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RESEARCH ON CLASSICAL PRESCRIPTIONS ONTOLOGY FOR KNOWLEDGE INNOVATION SERVICE

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Abstract. *Studies on the data of the classical prescriptions are very huge. In order to grasp the content of the whole data, and show the correlation between the data, we construct the semantic Ontology of the classical prescriptions for knowledge innovation service. This work presents the ideas and methods to construct the Ontology of the classical prescriptions. The results show that the classical prescriptions Ontology can be used to reveal the original thinking of Traditional Chinese Medicine, improve the clinical diagnosis and treatment level and realize the innovation.*
Keywords: Classical prescriptions, Ontology, *Treatise on Febrile Diseases*

1. **Introduction.** Classical prescriptions refer to the 112 prescriptions of Zhang Zhongjing's book *Treatise on Febrile Diseases* during the Han Dynasty [1]. People have studied classical prescriptions for more than two thousand years and produced a large amount of literature. There is a unique and complete theoretical system about the classical prescriptions. The basic principle contained in the classical prescriptions system is the standard of prescriptions. The implicit rule of syndrome differentiation is an important basis for revealing the original thinking of Traditional Chinese Medicine, improving the clinical diagnosis and treatment level and realizing the innovation.

The preparations of the classical prescriptions are the earliest traditional Chinese medicine compound preparation accepted internationally. It has become the main force of the international Chinese patent medicine market. In Japan, the relevant industry develops very rapidly. Kampo preparations from the classical prescriptions were included in the Japanese national health insurance. Compared with the domestic the studies on the classical prescriptions abroad have obvious shortcomings although these studies are unique in the extraction process and preparation technology of Traditional Chinese Medicine and are in a favorable competitive position. They do not have enough research and understanding of the classical prescriptions, nor the formation of classical information knowledge cloud.

Now, the classical prescriptions research has become a hot spot, but has not been effectively promoted. Firstly, the application has not yet formed a data and systematized model. Secondly, there are low levels of duplication of research and development of classical prescription. The results cannot clearly clarify the mechanism of the group and the mechanism of curative effect. There are information isolated islands in the development of patent medicine and clinical application. Therefore, the establishment of the knowledge

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cloud service system and the construction of the classical prescriptions Ontology have important significance to improve the level of drug use and the precision of clinical effect.

In recent years, big data have attracted the attention of industry, science and technology and government departments. On March 22, 2012, Obama announced that the U.S. government invested $200 million to start the Big Data Research and Development Initiative. Big data implies great social, economic and scientific research value, which has attracted great attention from all walks of life. If we can effectively organize and use big data, we will play a great role in promoting the development of social economy and scientific research, and also pregnant with unprecedented opportunities.

We analyzed the characteristics of the literature and reconstructed the knowledge. On this basis, we conducted an omni-directional research on the key scientific problems of etiology, pathogenesis, syndromes, symptoms, medication, prescription compatibility, addition and subtraction, decocting method, etc. We correlated the classical prescriptions with Traditional Chinese Medicine, traditional Chinese pharmacology and other aspects of knowledge, and constructed the semantic Ontology about the classical prescriptions with network relationships. These studies can support knowledge innovation by the clinical treatment and drug development based on the classical prescriptions.

2. **Process of Classical Prescriptions Ontology.** The construction of Ontology was divided into three parts: the data of basic research, constructing Ontology conceptual model, the formalization of the Ontology conceptual model.

