إقرار

أنا الموقع أدناه مقدم الرسالة التي تحمل العنوان:

An Ontology Based Approach to Enhance Information Retrieval from Al-Shamelah Digital Library

أقر بأن ما اشتملت عليه هذه الرسالة إنما هي نتاج جهدي الخاص، باستثناء ما تمت الإشارة إليه حيثما ورد، وإن هذه الرسالة ككل، أو أي جزء منها لم يقدم من قبل لنيل درجة أو لقب علمي أو بحثي لدى أية مؤسسة تعليمية أو بحثية أخرى.

DECLARATION

The work provided in this thesis, unless otherwise referenced, is the researcher's own work, and has not been submitted elsewhere for any other degree or qualification

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An Ontology Based Approach to Enhance Information Retrieval from Al-Shamelah Digital Library

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نتيجة الحكم على أطروحة ماجستير

بناءً على موافقة شئون البحث العلمي والدراسات العليا بالجامعة الإسلامية بغزة على تشكيل لجنة الحكم على أطروحة الباحث/ محمد غازي عبدالله المصري لنيل درجة الماجستير في كلية *تكنولوجيا المعلومات* برنامج تكنولوجيا المعلومات وموضوعها:

استخدام الأنتولوجي لتحسين استرجاع المعلومات من المكتبة الشاملة

An Ontology Based Approach to Enhance Information Retrieval from Al-Shamelah Digital Library

وبعد المناقشة التي تمت اليوم الأربعاء 30 شعبان 1436هـ، الموافق 2015/06/17م الساعة الواحدة ظهراً، اجتمعت لجنة الحكم على الأطروحة والمكونة من:

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د. ريحــي ســليمان بركــة	مناقشاً داخلياً	....
د. تـــامر ســعد فطــاير	مناقشاً خارجياً	....

وبعد المداولة أوصت اللجنة بمنح الباحث درجة الماجستير في كلية *تكنولوجيا المعلومات*/ برنامج تكنولوجيا المعلومات.

واللجنة إذ تمنحه هذه الدرجة فإنها توصيه بتقوى الله ولزوم طاعته وأن يسخر علمه في خدمة دينه ووطنه.

والله ولي التوفيق ،،،

مساعد نائب الرئيس للبحث العلمي والدراسات العليا

أ.د. فؤاد علي العاجز

Abstract

With the huge number of Islamic references that emerged over hundreds of years, several difficulties were introduced when searching this huge Heritage. This has challenged researchers to develop computer systems to facilitate information retrieval and extraction from the Islamic heritage. One of these systems is Al-Shamelah Digital Library (ADL), Al-maktabah Al-Shamelah, which is a huge database containing thousands of books in different Islamic disciplines. Information retrieval from ADL is mainly based on keyword matching, and does not provide semantic interpretations of Islamic texts. Current information retrieval capabilities in ADL do not provide the possibility to handle complex queries, provide intelligent results based on the semantic processing of content, or extract implicit relations and meanings from text. Islamic texts, such as the Quran and Sunna, are rich sources of knowledge with many underlying thoughts, meanings and laws. They often include many metaphors and figurative speech which cannot be directly interpreted. In addition, the Islamic Knowledge is known to be very diverse and interrelated. Traditional search services provided by ADL only allows access to information without revealing the relationships or dependencies between various information resources.

Driven by the above challenges, this thesis proposes a system which called OntoADL that supports semantic search and recommendation over a subset of ADL. At the core of OntoADL is our ontology-based approach that leverages ontology-based annotations to produce highly relevant search results and to offer recommendations of related topics of interest. It is based on the Hadith ontology that we built, in cooperation with domain experts, to model the different entities included in the Prophetic Medicine, the domain we selected to assess our approach. This thesis explains the design and architecture of OntoADL, focusing on how ontology-based reasoning can result in intelligent results that meets the user's interests. The search service in OntoADL was evaluated by being compared with the search service in the conventional ADL. The OntoADL achieved (90%) recall and (83%) precision while the ADL system achieved 69% recall and 30% precision. These results indicate that our approach surpasses the ADL search facility. To assess the rankings of retrieved results, the Mean Average Precision (MAP) was calculated for both OntoADL and ADL. OntoADL achieved 86% MAP while the ADL system achieved 36%. This result also indicates that OntoADL outperforms the conventional ADL in terms of the ranked retrieval results.

Keywords: Al-Shamelah Digital Library (ADL), Semantic web, Ontology, OWL

I

الملخص

في ظل العدد الهائل من المراجع الإسلامية التي ظهرت على مدى مئات السنين، قُدمت عدة صعوبات عند البحث في هذا التراث الضخم. ولقد شكل هذا تحدياً للباحثين لتطوير أنظمة كمبيوتر لتسهل استرجاع المعلومات واستخراجها من التراث الإسلامي. أحدى هذه الأنظمة هي المكتبة الرقمية الشاملة، (المكتبة الشاملة) وهي قاعدة بيانات ضخمة تحتوي على الآلاف من الكتب في التخصصات الإسلامية المختلفة. ويستند استرجاع المعلومات من المكتبة الشاملة أساسا على مطابقة الكلمات الرئيسية، ولا توفر تفسيرات دلالية للنصوص الإسلامية. وقدرات استرجاع المعلومات الحالية في المكتبة الشاملة لا توفر إمكانية للتعامل مع الاستفسارات المعقدة، وتقديم نتائج ذكية تقوم على معالجة الدلالية للمحتوى، أو استخراج العلاقات الضمنية والمعاني من النصوص.

نصوص الشريعة الإسلامية، مثل القرآن والسنة، هي مصادر غنية من المعرفة مع عديد من الأفكار والمعاني والقوانين الضمنية الأساسية. وغالباً ما تتضمن العديد من الاستعارات والكلام المجازي الذي لا يمكن تفسيره مباشرة. وبالإضافة إلى ذلك، أن المعرفة الإسلامية معروفة إلى أن تكون متنوعة جدا ومترابطة. خدمات البحث التقليدية التي تقدمها ADL يسمح فقط الوصول إلى المعلومات دون الكشف عن العلاقات أو الاعتمادات بين مصادر المعلومات المختلفة.

وانطلاقا من التحديات المشار إليها أعلاه، تقترح هذه الأطروحة OntoADL ، وهو النظام الذي يدعم البحث الدلالي والتوصية على مجموعة فرعية من المكتبة الرقمية الشاملة. في صميم OntoADL نهجنا القائم على الأنطولوجيا والذي يعزز الشروح على أساس الأنطولوجيا لإنتاج نتائج بحث ذات صلة بدرجة عالية، وتقديم توصيات من الموضوعات ذات العلاقة من الاهتمام. ويقوم على أنطولوجي الحديث الذي بنيناها، بالتعاون مع خبراء المجال، لنمذجة مختلف الكيانات المتضمنه في الطب النبوي، وهو المجال الذي اخترناه لتقييم نهجنا. هذه الأطروحة تشرح التصميم وهيكليةOntoADL ، وتركز على كيفية الاستدلال على أساس الأنطولوجي يمكن أن يؤدي إلى نتائج ذكية والتي تلبي اهتمامات المستخدم.

تم تقييم خدمة البحث في OntoADL بمقارنتها مع خدمة البحث في المكتبة الشاملة التقليدية. نظامنا المقترح OntoADL أنجز (90٪) average recall، و(83٪) average precision فيما حقق نظام المكتبة الشاملة (69%) average recall و(30%) average precision. هذه النتائج تشير إلى أن نهجنا فاق أداء البحث في المكتبة الشاملة. ولتقييم ترتيب استرجاع النتائج ، تم احتساب متوسط متوسط الدقة (MAP) لكل من نظامنا ونظام المكتبة الشاملة.OntoADL حققت (86%) MAP بينما حقق نظام ADL (36%) MAP. وتشير هذه النتيجة أيضا أن OntoADL يتفوق على المكتبة الشاملة التقليدية من حيث مفردات نتائج الاسترجاع المرتبة.

كلمات مفتاحية : المكتبة الشاملة ,الويب الدلالي ,انتولوجيا , لغة انتولوجيا الويب(لغة وجودية الويب)

Dedication

To my beloved Parents, for their constant prayers, their support, encouragement, and constant love have sustained me throughout my life.

To my Wife, for her relentless care and support.

To my Children, with hope for a bright future.

To my brothers and sisters, for their endless love and support.

And to the soul of my brother the martyr Abduallah "Abu Muaath" who gave his last breath fighting for Palestine

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To my father, who encouraged me to be the best I can be, to have high expectations and to fight hard for what I believe. The man to whom I will be grateful, for the rest of my life.

To my mother; who has been a source of inspiration to me for years. I would never forget her continuous prayer for the sake of my success.

No acknowledgement would be complete without expressing my appreciation and thankfulness for my wife; I can't refute her long lasting patience and support which she showed during this work and which was essential to accomplish it.

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Mohammed Gh. Al Masri

May, 2015

Table of Contents

`Table of Figures

List of Tables

List of Abbreviations

ADL   Al-Shamelah Digital Library

OWL   Web Ontology Language

RDF   Resource Description Framework

RDFS   Resource Description Framework Schema

SPARQL   SPARQL Protocol and RDF Query Language

URIs   Uniform Resource Identifiers

XML   Extensible Markup Language

Chapter 1 : Introduction

Digital libraries are the primary tools used for serving researchers in their specialization fields. These various specialized libraries depend on providing the required information using searching by keywords. The results do not meet the ambitions and needs of researchers to obtain quick and accurate information in the search.

ADL is considered one of the largest libraries used by researchers, professionals, intellectuals and other strata of society to take advantage of the offered services. It is regarded as a fundamental tool to retrieve the necessary information due to its comprehensiveness and diversity. Here lies the importance of enhancing information retrieval in the ADL under the considerable increase in the volume of information in internet or digital libraries.

ADL is a huge database of thousands of books in different disciplines like doctrine المذاهب, hadith interpretation،تفسير الحديث prophet biography،السيرة النبوية jurisprudence (Fiqh) الفقه, history التاريخ، genealogy, literature and rhetoric الأدب وعلم البلاغة. The ADL aims to be inclusive of all scholarly requirements of books and researches. The ADL software works on Windows OS platform and supports different text formats. It is categorized in a single easy to use framework. It also presents many rich features like the ability to add or delete books and the ability to link book scripts with OCR copies which enables the user to find the original source directly [1].

ADL has become popular and disseminated quickly among students and others due to three reasons:
- a. It contains a huge number of E-books in its database reaching in some versions up to 11000 books.
- b. It contains the most important books under every discipline of the different disciplines of Islamic religion sciences.
- c. It's a totally free application which can be downloaded and used by any computer user.

These reasons have made ADL one of the most important tools for students and researchers. it is essential first to explore its components, possibilities and limitations of its searching capabilities which is our basic starting point in this research.
ADL offers different searching capabilities which include:

- Searching for book titles
- Searching inside books and in the comments section of books.
- Searching for authors.
- Using logical operators, e.g. "AND" and "OR" for searching for multiple words.

However, all the above searching criteria are merely based on syntactic search whereas the search keywords are matched with the content of ADL. If the search keywords are not literally present in the content of ADL, no results will be retrieved. In addition, the Islamic texts, e.g. Quran and

Sunna, have their own characteristics that demand custom solutions. These characteristics can be summarized as the following:

1- Islamic texts comprise meanings, intents and metaphors that cannot be easily understood. These characteristics make exact keyword matching not suitable for searching in the Islamic resources. It is necessary to support information search and retrieval from ADL at the semantic level so that ordinary users can reveal the underlying meanings and thoughts.

2- Islamic Knowledge is known to be very diverse and interrelated: Information from one discipline, such as the Hadith of Prophet Mohammed, cannot be fully understood without relating it to other disciplines such as Aqidah"العقيدة" and Feqh"الفقه" . The traditional search provided by ADL only allows access to information without revealing the relationships or dependencies between various information resources.

3- The Islamic terminology often includes legacy terms that are difficult to memorize or not in common everyday usage. However, users may know familiar synonyms of the target term but without memorizing the exact term. Using these synonyms to search for the original term may not return the desired results as the current search engine of Al-Shamelah lacks the ability to recognize synonyms or semantically-related terms.

Despite its great benefits, the search functionality offered by the ADL presents several limitations. In this work, our intention is to improve information retrieval from ADL by exploiting Semantic Web technologies. Therefore, In order to fully explore the limitations of the current search in ADL, and the requirements of the intended semantic search, we interviewed two experts who have intensively used ADL for research. The intention was to identify the existing problems by asking them to answer a questionnaire to determine the problems and system requirements.

The first interviewee was a Lecturer of Islamic studies in Daawa College of the ministry of Waqf (الأوقاف) and one of the users who is experienced in using ADL. We asked him about the limitations he encountered while using the ADL throughout his long career. He clarified that although the library offers a lot of distinctive advantages and possibilities there are some deficiencies in the required information retrieval process in terms of accuracy and relativeness. He identified the following problems:

1. **Restricted searching capability**: The expert indicated that the search service offered by ADL often gives restricted, narrow results that exactly matches the keywords inputed by the user. If the user forgets or miswrites the keywords, the search service is likely to give zero or incorrect results. In addition, the search service may return a large number of irrelevant results that do not meet the user's exact needs.

2. **Lack of subjective search**: the current search facility in ADL does not support subjective search, which means the ability to search for content related to particular subjects. It is worth noting that some existing Islamic programs such as Gwami Alkalem "جوامع الكلم"[2] offered support for subjective search. However, the experts reports that the programs often rely on a predefined classification of topics, and lacks the ability to infer topical relations

that may be useful for the user. While searching for a particular topic, the user may often be interested in exploring related, broader or narrow topics. This will help him gain a broader view of the topic of interest.

Regarding the second expert who is an expert in the field of Hadith and who has used ADL intensively for his research he confirms that it has a huge resources and wealthy of information as it holds thousands of books and references.When asked about the limitations of the ADL search facility, **he identified the following problems**:

1. **Inaccuracy of the retrieved results**: the expert indicated that the search service offered by ADL often presented information that is not within the interest of the user or did not give the required results, when the user entered words that have the same meaning.
2. **Lack of an objective classification**: The expert also pointed out that the search service gives loss of information because of the lack of an objective classification for topics. This problem is compatible with the first problem mentioned and clarified by the first expert
3. **Lack of multiple conditions**: Not dealing with a complete sentence when you perform a search Due to the mismatch of the words, consequently the results are incorrect or irrelevant.

According to the previous, we can summarize the limitations as the following:
-   Most of these limitations emerge from the lack of semantic inferring ability and the lack of semantic guidance for end users. Without semantic inferring, information retrieval systems may miss some information that users really want and return information that is out of the user's interests. The need for semantic search in ADL also stems from the unique characteristics of Islamic Resources which encompasses many underlying thoughts and meanings. These thoughts and meanings cannot be directly captured by using syntactic search techniques.

To illustrate how the lack of semantics may be problematic in the case of Al-Shamelah, let's assume that a user is looking for all the Hadiths whose topic is backbiting "الغيبة". By inputting the keyword "الغيبة", results retrieved are unlikely to include many hadith that do not include the exact word "الغيبة" even though these Hadiths are classified under the topic "backbiting". For example, the core subject of the following hadith is backing "الغيبة", although this subject is never mentioned in the Hadith.

مَرَرْتُ بِقَوْمٍ لَهُمْ أَظَافِرُ مِنْ نُحَاسٍ يَخْمِشُونَ وُجُوهَهُمْ وَصُدُورَهُمْ فَقُلْتُ: مَنْ هَؤُلاءِ يَا جِبْرِيلُ؟ فَقَالَ: هَؤُلاءِ الَّذِينَ "
" يَأْكُلُونَ لُحُومَ النَّاسِ وَيَقَعُونَ فِي أَعْرَاضِهِمْ

The Messenger of Allah (ﷺ) said, "During the Mi'raj (the Night of Ascension), I saw a group of people who were scratching their chests and faces with their copper nails. I asked, 'Who are these people, O Jibril?' Jibril replied: 'These are the people who ate flesh of others (by backbiting) and trampled people's honour.'" [3].

- Another limitation of the search functionality offered by ADL is the inability to recognize synonyms or semantically-related terms. For example, searching for the words "prophet" and "messenger" will give different results although the two words are semantically related.
- Besides the above limitations, ADL currently lacks any support for complex queries that involve multiple conditions or objectives. For example, ADL does support querying for all the Hadith that Talk about colic disease and Methods of treatment.

The Semantic Web provides technologies that help meet these problems [4]. Using ontologies for digital libraries enable the machine to understand and process information automatically, and then helps the digital library to provide better knowledge service for users[5].

Since the emergence of the Semantic Web, research in digital libraries has widely considered the use of ontologies to empower information retrieval with semantics. This work builds on previous efforts of semantically-enhanced digital libraries, and aims to particularly empower information retrieval from ADL.

The market of Islamic software provided a variety of applications providing services such as Hadith classification [[1, 2, 6]], judgment of Hadith Isnad [[7-9]], and search services [[5, 10-13]]. However, none of these efforts, to our knowledge, support semantic search or complex queries (Refer to the related work section for a review of these applications).

This work will focus on a specific part of ADL. However, we propose an ontology based-approach to enhance information retrieval in hadith domain from ADL. We plan to construct an Ontology to model the fundamental concepts included in a subset of ADL as well as the relationships between these concepts. Afterwards, semantic annotation will be performed by linking entities in the Hadith of Prophet Mohammed, such as the names of historic people, places and animals to the ontology concepts. These semantic annotations can then be used by search agents to retrieve intelligence results or process complex queries. In the methodology section, we discuss this approach in detail.

We will use an Ontology-based approach to make our proposed system compatible with Semantic Web technologies. An increasing amount of data is currently available on the Web in RDF and OWL standard formats. Adhering to Semantic Web standards will make the system easy to interface to different ontology servers and knowledge representation platforms.

The approach will be evaluated by comparing results obtained from keyword-based search in the conventional ADL with results obtained from ontology based search in our system. We will ask the two experts to input keywords to the system. , Then we will evaluate the system by using Techniques Such as Precision, recall and Map for each case.

4

1.1 Statement of the Problem

The main problem addressed in this research is how to support semantic search and complex queries in ADL by using semantic web technologies. This problem can be divided into the following categories:

1. How to properly model the various entities, concepts and relationships mentioned in a particular domain of ADL. This is essential for ontology construction.
2. How semantic annotations and reasoning can be used to provide intelligent results and recommendations for users.
3. How to capture complex queries from end users and translate them to a machine processable format.

1.2 Objectives

In this section, we will present both the main and specific objectives of the research work.

1.2.1 Main Objectives

Building an ontology-based approach that allows more intelligence searching and querying in ADL.

1.2.2 Specific objectives

1. Building an ontology to define the fundamental concepts contained in selected sections of ADL including hadith terms, relations, and properties.
2. Building the annotation mechanism which will enable linking Hadith terms with the ontology concepts.
3. Exploring how the reasoning system reasons about the semantic markup and draw inferences from axioms in the ontology.
4. Identifying how to translate user queries to SPARQL queries.
5. Identifying how to evaluate the system by using Evaluation Metrics

5

1.3 Scope and Limitation:

1- Due to the massive size of the ADL content, our ontology-based approach has been implemented and tested using a specific part of ADL content. However, we see that the potential benefits can be generalized if applied on the whole library.

2- For simplicity, question answering is out of scope of this research. Users are expected to use the system by inputting keywords rather than complete questions. Our intention is to improve the search service by retrieving results that best match the user interests.

3- The annotation of the selected data, i.e. sayings of Prophet Mohammed, will be done manually; therefore automatic annotation is out of the scope of this research.

4- The evaluation of the system by means of precision and recall was limited to 20 queries. This is due to the difficulty of calculating the recall.

1.4 Importance of Thesis:

1. Providing facilities for the scholars and researchers in order to obtain satisfactory and intelligence results with minimal efforts.

2. Proposing an approach to make ADL compatible with semantic web technologies and easy to interface with web agents and ontology based servers.

3. To our knowledge, this is the first work that addresses the integration of semantic search in Arabic digital libraries especially into ADL.

4. The system can be easily configured with any Arabic digital library to improve the retrieval information.

6

1.5 Research Methodology

We use the following approach to enhance information retrieval from ADL. Due to the limited time, the proposed approach will be applied only on specific sections of ADL. For example, we will consider some of the objective classifications of the Hadith (e.g. the Chapter of Ethics and Morality) (see Figure 1.1). Our prospective approach can be summarized as the following:
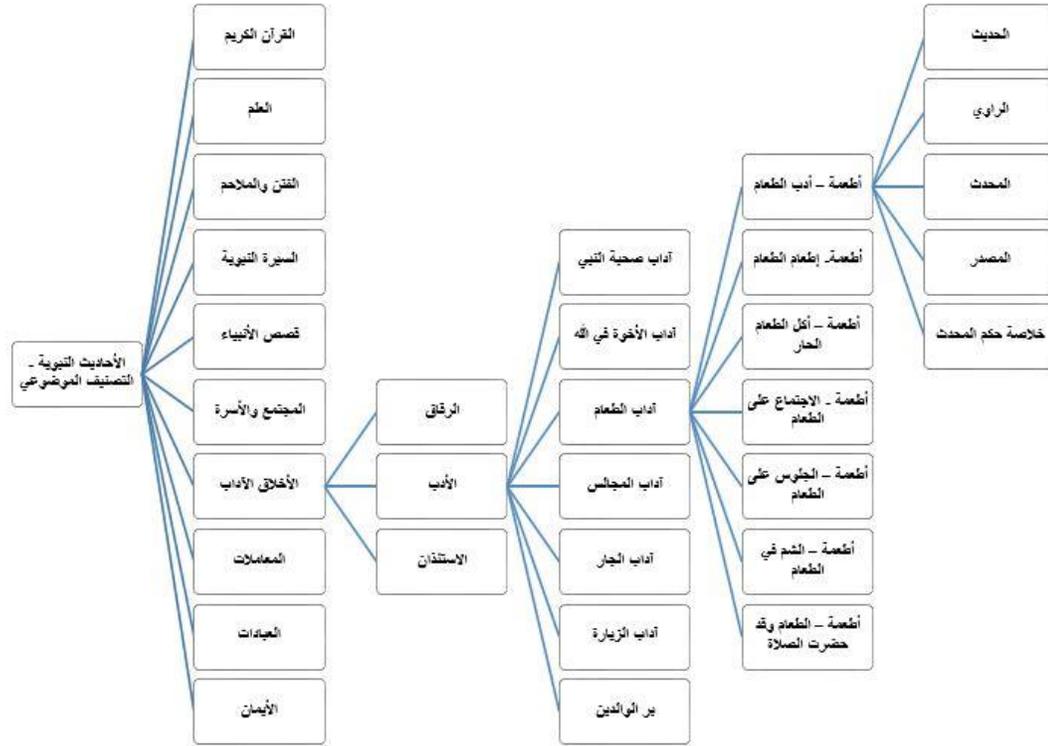
Figure 1-1: Shows the part of hadith classification

Construction of Domain Ontology:

We have chosen only a subset of the Hadith domain covering the domain of the Prophetic Medicine in ADL. We built a prototype ontology to model the concepts and relationships within the chosen domain, and used it to annotate the Hadith text. The Sayings of Prophet Mohammed related to the Prophetic Medicine will be annotated against the instances and classes of the ontology. The annotations should be exploited by the information retrieval system and the ontology reasoned.

Based on an ontology, we made a system that allows the user to enter queries and retrieve the results and recommendations

To give an overview of the structure of our ontology, and how it will be used to enhance information retrieval and intelligent, we give the following examples:

7

Example 1:

Consider the following Hadith of our Prophet Mohamed:

" "صلاة في مسجدي هذا أفضل من ألف صلاة فيما سواه إلا المسجد الحرام

"Prayer in my Masjid is better than a thousand prayers anywhere else except Masjid al-Haram"
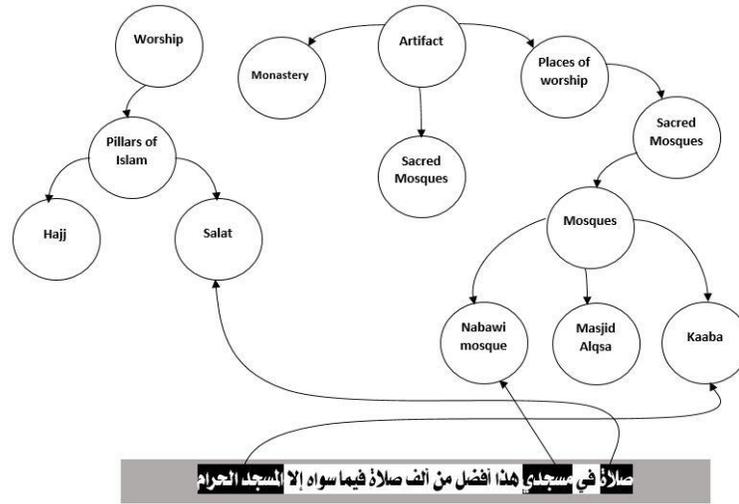
Figure 1-2: an excerpt of proposed ontology and how it is used to annotate

Figure 1.2 shows an excerpt of our proposed ontology (tentative structure) and how it is used to annotate the above Hadith. The concepts of this Hadith can be linked to the concepts of the ontology as the following:

- Annotation 1: The word "صلاة" is linked to the ontology concept "Salat" which is a subclass of the concept "Pillars of Islam".
- Annotation 2: The word "مسجدي" is linked to the concept "Al-Nabawi mosque" which is a subclass of the concept "Sacred Mosques".
- Annotation 3: The word "المسجد الحرام" is linked to the concept "Kaaba" which is a subclass of the class "Sacred Mosques".

