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TO WHOM IT MAY CONCERN

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Building an e-health component for a multipurpose ommunication centre for a marginalized community using FOSS

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Abstract:

Information and Communication technologies (ICTs) in marginalized communities act as a link that connects community members to the information that they need. This paper represents an underway research which aims at developing an e-health portal for a multipurpose communication centre for the Siyakhula Living Lab (SLL) project. SLL is an Information and Communication Technologies for Development (ICT4D) project that is undertaken in Dwesa rural area. Dwesa is a rural area that is located in the province of Eastern Cape in South Africa, former Transkei. The portal aims to eliminate the lack of useful and relevant health information in this community by facilitating health knowledge delivery over the web. This research seeks to accomplish these requirements by developing an e-health portal that will make browsing of health resources from the Internet and the Department of Health easy. This portal will accomplish this by facilitating knowledge sharing between clinic nurses and community members. In addition we seek to make use of combination of semantic web tools and develop a medical ontology as part of this portal. This medical ontology will act as information repository for the local knowledge. The initial ontology will be constructed from traditional medical information that will be collected from an Isixhosa traditional doctors and practitioners. Then the system users will also be allowed to add indigenous knowledge that will be approved by administrator. We seek to accomplish the development and implementation of this portal by making use of combination of Free and/or Open Sources such as LAMP, Protégé and RAP.

Keywords: e-Health, FOSS, ICT4D, medical ontology, protégé, SLL, RAP

1. Introduction

Information and Communication Technologies (ICTs) have a potential of eliminating the problem of limited access to knowledge, hence they are the targeted tool that can be used for information delivery in marginalized communities and that doesn't exclude health knowledge delivery (Hlungulu & Thinyane, 2009). E-health portals have been built using these ICTs for the purpose of delivering health information to communities and facilitate health knowledge sharing between the participants (Sadeghi *et al.*, 2007). The main purpose of these e-Health portals is to deliver health knowledge and bring awareness to communities.

There are many e-Health portals that have been implemented using ICTs but there are very few portals in marginalized areas. This is caused by the lack of infrastructures (road networks, communication, etc.) in marginalized communities and that leaves community members in need of health knowledge and awareness (Maheu *et al,* 2001) & (Thinyane *et al*, 2007). Marginalized communities suffer from this because there is a lack of or no connection between them and the relevant information/knowledge. ICT in developing countries is used for the purpose of providing community members connectivity to the required information thereby narrowing the digital divide (Thinyane *et al*, 2007).

This paper represents an underway development process of an e-Health portal that will try to eliminate the lack of useful and relevant health information in Dwesa community by facilitating health knowledge delivery over the web. An e-Health "is the use of information and communications technology to deliver health services and exchange health information when distance separates the participants" (Sadeghi *et al.*, 2007). This e-Health portal will make browsing of health resources from the Internet and the Department of Health easy by facilitating knowledge sharing between local clinic nurses and community members.

In addition to that this portal will also provide a semantic web based IsiXhosa traditional medicine knowledge repository or IsiXhosa traditional medicine medical ontology as part of this portal. Ontologies are "data schemas, providing a controlled vocabulary of concepts, each with an explicitly defined and machine processable semantics" (Maedche & Staab, 2001). The initial ontology will be constructed from traditional medical information that will be collected from an IsiXhosa traditional doctor or practitioner. Then the system users will also be able to add approved indigenous knowledge to the ontology. We seek to accomplish the development and implementation of this portal by making use of combination of Free and Open Source Software so as to make it affordable to the community.

