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TibbOntoExpo: An Expert System based on Ontology Representation to use Prophetic Medicine

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ABSTRACT
Hadith is one of two sources of Islamic legislations beside the Quran. They are all about what Prophet Mohammed said or did during his life and his companions documented them. Hadith books contain, among all other aspect, prophet's medicine which describe a lot of substances and herbs to treat several diseases. This paper introduced an Expert System named TibbOntoExpo to use prophetic medicine by representing the knowledge base using Ontology Engineering. The proposed system helps users to get benefit of this valuable kind of medicine in an attempt of treating several diseases and health abnormalities without the need to visit the specialists. The system was evaluated by several experts in the field and its performance, precision and recall values showed that the proposed system is competitive.

Keywords:- Prophetic Medicine, Ontology

I. INTRODUCTION

In Islam, Prophetic medicine is the advice given by the prophet Muhammad with regards to sickness, treatment and hygiene as found in the hadith, and the writings undertaken primarily by non-physician scholars to collect and explicate these traditions. Prophetic medical traditions exhort humans to not simply stop at following Muhammad's teachings, but encourage them to search for cures as well. The literature of prophetic medicine thus occupies a symbolic role in the elucidation of Islamic identity as constituted by a particular set of relationships to science, medicine, technology and nature. Several researches had been published in the field of medicine by suggesting to treat some diseases using Prophetic medicine, which ensure the big role that can be played by this type of medicine in treating some perennial diseases [1-5].

Although, several researches proposed automatic systems to get benefit of some traditional medicines rather than Arabic or Prophetic medicines, such as Chinese, Indian, and Malay traditional medicines [6-13], very little researchers spot the light on this valuable medicine by the mean of making it available and easy to be used by normal non-expert people automatically using a computer or a smart phone [14, 15]. For these reasons there is a vast demand to focus on this issue and proposes an automatic system that has the ability to interact with un-expert users and get help them get benefits from Prophetic medicine.

This paper proposes an Expert System based on Ontology engineering (TibbOntoExpo) to represent its knowledge base. Several ontology Expert Systems had been proposed to represent the knowledge base in the field of medicine [16-24]. Some languages have been proposed to encode the knowledge about a specific domain. Ontology Inference Layer (OIL), Web Ontology Language (OWL), and Resource Description Framework (RDF) are examples of markup ontology languages. This work used OWL2, which is a W3C recommendation language, with its OWL-DL sublanguage and its Pallet reasoner. Since it is more expressive than OWL-Lite and it has the abilities of automated reasoning, automatic computation and classification hierarchy, and check for inconsistencies for the designed ontology [25-27]. The main building block of any expert system is the knowledge base. In Ontology-based expert systems Semantic Web Rule Language (SWRL), another W3C recommendation, is a rule and logic expressive language that combines both OWL-DL and OWL-Lite with the rules markup language [25, 28].

II. METHODOLOGY

The architecture of the proposed system consists of several modules. Figure 1 illustrates these modules and the interactions between them. As any other expert system, the core of our system is the knowledge base module which consists of the fact base and the rule base. The facts are extracted, using the user interface, from the user as the patient's symptoms in addition to the laboratory and clinical test results.

