

An Ontology-based Herb Expert System for Digestion System Wellness

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Abstract -- Holistic health is a diverse field of alternative medicines in which the whole person is focused on. Life style and diet are two of the important factors of shaping one's health and wellness. Among several healing mechanisms, herb is important not just as a source of diet but a source of medicine. However, even though herbs are easily accessible in every cultures and areas, the knowledge of applying herbs on improving health is complicated and it takes quite lots of efforts to acquire the knowledge. In this paper, we design and implement an ontology-based herb expert system for digestive system health. This system has several main merits. The ontology is derived from comprehensive knowledge of herbs, their actions and herb-based treatments.

Keywords: Herb; ontology; digestion; OWL; recommendation; treatment.

1. INTRODUCTION

There are many factors influencing one's health and wellness: gene, diet, environment, exercise, mental status, attitude, life-style, and so on. Nowadays many people used to lead a fast-pace life-style and used to eat out, especially in urban areas. This life-style and diet habits significantly influence one's health- for example digestive system health. Hippocrates said "Let food be thy medicine and medicine be thy food", and "If we could give every individual the right amount of nourishment and exercise, not too little and not too much, we would have found the safest way to health." We can see that a right choice of diet and leading a healthy lifestyle could significantly enhance one's digestive system health. However, the knowledge of food nutrition and the actions consist of several disciplines and huge volume of inter-related know-how.

Herb has been an indispensable source of

nutrition and medicines in many cultures. There are many wisdoms and knowledge around the world that specialize in using herbs as diets and as medicines; to name a few, Indian Ayurvedic medicines, Thai's herb knowledge [14, 15, 16], Chinese herb medicines, and so on. However, the knowledge of herbs and their actions is quite huge, inter-related and needs carefully discerned. Nowadays it is not difficult to access herbs or many herb-related products like nutrition supplements. However, without ease access to comprehensive knowledge of herbs or success to experts, it is very difficult for the general public to apply them in daily life. Even the main stream medication like [19] has confirmed that proper diet and using herb can greatly improve people health.

An expert system is a knowledge-based computer system that applies domain knowledge and rules to answer users' queries on domain questions. It greatly improves the dissemination and accessibility of the knowledge, answers people's questions or provides recommendations, as computers can unceasingly provide its services. Therefore, various expert systems like [3, 4, 5, 2] have been designed and implemented to solve various domain challenges.

In this paper, we design and implement an ontology-based herbalist expert system for digestive system health. We use OWL to represent a comprehensive knowledge of herbs, their actions and related treatments, mostly based on Hoffmann 's publications [17, 18]. Hoffmann is one prestigious herbalist.

2. RELATED WORK

Ontology has been widely applied in solving several domain challenges. Some examples are like tourism recommendation [3, 4], ontology-based tour guidance [10], Herb-related systems [14, 15, 16], or medicine-related systems [13b, 9], and diet-related systems [8, 11, 12].

MYCIN [23], developed in the 1970s, is a well-known infectious disease distinguishing diagnosis system. Through a series of interface conversations, MYCIN provides infectious disease diagnosis as well as antibiotic dosages and treatment. Developed out of INTERNIST-I, Quick Medical Reference (QMR) [13b] is an in-depth information resource that helps physicians to diagnose adult diseases. It provides electronic access to more than 750 diseases representing the vast majority of the disorders seen by internists in daily practice as well a compendium of less common diseases. Roventa and Rosu [20] used Prolog to develop an expert system for kidney disease diagnosis providing probable evaluation models to assist medical specialists making diagnosis decision.

The above systems focused on diagnosis. Some other systems were designed for diet recommendation for specific kind of patients. [8, 11] respectively constructed a general dietary recommender system for chronic patients. Chen, Huang, Bau, and Chen [9], based on ontology and SWRL, implemented an anti-diabetic drugs recommendation system for diabetes patients. Lee et al. [12] developed a dietary assessment system using fuzzy techniques and a domain ontology with fuzzy set layer extension to evaluate diet healthiness.

