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EQPH2D : Techniques for Effective Query Processing In Heterogeneous Health Data

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ABSTRACT

Web Search engine is the well known term for an information retrieval (IR) framework. While analysts and engineers take a more extensive perspective of IR frameworks, patients or user consider them more as far as what they need the frameworks to do - to be specific inquiry the Web, or an intranet, or a database. All things considered patients would truly incline toward a discovering engine, as opposed to a web search engine. With the advancement of the Semantic Web, heterogeneous information has turned into the critical means for speaking to ideas in different areas of intrigue. In spite of the fact that the flow web search tools return comes about in view of keyword search and page ranking, human intervention is as yet required to choose the most relevant document. Subsequently to conquer the hindrances with the momentum look situation, this paper proposes search based on multiple ontologies to make information retrieval efficient. It rewrites the user query by adding semantic information, after consulting multiple ontologies. An essential inspiration for utilizing Heterogeneous Health Data is the guarantee they hold for incorporating data. Search is made conceivable by development of a various cosmology which frames the learning base. The goal is to user clients to perform inquiries without being familiar with ontology or concept hierarchies. In our proposed work, end user or patient needs just to enter the keywords to perform his specific search. This paper gives the thought, what are the calculations in information mining are appropriate, and furthermore break down how to algorithms the particular task in various applications for effective query processing results. We likewise propose a system to breaking down the healthcare support applications with receiving the appropriate procedure for future being used.

Keywords : Ontology, Semantic Web, Query Expansion, Reasoning, Information Retrieval.

I. INTRODUCTION

The field of Information Retrieval (IR) or effective query processing result to encourage the fast and relevant retrieval techniques are implementing with a specific end goal to various Healthcare applications at the season of developing significantly, in these Healthcare applications of query processing results will be extremely viable and necessary. At the point When the nonattendance of effective query process techniques in any reasonably applications, the applications will have take longer time for developing and not to be effective and it may not be large. However, finding relevant and useful information from large collections of data sources still poses some significant challenges. In this context, one of the substantial opportunities is to consider the semantics of the information using ontology. The utilization of ontology helps to overcome the limitations of keyword-based search and puts forward united of the motivations of the present work. In most achievements so far either make partial use of the full expressive page ranking, human intervention or are based on Boolean retrieval models, and therefore lack an appropriate ranking model which is needed for scaling up to massive information or relevant documents. Therefore we use power of associate ontology-based knowledge. In this paper we propose search based on multiple ontologies to create information retrieval economical. It rewrites the user query by adding semantic information, once consulting multiple ontologies.

The way toward of finding similar and associated ideas is one in all the premier trademark activities of attribute and, particularly, of medicinal services. . In fact, the order of surely well-known ideas (i.e. the correct distribution of the concepts in manageable classes, wherever every class contains solely ideas that are just like every other) introduces an abstraction layer over the fact that permits a lot of focused reasoning over experimental results and empirical observations. However, it's vital to note that the results that i'll describe later and also the contributions that stem from the work that I administrated are generalized into alternative areas of analysis with marginal effort.

A. **Limitations of existing search techniques**

With the growth in digital literature, it is increasingly difficult for users to have effective search and retrieval of relevant documents particularly in the health care domain. The top most pages returned by the search engines may not always be relevant. The medical domain offers controlled vocabularies and various tools for using them, such as the Unified Medical Language System (UMLS). UMLS Meta thesaurus has semantic information about various biomedical concepts, their semantic types and the relationships among them. In current standard web which is not supporting Semantic Web technology, information retrieval is essentially based on keyword-matching technologies. The fact that individuals use different terminology to mean the same thing presents a challenge – especially in the healthcare industry. Healthcare is one of the best represented subject areas on the Semantic Web right now. In Medline, textual query is converted into a set of representative concepts and are matched to the indexed documents according to the MeSH conceptual hierarchy. However such approaches do not take advantage of the hierarchical relations among the concepts. End users generally have to search for appropriate documents manually. Since visiting all the web-page and manually analyzing data is nearly impossible, the identification of relevant information becomes a crucial task. Search is one of the key motivations behind semantic web.