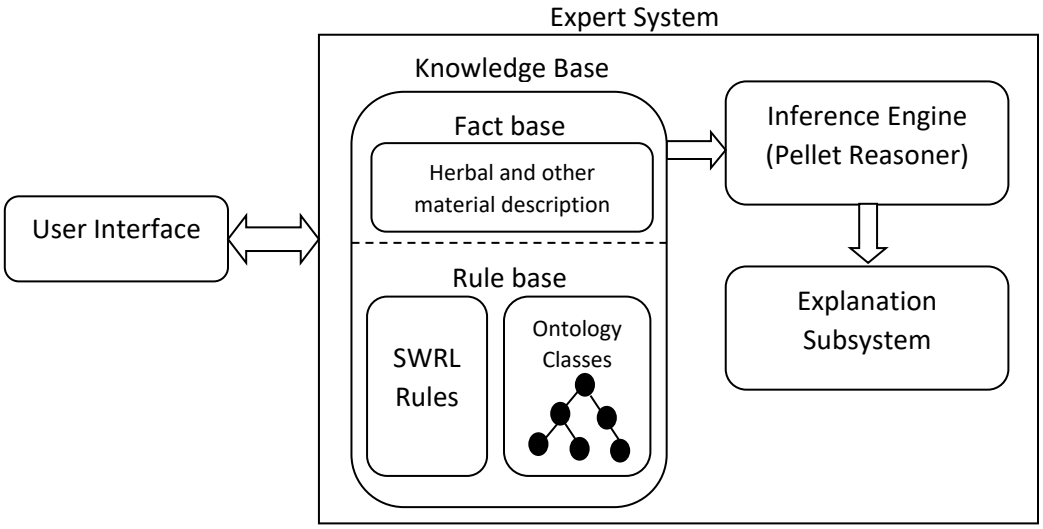

Figure 1: TibbOntoExpo framework

The rules base consists of SWR decision rules and the ontology structured classes along with the relationships between these classes. The decision rules were inferred from one of the most famous books that gathered all the Prophetic medicine [29], while the ontology classes were formed using Protégé Ontology editor.

The inference engine is the core of any expert system which depends on the facts and the rules to reason the required decision. In our work we use Pellet [30, 31], which considered to be one of the best OWL-DL reasoner with several features such as data-type reasoning and debugging, rules integration, and reasoning conjunctive queries. In this stage more decision rules could be inferred and added to the list of available rule base. The final decision results will be introduced to the user through the user interface alongside with the explanation about this decision inferred from the explanation module.

III. METHODOLOGY

Several methodologies have been proposed to be used in building and developing ontology-based expert systems. One of these methodologies is METHONOLOGY, which is considered to be the most comprehensive ontology engineering methodology [32].

As illustrated in Figure 2, METHONOLOGY does not specify only the stages that the development process should

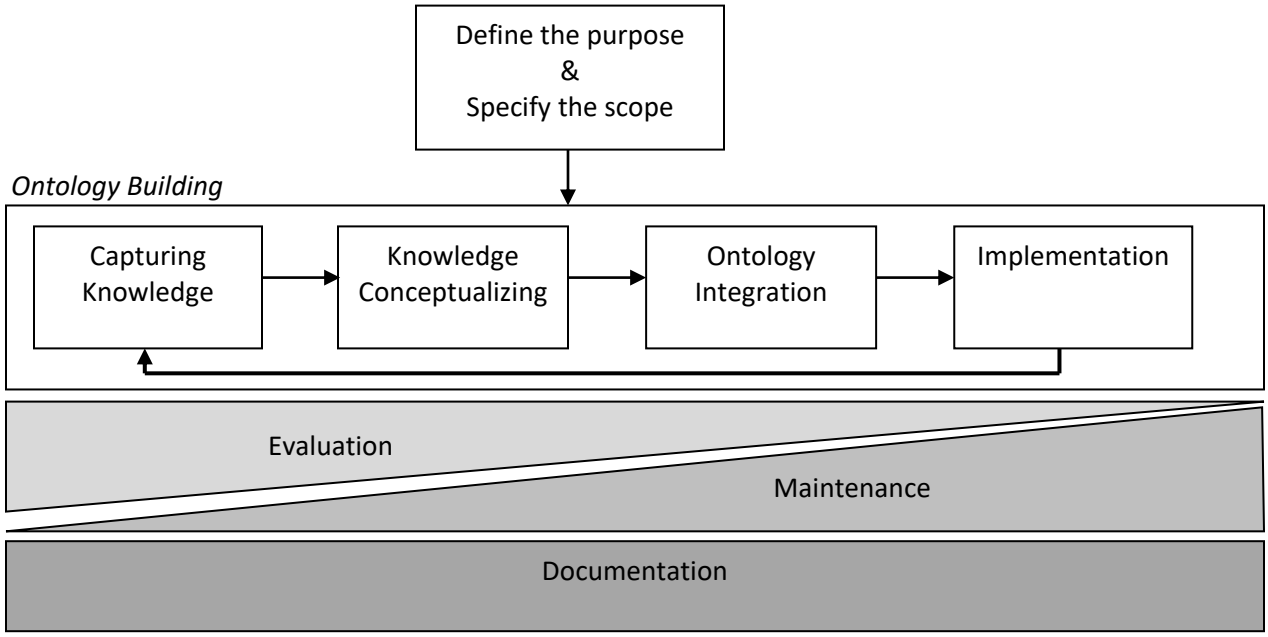

Figure 2: Ontology development life-cycle.