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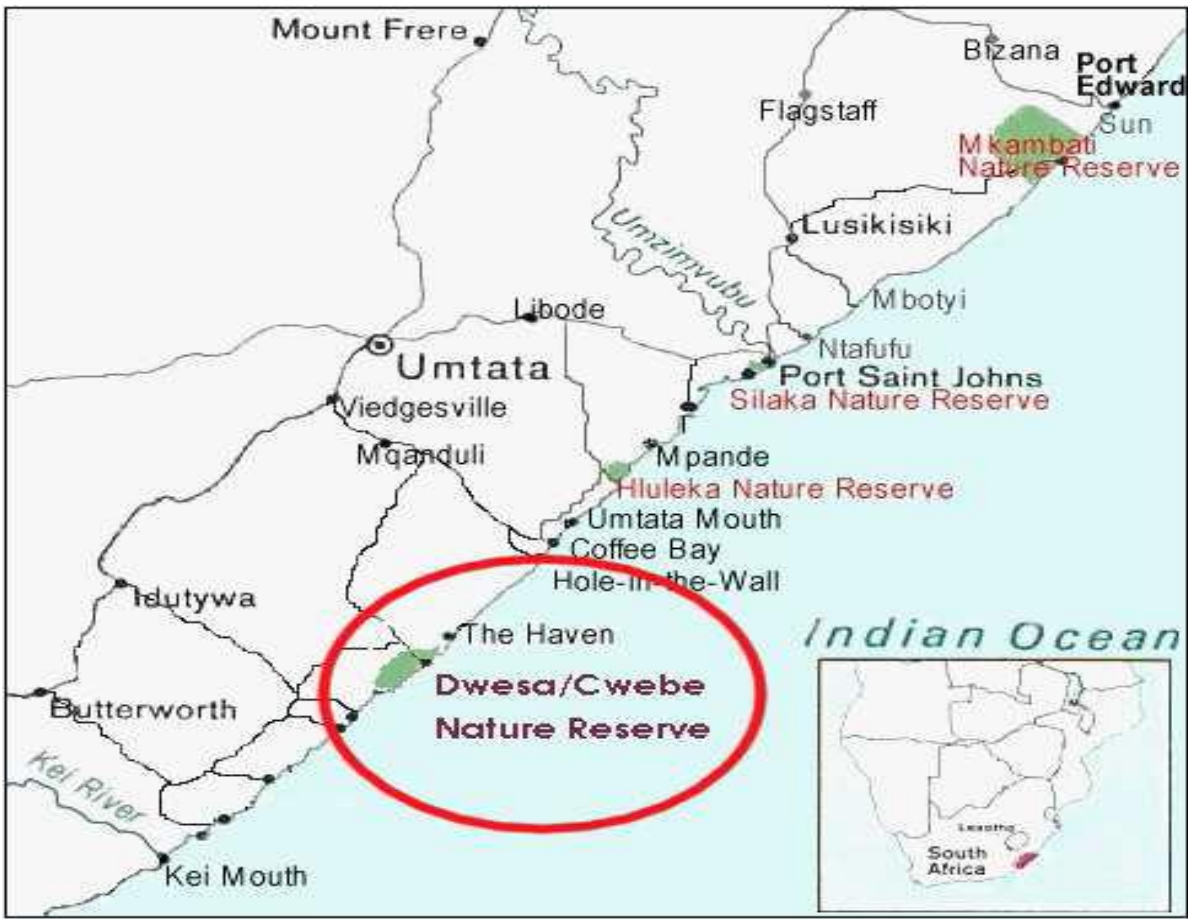
2. Research context

Dwesa is a rural area that is located in the province of Eastern Cape in South Africa (Wild coast of the former homeland of Transkei). Dwesa is being administered by the Mbashe Municipality (situated in Idutywa) that falls within the Amathole District Municipality (Situated in East London) (Timmermans, 2004). Dwesa is 50 km away from Willowvale and 75 km away from Idutywa (Timmermans, 2004) & (Dalvit *et al*., 2007), please see figure 1. These two towns are the closest towns to Dwesa. The total population of this community adds up to 15000 (COFISA, 2008). This community is made up of people who speak IsiXhosa and these people depends on pensions/grants, remittances, livestock production, local resource utilization, cultivation, limited tourist-based jobs, etc (TRALSO, 2007).

Figure 1: Transkei and the Dwesa region (Dalvit el al, 2007)



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2.1 The Siyakhula Living Lab (SLL) project

The Siyakhula Living Lab (SLL) project is an Information and Communication Technologies for Development (ICT4D) project that is undertaken in Dwesa rural area. Figure 2 shown below shows ICT infrastructure or the equipment that is deployed in Dwesa. This equipment is deployed in 4 different schools because of the availability of electricity in schools (Scott, 2010). These different schools are Mpume, Ngwane, Mtokwane and Nondobo (Dalvit *et al.*, 2007).