Given these ontology-based annotations, assume that a user is looking for the value of the prayer at al Al-Nabawi-Mosque by entering the following query " ما فضل الصلاة في المسجد النبوي؟". Using the above annotations, the system will be able to recognize that the word "المسجد النبوي" refers to "المسجد النبوي" although the word "مسجدي" is not literally mentioned in the Hadith. Therefore, the system may suggest the above Hadith as a result that satisfies that user's interest.

Similarity, assume that a user is looking for the value of worshipment at al Al-Nabawi-Mosque by entering the following query "ما فضل التعبد في المسجد النبوي؟". It is obvious that the word "التعبد" is not mentioned literally in hadith. However, a reasoning

system can infer that the word "الصلاة" is a sub-concept of the word "التعبد" according to the relationships defined in Figure 2. Thus, the system will determine that the above Hadith may answer the user's query.

Assume also that another user is looking for the value of prayers in all sacred mosques. The search agent infer from the ontological relationships that the "Al-Nabawi Mosque" is of type "sacred mosques. Therefore, the above Hadith will be retrieved among other Hadith about the value of the prayers in all sacred mosques.

Example 2:

Given the following Hadith:

"عليكم بالحبة السوداء فإن فيها دواء لكل داء إلا السام"

"There is healing in black cumin for all diseases except death"
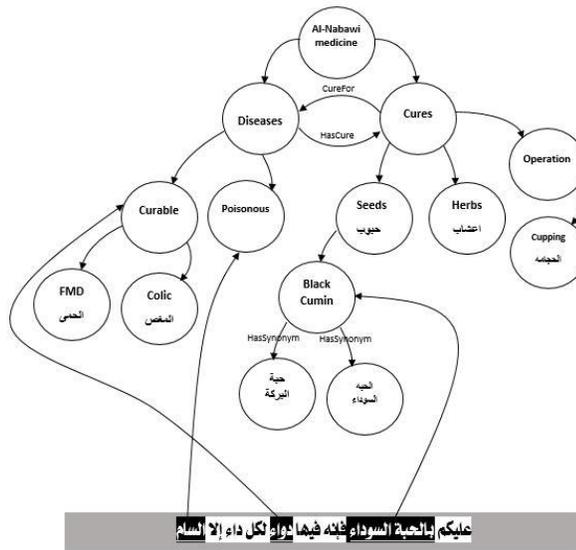
Figure 1-3: an excerpt of proposed ontology and how it is used to annotate

The annotations of this Hadith using the ontology concepts is shown in Figure 1.3. The Term "الحبة السوداء" is linked to the term "Black cumin" which is a subclass of "cure". Note that the synonyms of the term "Black cumin" are also defined within the ontology and include the term "حبة البركة".

Assume that a user is searching for the benefits of "حبة البركة". With the help of the given ontology and semantic annotations, the search agent will be able to recognize that "حبة البركة" and "الحبة السوداء" refer to the same concept, and will retrieve this Hadith to answer the user's query.

Now, if the user is generally interested in all cures from the medicine of the Holy Prophet "Tibb an Nabawi", the search agent can retrieve all the sayings of our Prophet Mohammed which are annotated with any subclass of the class "cures" from the domain ontology, including this Hadith.

1.6 Thesis Structure
This thesis consists of seven chapters. It has been organized in general as follows.

Chapter 1: an introduction: This chapter provides a simple introduction to the ADL and its problems, and how to solve these problems through construction ontology-based system that support semantic search in ADL. We explained the importance of this research for the scholars and the scope and limitation of this research that will focus on a specific part of ADL. Finally, we presented the methodology that will follow to build an ontology and the overall architecture of our proposed system.

Chapter 2: Literature Survey: this chapter focuses on the background that are related the theoretical and technical foundations needed for thesis work, the concepts of digital library and semantic web technologies. In addition to the related work that used semantic web technologies to develop search Semantic in Digital libraries.

Chapter 3: System Requirements: this chapter aims to identify the limitations of the current search service of ADL. Two domain experts were interviewed and asked to report on the practical challenges and limitations they encountered while searching in ADL. Based on these limitation, we derived the requirements of the proposed system.

Chapter 4: Hadith ontology: This chapter describes the steps of developing hadith ontology that used a bottom-up approach to construct our Hadith Ontology, the ontology was designed through a cooperative effort which included domain and ontology experts. The Hadith ontology domain was constructed using Protégé and OWL.

Chapter 5: The OntoADL System: This chapter presents the architecture of our proposed system that involved hadith ontology to provide semantic search over ADL. It describes the system modules to be implemented and how they relate to each other and show what is currently implemented. The system can allow to the end-user to enter the keywords, and the system will retrieve specific sayings of Prophet Mohammed.

Chapter 6: System Evaluation: This chapter is dedicated to evaluation of the proposed system and discussing the results.

Chapter 7: The conclusions and future works: Discusses the conclusions and presents possible future works.

1.7 Summary

In this chapter we presented an introduction about the features of digital libraries and the limitations faced. The ADL is considered one of these libraries that depends on keyword matching and does not provide semantic directions for users. We addressed the problem about how to support semantic search and complex queries in ADL by build Hadith ontology. Also, we explained the importance of this research that Provide facilities for the scholars and researchers in order to obtain satisfactory and intelligent results and make ADL compatible with semantic web technologies. We stated the scope and limitation of this research that will focus on a specific part of ADL Because of their large size and Natural language processing of user queries will not be considered. We presented the methodology that will follow to build an ontology and the overall architecture of our proposed system that will enhance information retrieval and intelligent. In addition to Evaluation of an ontology and the system. Finally, the thesis structure has been explained.

11

Chapter 2 : Literature Survey

2.1 Introduction

In this chapter we reviewed and investigated the concepts of digital library and semantic web technologies that can be used to semantically enable technology to the users of digital libraries such as ontology, RDF, and SPARQL. The chapter presents many applications based on the classification of hadith as well as the related work that used semantic web technologies to develop search Semantic in Digital libraries.

2.2 Background

2.2.1 Digital library:

Digital library is the national knowledge infrastructure which provides various kinds of knowledge Services for promoting knowledge innovation. In order to effectively organize the complex information resources in the digital library and make them understood and processed by machine automatically, more semantic descriptions are needed [5]. The core task of digital library is that provides good information retrieval system for the users, moreover it must be provided by scientific reasonable organization and storage information technology and retrieval software.[14]. digital library presented useful information retrieval system to the users .this information retrieval technology depend on keywords matching and has little semantic inferring ability .besides, it doesn't present semantic guidance for users as some information may miss some information that users want [14].

2.2.2 Semantic Digital libraries

Semantically enabled technology is expected to bring a number of benefits to the users of corporate digital libraries. In particular, the technology will help people find relevant information more efficiently and more effectively, give better access to that information, and aid the sharing of knowledge within the user community of a digital library [15]. High quality information is often stored in dedicated databases of digital libraries. Managing this information still poses challenges. The Semantic Web provides technologies that are about help to meet these challenges [4]. Information access in digital libraries is one of the key functions. Semantic technologies can offer more efficient solutions for accessing content and metadata. Semantic annotations deliver powerful information to build personalized query-answering, similarity-based search, and collaborative filtering systems [16].

Semantic technology is used to identify the exact meaning of the word or item requested. Semantic search is a process used to improve searching by using data from semantic networks to disambiguate queries and web text in order to generate more relevant results [5]. Semantic search targets on answering user queries, by exploiting both explicit and implicit related knowledge. Reasoning on available knowledge bases, based on appropriate

Representations and languages, such as description logics, RDF, OWL can be the means to move ahead in this direction. [10].

2.2.3 Semantic Web

The Semantic Web is the extension of the World Wide Web that enables people to share content beyond the boundaries of applications and websites[17]. It has inspired and engaged many people to create innovative semantic technologies and applications that play a major role to retrieve meaningful information intelligently from digital library. Semantic Search attempts to augment and improve traditional search results. Ontologies play a key role in this kind of search. An ontology, by definition, represents a formal model of the common interpretation of the entities and relationships in a domain of interest[18]. Semantic Web uses documents called Semantic Web Documents (SWD's) that are written in SW languages like OWL, DAML+OIL. SW is an XML application.[19]

Semantic web layers

Berners-Lee proposed the systematic structure of semantic web, which include of seven layers: UNICODE and URI, XML, RDF, ONTOLOGY, LOGIC, PROOF, TRUST as shown as in figure 2.1
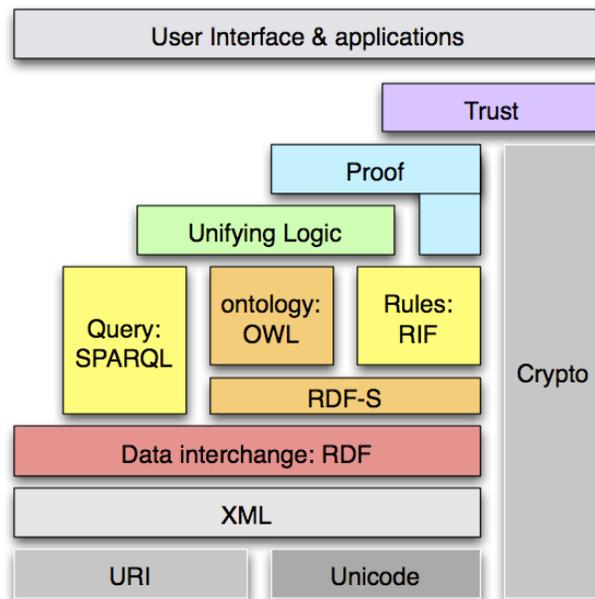
Figure 2-1: Berners-Lee Semantic Web Layers [4]

2.2.4 Ontology

An ontology is a formal representation of a set of concepts within a domain and the relationship between those concepts. The common components of ontologies include: individuals, classes, Attributes, relations, function terms, restrictions, rules, axioms, and events. Those components describe our world together and play important roles of intelligent information processing.[20]. It is used to capture the knowledge of any

13

particular domain to avoid Ambiguity of terms. The major advantage of use of ontology is that it will provide a globally unique identifier for all concepts. It is used to capture knowledge in any given domain. It helps to share common understanding of the structure of information among the users, to enable reuse, analyze the domain knowledge. It enables to merge already existing knowledge there by expanding it further [21]. Applying ontology in the digital library would facilitate machine to understand and process information automatically, and then help the digital library to provide better knowledge service for users [5].

2.2.5 Ontology Development

The ontology was developed from information gathered by domain experts and assigned to the ontology expert in the form of a set of concepts, relationships and definitions. There are several well established and defined methodologies to develop an ontology [22]. This methodology is done by using steps defined in [23]. The steps are:

1) Determine the domain and the scope or purpose of the ontology:

The first step in ontology development is by defining ontology domain and scope in which the ontology will be developed in order try to find an answer to questions such as:
- What is the domain that the ontology will cover?
- For what we are going to use the ontology?
- For what types of questions the information in the ontology should provide answers?
- Who will use and maintain the ontology?
- The answers to these questions may change during the ontology-design process, but at any
- Given time they help limit the scope of the model.

2) Consider reusing existing ontologies

It is almost always worth considering what someone else has done and checking if we can refine and extend existing sources for our particular domain and task. Reusing existing ontologies may be a requirement if our system needs to interact with other applications that have already committed to particular ontologies or controlled vocabularies [22].

3) Enumerate important terms in the ontology

It is useful to write down a list of all terms we would like either to make statements about or to explain to a user. What are the terms we would like to talk about? What properties do those terms have? What would we like to say about those terms?

14

4) Define the classes and the class hierarchy

This step defines classes used in an ontology domain. There are several possible approaches in developing a class hierarchy [22]: a top down development process, which starts with the most general concepts and subsequent specialization of the concepts. Bottom-up starts with the most specific concepts or classes, the leaves of the hierarchy with subsequent grouping of these classes into more general concepts. Middle-out is a combination of the top-down and bottom-up approaches starts with the salient concepts first and then generalize and specialize them appropriately [23].

5) Define the properties of classes—slots

This step used to describe the attributes or properties of the classes. These properties Defined as the "slots" of the models. Once the classes have defined, the next step is to describe the internal structures (properties) of the concepts. Again, these should be readily available from the list produced because of Step 3.

6) Step 6. Define the facets of the slots

Slots can have different facets describing the value type, allowed values, the number of the values (cardinality), and other features of the values the slot can take.

7) Step 7. Create instances

The last step is creating individual instances of classes in the hierarchy. Defining an individual instance of a class requires (1) choosing a class, (2) creating an individual instance of that class, and (3) filling in the slot values

2.2.6 Web Ontology Language (OWL)

The Web Ontology Language (OWL) is a Semantic Web language designed to represent rich and complex knowledge about things, groups of things, and relations between things. OWL is a computational logic-based language such that knowledge expressed in OWL can be exploited by computer programs. OWL is part of the W3C's Semantic Web technology stack, which includes RDF,RDFS, SPARQL, etc. [24]. It stands for Web Ontology Language. It is used to represent relations between entities by using formal semantics and vocabulary [25]. Web Ontology Language (OWL) is widely used to develop ontologies [26].

2.2.7 RDF (Resource Description Framework)

RDF is the W3C standard for encoding knowledge on the semantic web. RDF is a formal data model for machine understandable metadata used to provide standard description of web resources [27]. RDF identifies things using Web identifiers (URIs), and describes resources with properties and property values. Information is represented as statements in RDF. The combination of a Resource, a Property, and a Property value forms a Statement.

RDF can be represented as a triple of subject, predicate and object as shown in figure 2.2 [27].
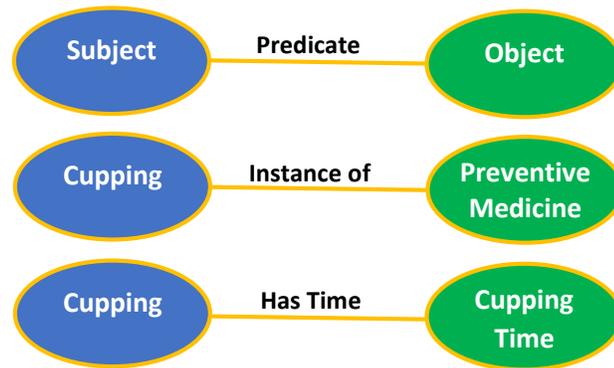
Figure 2-2: RDF Triples

2.2.8 SPARQL

Semantic searching is done with the help of SPARQL. SPARQL is an RDF query language which is Able to retrieve and manipulate data stored in Resource Description Framework format. SPARQL Allows users to write unambiguous queries. SPARQL is just like the SQL only. SPARQL contains capabilities for querying required and optional graph patterns along with their conjunctions and Disjunctions.

The results of SPARQL queries can be results sets or RDF graphs. Query is specified in the triple pattern which is subject, object and predicate [28]. The core of SPARQL queries are triple patterns, with the capabilities of filtering RDF triples and binding variables to values. When two triple patterns contain common variables, the results of two triple patterns need to be joined. Join computation is a bottleneck of query evaluation [29].

SPARQL can be used to express queries across diverse data sources, whether the data is stored natively as RDF or viewed as RDF via middleware. SPARQL contains capabilities for querying required and optional graph patterns along with their conjunctions and disjunctions. SPARQL also supports extensible value testing and constraining queries by source RDF graph. The results of SPARQL queries can be results sets or RDF graphs [24].

2.3 Related Work

2.3.1 Search Apps based on Hadith classification

Many applications based on the classification of hadith. This classification include subcategory such as Food, faith, Quran, sedition and epics, Biography of the Prophet, the virtues, the community and the family…etc. The following Online applications provide search service and classification of hadith.

1. Al-Dorrar Al-Suniya

[6] Al-Dorrar Al-Suniya is considered as a very large and comprehensive database for the prophet heritage pbuh, that allow access using a modern tech tools and which contain a group of encyclopedias in different subjects. Recently "Al-Dorrar Al-Suniya" establishment released on its website a beta version of subject classification service for hadith as shown in Figure 2.3, which considered as the largest electronic work in the field of prophet hadith classifications on the internet which lead to the classifications of all hadith encyclopedias on the website which almost reaches hundreds of thousands of classifications based on the category headlines, where the required topic is selected for search. This service includes a group of search criteria but it lacks the links between the hadith and the narrator, also it depends on the exact phrase search.

Figure 2-3: Online Al-Dorrar Al-Suniya Website

2. Jawame El-Kalem

[2] Jawame El-Kalem is considered as a Hadith encyclopedia, it provides a rich and comprehensive source for experts, scholars and students, it includes thousands of sources and it adopts the classification for hadith in the form of a tree which has many categories. A subject is selected and the sub-topics can be explored under this subject as shown in figure 2.4. The search service presented group of search criteria, also it depends on the exact phrase search.

Figure 2-4: Search Service in Jawame El-Kalem application

3. AL-Shamelah library application:

[1] Search service in AL-Shamelah library relies on the usage of keywords in the search process. Whether in the text, phrases or comments with use of multi-search at the same time using the Boolean operators AND, OR, to match what was entered as shown in figure 2.5. In addition, it's used the index style to indexing all the books that are not indexed to speed up the search process.

Figure 2-5: The Search service in the ADL application

As a result, we believe they do not provide service for complex queries over hadith classification.

2.3.2 Search Apps for Judging Hadith Isnad

There exist various researches was used semantic Web that are helpful in Hadith judgment.

[7] Presented a prototype of a semantic web-based system for supporting judgment hadith Isnad. It build an ontology-based system that automatically generates suggested judging of

18

hadith Isnad. It based on the rules that hadith scholars follow to produce a suggest judgment.

[8] automatically generates and graphical visualization of the narration chain of the Hadith. This process involved creating natural language lexer, performing shallow parsing, and building syntactic analyzer and finally graph presenter that displays the narrators' chain graphically.

[9] Proposed a complete-text-mining system called (AuthenTique) that used for knowledge extraction from a database of prophetic traditions "Hadith". It provides a list of Hadith classified according to their degrees of similarity based on a given query. The implemented methods of text mining in Authentique are classical methods such as vector space model, TFIDF, and cosine measure.

In edition there exist various electronic encyclopedias in Hadith judgment like ADL, encyclopedia of the narrators of hadith (Noor Islam), encyclopedia of harf the nine books, Al-Dorrar Al-Suniya site [7].

All research and electronic encyclopedias that have been mentioned in this section focused on Hadith judgment but we will focus in this research on hadith classification

2.3.3 SW + Digital libraries

Semantic Web is widely used in various services of digital library. So it is very necessary for the digital library to apply technologies effectively in the knowledge services. Many researchers have done a lot of work in this area.

[10] presented a new semantic search methodology in Digital Libraries Using Multimedia Analysis, including a query answering mechanism which meets the semantics of users' queries and enriches the answers by exploiting appropriate visual features, both local and MPEG-7, through an interweaved knowledge and machine learning based approach. Improving Semantic Search in Digital Libraries Using Multimedia Analysis.

Constantinescu and Vladoiu [12] Was presented socio-semantic contextual model on bilingual subject-based information retrieval in digital library. This model allows rich bibliographic description of the content, along with semantic annotations, reviewing, rating, knowledge sharing. It is multi-layered and allows both integration of local and distributed information via web services and construction of rich hypermedia documents. NECLIB's model can express the complex relationships that exists between various objects.

[30] They present a prototype that allows users to annotate content within digital libraries; the annotation schema is built upon the Annotation Ontology. Data is available as RDF making it possible to publish it as linked data and use SPARQL and SWRL for querying, reasoning, and processing.

[13] presented a prototype system that include an ontology schema to provide subject-based information retrieval within Library of Congress Subject Headings (LCSHs) through modeling the semantics into adequate ontologies and exploitation the explicit and implicit relations that contained within the Library in order to provide more effective subject-based, information retrieval within digital libraries. The prototype describes a system capable of making the expressiveness of the underlying ontology readily available to end users while at the same time retaining simplicity and ease-of-use.

[5] Providing ontology technology to knowledge service in digital library would prove useful to support knowledge automatic processing and integration. In order to make the knowledge service system understand users' demands more comprehensive and provide more effective services to them. The paper proposed some reasonable methods and ways to construct a framework for knowledge service based on the two ontologies.

All research that have been mentioned in this section focused on search services in digital libraries but most of these researches does not support more intelligent results.

2.4 Summary

This chapter presents the required background and related work in order to provide an overview of the Semantic Web and its associated technologies and functionalities that underpin the research on developing digital libraries.

Chapter 3 : Hadith Ontology

3.1 Ontology Overview

Ontologies play the key role in the semantic digital libraries. It supporting the main aspects of contemporary knowledge. it widely used in knowledge engineering, artificial intelligence; as well as applications related to knowledge management, information retrieval and the semantic web[31]. Ontology has become a kind of important means in computer science, especially it used in semantic Web and information retrieval in Digital library[14] . Ontology contains a set of specific and clearly described classes or concepts, properties of the concepts, slots, restrictions, facets and a series of instances related to classes, which combine to form the knowledge. A Class is the core of ontology, which describes the concepts in some domain. Slot describes the property of the class and the instance[7].

As we mentioned previously, ADL is a huge database that includes different scientific fields, Such as Aqidah (العقيدة), Feqh (الفقه) and Hadith (الحديث), biography and history (السيرة والتاريخ)... etc. And every field covers abundant of topics that perhaps contain a variety of subtopics. Hadith science is one of the sources of Islamic legislation that contains the sayings of the Prophet Mohammed and his actions, the conditions and Attributes. It comprises some of the subjective classifications (e.g. the Chapter of Ethics and Morality (الأخلاق والآداب), faith (الإيمان) Prophetic Medicine (الطب النبوي) .etc.).

Due to the large number of domains contained in the ADL, we have chosen only a subset of the Hadith domain covering the domain of the Prophetic Medicine. We built a prototype ontology to model the concepts and relationships within the chosen domain, and used it to annotate the Hadith text. Our intention was to provide a proof of concept of how information retrieval can be enhanced by integrating ontology based semantics and reasoning.

3.2 The Prophetic Medicine

The Prophetic Medicine or (Tibb an Nabawi) refers to words and actions of the Prophet with a bearing on disease, treatment of disease, and care of patients. It covers preventive medicine, curative medicine, mental well-being, spiritual cures or ruqyah, medical and surgical treatments[32].

We used a bottom-up approach to construct our Hadith Ontology: We first extracted the 60 sayings of the Prophet Mouhammad (hadith) from the book of "Ibn Qay'em El-Jozeyah" which covers different aspects of the Prophetic Medicine. From these sayings, we identified, with the help from experts, all concepts to be included in the domain ontology. We then classified these concepts and linked them with appropriate relations and hierarchies to end up with our Hadith ontology.

3.3 Classification of Prophetic Medicine:

This classification depends on the experts and the same book (Ibn Qay'em) as well as some specialized sites that the experts based upon it.

We have used the following procedure to construct the ontology of Prophetic Medicine:

1. Extracting and Classifying the main topics (concepts) and subtopics in a Prophetic Medicine domain.
2. Extracting hadiths related to each topic.
3. Defining relevant terms, as well as their synonyms, that relate to the topic determined from 1.
4. Building of the hierarchy of concepts identified from 1;
5. Identifying the relations between concepts and properties.

