J11305-0127

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ONTOLOGICAL MODEL FOR REPRESENTATION OF LEGAL KNOWLEDGE

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Introduction

The current generation of students is to get more knowledge than the previous generation, in the same period of study time. Besides content knowledge in academic subjects is continually updated, making the urgency to create and update operational manuals that meet the latest achievements in science and technology. This is especially important for higher education that by its content must reflect the current and future trends of disciplines development.

Providing for updating of training materials into electronic resources is much easier than in printed ones. Therefore, in many universities e-learning materials are in active use. For example, in Ukraine for the specialty «Jurisprudence» in National University «Yaroslav the Wise Law Academy of Ukraine» on the basis of program MOODLE about 30 training electronic information complex-systems in various academic disciplines are created. Lecturers are involved to update content in them. The fact is that Ukraine is in active formation of a democratic society, so the legislation is changing at an intensive rate and lecturers of law disciplines have to change the content of academic disciplines literally every day.

In order to reduce labour costs for updating the content of training disciplines and make the process faster, in National University «Yaroslav the Wise Law Academy of Ukraine» a software system that automatizes the process of accumulating and updating of educational information on the basis of ontological scheme of knowledge representation is developed.

Computer networks are seen as a fundamental infrastructure for electronic education (e-education). Networks provide a flexible, secure, coordinated resource sharing among dynamic information collections of individuals and institutions.

Convergence between the networks and the latest developments in Web technologies such as service UDDI (http://www.uddi.org/), SOAP1 and WSDL suggest the development of distributed technologies towards open architecture Open Grid Services Architecture (OGSA) [1].

However, at present there is a gap between these network tools developed by the hardware and the prospects of e-learning, in which there must be a high degree of automatization which is easy to use as well as a flexible system of information and knowledge representation, backed on global resources. It is considered that the implementation of e-education prospects will depend on how effectively heterogeneous information resources of training, and procedures of its searching, processing, describing and presenting to the user for training can be described.

Semantic Web (Semantic Web) can provide support for the completeness of the e-education functions, considering the requirements of e-learning in the broadest sense. The Semantic Web is an extension of an existing Web in which information has a clear meaning, more available for processing, presentation and software. The information in the semantic web is defined and linked in such a way that it can be used for a more efficient search, automatization process, integration and reuse in various applications. Advanced technologies of knowledge representation are connected with the process of management of scientific knowledge in terms of life-cycle of knowledge-oriented activities that includes the acquisition of knowledge, modelling, searching, re-using, publication and service. This provides knowledge infrastructure, i.e. the use of tools and methods to support the management and use of knowledge.

The urgency of these tasks is dictated by the need to improve education and the creation of conditions for the introduction of modern distance education and the implementation of automated (eventually automatic) for the formation of the school content in electronic education.

The problem area.

Legal action in Ukraine is not enough supported by information technologies. There are serious reasons for this: large volume of information that is used in legal

practice; structural peculiarities used in legal information; the complexity of processes of automated processing and, consequently, the lack of effective software tools. Each legislative act has the necessary details that reflect its legal effect, subject of regulation, scope of application, give it official character. Traditional advantages of legal language are clarity, certainty, stereotype, uniformity, its meagerness, understandability. The normative statement always contains regulatory terms «prohibited», «obliged», «have a right to» etc. On the other hand, the formal legal information is mainly represented in the form of unstructured text information, quite synonymous, has a time limit of its legality, reliability requirements, timeliness etc. It is also to be noted that at present there is an intense work in progress with legal environment of Ukraine and the consequence of this is the high level of content variability of this information. The above features make it difficult to its presentation and processing [2].

In the Center of Information Technologies of National University «Yaroslav the Wise Law Academy of Ukraine» the works are underway to create a system of education that focuses on effective work with legal information and is based on the principles of artificial intellect. For this purpose it is suggested to solve the following theoretical and practical tasks: formalization of legal knowledge as a semantic network; development of methodology of multi-user populated knowledge database; metric line development to determine the semantic distance between ontology concepts; to create technology for efficient use of the e-learning; to define ways to test students' knowledge in this system; the design of software components in this system.

Formal apparatus for constructing a knowledge base of legal information

Among the principal features of the system to be developed it is to be noted the use of the ontological approach to the organization of knowledge base in the field of legal information that organizes semantic network of concepts and related definitions. For the perception of integrity of the presented material we will indicate the well-known definition of ontology and its properties [3].

Ontology is a structural specification of a certain subject area, its formalized view that includes a dictionary (or names) of pointers to the domain terms of subject area and logical expressions describing how they relate to each other. In other words, on the theoretic level the ontology is represented as:

$$O =< P, R, F >, \quad (1)$$

where P - a finite set of concepts (concepts, terms) domain, which is an ontology O; R - a finite set of relations between concepts (concepts, terms) of a given subject area; F - a finite set of functions of interpretation (axiomatization) given on the concepts and / or relations of ontology O.

$$P = \{P_i\}, \quad (2)$$

where P_i – separate concept (concept), which has its own semantic representation, which is associated with the set of concrete facts and the set of feasible syntactic constructions.

