Ontology in Multi agent conception

Case of African Traditional Medicine

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RÉSUMÉ. Nous présentons dans cet article un travail en amont dans la conception d'un système multi agents dans le domaine de la médecine ; plus particulièrement de la médecine traditionnelle africaine. Il s'agit de la nécessité de la mise sur pied d'une ontologie viable pour les connaissances échangées entre les agents d'un tel environnement, étant donné la non structuration de celles-ci à ce jour. Nous partons de l'existant dans le domaine de la médecine en général pour déboucher dans un travail que nous menons dans un outil précis pour le cas de la médecine Douala (Cameroun) ; dans le but de justifier à la fin de l'ouvrage son adéquation dans l'environnement multi agent SADMedTra (Système d'Aide à la Médecine Traditionnelle).

ABSTRACT. In this article we present work on the conception of a multi-agent system for knowledge management in the medicine domain; more precisely in traditional African medicine. It concerns the need to create a viable ontology for the knowledge exchanged between the agents of such an environment because a structured one has not existed until now. We start from the existent work in medicine in general to lead to a current work in which we deal with a precise tool in the case of the Duala medicine (Cameroon) in order to justify at the end of the paper its suitable place in the multi agent environment SADMedTra (Aid System for Traditional Medicine).

MOTS-CLÉS : ontologie, médecine traditionnelle africaine, conception agent, base de connaissances.

KEYWORDS: Ontology, African traditional medicine, agent conception, knowledge base.

1. PURPOSE

African Traditional Medicine (ATM) uses many symbols and rites in its way to cure. It distinguishes symptoms from illness. When a patient goes to a traditional-practitioner, he suffers from something (an illness) that has a name in the set of the diseases known to modern medicine. But the traditional-practitioner seems to deal with a "social unrest" expressed by the tensions (revealed or not) that could exist in the patient's environment. Also, in this medicine we have to face a wide range of factors, causes of diseases and medicinal plants. However, this knowledge has not had, until now, a formal codification for a better understanding and management of concepts and the relations between them. This work intends to lay the foundations of what we view as necessary in order to clearly identify the concepts and be able to use them in other systems when needed. We think that it is a good start in this field in order to facilitate a further standardization of these concepts through an evolutionary process, something like what is done with other existing knowledge management frameworks, such as the Wikipedia project. In order to achieve this goal, this paper presents a formalization of an ontological system for ATM and the principles of a design for a multi agent system in the ATM Knowledge Management System.

2. Ontologies

In the context of computer and information sciences, ontology defines a set of representational primitives with which to model a domain of knowledge or discourse. The representational primitives are typically classes (or sets), attributes (or properties), and relationships (or relations among class members). The definitions for representational primitives include information about their meaning and constraints on their logically consistent application. [1, 2]

According to the Standard Upper Ontology Working Group (SUO WG) [3], "ontology is similar to a dictionary or glossary, but with greater detail and structure that enables computers to process its content", consisting of a set of concepts, axioms, and relationships that describe a domain of interest. The standard defines an Upper Ontology that is limited to meta-concepts, enough to address a broad range of domain areas. This is useful to provide a structure and a set of general concepts upon which domain ontologies (e.g. medical, financial, engineering, etc.) could be constructed.

2.1. Historical Background

According to [1] the term "ontology" comes from the field of philosophy that is concerned with the study of being or existence. In Philosophy, the term is related as a theory of the nature of existence (e.g., Aristotle's ontology offers primitive categories, such as substance and quality). But for the computer and information science, ontology is a technical term denoting an artefact that is *designed* for a purpose, which is to enable the modelling of knowledge about *some* domain, real or imagined. This reflects the intention that an ontology be a specification of an abstract data model (the domain conceptualization) that is independent of its particular form.

Similarly, while an ontology must be formulated in *some* linguistic representation, it is intended to be a specification at a semantic level -- that is, being independent of data modelling strategy or implementation. *Ontology engineering* is concerned with making representational choices that capture the relevant distinctions of a domain at the highest level of abstraction while still being as clear as possible about the meanings of terms. As in other forms of data modelling, knowledge and specific skills are required.

