vocational Education and Teaching Reform Project in 2023, (No. Z233059S).

References

- [1] Zeng Yuanyue. Research on field inspection opinion issuance system for special equipment based on knowledge graph[J]. Market Supervision and Quality Technology Research,2023(01):10-12.
- [2] Ge Juan, Zhang Jixian, Han Wenli, et al. Discussion on the design of knowledge mapping ontology for quality inspection of natural resources survey and monitoring results[J]. Geographic Information World,2022,29(05):39-42.
- [3] Li Chunhua. Design and realization of automotive parts inspection and testing service system based on cloud platform[D]. Southwest Jiaotong University,2020.
- [4] Jin Yanni, Wang Huazhen, Wang Shuo et al. Construction and application of medical testing knowledge mapping[J]. Fujian Computer,2020,36(02):1-7.
- [5] Xiu Xiaolei. Research on the construction of tumor knowledge graph based on Chinese electronic medical records [D]. Peking Union Medical College,2019.
- [6] Pingping Zhao. An empirical study on knowledge mapping to promote elementary school students' mathematical knowledge construction[D]. Northwest Normal University,2018.
- [7] Zhong Z. Research on the reliability test of knowledge mapping analysis methods--Taking co-word analysis as an example[J]. Research on Science,2015,33(05):647-653.