The equipment deployed in Mpume is as follows (Dalvit *et al., 2007*):

- VSAT connection (satellite dish, indoor unit and cabling).
- WiMAX (Alvarion Breezemax CPE outdoor unit, and CPE indoor unit, wall mounting).
- A server (LTSP, HTTP, MySQL).
- 6 client PCs.
- An 8 port DLink switch.
- A VoIP phone.

In Ngwane there is (Dalvit *et al., 2007*):

- WiMAX (Alvarion Breezemax CPE outdoor unit, and CPE indoor unit, wall mounting).
- Switch rack (wall mounted) and 24 port switch.
- A server (Asterisk, DHCP).
- A VoIP phone.

Initially this school also managed to source their own lab with approximately 20 PCs and a printer (Dalvit *et al*., 2007).

In Nondobo and Mtokwane there are (Dalvit *et al., 2007*):

- “WiMAX (Alvarion Breezemax CPE outdoor unit, and CPE indoor unit).
- A client PC.
- A VoIP phone.

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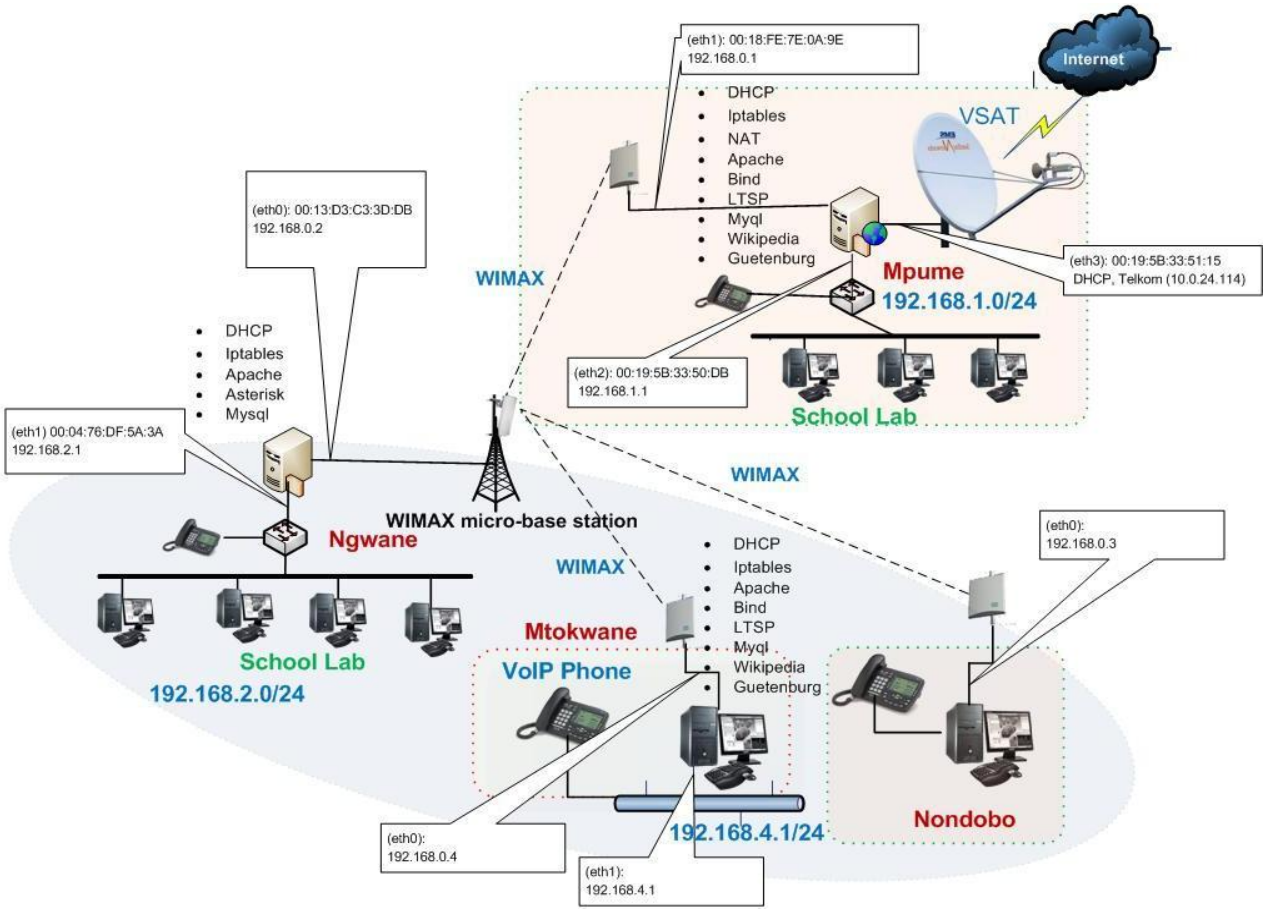
Figure 2: ICT infrastructure deployed in Dwesa (Scott, 2010)