B. **Semantic Approaches**

Currently, as the web turn out to be more semantic, knowledge-based query expansion techniques become more accepted. It is harder for search engines to interpret user queries since, majority of them utilize popular or general terms. Semantic approaches have established to be very successful in improving search processes. Intelligence should be embedded in search systems to manage efficient search and presenting relevant information. This can be done by information retrieval techniques based on ontology. Ontologies are useful for disambiguation in natural language. Natural language processing (NLP) tools can help in automating the translation of the existent natural language descriptions into semantically equivalent ones.

C. **Role of ontologies**

The main advantage of using ontologies is the formalized semantics. Semantic web based search engines employ ontologies in a particular domain to enhance the performance of information retrieval process. The ability to deduce additional facts based on the axiomatic content of ontology can be important from a research point of view. A reasoner can automatically infer new statements without writing specific code. The use of ontologies in medicine is mainly focused on the representation of medical terminologies. Medical professionals use them to represent knowledge about symptoms and treatments of diseases. Pharmaceutical companies use them to represent information about drugs, dosages, and allergies. On the other hand, the decentralized nature of the web makes it difficult to construct a single ontology. Although using a single ontology could make the task of integration and semantic interoperation easier, from the perspective of scalability, it is impractical to preserve global consistency with a single huge ontology. Therefore, integration of multiple ontologies is one of the key technologies that need to be developed for the Semantic Web. This paper proposes an **Effective Query Processing in Heterogeneous Health Data** (**EQPH2D**) to overcome this problem.

D. **Objective**

An important motivation for using ontologies is the guarantee they hold for integrating information. Search is made possible by construction of a multiple ontology which forms the knowledge base. The objective is to enable users to perform queries without having to be familiar with ontology or concept hierarchies. In our proposed work, end user needs only to enter the keywords to perform his specific search.

The purpose of this paper is to construct multiple ontologies and to develop an information extractor system that explores the utilization of semantic information to support more expressive queries. The orientation of this paper is to focus on refining the user queries i.e. include more relevant search terms in the query for improved retrieval results. For example, when users utilize irrelevant keywords, query expansion based on ontologies can improve retrieval accuracy by providing an intelligent information selection.

II. LITERATURE SURVEY

The advancement of successful retrieval techniques has been the core of IR research for over 30 years. The fundamental target of IR is the recovery of significant information. Clients like to post inquiries in their local languages, while generally questions in these human languages can't be precisely comprehended by PCs. Inquiries communicated by means of keywords are the minimum expressive one, since it is spoken to as an arrangement of terms with no unequivocal connection between them. A noticeable answer for these issues is to utilize ontology based data recovery.

The introduction of ontologies to enhance the capabilities of current search technologies has been depicted in the area of semantic-based technologies since the late nineties. Most methodologies utilize extensive lexical ontologies like WordNet since they are not domain specific. Although mapping of query keywords to WordNet synset is able to find the relations between the keyword, these are subjected to the limitations of lexical ontology. SIEU utilizes ontology as a learning base for the data recovery process in University domain. The Google results are reranked for giving the relevant links. Their approach can be utilized as a prototype to the developers and researchers who take a shot at semantic web information retrieval. A few applications get to the ontologies without respect to the heterogeneity and the scattering of the ontologies. To help such a demand, an efficient query processing over the distributed ontologies is essential. KAONP2P recommends the P2P-like design for question replying over dispersed ontologies.

Query evaluation is performed against the virtual ontology generated from the target ontology to which the query is issued and the semantic mapping between the target and the other ontologies. Jihyun Lee modelled a distributed query processing method considering models of the distributed ontology and the semantic mapping among distributed ontologies. Another significant phase that characterizes semantic search models is the manner in which the user expresses his request. In information retrieval systems the relevancy of search results depends on the user's ability to represent her information needs in a query. Natural language representation of query provides more information than the keyword-based approach since a linguistic analysis can be performed to mine syntactic information4. The semantic search requires knowledge about the data source schema and a user's proficiency with the syntax of the query language. Users cannot be expected to have an understanding of the knowledge structure nor mastering the formal query language construction. Along these lines it is significant to furnish users a method for communicating with the data particularly in natural language.