There were some works that concerned applying herb to improve human health. Kato et al. [14], based on ontology and Semantic Web Technologies, designed a Thai herb recommendation system that consider a patient's symptoms, chronic diseases, Thai herb actions, and the user's taste preference. Their similar publication [16] focuses on representation of Thai herbs and their actions using ontology.

3. SYSTEM DESIGN

We describe our design approach in Section 3.1, the domain ontology which is an herb guide for enhancing digestive system health in Section 3.2, and the system architecture, the functions and user interfaces in Section 3.3.

3.1. The development approach and the overall system architecture

We think that strong domain knowledge expertise, availability and friendly usage are key factors in designing an expert system. With professional domain knowledge, a system would provide valuable and trustable information. The portability of a system would significantly affect

the dissemination of the knowledge and the service. Choosing open source development platform/API like Protégé [5], OWL API[1, 2, 21] and Java helps the portability of our system and increases the availability of the service. The potential users of our expert system for digestive system health include people with digestion ailment and also the general public who wants to enhance their wellness. Therefore, the usage scenarios should consider these two sectors, and should be practical and friendly.

Knowledge acquisition is an important process of building expert system. Previous works used to adopt the following approaches to acquire domain knowledge: (1) domain experts sort out the domain knowledge and build the ontology, and (2) knowledge engineers interview the experts and co-operate with the experts to build the ontology. One of the advantages of these two approaches include that committed domain experts could verify the ontology on the spot. However, it might be very time-consuming and the ontology might be not thorough, if the experts are too busy to fully commit to the ontology building. This is why we could see the discontinuation of several previous projects. On the other hand, if domain knowledge has been well written as books by experts and the books are understandable by knowledge engineers, then one another potential approach is to have engineers digest the contents and build the ontology. One strong point of this approach is that the knowledge content is complete and well organized, and knowledge engineers could digest the content and build the ontology at full speed. In this project, we adopt this approach.

3.2. The Domain ontology

This system focuses on providing complete and professional herb knowledge for improving one's digestive system health. The main source of the knowledge is Hoffmann's prestigious book titled "Healthy digestion" (Hoffmann, 2000). Hoffmann [17, 18] was a lecturer for ecology in the Universities of Wales, an herbalist, ex-Director of the California School of Herbal Studies, and a fellow of Britain's prestigious National Institute of Medical Herbalists. He published several prestigious books about medical herbs. We studied his books, sorted out the knowledge and compiled the knowledge into ontology in OWL language format. To extend the ontology with some add-on features like flavor, energy, popular name and pictures, we consulted other sources like [22] (American

Botanical Council).

The relation of main classes of our ontology is depicted in Fig. 1 (at the end of this paper). The listings of classes, object properties and data properties in protégé are respectively shown in Fig. 2 (a)(b)(c), and the corresponding short descriptions are given respectively in Table 1-3. Some key classes are described as follows.

The Class Action is designed for describing the changes that occur in the body or in a bodily organ as a result of herb's functioning. Some instances of the class are astringent, anti-inflammatories, antimicrobials, antispasmodics, etc. The properties of this class include hasDescription (which provides the explanation of an Action), hasNotice (which describes what one should notice about this Action), hasHerb (what herbs have such an Action), hasBodyPart (which organ this Action has effect on) and hasIntensity (the intensity of this Action).

The Class Ailment consists of two sub-classes: Symptom and Disease. This class describes an ailment and its related properties. These properties include hasDescription, accompaniedSymptoms (which provides potential symptoms of this ailment), hasCaution (which reminds users what they should notice about this ailment), treatedBy (which lists potential therapies), and effectiveHerb (which lists popular herbs for treating this ailment).

The Class Therapy contains various Therapy instances. This class has the properties: hasTreatment (which specifies various treatments in this therapy, where treatments are like herbs, actions and a text description of a treatment), inCondition (which specifies in which conditions this therapy could be applied), hasEffect (which describe what kinds of effect this therapy causes), and hasCaution (that provides the risks/cautions/results/symptoms that one should notice).