pass, but it also depicted the depth of some of these stages. Although the methodology seems to have several independent stages, most of these stages are interfere with each other and can be operate simultaneously. TibbOntoExpo depends on this methodology and the stages of the development process are as follows:

1. *Define the purpose and specify the scope stage:* This stage should determine the purpose of building the ontology, its formality, and its scope. The purpose of TibbOntoExpo is to be a knowledge representation of Prophetic medicine domain embedded in an easy to use GUI. Since TibbOntoExpo was expressed in a formally defined language (OWL), its degree of formality is "semi-formal". The proposed system can be used by the specialist in the field in order to get an accurate diagnosis based on the reasoning process embedded in the ontology.
2. *Capturing knowledge stage:* The depth of this stage start to be high in the beginning of the design process and it decreases as the process goes farther. Several techniques were used in capturing the knowledge required to build TibbOntoExpo. Non-structured interviews with the experts in the field were useful to specify the requirement of these experts, while structured interview were used to get the detailed knowledge and to specify the concepts, object properties, data properties and the relations between them. On the other hand, formal and informal text analyses were used in this stage to identify the main structure of the ontology and to fill the concepts in this structure respectively.
3. *Knowledge conceptualization stage:* This stage depends on the output of the previous stages by constructing the Glossary of Terms (GT) [32] which include the concepts and the properties used in designing the ontology. These terms are useful to construct the class hierarchy and to determine the properties and the relations between these classes. For this purpose we use the rich semantic tree (RST) suggested by [33]. Figure 3 shows the TibbOntoExpo RST tree and the key shapes used in it.
4. *Integration stage:* This stage specifies if the developed ontology can have benefit from other existing ontologies. This process exemplifies the feature of ontology reusability, when the existing ones can be integrated in to a new developing one. TibbOntoExpo integrate part of the ontology used in [14].