2.2. Ontologies in medicine

The use of ontologies in medicine is mainly focussed on the representation and (re-) organization of medical terminologies. Physicians developed their own specialized languages and lexicons to help them store and communicate general medical knowledge and patient-related information efficiently. Such terminologies, optimized for human processing, are characterized by a significant amount of implicit knowledge. Medical information systems, on the other hand, need to be able to communicate complex and detailed medical concepts (possibly expressed in different languages) without ambiguities. This can be achieved by constructing medical domain ontologies for representing medical terminology systems. Ontology-based applications have also been built in the field of Medical Natural Language Processing.

Ontologies are useful in the field of medicine in several ways: (i) Ontologies can help build more powerful and more inter-operable information systems in healthcare; (ii) Ontologies can support the need of the healthcare process to transmit, re-use and share patient data; (iii) Ontologies can also provide semantic-based criteria to support different statistical aggregations for different purposes; (iv) and possibly the most significant benefit that ontologies may bring to healthcare systems is their ability to support the indispensable integration of knowledge and data.

3. Existent applications in medicine

Ontologies are part of the W3C standards stack for the Semantic Web, in which they are used to specify standard conceptual vocabularies for exchanging data among systems, the provision of services for answering queries, the publication of reusable knowledge bases, and install services to facilitate inter-operability across multiple, heterogeneous systems and databases. Successful applications to date include database inter-operability, cross database search, and the integration of web services. As examples of applications of ontologies in medicine, here we present two relevant applicants we found interesting to see the way in which we can approach our work.

We first have **METeOR** [4], which is a domain specifically with information from the Australian Institute of Health and Welfare Knowledgebase. It is Australia's repository for national data standards for the health, community services and housing assistance sectors. METeOR provides users with suite features and tools. These include online access to a wide range of nationally endorsed data definitions and tools for creating new definitions based on existing already-endorsed components. It has a strong focus on providing comprehensive user support and assistance.

Secondly, **CO-ODE**: [5] Collaborative Open Ontology Development Environment project, by the Medical Informatics Group at the University of Manchester: The CO-ODE project aims to build authoring tools and infrastructure that make *ontology* engineering easier. They specifically support the development and use of *OWL-DL* ontologies, by being involved in the creation of infrastructure and plug-ins for the *Protégé* platform.

Thirdly, **SNOMED CT®** [6] is a clinical terminology - the Systematised Nomenclature of Medicine which was developed by both the NHS (National Health Service-England) and the College of American Pathologists (CAP) to improve patient care by using an agreed terminology. It is a computerised language that enables sharing and exchanging clinical knowledge within all areas of a patients care cycle in unambiguous terms. Researchers and organisations could be able to track and study healthcare records based on SNOMED CT®, confident that the data retrieved from multiple systems and health organisations is comparable.

4. Ontology development in African Traditional Medicine

By using *Protégé 3.3* [7] we enriched two different ontologies: one of the Duala (Cameroon) pharmacopoeia and the other one of Rwanda; because it is difficult to deal with just a unique traditional medicine in various aspects of the way a treatment is done. But the universality can be seen in the same conception of considering an

illness and the relation patient-healer. The advantage of Protégé consists in the option of exporting a project to an XML file for further exploitation.
In one of our preceding works [8] we present a general representation of some key concepts that we saw as important to be considered as part of Ontology in Traditional Medicine, covering the two main components of those practices. But for the moment, we are dealing more with the traditional pharmacopoeia while investigating a way of representing the ritual knowledge to our agents that best feeds into the domain. Thus in an incremental way, we will integrate these agents into our system.

4.1. DualaMedTra Ontology

In collaboration with a group of traditional Duala healers (from the Cameroon littoral and coastal areas) presided by the anthropologist Eric de Rosny; we have the chance to access more than thirty years of research; in the publication of two volumes [9] issued during 1928-1939 to unite and protect the Sawa (Duala) pharmacopoeia. It is a set of 2,500 traditional prescriptions based on around 400 vegetable and mineral products, with animal products as secondary. This work represents a significant sample of the curative plants of the Duala tradition. Here they do not mention a lot about the "mystical" component of the traditional art of treatment. Figure 1 gives the UML scheme used to put that precedent sample in Protégé tool.