The Class Treatment provides the treatment for a therapy, and it consists of the union of the Herb Class, the Action Class and the Class hasTreatment_string (which is a text describing those treatments that could not be fully specified by herbs or actions).

The Class Herb holds the properties of an herb. The properties of this class include hasAction (which provides what kinds of action a herb has; some examples of actions are like astringent, anti-inflammatories, antimicrobials, antispasmodics, etc), hasFlavor (the flavor of an herb), hasHerbPart (the edible parts),

hasScientificName (the scientific name), hasAlias (the popular names/local names of a herb), and hasChinesemedicion (its actions in Chinese medicine context; this part is for Chinese medicine doctor's or herbalist's reference).

We take some examples to further explain the class, instance and properties of our ontology. Fig. 3 shows the instance Chamomile of Herb class with object properties. Here, it describes that Chamomile has actions- Mild Bitter, Digestive system Nervine, Vulnerary, Carminative, Antispasmodic, Nervine, and so on. Its edible part is flower. Its scientific name is *Matricaria recutita*.

Fig. 4 shows one instance of Class Action- Carminatives and its properties. Here, it shows that the herbs ginger, agrimony, Chamomile, and so on have the action "Carminatives".

Fig. 5 shows Instance Indigestion which belongs to Class Symptom. Its properties depict its possible causes including "using medicine that irritate the stomach lining", "stress", "exercising with full stomach", "eating high-fat foods", "drinking alcohol", and so on. Effective herbs for this symptom include chamomile, gentian, lemon balm, etc. The accompanied symptoms for Instance indigestion include vomiting, epigastric pain, peptic ulceration, flatulence, abdominal pain, belching, etc. The therapies include indigestion bitters, indigestion antispasmodics, etc. The treatment formulas for it include "combination indigestion tincture", "indigestion simple", etc.

Fig. 6 shows "indigestion antispasmodics" is an instance of Class Therapy, and it has Treatment "Antispasmodics" and the condition of applying this therapy is "if the carminatives do not ease abdominal cramping".

Fig. 7 shows Instance "Indigestion simple" is an instance of Class TreatmentFormula and its category is infusion. Its ingredients include peppermint, chamomile and lemon balm. The suggested time to have this infusion could be either before or after the meal, and users can experiment it to have personal best application.

3.3. The architecture and the functions

As we can see that the user interface of protégé is quite useful and handy to knowledge engineers to build ontology, but it is not so friendly to the general public to acquire and apply the knowledge. Our system is designed for herbalist, knowledge engineer and also the general public; therefore, a well-designed interfaces and usage scenarios (functions) could

boost the performance of an expert system. Based on Java and OWL API, we design our expert system that provides herb guides for enhancing digestion system health.

The architecture of our system is depicted in Fig. 8, where users have two approaches to access the knowledge: one is via protégé interface and the other is via our system interfaces. We, based on Java and OWL API, designed a custom-designed system. This custom-designed system provides friendly interfaces, applies Hermit (a reasoner) on the knowledge (ontology), and replies users' queries.

Via analyzing users' habits and preferences, we designed six main scenarios (functions). These functions are briefly summarized as follows.

1. Query an herb and its properties: Users can click on a specific herb instance, and the system answers the specified properties like herb's actions, edible parts, local names, etc.
2. Query an action and its properties: Sometimes users are not familiar with herbs, but they need to acquire the knowledge what herbs own a specific action. This function is designed for this scenario. For example, if a user is interested in carminatives, then he/she can select carminatives and the system will respond the herbs that own this action.
3. Query an ailment and its properties: From this function, users select an ailment instance, and the system answers the properties for it. The properties include (1) the possible causes, (2) the life-style treatment, (3) the cautions, (4) the possible causes, (5) the potential symptoms, (6) a series of therapies, (7) effective herbs, and so on. Each therapy provides (1) the conditions to apply this treatment, (2) the cautions for this therapy, and (3) the effects.
4. Query a treatment formula and its properties like (1) its ingredients, (2) how to make it, and (3) how to use it.
5. Use symptoms to query possible ailments. Sometimes users have no idea what herbs they are interested and what ailments they might have, but they observe some symptoms they have. So this function is quite useful. A user provides the symptoms he has, and the system lists all potential ailments for those specified symptoms. And, from the listed ailments, the user can further select the ailment and check the corresponding

therapies and herbs.