Each step of the above procedure is explained in the following subsections:

1- **Extraction and Classification of The Prophetic Medicine:** We have classified the content of the Prophetic Medicine into these 6 main categories:
1. Preventive medicine diseases (أمراض ناتجة لعدم الوقاية)
2. Preventive medicine remedies (أدوية الطب الوقائي)
3. Spiritual medicine diseases (أمراض الطب الروحاني)
4. Spiritual medicine remedies (أدوية الطب الروحاني)
5. Curative medicine diseases (أمراض الطب العلاجي)
6. Curative medicine remedies (أدوية الطب العلاجي)

Each of these categories are explained in what follows:

1. **Preventive medicine**: We have listed preventive medical measures taught in hadith such as:
   - Food and exercise. (الطعام والرياضة)
   - quarantine for epidemics,(الحجر الصحي للأوبئة)
   - forbidding urination in stagnant water, (النهي عن التبول في الماء الراكد)
   - use of tooth stick, siwaak, (استخدام عصا الأسنان، السواك)
   - precautions in the house at night regarding fire and pests, الوقاية في المنزل ليلا فيما يتعلق) النار والآفات)
   - Leaving a country because of its water and climate, (ترك البلاد بسبب المياه والمناخ)
   - marriage and mental health, (الزواج والصحة العقلية)
   - Marriage and sexual health, (الزواج والصحة الجنسية)
   - dietary control (السيطرة الغذائية"الحمية")
   - Cleanliness and avoiding filth.(النظافة وتجنب القذارة)

2. **Spiritual medicine:** Study of Prophetic Medicine reveals that there are spiritual aspects of healing and recovery such as:
   - Prayer, dua (الصلاة والدعاء).
   - Recitation of the Qur'an,(تلاوة القرآن)

22

- Remembrance of Allah.(ذكر الله)
- Psychosomatic diseases(الأمراض النفسية الجسمية) such as (scrupulosity"وسواس", fear"الخوف", mania"الهوس", insomnia"الأرق") could respond to spiritual approaches.
- The use of Ruqyat(الرقية) (Surat al fatiha"سورة الفاتحة", al mu'awadhatain"المعوذتان").

3. **Curative medicine**: We have listed many diseases with their recommended treatments from Prophetic Medicine.
   - Fever (humma) (الحمى أو أرتفاع درجة الحراة).
   - Bowel movements (استطلاق البطن).
   - Dropsy (داء الاستسقاء).
   - Wounds (جروح).
   - Epilepsy (صرع).
   - Sciatica (عرق النسا).
   - Skin itch (حكة الجسم).
   - Pleurisy, (ذات الجنب).
   - Headache and hemicranias (الصداع والشقيقة).
   - Inflammation of the throat (العذرة).
   - Enlargement of the heart (المفؤود).
   - Ophthalmic (الرمد).
   - Pimples (بثرات).
   - Skin eruptions (أورام).
   - Food poisoning (سم).
   - Witchcraft (سحر).
   - Head lice (القمل).
   - And other diseases.

3.1 Forms of treatment:
In the sayings of Prophet Mohammad mentioned many of the recommendations that are a guidance's and instructions of the Prophet Muhammad Which give information about how to deal with the disease and the possibility of treatment. These recommendations were extracted from the sayings of Prophet Mohammed as follows:
   - The use of honey (العسل), cupping (الحجامة), cauterization (الكي) for healing.
   - The use of cold water (الماء البارد) for fever.
   - The use of dates (التمر) for enlargement of the heart.
   - The use of cauterization for causing "pain and menace to a patient".
   - The use of traditional medicine, include olive oil (زيت الزيتون); dates (التمر); siwaak (السواك) as a necessity for oral health and black cumin and its oils.
   - And Other.

2- Extracting the sayings related to each topic.
In this step we have listed the sayings of Prophet Mohammed according to every topic (see Appendix H).

23

3- Defining relevant terms, as well as their synonyms, that relate to the topic determined from 1.

We have identified keywords and their synonyms according to each hadith (See Appendix H). Table shows two sample sayings of the Prophet along with the terms that we linked with the ontology content during the annotation process. Synonyms of these terms are also added to the ontology to broaden the scope of search. (See Table 3.1)

Synonyms	Terms	Preventive medicine - (الطب الوقائي)
		الحث علي المداوة أو التداوي
مرض	داءٍ	فى ((الصحيحين)): عن عطاءٍ، عن أبى هريرة قال: قال رسول الله صلى الله عليه وسلم: ((ما أنزل اللهُ مِنْ داءٍ إلا أَنْزَلَ لَهُ شِفاءً))
دواء	شِفاءً	
	تَدَاوَوْا :	وفى ((مسند الإمام أحمد)): من حديث زياد بن عِلاقة عن أسامة ابن شَريكٍ، قال: ((كنتُ عندَ النبىّ صلى الله عليه وسلم، وجاءت الأعرابُ، فقالوا: يا رسول الله؛ أَنَتَدَاوَى ؟ فقال: ((نَعَمْ يا عبادَ اللهِ تَدَاوَوْا، فإنَّ اللهَ عَزَّ وجَلَّ لم يضَعْ داءً إلا وَضَعَ لَهُ شِفاءً غيرَ داءٍ واحدٍ))، قالوا: ما هو ؟ قال: ((الهَرَمُ)).
شِفاءً : دواء	شِفاءً : دواء	
مرض	داءٍ :	
الموت – كبير السن	الهَرَمُ	

Table 3-1: Sample sayings of the Prophet Mohammed

4- Building of the hierarchy of concepts identified from 1

Figure 3-1: The hierarchy of concepts of Prophetic Medicine

24

5- Identifying the relations between concepts and properties.

The hierarchy in previous step explains the relations between the various concepts of Prophetic Medicine where each concept can have a set of sub concepts that can be contain more properties, in table 3.2 explained some of these properties:

English	Arabic
Honey **cure** alsttlaq	العسل **يعالج** استطلاق البطن
Cupping **cures** headache	الحجامة **تعالج** الصداع
Cupping **cures** migraine	الحجامة **تعالج** الصداع النصفي
Cupping **has time** of treatment	الحجامة **لديها وقت** علاج
Cupping **has method** of treatment	الحجامة **لديها طريقة** علاج
Cupping **has fees** of treatment	الحجامة **لديها أجر** علاج
Cupping **cures** wound	الكي **تعالج** الجرح أو القرحة
Humma **cured by** cold water	الحمي **تعالج** بالماء البارد
Siwaak **has benefit** "tatheer alfam"	السواك **لدية فائدة** تطهير الفم
Siwaak **has benefit** "mardat alrab"	السواك **لديه فائدة** مرضاه للرب
Headache **cured by** costus	الصداع **يعالج** بالقسط البحري
costus **cures** Pleurisy	القسط **يعالج** ذات الجنب (الالتهاب الرئوي)
Black cumin **cures** colic	الحبة السواك **تعالج** المغص
Black cumin **cures** headache	الحبة السوداء **تعالج** الصداع
Pimple **cured by** Darirrah	البثرة **تعالج** بالذريرة
Magic **cured by** Ruqyat	السحر **يعالج** بالرقية
Humma **has prevent** revilement	نهي **سب** الحمي
Humma **has method** of treatment	الحمي **لديها طريقة** علاج

Table 3-2: Shows the concepts and properties

3.4 Ontology development

As mentioned the hadith ontology aims to represent the Hadiths of Prophetic Medicine with their different categorizations. The ontology was designed through a cooperative effort that included domain experts and ontology experts. The Hadith domain ontology is constructed using Protégé and OWL. The hadith ontology was developed according to the following steps listed in [23] :

Step 1: Determine the Domain and Scope of the Ontology

The ontology development started by defining its domain and scope that can be defined by answering the following questions.

– What is the domain that the ontology will cover?

The domain of the ontology will cover the existing hadiths of Prophetic Medicine as subset of hadith domain

25

– For what we are going to use the ontology?

The Sayings of Prophet Mohammed related to the Prophetic Medicine will be annotated against the instances and classes of the ontology. The annotations should be exploited by the information retrieval system and the ontology reasoner to provide the following features:

- Link the hadith text and terms in a way that helps the user to perceive the relationships and dependencies between different topics so that he gains a broader knowledge of overall domain.
- Provide recommendations related to the topic being searched.
- Provide an ontology-based search service that rely on semantic rather than syntactic matching.

– Who will use and maintain the ontology?

The ontology will be used through the experts in hadith and users of library to access the required information.

Step 2: Reuse Existing Ontologies

We can reuse ontology in the same domain knowledge if it exist, but no ontology exist, so, we have created a new one for our system.

Step 3: Defining Classes and Class Hierarchy of Ontology

This step starts by defining classes. All the main terms that we have selected in the earlier stages **that mentioned in above procedure** will be classes in the ontology. Classes are also organized into a hierarchical taxonomy. Some possible approaches of developing a class hierarchy are: **Top-down approach**, which starts with creating definition of the most general concepts and then their specialization (creating subclasses); the process is recursive for every class until we reach the most specific Definitions. **Bottom-up approach**, which goes the other way first we define the most specific concepts ant then group them into more general concepts by creating common superclass for them. **Combination of both** when we start with few general (or `top-level') concepts and few specific (or `bottom-level') concepts and fill the middle levels consequently .[23]

We used a bottom-up approach to build the ontology. Through represented the core concepts (main classes) and subclasses as classes in an ontology.
We defined six main classes: the **Preventive medicine** class, **Spiritual** disease class, **Curative medicine** class, **Bodies diseases** class, **Spiritual remedies class, Preventive diseases class**. Table 3.3 shows descriptions of these classes. Each of these classes is used as a top concept that subsumes many subclasses such as "prayer- دعاء " - "Roqya – رقية". Figure 3.2 represent an example of this relation:

Prayer **is a sub class of** spiritual medicine

Figure 3-2: Example of relation from the metadata ontology

No.	Class	Description
1.	Preventive medicine	Represents a set of preventive and therapeutic prescriptions
2.	Spiritual disease	Presented a List of diseases such as eye, magic that could respond to Spiritual remedies.
3.	Curative medicine	Presented a List of natural remedies
4.	Curative diseases	Presented a List of the diseases treatable by natural remedies
5.	Spiritual Cures	Focus on aspects of healing and recovery Prayer, dua, recitation of the Qur'an.
6.	Preventive diseases	Presented a List of the Psychosomatic diseases that could respond to spiritual approaches.

Table 3-3: Hadith Ontology Classes

Here's a graphical illustration a portion of the taxonomy hierarchy for the Prophetic Medicine we've defined as following (see figures 3.3):
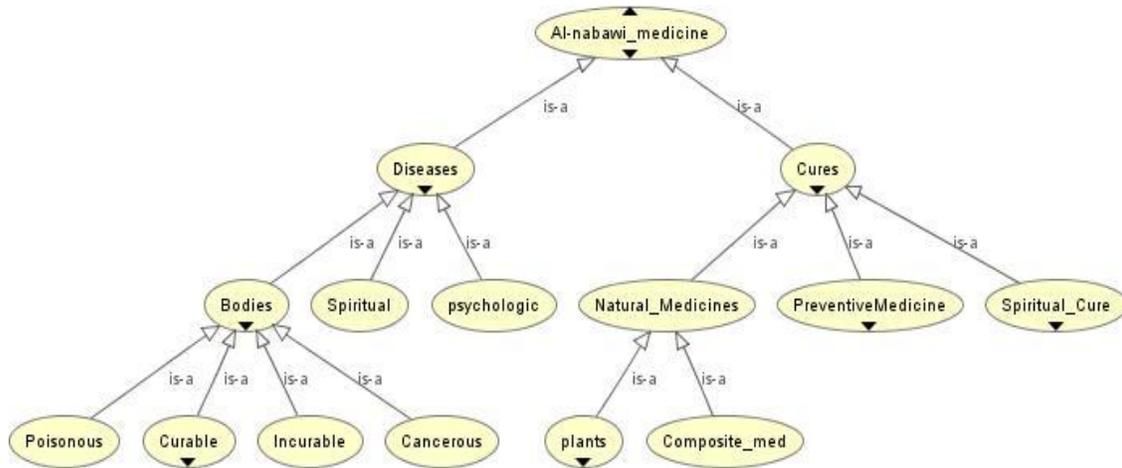
Figure 3-3: An example of a taxonomy hierarchy

Step 4: Defining the Properties of Classes (Slots)

In this step, the classes that are created in the previous step does not provide enough information alone. So once we have selected the defined classes in the list of terms we created in Step 3, most of the remaining terms consider properties (slots) of these classes [23] . Object properties can have other object properties as subproperties. The object properties we defined are illustrated in Table 3.4. For

27

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Example: **plants** have three types of plants which are **herbs**, **seeds** and **trees** and each type of plants has an instances such as **siwaak**. Every instance of **trees** has properties such as cures, hasBenefit and others. Object properties are binary relations on individuals. Properties link two individuals together. For example, the property **cures** might link the individual **cupping** to the individual **headache.** Similarly, the property **IsCuredby** might link the individual **diarrhea** to the individual **honey**. Properties can have inverses. For example, the inverse of **Cures** is **IsCuredBy**. Inverses of all object properties were also defined in the ontology see Figure 3.4.
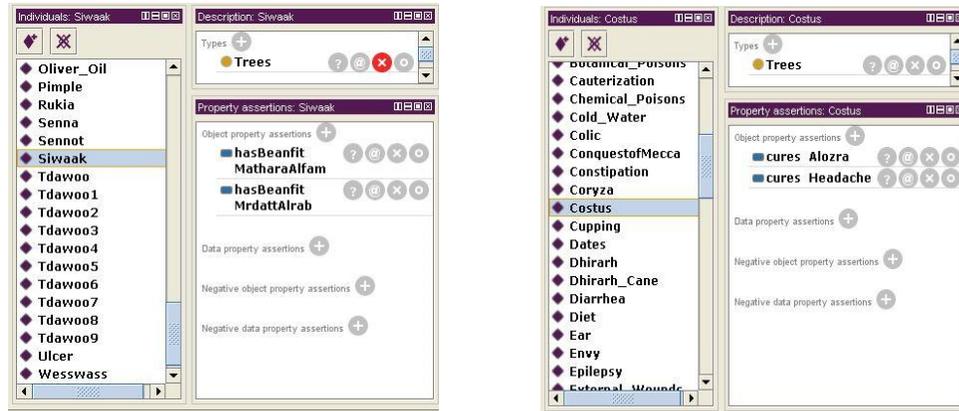
Figure 3-4: Some properties linking some individuals together

Table 3.4 illustrates the object properties structure of hadith ontology

Object Properties	Domain	Range	Description
Cures	Cures	diseases	يعالج
IsCuredby (inverse of "Cures")	diseases	Cures	معالج
hasCureMethod	Cures	TreatmentMethods	طريقة العلاج
hasTime	Cures	TreatmentTimes	وقت العلاج
ArticleOf	category	category	أداة أو جزء أو بند
IsbracnchOf	category	category	فرع من
hasType	category	category	لديها نوع
IsTypeof	category	category	نوع من
IsOneOf	category	category	واحد من .. احدى
IsPartOf	category	category	جزء من
IsReasonOf	category	category	سبب من
hasPrevent	category	prohibition	لديه نهي
hasPlace	category	TreatmentPlace	لديه مكان
hasFees	category	TreatmentFees	لديه أجره
HasBenefit	category	Benefits	لديه فائدة

Table 3-4: Hadith Ontology Object Properties

28

The Object property have been determined based on the context of the Hadith. For example, Figure 3.5 Show a sample Hadith and a sample object property that we defined based on the meaning and context of the hadith text.

Text of hadith:

أَخْبَرَنَا حُمَيْدُ بْنُ مَسْعَدَةَ، وَمُحَمَّدُ بْنُ عَبْدِ الأَعْلَى، عَنْ يَزِيدَ، – وَهُوَ ابْنُ زُرَيْعٍ – قَالَ حَدَّثَنِي عَبْدُ الرَّحْمَنِ بْنُ أَبِي عَتِيقٍ، قَالَ حَدَّثَنِي أَبِي قَالَ، سَمِعْتُ عَائِشَةَ، عَنِ النَّبِيِّ صلى الله عليه وسلم قَالَ: " السِّوَاكُ مَطْهَرَةٌ لِلْفَمِ مَرْضَاةٌ لِلرَّبِّ "

Figure 3-5: The hasbenefit Property/Relationship

Data properties describe the relationships between instances (individuals) and data values. Table 3.5 illustrates the data properties structure of hadith ontology.

A set of ontology classes can be specified as a property's domain; in that case the property can be associated with the instance belonging to all of the classes specified in that domain only.

Datatype Properties	Domain	Range	Description
hasCategory	Annotation	String	URI for any category whether classes or individuals
hasSource	Annotation	String	URI address for the hadith that contained specific text
hasText	Hadith	String	a word or text we want to annotate with some details
hasStartIndex	Annotation	Integer	Reflects the beginning of text in hadith
hasendIndex	Annotation	Integer	Reflects the end of text in hadith
hasAnnotation	Hadith	String	URI for an annotation

Table 3-5: Hadith Ontology Data Properties

Hadith domain: represents a group of different Individuals (sayings of Prophet Mohammed, that share common characteristics, which may be more or less specific

Annotation domain represents a set of different annotations that share common characteristics such as hasCategory, hasSource, hasText, hasStartIndex, hasAnnotation. The ontology enables the text of hadith to be linked to Individuals or classes in an ontology by means of annotations.

HasStartIndex Datatype Property reflects the beginning of text in hadith and **hasEndIndex Datatype Property** Reflects the end of text in hadith that they will be used to highlight the annotated segment when results are presented to the used

Step 5: Defining the Facets of the Slots

One way to specify constraints on allowed slot values is through facets. The constraints specified using facets include cardinality of a slot restrictions on the value type of the slot such as integer, string, instance of a class. In our ontology most of the slot values are string and integer. For example, the value type of data property hasText (نص) for domain Hadith Class (الحديث) is string and the number of the values (cardinality) has a minimum cardinality of 1: which means that each Hadith at least has one text. And value type of hasStartIndex is integer. The figure 3.6 illustrates the data restriction for has text Property.
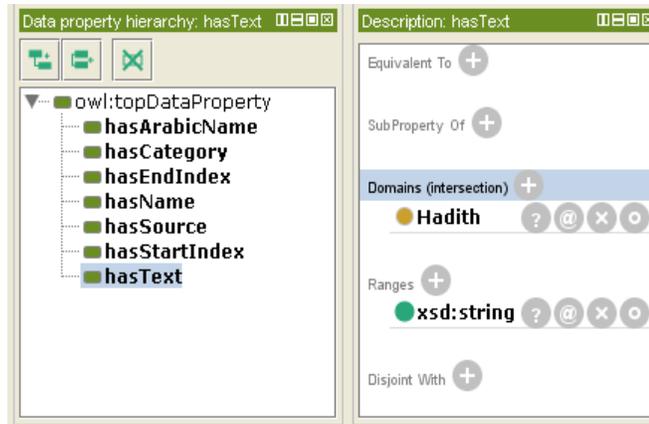
Figure 3-6: illustrates the data restriction

Step 6: Creating Instances

OWL classes are interpreted as sets that contain individuals. Individuals are also known as instances. Individuals can be referred to as being 'instances of classes'. [9] Individuals, represent objects in the domain in which we are interested.

Thus, the final step in the development of an ontology is to create actual instances from the abstract representation created. This involves choosing a class, creating an individual instance of that class and filling in the property values. In our ontology, we defined about 90 instances representing all ontology concepts. (For example, "costus, (القسط)" is an instance of the class "tree, (أشجار)" and "Alozra, (العذرة)" is an instance of the class "ThroatDiseases, (أمراض الحلق)".

Every subclass doesn't have branches will deem as individuals such as "fever–الحمى" "black cumin-الحبة السوداء" . The Information of individuals taken from the text of hadiths that were previously selected such as the following hadith:

عن أبي هريرة رضي الله عنه أنه سمع رسول الله صلى الله عليه وسلم يقول: «في **الحَبَّةِ السوْدَاءِ** شِفَاءٌ من كل دَاءٍ إلاَّ السَّام.»

30

We can create an individual instance **Black Cumin** to represent a specific type of **Seeds**. This instance has the following slot values defined (Figure 3.7):
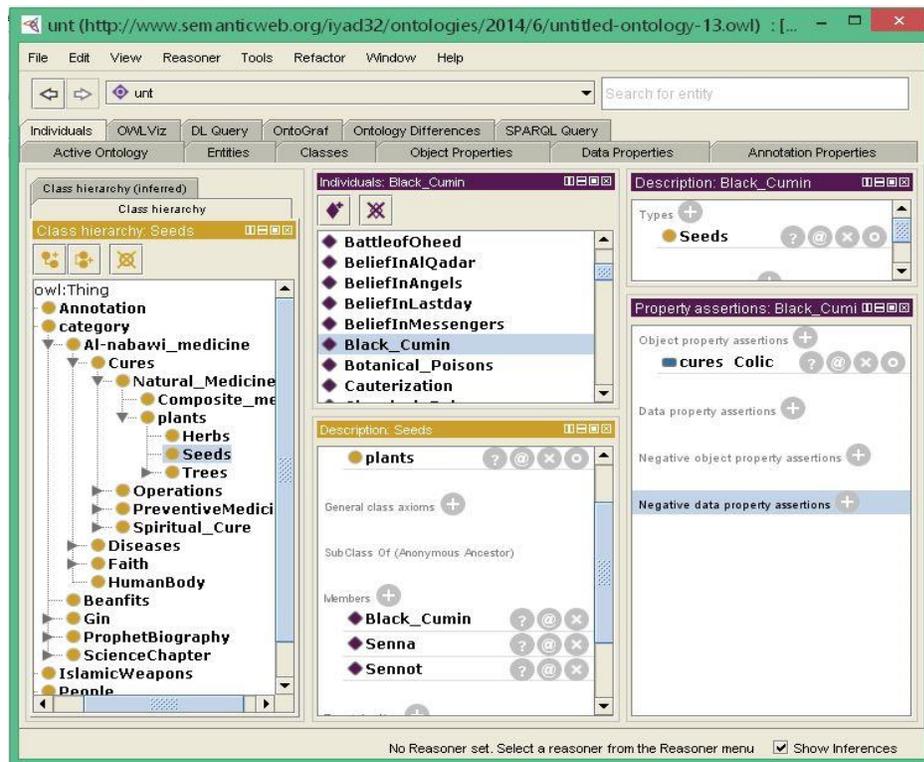
Figure 3-7: The definition of an instance of the Seeds

Figure 3.8 represents the main structure of the competence ontology with all the classes, subclasses, instances and object properties.
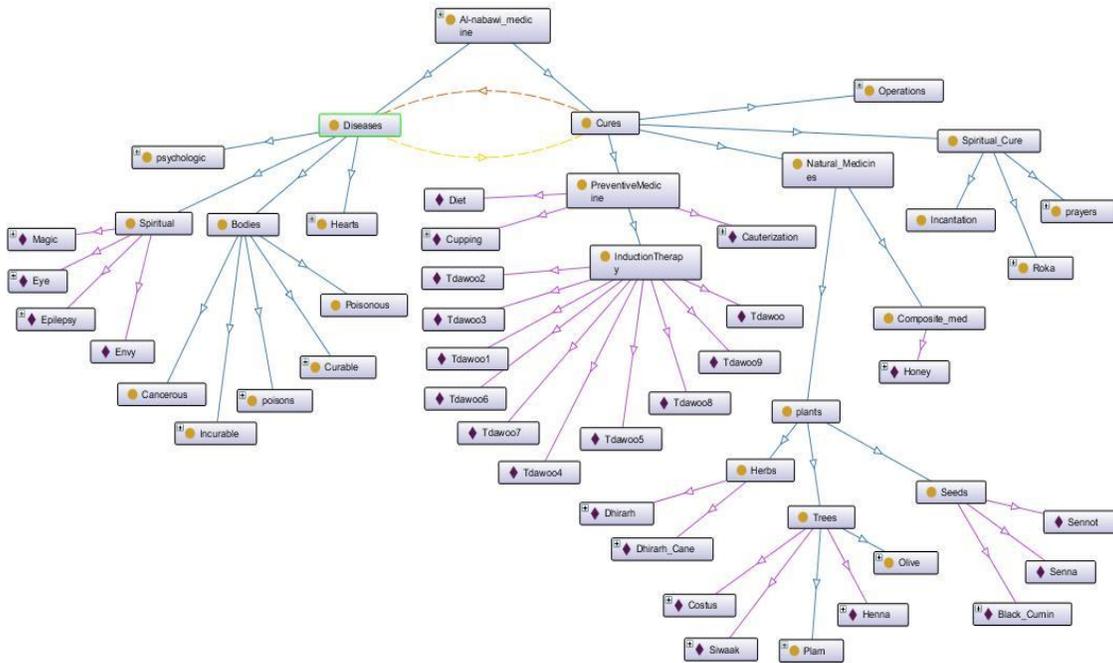
Figure 3-8: Graphical representation of the ontology Concepts and Instances

Step 7: Hadith annotation:

Semantic annotation module is responsible for annotating Hadith text with classes and/or instances from the ontology. An annotation should be well defined, unambiguous and easy to understand by domain specialists, in a way that it could be useful for the information retrieval process[28].

