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Development of a semantic search method for retrieving food related verses & concepts from the holy Quran using ontology

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Abstract

Qur'an is Allah (SWT)'s greatest miracle and is the source of all knowledge and information. As a Muslim, obligation is not only to recite the Qur'an but also it is important to gain knowledge from the Qur'an. Ontology is the best way to retrieve Quranic knowledge in a technical way. With the help of internet many search engines are found to discover information from Qur'an. But most of the search engines or information retrieval systems are keyword-based which can often lead to irrelevant results. To overcome this problem, semantic search is most useful in this case. The aim of research is to develop an ontological semantic based method to retrieve the food related verses and concepts from holy Qur'an by using natural language query. In this work, triplet extraction algorithm has been used for generating triple, the protege OWL editor 4.3 version used to create food ontology and the SPARQL Apache Jena fuseki server was used for querying. Quranic data are collected from English translation of the holy Qur'an.

Keywords Natural language query, Quranic ontology, SPARQL, Semantic search

Paper type Research paper

1. Introduction

The Qur'an is the perfect way of life in Islam. It is the bearer of all knowledge and information of all domains. The knowledge of Qur'an is scattered in various chapters, verses. It is the complete and best guideline to live one's life and seeking Allah's pleasure. Al-Qur'an consist of 30 divisions (Juz), 114 chapters (sura), 6236 verses (ayah), and less than 80,000 words (Ta'a, Abed, & Ahmad, 2017). Islamic knowledge and information can be gained through the understanding and analyzing of Al Qur'an. Qur'an contains all the domains of life and food is one of the biggest domains of the Qur'an. As Qur'an is the reservoir of different various domains, this research work mainly focuses on the concepts of food domain of Quran. The concept of food domain that has not yet been researched in details. The fastest way to get information about Quranic food is to able to search it and get instant results based on the user query. Therefore, the

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purpose of this work is to develop a semantic web technology application for retrieving food related concept from the holy Qur'an where users can search for any food related topic from the Qur'an using natural language query.

The web searching systems that are based on keyword search have low precision, most of the time, keyword-based search leads inaccurate and irrelevant result dealing with the ambiguity of natural language (Yauri, Kadir, Azman, & Murad, 2014). For solving the existing web searching problem semantic web technology was introduced by the World Wide Web Consortium(W3C) and in this work semantic search approach is used so that semantic search is basically user friendly and more efficient in case of information retrieval system. This proposed work is basically based on the ontological technique which is the technical way of knowledge representation of a collection of objects and their relationships. Ontological technique is the best suitable approach for extracting information from a certain domain. So, for extracting about food related knowledge, in this work ontological approach is used to create food ontology. In this research work, the methodology consists of two phases. First phase is to generate triple from user query. For generating triple from user query triplet extraction algorithm is used. The second phase is to design ontology by using protege ontology editor 4.3 version based on RDF/OWL language designing the necessary system for the construction of a unified and integrated ontology for the food domain referred to in the Holy Quran. After reviewing literatures, the following terms and topics are found which are related with this proposed work. So, briefly describes these terms in the following.

Ontology

Ontology is a complete understanding of a series of data and ideas about a specific area and identifies how these concepts are interlinked. Ontology has several features such as classes, sub classes, object property, data property, individual or instances etc. Ontology is created on the basis of RDF query language. It plays an important role in semantic web, information extraction, artificial intelligence, natural language processing, and knowledge management etc. In this work, a food ontology is created which covers the food domain of Qur'an by using protege ontology editor 4.3 version.

Stanford CoreNLP Parser

CoreNLP is one of the most important toolkits for natural language processing which is implemented in java language and support several programming languages such as python, C# etc. CoreNLP parser enables

users to derive lingual annotations including token and sentence splitting, parts of speech tagging, named entities recognition (NER), numeric and time values, dependency parsing and constituency parses, sentiment analysis, quote attributions, and relations. Stanford CoreNLP makes text data analysis easier and more efficient. Its support four languages such as Arabic, Chinese, German, French, Spanish. In this work, CoreNLP parser is used to generate the accurate parse tree of the user query which will be used in the triplet extraction algorithm as input.