Query expansion is required because of the uncertainty of natural language. It improves information retrieval by extending the query with terms related to the original query terms. The different query expansion approaches include relevance feedback, corpus dependent knowledge models and corpus independent knowledge models. The simplest way to develop a query is to navigate the ontology along different relationships. Query expansion with synonyms or hypernyms has a limited effect on web information retrieval performance. Before ontology is utilized in term selection, it must be processed by reasoners to make implicit knowledge available. Reasoning is a mechanism used for answering queries over ontology classes and instances. Hence to overcome these limitations OWL-DL reasoner is used to compute explicit plus inferred equivalent classes for a concept in the query. These equivalent concepts are used as a basis for expansion. This paper hence addresses query expansion to include more relevant search terms in the query for enhanced retrieval results.

III. EQPH2D ARCHITECTURE

Multiple ontologies utilize the same description logic, even though the different vocabulary is utilized for representing the same concept. The objective is to create a collaborative system in which ontology co-operate with one another to answer questions about the information they have. Issues in interpreting a query from different ontologies incorporates

- ✓ User queried keyword must to be decoded into ontology-centric vocabulary.
- ✓ Query response may require the merging of concepts from multiple ontologies.
- ✓ It is not possible to determine in advance which ontologies will be significant to a particular query.

Ontologies in the same domain may have difference in the level of details. This poses additional challenges to choose the potential ontology that has the precise concept coverage. Ontology selection is the process of identifying one or more ontologies that satisfy certain criteria. These criteria can be related to topic coverage of the ontology. The actual process of inspecting whether ontology satisfies certain criteria is fundamentally an ontology evaluation task. In this approach ontology concepts are compared to a set of query terms that represent the domain. It first tries to determine ontologies that contain the given keyword. If no matches are found, it queries for the synonyms of the term and then for its hyponyms. The ontology selection process returns combinations of ontologies that jointly satisfy a certain information need. Whether a user query fits in the domain underlying ontology is a vital issue to ontology-based query rewriting. This paper assumes that the user queries are within a particular domain so that the ontologies can be directly utilized.

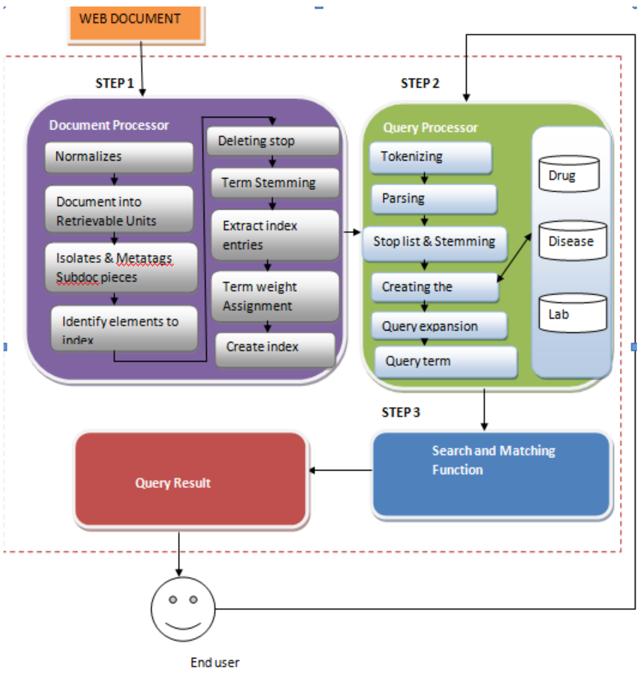

Figure 1. High level architecture

There is a user interface that allows the consumer to enter queries in natural language (NL). The natural language query is sent to NL Processing engine where in it is processed and converted to Description Logic (DL) query. Stop words are stripped off the queries. NL-DL query convertor includes different natural language processing tools such as the Stanford Parser for creating the parse tree while WordNet can be utilized to account for syntactic variability by finding synonymous words. The query processor's task is providing the user with the best answer to the question from the ontology. High level architecture of the model is shown in figure 1.