To facilitate the manual annotation of Hadith text, we provided an easy-to-use interface that enables the user, i.e. domain expert, to easily link segments of the Hadith text to the ontology content. The main window of the annotation interface is shown in Figure 3.9: The whole ontology content is visually represented as a tree (see Fig 3.9.A) where inner nodes denote ontology classes while leaf nodes denotes instances/child classes. The annotation process is done as the following: 1) the user highlights the text segment to be annotated. 2) The user selects relevant ontology terms, i.e. classes and/or instances, from the ontology tree. 3) On clicking "Add annotation" button, the appropriate annotation is created and stored in the RDF store. The annotation tool also enables the user to view all stored annotations and delete them.

Figure 3-9: Hadiths annotation tool

For testing purposes, We selected 60 sayings of prophet Mohammed from the book titled "ATTeb Al-Nabawi", authored by "Ibn Qay'em El-Jozeyah" (refer to Appendix H for the full list of the selected Sayings of Prophet Muhammad) and annotated them against the domain ontology. An RDF store was used to maintain the annotations in the format of RDF triples. To illustrate how annotations are created and stored, consider the saying of Prophet Mohamed shown in Figure 3.10:

حَدَّثَنَا مُحَمَّدُ بْنُ مُقَاتِلٍ، أَخْبَرَنَا عَبْدُ اللَّهِ، أَخْبَرَنَا حُمَيْدٌ الطَّوِيلُ، عَنْ أَنَسٍ. رضى الله عنه. أَنَّهُ سُئِلَ عَنْ أَجْرِ الْحَجَّامِ، فَقَالَ
احْتَجَمَ رَسُولُ اللَّهِ صلى الله عليه وسلم حَجَمَهُ أَبُو طَيْبَةَ، وَأَعْطَاهُ صَاعَيْنِ مِنْ طَعَامٍ، وَكَلَّمَ مَوَالِيَهُ فَخَفَّفُوا عَنْهُ، وَقَالَ " إِنَّ
أَمْثَلَ مَا تَدَاوَيْتُمْ بِهِ الْحِجَامَةُ وَالْقُسْطُ الْبَحْرِيُّ ". وَقَالَ " لاَ تُعَذِّبُوا صِبْيَانَكُمْ بِالْغَمْزِ مِنَ الْعُذْرَةِ، وَعَلَيْكُمْ بِالْقُسْطِ ".

Figure 3-10: Sayings of our Prophet Mohamed

The highlighted phrases of this saying can be linked to concepts of the ontology as the following:

- Annotation 1: through annotation tool, the word "أجر الحجام" was linked to the ontology concept "CuppingFees" (add the Arabic name) which is an instance of the class (concept) "TreatmentFees" (Arabic name). The following attributes were assigned to the annotation created for the word "أجر الحجام" as the following table 3.6:

33

Property Name	Value	explanation
Annotation Uri:	**"http://www.semanticweb.org/iyad32/ontologies/2014/6/untitled-ontology-13.owl#**Hhojama5Ann1"	a URI is expressed at the current annotation Hhojama5Ann1 : this name is created by the user
Category Uri:	"http://www.semanticweb.org/iyad32/ontologies/2014/6/untitled-ontology-13.owl#**CuppingFees** "	a URI is expressed at the Category in the ontology that linked with the current annotation
SourceHadith Uri	"http://www.semanticweb.org/iyad32/ontologies/2014/6/untitled-ontology-13.owl#**Hhojama5**"	URI of the saying containing the annotated word, i.e. "أجر الحجام". **Hhojama5**: This name is created by the user
Text	"أجر الحجام"	Annotated text within the saying.
StartIndex	93	Character index denoting the start of text in the saying
EndIndex	103	Character index denoting the end of text in the saying

Table 3-6: attributes were assigned to the annotation

Figure 3.11 shows the generated RDF code for the annotation attributes given in Table 3.6.

```
<owl:NamedIndividual rdf:about="&untitled-ontology-132;Hhojama5Ann1">
    <rdf:type rdf:resource="&untitled-ontology-132;Annotation"/>
    <rdfs:label rdf:datatype="&xsd;string">Hhojama5Ann1</rdfs:label>
    <untitled-ontology-132:hasStartIndex rdf:datatype="&rdfs;Literal">147</untitled-ontology-132:hasStartIndex>
    <untitled-ontology-132:hasEndIndex rdf:datatype="&rdfs;Literal">165</untitled-ontology-132:hasEndIndex>
    <untitled-ontology-132:hasCategory rdf:datatype="&rdfs;Literal">CuppingFees</untitled-ontology-132:hasCategory>
    <untitled-ontology-132:hasSource rdf:datatype="&rdfs;Literal">Hhojama5</untitled-ontology-132:hasSource>
    <untitled-ontology-132:hasText rdf:datatype="&rdfs;Literal">أجر الحجام</untitled-ontology-132:hasText>
</owl:NamedIndividual>
```

Figure 3-11: RDF triples of the annotation 1

Similarly, the following annotations were created and linked for the saying given in Figure 3.10 as follows (Figure 3.12 depicts the annotation process):

- Annotation 2: The word "صَاعَيْنِ مِنْ طَعَامٍ" is linked to the concept "CuppingFees" " أجر الحجامة" which is an instance of the class (concept) "TreatmentFees""أجور العلاج" .
- Annotation 3: The word "الْحِجَامَةُ"is linked to the concept "Cupping" "الحجامة" which is an instance of the class "PreventiveMedicine""الطب الوقائي" .
- Annotation 4: The word "الْقُسْطُ الْبَحْرِيُّ"is linked to the concept "Costus" "القسط" which is an instance of the class "Tree""أشجار" .

- Annotation 5: The word "الْعُذْرَةِ" is linked to the concept "Alozra" "العذرة" which is an instance of the class "ThroatDis" "أمراض الحلق".
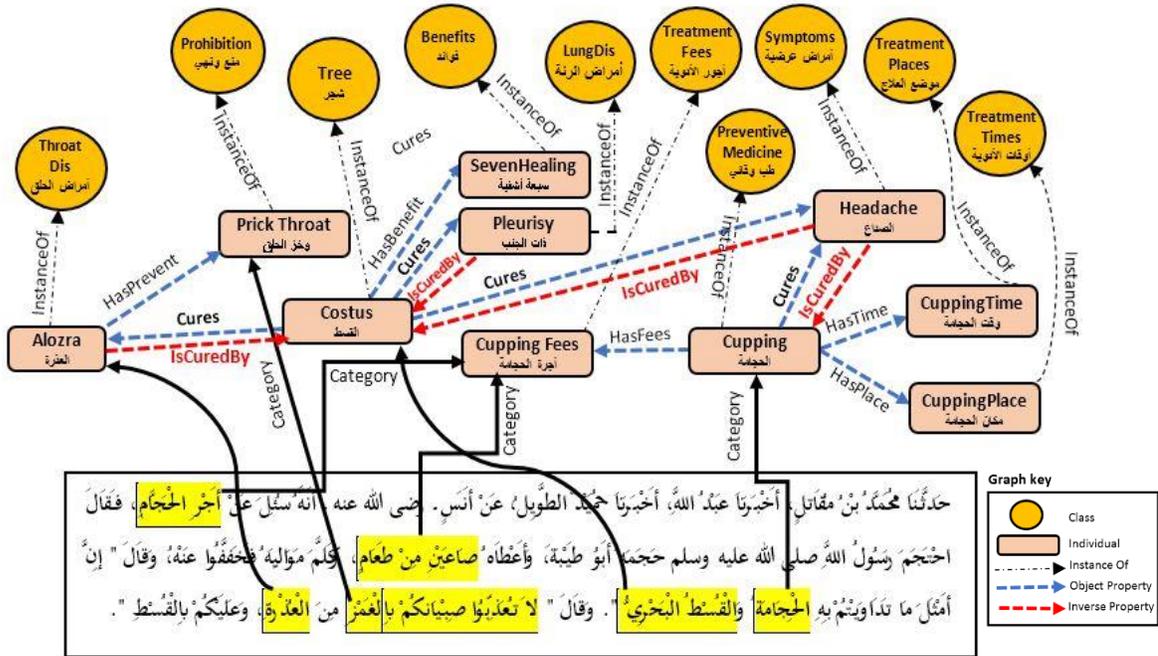
Figure 3-12: Hadith concepts linked to concepts of the ontology with relationships

The Terms in sayings of Prophet Mohammed are linked to the term in ontology which is a class or individual. We link the hadiths terms to ontology classes because we need to classify some sayings that do not contain keywords denote to particular topic. To illustrate this case, assume that a user is looking for all the hadith whose topic is "أدوية وقائية". By inputting the keywords "أدوية وقائية", results retrieved are unlikely to include many hadith that do not include the keywords or synonym that related with terms in ontology. For example, the core subject of the following hadith is Preventive remedies "أدوية وقائية" although this subject is never mentioned in the Hadith.

> عن النبي صلى الله عليه وسلم أنه قال: «ما ملأ آدمي وعاء شرا من بطن، بحسب ابن آدم لقيمات يقمن صلبه، فإن كان لا بد فاعلا، فثلث لطعامه، وثلث لشرابه، وثلث لنفسه»

35

3.5 Summary

This chapter presented the steps of developing hadith ontology in order to model the concepts and relationships within the chosen area, and used it to annotate the Hadith text. The procedure used to construct the hadith ontology included extracting and Classifying the main topics and subtopics in a Prophetic Medicine domain, extracting hadiths related to each topic, defining relevant terms and their synonyms that relate to the specific topic, and identifying the relationships between concepts and properties. Finally, the ontology was designed through a cooperative effort which included domain and ontology experts. The Hadith ontology domain was constructed using Protégé and OWL.

Chapter 4 : The OntoADL System

4.1 Overview:

This chapter presents OntoADL, our Prototype System to achieve and support the following requirements over ADL:

1- Semantic inferring ability and provide semantic guidance for end users. Information retrieval system should not lose some of the information that the users want and be within the user's interests

2- The ability to recognize synonyms or semantically-related terms.

3- Support complex queries that involve multiple conditions or objectives.

The core of OntoADL is the Hadith ontology that we built to model the different entities included in a specific domain of ADL, i.e. Prophetic Medicine. This chapter reports on the design and architecture of OntoADL, and discusses how the semantic markup and reasoning has the potential to improve information retrieval for end users.

For convenient understanding of the OntoADL system, the system can be used by two type of users, the annotator that is responsible for annotating the hadith text with content of the ontology and prepare rdfstore. End users are people who work with system by enter keywords and then data retrieve. Therefore, we divided the system's functionality into two tasks as follows:

1- Creating RDF store and building Ontological Dictionary: through the use of annotation, reasoning and Linguistics modules.

2- Information retrieval (Retrieving specific sayings of Prophet Mohammed): when the user inputs keywords, the natural language query is handled by the Linguistics Module to make the query words comparable with the content of the ontology and rdfstore. The matcher is used to match these words with the content of the ontology and rdfstore. Terms that match with the query words will be used later to build the RDF triple patterns of the SPARQL query. Then it executes the SPARQL query to retrieve results from the RDF store. In the following sections, the components of the system are explained in detail. The overall architecture of OntoADL system is depicted in Figure 4.1.
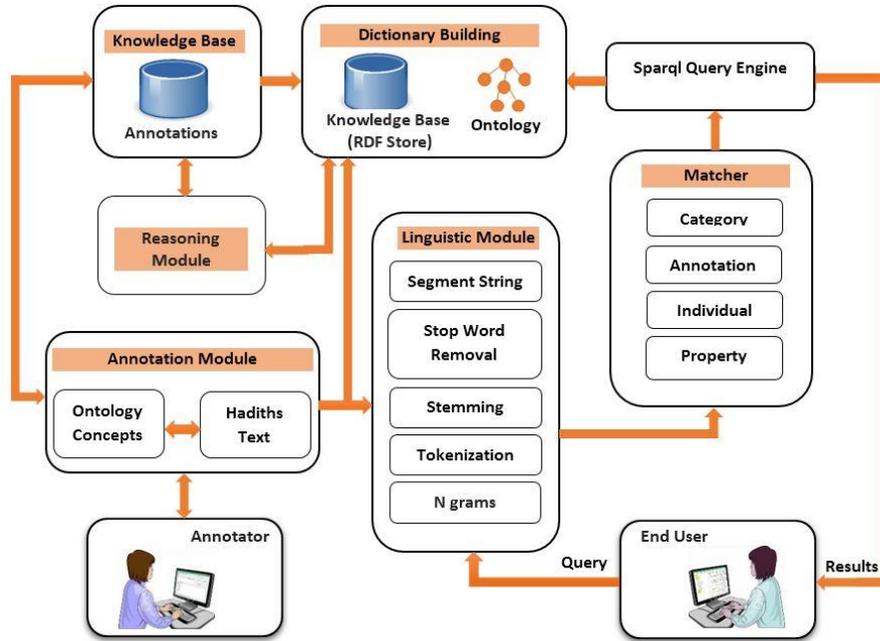
Figure 4-1: The Architecture of OntoADL system

The Components of the systems are explained as follows:

4.2 Annotation Module:

Annotation module is responsible for annotating Hadith text with terms in ontology by the annotator. We have provided an easy-to-use annotation interface (see figure 4.2) to annotate the sayings of our prophet against our domain ontology. We clarified its work in the part of the hadith ontology chapter.
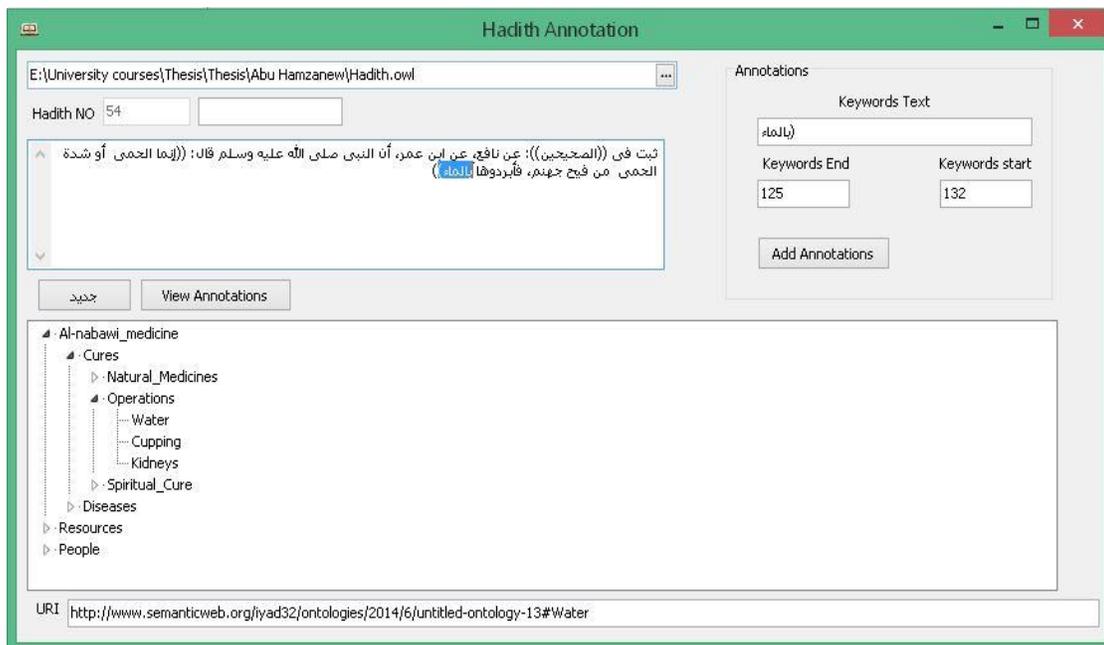
Figure 4-2: Hadiths annotation tool

38

4.3 Reasoning Module:

This module includes an OWL inference engine (i.e. Jena Reasoner). After annotating all the sayings, we run the inference engine over the annotations in the RDF store in order to infer new RDF triples. All inferred information is stored as new triples in dictionary thus exposing them to the queries. This enables the declaration of derived classes or the declaration of further property characteristics (e.g. transitivity and symmetry of properties). The Reasoning Module was implemented in Java by using the Jena API. It utilizes the rules to get best answers for user queries

The inference engine can also extend the RDF knowledge with additional axioms involving inverse properties. A good example of that is the property cures. Clearly, if the cupping cures Headache, then we can define the inverse property "IsCuredBy" to indicate that the headache is cured by the cupping. Having the inverse property "IsCuredBy" defined in our ontology, the reasoner will gather the following statements which found in ontology:

<http://www.semanticweb.org/iyad32/ontologies/2014/6/untitled-ontology-13.owl#**cupping**
Hadith: **Cures**
 <http://www.semanticweb.org/iyad32/ontologies/2014/6/untitled-ontology-13.owl#**Headache**>

And will use the inverse property to derive and then add the following statement without us doing anything:

<http://www.semanticweb.org/iyad32/ontologies/2014/6/untitled-ontology-13.owl#**Headache**>
Hadith: IsCuredBy
<http://www.semanticweb.org/iyad32/ontologies/2014/6/untitled-ontology-13.owl#**cupping**>

In another example: when the end user is looking for the value of the treatment of diarrhea entering the following query "علاج اسهال البطن؟". Using the annotations, the inference engine will be able to recognize that the word "اسهال البطن" refers to "الاستطلاق" although the word "اسهال البطن" is not literally mentioned in the Hadith. It will be able to recognize the synonyms or the semantically related terms which can be described as both symmetrical and transitive. That can be represented graphically as is done in Figure 4.3
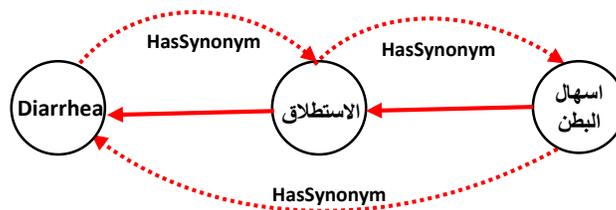
Figure 4-3: synonymous or the semantically related terms

Given the statement ":Honey :cures :Diarrhea", the reasoner will use the inverse property to add the following new fact: ":Diarrhea :iscuredby : Honey". Therefore, the system may suggest the following Hadith in (figure 4.4) as a result which satisfies the user query.

حَدَّثَنَا مُحَمَّدُ بْنُ بَشَّارٍ، حَدَّثَنَا مُحَمَّدُ بْنُ جَعْفَرٍ، حَدَّثَنَا شُعْبَةُ، عَنْ قَتَادَةَ، عَنْ أَبِي الْمُتَوَّكِلِ، عَنْ أَبِي سَعِيدٍ، قَالَ جَاءَ رَجُلٌ إِلَى النَّبِيِّ صلى الله عليه وسلم فَقَالَ إِنَّ أَخِي اسْتَطْلَقَ بَطْنُهُ. فَقَالَ " اسْقِهِ عَسَلاً ". فَسَقَاهُ. فَقَالَ إِنِّي سَقَيْتُهُ فَلَمْ يَزِدْهُ إِلاَّ اسْتِطْلاَقًا. فَقَالَ " صَدَقَ اللَّهُ وَكَذَبَ بَطْنُ أَخِيكَ ". تَابَعَهُ النَّضْرُ عَنْ شُعْبَةَ.

Figure 4-4: synonyms or the semantically related terms

4.4 Ontological Dictionary:

When the system is first started, an ontological dictionary is automatically constructed by extracting all ontology entities including classes, properties and instances, preprocessing and storing them in a special data structure. Ontological dictionary enables for rapid access and retrieval from the ontology especially when matching the user query with the ontology terms.

4.5 Linguistics modules:

In this module, all search terms (keywords) which entered by the user are subject to major preprocessing operations such as (Tokenization, Removing stop words, Stemming, N-grams). The aim of preprocessing the keywords is to prepare it for mapping with terms in Ontological Dictionary. Figure 4-5 shows Example of preprocessing operations on keywords

The user natural language inquiry is entered to the system which represents his question by using a tokenization process without changing its meaning whole text, it is segmented into sequential manner of words and sentences which represent a token. A token is an instance of a sequence of characters in some text that are grouped together as a useful semantic unit for processing [33]. In Stop word removal method whole sentence in the form of questions will be filtered out. So that only useful and meaningful words will be sorted out from a process of stop word processing. Stop word removal method sorted those words and removed that from original question given from a user. Stemming is a process of removing prefixes and suffixes from words. By using stemming process we can combine word forms to avoid mismatches that may be occurs during a searching time. Which make a system more understandable according to user's point of view and the system performance will be increased[33].
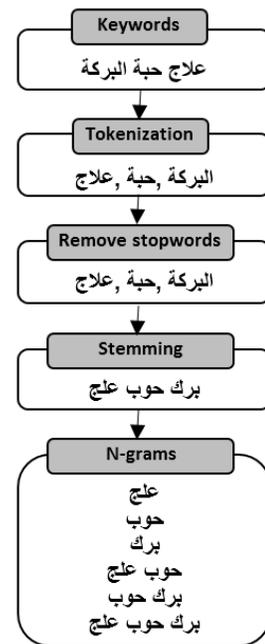
Figure 4-5: Example of preprocessing operations on keywords

Accurately, the system does not solve the questions or question marks but removes unimportant words and keep the keywords.

4.6 End user UI:

We built OntoADL system in such a way that the user can easily interact with the system and get the appropriate results according to the search terms. The user is provided with a graphical user interface (see Figure 4-6) to prompt search terms which will then be processed and converted to SPARQL queries.
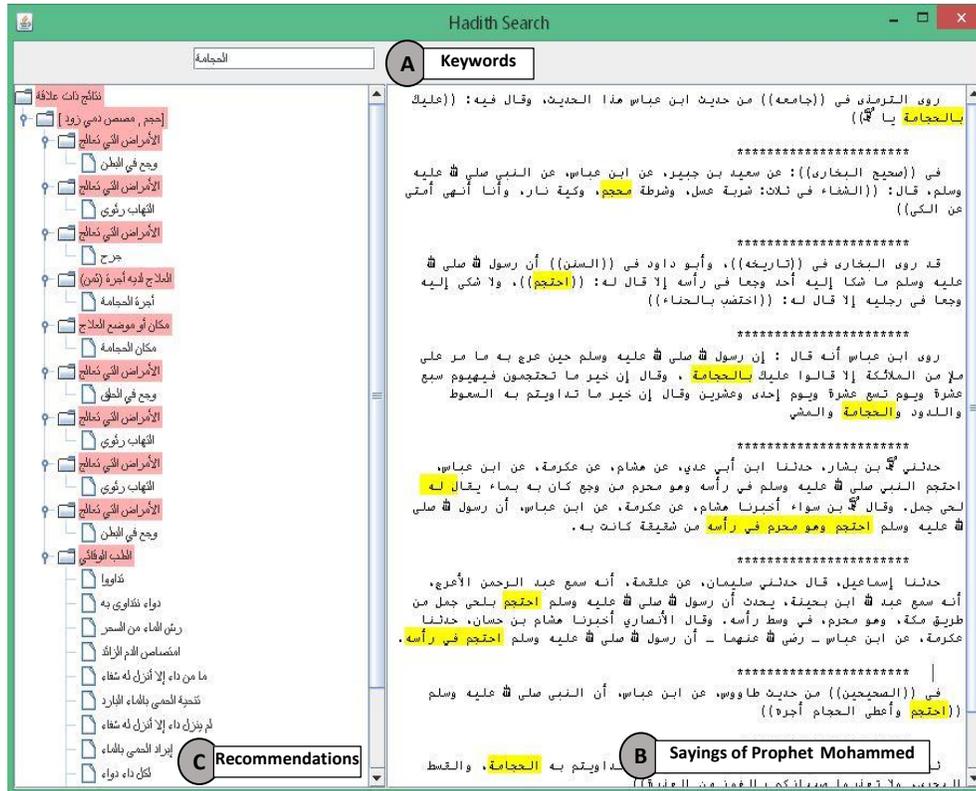
Figure 4-6: shows a snapshot of the end user interface

User interface provides search service through the text filed as place to inter the keywords (see figure 4.6.A). As well as, we divided the search results into two panes: on the right show the retrieved sayings of Prophet Mohammed (see figure 4.6.B). And On the left is the Recommendations list represented as a tree that related with search term entered by the user (see figure 4.6.C)

4.7 The Matcher:

The Matcher handles the process of matching the search terms to the ontology: When keywords are entered by the user, they are first processed by applying words segmentation, stop word removal and stemming. Afterwards, we generate all possible N-grams from the query words where N ranges between 1 and 3 (length of noun phrases is limited to 3 words in our system). Each N-gram is then matched with the content of the ontological dictionary starting with the N-gram of highest length. Using N-grams rather than single words for ontology matching ensures the best matching results and the extraction of ontology phrases. Note that keywords can match with classes, properties, instances and literals of the ontology.