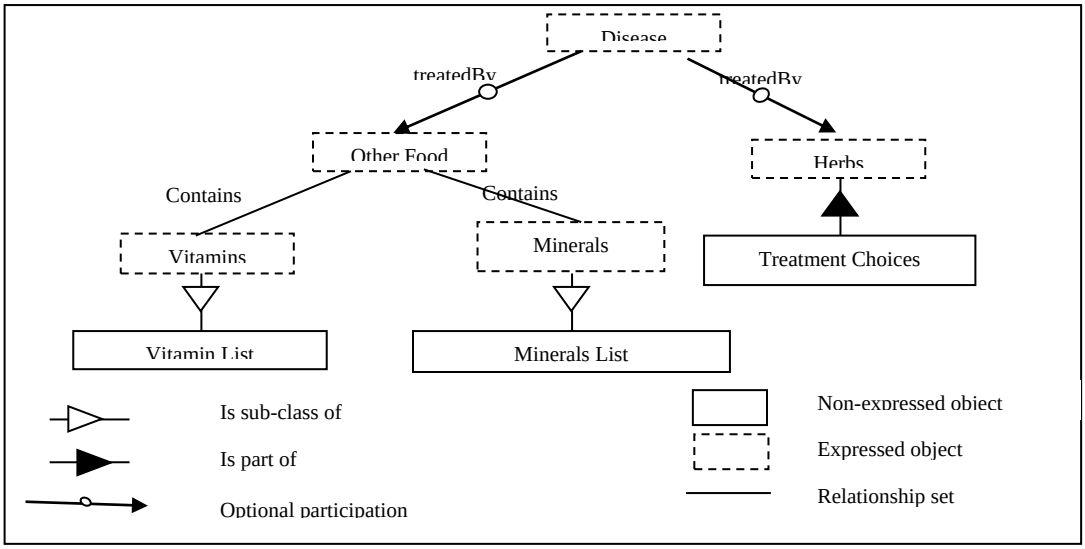

Figure 3: TibbOntoExpo RST

5. *Implementation Stage:* This stage is responsible on implementing the ontology in one of the available ontology editors. TibbOntoExpo used Protégé v5.5.0 as an editor which has the ability to check the lexical and syntax errors. Protégé is integrated with several types of reasoner which guarantee the completeness, consistency, and non-redundancy in the defined ontology. The reasoner used by the developed ontology is Pellet [30, 31]. **Error! Reference source not found.** shows the tree structure built by using Onto-Graf plug-in embedded with Protégé for TibbOntoExpo ontology. Protégé provides the abilities to create the concepts and their data properties and object properties in expressive description logic. Protégé 5.x provides a nice environment to write Semantic Web Rule Language (SWRL), while the later versions (**Error! Reference source not found.**) provide a very simple SWRL editor.

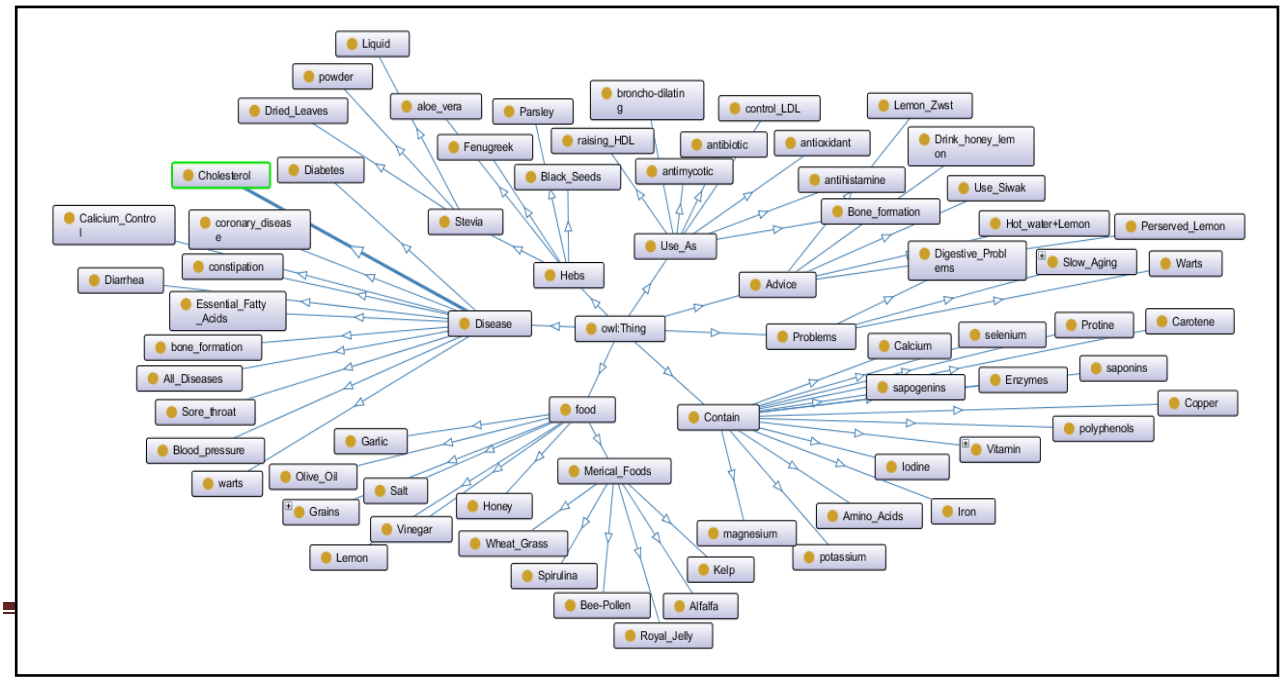

Figure 4: TibbOntoExpo tree structure produced by Protégé.

6. *Evaluation:* It is not a standalone stage but it is the one that interfere with all the previous stages. As seen in Figure 2, the evaluation stage depth starts to be high at the first stages of the development process and then it decreases as the process goes farther. In the first stages the important thing is to guarantee the verification of the developed ontology which is done by checking the correctness of the captured knowledge and the conceptualizing table and its tree using interviews with the experts in the domain. While in the later stages, the validation of TibbOntoExpo has been checked by the experts to make sure that the designed system meets their requirement.

