NEW ENTERPRISE CONCEPTS. REPRESENTING ORGANIZATIONAL MEMORY THROUGH ONTOLOGIES

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Abstract:
The present paper is a component of an exploratory research project focused on discovering new ways to build, organize and consolidate organizational memory for an economic entity by means of the new "Semantic Web" technologies and also encloses some of the results of a previous doctoral research in the field of information technology assistance for the financial audit. The paper is an attempt to synthesize the ways "Semantic Web" ontologies definition, description and representation may be improved by the use of the Unified Modeling Language (or UML). The use of a modeling tool for ontologies description and representation is, in the author's opinion, a way to further interconnect human-level knowledge and machine-level data in order to "get the best of both worlds", which is the final objective of the Semantic Web.

Key words: *organizational memory, unified modeling language, semantic web, ontologies*

JEL classification: *M15*

Introduction

The essence of an ontology (at least, according to the interpretation the new "wave" of the Semantic Web imposed) is tightly related to vocabularies (as collections of terms) and the completion of the terms' significance by means of expressive, explicit and well-defined semantics. The involved semantics should provide enough structure and contents so as interpretation of an ontology by an information system (a machine) should be regarded as a tangible goal for the very near future (Davies *et al.*, 2006). In order to get a realistic and quite complete view of the ontologies' place and role in the wider landscape of the Semantic Web, one should be familiar with quite a comprehensive set of concepts (including semantics, knowledge representation, truth function, intension, extension, axiom, theorem, theory etc.). In the absence of these concepts, the actual tendencies and trends of semantic technologies are extremely difficult (if not impossible) to understand.

Research Methodology

The paper is a component of a wider research project called "*Development of Romanian Accounting Regulation between Heredity and Thanatogenesis*", and also continues a previous doctoral research in the field of computer-assisted financial audit tools and techniques, whose final results were publicly defended in order to be validated by the scientific and academic community. The main goal of the aforementioned research was the identification of some new areas of applicability for the modern knowledge-based information technologies in the field of financial audit.

In order to provide a set of valid and well-documented opinions about the realistic ways of augmenting the use of organizational memory by means of the modern information technologies, the author's proposals were preceded by an ample process of documentation and analysis of the field literature, allowing to get into terms with the main schools and opinion trends in the area, as well as the actual level of interconnection among the disciplines contributing to the present content of the "organizational memory" and "Semantic Web" concepts. When possible, practitioners' expectations identification was attempted, both by means of questionnaires and direct interviews. In case some other author's opinion was enclosed, whether in exact quotation or synthetic form, a complete mention of the source identification information was made.In the author's opinion, the main limitations of this research work may be synthesized as follows:

- Some of the technologies taken into account for both design and implementation of financial and accounting organizational memory management systems are still in some early development or adoption phases, as others are in the specifications refinement phase, and, as a result, their current versions may have a set of serious limitations as opposed to the users' expectations.
- Due to the special status and confidential or "classified" contents of the detailed and complete financial and accounting data, the author was not able to access an exhaustive set of real-world data, most of the design and implementation iterations being performed on a set of test computer-generated data.

By defending the research results at the proceedings of such a scientific conference, attended by both scholars and practitioners bearing some interest in the research area, the author attempts to get further validation of his opinions, both confirmation and rejection of the aforementioned opinions' scientific and practical importance being welcome.

Ontologies Representation and Management, As a Semantic Tool for Organizational Memory Consolidation

According to its common definition, an *ontology* defines terms and concepts (or meanings) employed to describe and depict an area (or domain) of knowledge. In order to get a first idea about the meaning of the term *ontology*, an explicative dictionary may be consulted. This attempt usually leads to one of the two related definitions: "a branch of philosophy studying the most general attributes of *existence*" or, "the theory of *existence*" (www.dexonline.ro, 2009). The two definitions place the term in the field of philosophy, as a branch oriented towards the study of the principles underlying an object of thought. The term was also employed in the field of information technology, in order to describe the field of knowledge design, description and organization outlined during the last decade. Even if the relevant literature has not yet provided a unanimously accepted definition, in the author's opinion there are at least three definitions which need to be taken into account:

- "*An* ontology *defines the language elements, along with the underlying concepts (or meanings) used to describe a domain of knowledge*" (Hendler, 2001).
- "*An* ontology *is an information systems design product, enclosing a specialized vocabulary employed to describe an aspect of the reality, together with a set of explicitly assumed premises (explicit assumptions) regarding the aforementioned vocabulary's purpose and goal*" (Guarino, 1998).
- "*An* ontology *is a way to exhaustively and rigorously organize knowledge form inside a domain. Organization is usually performed in an hierarchical manner and encloses*

all the relevant entities pertaining to the modeled domain, along with the relationships arising among the entities themselves” (WordNet, 2009).

A comparative analysis of the three aforementioned definitions emphasizes the terms “*description*”, “*organization*” and “*knowledge*”. Any description of a knowledge domain assumes that sufficient explanations are provided, concerning both the *entities* inside the domain and *relationships* arising among the entities. The domain description may also include a set of domain *rules* that may be employed as a basis for new knowledge generation. As a consequence, we may be able to conclude that any complete and rigorous description may represent an ontology. The following table (Table 1) provides a comparative presentation of the elements considered (according to the author’s opinion) to be of main importance for the content of an ontology, along with proposals concerning the Unified Modeling Language (or UML) elements which optimally comply with each item’s representation needs.

ELEMENT NAME		**DESCRIPTION**	**UML DIAGRAMS PROPOSED FOR PRESENTATION**
ONTOLOGY	**UML**		
Class	*Class*	A general element pertaining to the modeled domain.	- Class diagram - Component diagram - Object diagram - Package diagram - Composite structure diagram
Instance	*Object*	A particular element pertaining to the modeled domain.	- Class diagram - Component diagram - Object diagram - Any interaction diagram
Relationship	*Dependency, Association, Aggregation, Composition, Generalization, Participation, Message (Call)*	A semantic relationship among two or more (general or particular) elements.	- Class diagram - Package diagram
Propriety	*Attribute*	A characteristic of a general element able to receive a value for each of the pertaining particular elements.	- Class diagram
Function	*Method*	A behavioral item or a phase of a process involving general or particular elements.	- Class diagram - Activity diagram - Statechart diagram
Process	*Process*	A collection of interconnected treatments designed to fulfill a single goal.	- Activity diagram (for the business process level) - Use case diagram
Constraint	*Guard, Condition*	A condition that needs to be satisfied by an element or a behavior.	- Object constraint language (or OCL)
Rule	*Restriction*	A principle governing a behavior or a part of a behavior.	- Object constraint language (or OCL)

Table 1 - Ontology versus UML elements comparison

In order for the *description* of a knowledge domain to be complete, the description should also be *represented*. The *representation* involves structuring the description in a manner which renders it usable bay all the stakeholders (both humans and information systems or computers). In its broadest sense, *representation* involves the *definition* of terms, followed by an *integration* of the terms defined, so as a larger part of the modeled knowledge domain is rendered accessible for the user (Barry and Welty, 2001). Although, in the field of information technology, *representation* has a more complex meaning: it involves building a model which is complete and rigorous enough to be used not only by a human being, but also by a machine or an information system (Rodriguez *et al.*, 2004). In the author's opinion, the Unified Modeling Language optimally complies with the aforementioned requests and, by consequence, may be used on a wide scale to represent the content of any ontology from within the Semantic Web, becoming an important tool for the organizational memory building and configuration.

UML models may enclose both information and decision elements regarding the semantics of the modeled domain and, as a consequence, they may be employed for the understanding, browsing, configuration, maintenance and control of the described domain (Evans *et al.*, 2000). The Unified Modeling Language is the quintessence of all the previous experience in the field of modeling techniques, an attempt to integrate all the best practices in the field into a unique standard and set of specifications. The UML has quasi-unanimous support from the visual modeling tools nowadays, mainly because it does not define a particular process, but is rendered compatible with any of the modern development processes, particularly with the iterative and incremental object-oriented ones. According to the author's opinion, the unified modeling language suits well the purpose of the present research and, as a consequence, may be successfully employed for an ontology's content representation and description.

