An Ontology for African Traditional Medicine

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Abstract . This paper describes an ontology for African Traditional Medicine (ATM), which is the basis for a knowledge management system, controlled by a multi-agent system. The interest of this problem, from the point of view of artificial intelligence and software engineering lies on the issues that arise from integration of the requirements of the different stakeholders in such a system and the diverse nature of concepts to be considered in such an ontology. One of these issues is the need to allow the ontology to evolve as far as experts provide more knowledge and the mechanisms for validation of such knowledge.

Keywords: African Traditional Medicine, Ontology, Multi-agent systems, Knowledge Management.

1 Introduction

African Traditional Medicine (ATM) is the result of diverse experience, mixing customs and knowledge about Nature, which has been transmitted by oral tradition along the history. Today, the availability of computers and networks in more and more places around the African continent opens the possibility to consider the support of knowledge systems for new practitioners, who can take benefit of ATM knowledge. Building an ATM knowledge management system requires first a formalization of ATM concepts and their relationships. From the software engineering point of view, this task implies several challenges: the specification of an ATM ontology, and the development of tools for allowing experts in ATM to build a knowledge base, validate such knowledge, and recover it when needed. This paper addresses the problem of defining an ontology for ATM that should be

easy to extend as required, and that facilitates structuring and integration of knowledge from different complementary areas, as described below.

An attempt to structuring ATM concepts in order to bring these data into a well-structured representation [1] was not within the mark up of other medicine ontologies. Hence, the definition of an ATM ontology has to consider many aspects derived from traditional medicine particularities. First, there is a need to complete ontologies from other domains, e.g. from Botany and Medicine, which are incomplete in the scope of ATM. For instance, it is necessary to take into account the role of elements from Nature in rituals and traditional domains. This has not been addressed yet in other works, probably because the lack of concrete applications dealing explicitly with these domains. The problem of integration and extension of these ontologies in relation with ATM requires the consideration of an open ontology, that should be able to evolve with contributions from experts in different fields (medicine, botanic, rituals, etc.) and being able to contrast experts knowledge in order to validate new concepts.

Due to the lack of a common and structured vocabulary specifically dedicated to ATM, as it is a particular and sometimes efficient way of many traditional healers in Africa to contribute to health issues of the native population, a well structured computational representation of ATM domain can therefore be used to manage knowledge and information gathered from the field practices. In addition, using the same concepts for the description of this domain in other similar ontologies would facilitate interoperability among them.

To address these needs, this paper presents an ontology that describes the ATM domain, which can be used by experts of the field and the scientists' community with interests in the development and the expansion of a different way of treatment and cure. The benefit is the protection by the means of new technologies of many centuries of oral transmission knowledge, which is in the way of disappearance. The use of the ATM ontology intends to promote an harmonization and integration of data from diverse sources.

The rest of the paper is organized as follows. Section 2 reviews some medicine ontologies that are taken as reference for the definition of ATM ontology. This is followed by the presentation of the main concepts of ATM in Section 3. Section 4 presents how the ontology is implemented and its elements. Section 5 briefly describes the multi-agent system that is used to manage the ontology. Finally, Section 6 discusses how this work could be extended for knowledge management in other domains, and identifies open issues.

2 Medicine ontologies

Ontology is a technical term denoting an artifact that is *designed* for a purpose, which is to enable the modeling of knowledge about *some* domain, real or imagined [2]. Ontologies play an important role in facilitating information retrieval for structured controlled vocabularies and relationships between terms.

Since the development of the Gene Ontology (GO) for the annotation of attributes of gene products, many ontologies have been developed and many of these are available from the Open Biological Ontologies (OBO) site [3]. They include several ontologies from different aspects such of health, anatomy, environment, taxonomy, biological process. Thus, there exist ontologies on biological processes, cell types, environments, human diseases, infections diseases, pathogen transmissions and plant structures, among others. Each of these ontologies covers a specific domain with the purpose of being more precise and specialised. Hence, it is normal that for a large domain like medicine, a unique ontology does not exist to cover all the aspects.