3. Design and methodology of the SLL e-health portal

Shown below (Figure 3) is the design of SLL e-health portal. Figure 3 below shows a system user (indicated by 1) accessing knowledge via web browser. The knowledge that the user is accessing will be extracted from the two databases (indicated by 3 and 4 on Figure 3) by scripts. These scrips will be stored on the server (indicated by 2 on Figure 3).

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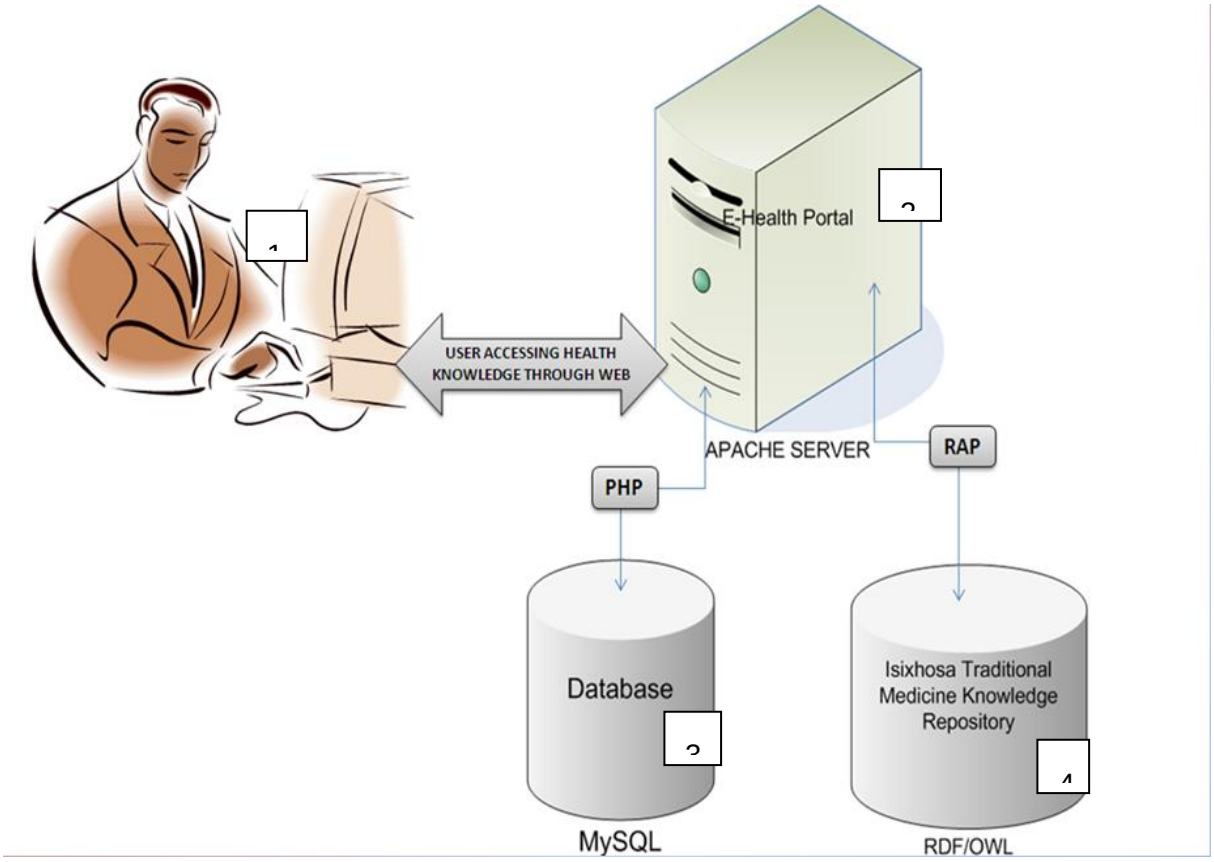
Figure 3: Portal design



The developing of the system started off by focusing on the development of the medical ontology (IsiXhosa Traditional medicine knowledge repository). The reasons behind developing this ontology are:

- To facilitate domain knowledge sharing between system users (traditional practitioners/doctors, nurses and community members).
- To use the system for collecting indigenous knowledge from the community members.
- To store indigenous knowledge collected in a form of a structure so that it can be easily accessed by the community.