Query processor system parses the query and interprets the meaning of the end-user's query terms. This enables the construction of a meaningful query. Before any actual query re-formulation, the mapping between the vocabulary of the ontologies and the query is required. The mapping is indispensable for retrieval improvement using ontology based query approaches. The first step of the processor is to identify the set of ontologies likely to provide the information requested by the user. Hence it searches for near syntactic matches within the ontology indexes, utilizing lexically related words obtained from WordNet and from the ontologies, used as background knowledge source. It makes out the subject, predicate and object, which is used to create the DL query and runs it against the ontology to attempt to answer it from existing knowledge. Query expansion is a query reformulation technique that appends to query Q a (possibly empty) set of keywords {Ki, . . . , Ki+j} while retaining the semantics of Q, for some positive integers i andj. Query expansion does not mean to expand concepts implicit in a query but to supplement the keyword set by including terms more relevant to the concepts such that the query purpose becomes more concrete to search engines. The consequential query is the disjunction of the original query concept and the concepts intensifying it, formed using the Boolean operation OR. Few web users only employ advanced searching options, e.g., Boolean operators, in query formulation.

Query expansion has some intrinsic dangers like query drift, that is moving the query in a direction away from the user's intention. This occurs normally when the query is ambiguous. The concerns addressed with query expansion are the selection and the weighting of added search terms. Instead of choosing phrases that are similar to the query terms, they are expanded by adding those terms that are equivalent to the concept of the query. The semantically related keywords in the ontology are retrieved to form the refined query. Hence these refined queries have more semantic relevance. The refined queries are sent to Google search API which fetches the web links related to the user query. The result(s) are returned to the end user. The log details of the processed query are stored in log file for future reference. There are several tools available for developing the ontologies like OntoEdit, WebODE and Protege. In the proposed work, Protege is used as the tool for developing ontology. Protégé allows the support of web ontology language (OWL) and export Protégé ontologies into a variety of other formats such as RDF/S and XML

Schema. Besides that, it has plug-in, which include ontology visualization (OntoViz) and OntoGraph, and interfaces with rule engines and formalisms such as SWRL (Semantic Web Rule Language)

A. WordNet

Adding WordNet for more specific queries in Google, more terms need to be added to the Google query string, other than those given by users when searching for ontologies. These extra query terms can be obtained from WordNet. The use of WordNet has two benefits; while specifying a more specific query to Google; it also allows the system to disambiguate any terms provided by the user which may have more than one meaning (e.g. Cancer as a disease rather than a zodiac sign).

IV. ALGORITHMS

A. **Selection Algorithms**

The Select operation must search the data files for records which satisfies the selection criteria. Some examples of simple i.e. one attributes selection algorithms are as follows:

1) Linear search: Here each and every record from the files is read and compared with the selection criteria. For these searching the execution cost for non-key attribute is bk, where bk contains number of blocks in the file which represents the relations r.The average cost of key-attribute is bk/2, with a worst case of bk.

2) Binary search: Binary search equality is performed on a primary key attribute which is having a worst-case cost of [log (bk)]. This is most efficient than linear search which is utilized for large number of data records.

3) Search using a primary index on equality: An equality comparison with B+-index on a key attribute will have a worst -case cost of height of the tree and also includes retrieving the record from the data file. An equality comparison on a non-key attribute will be same except that to meet the condition we need multiple records; in that case, we need to add the number of blocks which are containing the records to the cost.

4) Primary index on comparison using search:
When the comparison operators (<,>) are used to retrieve different multiple records from a file which are sorted by search attribute, the first record which is satisfying the condition is located and the total blocks before (<,) or after (>,) is locating the first record and the cost is added to it.

B. **Partial Index**

PI reduces the time cost of on-line query processing by pruning the candidate documents that are not promising and skipping the operations that make little contribution to similarity scores. Extensive experiments through comparison with LSA have been done, which demonstrate the efficiency and effectiveness of our proposed algorithm.