The approach for management an ontology for ATM starts from considering some existing ontologies, part of the modern medicine ontologies, such as plant structure, human disease and disease transmission, could be used in the ATM ontology. In concrete, the following ontologies have been taken into account because they are closed and can be considered also as part of the domain, as medicine issue en general:

- The Plant Ontology (PO) [4] contains many classes, but for ATM the interest is mainly with <*plant structure*> class, and not others such as <*in vitro cultured cell, plant cell and tissue*>. Figure 1 shows the relationships between concepts within that specific class by the use if Directed Acyclic Graph (DAG) viewer.
- The Pathogen Transmission Ontology (TRANS) [5] describes the means during which the pathogen is transmitted directly or indirectly from its natural reservoir, a susceptible host or source to a new host. It considers two types of transmission: direct and indirect. The former has three subclasses (congenital, contact and droplet spread) and the later structured in airborne, vector borne and vehicle borne.
- The Human Disease Ontology (DOID) [6] classifies diseases in five groups: behavioral disease, biological process disease, disease of anatomical entity, disease on environmental origin and syndrome. It also has at the top level class <*temp holding*> with head, neck, dermatologic disease, etc.
- The Infectious Disease Ontology (IDO) [7] deals with the means during which the pathogen is transmitted directly or indirectly from its natural reservoir, a susceptible host or source to a new host, en definitely the process transmission.

3 Concepts of African Traditional Medicine

African Traditional Medicine (ATM) is a complex system of cure in which disease is considered as a social illness, which is necessary to eradicate from the root. There is intervention of several actors from several domains, which turns complex

and diversified exchanges and treated knowledge. This knowledge is passed on with oral way and is not structured [8].

Several actors can be identified in ATM, with specific roles and functions:

- The h*ealer* is a well-known and respected person, psychologist, botanist, pharmacologist and doctor. He knows the names of plants, animals and rocks.
- The fetishist predicts important events (misfortune or happiness) and is consulted to find the cause of a disease, to protect against certain misfortunes.
- The *Soothsayer* predicts and is seeing as the intermediary with the divinity. He generally diagnoses but can advise a healer to a patient.
- The *Magician* throws lots and makes use of black arts. But he is part of the actors as well.

In the process of treatment, a healer tries to reconcile the patient in all its integrity, as well physical as psychic, by using symbols that are a part of the universe and the life of every day of the patient during its interventions. For example, one pinched of ground collected in the market will represent the social activity of the patient; bits of gravel collected in the crossroads, public life and a washbasin of water, the river at the edge of which extends the village of origin.

In ATM, it is also necessary to distinguish symptoms from disease. When a patient meets a traditional doctor, he suffers from the evil of which one can attribute a name in human disease of the modern medicine. But for the traditional doctor, this patient is seen as a person who possesses a *symptom*, a sign of a social illness. *Social illness* expresses tensions (hidden or revealed) that could exist in the circle of acquaintances of the patient. Certain anthropologists, such as [9], introduce the concept of traditional model to express all that is lived in the traditional vision. The body in this model consists of two entities: a visible part and an invisible part.

The global step in the traditional model is the following one:

- Interpretation of the cause of the bad physical appearance (sort of diagnosis): the traditional doctor considers that the disease that the patient suffers can result from several sources: death ancestors, who continue to live and who sometimes show their *dissatisfaction*, acting on the alive, witchcraft, incest (the fact of falling under the yoke of the forbidden), twins who possess supernatural powers, destiny which is individual, God who here is a natural cause. [10]
- Phase of divination to know how to treat the patient.
- Prescriptions according to the cause of the disease: remedies with natural base, ritual products and other sacrifices to be done. [11]
- Follow-up of the patient evolution in the process of cure which sometimes can take years.