In order for these requirements to be met information needs to be machine understandable. By making information to be machine understandable we will be enforcing enhanced information discovery, data exchange and integration (Oldakowski *et al*, 2005). To achieve this, information needs to be in a form of a structure, and to achieve this RDF (Resource Description Framework) is required. RDF is a core technology of semantic web that provides ways of obtaining structure and semantic description of data (Oldakowski *et al*, 2005). There are several software that can be

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used for obtaining resource description framework, one of them is protégé. Protégé is a platform independent java application that is used for developing Ontologies (OWL/RDF Ontologies) (Horridge, 2009). Ontologies are used for classifying vocabulary of knowledge systematically, define the relation of the vocabulary by property, and be able to describe meaning of the vocabulary and the relation in a form of a hierarchy (Minegishi *et al*, 2008).

3.1 Ontology design

In designing this ontology protégé 4 was considered. This software allows a developer to build OWL Ontologies. OWL is the most recent development in standard ontology languages from the W3C (World Wide Web Consortium) (Horridge, 2009). There are several reasons why we chose to use OWL ontology. Some of these reasons are (Horridge, 2009):

- OWL ontology model is based on model that allows concepts to be defined and be described.
- OWL ontology has a reasoner that helps in maintaining the hierarchy correctly.

OWL Ontologies consists of the following important components (Horridge, 2009):

- Individuals
- Properties
- Classes

3.1.1 OWL ontology classes

Upon constructing our OWL ontology we used all the three above mentioned components. The main function of classes in an ontology is to contain certain individuals that belong to it, for example in our ontology we have two main classes one for medicine (TraditionalMedicine) and one for ailments (AilmentsCured) cured (see Figure 4 below) (Horridge, 2009).

For the two main classes we have different subclasses that belong to the main classes. These subclasses classify different categories of medicine and different categories of ailments that the medicine treats. Under *TraditionalMedicine* class we have two subclasses, *Plants* and *Trees*. We have these two classes because most IsiXhosa traditional medicine either comes from plants or trees. Further we have subclasses classes of plants and trees. These subclasses specify the useful part of the plant. For example in *Umhlonyane*, leaves of a plant are used for treating fever, and that indicates

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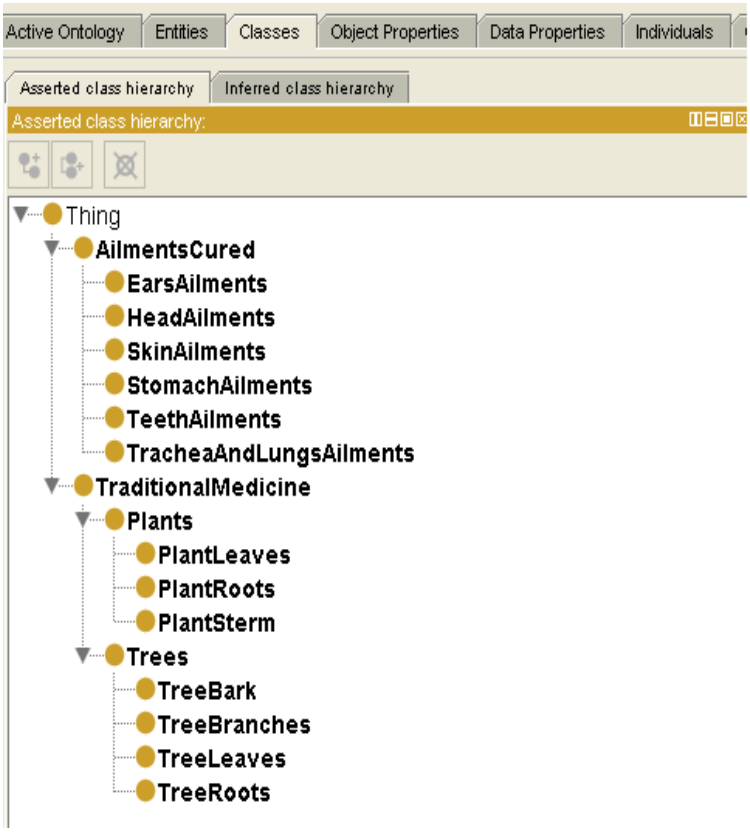
that *Umhlonyane* belongs to *PlantLeaves* subclass of *Plants* and so on (see Figure 4 below). The *AilmentsCured* subclasses are also designed the same way, for example cough belongs to *TracheaAndLungsAilments* (see Figure 4 below). All these classes are set to be disjoint because they have nothing in common.