6. Use causes to query potential ailments. Sometimes people do not feel well but are not sure what ailments they have. In addition to providing symptoms, they can also provide the causes (the life styles or habits), and the system will answer possible ailments and the corresponding symptoms. For example, a user might feel high pressure and feel fatigue, and he would like to know what ailments might result in.

The user interfaces

A user-friendly interface is designed and shown in Fig. 9. .

4. CONCLUSIONS

In this paper, we have designed and implemented an ontology-based expert system which provides professional guide for improving digestion system health. The feedbacks from users confirm its practicality and usefulness. This project also verifies the effectiveness of one another approach of building ontology: knowledge engineers study professional books in the building phase and then verify the contents in the verification phase.

Acknowledgements: This project is partially supported by the National Science Council, Taiwan, R.O.C., under grant no. MOST 103-2221-E-260 -022.

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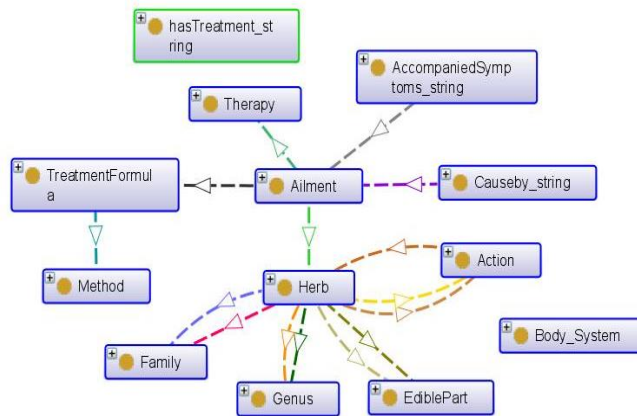


Figure 1. The relation of classes of our ontology

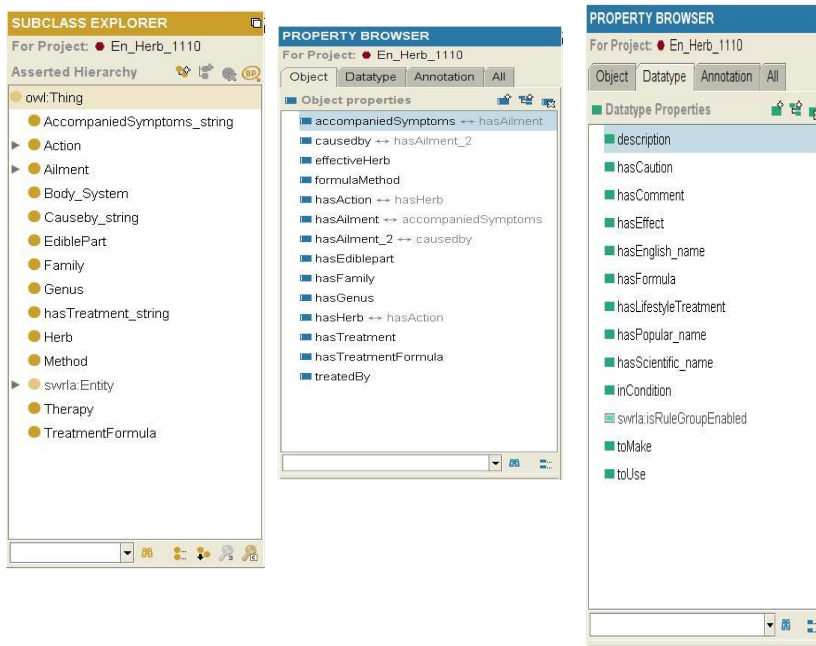


Figure 2(a)(b)(c). Listing of (a) classes, (b) object properties, (c) data properties.