Natural language query

Natural language processing (NLP) enables software to "recognize" typical human language or written material as input and, depending on the application, respond to it.

Description of triplet extraction algorithm

During the literature review phases, reviewed various research papers and found two algorithms such as multi liaison algorithm (Jivani, Shingala, & Virparia, 2011) and triplet extraction algorithm (Rusu, Dali, Fortuna, Grobelnik, & Mladenic, 2007) which are able to generate triple from sentences. Among these algorithms multi liaison algorithm generates multiple triple and multiple relations which is not consistent with this proposed thesis. Because the ontology dictionary has created based on the single triple and relation. But triplet extraction algorithm (Rusli, Ridzuan, Zaki, Sayuti, & Salam, 2018) can generate single triple from user query and for that reason this algorithm is used in this argument.

Triplet extraction algorithm

According to triplet extraction algorithm (Rusli, Ridzuan, Zaki, Sayuti, & Salam, 2018) the user query is divided into three sub parse tree such as noun phrase or NP sub tree, verbal phrase or VP sub tree and full stop (.) or question mark(?) the root of tree will be S. For finding subject from the query the noun phrase sub tree is used as argument of EXTRACT_SUBJECT function. For this purpose, breadth first search is used and the first descendant of NP sub tree that is a noun is selected as subject. After getting subject it is used as argument of EXTRACT-ATTRIBUTES function to test whether the subject has any attribute. For finding predicate from the user query the VP sub tree is used as argument of EXTRACT-PREDICATE function. The deepest verb descendant of the verb phrase is selected as predicate of query. After getting predicate it is used as argument of EXTRACT-ATTRIBUTES function to test whether the predicate has any

attribute. For searching object from the user query three different sub tree is used as argument of EXTRACT-OBJECT function. All siblings of the VP sub tree containing the predicate. The sub trees are PP (prepositional phrase), NP (noun phrase) and ADJP (adjective phrase). In NP and PP, we search for the first noun, while in ADJP we find the first adjective. Getting object, it is used as argument of EXTRACT-ATTRIBUTES function to test whether the object has any attribute value.

Resource description framework (RDF) for query language
The Resource Description Framework (RDF) is a W3C family and a standard web-based data exchange model. It is a framework to represent statements in form of triple. The triple consists of three components, the subject, the predicate and the object. A triple is a single edge that connects two nodes. It identifies the binary relationship between the subject and the object through the predicate. Predicate of a triple is basically presenting the object property of ontology. There are some common serialization formats are used as RDF technology such as, turtle, N-triples, JSONLD, N3 and RDF/XML format.
For example: **Allah sent provision**

Here 'Allah' is the subject 'sent' is predicate, and the object is 'provisions'. To retrieve information about what provisions Allah (SWT) are sent for the followers of Moses(A) above triple is used as RDF language.

Resource Description Framework Schema (RDFS) for data modeling
RDF Schema or Resource Description Framework Schema is commonly known as RDFS. It covers basic data modeling vocabulary for RDF data. This is an extended version of foundational RDF lexicon. Hierarchies of classes and properties are created by using RDFS. It contains basically two types of vocabulary such as classes and properties. Among classes the following components are used such as resources, class, literal, data type. Among properties the following components are used as RDFS vocabulary such as domain, ranges, comment, label, sub class of, sub property of etc.

Semantic search used to improve search accuracy
The term "semantic" explains the meaning of a something. In others words, Semantics is described as the analysis of words, the research of the definition of words and the analyze of the logic of words. Semantic search improves search accuracy by evaluating searcher intent with effective understanding,

concept matching, synonyms, and natural language algorithms, etc. Semantic search has the capacity to decide which you signify when you type a query and then return search results that do not necessarily match the entries or words you entered in your query. This research proposed a semantic technique that aims to overcome the problems associated with traditional searching for keywords in order to improve the search ability of Quranic information. Most people rely on search engines to extract and express knowledge about particular Quran fields from a variety of resources. All the results returned by search engines are not always relevant and accurate because most of search engines are keyword based. Moreover, it is difficult for a naive user to confirm that the results obtained are noteworthy to the user request. Therefore, Semantic web plays a major role in explaining the relevance of the search results. This semantic search method permits users to find verses and concepts semantically related to food found in the Qur'an and their associated relationships.

