Developing an Ontology from Set of Experience Knowledge Structure.

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Abstract. When referring to knowledge forms, collecting *formal decision events* in a knowledge-explicit way becomes a significant task for any company. Set of experience knowledge structure can assist in accomplishing this purpose. However, after collecting, distributing and sharing that knowledge as a decisional DNA is even a more important advance. Distributing and sharing companies' decisional DNA through an efficient development of Ontologies would improve the decision-making job that nowadays is overwhelming managers. Constructing set of experience knowledge structure upon Ontology-based technology would facilitate the implementation and progress of an e-decisional community which will support decision-makers on their continue operation. The purpose of this paper is to explain initial developments on this Ontology. A shareable decisional Ontology built upon set of experience would make explicit knowledge of formal decision events, that it, decisional DNA, a useful element in multiple systems and technologies, and at the same time, in the construction of the e-decisional community.

1 Introduction

Knowledge is an invaluable asset of incalculable worth and has been considered as the only true source of competitive advantage of a company [3]. Hence, managers have turned to knowledge administration and companies want technologies that make possible all forms of controlling knowledge. Knowledge management can be considered as the key for the success or failure of a company. One of the most complicated issues about knowledge is its representation, because it determines how knowledge is acquired and how knowledge is transformed from tacit knowledge to explicit knowledge, that is, knowledge must be obtained and represented in an understandable form for the agents that experienced it.

One theory proposes that experienced decision-makers base most of their decisions on situation assessments [8]. In other words, decision-makers principally use experience for their decisions. They extract the most significant characteristics from the current circumstances, and relate them to comparable situations that have worked well in the past. In consequence, tools for representing and store *formal decision events* in a knowledge-explicit way are evidently necessary, understanding that a *formal decision event* is a decision occurrence that was made following procedures that make it structured and formal [15].

Set of experience knowledge structure has been developed to facilitate representation of formal decision events. It is a structure developed as part of a platform for transforming information into knowledge named Knowledge Supply Chain System (KSCS) [14]. In brief, the KSCS takes information from different technologies that make formal decision events, integrates them and transforms them into knowledge making use of sets of experience.

Having a structure such as set of experience, which allows constructing the decisional DNA of a company, it is necessary to develop the means for sharing this experience among different agents. Distributing decisional DNA, not just inside a company, but also among many companies, would help on the establishment of a knowledge sharing community, which if it is developed through internet, it would be called the *e-decisional community*, that is, a decisional Community of Practice (CoP).

Different technologies can be help in accomplishing such task, but no one like Ontology-based technology, which offers differentiable advantages.

Probably the fields in which computer-based semantic tools and systems are more extended nowadays are Ontology-based applications for several heterogeneous domains, mainly focused in querying and classification purposes in information sharing and knowledge management contexts.

Ontologies are commonly used in artificial intelligence and knowledge representation. Computer programs can use Ontologies for a variety of purposes including inductive reasoning, classification, a variety of problem solving techniques, as well as to facilitate communication and sharing of information among different systems. In addition, emerging semantic web systems use Ontologies for a better interaction and understanding between different web-based systems using agents. In this last direction, a recent survey of Ontology-based applications, with focus on e-commerce, knowledge management, multimedia, information sharing and educational applications, can be found in [12].

In conclusion, the purpose of this paper is to explore Ontologies under the view of set of experience knowledge structure, leading onto the creation of a new community of practice named *e-decisional community*, which would share companies' decisional DNA. In such way, set of experience Ontology-based knowledge structure would have the potential to improve the way knowledge is managed as an asset in current decision-making environments.

2 Background

2.1 Set of Experience Knowledge Structure

In this text a concise idea of set of experience and its components is offered, for additional information Sanin and Szczerbicki [15] should be examine.