We next introduce an index, called partial index, for reducing the searching space of LSA. The partial index used for storing the partial similarity scores in order to reduce the candidate size and optimize similarity computation. The spiritual of the partial index is similar to the pruning index proposed
An example of partial index is shown as Figure 2,

where TermID depicts the term ID, DocID denotes document ID, PartialSim denotes the partial similarity, and the two-tuple <DocID, PartialSim> describes that the partial similarity between a document DocID and a term TermID that the document DocID belongs to is PartialSim. For example, in the set of "7632", the <1780, 0.004> describes that the partial similarity between document "1780" and term "7632" is 0.004, and in the set of "1780", the <6110, 0.015> describes that the partial similarity between document "6110" and term "1780" is 0.015.

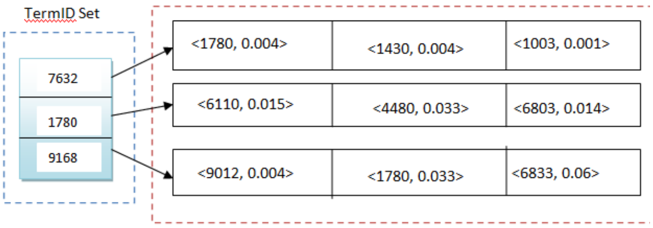

Figure 2. Example of partial index

1) Partial Index Building Algorithm:

Algorithm 1 Algorithm for building partial index.

Input:

Matrix V

r, document set D, threshold θ;

Output:

Partial index I_θ;

1: Initialize I_θ as ∅

2: **for** $t_j \in \{t_j \,||\, V_r^T\ (t_j\ :)| \neq 0\}$**do**

3: $I_{\theta(}(t_j) \leftarrow \emptyset$

4: $I_\theta \leftarrow I_\theta \cup \{I_\theta(t_j)\}$;

5: **for** $d_i\ \epsilon D$ **do**

6: PartialSim$_\theta\,(d_i,\ t_j) \leftarrow \frac{V_r^T(j,i)}{\sqrt{\sum_j \left(V_r^T(i,j)\right)2}}$

7: if PartialSim$_\theta\,(d_i,\ t_j) \geq\ \theta$ ***then***

8:$I_\theta(t_j) \cup \{< d_i, PartialSim\theta(d_i, t_j) >\}$;

9***: end if***

10: **end for**

11: **end for**

12: **return** I_θ;

V. ONTOLOGIES IN EQPH2D

Common diseases and their symptoms are incorporated in disease ontology. These information were collected from various resources like Bioportal and Open Biomedical Ontologies Foundary. Disease Ontology (DO) and UMLS vocabularies (SNOMED-CT, NCI, MeSH, and ICD-9) were used as controlled vocabulary for disease names. Various drugs, their usage and side effects are included in drug ontology whereas common tests done for different diseases are dealt in laboratory ontology. Figure 3 presents the some of the drugs used in children from drug ontology using OWLViz tool in Protégé 4.3. OWLViz tool shows the graphical representation of the class subsumption hierarchy. Axioms can be used for defining complex relationships or obtaining new information. SWRL adds rules to OWL DL and they provide more expressive power to Description Logic. Some of the sample rules from laboratory ontology are given in figure 3.

Patient(?p),hasDisease(?p,Pancreatic_Disorder)→ doTest(?p,Amylase_Test)
Patient(?p),hasDisease(?p,Diabetes)→ doTest(?p,HbAIC)
Patient(?p),hasDisease(?p,Bristle_ Asthma),hasSymptom(?p,fever)→doTest(?p,Blood_Test)
Patient(?p),hasSymptom(?p,anemia)→doTest(?p,CBC)
Patient(?p),hasSymptom(?p,inflammation),hasSymptom(?p,muscle_pPain)→doTest(?p,ESR)
Patient(?p),hasSymptom(?p,mononucleosis)→doTest(?p,Mono)
Patient(?p),hasDisease(?p, Hypothyroidism),hasSymptom(?p,thyroid_disorder)→ doTest(?p,TSH)
Patient(?p),hasSymptom(?p,UTI)→doTest(?p,Urine_Culture)
Patient(?p),hasSymptom(?p,blood_in_urine),hasSymptom(?p,abdominal_pain)→ doTest(?p,Urinalysis)
Patient(?p),hasDisease(?p,Diabetes),hasSymptom(?p,hypertension),hasSymptom(?p,kidney_disorder)→
doTest(?p,Microalbumin)

Figure 3: Some SWRL rules in Laboratory ontology

Table 1 gives the restrictions used in description logic and the corresponding Manchester syntax. Keyword "some" or existential restrictions denotes classes of individuals that participate in at least one relationship along a specified property to individuals that are members of a specified class. "Only" or universal restriction is used to describe classes of individuals that for a given property only have relationships along this property to individuals that are members of a specified class.