1.1. Problem statement

Qur'an is a large termination stage of information of various domains. There are many domains mentioned in the Qur'an which are not yet investigated or researched elaborately, especially food domain. For this reason, users can not find any dependable source from which they can obtain knowledge about food related concepts from holy Qur'an. When users search any specific topic from the Qur'an by using internet or any search engines, the returned results by search engines are not fully accurate because most of the search engines based on keyword method. Furthermore, when users input a natural language query on any search engines the users have to disappoint with the returned result. As a result, when users search a specific relation between two or more object, they don't find expected result. Because these engines returns result based on keyword. For solving this problem, this work proposed a semantic search method by which the user can find the specific answer and relation among the concept based on their own query. Ontology is one of the most suitable approaches to retrieve information or concept from the holy Qur'an. It is a platform to represent a collection of facts and objects and their relationship. So, this research proposed the development of ontological semantic search method for the food domain of holy Qur'an Qur'an using natural language query.

1.2. Research objectives

a. To develop an ontological semantic based method so that user can search food related verses and concept from holy Quran easily using

natural language query.

b. To generate triple (which consist of subject, predicate and object) from user query by using Triplet Extraction algorithm for creating SPARQL query and to integrate the food ontology with the Apache Jena Fuseki server so that SPARQL query can efficiently search the expected result.

c. To run the SPARQL query in the Apache Jena Fuseki server. When the SPARQL query is run, it searches the verses or concept according to the relevant user query semantically from the food ontology dictionary and then presents the expected result.

The remaining sections of this article are organized as follows: section 2 discusses the review of literature, section 3 discusses the suggested system's approach, section 4 provides the experimental results and discussion, and section 5 concludes.

2. Review of previous works

There has been much research done in the field of ontology and the mechanism of retrieval of information. In Sadi, et al. (2016) and Khan, et al. (2017) implemented an ontological model of concepts related to nature described in the Quranic verses, which are spread over different chapters. A search method based on ontology to answer related queries in the Qur'an using recall and precision measurements is proposed in Safee, et al. (2018). In this paper they apply both semantic and keyword search which simply called hybrid search method. Developed a Quranic ontology that represents the meaning of words and their relations by using Quranic ontology based semantic search approach (Beirade, Azzoune, & Zegour, 2021). In (Khan, Saqlain, Shoaib, & Sher, 2013), proposed an ontology for extracting the concept of birds and animals mentioned in the holy Qur'an using semantic search. A system that helps the end user to query and explore the Qur'an ontology and their working domain noun concepts identified in Al-Qur'an (Yauri, Kadir, Azman, & Murad, 2013). A semantic based Quranic ontology is done using natural language query where they included the historical concepts of Quran in their domain (Yauri, Kadir, Azman, & Murad, 2014). To implement their methodology n-gram maximum likelihood estimate model and n-gram maximum entropy model are used. Ontology-based keyword pattern matching approach is proposed where they develop a search strategy to retrieve authentic and relevant verses in Al-Qur'an using ontology (Ta'a, Abed, Ali, & Ahmad, 2016). Identifying relevant experimental studies from various modern electronic data sources (SLR) (Rusli, Ridzuan, Zaki,