From the above description, some relevant concepts can be pointed out, as part of the ontology. Concepts such as:

- FUNCTION for the actors of this medicine: the healer, the fetishist or the soothsayer.
- PROCESS for all the different types of proposed process of treatment.
- SYMPTOMS for the role of the symptoms.
- DISEASE as it is considered in this medicine.

4 The ATM ontology

The first design decision was whether to integrate all the aspects of ATM or only those that make it different from modern medicine. Although it may be relatively easy to design an ontology based on concrete facts such as names, birth dates, etc., it is considerately more difficult to design an ontology based on knowledge that is incomplete or not yet well understood, or that it does not have yet a common-agreed vocabulary [12].

The ontology consists of concepts or terms (nodes) that are linked by three types of relationships (edges). That means the ontology appears as a directed acyclic graph. The parent and child terms are connected to each other by *is_a* and *part_of* relationships. The former is a relation in which the child term is a more restrictive concept than its parent (thus divination *is_a* traditional_practice). The latter is used to show the inclusion relationships between concepts, for example that a potion_type is *part_of* a potion.

The rules for building the ontology are the same as those defined by the GO consortium. That is, each concept in the ATM Ontology has an identifier with the syntax ATM:nnnnn, where nnnnn is a unique integer, and ATM identifies the ATM Ontology. In addition, if there are precisely equivalent terms in other databases, for example in the Plant Ontology, the unique identifiers from these databases are included in the ATM Ontology. The present version of the ontology has an average depth of about five nodes.

The six top-level nodes of the ATM Ontology are *disease_conception, traditional_act, traditional_believes, traditional_intervenor, traditional_practices* and *traditional_treatment*. The *disease_conception* includes abnormal disease (disease caused by external agents such as spirits, etc.) and natural disease. All the actors of the medicine are included into the *traditional_intervenor* class. Regarding to the form of diagnosis, divination and other religion practices, they are classified as children of *traditional_practices* class. Concerning the way treatments are done, from the medicinal plants to rituals, we have the *traditional_treatment* class to structure the previous concepts.

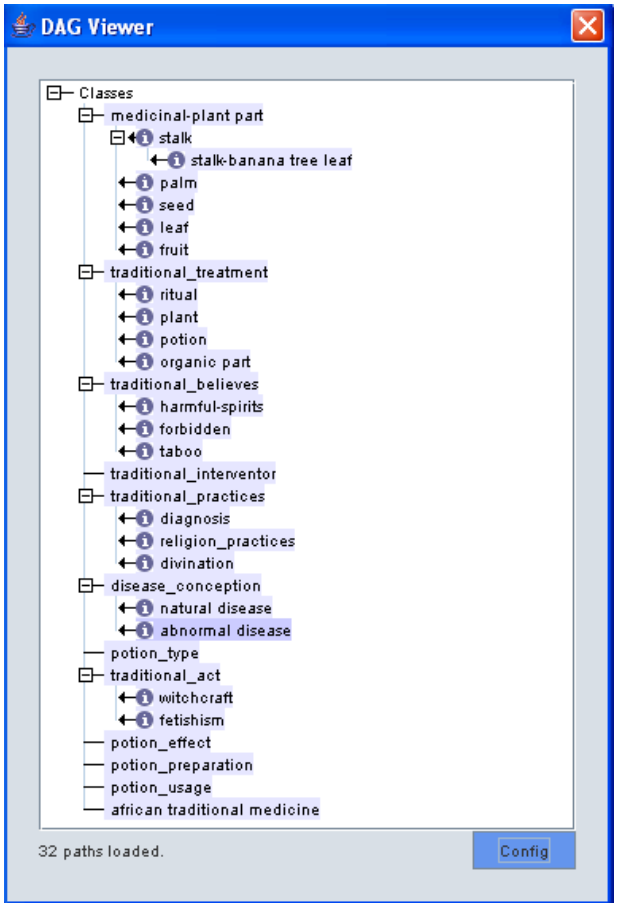

Fig. 1. ATM ontology view within a Directed Acyclic Graphs structure.