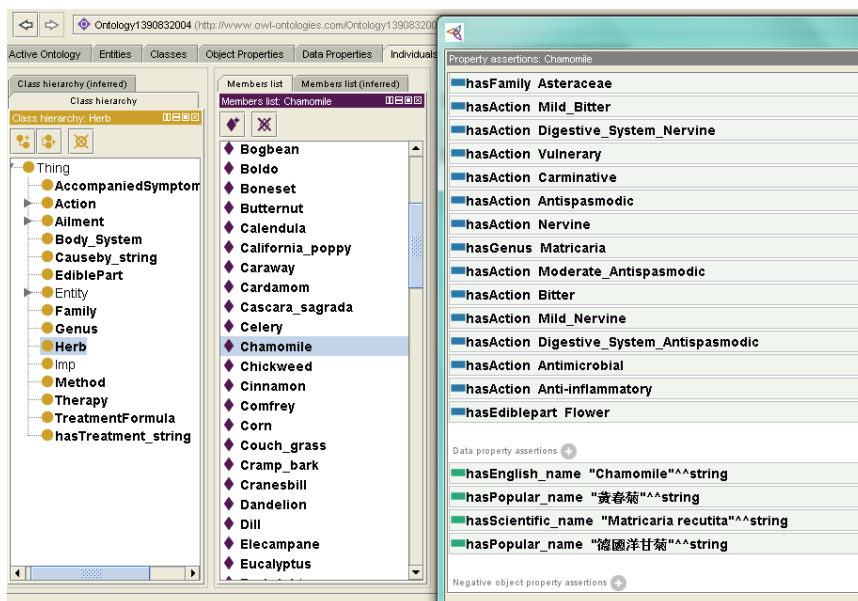


Figure 3. The Instance Chamomile of Herb class

Table 1. Descriptions of classes

AccompaniedSymptoms_string	The accompanied symptoms of an ailment
Action	The actions of herbs
Ailment	It consist of two sub-classes: ailment and disease
Body_System	The organs
Causeby_string	The causes of an ailment
Ediblepart	The edible parts of a herb
Family	The Family of a scientific name
Genus	The Genus of a scientific name
hasTreatment_string	various treatments
Herb	herbs
Method	Categories of a treatment like infusion, tinction, etc.
Therapy	Therapies
TreatmentFormula	The formula of a treatment. It consists of how/what to make and how to use it.

Table 2. Object properties in our ontology

accompaniedSymptoms	It indicates what symptoms an ailment might have. This is an inverse property of “hasAilment”.
causedby	It indicates possible causes for an ailment. This is an inverse property of “hasAilment_2”.
effectiveHerb	The popular herbs for healing an ailment.
formulaMethod	The category of a treatment formula. It consists of infusion, decoction, capsule, decoction, pill and tincture.
hasAction	It indicates what actions an herb has. This is an inverse property of “hasHerb”.
hasAilment	It indicates what ailments an AccompaniedSymptoms_string instance might have. This is an inverse property of “accompaniedSymptom”.
has Ailment_2	It indicates what possible ailments a cause might result in. This is an inverse property of “causedby”.
hasEdiblepart	This indicates the edible parts of an herb.
hasFamily	The family of an herb.
hasGenus	The genus of an herb.
hasHerb	It indicates what herbs could have the specified action. This is an inverse property of “has Action”.
hasTreatment	It indicates what treatments a therapy has.
hasTreatmentFormula	This text specifies the formula description of a treatment formula.

treatedBy	This specifies the therapies for an ailment.
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Table 3. Data properties in our ontology

description	Texts describe accompanied symptoms, ailment, cause or treatment.
hasCaution	Texts describe what one should notice when applying a treatment.
hasComment	Texts describe additional information about an herb.
hasEffect	Texts specify what effects a treatment might have.
hasEnglish_name	Popular names of an herb.
hasFormula	Texts specify the procedures of a treatment formula.
hasLifestyleTreatment	The life style suggestion for healing an ailment.
hasPopular_name	Popular names/local names of an herb.
hasScientific_name	Scientific name of an herb.
inCondition	It specifies the conditions on which n treatment could be applied.
toMake	The making procedures of a treatment formula.
toUse	It specifies how to use a treatment formula.