Sayuti, & Salam, 2018). Proposed an ontological model for Arabic language vocabulary to retrieve the concepts of place nouns from holly Qur'an (Alromima, Moawad, Elgohary, & Aref, 2015). In (Yauri, Kadir, Azman, & Murad, 2013; Yauri, Kadir, Azman, & Murad, 2012), an ontology lexicon semantic search system in the Qur'an domain. They run 40 queries and most of the queries successfully return the result. Developed theme-based keyword pattern matching approach that aided the search for Al-Qur'an ontology and the retrieval of Al-Qur'an knowledge (Ta'a, Abed, & Ahmad, 2017). In Shmeisani, Tartir, Al-Na'ssaan, and Naji (2014) proposed a semantic approach to represent Quranic content and interpret user questions written in Arabic. Salat domain is included in (Islam & Laeeq, 2019) where an ontological application is developed that can answer salat related queries from user. An algorithm is implemented in Rusu, Dali, Fortuna, Grobelnik, and Mladenic (2007) that can generate triple by using open NLP, Stanford parser, link parser and mini par parser. A multi liaison algorithm is implemented in (Jivani, Shingala, & Virparia, 2011) which can generate multiple triple and multiple relationship from user query. Proposed a ontological based and pattern based application in Ismail, Rahman, Bakar, and Makhtar (2018) which retrieve Hajj related concept and verse from holy Qur'an using shallow NLP.

3. Methodology of the proposed system

This research aims to develop a semantic search method for retrieving food related verses and concepts from holy Quran using natural language query. To attain the research goal this research involves the following steps.

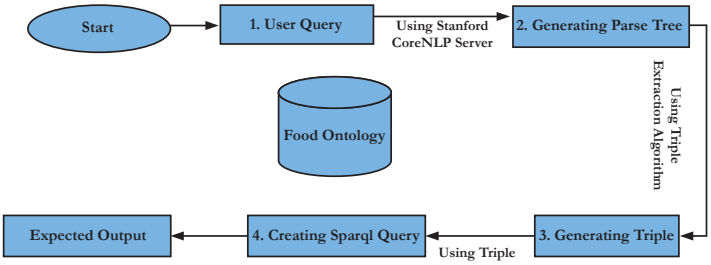

Fig 1: Outline of the Recommended Methodology

Firstly, user have to start the program, then user have to give input a question using natural language query. For example, "What are the foods Allah forbade for human in Qur'an". The next step is to generate parse tree from user query. For generating parse tree from user query Stanford Core

NLP server is used. Then the next step is to generate triple from parse tree. For generating triple from parse tree Triplet Extraction Algorithm is used. Then the SPARQL query is created by using triple in the next step. When the SPARQL query is run it searches the expected result in the food ontology dictionary. If the SPARQL query is matched with any result then the expected output is return in the Apache Jena Fuseki server.

3.1. Generating parse tree from user query by using Stanford core NLP

To generate parse tree from user queries there are four types of parse tree generator can be used Stanford parser, Link parser, Open NLP parser and Minipar parser. In Rusu, Dali, Fortuna, Grobelnik, and Mladenic (2007) the performance of these parser are defined as like as, Stanford parser can generate 118 triples within 178.1 seconds. The sentences parsed by the Open NLP parser in 29.95 seconds and generates 168 triples. Link parser can generate 110 triples within 271 seconds. Sentences have been parsed by Mini par in 104 seconds and generates 153 triples. Among these four parsers Open NLP has the highest performance which is best suitable in the C# platform. Since the triplet extraction algorithm is implemented in python, Stanford CoreNLP parser has been used instead of Open NLP where two parsers give the same performance.

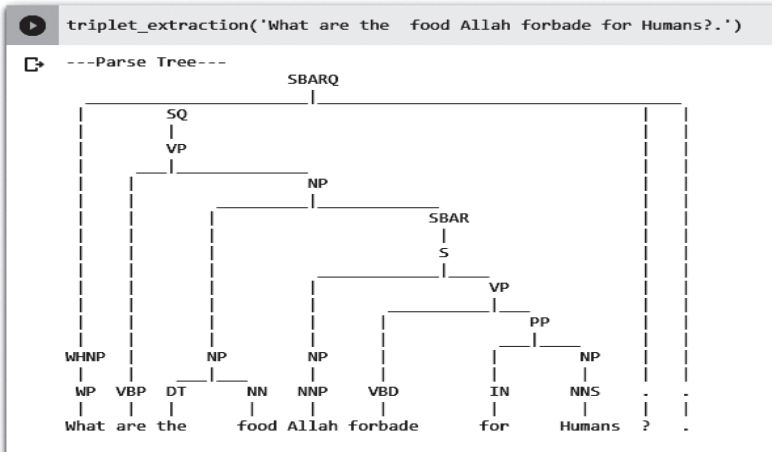

Fig 2: Generating Parse Trees from User Query by Using Stanford CoreNLP Parser

3.2. Generating triple from parse tree by using triplet extraction algorithm

The next step is to generate triple from parse tree. The triples are generated by the use of triplet extraction algorithm.