Arnold and Bowie [1] claim that "the mind's mechanism for storing and retrieving knowledge is transparent to us… somehow, during this process, all the essential qualities of an object are stored. Later, when someone mentions it, our senses are activated from within, and we see, smell, touch, and taste the object all over again". Computers, unfortunately, are not yet capable of forming representations of the world in this way, and even simpler, representations of just formal decision events. This presents a problem of how to adequately, efficiently, and effectively represent information and knowledge inside a computer.

Set of experience has been developed to store formal decision events in an explicit way [15]. It is a model based upon existing and available knowledge, which must adjust to the decision event is built from. Four basic components surround decision-making events: *variables, functions, constraints,* and *rules.* They are stored in a combined dynamic structure that comprises set of experience (see Figure 1).

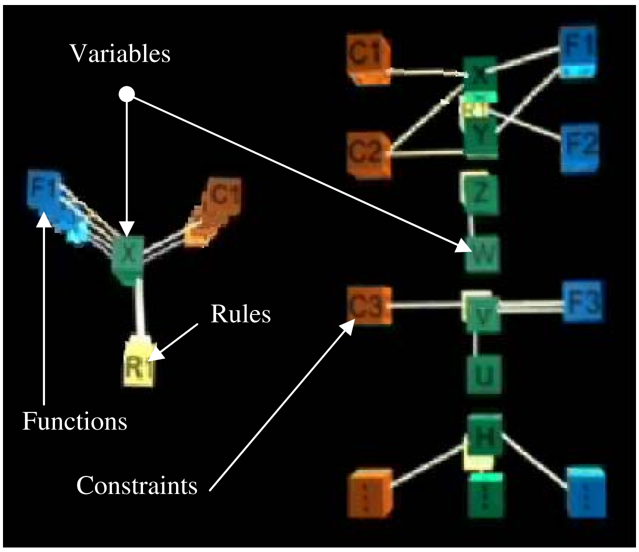


Fig.1: Structure of the Set of Experience

Variables usually involve representing knowledge using an attribute-value language (that is, by a vector of variables and values) [6]. This is a traditional approach from the origin of knowledge representation, and is the starting point for set of experience. Variables that intervene in the process of decision-making are the first component of the set of experience. These variables are the centre root of the structure, because they are the origin of the other components.

Based on the idea of Malhotra [7] who maintains that "to grasp the meaning of a thing, an event, or a situation is to see it in its relations to other things", variables are related among them in the shape of functions. Functions, the second component, describe associations between a dependent variable and a set of input variables; moreover, functions can be applied for reasoning optimal states, because they come out from the goals of the decision event. Therefore, set of experience uses functions, and establishes links among the variables constructing multiobjective goals.

According to Theory of Constraints (TOC), Goldratt [4] affirms that any system has at least one constraint; otherwise, its performance would be infinite. Thus, constraints are another way of relationships among the variables; in fact, they are functions as well. A constraint, as the third component of set of experience, is a restriction of the feasible solutions in a decision problem, and a factor that limits the performance of a system with respect to its goals.

Finally, rules are suitable for associating actions with conditions under which the actions should be performed. Rules, the fourth component of set of experience, are another form of expressing relationships among variables. They are conditional relationships that operate in the universe of variables. Rules are relationships between a condition and a consequence connected by the statements IF-THEN-ELSE.

In conclusion, the set of experience consists of variables, functions, constraint and rules, which are uniquely combined to represent a formal decision event. Set of experience can be used in platforms to support decision-making, and new decisions can be made based on sets of experience.

2.2 Ontology-based Technology

Let us recall shortly what Ontologies are and how they are used. In philosophy, Ontology is the most fundamental branch of metaphysics. It studies being or existence, as well as the basic categories thereof, that is, tries to find out what entities and what types of entities exist. However, in the Computer Science domain there is a different definition. The following is a Tom Gruber's widespread accepted definition of what Ontology is in this context: Ontology is the explicit specification of a conceptualization; a description of the concepts and relationships in a domain [5].