Figure 4: Classes of the ontology



3.1.2 OWL ontology properties

OWL ontology properties are used for specifying relationship between two individuals (Horridge, 2004). There are two types of OWL properties (Object properties and Data type properties) and they were both used our ontology (Horridge, 2004). Object properties are properties that are used for linking individuals *(please see next section 3.1.3)* to each other (Horridge, 2009) whereas data type properties links individuals to an XML Schema Data type value (Horridge, 2009).

Object properties have several characteristics; Functional, Inverse functional, Transitive, Symmetric, Asymmetric, Reflexive and Irreflexive (see Figure 5). Among those characteristics

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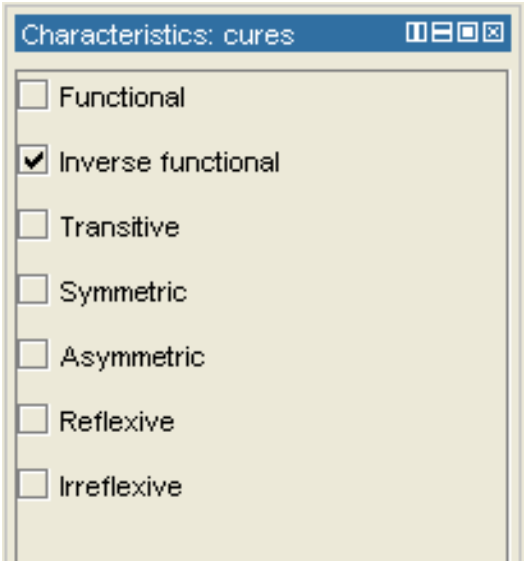
we used Inverse functional to link medicine to ailments that the medicine cures and vice versa. For example in this ontology there are two object properties *cures* and *cured_by*. If *cough* is *cured_ by Vicks Acta plus Cough Syrup* then inverse property will say *Vicks Acta plus cures cough*.

Figure 5: Object properties characteristics



3.1.3 OWL ontology individuals

OWL Ontology Individuals are used for representing objects of the domain that we are interested in (Horridge, 2009). They represent domain knowledge of isiXhosa traditional medicine and the ailments cured by it in this ontology. OWL ontology allows developers to give a description of medicine or ailment, for example in Figure 6 there is Iqwili, a medicine (indicated by annotation) that belong to PlantRoots, a subclass of Plants, a subclass of TraditionalMedicine.

Figure 6 also shows Property Assertions of this medicine. Figure 6 show that Iqwili cures IntlokoEqaqambayo (Headache) and Ukhohlokhohlo (cough). These functions shown are part of operations that OWL ontology allow a developer to do. Not only object properties that are there, there are data type properties and here they serve a purpose of giving proper description of a medicine.