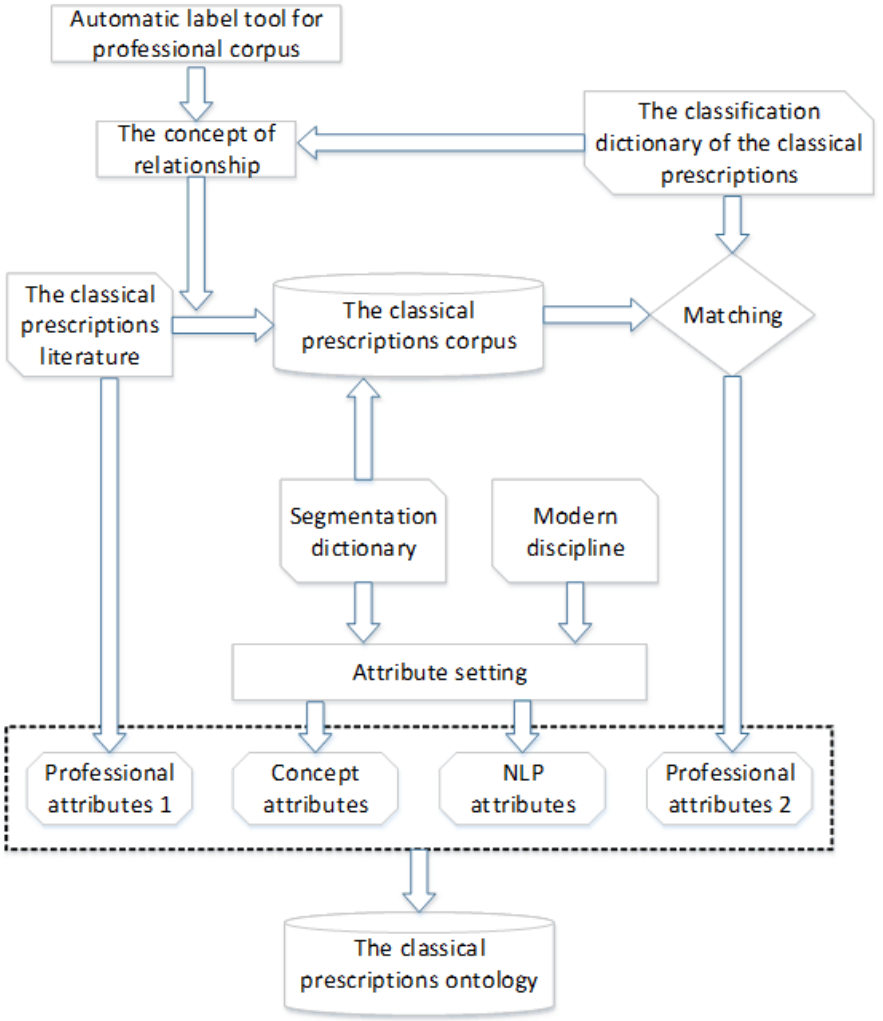

FIGURE 1. Process of classical prescriptions Ontology

The Ontology construction process could be summarized as the following three steps. The first step was to carry out the basic research of data. According to the knowledge characteristics of Traditional Chinese Medicine, we made a new classification of classical literature knowledge content taking the content of literature as the object of study. We built the dictionaries, split the original document, and constructed the corpus. The second step was the construction of conceptual model for the Ontology. First of all, we needed to determine the top-level conceptual relationship system. The hierarchy of concepts represented the primary division of knowledge. Secondly, we built a network concept relationship to determine the extensive relationship between concepts. Thirdly, we rebuilt the knowledge description system. Finally, we rebuilt the form of knowledge description. In the third step, we formalized the above model, and formed the classical prescriptions Ontology.

3. **Data Analysis.** The system of the classical prescriptions is a complex system composed of disease, etiology, pathogenesis, TCM syndrome, symptoms, therapeutic methods, composing prescriptions, dose of Chinese medicine, decoct and drink methods, processing methods and prognosis, etc. This system is closely related to Chinese medicine, theory of TCM and clinical diseases. Single research on the classical prescriptions from a certain aspect cannot grasp the medication rule as a whole, but also cannot reveal the objective mechanism of exerting therapeutic effects through precise compatibility of the classical prescriptions. Through the text analysis of *Treatise on Febrile Diseases*, we constructed the classical segmentation dictionary and automatically import data processing system. We gradually constructed a classical corpus, which provided better basic data for the classical prescriptions Ontology. Our studies analyzed the literature and reorganized the knowledge, in order to make the content of all aspects about the classical prescriptions systematized and systematized. And the inner link of the classical prescriptions content will be presented through the classical prescriptions Ontology.

3.1. **Research contents of classical prescriptions corpus.** The research of the corpus included the construction of the classification dictionary and the segmentation of the literature. Conceptual terms were at the core of the whole Ontology, providing the most basic vocabulary for the Ontology, as the main component of the concept attribute values. In this study, through the analysis of the text, we formed a concept classification system. Then, based on the text analysis about *Treatise on Febrile Diseases*, we extracted professional terms, and formed the basic classification dictionary. Finally, we used the dictionary and concept classification system to do the document segmentation and form a tagged corpus.

The work of corpus development consisted of three links: the collection of corpus, the segmentation of the corpus and the artificial test. In the course of actual construction, according to the results of the latter link, we could adjust the work of the previous link properly. The corpus of the classical prescriptions was a random open corpus, and could continue to add new data and update the contents.

