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USE OF MEREOLOGICAL APPROACH FOR ONTOLOGICAL CONSTRUCTING IN EDUCATION TASKS

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The growth of the information society provides a way for fast data access and information exchange all over the world. Now, a lot of materials that used for education process exist in electronic form. In many domains the results of work are plain test materials. However, human readable data resources (like student control works, reports etc.) have serious problems for achieving machine analyses.

Computer technologies have been significantly changing the content and practice of education. The consequent applications of multimedia, simulation, computer-mediated communication and communities, and internet-based support for individual and distance learning all have the potential for revolutionary improvements in education [1]. E-learning is an alternative concept to the traditional tutoring system that offers new possibilities in learning [2]. In order to obtain better tutoring outcomes, a software tutoring system should emphasize engaging students in the learning process and be adaptive to each individual learner.

The goal of the early software tutoring systems was to build user interfaces that provide the efficient access to knowledge for the individual learners. Recent and emerging work focuses on the learner control over the learning process such as learner exploring, designing, constructing, and using adaptive systems as tools.

With the application of more computer techniques in education and the involvement of more adults in software tutoring systems, the learner control strategy has become more appreciated than tutor control or program control. Learning control needs the comparison means of learner's knowledge base that

forms (and modifies) in learning process with the course domain knowledge base.

Ontological approach is a base for development of semantically enriched e-Learning systems: domain ontology can be used as a interoperable reused knowledge base. Thought the design of domain ontologies is an important part of the intelligent e-Learning systems design.

Ontologies in e-Learning. In modern researches in the field of the distributed knowledge management the term "ontology" is used for explicit conceptualization of some subject domain. The ontologies provide the common dictionary of the certain sphere of activity and determine - with various levels of formality - meaning of the terms and relations between them. A structured information representing is required and ontologies (machine processable representations containing the semantic information of a domain) can be very useful. The ontology systems serve as a flexible and extendable platform for knowledge management. The inspiring idea to develop reusable atomic learning components and to capture their characteristics in widely-accepted, formal metadata descriptions will most probably attract learning object providers to annotate their products with the accepted standards [3].

The experience of the developed countries shows the technological achievement of remote training – e-learning - that opens many new opportunities in expansion of student's number with the same number of the tutors and in improving of education quality. In recent years, e-Learning has been widespread, especially since standardizing initiatives for learning technologies have begun.

The domain ontology plays central role as a resource structuring the learning content [9]. One of the key challenges of the course construction process is to identify the abstract domain of information within which this course will exist. Tutor has to describe the main terms and concepts from which a course is to be constructed.

The domain ontology is not only the instrument of learning but an object of examining and forms by students. We propose for students to build the domain ontology of examine discipline and then compare it with reference one. Results of this comparison show the mistakenly understood parts of domain knowledge and help tutor in improvement of distant course .

Fundamental relations of ontologies. The purpose of work is to offer methods of the description of ontological relations deal with "the part of" semantic. Elements of the mereological analysis are used for it.

The most common relations in real domain ontologies are discriminated: *connection of equivalence; taxonomical connection; structural connection;*

connection of dependence; topological connection; connection of the reason and consequence; functional connection; chronological connection; connection of similarity; conditional connection; target connection. Examples of the binary relations: "A is a subclass of B " and "A is connected with B".

However not all these ontological relations are equal in value. There is possible to allocate some fundamental relations in this set, such as taxonomy and mereology.

The relation is named fundamental if on the basis of this one given relation the formal system allowing to express the basic mathematical concepts can be constructed.

Taxonomy is a system of classification. A typical example of taxonomy is the hierarchical list (qualifier). The classes in ontology are usually organized in the taxonomy. The taxonomy in which the object can meet more than in one branch, refers to as "poly-hierarchical". The word "taxonomy" comes from two Greek words: "taxis" (order) and "nomos" (agreement). Term is borrowed from philosophy. The taxonomy is the science which studies sharing into the ordered groups or categories. From the ontological point of view, taxonomy is the ontological organization based on the partial ordered relation called «x is A» by means of which the objects are grouped together or more high level is referred to classes. Only a few of common taxonomic properties exists: 1) asymmetry; 2) transitivity; 3) antireflexiveness.

The good taxonomy should have a resolution threshold that is able to don't group various objects in the same category and to ensure the appropriate number of categories for domain modeling in a controlled way.

The term "taxonomy" has a widespread and does not require an additional definition but the term "mereology" in researches connected with IT is applied more occasionally and that`s why requires an additional decoding.

Mereology (from Greek "part" и "study") - formal theory about parts and concepts connected to them. This term was used by the Polish philosopher Lesnevsky [4] who had analyzed philosophical, logic and mathematical components of the mathematics bases. The calculus of names of Lesnevsky is constructed as alternative to logic system of Rassel for purposes of natural generalization of traditional logic.