Table 1. Manchester Syntax Restrictions

Description Logic	**Manchester Syntax Restrictions**
Some	∃
Value	∀
Only	∋
Min	≥
exactly	=
Max	≤
Boolean Concept Constructors — And or Not	

Table 2. Samples of ontology selection Keywords

Disease Ontology	**Drug Ontology**	**Lab Ontology**
Complicated by	DbXref	Diagnoses
Cure	Disease	Test
Occurs with	Drug	X ray
Results in	Overdose	Scan
Symptom	Medication	Result
Transmitted by	Potency	Screening
Treatment	Side effect	Normal range
Vital Signs	Therapy	Percentage deviation

Query reformulation can be abridged in three steps:

1) **Identify the key ontology concepts in the query:**
The input query keywords are used to choose the most related group and the domain ontology associated with selected group to identify the associated concepts for the expansion of the user query. So the choice of ontology is based on query phrases. A sample of ontology selection criteria is given in the table 2 and sample query is given in table 3.

2) **Concept expansion:**
Input query is semantically expanded in ontology based information retrieval. The phrase concepts are not split into single terms because single terms are likely to be semantically different than their associated phrase concepts (e.g. “sleep walking disorder”). Moreover expanding concepts by their superclass concepts is avoided because broader concepts are more likely to compromise precision and cause query drift. Hence the detected ontology term is expanded by its equivalent concept. For each identified ontology concept, estimate its weight using the log file created.

3) Aggregation of concepts:
Lists of expansion terms for each concept are merged into one final expansion list. The query is finalized by ORing the query term with the set of expansion terms obtained and then ANDing the query with the semantic type retrieved from UMLS thesaurus. Normally ORing the terms with its synonyms will not have considerable impact on the precision of top 10 results. ANDing semantic type of the query term with the expanded query increases the precision of the top 10 search results in most cases.

Table 3. Sample Query

Query	**# of ontology involved**	**Ontologies used**
What is Disease_X ?	Single	Disease
What are the preconditions for doing test_A?	Single	Laboratory
How can drug_X be used in the treatment of disease_Y?	Multiple	Disease and drug
How can test_U be used in the diagnosis of disease_V?	Multiple	Laboratory and disease
Causes and treatments of mental deterioration like Alzheimer?	Multiple	Disease, drug and laboratory

It is necessary that there should be better coordination between multiple ontologies. Multiple distributed
queries need to be generated from an original query to obtain results from dispersed ontologies. Some examples of query expansion are illustrated below.

Case 1: input with multiple query term.
Typically users submit short queries resulting in poor recall and precision. Moreover, the keyword queries that users submit are inherently ambiguous.

Some drug like Triall is ambiguous. Even if "drug triall" is given as the query term in Google, it shows the result of clinical drug trial instead of drug triall. But according to National library of medicine in RxNorm, triall has RxNorm 745619. When given to our

system it returns Chlorpheniramine (trade name) as query refining term, thus enhancing precision.

Case 2: input with phrase or a sentence.

The query "symptoms of liver failure because of paracetamol overdose" to Google search engine retrieves more than 160,000 pages that grasp both relevant and irrelevant pages. User is willing, typically, to look at solely a number of those pages. However most of the medical journals utilize the term acetaminophen ortylenol rather than the term paracetamol. once the query is given to our system (figure 4).it parses the input and identifies the key terms within the question, that once consulted with WordNet and ontologies, return Acetaminophen as equivalent term for paracetamol from drug ontology (figure 5).