Triplet Extraction Algorithm

```
function TRIPLET-EXTRACTION(sentence) returns a solution, or failure
result ← EXTRACT-SUBJECT(NP_sub-tree)
  EXTRACT-PREDICATE(VP_sub-tree)
  EXTRACT-OBJECT(VP_siblings)
if result ≠ failure then return result
else return failure
function EXTRACT-ATTRIBUTES(word) returns a solution, or failure
// search among the word's siblings
if adjective(word) result ← all RB siblings
else if noun(word)
result ← all DT, PRP$, POS, JJ, CD, ADJP, QP, NP siblings.
else if verb(word)
result ← all ADVP siblings
// search among the word's uncles
if noun(word) or adjective(word)
if uncle = PP result ← uncle sub-tree
else if verb(word) and (uncle = verb)   result ← uncle sub-tree
if result ≠ failure then return result
else return failure.
function EXTRACT-SUBJECT(NP_sub-tree) returns a solution, or failure
subject ← first noun found in NP_sub-tree
Subject attributes ←EXTRACT-ATTRIBUTES(subject)
result ← subject    subject-attributes
if result ≠ failure then return result
else return failure.
function EXTRACT-PREDICATE(VP_sub-tree) returns a solution, or failure
predicate ← deepest verb found in VP_sub-tree
predicate-attributes ←EXTRACT-ATTRIBUTES(predicate)
result ← predicate    predicate-attributes
if result ≠ failure then return result
else return failure.
function EXTRACT-OBJECT(VP_sub-tree) returns a solution, or failure
siblings ← find NP, PP and ADJP siblings of VP_sub-tree.
for each value in siblings do
if value = NP or PP       object ← first noun in value
else      object ← first adjective in value
Object-attributes ←EXTRACT-ATTRIBUTES(object)
result ← object    object-attributes
if result ≠ failure then return result
else return failure.
```

The triplet extraction algorithm used to convert user query to triple. The time complexity is O(n3+n) and worst-case complexity is O (n3); where n stands for order of operations. And this algorithm cannot fully extract all triplets from the query sentences because it cannot recognize if that input

sentence may contain more than one subject, predicate and object (Ismail, Rahman, Bakar, & Makhtar, 2018).

In that case, a sentence is represented as a parse tree generated by Stanford CoreNLP parser and divided three sub tree like a noun phrase (NP), a verbal phrase (VP) and the full stop (.). To find the subject from user query the algorithm searches the NP sub tree using breadth first search and the first noun of NP sub tree is selected as subject. To find the predicate of the sentence this algorithm searches the VP sub tree and the deepest verb of VP sub tree will decide as predicate of query. The objects are found in VP sub trees. The VP sub trees can be divided into three different sub trees such as PP (prepositional phrase), NP (noun phrase) and ADJP (adjective phrase). In case of NP and PP the first noun is selected as object, in case of ADJP the first adjective is selected as object.

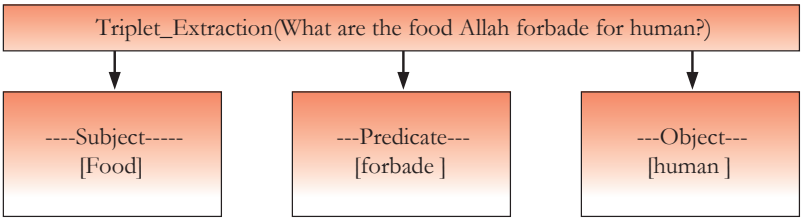

Fig 3: Generating Triple from Parse Tree by Using Triplet Extraction Algorithm

3.3. Creating SPARQL query using triple

SPARQL means Simple Protocol and RDF Query Language which is used to query any data which is based on RDF. A query language is needed in order to retrieve information from semantic web applications. SPARQL query is most suitable for this purpose. SPARQL query is created by triple that consist of subject, predicate and object which are generated by using triplet extraction algorithm. The general structure of SPARQL query is:

```
SELECT ?O
        WHERE { ?S  ?P  ?O }
```