We must carry on the knowledge classification to construct the classification dictionary firstly. Taking the theory of TCM as the framework the classification of the classical prescriptions dictionary was based on the meaning of the article in the clause of *Treatise on Febrile Diseases*. Selecting the version of *Treatise on Febrile Diseases* and the standard of interpretation the classification of the concepts and terms was a classification of knowledge of Traditional Chinese Medicine covered by the classical prescriptions in essence. We put the classical prescriptions and the related knowledge in TCM into the classical prescriptions knowledge framework. We divided more than 1600 entries into the following 13 first class categories: diseases, symptoms, location, syndromes, therapeutic method, etiology, pathogenesis, classical prescriptions, medicine, medicine processing, method of decocting

and taking, contraindication, and prognosis. Under the category of each first class, it was divided into a number of class two and class three. In addition, when we were working on the actual corpus, we summarized the newly discovered and uncategorized concept terms, and established new classifications, which were added to all levels of conceptual systems.

3.2. **Construction of classical prescriptions corpus.** Firstly, we imported the classification dictionary that could be edited manually. The imported dictionary was used as a label-set dictionary at the time of tagging the corpus, the function was: this study was segmented in sentences, while corpus was composed of paragraphs, and there were multiple sentences in the same paragraph. Therefore, the semantics contained in each sentence needed to be tagged with labels. After importing the dictionary, we could use the manual editing function.

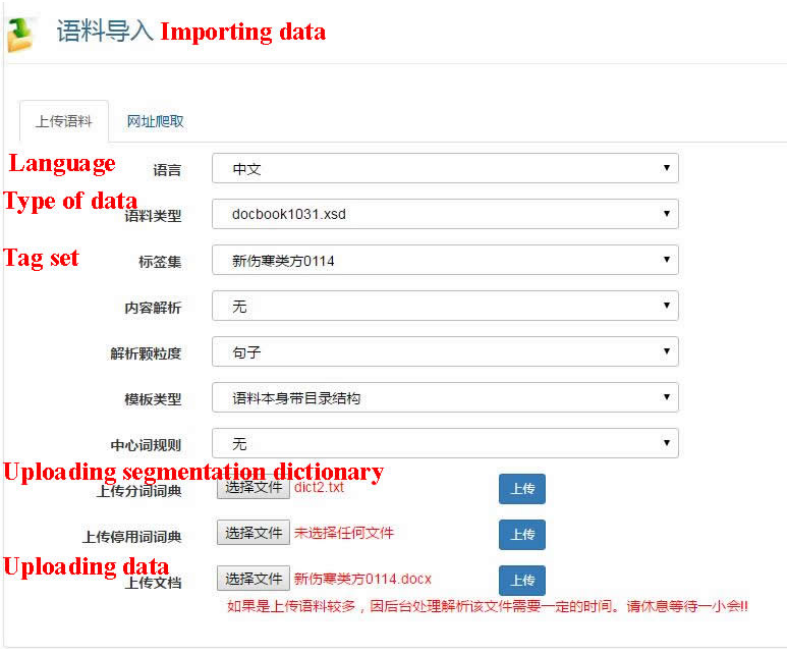

FIGURE 2. Construction of classical prescriptions corpus

Secondly, through the importing of the dictionary and the text of *Treatise on Febrile Diseases*, we automatically constructed the classical prescriptions corpus. Thirdly, after the corpus is constructed, we proceeded to the manual inspection and editing, and constantly improved the corpus. Finally, through the repetition of the process, we could constantly supplement the new corpus to improve the quality and quantity.

The classical prescriptions corpus could realize the retrieval function by the KWIC (Key Word In Context) way that displayed all the annotations of the same word in red form at the same interface and supported modification and proofreading under the same interface. This not only greatly improved the speed of the manual proofreading, but also ensured the consistency of the results of the annotation.

4. **Construction of Classical Prescriptions Ontology.** It has four steps in our research. We construct the system with the concept of classical prescriptions. Starting with the concept of top level we took a top-down method and defined most obvious concepts. Then, these concepts were properly summed up and refined by adding subclasses. At the same time, using the bottom-up method, taking *Treatise on Febrile Diseases* and the important works of the study of *Treatise on Febrile Diseases* in the past dynasties as the source of information, starting with the definition of a specific concept, we draw the concept from *Treatise on Febrile Diseases* and the related literature, and then organized

these thinning concepts under a more comprehensive concept. Secondly, one by one we established professional and general attributes of the classical prescriptions concepts, and established a conceptual model of the classical prescriptions Ontology. Thirdly, based on the professional attributes, and the literature characteristic analysis, we constructed the semi-structured data. Finally, we constructed the classical prescriptions Ontology in order to formalize the conceptual model.

