Date submitted: 31/05/2010

Development of Integrated Application System in Digital Medicine

Priorities and Strategies for the Use of Health Information in China Military Hospitals

Wenju Zhang,
Yan Li,
and
Huaijun Gong
Medical Library of Chinese People's Liberation Army, Beijing, China

Meeting: **95. Knowledge Management**

WORLD LIBRARY AND INFORMATION CONGRESS: 76TH IFLA GENERAL CONFERENCE AND ASSEMBLY

10-15 August 2010, Gothenburg, Sweden

http://www.ifla.org/en/ifla76

Abstract:

Information today is often distributed among many different systems within a complex IT environment. Using this information for creating knowledge organization systems and services thus involves using this distributed information and repurposing it within new applications. This paper describes the approach for searching heterogeneous resources, which are explained as they are used in two corresponding existing systems (Resource Integration Retrieval System and Heterogeneous Resource Union Search Platform). The current trend in Web technologies to build systems not in a monolithic fashion, but rather intended as building blocks within a constantly evolving and unplanned landscape of information processing agents. This approach can be used as a foundation for building knowledge organization system. We investigate the possibilities and challenges of this type of application, and as a case study describe a service for managing bibliographic metadata.

1 Introduction

With the social changes and new types of services, there appears to be complex situation in information service pattern, which changes information interchange and service environment on which traditional library relies. Traditional information

services are under the double impact of knowledge economy and digitalized world. Strong demand for knowledge innovation and knowledge information provides bright prospect for development of library information services. Social information environment, such as network and digitization, presents unrivalled opportunity for library information service. Therefore, in such situation, only by grasping opportunity and developing knowledge service, can library become favorable to the existence and development of the future library.

One of the most interesting and challenging facets about knowledge is that it is constantly changing, and that any formalization of knowledge and facts will be obsoleted at some point in time. This always was and still is a huge challenge for the knowledge formalization community, and in almost all productive systems using knowledge organization techniques, a static ontology is assumed. Many ontology models allow growing ontologies, but in most cases this in only allowed in a monotonic fashion, so that no older data can be invalidated by ontology

2 Traditional Knowledge Organization Method

Traditional knowledge organization method: bibliography, classification and subject.

Traditional knowledge organization method provides the literature clue and original literature that is ordered array of outward features and content features of literature, which can not reflect accumulation of knowledge, storage of knowledge and amount of knowledge acquisition. Regardless of whatever method, it can not avoid the distortions and errors of knowledge.

- **New Concept of Knowledge Organization Based on Knowledge Element**

Knowledge is composed of knowledge units, and knowledge unit is composed of several fragments of knowledge, and each fragment of knowledge is composed of a number of knowledge elements.

A knowledge element is the smallest unit of anatomic, explicit, formally defined knowledge content, a record of some form of externalization viewed as a single organized unit both from a conceptual and from a technical perspective. It is composed of a grouping of formatted information objects which can not be separated without substantial loss of meaning together with meta-data describing the element.

- **Integrated Application System in Digital Medicine (IASDM)**

Information construction is a long-term and tremendous task. Journal is taken as a breakthrough point in document information to accomplish the construction of information network in China. Up to now, a periodical service system in all-dimensional and multiple levels has been created. China National Knowledge

Infrastructure also called China Knowledge Resource Integrated Database has been at the forefront in information industry from digital to knowledge management. Information institutions in China have focused on journals and have enabled periodical service system to reach a considerable scale.

The object of library knowledge organization is no longer the books and journals in the library, but the knowledge hidden in books and journals. The information organization techniques have long been at revealing the physical features of the traditional model. Development of knowledge database according to content based knowledge organization service model is our motivation of this project.

IASDM is an extension of product development on the basis of the previous disease database system (CDD), which began in 2006 as we called it first phase project. It is composed of four databases: Disease Database, Drug Database, Laboratory Examination Database and Evidence-based Medicine Database. The Disease Database System is a diagnostic consultant system using a multi-membership design for its inference engine and relational database technology for its knowledge base maintenance. The Disease Database System has the capacity to collect disease information, drug information, laboratory findings. The disease information correlates with the clinical information from drug, laboratory and evidence-based medicine databases.

The disease database system covers about 7000 kinds of diseases collected from 26 different specialties, which include rheumatology, gastroenterology， cardiology, respiratory system, endocrinology, neurology, hematology, nephrology, metabolic system, cardiovascular surgery， thoracic surgery, hepatobiliary surgery, general surgery, urological surgery, neurosurgery and orthopedic surgery and burn surgery. Besides, there are also obstetrics and gynecology, pediatrics, ophthalmology, dermatology, epiphytology, psychiatrics, oncology, stomatology and otolaryngology. In terms of drug database, it covers about 6000 drugs classified into more than 10 categories. With regard to laboratory examination database, it involves more than 1300 types of items.