Mereology is the part of this triad of the deductive theories (Lesnevsky considered an ontology only as a system with the unique relation "is_a"). It is more correct to speak not about three systems Lesnevsky but about three section of one system named as "the basis of mathematics" that consists of the appropriate formal theories. The relation "part - whole" is extremely important

because it forms a concept basis of system that is central in modern scientific knowledge.

In mereology the relation "part-of" is expressed through the operator "<". The use of two meanings of such relation is taken into account here: (1) Something that includes concept of equality between instances is named as a characteristic part (" < < "); (2) Something that excludes occurrence of equality is named as a part ("<").

Both aspects can be formalized as follows. Two objects, x and y, are given, and x - part y, then x < y if and only if: 1. $x << y$ or 2. $x = y$, where $x << y$ designates that x is the essential part of y.

The relation "part - whole " has the following properties: 1) asymmetry: $(x << y) \Rightarrow \neg(y << x)$; 2) Transitivity: $(x << y) \wedge (y << z) \Rightarrow x << z$.

The *system* represents structural connection of it's elements. Its base formal characteristic is the property that the elements not are simply included into system, but are included into it as a result of interaction with other elements. As initial the relation M (a, b, c, s) is used. It means that in system s a incorporates with b by means of c, that designate usually as $a \xrightarrow{c} b$ if S is explicit from a context, and c connects only these two elements.

The capacity axiom is applied for mereology: the systems connecting the same objects by the same ways are equal.

Other axioms of mereology describe relations between system and its elements. Mereology exceeds the bounds of study of the partial relations between elements of general systems. It also is engaged in those objects which parts are relevant to whole. Such objects are identified as instances.

Among the mereological relations it is possible to allocate seven classes, and in general, the transitivity is not accepted among instances of different classes [5]: 1. *Component - object*: page - book; 2. *Member - collection*: tree - wood; 3. *Part - weight*: piece - bread; 4. *Material - object*: aluminum - airplane; 5. *Property - activity*: to see – to read; 6. *Stage - process*: boiling - preparation of tea; 7. *Place - area*: Ukraine- Europe.

Use of the mereological relations for e-Learning Tasks. Process of construction of ontology, according to methodology of development of ontological models IDEF5 (Integrated DEFinition Methods) [6], consists of five basic actions:

1) Study and systematization of the entry conditions. This action establishes the basic purposes and contexts of the project of development of ontology, and also allocates roles between the members of the project

2) Collection and accumulation of the data. At this stage a collection and accumulation of initial data that are necessary for ontology construction is carried out.

3) Analysis of the data. This stage consists of the analysis and grouping of the assembled data and is intended for simplification of terminology construction.

4) Initial development of ontology. At this stage the preliminary ontology is formed on the basis of the selected data.

5) Specification and confirmation of ontology - Final stage of process.

For maintenance of ontologies construction process in IDEF5 special schematic language (Schematic Language-SL) exists. There is a graphic language specially intended for a statement of main data of system by the competent experts in considered area in the ontological form. SL allows to build various types of the diagrams and schemes in IDEF5. A designation of a class and designation of a separate element enter to it.

Conclusion. Mereological approach defines the semantics of the different aspects of ontological relations between the parts and the whole. All mistakes deal with the ontology's relations of concepts “is a part” result to the great problems on the understanding of the subject domain and student skills examining in the learning process. If we classify the subtypes of all mereological relations of domaim ontology then we can more accurately define the subject domain.

Literature

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Summary. Mereological approach is an important instrument of ontological analysis that deals with the different aspects of the fundamental relations between the ontology's concepts “is a part”. All mistakes of this phase result to the great problems on the understanding of the subject domain and student skills examining in the learning process. We propose to classify the subtypes of all mereological relations of domain ontology for their more correct development.

Keywords: e-learning, ontology, mereology, knowledge.

Аннотация. Мереологический подход является важным инструментом онтологического анализа, который касается различных аспектов фундаментальных отношения между онтологическими терминами типа “быть частью”. Ошибки, возникающие на этом этапе, приводят к значительным проблемам в понимании предметной области и оценке навыков студентов в процессе обучения. Мы предлагаем классифицировать все мереологические отношения онтологии домена для ее более корректной разработки.

Ключевые слова: е-обучение, онтология, мереология, знания.

Анотація. Мереологічний підхід є важливим інструментом онтологічного аналізу, що стосується різних аспектів фундаментальних відношень між онтологічними термінами типу “бути частиною”. Усі помилки, що виникають на цьому етапі, приводять до значних проблем у розумінні предметної області й оцінці навичок студентів у процесі навчання. Ми пропонуємо класифікувати всі мереологічні відношення в онтології домену для її більш коректної розробки.

Ключові слова: е-навчання, онтологія, мереологія, знання.