The Unified Modeling Language specifications allow the modeler to collect data concerning the static structure and also the behavior related to a knowledge domain which is modeled in the form of a collection of interconnected objects able to interact in order to fulfill the needs and requests of an external user. The UML static structure defines the object types required for the description of an ontology, along with the attached relationships, while the behavior (the knowledge domain dynamic) defines the timeline evolution of the elements and also the communication network the elements employ in order to fulfill the system's goals. Modeling and presenting an ontology from different, but interconnected perspectives allows for a deeper understanding of the way the ontology addresses the functional requests of the underlying domain. Moreover, the UML provides a universal tool for grouping elements in the form of packages, allowing for the division of large-scale ontologies into manageable components and also for the control of inter-package dependencies and components versions management inside a complex development environment. And, in order to complete the picture, a set of comprehensive implementation decisions description and executable elements or components organization tools is provided.

The Unified Modeling Language is by no means a programming language, but a large set of software applications provide the tools needed to translate UML visual representations into modern logical or object-oriented programming languages source code (*direct engineering*) and also to automatically construct UML models based on the source code analysis (*reverse engineering*).

In order to provide an example for the representation of an ontology by means of the Unified Modeling Language formalism the author has chosen a section of a human resources related ontology (applicable for any economic entity or, at a more general level, for any organization). The example depicts the basic concepts (like *person*, *employee* and *organization*), their derivatives or subclasses (like *management employee*, *company*, *group*, *division* and *department*), along with the relationships arising among the aforementioned elements, represented by means of the UML inter-class relationship types (dependency, association, aggregation, composition, inheritance). The result is presented in Figure 1.