It should be pointed out that, like many such resources, this ontology is not complete: although it contains the main concepts of traditional medicine, it is intended to be extended and completed by the experts in an incremental way. For example the categories identified as *traditional_believes* or *traditional_act* have to be much more populated. The ontology was constructed using the open source Java tool OBO-Edit, which is convenient for building ontologies that are consistent with the GO formalism. The resulting ontology [13] is available in the "OBO format" [14] and can be easily viewed.

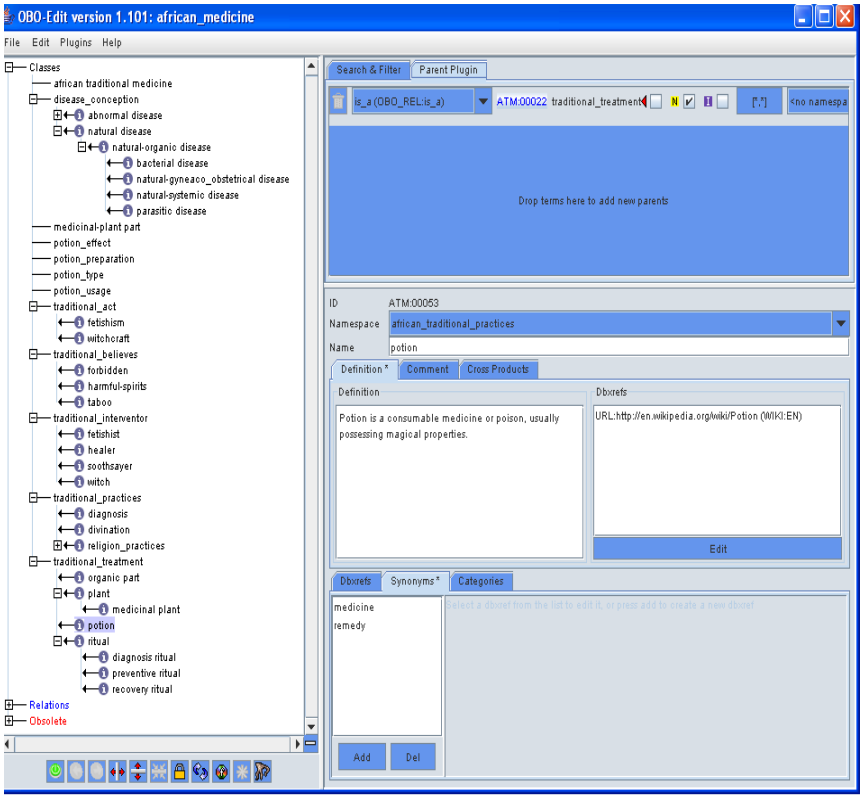

Fig. 2. : A screenshot of the ATM Ontology within the OBO-Edit program, displaying all the information associated with the term potion. The left-hand panel shows all the top-level terms, together with the location of potion within the traditional_treatment classification.

5 Using agents to manage ATM ontology

According to the importance of maintaining and sharing the ATM knowledge, for both the traditional practitioners and the experts of the domain, the need for having an environment that facilitates the management of the ATM ontology is necessary to better make use of the new techniques in Knowledge Management (KM) techniques. Based on that, a multi-agent system to help access, validate and recover ATM information, described in [15] has been designed and is currently being implemented. The system consists of five main types of agents: user, interface, ontology manager, profile, and broker agents.

Each user of the system is managed by a *user agent*, which is in charge of the connexion, error reports and assignation of authentication to the registered users, and the notification of context information to the user from the system.

The *interface agent* facilitates the user's view of the system depending of the users preferences and communicates with the *user agent*. Also deals with the session connection.

The *ontology manager* manages ATM information proposal, modification and publication. That's says all the cycle of proposal to the publication of ATM information.

The *profile agent* keeps the users preferences of the system to give contextual information and suggestions to the system users.

The *broker agent* realizes the connection to the ontology, retrieve and modify knowledge. It is also in charge of doing the necessary conversion between different types or formats of manipulated knowledge.