The triple (subject, predicate and object) are replaced in the SPARQL query such as 'S' is replaced by subject, 'P' is replaced by predicate and 'O' is replaced by the object. Then the SPARQL query is formed and the corresponding result of that query is showed. For example: a query is "What are the foods Allah forbade for humans" while executing that query in the triplet extraction algorithm as a result the triple "food, forbade, humans" are generated and food is replaced in place of 'S' forbade is replaced in place of 'P' and human is placed in place of 'O' in the SPARQL query. Then the

SPARQL query will be like that:
SELECT ?human
WHERE{Food: food Food: forbade ?human}.

3.4. Creating food ontology using Protégé

To create food ontology the protégé OWL editor 4.3 version is used. Firstly, added IRI (Internationalized Resource Identifier) and prefix name. The ontology has various features such as, Class is the most important part of ontology. In fact, class is the basic building block of an ontology. OWL classes are defined as sets that contains a set of individuals. For example, a class Food-in-Akhirat which contains that food those are related to Akhirat. A class can have one or more smaller classes those are called subclass. For example, Food-in-hell and Food-in-paradise are the subclass of Food-in-Akhirat. Food ontology consist of several classes including Allah, Food and Quranic verse. The class Allah contains all the Allah related instances. Food class contains all the subclass that are related to food and Quranic verse contains all the Quranic verses those are related to food of Quran.

Table I: Description of Classes

Classes	Description
Food	Basically food class is the main class or mother class of that food ontology. We divided food domain into various sub domain under the food class. It includes all the sub classes that are related to food such as Food-in-Akhirat, Food-in-earth etc.
Food-in-Akhirat	Food-in-Akhirat is the super class of Food-in-Hell and Food-in-Paradise class. The foods which are related to hell or which foods those are provided to the sinners of hell are contains in Food-in-Hell and which foods those are provided to the righteous people in heavens are contains in the Food-in-Paradise class as instance.
Food-in-Earth	Food-in-Earth is the super class of drinks, vegetables, fish, forbidden food, provisions, fruits etc.
Drinks	Contains those instances which foods are mentioned in Qur'an as drink such as water, milk, honey etc.
Forbidden Food	This class contains those items as instances which Allah has forbidden for humans to enjoy such as blood, wine, flesh of swine.
Fruits	Fruits class contains the various fruits mentioned in the Qur'an as instances such as dates, grapes, bananas, fig etc.
Vegetables	Vegetable class contains all those instances those are vegetables are mentioned in the Qur'an such as onions, cucumbers, gourd, mustard seed, lentil, garlic etc. All the vegetables related verses from Qur'an are also included that class.
Provisions	In this class, those instances are included that are mentioned in the Qur'an as provisions. In fact which foods are sent down by Allah from the heavens for the followers of Muses (A) that foods are known as provisions.

Instances are the basic ground level elements of ontology. The features which represent the objects in the domain in which we are interested that are known as instances or individuals. In this food ontology various food related instances is used.

Object property is one of the most important elements of an ontology which represents the relationship between two individuals. In fact, object properties are binary relations on individual i.e., they link two individuals together. Object property has various characteristics and descriptions. Classes, subclasses, individuals, object properties, and their domains and ranges are gradually added step by step in the protégé OWL editor. For this reason, in this work did not use any specific algorithm to design a food ontology database.

