Combining Technologies to Achieve Decisional Trust

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Abstract

In this article, we introduce the necessary elements that must integrate a decisional technology that can offer trust and use them for the implementation of decisional trust systems. Thus, we refer to this approach as Decisional Trust, which can be achieved through the use of elements such as Decisional DNA, Reflexive Ontologies and Security Technologies.

Decisional Trust operates in two fronts: (i) the construction of Decisional DNA as a knowledge structure capable of collecting organizations' decisional fingerprints; (ii) the construction of Reflexive Ontologies as descriptions of concepts and relations with a set of self contained queries in a domain of study; and (iii) the addition of security technologies. Our approach extends the use of Decisional DNA and Reflexive Ontologies with the aim of offering trustable decisions, and introduces elements for the exploitation of embedded trustable decisional knowledge which added to security elements can lead to trustable technologies. Fully developed, it would advance the notion of administering trustable knowledge in the current decision making environment.

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INTRODUCTION

Semantic technologies constitute one of the most interesting technologies derived from the World Wide Web revolution. It is a field constantly reviewed in different areas of knowledge and its greatest improvements for information and knowledge technologies are still there to be discovered.

According to some members of the scientific community, it is true that the whole concept of the semantic web presented by Tim Berners-Lee in his foundational article (Berners-Lee et al. 1001) is not reached yet; however, the improvements present in today's Web sites and search engines are not to be underestimated.

Within the myriads of semantic based techniques available, a great attention has been given to ontologies and how their implementation and use enhance real world applications that are not directly related to the Web itself. Ontologies offer great flexibility and capability to model specific domains, and hence, conceptualize the portion of reality to which such domain refers. Nevertheless, it is not enough to have a good modelled ontology fed with real world instances (individuals) from trustable sources of information; nowadays, it is of the utmost importance to enhance such technologies with decisional capabilities that can offer trustable knowledge in a fast way. On this regard, the introduction of concepts such as the Set of Experience Knowledge Structure (SOEKS or shortly SOE), Decisional DNA (Sanin & Szczerbicki, 2005a) and Reflexive Ontologies (RO) (Toro et al. 2007) lead to alternative technologies that can offer trustable knowledge.

On one hand, the SOE is a knowledge structure that allows the acquisition and storage of formal decision events in a knowledge-explicit form. It comprises variables, functions, constraints and rules associated in a DNA shape allowing the construction of the Decisional DNA of an organization.

On the other hand, the RO technique can be used to add self contained queries to an ontology and improves: (i) the speeding of the query process (ii) the possibility of the ontology itself to add new queries on individuals with the correspondent answers to such queries (a feature that adds knowledge about the domain); and (iii) the self containment of the Knowledge Structure in a single file; including the model, the relations between the elements of the model, the individuals (instances) and queries over such individuals.

Having a powerful knowledge structure such as the SOEKS in the Decisional DNA shape enhanced with the RO technique can be considered as an important advance in the development of knowledge systems.

However, the need of trustable knowledge makes necessary to include additional elements in order to achieve what Tim Berners-Lee et al. (2001) proposed.

BACKGROUND

SET OF EXPERIENCE KNOWLEDGE STRUCTURE AND DECISIONAL DNA

Arnold and Bowie (1985) argue that “the mind’s mechanism for storing and retrieving knowledge is transparent to us. When we ‘memorize’ an orange, we simply examine it, think about it for a while, and perhaps eat it. Somehow, during this process, all the essential qualities of the orange are stored [experience]. Later, when someone mentions the word ‘orange’, our senses are activated from within [query], and we see, smell, touch, and taste the orange all over again” (p. 46). The SOEKS has been developed to keep formal decision events in an explicit way (Sanin & Szczerbicki 2005a). It is a model based upon existing and available knowledge, which must adjust to the decision event it is built from (i.e. it is a dynamic structure that relies on the information offered by a formal decision event); besides, it can be expressed in OWL as an ontology in order to make it shareable and transportable (Sanin & Szczerbicki 2005a, 2005b, 2007). Four basic components surround decision-making events, and are stored in a combined dynamic structure that comprises the SOE. These four components are variables, functions, constraints, and rules.

Additionally, the SOEKS is organized taking into account some important features of DNA. Firstly, the combination of the four nucleotides of DNA gives uniqueness to itself, just as the combination of the four components of the SOE offer distinctiveness. Moreover, the elements of the structure are connected among themselves imitating part of a long strand of DNA, that is, a gene. Thus, a gene can be assimilated to a SOE, and, in the same way as a gene produces a phenotype, a SOE produces a value of decision in terms of the elements it contains. Such value of decision can be called the efficiency or the phenotype value of the SOE (Sanin & Szczerbicki 2005a); in other words, the SOEKS, itself, stores an answer to a query presented.