The project began in 2006 and the network trial users reached 400 and mirror site users reached 50.

3 Development of Integrated Application System in Digital Medicine (second phase)

In order to enlarge its expansion and development of the original database system, proposal for the construction of the second phase project, for which the research background, research significance, pivotal questions, research contents, technical approach and implementation steps, has been worked out.

IASDM on the basis of the resources of the Medical Library of Chinese People's Liberation Army integrates the resources from many institutions in China.

It is inevitable that the first phase research achievements should be expanded according to users' feedback to work out new research contents for the second phase project. A survey was conducted with questionnaires including safety, performance, convenience and quality of the disease database system and feedback was received and analyzed. The response focused on the expansion of the original system, and the expansive project may cover surgery database, atlas database of surgery and database of surgical procedures on video, which could be integrated into a multimedia resource system with text, atlas and video. Specifically, on the basis of the existing system, additional databases such as surgery, atlas and model surgery video would be made with the latent power from the mobilization of the whole army. To ensure the success of the project, a leading team was established, under which several groups such as an office, an experts committee and a research team was established to be respectively responsible for coordination, supervision, administration and implementation. Standard of classification for video of surgical procedures was worked out, and an instruction about collection of model surgery video within the army was made.

It is expected that members of the research group would typically have clinical experience with the diseases of interest. Members of the group should represent many of the areas of expertise required to address the clinical problem in a comprehensive manner through collaborations. Equipment, staffing, or resources may be needed, such as acquisition of servers and computers for data processing.

IASDM group is a group of computer scientists contributing to the aim of designing and developing a public disease knowledge base, which would become available to all clinicians for study and analysis. This repository contains and correlates the information necessary to make pharmacological and disease-related interpretations.

All aspects of the component design should be considered and discussed, and the approaches proposed should be clearly explained and justified. In the final form, these functions must be presented in a user-friendly manner.

The experts committee would discuss the overall progress made within the IASDM at its meetings. The committee would make recommendations regarding how data should be obtained and expressed, in order to encourage data collection that is as uniform and as complete as possible and maximally valuable to all clinicians. The committee also discusses and advises development of IASDM, and it would seek to develop common guidelines and procedures for depositing the information. The committee would work to set standards for data format, and would also identify and discuss any issues that arise in connection with the scientific aspects of IASDM. It can create information-gathering subcommittees to follow up on particular issues or needs at any time.

3.1 Objectives

The objectives of the project are to improve the professional quality and upgrade technical and research capabilities of the health professionals in China, and to establish a digitalized medical network platform which is bulk memory, technologically advanced, two-way interactive, safe and reliable, and to realize medical education transformation and modernized education network. One of the most important goals of the project was to create a tool which could be easily understood and used by researchers to support them in their routine tasks.

3.2 Research Contents

The project is an integrated multimedia resource system together with text, atlas as well as video on the basis of expansion and development of the original database system. It can also be an independent system. Apart from the original functions, individual functions will be added. More than 3500 kinds of surgical operations, about 25000 atlas and 3000 surgical videos will be made. The surgical operations refer to the following specialties: general surgery, plastic surgery, orthopedic surgery, neurosurgery, thoracic surgery, cardiovascular surgery, urological surgery, pediatric surgery, ophthalmic microsurgery, head and neck surgery, oral and maxillofacial surgery and obstetrics & gynecology. Surgery Database System newly developed generates the information of more than 3000 surgeries including surgical indications, surgery contraindication, preoperative preparation, anesthesia, positioning, surgery steps, postoperative processing and surgical complications. It allows users to access the disease information from surgical indications that describe different diseases.

In addition, a platform will be built with all the available heterogeneous databases ordered by the Medical Library of Chinese People’s Liberation Army. In the database-based method, the metadata records of all the available heterogeneous databases are imported into a new database. The user's search is then performed on this new database. The full text of a document from a source database can be imported into the destination database as well (if authorized), or alternatively a hyperlink to the full text may be provided in lieu of the full text. Because of the diverse types of metadata, the new database must have a core metadata set as the transform standard in order to integrate the different types of metadata forms into the union retrieval system. The system has been established and is being tested in the Medical Library of Chinese People’s Liberation Army, and it will be in operation soon.

In any complex environment, it is unlikely that it is possible to design and build one unified knowledge organization system or service which will satisfy all requirements and thus be used by all people.