Figure 2 gives a view of the proposal sequence of ATM information, showing the role of the Ontology Manager Agent in the process.

6 Conclusion

This paper presents the effort to build structured information for African Traditional Medicine. This starts by considering some ontologies from the field of modern medicine, structured following the Open Biological Ontologies (OBO), which are integrated and extended in order to consider elements from ATM, such as actors, treatment process and the general step in its way of curing illness. The identification of such elements is the basis for developing the ontology, reusing existent ontologies and applying OBO-Edit tool. This facilitates the follow-up of relations that exist with some specific ontologies and the concepts used in ATM, and points out some different choice of conception while building ATM ontology regarding to the particularity of the domain.

Some ideas used in this paper for ATM could be transposed to others domains or applications where a community of experts needs to build in a collaborative environment a knowledge based support system incrementally.

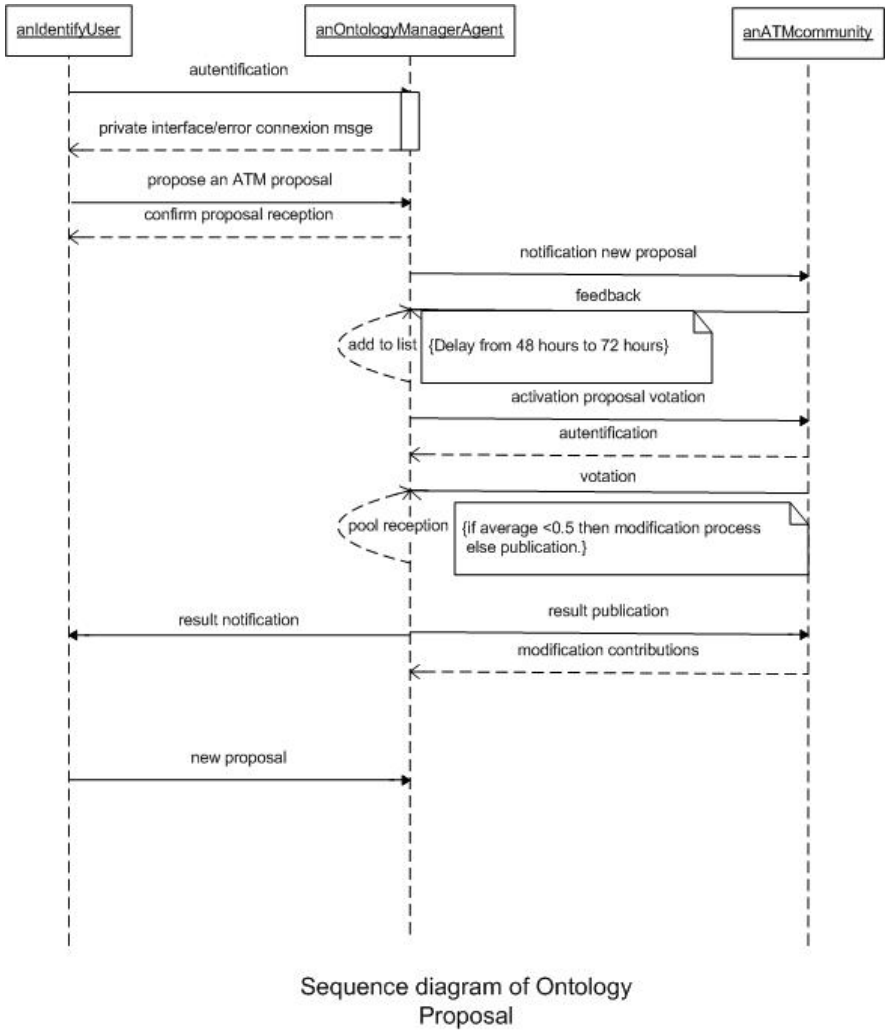

Fig. 3. : Sequence diagram for management of a new proposal in the ATM Ontology

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