A unique SOE cannot rule a whole system, even in a specific area or category. Therefore, more Sets of Experience should be acquired and constructed. The day-to-day operation provides many decisions, and the result of this is a collection of many different SOE. A group of SOE of the same category comprises a decisional chromosome, as DNA does with genes. This decisional chromosome stores decisional "strategies" for a category. In this case, each module of chromosomes forms an entire inference tool, and provides a schematic view for knowledge inside an organization. Subsequently, having a diverse group of SOE chromosomes is like having the Decisional DNA of an organization, because what has been collected is a series of inference strategies related to such enterprise (Figure 1).

In conclusion, the SOEKS is a compound of variables, functions, constraints and rules, which are uniquely combined to represent a formal decision event. Multiple SOE can be collected, classified, and organized according to their efficiency, grouping them into decisional chromosomes. Chromosomes are groups of SOE that can accumulate decisional strategies for a specific area of an organization. Finally, sets of chromosomes comprise what is called the Decisional DNA of the organization (Sanin & Szczerbicki 2005a, 2005b).

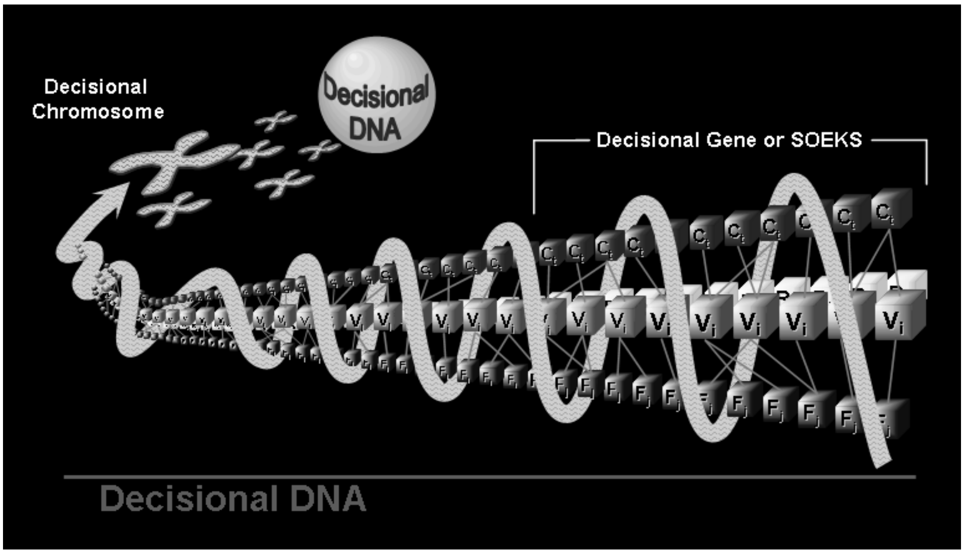

Figure 1: SOEKS and Decisional DNA

ONTOLOGIES AND REFLEXIVE ONTOLOGIES (RO)

Tom Gruber's (1995) accepted definition in the computer science field for an ontology sates that it is the explicit specification of a conceptualization; a description of the concepts and relationships in a domain . In the context of Artificial Intelligence (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 with human-readable text describing what the names mean, and formal axioms that constrain the interpretation and well-formed use of these terms. Computer programs can use ontologies for a variety of purposes including inductive reasoning, classification, and problem solving techniques, as well as communication and sharing of knowledge among different systems. In addition, emerging semantic systems use ontologies for a better interaction and understanding between different agent-based systems. Ontologies can be modelled using several languages, being the most widely used RDF and recently OWL (Ontology Web Language).

User modelling, task, knowledge and experience are also possible scenarios for the exploitation of semantic data by ontology based technology as it was addressed for example in the European IST-Project WIDE (Sevilmis et al. 2005) and Toro et al. (2007a; 2007b).

Reflexivity addresses the property of an abstract structure of a knowledge base (in this case, an ontology and its instances) to "know about itself". When an abstract knowledge structure is able to maintain, in a persistent manner, every query performed on it, and store those queries as individuals of a class that extends the original ontology, it is said that such ontology is reflexive. Thus, Toro et al. (2007a) proposed the following definition for a Reflexive Ontology: "A Reflexive Ontology is a description of the concepts and the relations of such concepts in a specific domain, enhanced by an explicit self contained set of queries over the instances". Therefore, any RO is an abstract knowledge structure with a set of structured contents and relationships, and all the mathematical concepts of a set can be applied to it as a way of formalization and handling.

A RO is, basically, an ontology that has been extended with the concept of reflexivity and must fulfil the properties of: Query retrieval (storing every query performed), integrity update (updating structural changes in the query retrieval system), autopoietic behaviour (capacity of self creation), support for logical operators (mechanisms of set handling), and self reasoning over the query set (capacity of performing logical operations over the query system).