Nowadays, probably the fields in which computer-based semantic tools and systems are more extended are Ontology-based applications for several heterogeneous domains: medical (LinkBase), chemical (ChEBI BAO), legal (LODE), cultural (CIDOC-CRM), etc. They mainly focus in information sharing and knowledge management contexts for querying and classification purposes.

It is true, however, that many researchers in the AI society start their publications with their own definitions of Ontologies, but in short, the definition above is well accepted. Thus, in the context of AI, we can describe the Ontology of a program by defining a set of representational terms. In such Ontology, definitions associate names of entities in the universe of discourse (e.g. classes, relations, functions, or other objects) with human-readable text describing what the names mean, and formal axioms that constrain the interpretation and well-formed use of these terms.

Ontologies are commonly used in artificial intelligence and knowledge representation. Computer programs can use Ontologies for a variety of purposes including inductive reasoning, classification, problem solving techniques, as well as communication and sharing of information among different systems. In addition, emerging semantic web systems use Ontologies for a better interaction and understanding between different agent web-based systems. In this last direction, a recent survey of Ontology-based applications, focused on e-commerce, knowledge management, multimedia, information sharing and educational applications, can be found in [12].

Ontologies can be modelled using several languages, being the most widely used RFD and recently OWL (both expressed in eXtensible Markup Language-XML). OWL (Ontology Web Language), a W3C Recommendation since February 2004 [9], has been designed to be used by applications that need to process content of information instead of just presenting information to humans. OWL facilitates machine interpretability of web content by providing additional vocabulary along with formal semantics, and it considered better than XML, RDF, and RDF Schema (RDF-S). Moreover, OWL has three increasingly-expressive sublanguages: OWL Lite, OWL DL, and OWL Full.

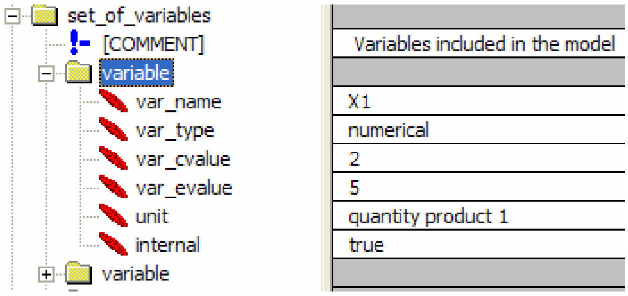
One of the most widely reviewed problems arising when handling large amount of data is to query the repository in an efficient way. Such problem has been researched from the databases point of view; however one big handicap is the fact that every query must be highly structured and well defined. Ontology modelling can deliver interesting benefits as it allows inferring semantically new derived queries. These queries relate concepts that were not taken into account initially. Modern inference engines and reasoners like Pellet and Racer [18] deliver a highly specialized, yet efficient way to perform such queries via a JAVA compliant API. In the literature, data handling by Ontology-based technology is reported by researchers in fields such as Large Model Visualization for industrial plants [10], Geographic information Systems [13], and the modeling of design stages and processes [2].

Furthermore, user modeling, task and experience are also possible scenarios for the exploitation of semantic data by Ontology-based technology as it was addressed for example in the IST-Project WIDE [19]. Moreover, by its own nature Ontologies provide a semantic point of view over an XML approach as the query process of the shareable knowledge structure is enhanced by the use of reasoners and semantic information embedded in the system.

In conclusion, set of experience Ontology-based containing knowledge about formal decision events can be a scenario for exploitation of semantic data, and in such way, it can be used as a shareable structure for helping in the decision-making process. Following, set of experience Ontology-based knowledge structure is exposed.

3 Set of Experience Ontology-based Knowledge Structure

In this section, we introduce our approach to the modelling of sets of experience knowledge structure from an Ontology perspective. In order to obtain such Ontology, we start from the XML set of experience model presented by Sanin and Szczer-



bicki [16, 17], where they established an initial shareable model for set of experience. Afterwards, an Ontology model process was performed using the Protégé editor [11].