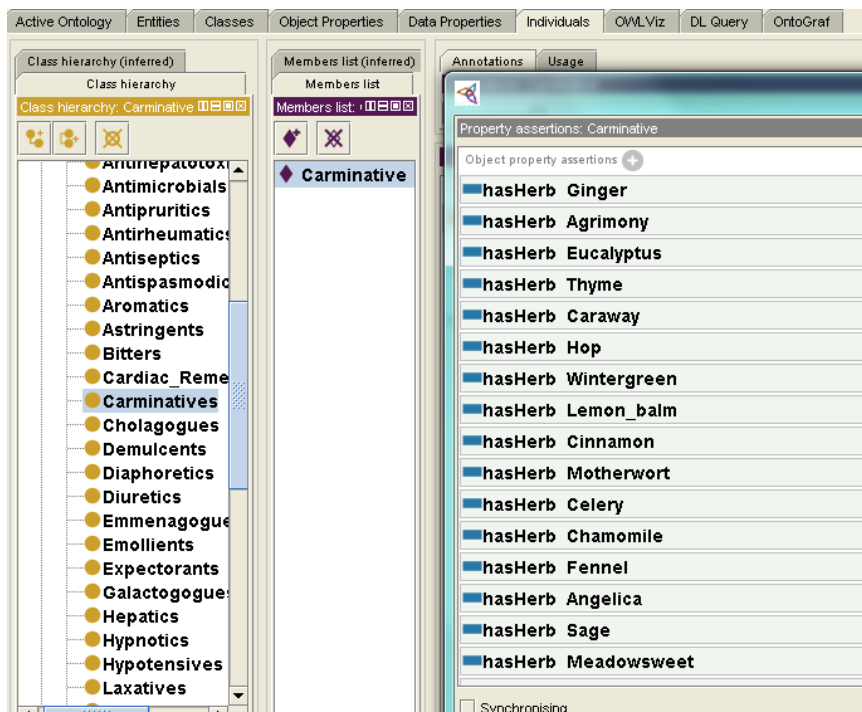


Figure 4. The Instance Carminatives of Action class.