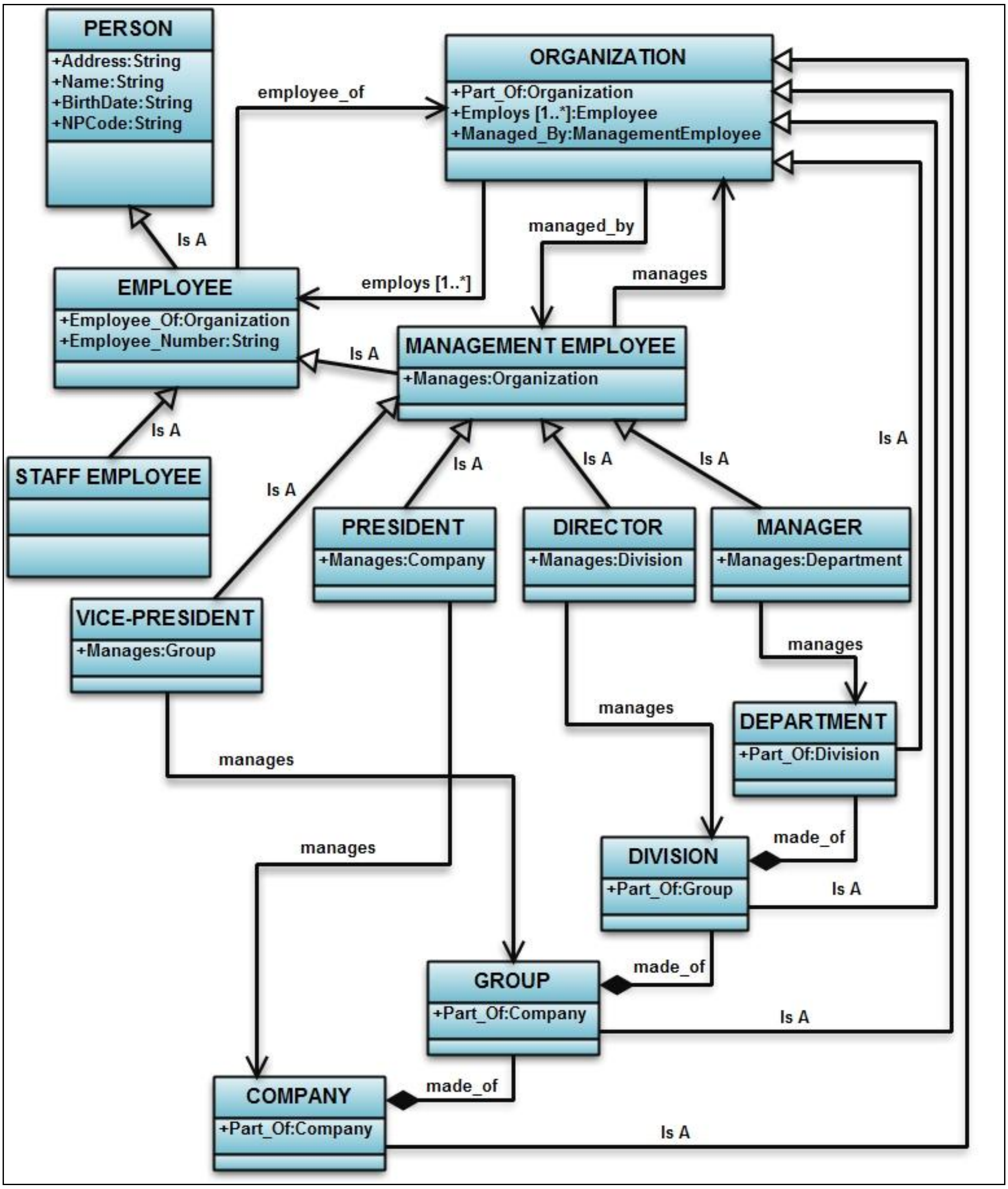

Figure 1 - A fragment of an ontology described by means of the Unified Modeling Language

The wide spread and adoption of the ontologies depicting both domain knowledge and inter-domain knowledge, as well as the improved of such ontologies with UML-based representations constitutes, according to the author's opinion, an important step forward in the development of information technologies, as they allow computer systems to interact with the users more at a human knowledge level and less at a machine-specific non-semantic data level. The ability to perform an significance exchange (not only a data exchange) with a machine may represent a revolutionary concept whose effects are already beginning to appear and are able to develop exponentially in a (very) near future.

Conclusions

The present research is an attempt to identify the ways that the Unified Modeling Language may be used to represent (define and describe) ontologies, which are looked at as a fundamental element of the new semantic-content technologies and, by consequence, as the basis for organizational memory design and management at the organization level. In the author's opinion, the Unified Modeling Language may be an appropriate tool for the representation of ontologies, as its specifications already enclose elements able to represent the mandatory concepts in the field of ontologies: *syntax*, *structure*, *semantics*, *definition* and *use*. By a set of complex elements (like *visibility*) the UML allows for the representation of some essential elements, like the distinction between *labels* (or *terms*) and the *concepts* (or *meanings*) underlying those terms. The multi-level structure of the UML specifications also fits the multi-level structure of an ontology, as both have a meta-language level, a language level and also a specifications (domain) level.

Above all the resemblance and differences, the final goal has to be taken into account, and an answer should be provided to a legitimate question: "*Which is the real advantage in using ontologies?*". In the author's opinion, the real advantage in using ontologies is that for the first time in the history of information technology designers and users are able to describe the *meaning* of their data collections, document collections and information systems, based on a single mechanism, which is understandable both for humans and machines. As a consequence, the recourse to the Unified Modeling Language may offer another major advantage: the ability to reuse the own ontologies and also the ontologies created by others, to extend them and to implement them in related domains of knowledge, and, as a consequence, in related areas of an economic entity's activity. Setting a common semantic at the organization level may be regarded as a solid foundation and a first important step for the building and consolidation of the organizational memory.

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