Thus, ontologies provide a vocabulary for representing and sharing of knowledge about a certain subject area and set of relations established between terms in this dictionary.

Formally, the notion P_i (2) is represented as a set of phrases W_i that are composed of groups of synonyms W_i:

$$\begin{aligned} P_i &= (W_1^i, \ldots, W_n^i); \\ W_i &= (S_1^i, \ldots, S_n^i). \end{aligned} \quad (3)$$

Element of the ontology is also a connection between the concepts or groups of concepts:

$$(P_n, \ldots, P_m) R_r (P_k, \ldots, P_l). \quad (4)$$

In the aggregate of concepts of the ontology (3), as on sets, you can perform: reflexivity, symmetry, transitivity, linearity. And over the ontologies and their parts can perform the following operations: meshing, cross-cut, diminution, excerpt etc.

In the process of content development the groups of users are aimed to build up an ideal ontology. By this term let us set a dynamic knowledge base, which is constantly improved and developed by groups of users. A graphical representation of

the ontology as a hierarchy of concepts and sets of relations let us set as an ontology graph.

Building up of ontology (ontological engineering) is a powerful cognitive tool to determine the significant concepts for the task solution and the relations between the concepts. Ontological engineering algorithm can be represented as a sequence of operations:

• allocation of concepts − the basic concepts of the subject area;

• the definition of «tree height ontology» − the number of levels of abstraction;

• distribution of concepts by levels;

• building up of relations between concepts − definition of relations and interactions of basic concepts.

The advantage of ontological engineering is a holistic approach to the subject, especially with distributed and interconnected resources. As this takes place it is achieved:

• consistency − ontology represents a holistic view of the subject area;

• monotony − the material represented in a uniform manner is much better understood and reproduced;

• scientific character − building up of ontology allows to recover the missing logical connections in its entirety.

We give some reasons needed to develop the ontology:

• for shared use by people or software agents, a common understanding of the structure of information;

• for the reuse of domain knowledge;

• in order to make explicit assumptions in the subject area;

• to separate domain knowledge from the operational knowledge;

• to analyze the domain knowledge.

The practical realization of the approach

The proposed approach is implemented as a software system that provides on practice the two main contents: the ontology (contains concepts and relations between

them) and source code that forms the ontology [4, 5]. Relational database instrument was selected for data storage.

Structure of the database

In summary, the structure of the database consists of the following parts:

- concepts and communication;
- relations among groups of concepts;
- the source text;
- lexical indication of concepts and relations;
- usage indices of the concepts and relations in the text.

Let's consider the representation of each element.

- concept and relations: they are recorded with unique identifiers, with a string of titles to display a graphical interface.

- text-sources: they are stored as a set of string-sentences, with fixing of accessories to section and text, so it is possible to identify the following contents:

- text - ordered set of sections, type, name, list of authors and comments;
- section - name, ordered set of subsections, and ordered set of sentences;
- sentences - text of the sentence in the form of string and type of sentence (belonging to the main text of the title or its head label).

In lexical indication of concepts and relations it is allocated the four contents:

- the concept - is an ordered set of synonymous phrases;
- a phrase - is an ordered set of groups of synonyms and string-name to issue in the graphic interface;
- a group of synonyms - ordered set of words and string-name to issue in the graphic interface;
- a word-string (used to issue in the graphic interface and directly to find concepts in the text).

Relations between groups of concepts are organized in a separate data of belonging of the concept of group and separate data regarding relatedness of groups (considering the type of communication).

Usage indexes of the concepts and relations in the text are displayed in the database as follows:

- belonging of certain words to a particular concept, or communication are stored;

- binding point of reference between the two groups of concepts to the proposal on the whole, as the source of this communication, is saved.

Based on the above, the structure of the database was developed [6].

Software implementation of the system

Software implementation of the system is made in the form of four sub-systems, using modern technologies of object-oriented visual programming in Eclipce 3.4 in Java with support for version 1.6.

Web-user interface and automated operation with the knowledge database, including automated ontology content from text documents is provided.

The major subsystem that determines applicability of the system is the applique work of user. Global targets of the applique work of user are: 1) navigation in the ontology; 2) the search of text-sources fragments corresponding to the elements of the ontology; 3) viewing of the text-sources in full, divided into sections, marked text.

Each of these tasks requires the implementation of certain scenarios of work with application. For navigation in the ontology (the first task) the following features are provided:

1) selection of the date, so you can choose the actual data on the ontology and the text-sources;

2) a simple search engine of concepts, as part of the ontology, by the name of the selected concept;

3) the selection of communication;

4) review of all links of selected concept;

5) selection of a particular relation and to move to the viewing of the text-sources fragments;

6) the ability to select directly a concept that is used to build up a particular communication;

7) selection of the language elements of ontology, or translanguage mode to display the corresponding concepts in different languages.