The advantage of implementing RO relies on the following main aspects: Speed on the query process, incremental nature, and self containment of the knowledge structure in a single file.

Toro et al. (2007a) have defined the following architecture in order to implement the RO concept.

This architecture is divided in three layers (Figure 2) as follows: the repositories layer contains the real world elements that “feed” the ontology in the second layer, the base ontology layer. The reflexive layer, this is the extension itself, which contains two modules. The first module adds a new class to the base ontology with the needed schema for the reflexivity; this is called the “ReflexiveOntologyQueryStorer class”. Such extension hangs from the OWL:Thing super class and it has the OWL properties presented in Table 1. And the second module is the reflexiveness itself providing the ontology (programmatically) with a mechanism to perform queries and some logic on the queries that allows the handling of the reflexiveness.

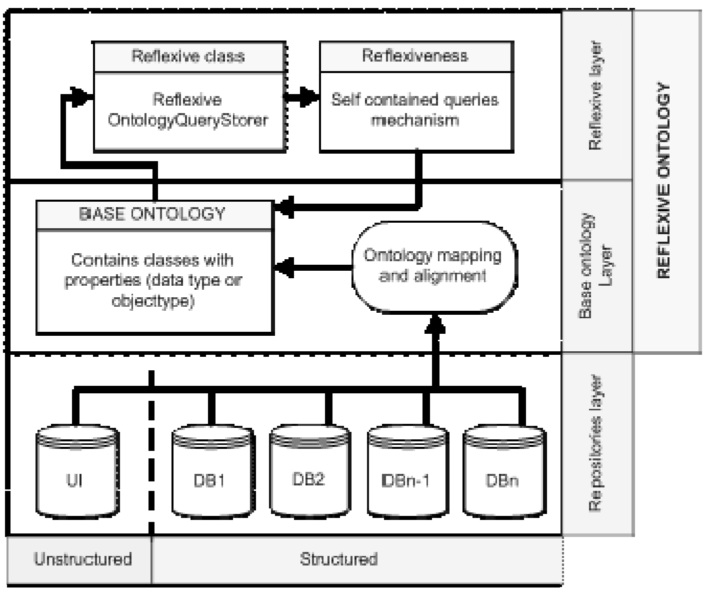

Figure 2: Reflexive Ontology architecture

THE SEMANTIC WEB

The World Wide Web (WWW) was created less than two decades ago, and in such short time, it has developed with an astonishing speed. It allows us to communicate and exchange information and knowledge all over the world in a way that was unthinkable some years before its creation. Furthermore, in 2001, Tim Berners-Lee et al. (2001) proposed a concept called the Semantic Web and offered a future vision of the WWW where information is understandable not only by humans but also by machines.

In the Semantic Web proposal, applications make use of knowledge in order to gain automation of tasks that are currently performed with heavy user interaction. Semantic Web systems will require new components of knowledge representation and semantic technologies immerse in web environments with intelligent capabilities. It will presuppose the existence of a common vocabulary shared by all the agents in the semantic system. Semantic Web applications may need semantic models that will enable it to draw conclusions and/or take decisions. Ontologies can be considered as one of these models. In this regard, one of the most active Semantic Web fields nowadays is concerned with what is known as ontology mapping. Ontology mapping deals with the problem of relating two concepts defined in two different ontologies and matches them as the same concept.

The W3C has proposed an architecture (Figure 3) for the Semantic Web based on three fundamental elements we have just mentioned: semantic annotations, ontologies and inference engines.

The bottom levels of Semantic Web architecture show semantic annotations (RDF models in this case) encoded as XML (eXtensible Markup Language) documents. In the middle levels, such annotations are expressed as ontology languages. Furthermore, logics and inference are added in the architecture to digital signature technologies as a way to gain trust. The Semantic Web will need to know how reliable the collected knowledge is.

New technologies are bringing the Semantic Web vision into fruition, opening doors to new web-based applications, ranging from semantic search engines to intelligent agents.