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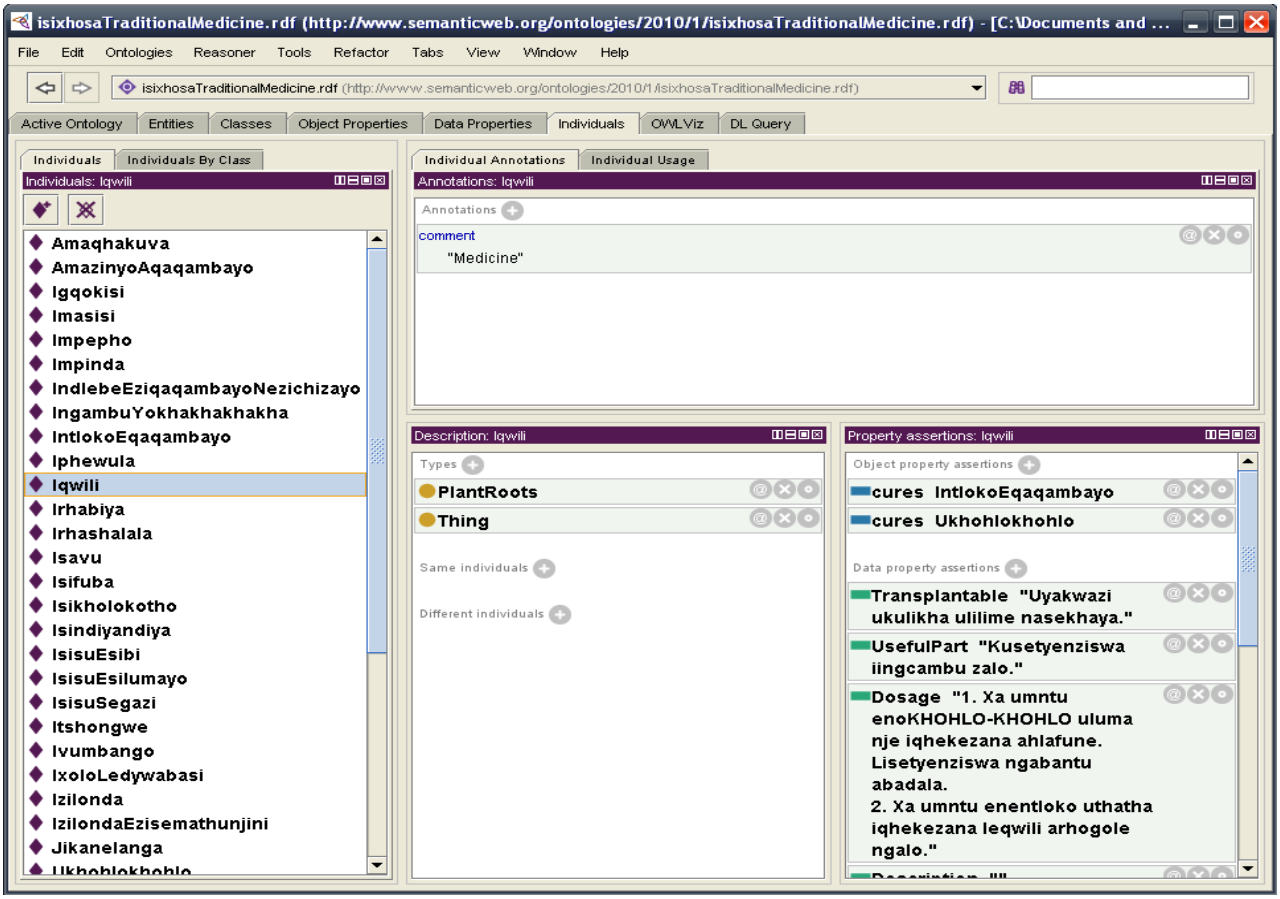
Figure 6: Individuals instances representing knowledge domain



3.2 Retrieving ontology

Upon completion of developing OWL ontology protégé produces an OWL/RDF file that represents the created ontology. This file is the one that is being used when one wants to retrieve knowledge stored there. For a three tie website this file needs to be uploaded to a database. Once the ontology is uploaded to a database knowledge can be able to be passed around in a form of triplets (Oldakowski *et al*, 2005). There are several advantages of using database as a back end; some of these advantages are to optimize speed and the portability (Oldakowski *et al*, 2005). We used RAP (RDF API for PHP) in overcoming this. RAP is a semantic web toolkit for PHP developers that allow parsing, manipulating, storing, querying, serving and serializing of RDF graphs (Oldakowski *et al*, 2005). RAP installation comes with a graphical user interface can be used for performing some tasks. We made use of RDQL as a querying language. RDQL (RDF Data Query Language) is query language that is used for extracting information from RDF graphs by allowing a user to formulate queries that return specified results (Oldakowski *et al*, 2005) & (Bernstein & Kiefer).