41

Figure 4.7. Shows an example processing and matching a user query with the ontology content.
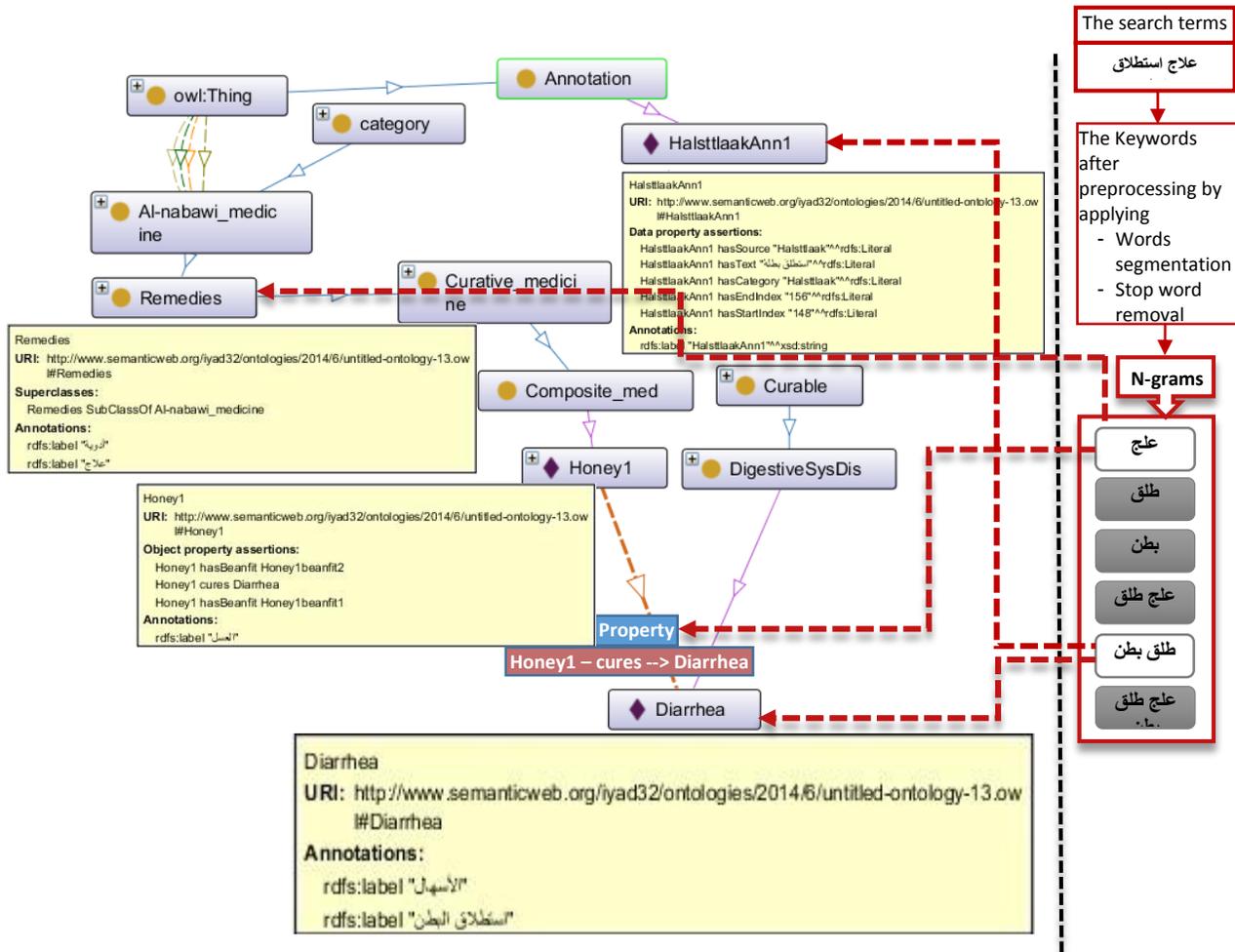
Figure 4-7: Matching the search terms to terms in Ontological Dictionary

As depicted in Figure 4.7, N-grams are linked to ontology terms as the following:

1) The query word (عالج) matches with object property (cures) (يعالج) in Ontological Dictionary.

2) The query word (عالج) matches with class (category) (Remedies) ("أدوية"،"علاج") in Ontological Dictionary.

3) The query word (طبق بطن) matches with individual (Diarrhea) ("الاسهال"،"استطلاق البطن").

4) The query word (طبق بطن) matches with annotation (HalsttlaakAnn1) ("استطلق بطنه").

5) These keywords ("علج طلق بطن"،"علج بطن"،"بطن"،"طلق"،) do not match with any ontology content.

After the process of matching, we notice there are keywords matches with multiple ontology terms such as the word (عالج) matches with object property and category, also the

42

word (طبق بطن) matches with individual and annotation, thus, We will consider all the matching results and used then to search in OntoADL system in order to retrieve all the results related with keywords.

4.8 SPARQL query engine:

This module is responsible for handling user queries and transforming them to SPARQL which is done by linking the ontology entities recognized by the matcher. After capturing the ontology entities from the matching process, they are linked to create RDF triples. These triples are then used to formulate a complete SPARQL query (as shown in table 4.1), which can retrieve the anticipated answers from the knowledge base. Note that this module does not extensively use natural language processing to translate the user's query to SPARQL (This is out of scope of our research).

Search terms "علاج استطلاق البطن"	Terms in Ontological Dictionary
طبق بطن =<== **Diarrhea**	**Diarrhea** (**Individual**)
عالج <== **IsCuredBy**	**IsCuredBy** (**property**)
عالج ==>**Remedies**	**Remedies** (**category**)
طبق بطن ==>**Diarrhea**	**HalsttlaakAnn1** (**Annotation**)

Table 4-1: Terms in Ontological Dictionary for each word in n-grams

the system will be able to recover the terms in Ontological Dictionary for each word in n-grams whether if it is a class, property, instance, annotation (see table 4.1). Then, the relations will be implemented through Sparql query (**as shown in Pseudo 1.1**) that will be able to determine that "Honey" is the cure and give all sayings of Prophet Mohammed that contains the words of Honey and the "استطلاق البطن". In addition to related recommendations

The mapping of the user keywords to query sparql is done as the following which is explained in pseducode 1: A user keyword can match with one or more of the following:

- **Match with annotation**: it means that a keyword matches with a part of text in hadith, so we will retrieve all sayings that are annotated with this annotation through executing the following query:

```
PREFIX rdf: < http://www.w3.org/1999/02/22-rdf-syntax-ns#>
PREFIX  hadith=  < http://www.semanticweb.org/iyad32/ontologies/2014/6/untitled-ontology-13.owl#>
SELECT  ?hadithtext ?hasText
WHERE {
        ?x hadith:hasSourceHadith ?hadithuri . FILTER(str(?x)='"+termuri+"').
        ?X hadith:hasText ?hasText . FILTER (STR (? x) ='"+termuri+"').
        ?y hadith:hasText ?Hadithtext. FILTER (STR (? y) =? hadithuri)
}
```

Query #1: Get all sayings that are annotated with annotation

The query can be stated "find triples of **hadithtext** where annotationURI has Source Hadith mapped hadithURI in the dictionary

- **Match with individual**:   An individual is an ontology instance that relates to a topic of Prophetic Medicine in the ontology. So if the query keyword matches any of ontology individuals, then each property linked with the matched individual is retrieved (see query #1), and combine them with the original keyword as a set of new query word. And extract all annotations referring to an individual (see query #2), after that, find the concept (class) which the individual belongs to it by using the Jena API.

```
PREFIX rdf: < http://www.w3.org/1999/02/22-rdf-syntax-ns#>
PREFIX  hadith=  < http://www.semanticweb.org/iyad32/ontologies/2014/6/untitled-ontology-13.owl#>

SELECT Distinct ?PropertyName
WHERE {{
        ?subject ?PropertyName ?object .FILTER(str(?subject)= hadith:Cupping)
        }
UNION {
        ?subject ?PropertyName?object. FILTER (str (?object) = hadith:Cupping)
        }}
```

Query #2: Get each property of the matched individual

The query can be stated "find triples of Property Name where the individual Cupping both subject and object"

```
PREFIX rdf: < http://www.w3.org/1999/02/22-rdf-syntax-ns#>
PREFIX  hadith=  < http://www.semanticweb.org/iyad32/ontologies/2014/6/untitled-ontology-13.owl#>


SELECT  ?annotation
WHERE {
        ?annotation hadith: hasCategory ?x . FILTER (str(?x)= hadith:Cupping)
      }
```

Query #3: Get all annotations referring to Cupping

The query can be stated "find triples of annotation where the annotation has Category Cupping"

- **Match with category**: A category represented a class inside the Hadith ontology. So if the query keyword matches with any one of ontology category, then we extract all sub class and all individuals of the matched category using the Jena API. It appear as a part in the list of recommendations (see figure 4.8.c) Where inner nodes denote ontology subclass while leaf nodes denotes instances (individuals).

 There are various possibilities to extend formulation of SPARQL, the keywords can be associated with each other as the following:

- **Individual and annotation:** It means there are sayings of Prophet Mohammed are annotated against specific individual in ontology. So if the query keyword matches any one of ontology individual and another keyword matches annotation that was linked to the same individual. we will retrieve all sayings that are annotated and linked this individual (see figure 4.8.B)through executing the following query:

```
PREFIX rdf: < http://www.w3.org/1999/02/22-rdf-syntax-ns#>
PREFIX  hadith=  < http://www.semanticweb.org/iyad32/ontologies/2014/6/untitled-ontology-
13.owl#>


SELECT *
WHERE {

        ?x a hadith:Cupping.  //Individual URI
        ?annotation hadith:hasCategory ?x.
}
```

Query #4: Get all hadith that are annotated with annotation "HSh2Ann3" and "Cupping"

- Individual and object property: it means that we need to make the type of properties explicit in our query. Every **Individual** in ontology has specific properties. If the query keyword matches any one of ontology individual and another keyword matches object property. Then firstly we obtain the property of the matched individual, and combine them with the original keyword as a set of new query word. After that, we will retrieve all sayings that contained the keyword (individual) which has the object property. (see figure 4.8.c)

```
PREFIX rdf: < http://www.w3.org/1999/02/22-rdf-syntax-ns#>
PREFIX  hadith=  < http://www.semanticweb.org/iyad32/ontologies/2014/6/untitled-ontology-
13.owl#>


SELECT ?diseases
WHERE {
        ?diseases hadith:isCuredBy ?y . FILTER(str(?y)= hadith:Cupping)
}
```

Query 5: get all diseases that are cured cupping

The query can be stated "find triples of diseases where diseases isCuredBy by Cupping"
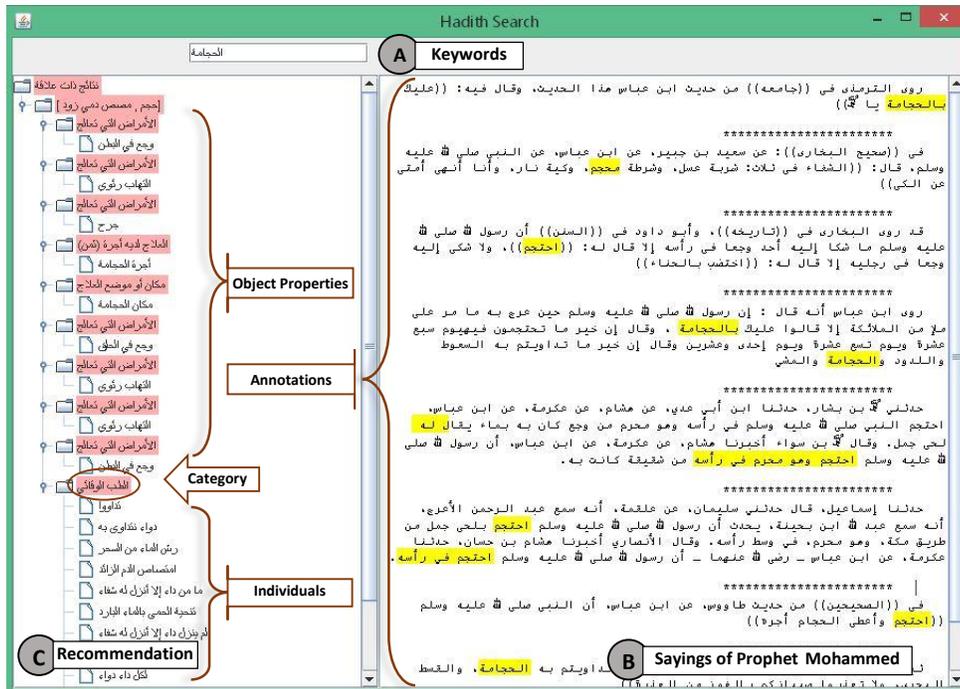
Figure 4-8: Example shows the results of matching cases in UI

The following Pseudo 1.1 Code Example explains how the system deal with the search terms entered by the user until get the results.

1. Enter keywords such as "علاج حبة البركة"
2. Apply text preprocessing (Words segmentation ،Stop word removal ،Stemming)
3. Generate N-grams (**Splitting Keywords** 1Gram, 2Gram, 3Gram)
4. starting from the highest n-grams
5. **For each n-gram**
   If (n-gram matches with ontology term(s)) then
     Input URIs [termURI]
    End if
   Next word

6. **For each termURI of URIs**
   If (termURI instance of Annotation) then
     - Get all sayings that are annotated with termURI by executing the query #1
   Else if (termURI instance of Individual) then
     - Get all sayings of Prophet Mohammed that are annotated with Individual by Executing the following query #2
     - get object properties which linked to current individual by executing the query #3
     - find the category (class) which the individual belongs to it by using the Jena API
     - Get Individuals Of class
   Else If (termURI instance of Object Property) then
     - Get subclasses and Individuals Of Category
     - Get individuals(subject and object) of which linked with every Object Property
     - Execute the following query

   Else if (termURI instance of Category) then
     - Get subclasses and Individuals of category using the Jena API

   Else if ((termURI instance of Individual) and (termURI instance of annotation)) then
     - Get all sayings that are annotated and linked this individual.
   Else if ((termURI instance of Individual) and (termURI instance of object property)) then
     - Get all sayings that contained the keyword (individual) which has the object property.
   End if
   Next termURI

47

4.9 Case study:

In the following, we illustrate a full usage scenario of the system, showing how the user query is internally processed until results are retrieved and presented to the user. Suppose that the user entered the following example query "فوائد السواك" In the search field as shown in figure 4.9. We mentioned clearly that processing questions is out of scope of this work, and we only consider simple user keywords and we do not consider the transformation of natural questions to the corresponding SPARQL queries.
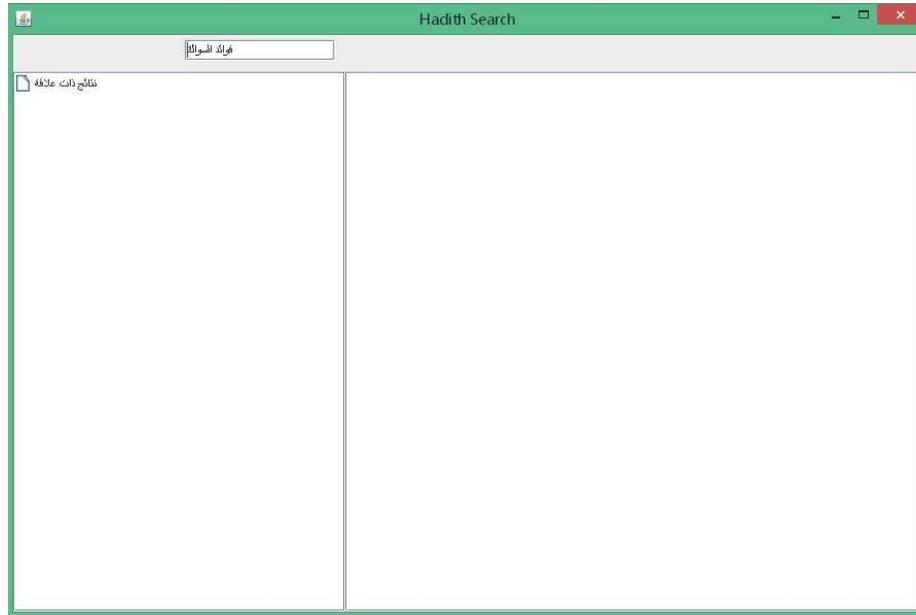
Figure 4-9: Graphical user interface to prompt query terms before the results

- **Preprocessing:**

In this step, words segmentation, stop word removal and stemming are applied and the following N-grams are generated as shown in figure 4.10: (limited to 3-N grams):
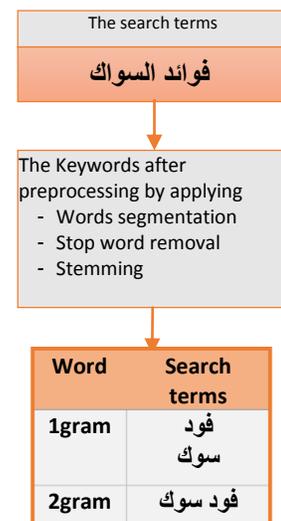
Figure 4-10: Splitting Keywords in the n-grams

48

- **Ontology Matching:**

Then, the ontology dictionary is searched for terms that match with the n-grams, starting from the highest n-grams. N-grams can be linked to terms in Ontological Dictionary as the following:

1) The query word (فود) matches with object property (hasBenefit) (لديه فائدة) in Ontological Dictionary.
2) The query word (فود) matches with class (**Benefits**) (''فوائد'').
3) The query word (سوك) matches with individual (**Siwaak**) (''السواك'').
4) The query word (سوك) matches with annotation **(HSewak2Ann2)** (''السواك'').
5) The query word (سوك) matches with annotation **(HSewak2Ann3)** (''السواك'').
6) These keywords (''فود سوك'') are not matching to the terms in Ontological Dictionary.

According to matching process, there are keywords matches with multiple ontology terms such as the word (فود) matches with object property and category and the word (سوك) matches with individual and annotation. Thus, we will consider all the matching results and used then to search in OntoADL system in order retrieve all the results related with keywords.

In example "فوائد السواك" the system will be able to recover URIs for each word in n-grams (as shown in following table 4.2).

Search terms ''فوائد السواك''	Terms in Ontological Dictionary
سوك => : **Siwaak**	**Siwaak** (Individual)
فود => :**hasBenefit**	**hasBenefit** (Object Property)
فود => : **Benefits**	**Benefits** (category)
سوك=> : **Siwaak**	**HSewak2Ann2** (Annotation)
سوك => : **Siwaak**	**HSewak2Ann3** (Annotation)

Table 4-2: shows URIs for each word in n-grams

- **Generate Sparql query:**

The results of SPARQL queries can be a set of RDF triple patterns. To construct SPARQL the matcher identifies the ontology entities that match best with the n-grams in the above example. These n-grams matched with the following ontology entities: ":Siwaak", ":has_benefit" which combining to formulate RDF triples.

49

The mapping of the user keywords to query sparql is done as the following which is explained in pseducode 1:

- o Matches with individual (Siwaak).
- o Matches with category(Benefits)
- o Matches with individual and object property(Siwaak , hasBenefit)
- o Matches with Individual and annotation(Siwaak, HSewak2Ann2)(Siwaak, HSewak2Ann3)

- **Output window:**

After combined the sparql query which is explained in pseducode 1, the System accomplished the following:

- o Returns all sayings that are annotated with individual "Siwaak" and Siwaak benefits through executing the query #4 (as shown in figure 4.11.B).
- o Returns all benefits of Siwaak that appear as a part in the list of recommendations (see figure 4.11.C) through executing the query #5.
- o It extract the category "فوائد" in list recommendation as related topic in Prophetic Medicine thought match the category "benefits" in ontology using the Jena API(see figure 4.11.C).
- o Likewise, extract the category "أشجار" that individual siwaak belong to it as related topic, and then extract all sub class and all individuals of the matched category using the Jena API (see figure 4.11.C).
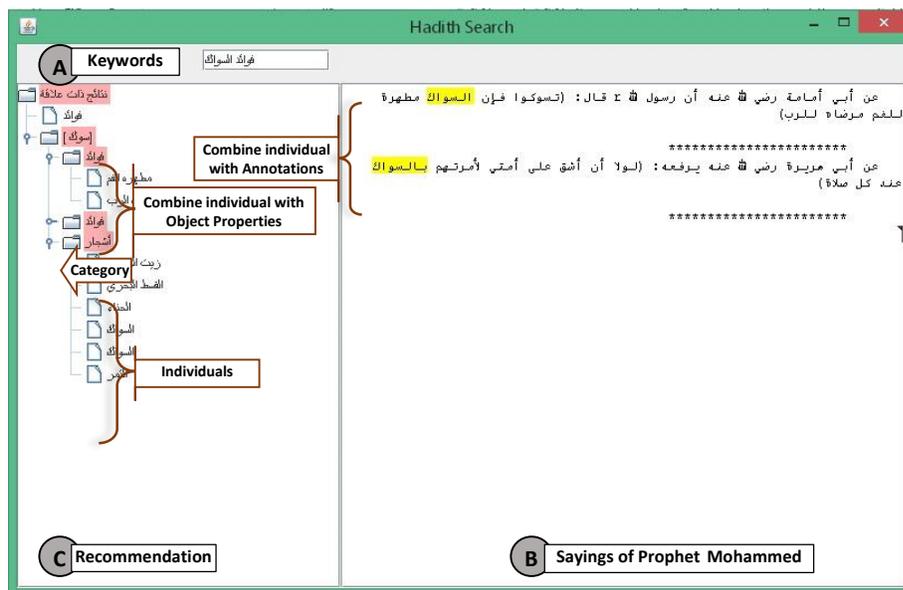
Figure 4-11: Graphical user interface after get the results

50

4.10 Summary

This chapter presents the architecture of the OntoADL system embodied in Hadith ontology that we built to model the different entities in Prophetic Medicine domain to support semantic search over ADL and improve information retrieval. The System contains modules that are interact with other through the use of two type of users where each user has specific function to deal with these modules. The functions of the system centered in two tasks; the annotating the hadith text with content of the ontology and prepare rdfstore through the use of annotation, reasoning and Linguistics modules by the annotator.

The system also will be used to allow end users to enter the keywords, and the system will retrieve specific sayings of Prophet Mohammed. These keywords are subject to major preprocessing operations to prepare it for mapping with terms in Ontological Dictionary. Terms that match with the query words will be used later to build the RDF triple patterns of the SPARQL query. Then it executes the SPARQL query to retrieve results from the RDF store.

Chapter 5 : System Evaluation

5.1 Introduction

This chapter presents the study we conducted to assess our system with the following objective in mind:

Assess the effectiveness of the search facility offered by our system, and compare it with the traditional search offered by ADL.

The experiment were conducted to evaluate the system's service: the system was tested using a set of search queries formulated by a domain expert. Search results were assessed in terms of precision and recall and MAP, and then are compared with the results obtained by the traditional search in ADL. The aim of this part was to explore the potential of our ontology-based approach to improve information search as compared to the conventional approach.

In the following section, we present details about the experimental settings including knowledge base, annotations and query set used. Subsequently, the experimental procedures and results are discussed.

5.2 Experimental Settings:

The dataset we used for evaluation was restricted to 60 Sayings of Prophetic Mohammed (Hadith) from the domain of Prophetic Medicine. These Sayings were extracted from the book titled "ATTeb Al-Nabawi", authored by "Ibn Qay'em El-Jozeyah". Since the same dataset is also included in the traditional ADL, our intention was to execute search queries over the same dataset and compare results generated by the two systems.

All sayings of Prophetic Mohammed were extracted and stored in the local database of our system. Then, words and phrases of these sayings were manually linked to instances and classes from our ontology. Overall, these resulted in 165 annotations at a rate of 2.75 annotations per Hadith. All annotations were then stored as RDF triples in a local database. Table 5.1 shows details about the size of our ontology and annotations.

Finally, we run an inference engine, i.e. reasoner, on the RDF store in an attempt to infer additional facts and expressive features. This can potentially improve the search capability by enabling the declaration of derived classes and/or further property characteristics (e.g. transitivity and symmetry of properties). Operating the reasoner on the RDF store generated a total number of 1875 triples. All Hadiths were annotated using instances and classes from our ontology.

Ontology Components	Number
Classes(main & sub)	108
Object Properties	15
Data Properties	7
Instances	110
Annotations	165

Table 5-1: illustrates the size of the ontology

To make our system comparable with ADL, we configured the ADL search facility to search only in the same reference book, i.e. "Atteb Al-Nabawi" (look Figure 5.1). We also excluded all results that were not contained in the 60 Sayings of Prophetic Mohammed (Hadith) used in our study.

Figure 5-1: ADL search engine

The dataset 60 sayings of Prophetic Mohammed (hadith) and the domain of Al-Tib Al-Nabawi as modeled in our ontology were all introduced to a human expert. We then asked him to formulate 20 queries (See Appendix Q for the full list of queries.) to search in the domain in hand.