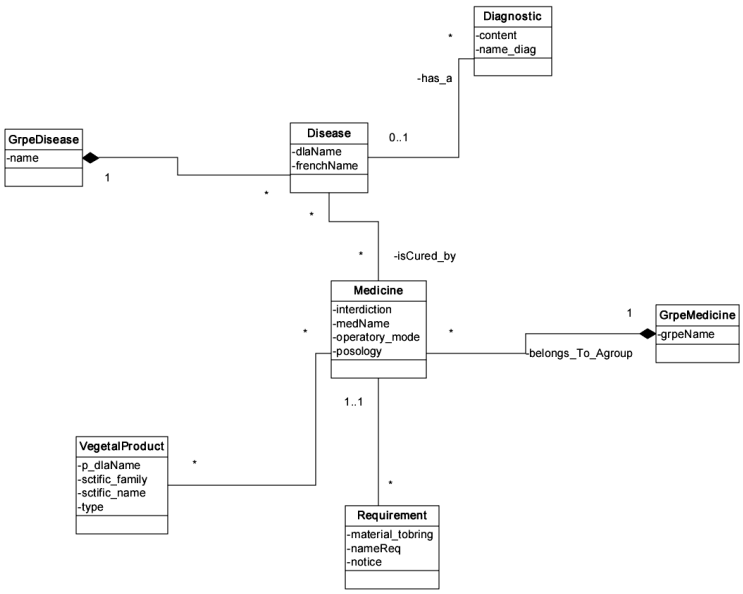

Figure 1: UML Class of DualaMedTra Ontology

The ontology now covers up to 152 diseases, classified in 28 different categories (by body parts); 26 remedies or potions, 42 vegetal products that enter in the elaboration of these remedies; 11 groups de potions and 3 conditions lying in the prescription of some medicines.

4.2. Illustration

An example of the knowledge in this Knowledge Base is as follows: in the Duala language, « *mulopo ma mbomo* » is considered as INFANTILE ACUTE HEADACHE and a well-known treatment for it is: « *crush mundo ma ngue and mix it with cool water. Filter and purge the child: two or three small pears. First purge the child with simple water* ».

5. Knowledge in SADMedTra

SADMedTra, the Intelligent Environment for Medical Practices in African Traditional Medicine, is an agent-based Knowledge Management System that uses the ontology previously illustrated above. As presented in [8], its structure consists of four types of resources in which an ontology of the African Traditional Medicine (ATM)'s function. This ontology served as main resource for the eight agents of the system's implication. Within the system, an identified user can do the following: (i) search for a potion; (ii) search for a medicinal plant; (iii) share ATM knowledge; (iv) find a treatment solution.

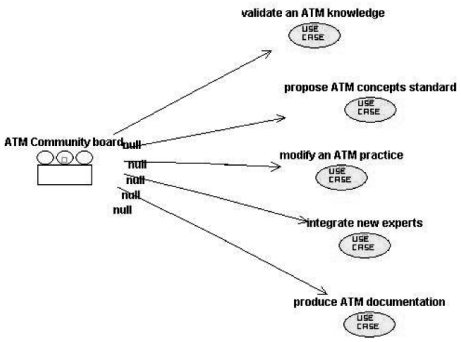

Figure 2: User Case of ATM Community board

The system offers the possibility for the incremental sharing of knowledge through an ATM community board, as shown in figure 2. Within the system, the ATM Community Board plays an important role in the validation of ATM concepts and knowledge. For that purpose, it assumes the following tasks:

- Propose ATM concepts standard
- Modify an ATM practice
- Validate an ATM knowledge
- Integrate new experts
- Produce ATM documents

In the system, a user can pursue different types of objectives. And one of them is provided by the system which is the possibility of sharing ATM knowledge. Figure 3 illustrates what is pretended to be done regarding this issue.