The second task involves:

1) obtaining of data inputs from the browser in accordance with the concept and communication, or a particular relation;

2) reflection of the text-sources fragments corresponding to data inputs;

3) ability to adjust the sizes of the fragments;

4) extraction of used and known concepts and relations;

5) ability to choose a concept or a relation of the text-sources fragments, and move to the navigation in the ontology.

The third task - data view - takes as its basis the classic image of e-books, which include the following aspects:

1) ability to choose the source text by name (perhaps later it will be implemented the search by the author);

2) tree sections display to navigate by the content;

3) visual display of the full text of the section;

4) marking of known concepts and relations in text;

5) Transition to navigation in the ontology by the selected concept or thread.

User application provides installation of data access mode, i.e. authorization system will be implemented.

Currently in the process of filling is the knowledge base of information from the field of criminal law of Ukraine. The Expert Group is building an ontology based on the content of the textbook [7] that is the base for the study of this discipline in Ukraine. In the future, the knowledge base will include information from related areas of law.

In order to compare the ontologies of different users (represented as graph model) and to avoid adding to the knowledge base of «unreliable information», the

evaluation metric of similarity of ontologies and rating model assessment of the significance of concepts is developed.

The approach to the comparison of objects based on ontology, proposes in work three independent components of assessment of similarity [8]:

• by synonyms categories defining objects;

• by distinctive properties of objects;

• by semantic relations.

Conclusion

The calculations found as a result of conducted research for implementing ontological principles of knowledge-oriented learning systems formed structure of the database, which realizes the knowledge base, principles of the software system that are worked out, interface forms that are designed and software modules and subsystems of expert and user which are developed. Worked out software applications are oriented on technology «client-server» and allow the construction of a semantic network to the server with the ability of multi-user work of experts in the Internet browser on the client workstations. The system is adopted in trial operation at the Center of Information Technologies of National University «Yaroslav the Wise Law Academy of Ukraine».

Prospective studies are going to be run in the direction of representation of fuzzy relations between the concepts in the knowledge base, depending on the degree of confidence in the relations among them.

Literature

1. Doroshenko, A. A distributed platform for resource management of heterogeneous cluster / A. E. Doroshenko, K. A. Ruhlis, A. S. Mohnitsa // Problems of programming, 2008. № 2-3. A special issue, p. 150 - 156.
2. Tatsyi, V. Semantic network of knowledge in science of law / V. Tatsyi, A.Getman,, S. Ivanov, V. Karasiuk, O. Lugoviy, O. Sokolov // Automation, Control, and Information Technology (ACIT in 2010): Proceedings of the IASTED International Conference on Automation, Control, and Information

Technology, held June 15 - 18, 2010 in Novosibirsk, Russia / The International Association of Science and Technology for Development. - Anaheim, USA, Calgary, Canada, Zurich, Switzerland: ACTA Press, 2010. p. 218 - 222.

3. Gavrilova, T. Knowledge Base of intelligent systems. / T.A. Gavrilova, V.F. Khoroshevsky - StPb.: Piter, 2001. - 384 p.
4. Karasiuk, V. Knowledge base model of the ontological system. / V.V. Karasiuk, S.N. Ivanov // Works of the scientific conference with international participation «Computer modeling in knowledge-consumptive technologies» (KMNT-2010). Part 1. - KNU them. V.N. Karazin: - Kharkov, 2010. p.159 - 162.
5. Tatsyi, V. Virtual information environment in science of law based on ontological knowledge model / V. Tatsyi, A. Getman, O. Sokolov, M. Shvets, S. Prylypko, S. Ivanov, V. Karasiuk, O. Lugoviy // Information Technology and Electrical Engineering - Devices and Systems, Materials and Technologies for the Future: Conference Proceedings 54.Internationales Wissenschaftliches Kolloquium, 07 - 10 September 2009. - Ilmenau University of Technology, Ilmenau, Germany, Published By Impressum, Verlag ISLE, Betriebsstatte des ISLE eV, on Flash, 2009. - 8 P.
6. Tatsiy B. Information preparation of modern lawyer: Problems and Prospects. / V.J. Tatsiy, S.M. Ivanov, V.V. Karasiuk // The professionalism of the teacher in the context of Ukraine's European choice: Materials of the international Scientific Conference «The professionalism of the teacher in the context of Ukraine's European choice», 18 - 20 September 2008. Yalta. - articles. - Yalta: HAE KSU, 2008. - Part 3. - p. 72 - 76.
7. Bazhanov, M. Criminal Law of Ukraine: the general part. / M.I. Bazhanov, Y. Baulin, V.I. Borisov for Ed. M.I. Bazhanov, V.V. Stashis, V.J. Tatsiy - Kyiv: Yurinkom, 2005. – 480 p.
8. Kapoor, B. A Comparative Study Ontology Building Tools for Semantic Web Applications / B. Kapoor, S. Sharma // International Journal, 2010. Vol. 1, p. 1-13.