Based on these sayings of Prophetic Mohammed we asked two human experts to input queries to the system to validate the ontology data and relationships. Based on their experiences in ADL they formulated 20 queries that included various topics and different patterns.

Note that only the keywords were used as search input. However, the statements of queries were necessary to assess the relevance of the obtained results and whether they actually met the expert's queries.

The measurement of recall, precision and mean average precision requires evaluation experts counseling of the relevance of a case to a query. Due to the effort involved in such an analysis, In addition to the longtime to obtain results from the ADL (as shown figure 5.2), the number of queries that can be evaluated is limited. In addition, the calculation of recall requires identifying all relevant elements (true negative + true negative) for each query. This process can be difficult and time consuming due to the large number of relevant results. Therefore, the experiment was limited to 20 queries which we carefully selected from a larger set of 70 queries set the domain expert (See Appendix Q1 for the full list of queries). The selection of the query set ensured the variety and coverage of different search scenarios and patterns.

Figure 5-2: Query results in ADL (Cupping)

The samples queries that have been tested are found in Appendix Q. And the source code, the whole dataset along with queries, and Results of the experiment are available online at this link:

("http://www.mediafire.com/download/3rtj4dvkgou6nm2/SourceCode%26DataSet%26Queries%26Resluts.rar **)"** to allow anyone to utilize and modify our work.

5.3 Evaluation of search result

- ### Evaluation Metrics

1- **precision and recall**

The system was evaluated based on the measures of Mean average precision which are defined as follows:

Precision measures the number of correctly identified items as a percentage of the number of items identified. Recall measures the number of correctly identified items as a percentage of the total number of correct items[34].

$$\text{Precision} = \frac{Number\ of\ relevant\ items\ retieved}{Number\ of\ retrieved\ items}$$

$$\text{Recall} = \frac{Number\ of\ relievant\ items\ retrieved}{Number\ of\ relevant\ items}$$

Results and Discussion

Table 5.2 illustrates the precision and recall evaluation results obtained over keyword-based search in ADL and results obtained from ontology based search in our system. (Refer to Appendix E: explains how we compute recall, precision and mean average precision for any query).

#	Keywords	ADL keyword-based search		OntoADL System ontology based search	
		Recall	Precision	Recall	Precision
1.	الحجامة	0.92	0.79	0.92	1.00
2.	الحث على المداوة	0.00	0.00	0.67	1.00
3.	علاج الحمى	0.14	0.20	1.00	1.00
4.	أمراض تعالج بالحناء	1.00	0.33	1.00	0.75
5.	التداوي بأمر الله	1.00	0.10	1.00	1.00
6.	فوائد العسل	0.67	0.40	1.00	1.00
7.	الأجرة على الحجامة	1.00	0.25	1.00	1.00
8.	علاج الصداع	0.50	0.25	0.75	0.75
9.	نهي سب الحمى	1.00	0.14	1.00	0.25
10	علاج الالتهاب الرئوي	0.00	0.00	1.00	0.67
11	أهمية السواك	1.00	0.50	1.00	1.00
12	نهي تعذيب الأولاد	0.00	0.00	1.00	1.00
13	الرقية من الوجع	1.00	0.22	0.50	0.50

14	مداواة روحانية	0.29	0.29	0.89	0.80
15.	الوقاية من السحر	1.00	0.14	1.00	1.00
16.	الأدوية الوقائية	0.50	0.45	**0.88**	**0.78**
17.	أمراض الجسم	0.87	0.68	**0.75**	**0.69**
18.	العلاج بالماء	1.00	0.50	**0.83**	**1.00**
19.	أنواع الأدوية الطبيعية	0.83	0.56	**0.83**	**0.83**
20.	تقرحات الجلد	1.00	0.14	**1.00**	**0.50**
average precision and recall		**0.69**	**0.30**	**0.90**	**0.83**

Table 5-2: depicts the number of queries and their results

Discussion

- Higher average precision and recall values in our proposed system compared to ADL: our proposed system achieved (90%) average recall and (83%) average precision while the ADL system achieved 69% average recall and 30% average precision. This result indicated that our system outperformed the ADL search facility. The enhanced performance can be attributed to two aspects:

- Information retrieval process was improved by introducing semantic inferring and providing semantic guidance for end user. The following example illustrated how the ontology-based approach resulted in better results as compared to the results: Given the query "الأدوية الوقائية". The results obtained from the system included all the hadiths that are semantically related to the core topic "الأدوية الوقائية", even if the phrase "الأدوية الوقائية" didn't literally exist. For instance, the following result didn't contain the phrase "الأدوية الوقائية" but it was retrieved our system as it denoted a natural protective remedy from the Prophetic Medicine (see figure 5.3). This result was not retrieved when the traditional search of ADL was used.

> قال صلى الله عليه وسلم: ما ملأ آدمى وعاء شرا من بطن، بحسب ابن آدم لقيمات يقمن صلبه، فإن كان لا بد فاعلا، فثلث لطعامه، وثلث لشرابه، وثلث لنفسه"

56

Figure 5-3: The results obtained from the system

- The system was able to recognize the synonyms or the semantically related terms. For example searching for the words ("ذات الجنب" and "الالتهاب الرئوي") or ("صبيانكم" and "الأولاد") gave the same results since the two words are semantically related.

Assume that a user was looking for the value of Treatment of pneumonia (علاج الالتهاب الرئوي) by entering the following query "علاج الالتهاب الرئوي؟". Using ontology-based annotations, the system could recognize that the word "الالتهاب الرئوي" referred to "ذات الجنب" although the word "الالتهاب الرئوي"was not literally mentioned in the Hadith. Therefore, the system suggested the following sayings as a result that satisfied that user's interest.

عن أم قيس بنت محصن قالت: سمعت النبي صلى الله عليه وسلم يقول: "عليكم بهذا العود الهندي فإن فيه سبعة أشفية يستعط به من العذرة ويلد به من ذات الجنب

حدثنا أبو اليمان، أخبرنا شعيب، عن الزهري، قال أخبرني عبيد الله بن عبد الله، أن أم قيس بنت محصن الأسدية. أسد خزيمة، وكانت من المهاجرات الأول اللاتي بايعن النبي صلى الله عليه وسلم وهي أخت عكاشة. أخبرته أنها أتت رسول الله صلى الله عليه وسلم بابن لها، قد أعلقت عليه من العذرة فقال النبي صلى الله عليه وسلم " على ما تدغرن أولادكن بهذا العلاق عليكم بهذا العود الهندي، فإن فيه سبعة أشفية منها ذات الجنب ". يريد الكست، وهو العود الهندي. وقال يونس وإسحاق بن راشد عن الزهري علقت

Conversely, the search functionality offered by ADL was unable to recognize synonyms or semantically-related terms. For example, searching for the words ("الالتهاب الرئوي" and

"ذات الجنب") or ("الأولاد" and "الصبيان") gave different results although the two words were semantically Related (see figure 5.4). Mostly, the results will not be retrieved because of the lack of these words synonyms originally in the domain of ADL.

Figure 5-4: The results obtained from the system

Besides that, the ADL traditional search relied on logical operators, e.g. "AND" and "OR" when searching for multiple words. If the search keywords were not literally present in ADL, no results will be retrieved.

Based on the above, our previous knowledge for the expected results of these queries Such as "الأجرة على الحجامة"، "فوائد العسل" "علاج الالتهاب الرئوي" and with the help of the given ontology and semantic annotations. That explained why our approach achieved 100% precision and recall for some queries.

In addition, the ADL lacked any support for complex queries that involved multiple conditions or objectives. For example, ADL did not support querying for all the Hadith that were given all diseases that were cured henna.

This explained why the results of recall and precision in some queries was very low such as "علاج الحمى" "مداوة روحانية" or achieved 0 precision and recall in ADL such as "علاج الالتهاب الرئوي" "نهي تعذيب الأولاد".

2- **Mean Average Precision (MAP):** it is the standard single-number measure for comparing search algorithms. Average precision (AP) is the average of precision values at all ranks where relevant documents are found. AP values are then averaged over a large set of queries.[35]

$$\text{MAP} = \frac{\sum_{q=1}^{Q} \text{AveP(q)}}{Q}$$

For a single information need, Average Precision is the average of the precision value obtained for the set of top Q queries existing after each relevant query is retrieved, and this value is then averaged over information needs. Then when a relevant query is not retrieved at all the precision value in the above equation is taken to be 0. After that, take the mean of ave.P values across queries. The motivation behind using MAP was to consider the order in which the results are presented.

Retrieval performance is evaluated with the mean-average precision (MAP), which is the average precision, over all queries, at the ranks where recall changes.

Table 5.3 illustrated the evaluation results obtained over keyword-based search in ADL and results obtained from ontology based search in our system by using Mean Average Precision for all queries. (Refer to Appendix E: explains how we compute recall, precision and mean average precision for any query).

#	*Keywords*	OntoADL System	ADL
		Precision	precision
1.	الحجامة	0.69	0.33
2.	الحث على المداواة	1.0	0.0
3.	علاج الحمى	1.0	0.96
4.	أمراض تعالج بالحناء	1.0	0.31
5.	التداوي بأمر الله	0.50	0.02
6.	فوائد العسل	1.00	0.83
7.	الأجرة على الحجامة	1.00	0.20
8.	علاج الصداع	0.92	0.20
9.	نهي سب الحمى	0.50	0.17
10.	علاج الالتهاب الرئوي	0.83	0.0
11.	أهمية السواك	1.00	0.58
12.	نهي تعذيب الأولاد	1.00	0.00
13.	الرقية من الوجع	1.00	0.75

59

14.	مداواة روحانية	0.97	0.27
15.	الوقاية من السحر	1.00	0.14
16.	الأدوية الوقائية	0.84	0.82
17.	أمراض الجسم	0.76	0.33
18.	العلاج بالماء	0.72	0.62
19.	أنواع الأدوية الطبيعية	0.88	0.46
20.	تقرحات الجلد	0.5	0.14
Mean Average Precision		**0.86**	**0.36**

Table 5-3: Mean Average Precision for all queries in two system

From this table we can infer the following:

Higher *Mean Average Precision* in our proposed system compared to ADL: Our proposed system achieved **86%** while the ADL system achieved **36%.** See Appendix E. (Example 1) explains how we can computed recall, precision and Mean Average Precision. Therefore, Ontology-based search had a better performance and accuracy in retrieving the Results than the ADL search engine.

After evaluating the system by experts, they commented as follows:
- o There is a satisfaction in the **retrieved** results.
- o The system generally provided solutions to some problems of ADL users to be able to search for any word and derivatives without being bound by a specific word.
- o Could display the sayings of Prophet Mohammed based on a particular topic.
- o Also he commented that a list of recommendations that appeared in the system facilitate and help to narrow the searching scope.
- o He suggested to display a number of hadiths that are obtained in related topics by category.

5.4 Summary

In This chapter, we have evaluated our system and discussed the results on the basis of search service. It was assessed using the relevant measure(s) of information retrieval.

Search service offered by our system was compare to the traditional search offered by ADL. In this service the system was evaluated based on the Evaluation Metrics precision, recall, and MAP. Average precision and recall values in our proposed system were higher compared to ADL. Our proposed system achieved (90%) average recall and (83%) average precision while the ADL system achieved 69% average recall and 30% average precision. This result indicated that our system outperformed the ADL search facility. Also retrieval performance was evaluated with the mean-average precision where our proposed system achieved 86% while the ADL system achieved 36%. Thus, ontology-based search had better performance and accuracy in retrieving the results than did the ADL search engine.

60

Chapter 6 : Conclusion and Future Work

Digital libraries represent a strategic information resource for specialists and experts. ADL is considered one of the large libraries that is used by researchers, professionals, intellectuals and other spectra of society to take advantage of the offered services. There are many limitations faced the digital library which are considered as barriers for maturity of digital libraries features. These limitations have been identified by the interviews we conducted with two experts who have intensively used ADL for research. Most of these limitations emerge from the lack of semantic inferring ability and the lack of semantic guidance for end users. Another limitation is the inability to recognize synonyms or semantically-related terms. In addition, the search service in ADL do not Support complex queries that involve multiple conditions or objectives. Based on the previous limitations, the requirements that are necessary to integrate the semantic search into ADL appeared to enhance the digital libraries performance and gives a good results fulfils user's needs.

In this thesis, we have developed the architecture of the OntoADL system embodied in Hadith ontology that we built to model the different entities in Prophetic Medicine domain to support semantic search over ADL and improve information retrieval. The System contains interacted modules through the use of two types of users where each user has a specific function to deal with these modules. The functions of the system centered in two tasks; the annotating the hadith text with content of the ontology and prepare rdfstore through the use of annotation, reasoning and Linguistics modules by the annotator. The system also allows the end users to enter the keywords, these keywords are subject to major preprocessing operations to prepare it for mapping with terms in Ontological Dictionary. Terms that match with the query words will be used later to build the RDF triple patterns of the SPARQL query. Then it executes the SPARQL query to retrieve results from the RDF store.

We have evaluated our system and discussed the results on the basis of search service. Search service offered by our system was compare to the traditional search offered by ADL. In this service the system was evaluated based on the Evaluation Metrics precision,

recall, and MAP. Average precision and recall values in our proposed system were higher compared to ADL. This result indicated that our system outperformed the ADL search facility. Also retrieval performance was evaluated with the mean-average precision where ontology-based search had better performance and accuracy in retrieving the results than did the ADL search engine.

Since this is the first work that addresses the integration of semantic search into ADL. There are still many limitations that need to be addressed and directions open for future research:

- We look to extend the system to cover multiple domains In ADL and Extend the ontology by adding more relationships and more data to give more Intelligent Results.
- Instead of using keywords we are looking to give support for Arabic question answering through entering nature language and covert it to sparql query.
- Also, we look forward to extend the evaluation to cover the largest number of users to gain access to an effective and successful evaluation.

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Appendices

Appendix H: Sayings of Prophet Mohammed

synonyms	terms	(الطب الوقائي) – Preventive medicine
		الحث على المداواة أو التداوي
مرض	داءٍ	
دواء	شِفَاءً	فى ((الصحيحين)): عن عطاءٍ، عن أبى هريرة قال: قال رسول الله صلى الله عليه وسلم: ((ما أنزل اللهُ مِنْ داءٍ إلا أَنْزَلَ لَهُ شِفَاءً))
	تَدَاوَوْا :	
دواء	شِفَاءً : دواء	
مرض	داءٍ :	
الموت – كبير السن	الهَرَمُ	وفى ((مسند الإمام أحمد)): من حديث زياد بن عِلاقة عن أُسامةَ ابن شَريكٍ، قال: ((كنتُ عندَ النبيِّ صلى الله عليه وسلم، وجاءت الأعرابُ، فقالوا: يا رسول الله؛ أَنَتَدَاوَى ؟ فقال: ((نَعَمْ يا عبادَ اللهِ تَدَاوَوْا، فإنَّ اللهَ عَزَّ وجَلَّ لم يضَعْ داءً إلا وَضَعَ لَهُ شِفاءً غيرَ داءٍ واحدٍ))، قالوا: ما هو ؟ قال : ((الهَرَمُ)).
مرض	داءً	
دواء – علاج	شِفَاءً	وفى ((المسند)): من حديث ابن مسعود يرفعه: ((إنَّ اللهَ عَزَّ وجَلَّ لم يُنْزِلْ داءً إلا أنزَلَ لَهُ شِفاءً، عَلِمَهُ مَنْ عَلِمَهُ، وَجَهِلَهُ مَنْ جَهِلَهُ)).
	رُقىً	
علاج	دواءً	وفى ((المسند)) و((السنن)): عن أبى خِزَامةَ، قال: قلتُ: يا رسول اللهِ؛ أرأَيْتَ رُقىً نَسْتَرْقِيهَا، ودواءً نتداوى به، وتُقَاةً نَتَّقِيهَا، هل تَرُدُّ من قَدَرِ اللهِ شيئاً ؟ فقال: ((هى من قَدَرِ الله)).
أرتفاع درجة الحراة	الحُمَّى	
النار	جَهنمَ	ثبت فى ((الصحيحين)): عن نافع، عن ابن عمرَ، أن النبى صلى الله عليه وسلم قال: ((إنَّمَا الحُمَّى أو شِدَّةُ الحُمَّى مِنْ فَيحِ جَهنَّمَ، فَأَبْرِدُوهَا بِالْمَاءِ)).
	بِالْمَاءِ	
ارتفاع درجة الحراة	حُمَّ	
	الماءَ الباردَ	وقد ذكر أبو نعيم وغيره من حديث أَنَسٍ يَرفعه: ((إذَا حُمَّ أَحَدُكُم، فَلْيُرَشَّ عليهِ الماءَ الباردَ ثلاثَ ليالٍ مِنَ السَّحَرِ)).
قبل طلوع الشمس	السَّحَرِ	
ارتفاع درجة الحارة	الحُمَّى	وفى ((سنن ابن ماجه)) عن أبى هُريرةَ يرفعه: ((الحُمَّى كِيرٌ مِن كِيرِ جَهنَّمَ، فَنَحُّوهَا عَنْكُم بالماءِ البَارِدِ)).
	بالماءِ البارد	
ارتفاع درجة الحراة	الحُمَّى	

65

	بالماءِ البارِد	وفي ((المسند)) وغيره، من حديث الحسن، عن سَمُرَةَ يرفعُه:
		((الحُمَّى قطعةٌ من النَّارِ، فأبْرِدُوهَا عَنْكُم بالماءِ البارِد))، وكان رسولُ الله
		صلى الله عليه وسلم إذا حُمَّ دَعَا بقِرْبَة من ماءٍ، فأفْرَغَهَا عَلَى رَأْسِه
		فاغْتَسَلَ.
باب الشِّفَاءُ في ثَلَاثٍ		
	عَسَلٍ	حَدَّثَني الحُسَيْنُ، حَدَّثَنَا أَحْمَدُ بْنُ مَنِيع، حَدَّثَنَا مَرْوَانُ بْنُ شُجَاعَ، حَدَّثَنَا
امتصاص الدم الزائد	مِحْجَمٍ	سَالِمٌ الأَفْطَسُ، عَنْ سَعِيدِ بْنِ جُبَيْرٍ، عَنِ ابْنِ عَبَّاسٍ . رضى الله عنهما . قَالَ
	كية	" الشِّفَاءُ في ثَلَاثَةٍ شَرْبَةِ عَسَلٍ، وَشَرْطَةِ مِحْجَمٍ، وَكَيَّةِ نَارٍ، وَأَنْهَى أُمَّتي عَنِ
		الكَيّ ". رَفَعَ الحَدِيثَ وَرَوَاهُ الفُتِيِّ عَنْ لَيْثٍ عَنْ مُجَاهِدٍ عَنِ ابْنِ عَبَّاسٍ عَنِ
		النَّبيّ صلى الله عليه وسلم في الْعَسَلِ وَالحَجْمِ.
	بالطاعون	فعن أسامة بن زيد – رضي الله عنهما – قال : قال رسول الله – صلى الله
		عليه وسلم – : (إذا سمعتم بالطاعون بأرض فلا تدخلوها، وإذا وقع وأنتم
		بأرض فلا تخرجوا منها فرارا منه)(البخاري)،
	لُقَيْمَاتٌ	))مَا مَلأَ آدَمِيٌّ وِعَاءً شَرًّا مِنْ بَطْنٍ حَسْبُ الآدَمِيّ لُقَيْمَاتٌ يُقِمْنَ صُلْبَهُ،
	لِلطَّعَامِ	فَإِنْ غَلَبَتِ الآدَمِيَّ نَفْسُهُ فَثُلُثٌ لِلطَّعَامِ، وَثُلُثٌ لِلشَّرَابِ، وَثُلُثٌ لِلنَّفَسِ((
	لِلشَّرَابِ	
	لِلنَّفَسِ	
باب : السواك		
	بالسواك	عن أبي هريرة رضي الله عنه يرفعه: (لولا أن أشُقَ على أمتي لأمرتُهم بالسواك
		عند كل صلاة).
	السواك	عن أبي أمامة رضي الله عنه أن رسول الله r قال: (تسوّكوا فإن السواك
	مطهرة للفم	مطهرة للفم مرضاه للرب).
	مرضاه للرب	
(الطب العلاجي) – Curative medicine		
بَابُ الدَّوَاءِ بِالْعَسَلِ		
	الْعَسَلُ.	حَدَّثَنَا عَلِيُّ بْنُ عَبْدِ اللَّهِ، حَدَّثَنَا أَبُو أُسَامَةَ، حَدَّثَنَا قَالَ أَخْبَرَني هِشَامٌ، عَنْ أَبِيهِ،
		عَنْ عَائِشَةَ . رضى الله عنها . قَالَتْ كَانَ النَّبِيُّ صلى الله عليه وسلم يُعْجِبُهُ
		الحَلْوَاءُ وَالْعَسَلُ.
	مِحْجَمٍ	حَدَّثَنَا أَبُو نُعَيْمٍ، حَدَّثَنَا عَبْدُ الرَّحْمَنِ بْنُ الْغَسِيلِ، عَنْ عَاصِمِ بْنِ عُمَرَ بْنِ
	أَدْوِيَتِكُمْ	قَتَادَةَ، قَالَ سَمِعْتُ جَابِرَ بْنَ عَبْدِ اللَّهِ. رضى الله عنهما . قَالَ سَمِعْتُ النَّبِيَّ
	عَسَلٍ	صلى الله عليه وسلم يَقُولُ " **إنْ كَانَ في شَيْءٍ مِنْ أَدْوِيَتِكُمْ** . أَوْ يَكُونُ في
الكي	لَذْعَةٍ بِنَارٍ	

		شَيْءٍ مِنْ أَدْوِيَتِكُمْ. خَيْرٌ فَفِي شَرْطَةِ مِحْجَمٍ، أَوْ شَرْبَةِ عَسَلٍ، أَوْ لَذْعَةٍ بِنَارٍ تُوَافِقُ الدَّاءَ، وَمَا أُحِبُّ أَنْ أَكْتَوِيَ ".
اسهال	يَشْتَكِي بَطْنَهُ. عَسَلاً	حَدَّثَنَا عَيَّاشُ بْنُ الْوَلِيدِ، حَدَّثَنَا عَبْدُ الأَعْلَى، حَدَّثَنَا سَعِيدٌ، عَنْ قَتَادَةَ، عَنْ أَبِي الْمُتَوَكِّلِ، عَنْ أَبِي سَعِيدٍ، أَنَّ رَجُلاً، أَتَى النَّبِيَّ صلى الله عليه وسلم فَقَالَ أَخِي يَشْتَكِي بَطْنَهُ. فَقَالَ " اسْقِهِ عَسَلاً ". ثُمَّ أَتَى الثَّانِيَةَ فَقَالَ " اسْقِهِ عَسَلاً ". ثُمَّ أَتَاهُ فَقَالَ فَعَلْتُ. فَقَالَ " صَدَقَ اللَّهُ، وَكَذَبَ بَطْنُ أَخِيكَ، اسْقِهِ عَسَلاً ". فَسَقَاهُ فَبَرَأَ.
		باب الدَّوَاءِ بِأَلْبَانِ الإِبِلِ
	أَلْبَانَهَا وَاسْتَاقُوا	حَدَّثَنَا مُسْلِمُ بْنُ إِبْرَاهِيمَ، حَدَّثَنَا سَلاَّمُ بْنُ مِسْكِينٍ، حَدَّثَنَا ثَابِتٌ، عَنْ أَنَسٍ، أَنَّ نَاسًا، كَانَ بِهِمْ سَقَمٌ قَالُوا يَا رَسُولَ اللَّهِ آوِنَا وَأَطْعِمْنَا فَلَمَّا صَحُّوا قَالُوا إِنَّ الْمَدِينَةَ وَخِمَةٌ. فَأَنْزَلَهُمُ الْحَرَّةَ فِي ذَوْدٍ لَهُ فَقَالَ " اشْرَبُوا أَلْبَانَهَا ". فَلَمَّا صَحُّوا قَتَلُوا رَاعِيَ النَّبِيِّ صلى الله عليه وسلم وَاسْتَاقُوا ذَوْدَهُ، فَبَعَثَ فِي آثَارِهِمْ، فَقَطَعَ أَيْدِيَهُمْ وَأَرْجُلَهُمْ، وَسَمَرَ أَعْيُنَهُمْ، فَرَأَيْتُ الرَّجُلَ مِنْهُمْ يَكْدُمُ الأَرْضَ بِلِسَانِهِ حَتَّى يَمُوتَ. قَالَ سَلاَّمٌ فَبَلَغَنِي أَنَّ الْحَجَّاجَ قَالَ لأَنَسٍ حَدِّثْنِي بِأَشَدِّ عُقُوبَةٍ عَاقَبَهُ النَّبِيُّ صلى الله عليه وسلم فَحَدَّثَهُ بِهَذَا. فَبَلَغَ الْحَسَنَ فَقَالَ وَدِدْتُ أَنَّهُ لَمْ يُحَدِّثْهُ بِهَذَا
		باب الدَّوَاءِ بِأَبْوَالِ الإِبِلِ
	أَلْبَانَهَا وَأَبْوَالَهَا	حَدَّثَنَا مُوسَى بْنُ إِسْمَاعِيلَ، حَدَّثَنَا هَمَّامٌ، عَنْ قَتَادَةَ، عَنْ أَنَسٍ. رضى الله عنه. أَنَّ نَاسًا، اجْتَوَوْا فِي الْمَدِينَةِ فَأَمَرَهُمُ النَّبِيُّ صلى الله عليه وسلم أَنْ يَلْحَقُوا بِرَاعِيهِ. يَعْنِي الإِبِلَ. فَيَشْرَبُوا مِنْ أَلْبَانِهَا وَأَبْوَالِهَا، فَلَحِقُوا بِرَاعِيهِ فَشَرِبُوا مِنْ أَلْبَانِهَا وَأَبْوَالِهَا، حَتَّى صَلَحَتْ أَبْدَانُهُمْ فَقَتَلُوا الرَّاعِيَ وَسَاقُوا الإِبِلَ، فَبَلَغَ النَّبِيَّ صلى الله عليه وسلم فَبَعَثَ فِي طَلَبِهِمْ، فَجِيءَ بِهِمْ فَقَطَعَ أَيْدِيَهُمْ وَأَرْجُلَهُمْ، وَسَمَرَ أَعْيُنَهُمْ. قَالَ قَتَادَةُ فَحَدَّثَنِي مُحَمَّدُ بْنُ سِيرِينَ أَنَّ ذَلِكَ كَانَ قَبْلَ أَنْ تَنْزِلَ الْحُدُودُ.
		باب الْحَبَّةِ السَّوْدَاءِ
حبة البركة	الْحَبَّةَ السَّوْدَاءَ	