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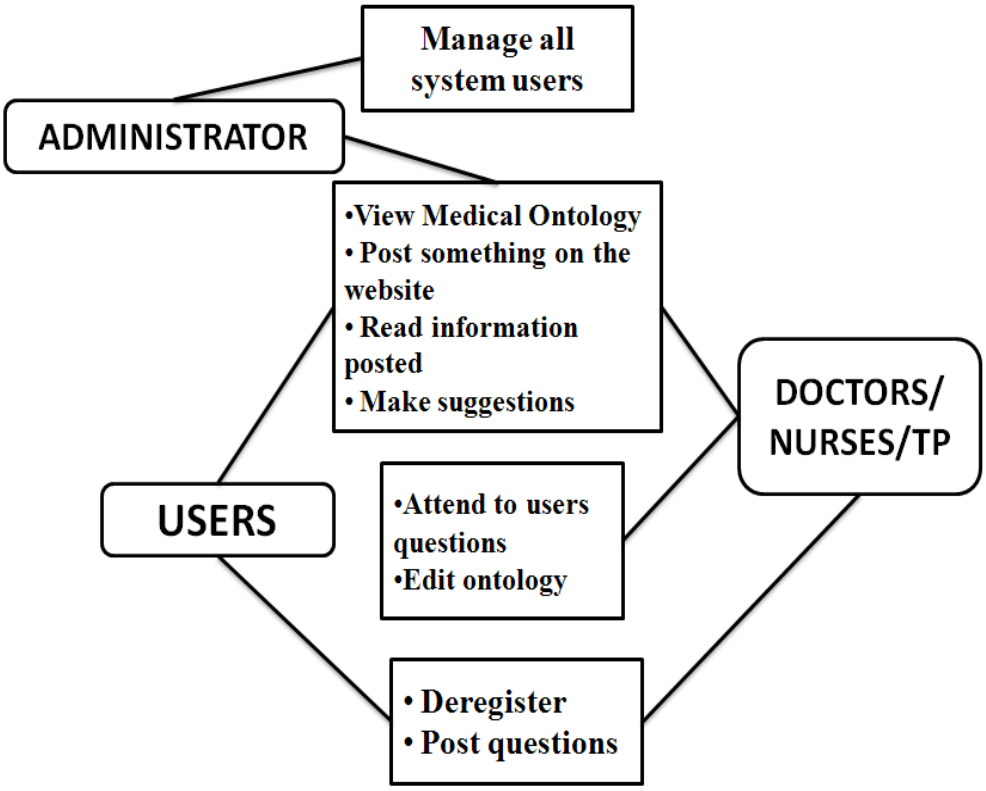
3.3 Interface development and proposed functionality

Upon successful completion of this medical ontology there is a need for the development of a proper interface. This web interface will allow users to have access to the knowledge that this repository store. Adding to that it will be designed in a way that will facilitate knowledge sharing between community members, nurses and traditional doctors. In designing the interface there are certain things that needs to be taken into account, such as literacy levels and affordability of the system to this rural community. To accommodate these requirements, a system has to be built with a combination of Free and / or Open Sources Software to make it affordable to the community. The usability of then follows because intimidating this community with technology that they cannot use is not of best interest, so system usability will be taken into account. LAMP is the tool that will be used for the development of the systems interface:

3.4 Proposed system functionality

Figure 7 shown below shows some of the functionalities that this system will have.

Figure 7: System functionality



This system will allow different operations to be performed by different users in different levels. The system will have an Administrator. An administrator will not register. There are several

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tasks that the administrator will perform in managing the system. One of those operations is to approve users that will be registering as Nurses or Traditional Doctors/Practitioners and so on because an administrator can see everything that is happening in the system. Nurses and traditional practitioners are the ones who will be playing a major role in this system. They are the ones who will be posting information to the website so that normal user can read about health and attend to users questions in a forum. Registered users will only be allowed to read information posted on the wall, post questions that they answers to in forum and add information to the ontology.

4. Conclusion

The successful development of this e-Health portal for the Dwesa community will help by bringing in health knowledge and awareness to this community. All this will be accomplished by facilitating knowledge sharing between local clinic nurses and system users in delivering health awareness and knowledge to Dwesa community. Apart from that this system will also give this community an opportunity to have access to Isixhosa traditional medicine. In addition to that this system will facilitate indigenous health knowledge sharing between the community members and also give community members add approved knowledge to the repository.

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