3.1 Class, Slots and Instances Organization

When developing Ontologies three actions must be taken into account:

(i) Initially a set of classes must be modelled with the elements of the domain; these classes contain the abstract concepts and their roles as concrete or abstract depending on the level of conceptualization desired.

(ii) Every class has properties including name, cardinality (single or multiple) and the data type that describes the property. In RDF, properties are called slots; while in OWL, they are branded properties with the capability to be data typed or object typed, that is, they can refer to other properties and even classes or instances of the Ontology.

(iii) When the Ontology modelling process is done, it must be instanced. This process can be performed using an Ontology editor like Protégé or programmatically via an API. The instancing process populates every class and the relationships between them with real world values. At this stage of our work we have modelled the Ontology under an RDF approach.

3.2 Set of Experience Knowledge Structure modelling – implementation - visualization

For every first level tag of the XML set of experience knowledge structure a concrete class of the Ontology is created (role concrete). For second level tags, a slot with the proper cardinality and data type is created. A tag from the XML version of set of experience knowledge structure can be seen in figure 2 (using a free visualization tool for XML). Same tag is shown in its Ontology perspective in figure 3, while the Ontology instancing process using the Protégé editor can be seen in figure 4.

Fig. 1: Tag Variable in the XML version of the Set of experience Knowledge Structure.

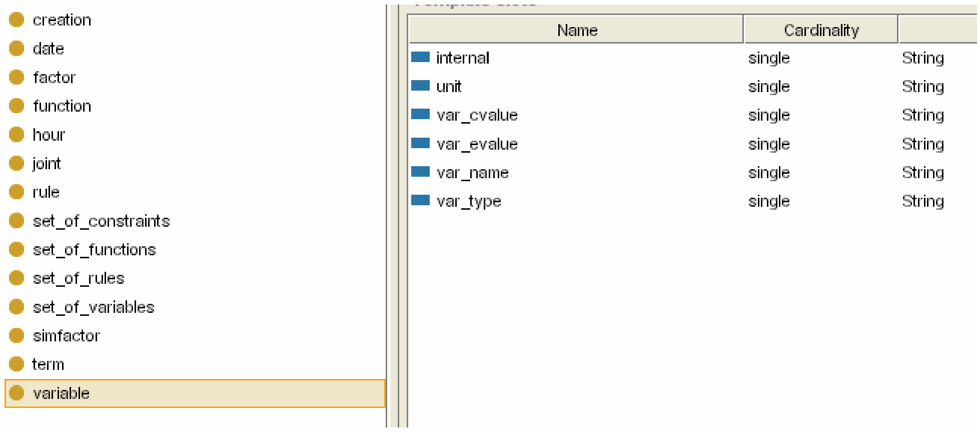


Fig. 2: Tag Variable in the Ontology version of the Set of experience Knowledge Structure**.**

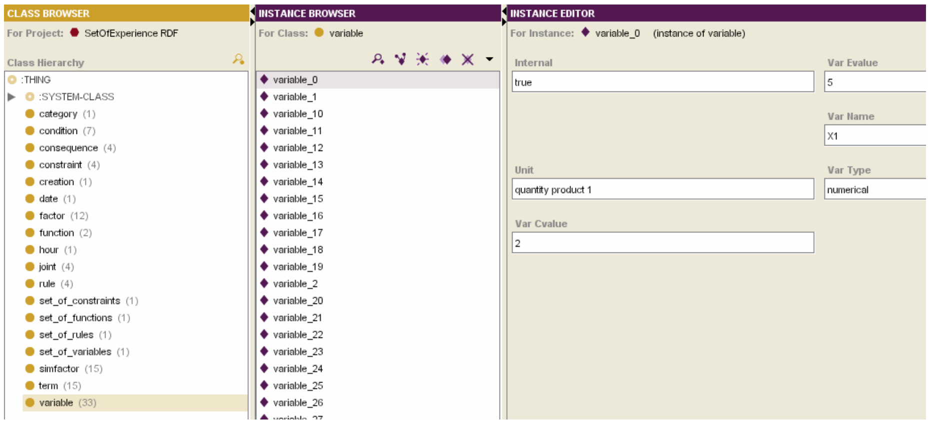


Fig. 3: Tag Variable instanced in the Ontology version of the Set of experience Knowledge.