		حَدَّثَنَا عَبْدُ اللَّهِ بْنُ أَبِي شَيْبَةَ، حَدَّثَنَا عُبَيْدُ اللَّهِ، حَدَّثَنَا إِسْرَائِيلُ، عَنْ
	السَّامُ	مَنْصُورٍ، عَنْ خَالِدِ بْنِ سَعْدٍ، قَالَ خَرَجْنَا وَمَعَنَا غَالِبُ بْنُ أَبْجَرَ فَمَرِضَ فِي
		الطَّرِيقِ، فَقَدِمْنَا الْمَدِينَةَ، فَعَادَهُ ابْنُ أَبِي عَتِيقٍ فَقَالَ لَنَا عَلَيْكُمْ
		بِهَذِهِ الْحُبَيْبَةِ السَّوْدَاءِ، فَخُذُوا مِنْهَا خَمْسًا أَوْ سَبْعًا فَاسْحَقُوهَا، ثُمَّ اقْطُرُوهَا
		فِي أَنْفِهِ بِقَطَرَاتِ زَيْتٍ فِي هَذَا الْجَانِبِ وَفِي هَذَا الْجَانِبِ، فَإِنَّ عَائِشَةَ حَدَّثَتْنِي
		أَنَّهَا سَمِعَتِ النَّبِيَّ صلى الله عليه وسلم يَقُولُ **" إِنَّ هَذِهِ الْحَبَّةَ السَّوْدَاءَ**
		شِفَاءٌ مِنْ كُلِّ دَاءٍ إِلاَّ مِنَ السَّامِ ". قُلْتُ وَمَا السَّامُ قَالَ الْمَوْتُ.
حبة البركة – الشُّونِيزُ	الْحَبَّةِ السَّوْدَاءِ	حَدَّثَنَا يَحْيَى بْنُ بُكَيْرٍ، حَدَّثَنَا اللَّيْثُ، عَنْ عُقَيْلٍ، عَنِ ابْنِ شِهَابٍ، قَالَ
	وَالسَّامُ	أَخْبَرَنِي أَبُو سَلَمَةَ، وَسَعِيدُ بْنُ الْمُسَيَّبِ، أَنَّ أَبَا هُرَيْرَةَ، أَخْبَرَهُمَا أَنَّهُ، سَمِعَ
		رَسُولَ اللَّهِ صلى الله عليه وسلم يَقُولُ **" فِي الْحَبَّةِ السَّوْدَاءِ شِفَاءٌ مِنْ كُلِّ**
		دَاءٍ إِلاَّ السَّامَ ". قَالَ ابْنُ شِهَابٍ وَالسَّامُ الْمَوْتُ، وَالْحَبَّةُ السَّوْدَاءُ الشُّونِيزُ.
		بَاب السَّعُوطِ
امتصاص الدم الزائد	احْتَجَمَ	حَدَّثَنَا مُعَلَّى بْنُ أَسَدٍ، حَدَّثَنَا وُهَيْبٌ، عَنِ ابْنِ طَاوُسٍ، عَنْ أَبِيهِ، عَنِ ابْنِ
	اسْتَعَطَ	عَبَّاسٍ . رضى الله عنهما . عَنِ النَّبِيِّ صلى الله عليه وسلم احْتَجَمَ وَأَعْطَى
		الْحَجَّامَ أَجْرَهُ وَاسْتَعَطَ.
		بَاب السَّعُوطِ بِالْقُسْطِ الْهِنْدِيِّ الْبَحْرِيِّ
القسط الهندي– القسط البحري	الْعُودِ الْهِنْدِيِّ	حَدَّثَنَا صَدَقَةُ بْنُ الْفَضْلِ، أَخْبَرَنَا ابْنُ عُيَيْنَةَ، قَالَ سَمِعْتُ الزُّهْرِيَّ، عَنْ عُبَيْدِ
	سَبْعَةَ أَشْفِيَةٍ	اللَّهِ، عَنْ أُمِّ قَيْسٍ بِنْتِ مِحْصَنٍ، قَالَتْ سَمِعْتُ النَّبِيَّ صلى الله عليه وسلم
	الْعُذْرَةِ	يَقُولُ **" عَلَيْكُمْ بِهَذَا الْعُودِ الْهِنْدِيِّ، فَإِنَّ فِيهِ سَبْعَةَ أَشْفِيَةٍ. يُسْتَعَطُ بِهِ**
		مِنَ الْعُذْرَةِ، وَيُلَدُّ بِهِ مِنْ ذَاتِ الْجَنْبِ ". وَدَخَلْتُ عَلَى النَّبِيِّ صلى الله
		عليه وسلم بِابْنٍ لِي لَمْ يَأْكُلِ الطَّعَامَ فَبَالَ عَلَيْهِ، فَدَعَا بِمَاءٍ فَرَشَّ عَلَيْهِ.
		بَاب أَىَّ سَاعَةٍ يَحْتَجِمُ وَاحْتَجَمَ أَبُو مُوسَى لَيْلاً
امتصاص الدم الزائد	احْتَجَمَ	حَدَّثَنَا أَبُو مَعْمَرٍ، حَدَّثَنَا عَبْدُ الْوَارِثِ، حَدَّثَنَا أَيُّوبُ، عَنْ عِكْرِمَةَ، عَنِ
		ابْنِ عَبَّاسٍ، قَالَ احْتَجَمَ النَّبِيُّ صلى الله عليه وسلم وَهُوَ صَائِمٌ

68

		باب الْحِجَامَةِ مِنَ الدَّاء
امتصاص الدم الزائد	الْحِجَامَةُ	حَدَّثَنَا مُحَمَّدُ بْنُ مُقَاتِلٍ، أَخْبَرَنَا عَبْدُ اللَّهِ، أَخْبَرَنَا حُمَيْدٌ الطَّوِيلُ، عَنْ أَنَسٍ
العود الهندي : القسط الهندي	وَالْقُسْطُ الْبَحْرِيُّ	رضى الله عنه . أَنَّهُ سُئِلَ عَنْ أَجْرِ الْحَجَّامِ، فَقَالَ احْتَجَمَ رَسُولُ اللَّهِ
أولادكم	صِبْيَانَكُمْ	صلى الله عليه وسلم حَجَمَهُ أَبُو طَيْبَةَ، وَأَعْطَاهُ صَاعَيْنِ مِنْ طَعَامٍ، وَكَلَّمَ
	الْعُذْرَة	مَوَالِيَهُ فَخَفَّفُوا عَنْهُ، وَقَالَ " إِنَّ أَمْثَلَ مَا تَدَاوَيْتُمْ بِهِ الْحِجَامَةُ وَالْقُسْطُ الْبَحْرِيُّ ". وَقَالَ " لاَ تُعَذِّبُوا صِبْيَانَكُمْ بِالْغَمْزِ مِنَ الْعُذْرَةِ، وَعَلَيْكُمْ بِالْقُسْطِ ".
		باب الْحِجَامَةِ عَلَى الرَّأْسِ
امتص الدم الزائد	احْتَجَمَ	حَدَّثَنَا إِسْمَاعِيلُ، قَالَ حَدَّثَنِي سُلَيْمَانُ، عَنْ عَلْقَمَةَ، أَنَّهُ سَمِعَ عَبْدَ الرَّحْمَنِ
مكان الحجامة	فِي رَأْسِهِ.	الأَعْرَجَ، أَنَّهُ سَمِعَ عَبْدَ اللَّهِ ابْنَ بُحَيْنَةَ، يُحَدِّثُ أَنَّ رَسُولَ اللَّهِ صلى الله عليه وسلم احْتَجَمَ بِلَحْيِ جَمَلٍ مِنْ طَرِيقِ مَكَّةَ، وَهُوَ مُحْرِمٌ، فِي وَسَطِ رَأْسِه. وَقَالَ الأَنْصَارِيُّ أَخْبَرَنَا هِشَامُ بْنُ حَسَّانَ، حَدَّثَنَا عِكْرِمَةُ، عَنِ ابْنِ عَبَّاسٍ . رضى الله عنهما . أَنَّ رَسُولَ اللَّهِ صلى الله عليه وسلم احْتَجَمَ فِي رَأْسِهِ.
		باب الْحَجْمِ مِنَ الشَّقِيقَةِ وَالصُّدَاعِ
امتص الدم الزائد	احْتَجَمَ	حَدَّثَنِي مُحَمَّدُ بْنُ بَشَّارٍ، حَدَّثَنَا ابْنُ أَبِي عَدِيٍّ، عَنْ هِشَامٍ، عَنْ عِكْرِمَةَ،
الصداع النصفي	شَقِيقَة	عَنِ ابْنِ عَبَّاسٍ، احْتَجَمَ النَّبِيُّ صلى الله عليه وسلم فِي رَأْسِهِ وَهُوَ مُحْرِمٌ
موعد الحجامة	مُحْرِمٌ	مِنْ وَجَعٍ كَانَ بِهِ بِمَاءٍ يُقَالُ لَهُ لَحْيُ جَمَلٍ. وَقَالَ مُحَمَّدُ بْنُ سَوَاءٍ أَخْبَرَنَا هِشَامٌ، عَنْ عِكْرِمَةَ، عَنِ ابْنِ عَبَّاسٍ، أَنَّ رَسُولَ اللَّهِ صلى الله عليه وسلم احْتَجَمَ وَهُوَ مُحْرِمٌ فِي رَأْسِهِ مِنْ شَقِيقَةٍ كَانَتْ بِهِ.
	عَسَلٍ مِحْجَمٍ	حَدَّثَنَا إِسْمَاعِيلُ بْنُ أَبَانَ، حَدَّثَنَا ابْنُ الْغَسِيلِ، قَالَ حَدَّثَنِي عَاصِمُ بْنُ عُمَرَ، عَنْ جَابِرِ بْنِ عَبْدِ اللَّهِ، قَالَ سَمِعْتُ النَّبِيَّ صلى الله عليه وسلم يَقُولُ " إِنْ
كي	لَذْعَةٍ مِنْ نَارٍ	كَانَ فِي شَىْءٍ مِنْ أَدْوِيَتِكُمْ خَيْرٌ فَفِي شَرْبَةِ عَسَلٍ أَوْ شَرْطَةِ مِحْجَمٍ أَوْ لَذْعَةٍ مِنْ نَارٍ، وَمَا أُحِبُّ أَنْ أَكْتَوِيَ ".
		علاج الصُّدَاع والشقيقة بالحناء
وجع في الرأس	الصداع – صُدِع	روى ابن ماجه في ((سننه)) حديثاً فى صحته نظر: أَنَّ النبى صلى الله عليه وسلم كان إذا صُدِع، غَلَّفَ رأسَه بالحنَّاء، ويقول: ((إنَّهُ نافِعٌ بإذنِ الله من الصُّداع)).
	الحناء	
	احْتَجم	

69

ألم في رجليه	وجَعاً فى رجلَيْه بالحِنَّاء	وقد روى البخارى فى ((تاريخه))، وأبو داود فى ((السنن)) أنَّ رسولَ الله صلى الله عليه وسلم ما شكا إليه أحدٌ وجَعاً فى رأسِه إلا قال له: ((احْتَجِمْ))، ولا شَكى إليه وجَعاً فى رجلَيْه إلا قال له: ((اخْتَضِبْ بالحِنَّاء)).
جرح	قرحة	وفى الترمذى: عن سَلْمَى أُمِّ رافعٍ خادمةِ النبى صلى الله عليه وسلم قالتْ:
	شَوْكة الحناء	كان لا يُصيبُ النبيَّ صلى الله عليه وسلم قرحةٌ ولا شَوْكةٌ، إلا وَضَع عليها الحِنَّاء
		باب الْعُذْرَة
التهاب في الأنف	الْعُذْرَة	حَدَّثَنَا أَبُو الْيَمَانِ، أَخْبَرَنَا شُعَيْبٌ، عَنِ الزُّهْرِيِّ، قَالَ أَخْبَرَنِي عُبَيْدُ اللَّهِ بْنُ
القسط البحري–القسط الهندي	الْعُودِ الْهِنْدِيّ	عَبْدِ اللَّهِ، أَنَّ أُمَّ قَيْسٍ بِنْتَ مِحْصَنٍ الأَسَدِيَّةَ، وَكَانَتْ مِنَ الْمُهَاجِرَاتِ الأُوَلِ اللاَّتِي بَايَعْنَ النَّبِيَّ صلى الله عليه وسلم وَهْىَ أُخْتُ
	سَبْعَةَ أَشْفِيَة	عُكَّاشَةَ . أَخْبَرَتْهُ أَنَّهَا أَتَتْ رَسُولَ اللَّهِ صلى الله عليه وسلم بِابْنٍ لَهَا، قَدْ
التهاب رئوي	ذاتُ الجَنْبِ	أَعْلَقَتْ عَلَيْهِ مِنَ الْعُذْرَةِ فَقَالَ النَّبِيُّ صلى الله عليه وسلم " عَلَى مَا تَدْغَرْنَ أَوْلاَدَكُنَّ بِهَذَا الْعِلاَقِ عَلَيْكُمْ بِهَذَا الْعُودِ الْهِنْدِيّ، فَإِنَّ فِيهِ سَبْعَةَ أَشْفِيَةٍ مِنْها ذَاتُ الجَنْبِ ". يُرِيدُ الْكُسْتَ، وَهُوَ الْعُودُ الْهِنْدِيُّ. وَقَالَ يُونُسُ وَإِسْحَاقُ بْنُ رَاشِدٍ عَنِ الزُّهْرِيِّ عَلَّقَتْ عَلَيْهِ.
		باب دَوَاءِ الْمَبْطُون
الاسهال	اسْتَطْلَقَ بَطْنُهُ	حَدَّثَنَا مُحَمَّدُ بْنُ بَشَّارٍ، حَدَّثَنَا مُحَمَّدُ بْنُ جَعْفَرٍ، حَدَّثَنَا شُعْبَةُ، عَنْ قَتَادَةَ،
	عَسَلاً	عَنْ أَبِي الْمُتَوَكِّلِ، عَنْ أَبِي سَعِيدٍ، قَالَ جَاءَ رَجُلٌ إِلَى النَّبِيِّ صلى الله عليه وسلم فَقَالَ إِنَّ أَخِي اسْتَطْلَقَ بَطْنُهُ. فَقَالَ " اسْقِهِ عَسَلاً ". فَسَقَاهُ. فَقَالَ إِنِّي سَقَيْتُهُ فَلَمْ يَزِدْهُ إِلاَّ اسْتِطْلاَقًا. فَقَالَ " صَدَقَ اللَّهُ وَكَذَبَ بَطْنُ أَخِيكَ ". تَابَعَهُ النَّضْرُ عَنْ شُعْبَةَ.
		باب ذَاتِ الجَنْب
التهاب الحلق – التهاب اللوزتين	الْعُذْرَة	حَدَّثَنِي مُحَمَّدٌ، أَخْبَرَنَا عَتَّابُ بْنُ بَشِيرٍ، عَنْ إِسْحَاقَ، عَنِ الزُّهْرِيِّ، قَالَ
القسط البحري–القسط الهندي	الْعُودِ الْهِنْدِيّ	أَخْبَرَنِي عُبَيْدُ اللَّهِ بْنُ عَبْدِ اللَّهِ، أَنَّ أُمَّ قَيْسٍ بِنْتَ مِحْصَنٍ، وَكَانَتْ، مِنَ
التهاب رئوي	ذاتُ الجَنْبِ	الْمُهَاجِرَاتِ الأُوَلِ اللاَّتِي بَايَعْنَ رَسُولَ اللَّهِ صلى الله عليه وسلم وَهْىَ

		أُخْتُ عُكَّاشَةَ بْنِ مِحْصَنٍ أَخْبَرَتْهُ أَنَّهَا أَتَتْ رَسُولَ اللهِ صلى الله عليه
		وسلم بِابْنٍ لَهَا قَدْ عَلَّقَتْ عَلَيْهِ مِنَ الْعُذْرَةِ فَقَالَ " اتَّقُوا اللهَ، عَلَى مَا
		تَدْغَرُونَ أَوْلَادَكُمْ بِهَذِهِ الْأَعْلَاقِ عَلَيْكُمْ بِهَذَا الْعُودِ الْهِنْدِيِّ، فَإِنَّ فِيهِ
		مِنْهَا ذَاتُ الْجَنْبِ ". يُرِيدُ الْكُسْتَ يَعْنِي الْقُسْطَ، قَالَ سَبْعَةَ أَشْفِيَةٍ
		وَهْىَ لُغَةٌ.

	باب الْحُمَّى مِنْ فَيْحِ جَهَنَّم

ارتفاع درجة الحرارة	الْحُمَّى	حَدَّثَنِي يَحْيَى بْنُ سُلَيْمَانَ، حَدَّثَنِي ابْنُ وَهْبٍ، قَالَ حَدَّثَنِي مَالِكٌ، عَنْ
	بِالْمَاءِ	نَافِعٍ، عَنِ ابْنِ عُمَرَ . رضى الله عنهما . عَنِ النَّبِيّ صلى الله عليه وسلم
		قَالَ " الْحُمَّى مِنْ فَيْحِ جَهَنَّمَ فَأَطْفِئُوهَا بِالْمَاءِ ". قَالَ نَافِعٌ وَكَانَ عَبْدُ
		اللهِ يَقُولُ اكْشِفْ عَنَّا الرِّجْزَ.

	الْحُمَّى	حَدَّثَنِي مُحَمَّدُ بْنُ الْمُثَنَّى، حَدَّثَنَا يَحْيَى، حَدَّثَنَا هِشَامٌ، أَخْبَرَنِي أَبِي، عَنْ
	بِالْمَاءِ	عَائِشَةَ، عَنِ النَّبِيّ صلى الله عليه وسلم قَالَ " الْحُمَّى مِنْ فَيْحِ جَهَنَّمَ
		فَابْرُدُوهَا بِالْمَاءِ ".

	حُمّ	وقد ذكر أبو نعيم وغيره من حديث أَنَسٍ يَرفعه: ((إذَا حُمَّ أَحَدُكُم،
	الماءُ الباردُ	فَلْيُرَشَّ عليهِ الماءَ البارِدَ ثلاثَ ليالٍ مِنَ السَّحَرِ)).
	ثلاثَ ليالٍ	
	السَّحَرِ	

	الْحُمَّى	حَدَّثَنَا أَحْمَدُ بْنُ سَعِيدٍ الْأَشْقَرُ الرِّبَاطِيُّ، حَدَّثَنَا رَوْحُ بْنُ عُبَادَةَ، حَدَّثَنَا
	بِالْمَاءِ	مَرْزُوقٌ أَبُو عَبْدِ اللهِ الشَّامِيُّ، حَدَّثَنَا سَعِيدٌ، رَجُلٌ مِنْ أَهْلِ الشَّامِ أَخْبَرَنَا
	فَلْيَسْتَنْقِعْ نَهْرًا	ثَوْبَانُ، عَنِ النَّبِيّ صلى الله عليه وسلم قَالَ " إِذَا أَصَابَ أَحَدَكُمُ الْحُمَّى
	جَارِيَ	فَإِنَّ الْحُمَّى قِطْعَةٌ مِنَ النَّارِ فَلْيُطْفِئْهَا عَنْهُ بِالْمَاءِ فَلْيَسْتَنْقِعْ نَهْرًا جَارِيًا
	صَلَاةِ الصُّبْحِ	لِيَسْتَقْبِلَ جَرْيَةَ الْمَاءِ فَيَقُولُ بِسْمِ اللهِ اللَّهُمَّ اشْفِ عَبْدَكَ وَصَدِّقْ
		رَسُولَكَ بَعْدَ صَلَاةِ الصُّبْحِ قَبْلَ طُلُوعِ الشَّمْسِ فَلْيَغْتَمِسْ فِيهِ ثَلَاثَ
		غَمَسَاتٍ ثَلَاثَةَ أَيَّامٍ فَإِنْ لَمْ يَبْرَأْ فِي ثَلَاثٍ فَخَمْسٍ وَإِنْ لَمْ يَبْرَأْ فِي خَمْسٍ
		فَسَبْعٌ فَإِنْ لَمْ يَبْرَأْ فِي سَبْعٍ فَتِسْعٌ فَإِنَّهَا لَا تَكَادُ تُجَاوِزُ تِسْعًا بِإِذْنِ اللهِ "

	الْحُمَّى	حَدَّثَنَا أَبُو بَكْرِ بْنُ أَبِي شَيْبَةَ، حَدَّثَنَا وَكِيعٌ، عَنْ مُوسَى بْنِ عُبَيْدَةَ، عَنْ
	لَا تَسُبُّهَا	عَلْقَمَةَ بْنِ مَرْثَدٍ، عَنْ حَفْصِ بْنِ عُبَيْدِ اللهِ، عَنْ أَبِي هُرَيْرَةَ، قَالَ ذُكِرَتِ
	تَنْفِي الذُّنُوبَ	الْحُمَّى عِنْدَ رَسُولِ اللهِ . صلى الله عليه وسلم . فَسَبَّهَا رَجُلٌ فَقَالَ النَّبِيُّ .