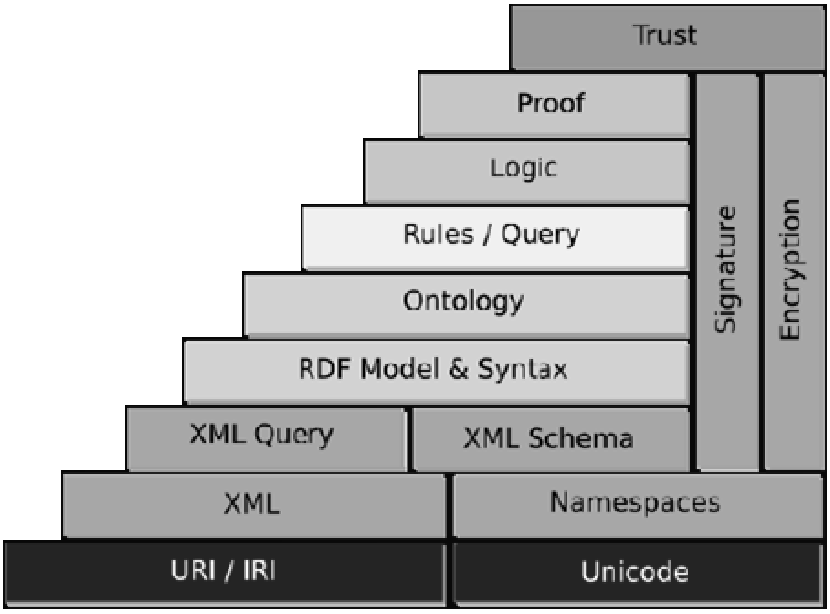

Figure 3: Semantic Web (Berners-Lee et al. 2001)

DECISIONAL TRUST

Decisional Trust (Figure 4) relies on three elements: the Decisional DNA, Reflexive Ontologies and Security Technologies.

The Decisional DNA offers adaptability on gathering, storing and managing decisional knowledge. It is a strong knowledge structure able to support diverse decisional elements at all levels. User modelling, task, knowledge and experience are possible scenarios for the exploitation of the Decisional DNA. Moreover, Decisional DNA has proven to be a useful mathematical and logical inference tool on decision making and knowledge management.

Furthermore, generally, any knowledge is subject to be modelled as an ontology; however, no precise normative exists in order to model knowledge. This is due to the inner nature of the object to be modelled as it is different from one schema to another. From our research experience, a good starting point is to have a well defined schema with the some general elements in the area of knowledge that is being described, in our case, the Decisional DNA. One of the advantages of a conceptual knowledge model expressed as an ontology is the capacity of inferring semantically new derived queries. These queries relate concepts that are not explicitly specified by the user; nevertheless the concepts are relevant to the query. Modern inference engines and reasoners like Pellet and Racer 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 different fields (Sanin & Szczerbicki 2007; Sevilmis et al. 2005; Toro et al. 2007).

Then, if a knowledge structure such as the Decisional DNA is enhanced with the capabilities of ontology based technology, its performance is increased in terms of two characteristics: complementary inference capabilities added by the inference engines of ontology technologies; and share abilities given by the semantic annotation meta-languages in which ontologies are transmitted.

Adding heavier semantics, logic, and expressiveness to the Decisional DNA resulted in an OWL decisional Ontology. However, we propose to broaden even more the Decisional DNA ontology with the capabilities of a Reflexive Ontology profiting in performance for its additional properties as they were presented above.

Finally, all this knowledge is boosted with security and signature technologies transforming such knowledge into trust within the Semantic Web.

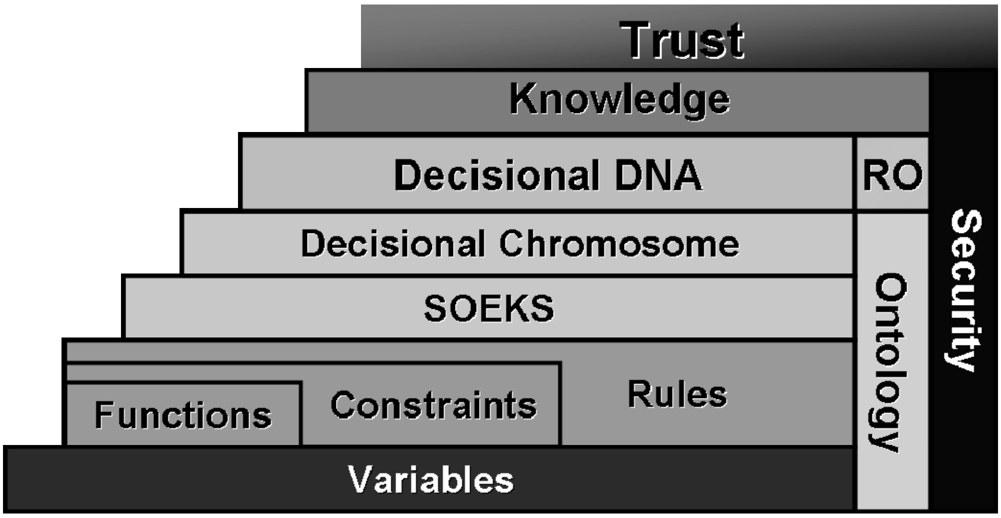

Figure 4: Decisional Trust

CONCLUSIONS

In this paper, the concept of Decisional Trust is presented. A schema based upon three main technologies is explained as the means to achieve a Semantic Web: the Decisional DNA, Reflexive Ontologies and security technologies.

This Semantic Web technology could support decisional knowledge and deliver knowledge and trust within the agents that share the technology advancing the current trends of knowledge management.

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