In figure 5, relationships among the different classes of the Ontology can be seen using a plug-in for visualizating the Ontology model.

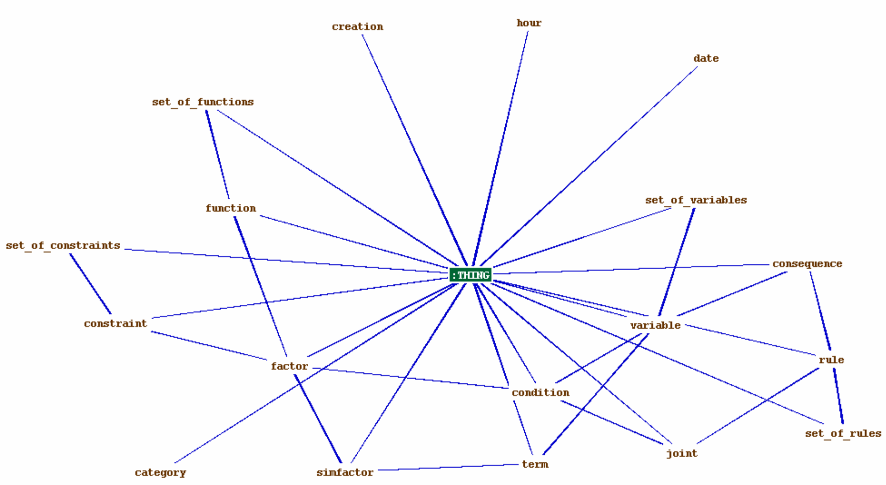


Fig. 4: Ontology model relationships.

Structural changes were not developed in the transformation of set of experience in XML to set of experience in OWL. Having finished first and second actions of the Ontology modelling process, the third action continues as it is explain in the next section.

3.4 Instancing Set of Experience Ontology-based Knowledge Structure

Formal decision events can be evaluated via an Ontology API (Protégé provides one which is based in JENA). Using such API programmatically, the Ontology instantiation process can be performed, that is, filling in the knowledge model with real world values. Furthermore, the API provides several mechanisms to test semantics on the conceptual model and the instanced model as well.

The Ontology model by nature is a Web based application with a predefined namespace. This permits storage of several instanced models in a web server way, allowing the users to interact with the model using a simple web browser, or in our case, a JAVA application for the handling of the Ontology.

Once the Ontology is instanced, the model becomes a shareable explicit knowledge that can be considered a repository.

Moreover and very important, the standardization of RDF and OWL by the W3 consortium indirectly gives this process a sort of modelling standardization, thus the instances themselves will be shareable among users.

The model is now ready for instancing with companies' decisional DNA, that is, formal decision events. A repository for sets of experience according to the Knowledge Supply Chain System platform exposed by Sanin and Szczerbicki in [14] can be created. Once this is done, this repository can be accessed through different queries, which would be developed according to similarity parameters and users requirements. Moreover, multiple sources feeding such repository with decisional DNA would allow decision-maker users to improve their day-to-day operation by consulting such repository, and along with this interaction, decision-makers will compose the e-decisional community.

4 Conclusion

A shareable set of experience Ontology-based knowledge structure able to store formal decision events would advance the notion of administering knowledge in the current decision making environment. Decisional DNA enables us to distribute experience among different applications, and in that form, and through the e-decisional community, companies that are expanding the knowledge management concept externally, can explore new ways to put explicit classifiable knowledge in the hands of employees, customers, suppliers, and partners.