71

		صلى الله عليه وسلم . " لاَ تَسُبَّهَا فَإِنَّهَا تَنْفِي الذُّنُوبَ كَمَا تَنْفِي النَّارُ خَبَثَ الْحَدِيدِ "
Spiritual medicine(الطب الروحاني)		
باب الرُّقَى بِالْقُرْآنِ وَالْمُعَوِّذَاتِ		
	يَنْفُثُ بِالْمُعَوِّذَاتِ	حَدَّثَنِي إِبْرَاهِيمُ بْنُ مُوسَى، أَخْبَرَنَا هِشَامٌ، عَنْ مَعْمَرٍ، عَنِ الزُّهْرِيِّ، عَنْ عُرْوَةَ، عَنْ عَائِشَةَ . رضى الله عنها . أَنَّ النَّبِيَّ صلى الله عليه وسلم كَانَ يَنْفُثُ عَلَى نَفْسِهِ فِي الْمَرَضِ الَّذِي مَاتَ فِيهِ بِالْمُعَوِّذَاتِ، فَلَمَّا ثَقُلَ كُنْتُ أَنْفِثُ عَلَيْهِ بِهِنَّ، وَأَمْسَحُ بِيَدِ نَفْسِهِ لِبَرَكَتِهَا. فَسَأَلْتُ الزُّهْرِيَّ كَيْفَ يَنْفِثُ قَالَ كَانَ يَنْفِثُ عَلَى يَدَيْهِ، ثُمَّ يَمْسَحُ بِهِمَا وَجْهَهُ.
باب الرُّقَى بِفَاتِحَةِ الْكِتَابِ		
	لُدِغَ	حَدَّثَنِي مُحَمَّدُ بْنُ بَشَّارٍ، حَدَّثَنَا غُنْدَرٌ، حَدَّثَنَا شُعْبَةُ، عَنْ أَبِي بِشْرٍ، عَنْ أَبِي الْمُتَوَكِّلِ، عَنْ أَبِي سَعِيدٍ الْخُدْرِيِّ . رضى الله عنه . أَنَّ نَاسًا مِنْ أَصْحَابِ النَّبِيِّ صلى الله عليه وسلم أَتَوْا عَلَى حَيٍّ مِنْ أَحْيَاءِ الْعَرَبِ فَلَمْ يَقْرُوهُمْ، فَبَيْنَمَا هُمْ كَذَلِكَ إِذْ لُدِغَ سَيِّدُ أُولَئِكَ فَقَالُوا هَلْ مَعَكُمْ مِنْ دَوَاءٍ أَوْ رَاقٍ فَقَالُوا إِنَّكُمْ لَمْ تَقْرُونَا، وَلاَ نَفْعَلُ حَتَّى تَجْعَلُوا لَنَا جُعْلاً. فَجَعَلُوا لَهُمْ قَطِيعًا مِنَ الشَّاءِ، فَجَعَلَ يَقْرَأُ بِأُمِّ الْقُرْآنِ، وَيَجْمَعُ بُزَاقَهُ، وَيَتْفِلُ، فَبَرَأَ، فَأَتَوْا بِالشَّاءِ، فَقَالُوا لاَ نَأْخُذُهُ حَتَّى نَسْأَلَ النَّبِيَّ صلى الله عليه وسلم فَسَأَلُوهُ فَضَحِكَ وَقَالَ " وَمَا أَدْرَاكَ أَنَّهَا رُقْيَةٌ، خُذُوهَا، وَاضْرِبُوا لِي بِسَهْمٍ ".
	دَوَاء	
الفاتحة	بِأُمِّ الْقُرْآنِ	
	رُقْيَةٌ	
باب رُقْيَةِ الْعَيْنِ		
	يُسْتَرْقَى الْعَيْنِ	حَدَّثَنَا مُحَمَّدُ بْنُ كَثِيرٍ، أَخْبَرَنَا سُفْيَانُ، قَالَ حَدَّثَنِي مَعْبَدُ بْنُ خَالِدٍ، قَالَ سَمِعْتُ عَبْدَ اللَّهِ بْنَ شَدَّادٍ، عَنْ عَائِشَةَ . رضى الله عنها . قَالَتْ أَمَرَنِي رَسُولُ اللَّهِ صلى الله عليه وسلم أَوْ أَمَرَ أَنْ يُسْتَرْقَى مِنَ الْعَيْنِ.
العينَ	النَّظْرَة	حَدَّثَنِي مُحَمَّدُ بْنُ خَالِدٍ، حَدَّثَنَا مُحَمَّدُ بْنُ وَهْبِ بْنِ عَطِيَّةَ الدِّمَشْقِيُّ، حَدَّثَنَا مُحَمَّدُ بْنُ حَرْبٍ، حَدَّثَنَا مُحَمَّدُ بْنُ الْوَلِيدِ الزُّبَيْدِيُّ، أَخْبَرَنَا الزُّهْرِيُّ، عَنْ عُرْوَةَ بْنِ الزُّبَيْرِ، عَنْ زَيْنَبَ ابْنَةِ أَبِي سَلَمَةَ، عَنْ أُمِّ سَلَمَةَ . رضى الله عنها . أَنَّ النَّبِيَّ صلى الله عليه وسلم رَأَى فِي بَيْتِهَا جَارِيَةً فِي وَجْهِهَا سَفْعَةٌ فَقَالَ " اسْتَرْقُوا لَهَا، فَإِنَّ بِهَا النَّظْرَةَ ". وَقَالَ عُقَيْلٌ عَنِ الزُّهْرِيِّ أَخْبَرَنِي عُرْوَةُ عَنِ النَّبِيِّ صلى الله عليه وسلم. تَابَعَهُ عَبْدُ اللَّهِ بْنُ سَالِمٍ عَنِ الزُّبَيْدِيِّ.
باب رُقْيَةِ النَّبِيِّ صلى الله عليه وسلم		

72

الاستشارات

اللَّهُمَّ الشَّافِي سَقَمًا		حَدَّثَنَا مُسَدَّدٌ، حَدَّثَنَا عَبْدُ الْوَارِثِ، عَنْ عَبْدِ الْعَزِيزِ، قَالَ دَخَلْتُ أَنَا وَثَابِتٌ، عَلَى أَنَسِ بْنِ مَالِكٍ فَقَالَ ثَابِتٌ يَا أَبَا حَمْزَةَ اشْتَكَيْتُ. فَقَالَ أَنَسٌ أَلاَ أَرْقِيكَ بِرُقْيَةِ رَسُولِ اللَّهِ صلى الله عليه وسلم قَالَ بَلَى. قَالَ " اللَّهُمَّ رَبَّ النَّاسِ مُذْهِبَ الْبَاسِ اشْفِ أَنْتَ الشَّافِي لاَ شَافِيَ إِلاَّ أَنْتَ، شِفَاءً لاَ يُغَادِرُ سَقَمًا ".
يَرْقِي الْبَاسَ		حَدَّثَنِي أَحْمَدُ بْنُ أَبِي رَجَاءٍ، حَدَّثَنَا النَّضْرُ، عَنْ هِشَامِ بْنِ عُرْوَةَ، قَالَ أَخْبَرَنِي أَبِي، عَنْ عَائِشَةَ، أَنَّ رَسُولَ اللَّهِ صلى الله عليه وسلم كَانَ يَرْقِي يَقُولُ " امْسَحِ الْبَاسَ رَبَّ النَّاسِ، بِيَدِكَ الشِّفَاءُ، لاَ كَاشِفَ لَهُ إِلاَّ أَنْتَ "
بِسْم اللَّهِ بِرِيقَةِ		حَدَّثَنَا عَلِيُّ بْنُ عَبْدِ اللَّهِ، حَدَّثَنَا سُفْيَانُ، قَالَ حَدَّثَنِي عَبْدُ رَبِّهِ بْنُ سَعِيدٍ، عَنْ عَمْرَةَ، عَنْ عَائِشَةَ. رضى الله عنها. أَنَّ النَّبِيَّ صلى الله عليه وسلم كَانَ يَقُولُ لِلْمَرِيضِ " بِسْم اللَّهِ، تُرْبَةُ أَرْضِنَا، بِرِيقَةِ بَعْضِنَا، يُشْفَى سَقِيمُنَا بِإِذْنِ رَبِّنَا ".
		علاج الكرب والهم والغم والحزن
الكرب		أخرجا في الصحيحين . من حديث ابن عباس . أن رسول الله صلى‌الله‌عليه‌وسلم ، كان يقول عند الكرب : « لا إله إلا الله العظيم الحليم ، لا إله إلا الله رب العرش العظيم ، لا إله إلا الله رب السماوات (السبع) ، ورب الأرض ، رب العرش الكريم ».
حزبه أمر		وفي جامع الترمذي عن أنس : « أن رسول الله صلى‌الله‌عليه‌وسلم ، كان إذا حزبه أمر ، قال : « يا حي يا قيوم ، برحمتك أستغيث ». وفيه عن أبي هريرة : « أن النبي صلى‌الله‌عليه‌وسلم ، كان إذا أهمه الامر : رفع طرفه إلى السماء ، فقال : سبحان الله العظيم. وإذا اجتهد في الدعاء ، قال : يا حي يا قيوم ».
المكروب اللهم		وفي سنن أبي داود ، عن أبي بكر الصديق ، أن رسول الله صلى‌الله‌عليه‌وسلم ، قال : « دعوات المكروب : اللهم رحمتك أرجو ، فلا تكلني إلى نفسي طرفة عين ، وأصلح لي شأني كله ، لا إله إلا أنت . »
هم حزن		وفي مسند الإمام أحمد عن ابن مسعود ، عن النبي صلى‌الله‌عليه‌وسلم ، قال : « ما أصاب عبدا هم ولا حزن . فقال : اللهم إني عبدك (ابن عبدك) (١) ابن أمتك ، ناصيتي بيدك ، ماض في حكمك ، عدل في قضاؤك ، أسألك بكل اسم هو لك ، سميت به نفسك ، أو أنزلته في كتابك ، أو علمته أحدا من خلقك ، أو استأثرت به في علم الغيب عندك ، أن تجعل القرآن العظيم ربيع قلبي ، ونور صدري ، وجلاء حزني ، وذهاب همي. . إلا أذهب الله حزنه وهمه ، وأبدله مكانه فرحا »

73

	مكروب	وفى الترمذي عن سعد بن أبي وقاص ، قال : قال رسول الله صلى الله عليه وسلم : « دعوة ذي النون إذا دعا به وهو في بطن الحوت . : (لا إله إلا أنت سبحانك إني كنت من الظالمين). لم يدع بها رجل مسلم في شئ قط ، إلا استجيب له ». وفى رواية : « إني لاعلم كلمة لا يقولها مكروب إلا فرج الله عنه ، كلمة أخي يونس ».

Appendix Q: The samples queries that have been tested

#	Query
1.	الحجامة
2.	الحث على المداواة
3.	علاج الحمى
4.	أمراض تعالج بالحناء
5.	التداوي بأمر الله
6.	فوائد العسل
7.	الأجرة على الحجامة
8.	علاج الصداع
9.	نهي سب الحمى
10.	علاج الالتهاب الرئوي
11.	أهمية السواك
12.	نهي تعذيب الأولاد
13.	الرقية من الوجع
14.	مداواة روحانية
15.	الوقاية من السحر
16.	الأدوية الوقائية
17.	أمراض الجسم
18.	العلاج بالماء
19.	أنواع الأدوية الطبيعية
20.	تقرحات الجلد

75

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Appendix Q1: the full list of queries

No.	The Keywords
1.	هل كل داء له دواء
2.	هل كل مرض له علاج
3.	الأمر بالتداوي / بالعلاج
4.	أسئلة الأعراب
5.	المرض الذي ليس له علاج
6.	الداء الذي ليس له دواء
7.	الداء والدواء من عند الله
8.	الرقية من القدر
9.	التداوي بأمر الله
10.	علاج الحمى
11.	العلاج بالماء
12.	الحمى
13.	كيفية علاج الحمى
14.	الاغتسال من الحمى
15.	صب الماء على الرأس
16.	سب الحمى
17.	النهي عن سب الحمى
18.	الحمى تكفر الذنوب
19.	فوائد العسل
20.	علاج الإسهال
21.	أمراض البطن
22.	التوكل على الله في العلاج
23.	الشفاءان
24.	فوائد العسل
25.	العلاج بالقرآن
26.	جراح رسول الله صلى الله عليه وسلم في أحد
27.	العلاج بالكي
28.	أنواع الأدوية / العلاجات
29.	النهي عن الكي
30.	فوائد الحجامة
31.	الحث / الحض / الأمر بالحجامة
32.	هل احتجم النبي عليه الصلاة والسلام

76

حجامة النبي عليه الصلاة والسلام	33.
الأجرة على الحجامة	34.
فضل / الحث / الأمر / مدح الحجامة	35.
من حجم النبي صلى الله عليه وسلم	36.
هل ذكرت الملائكة الحجامة؟	37.
أيام / أوقات الحجامة	38.
متى نحتجم / تكون الحجامة	39.
فوائد المشي	40.
علاج الصداع	41.
فوائد الحناء	42.
فوائد الحجامة	43.
علاج الصداع / ألم / وجع الرأس	44.
علاج ألم / وجع الرجلين / القدمين	45.
فوائد / العلاج بالحناء	46.
علاج الجروح	47.
القرحة / التقرحات / تقرحات الجلد	48.
فوائد / التداوي بالحناء	49.
فضل / مدح / الأمر / فوائد الحجامة	50.
القسط البحري / العود الهندي	51.
علاج أمراض الحلق	52.
النهي عن وخز حلق الصبي	53.
فوائد العود الهندي	54.
علاج الالتهاب الرئوي	55.
علاج التهاب الحلق	56.
التهاب الأنف	57.
علاج الأنف / التهابات الأنف	58.
فوائد العود الهندي	59.
النهي عن تعذيب الأولاد / الصبيان في العلاج	60.
علاج أمراض القلب والصدر	61.
فوائد التمر	62.
كيفية التداوي بالتمر	63.
الوقاية من السم	64.
الوقاية من السحر	65.
فوائد التمر	66.

77

تمر المدينة	67.
الأدوية الوقائية	68.
أمراض الجسم	69.
تقرحات الجلد	70.

Appendix Q2: Include a set of Keywords that have been implemented with the recommendations
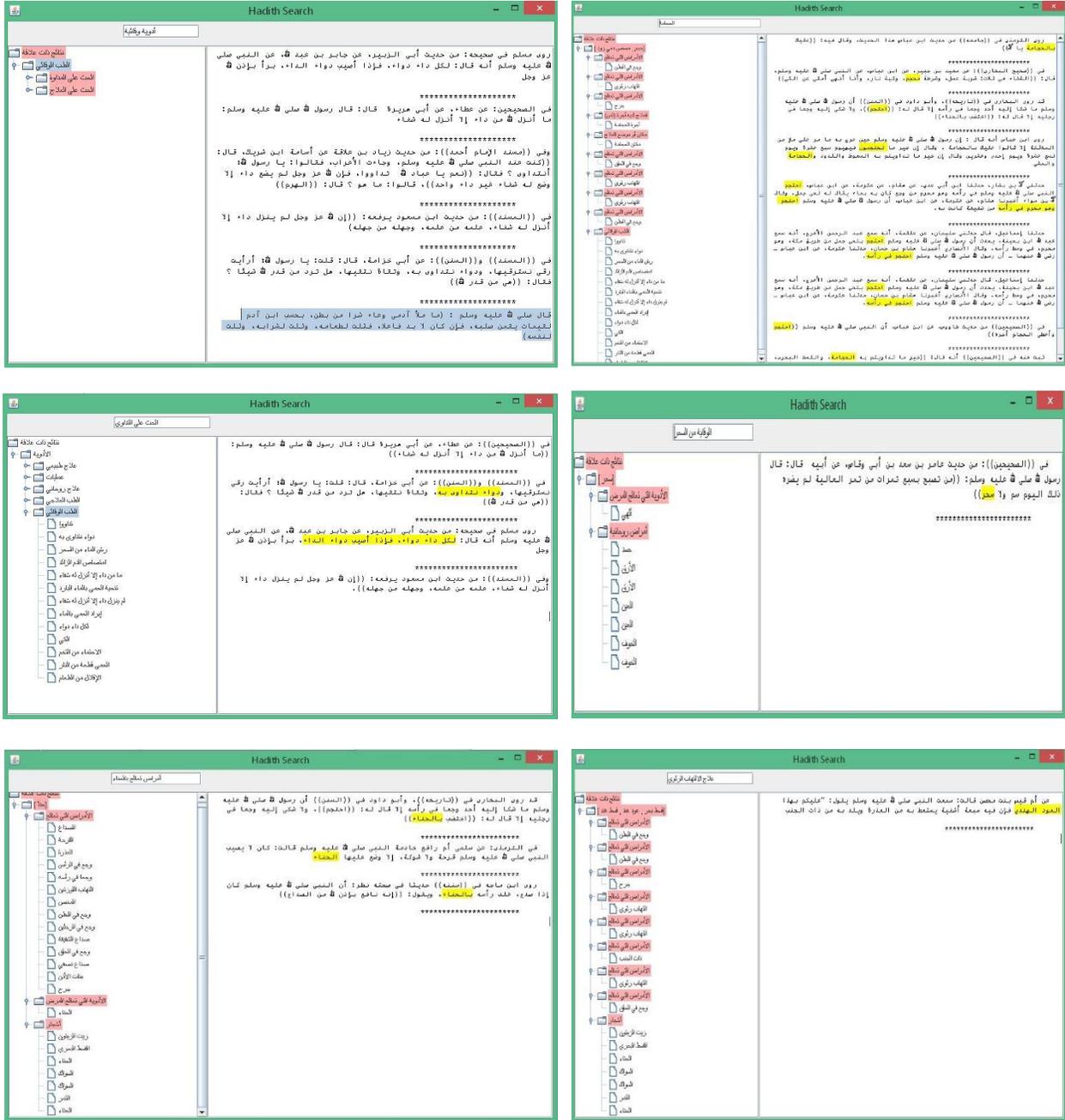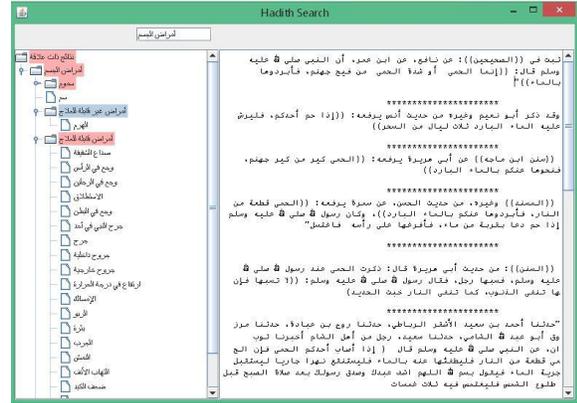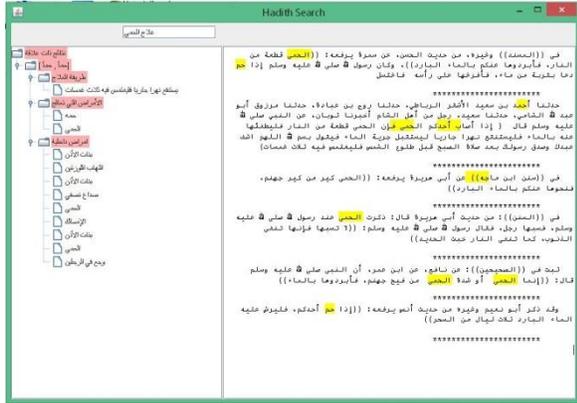
Appendix E: Compute recall, precision and Mean Average Precision

To explain how we compute recall, precision and mean average precision for any query, we give the following examples: Assume that a user is looking for the diseases treated with henna by entering the following keywords **"أمراض تعالج بالحناء؟"** in Search User Interface as shown in figure 1
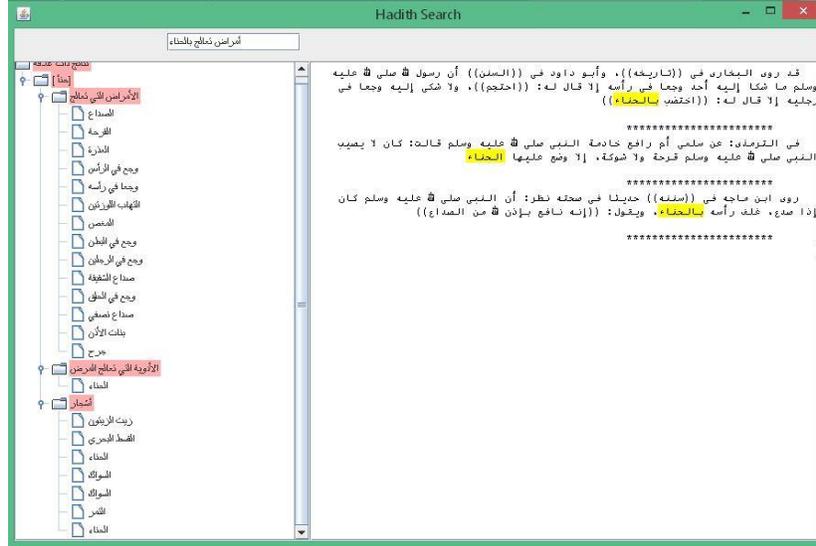

Fique 1: Snapshot from search interface to implement the query

Table 1 gives a list of expected relevant hadiths (expected Answer) for query in the case of query execution

	Relevant hadiths for query: "أمراض تعالج بالحناء"
1	قد روى البخارى فى ((تاريخه))، وأبو داود فى ((السنن)) أن رسول الله صلى الله عليه وسلم ما شكا إليه أحد وجعا فى رأسه إلا قال له: ((احتجم))، ولا شكى إليه وجعا فى رجليه إلا قال له: ((اختضب بالحناء))
2	روى ابن ماجه فى ((سننه)) حديثا فى صحته نظر: أن النبى صلى الله عليه وسلم كان إذا صدع، غلف رأسه بالحناء، ويقول: ((إنه نافع بإذن الله من الصداع))
3	فى الترمذى: عن سلمى أم رافع خادمة النبى صلى الله عليه وسلم قالت: كان لا يصيب النبى صلى الله عليه وسلم قرحة ولا شوكة، إلا وضع عليها الحناء

Table 1: Relevant hadiths for query

Based on relevant hadiths and returned Hadiths we have calculated average recall for each query as following:

$$\text{Precision} = \frac{number\ of\ correctly\ retrieved\ questions}{orrectly\ retrieved\ results + non-correctly\ retrieved\ results} = 3/(3+1) = 0.75$$

$$\text{Recall} = \frac{number\ of\ correctly\ retrieved\ results}{correctly\ retrieved\ results + correctly\ non-retrieved\ results} = 3/(3+0) = 1$$

As we can see in table 2 the evaluation shows the ranked list obtained by keyword-based retrieval, and the ranked-list obtained by ontology-based retrieval. In the same row we have rank position

81

information. We have Calculated average precision (AP) for each query where precision at each seen sign" ✔"means relevant hadith and Calculate the mean of the APs for all the hadiths.

Hadiths returned by two system for query: " أمراض تعالج بالحناء"					
Our System *ontology-based retrieval*		Precision		**ADL** *keyword-based retrieval*	Precision
✔	قد روى البخاري فى ((تاريخه))، وأبو داود فى ((السنن)) أن رسول الله صلى الله عليه وسلم ما شكا إليه أحد وجعا فى رأسه إلا قال له: ((احتجم))، ولا شكى إليه وجعا فى رجليه إلا قال له: ((اختضب بالحناء))	1/1	✗	في «المسند» وغيره: عنه صلى الله عليه وسلم أنه قال: «ما ملأ آدمي وعاء شرا من بطن، بحسب ابن آدم لقيمات يقمن صلبه، فإن كان لا بد فاعلا، فثلث لطعامه، وثلث لشرابه، وثلث لنفس»	0
✔	فى الترمذى: عن سلمى أم رافع خادمة النبي صلى الله عليه وسلم قالت: كان لا يصيب النبي صلى الله عليه وسلم قرحة ولا شوكة، إلا وضع عليها الحناء	2/2	✗	أنس رضي الله تعالى عنه: كان رسول الله صلى الله عليه وسلم يحتجم في الأخدعين والكاهل	0
✔	روى ابن ماجه فى ((سننه)) حديثا فى صحته نظر: أن النبي صلى الله عليه وسلم كان إذا صدع، غلف رأسه بالحناء، ويقول: ((إنه نافع بإذن الله من الصداع))	3/3	✗	وفي «سنن ابن ماجه» عن علي، نزل جبريل على النبي صلى الله عليه وسلم بحجامة الأخدعين والكاهل	0
✗	وفي «الصحيح» ، أنه قال في مرض موته: «وارأساه» وكان يعصب رأسه في مرضه، وعصب الرأس ينفع في وجع الشقيقة وغيرها من أوجاع الرأس	4/4	✔	روى ابن ماجه في «سننه» حديثا في صحته نظر : أن النبي صلى الله عليه وسلم كان إذا صدع، غلف رأسه بالحناء، ويقول: «إنه نافع بإذن الله من الصداع»	1/4
			✗	عن ابن عباس قال: خطبنا رسول الله صلى الله عليه وسلم، وقد عصب رأسه بعصابة.	1/5
			✗	وفي «الصحيح» ، أنه قال في مرض موته: «وارأساه» وكان يعصب رأسه في مرضه، وعصب الرأس ينفع في وجع الشقيقة وغيرها من أوجاع الرأس	1/6
			✔	وقد روى البخاري في «تاريخه» وأبو داود في «السنن» أن رسول الله صلى الله عليه وسلم ما شكى إليه أحد وجعا في رأسه إلا قال له: «احتجم» ، ولا شكى إليه وجعا في رجليه إلا قال له: «اختضب بالحناء»	2/7
			✔	في الترمذي: عن سلمى أم رافع خادمة النبي صلى الله عليه وسلم قالت: كان لا يصيب النبي صلى الله عليه وسلم قرحة ولا شوكة إلا وضع عليها الحناء	3/8
			✗	ثبت في «الصحيحين» من حديث عبد الله بن جعفر، قال: رأيت رسول الله صلى الله عليه وسلم يأكل الرطب بالقثاء	3/9
Average precision query = $(1.0 + 1.0 + 1.0)/3 = 1.0$			**Average precision query =** $(1/4 + 2/7 + 3/8)/3 = 0.31$		

Table 2: Result evaluation for query in two system

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