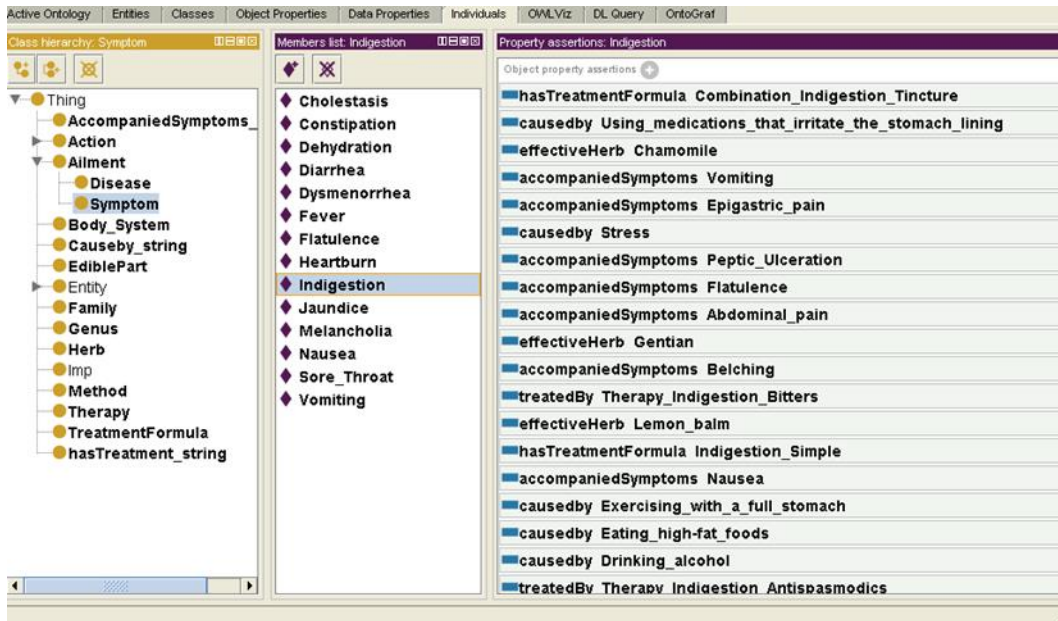


Figure 5. Instance indigestion and its properties.



Figure 6. Instance indigestion antispasmodics and its properties.

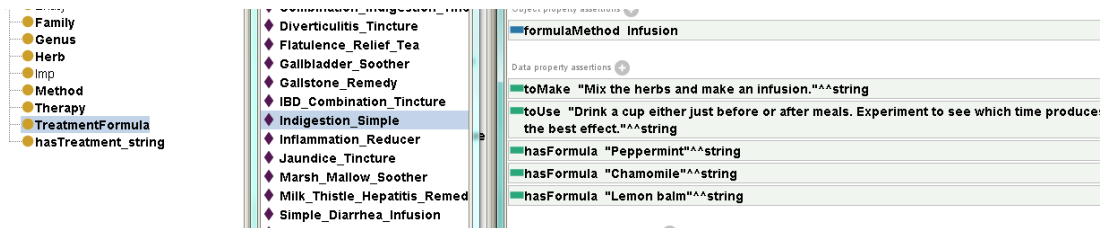


Figure 7. Instance “indigestion simple” and its properties.

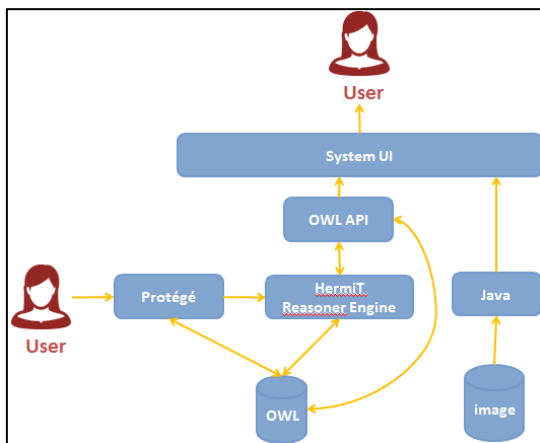


Figure 8. The system architecture



Figure 9. The functions on the main menu

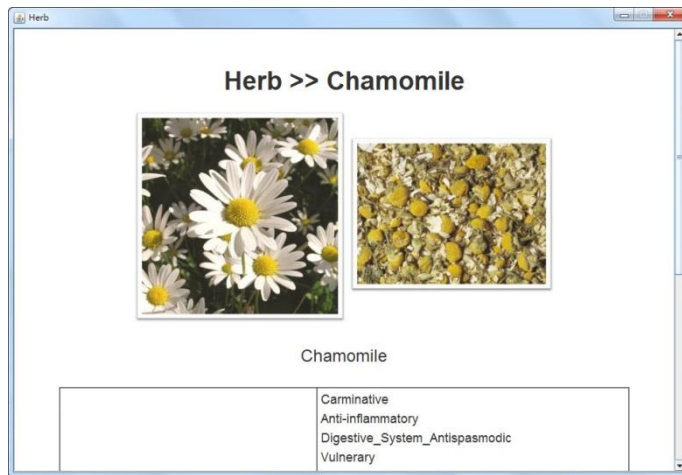


Figure 10. One herb class- Chamomile