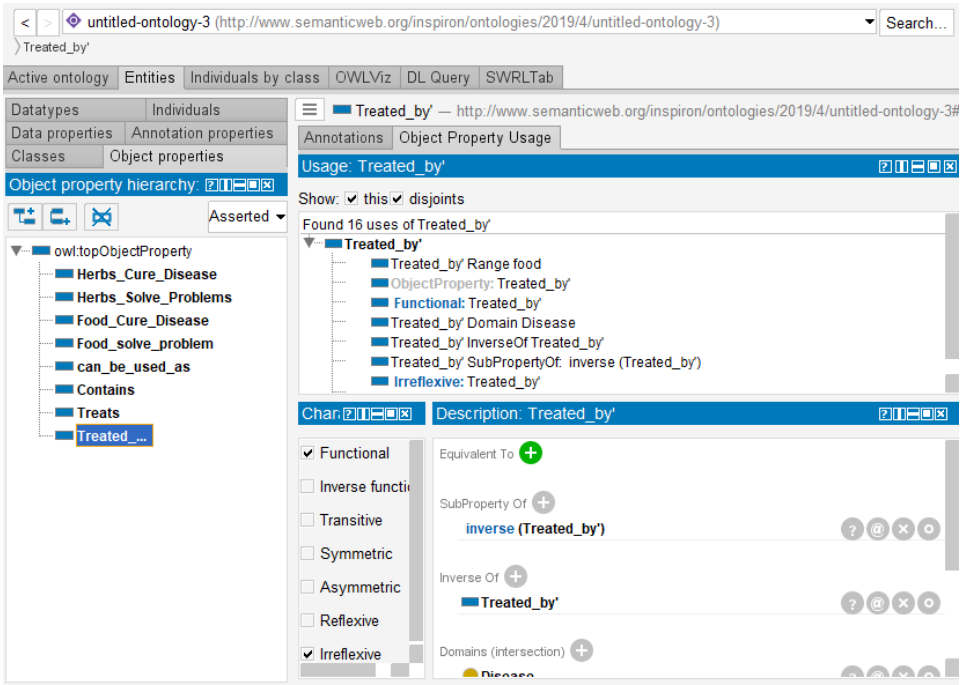

Figure 5: A screenshot of Protégé 5.5.0

7. *Documentation:* this stage is going in parallel with all other stages since the output of each stage is a document which is important to available as an input for the next stage. Moreover, publishing papers in journals or conferences in considered being a kind of documentation.

IV. EVALUATION AND DISCUSSION

The process of evaluating an expert system has two stages, technical evaluation and user evaluation. As mentioned in the previous sections, technical evaluation should pass through verification and validation. During the verification stage all the collected knowledge should be guaranteed to be correct, while during the verification stage the designed system should be guaranteed to work right. Several techniques were used to check the validation of an expert system and one of the most dominant ones is validation based on case studies.

Determining test instances is crucial to test the validation of the system. These instances should cover all the possible cases at the moment of a given instance. To test TibbOntoExpo, more than 20 instances were defined and the system runs by four different experts in the field of Prophetic medicine to ensure the generality of the designed system. The correct results obtained by the system after

implementing all the instances were 97.4% correct. Calculating the precision and the recall, the factors used in the field of information retrieval, were used to check the validation of TibbOntoExpo.

$$Precision = \frac{retrievedresults}{totalresults}$$

$$Recall = \frac{retrievedresults}{correctresults}$$

TibbOntoExpo average precision is 0.73, while the recall is 0.81. The reason behind low recall is that the system inferred some extra results that are not needed as a result.

V. CONCLUSION AND FUTURE WORK

The appearance of ontologies in the field of computer science affects the development of several types of systems and expert systems are one of them. This paper presents TibbOntoExpo, an ontology-based expert system to help people getting benefit from the very precious Prophetic medicine. The system was tested by some experts and their comments were taken into consideration to develop the system and guarantee its validation. The performance of the system was 97.4% correct and the precision and recall factors reflect the quality of the design.

Considering fuzzy logic is one of the required developments on the system. Moreover, embedding a machine learning technique could enrich the system by making it learn from the result of the system and then use these results for further diagnosing. Upgrading the system to be a Web application is another development required.

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