3.3 Methods

In the web-based method, an application is employed to accept and distribute the user's query. This application plays the role of an intermediary agency. If the source database search system is web-based, it can be added into the application as an option. Unlike the method described above, the core of the web-based method is to map a user's query between multiple database search systems. The Heterogeneous Resource Union Search Platform, developed by the Medical Library of Chinese People's Liberation Army, is a model of the web-based method.

IASDM has been developed by Medical Library of Chinese People's Liberation Army in collaboration with many doctors from different hospitals in Beijing. The system uses semantic Web technology, a new standard for knowledge organization and transfer on the Web. It organizes and manages knowledge using formal knowledge descriptions called ontology. These formal knowledge descriptions enable us to tie statements made in scientific publications to scientific evidence, biological terminologies, and knowledge bases.

A document indexing system specifically developed for clinical medical content on the Internet. By its limitations, further proof that medical knowledge is more than the sum of the lists physicians learn by rote.

Besides integrating database retrieval systems, it can integrate search engines (e.g., Google) into its platform. Theoretically, any retrieval system that supports the web-based search method—that is, B/S pattern—can be selected as a data source. The search mechanism and speed depend on the source retrieval systems and the status of networks.

Researchers working at levels ranging from basic to clinical, in the fields of pharmacology must demonstrate that they can work together, so that functional variation in the use of medicinal drugs that may play essential roles in determining drug responses can be studied, interpreted, and related to clinical research situations in a rapid and efficient manner.

IASDM should ultimately encompass a variety of diseases, drugs, surgical operations, laboratory findings, surgical atlas, clinical operative procedures and evidenced-based medicine. This would be accomplished by funding a research group and knowledge base group that were systematically organizing the information.

The researchers at the research group are of multidisciplinary, collaborating scientists. They should be formed by self-assembly of a highly integrated group of clinicians into a cross-disciplinary team, and each would have a unique blend and breadth of complementary research expertise, focusing on a disease or drugs of interest.

IASDM links clinical data for systems where variation information is required to optimally predict therapeutic drug responses. A secure, stable, interactive central structure is created that would link to other clinical data resources. Ultimately, IASDM will be a useful resource to discover previously unsuspected correlations.

3.4 Results

Integrated Application System in Digital Medicine within the Army has been developed. It is a diagnostic consultant system using a multi-membership design for its inference engine and relational database technology for its knowledge base maintenance. Drug Database System is the primary data entry module. Two major shortcomings of many medical drug systems are their incompleteness of commonly used drugs and the lack of interconnection with disease database from one system to another in China. In many cases, the information about a drug can be accessed only through the system that created the drugs. In addition, most drug systems do not have connection with disease information. To solve this problem, the drug system was developed as a front-end to disease database, but can serve as the front-end to many other systems as well. Laboratory Examination System supports the entry of complete physical and chemical examination including general descriptions, normal value, operating procedures, clinical significance and laboratory data. Laboratory examination system generates laboratory findings that allow disease information to be used in multiple domains by multiple systems. Multiple encounter records can be accessed by the physician at any point in the system. Other achievements have also been made.

The Feature Dictionary System was developed to support recognition of terms and to control the quality of the data shared by multiple domains. The feature dictionary supplies phrase equivalents for features, feature interactions, feature classifications, and mapping from one feature representation to another. The toolbox that supports creation of diagnostic patterns and treatment protocols also supports the addition of new feature dictionary entries as the system expands into new medical domains. Because different terminology is often used by physicians of difficult specialties or locations to refer to the same feature, it is necessary that IASDM knowledge base provide a means to compensate for discrepancies in terminology or definition. For this purpose, a new data base called the feature dictionary has been designed

IASDM is a cross-referenced index of human disease, medications, symptoms, signs, abnormal investigation findings etc. It provides a medical textbook-like index and search portal covering areas including. The application of the Diseases Database is intended as an 'aide memoir' and World Wide Web springboard for medically qualified health professionals and medical students. The Database itself provides

- Internal medical disorders
- Surgical disorders
- Common laboratory findings

- Drugs and medications
- Surgical atlas
- Evidence-based medicine materials
- A pre-loaded multiple search engine enquiry page using all item synonyms
- These facilities are tightly cross-navigable
- Subject specific hyperlinks to web information resources for many items
- A means of organizing medical knowledge electronically

IASDM **s**ystem includes more than 7000 kinds of diseases with description of cause of disease, epidemiology, clinical manifestations, pathogenesis, diagnosis, laboratory examinations, differential diagnosis, therapy and prognosis.

Drug database system provides more than 5400 kinds of drugs aiming an automated clinical drug system.

Laboratory examination system supports the entry of about 1300 kinds of complete physical and chemical examination including general descriptions, normal value, operating procedures, clinical significance and laboratory data.