References

1. Arnold, W. and Bowie, J.: Artificial Intelligence: A Personal Commonsense Journey. Prentice Hall, Inc., Englewood Cliffs (1985) 46.
2. Brandt, S.C., Morbach, J., Miatidis M., et al: Ontology-based information management in design processes. 16th European Symposium on Computer Aided Process Engineering (ESCAPE) and 9th International Symposium on Process Systems Engineering (PSE), Garmisch-Partenkirchen, Germany, July 9 – 13, (2006).
3. Drucker, P.: The Post-Capitalist Executive: Managing in a Time of Great Change. Penguin, New York (1995).
4. Goldratt, E.M. and Cox, J.: The Goal. Grover, Aldershot, Hants (1986).
5. Gruber, T.R.: Toward principles for the design of Ontologies used for knowledge sharing. International Journal of Human-Computer Studies, Vol. 43(5-6) Nov./Dec, (1995) 907-928.
6. Lloyd, J.W.: Logic for Learning: Learning Comprehensible Theories from Structure Data. Springer, Berlin (2003).
7. Malhotra, Y.: From Information Management to Knowledge Management: Beyond the 'Hi-Tech Hidebound' Systems. In Srikantaiah, K. and Koening, M. E. D (Eds.): Knowledge Management for the Information Professional, Information Today, Inc., (2000) 37-61.
8. Noble, D.: Distributed Situation Assessment. In proceedings: FUSION '98 International Conference, (1998).
9. OWL Web Ontology Language Reference. W3C Recommendation, 10 February 2004. http://www.w3.org/TR/2004/REC-owl-ref-20040210/. (2004).
10. Posada, J., Toro, C.A., Wundrak, S., Stork, A.: Ontology Supported Semantic Simplification of Large Data Sets of Industrial Plant CAD Models for Design Review Visualization. In Proceedings on Int. Conf. on Knowledge-base and Intelligent Information and Engineering Systems, KES, Part I LNCS 3681, Springer (2005).
11. Protégé. Stanford Medical Informatics. http://protege.stanford.edu/index.html. (2005).
12. Ramos, J., Gomez-Perez, A.: A survey on Ontology-based applications. e-commerce, knowledge management, multimedia, information sharing and educational applications. Public deliverable of the EU-Project OntoWeb. January (2004).
13. Rewerse: Ontology Driven Visualisation of Maps with SVG – Deliverable from the European Project REWERSE, Project number: IST-2004-506779. Munich (2005).

14. Sanin, C. and Szczerbicki, E.: Knowledge Supply Chain System: A Conceptual Model. Knowledge Management: Selected Issues. Szuwarzynski, A. (Ed), Gdansk University Press, Gdansk, (2004) 79-97.
15. Sanin, C. and Szczerbicki, E.: Set of Experience: A Knowledge Structure for Formal Decision Events. Foundations of Control and Management Sciences, Vol. 3 (2005) 95-113.
16. Sanin, C. and Szczerbicki, E.: Using XML for Implementing Set of Experience Knowledge Structure In Proceedings on Int. Conf. on Knowledge-base and Intelligent Information and Engineering Systems, KES, Part I LNCS 3681, Springer (2005) 946-952.
17. Sanin, C. and Szczerbicki, E.: Extending Set of Experience Knowledge Structure into a Transportable Language XML (eXtensible Markup Language). Cybernetics and Systems: An International Journal, Vol. 37 (2-3), (2006) 97-117.
18. Sattler, U.: Description Logic Reasoners, 06 April 2006. http://www.cs.man.ac.uk/~sattler/reasoners.html. (2006).
19. Smithers, T., Posada, J., Stork, A., Pianciamore, M., et al.: Information management and knowledge sharing in WIDE. European Workshop on the Integration of Knowledge, Semantics and Digital, 2004.