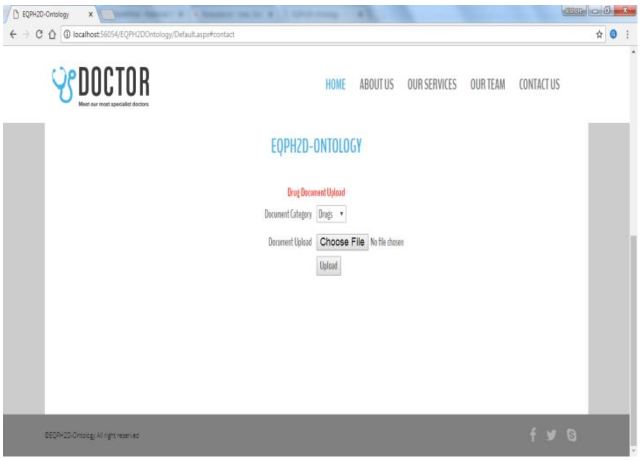

Figure 4. Drug Document Upload

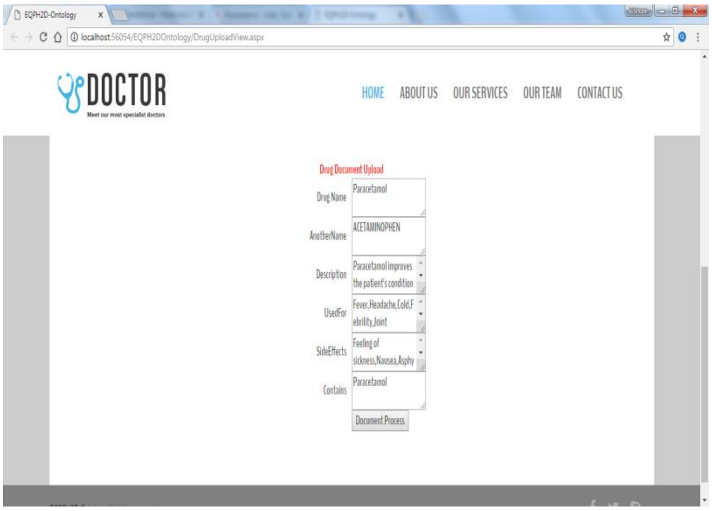

Figure 5. Drug Document Processing

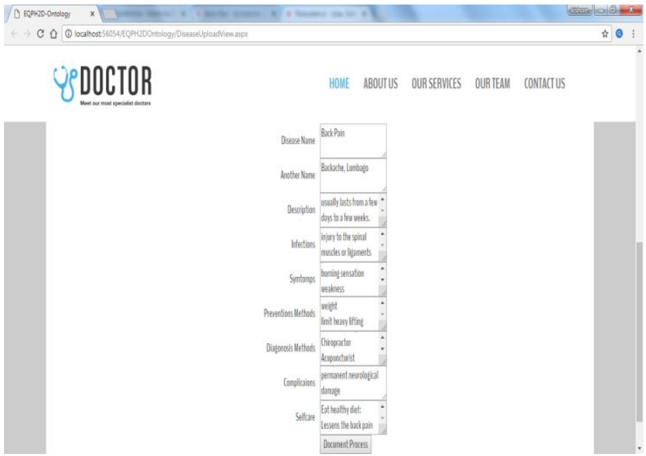

Figure 6. Disease Document Processing

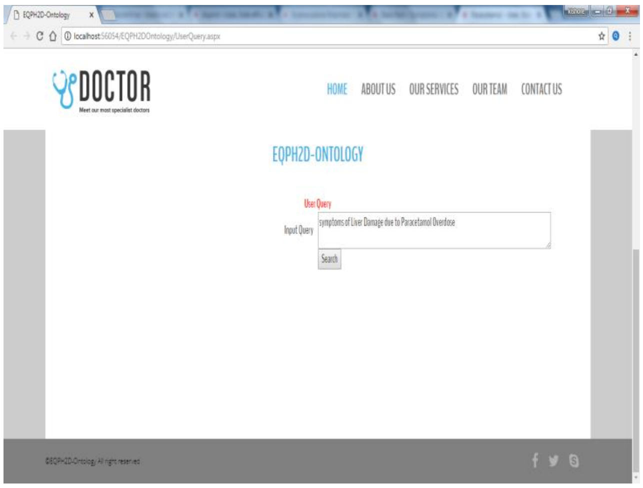

Figure 7. User Query input

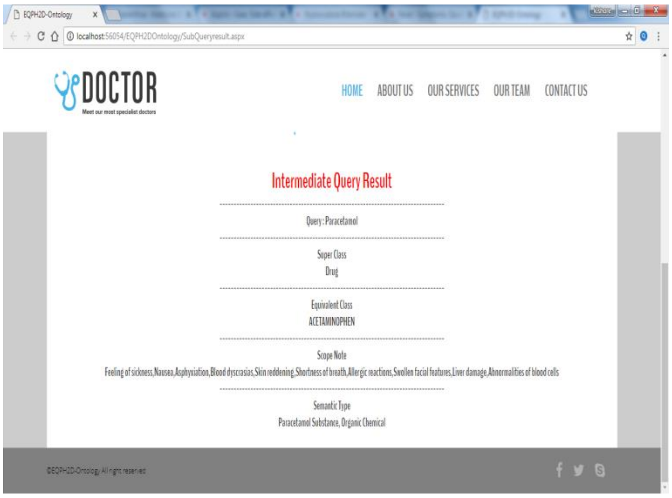

Figure 8. Intermediate Query Result

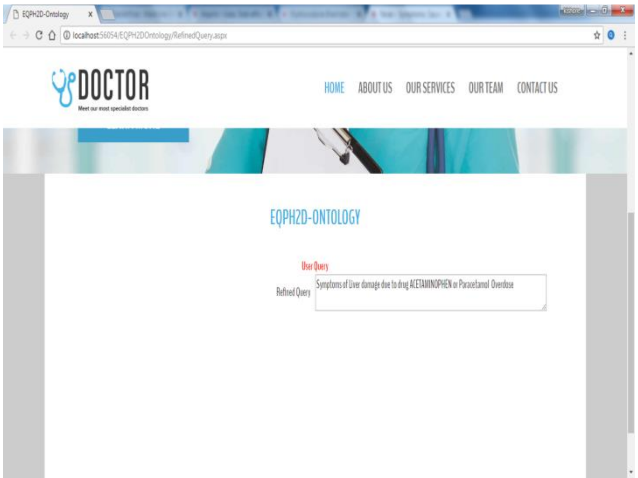

Figure 9. Refined Queries for Document Search

Generally, query expansion is acknowledged by adding new terms to the initial query using the OR operator to broaden a query as shown in figure 6. Semantic kind info for acetaminophen, T109 (Organic Chemical) and T121 (Pharmacologic Substance), is retrieved from UMLS vocabulary MeSH. This refined query is then issued on search engine through Google API to retrieve the search results. Unlike the convention search, this increased search result contains info from eMedicine world medical library, MedlinePlus medical encyclopedia and America national library of drugs within the top ten pages of result. Subsequently the power to retrieve top-ranked documents that are principally relevant is high. Consequently, query growth is primarily related to its potential to induce will increase in preciseness and recall.

Evaluation Measures:

Precision@k may be a measure for evaluating high k positions of a hierarchic list.

Precision k= $\frac{1}{k}\sum_{j=1}^{k} r_j$, where k = the truncation position, rj =1 if the document within the jth position is relevant and zero otherwise. Precision@10 measures the proportion of relevant documents among the highest 10 retrieved. This metric is especially essential for search engines, because most users will not browse beyond the first ten pages of results. Table 4 shows that exactness is increased once question is given through EQPH2D ontology

VI. CONCLUSION

This paper has given a numerous ontology query process approach and analyzed case studies on domain-specific ontology based mostly query expansion. Utilization of ontologies for information retrieval, in Specific their utilization inside the space of query expansion is introduced. Concept-based query expansion holding unique keywords yields extra entrancing and helpful results. The method of query Expansion that's based on ontologies and WordNet advantages short query statement over long statement. Query expansion makes little distinction in retrieval efficacy for long queries as they usually have a full description of the information required. Compound words add complexness to the query expansion, but more analysis experiments area unit desirable to check the effects of using ontology for query expansion. At last more research is printed for the exploit of metaphysics based generally information retrieval in Cloud.

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