4.1. **Construction of the top-level concept category.** The top level concept category of the classical prescription refers to the concept of the highest level in the network [2]. The classification of the classical prescriptions concepts is actually using the Ontology to reconstruct knowledge. We took the classification thesaurus of the classical prescriptions including 13 categories as the same knowledge classification of the classical prescription Ontology.

4.2. **Reconstruction of the conceptual relationships.** We transform the two-dimensional and linear conceptual relationship into a tridimensional and multidimensional network structure, which is used to describe more complex data objects. In the structure, any two concepts may be related, that is, the adjacency relationship between the concepts can be arbitrary.

In order to establish the hierarchical structure system for a specific relationship of knowledge, we took the classical prescription as the basic unit of knowledge description. Then, using other categories, such as disease, symptom, Traditional Chinese Medicine, and concepts split from the categories as the properties of classical prescriptions, we described the concept from different angles, in order to establish the extensive relationship of classical prescriptions. The attributes of classical prescriptions can be used as categories. For example, disease or symptom categories are attributes of classical prescriptions; classical prescriptions can be used as attributes of disease or symptom categories, and so on. Therefore, the association mapping between concepts is formed.

4.3. **Reconstruction of the attribute description system.** According to the property of classical prescriptions, and amalgamating or splitting other categories, we have 8 attributes of classical prescriptions, such as name, composition, main treatments, usage, contraindications, and modified. We set the attributes of TCM in order to describe the classical prescriptions accurately, and show the relationships between concepts. According to the property of TCM, and amalgamating or splitting other categories, we have 6 attributes of TCM, such as name, synonym, classical prescriptions, main treatments, and processing.

In addition, other knowledge description systems are omitted.

4.4. **Reconstruction of knowledge description method.** We differentiated the attributes into 3 categories: summarization descriptions, natural language proceeding (NLP) semanteme and specialized description [3]. Specialized description included traditional and modern properties of Chinese medicine which were described by the natural language and keyword. Summarization descriptions include explanation, name, English name, codes, and the last three descriptions are supported on autogeneration from thesaurus. Explanation is filled of the entries from the subject headings after matching the specialized dictionary automatically. NLP semantic descriptions include free words, synonyms, relevant words, etc. Specialized descriptions are described in two forms: specialized attributes1 and specialized attributes2. Specialized attributes1 are described by natural language text. Specialized attributes2 are described by subject headings automatically formed by mapping association from natural language text which is automatically indexed. Therefore, specialized attributes2 are the integration and association of the related attributes carrying their inherent relationships and structures.

4.5. **The formalized representation of classical prescriptions Ontology.** Ontology construction has a maturity theory, but there will be some problems for application. For example, the construction and application of Ontology are disjointed, and the concept system of Ontology is not perfect. In order to solve the problem of Ontology construction and application, according to the mature Ontology methodology and the characteristics of domain Ontology, we started from the top-level Ontology to construct a domain Ontology, refer to the seven-step method and integrate the thesaurus and the top-level Ontology resources [4].

After importing the indexed corpus, and uploading the classification thesaurus of classical prescriptions, attributes table and thesauri automatically, we constructed classical prescriptions Ontology and checked the results, as shown in Figures 3 and 4.

FIGURE 3. Constructed classical prescriptions Ontology

FIGURE 4. The interface of the Ontology analysis results

Under the framework of Ontology, we acquitted specialized attributes2 by corpus analysis to represent the core word of the attribute, for example, related symptoms2 (specialized attributes2) of wind-stroke syndrome of taiyang include fever, aversion to cold, spontaneous perspiration, which are the core words of clinical symptoms.

5. **Results.** We analyzed the original corpus of the classical prescriptions. After three levels of knowledge reorganization, we constructed classical prescriptions Ontology for knowledge innovation service. The Ontology was built on the basis of actual literature, and it has network relationships of the concepts. It also described the unique and complete theoretical framework of TCM, and clarified the basic principles of the prescriptions formulation and compatibility, the prescription and rule of syndrome differentiation treatment according to the professional attributes and the network relationships. Furthermore,

the Ontology is useful for revealing the original thinking mode of TCM, improving the clinical diagnosis and treatment level of TCM and realizing the innovation.

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