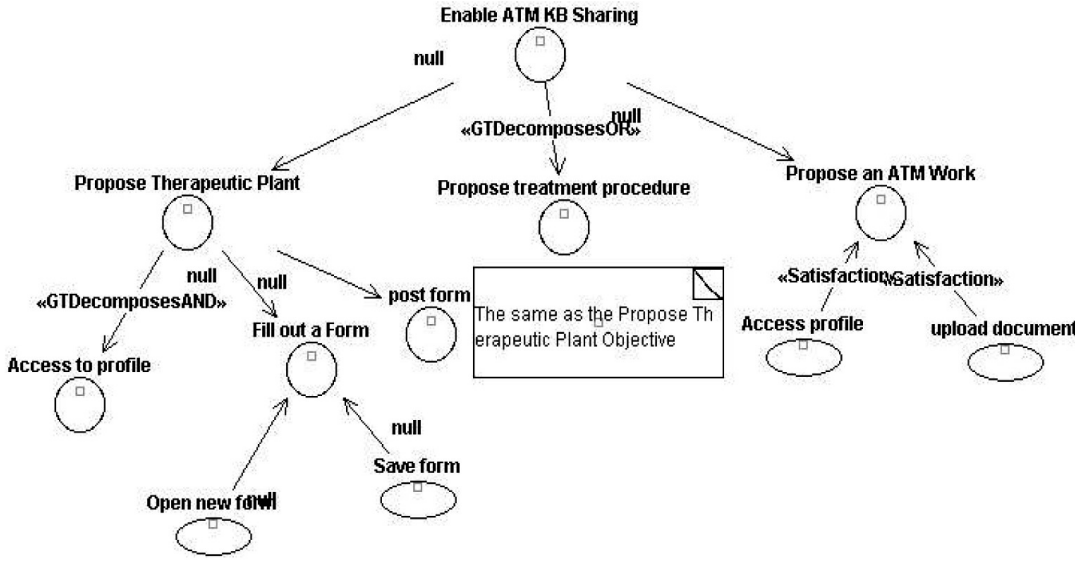

Figure 3: Enable ATM knowledge sharing

The objective can be achieved as a three OR-Decomposition of the sub-objectives: *propose therapeutic plant*, *propose treatment procedure* or *propose an ATM work* (which can be a publication or research work in the field). For their part, each of them has some specifics tasks that together help to achieve the purpose of the objective.

Along with the possibility of sharing knowledge, one of the requirements of the system is to provide medicinal plant information to a patient or a specific user of the system. This is achieve throw a set of goals that are resumed in figure 4.

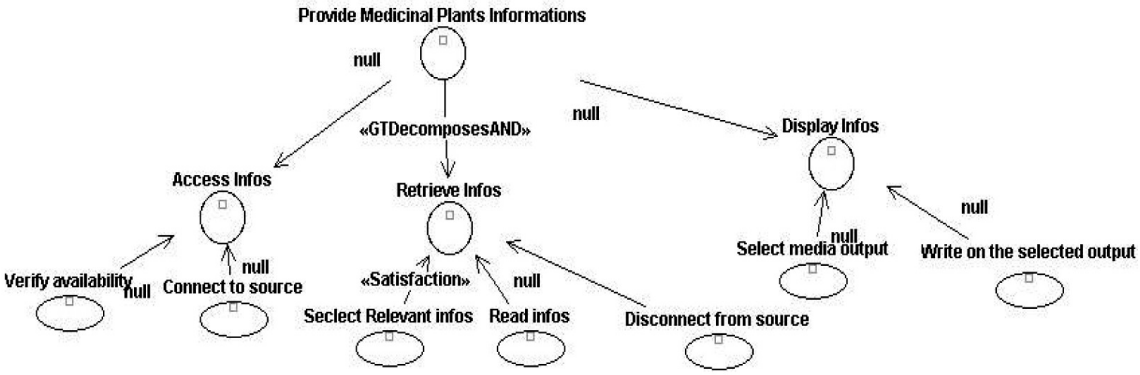

Figure 4: Provide medical information objective

To provide Medicinal Plants information, we need necessarily to have access to the information, a way to retrieve them and finally a need to display it in a convenient way. Since our knowledge base is design in Protégé, we have developed a java program access that takes advantage of the *OntoBridge* java library, which is a Jena wrapper [10].

6. Conclusion

This article presents an up-to-date investigation regarding the use of the term ontology, coming from the philosophy field, in engineering and medicinal applications. However, according to the text, none of our knowledge was applied to the specific field of African Traditional Medicine, as this is made up of many orally transmitted traditions and behavioural patterns. We also point out the current work related to the acquisition and the structuring of Duala knowledge within Protégé. Concerning this point, we show which multi-agents system uses that ontology: SADMedTra. In doing so, we illustrate three different aspects of this system, in which knowledge is required to ensure its efficiency. We hope to gather much more information in order to prevent the loss of a large and rich therapeutic tradition. This work is also illustrative of applications of agent theory and ontology to build a dynamic Knowledge Management System.

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