Evidence-based medicine system maintains 90,000 entries of evidence-based medicine material from 200 Chinese medical journals and 18 foreign medical journals and 4 evidence-based medicine databases.

Surgery database system provides moth than 3,000 various kinds of operations with links to the disease database.

Difficulties of ensuring different users with adequate access to Internet still exist.

The Feature Dictionary will provide a means for transcending the medical "language barrier" by recognizing the entry of a feature into the knowledge base no matter which of the common terms the particular expert has used. For instances in which the expert comes across an unfamiliar term in the system, he or she will be able to call up a definition of up to four expressions which will describe exactly what the feature is to which the term refers.

In terms of the system use, type a single symptom, sign, disease, non-branded drug name, surgery name or laboratory test name result on an in-house search engine, and it generates a list of associated subjects. In turn the search term can also be submitted to some highly respected external internet resources, generating an impressive range of useful links.

It provides a searchable interface that indexes (by topic) thousands of pages from reliable sources such as the Cochrane Library, and so forth. Users can "drill down" more deeply into each topic for signs, symptoms, risk factors, and related topics.

4 Future Work

We have presented a proposal and outlook for constructing knowledge organization systems in a new way, following the general idea of knowledge element being built from independently constructed components. One of the most important aspects of knowledge element is that they are built from easily understandable components, and should present themselves as easily understandable components. Because of this, we propose to build these components based on standard XML technologies rather than more advanced technologies for which tools and know-how are not very wide-spread.

While the approach presented here is a modest one in terms of advanced underlying technologies, it may have more practical impact because it helps people to help themselves. However, some support is required, and future work in this direction should include methods and tools for tracking and documenting the development of Knowledge Organization within an organization, and the question how to distribute this information.

At present, IASDM is not the final goal, and it may be necessary to develop it in stages, thus applications for significant components that complement the present knowledge base will be considered. From time to time the researchers may propose to develop computational tools to view and evaluate the data in different ways, and to query the data to identify new relationships. The goal will be to explore complex, interconnected data, and to integrate the data in order to enhance understanding of its clinical significance.

5 Conclusions

In a digital environment librarian should be familiar with search engines such as Google, yahoo etc. and relevant websites according to their users needs. In a traditional library system, librarian used to compile cumulative indexes for the benefit of their users. But in a digital system librarians can use various databases, library networks, search engines, websites etc. to search information.

We use traditional and non-traditional knowledge organization systems for content organization. In the digital environment, we use classification systems to organize the knowledge. The approach presented here is a light-weight approach in the sense that it trades semantic expressiveness for ease-of-use and increasing the chances of a dynamic evolution of knowledge organization systems and services. In a federated environment, this approach is more likely to produce an environment in which information and knowledge can be easily used, shared, and reused and are thus put to their best use.

IASDM is considered a reform project in the field of diseases and drugs and it is hoped that it will be changing Chinese readers' information searching behavior.

The Health Ministry of General Logistics Department of Chinese People's Liberation Army is supporting a 3 year project to help fund the development of IASDM that will assist clinicians understanding the knowledge of diseases and related subjects such as drug information and laboratory examinations to accelerate the development of diagnostics, and therapies. The knowledge base will enable individual clinician to manage data from private and public sources in both the scientific and medical communities. The web based system being developed will be available by a portal on a website. A security system will allow smaller networks of colleagues to exchange ideas to test hypotheses and, later, to release the data to the public knowledge base.

References:

1. Fujita T, Miura Y, Mayama T. A pilot study to build a database on seven anti-hypertensive drugs. Pharmacoepidemiol Drug Saf. 2005 Jan;14(1):41-6.

2. Case definitions for infectious conditions under public health surveillance [http://www.cdc.gov/ncphi/disss/nndss/casedef/index.htm]

3. Panackal A, M'ikanatha N, Tsui F, McMahon J, Wagner M, Dixon B, Zubieta J, Phelan M, Mirza S, Morgan J, Jernigan D, Pasculle A, Rankin J Jr, Hajjeh R, Harrison L: Automatic electronic laboratory based reporting of notifiable infectious diseases at a large health system. Emerg Infect Dis 2002, 8:685-691

4. National Electronic Disease Surveillance System –Lab Reporting [http://www.cdc.gov/nedss/ELR/index.html]

5. College of American Pathologists. SNOMED-CT [http://www.snomed.com/snomedct/index.html]

6. Federal Information Processing Standards (FIPS) Codes [http://www.census.gov/geo/www/fips/fips.html]

7. Price, C. and Spackman, K. (2000). SNOMED clinical terms. BJHC&IM-British Journal of Healthcare Computing & Information Management 17(3): 27-31.