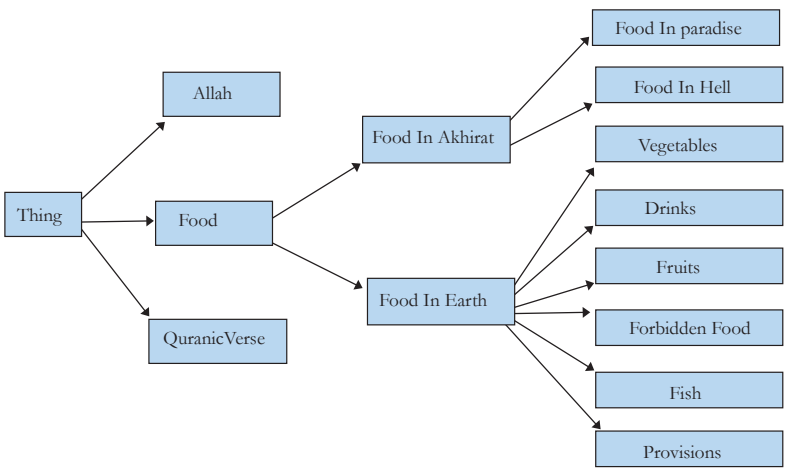

Fig 4: Overview of food ontology

4. Experimental results and discussion

The above diagram shows how to generate a complete result from a user query using the proposed methodology. Firstly user has to start the program and then the user have to give the input a user query "Which are the milk related verses of Qur'an? When the user runs the program by giving an input then a parse tree is generated from the user query by using the Stanford CoreNLP parser. After that, A triple is generated from the parse tree by using Triplet Extraction Algorithm that is 'milk-related Quran'. In the next step, a SPARQL query is created by using triple in the apache Jena Fuseki server. The SPARQL query is "SELECT? Qur'an WHERE {Food:milk Food:related ? Qur'an}".

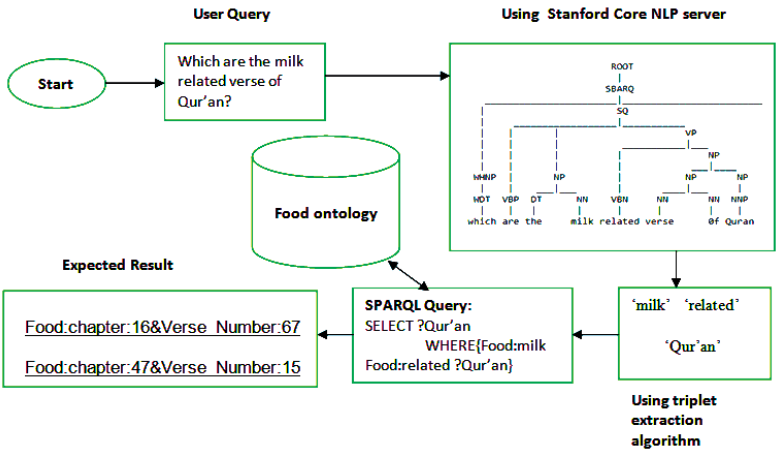

Fig 5: Overall work flow of Proposed Model

When the SPARQL query is run, SPARQL query searches the expected result in the food ontology dictionary. If any result is matched with the SPARQL query then the apache Jena Fuseki server shows the result. The expected result is "chapter:16 & Verse_Number:67 chapter:47 & Verse_Number:15".

To show the experimental analysis and design the following steps have to be performed:

1. The first step is to create a dataset in the Apache Jena Fuseki server and set dataset name and dataset type. The next step is to upload food ontology as TTL file to the Apache Jena Fuseki server. This server is used in this work because it is more users friendly and efficient for executing SPARQL query.
2. The next step is to generate triple (subject, predicate and object) from user query. After generating triple, a SPARQL query is created by using that triple in Apache Jena Fuseki server. Finally, in the query tab of the fuseki server the SPARQL query has to run and get expected result. Some example queries are run in the following section.

Query-1: Which food Allah forbade in Qur'an?
Generated Triple: Allah forbade Qur'an
SPARQL Query:
SELECT? Qur'an
WHERE {Food: Allah Food: forbade? Qur'an}

In this query, user want to know which food Allah (SWT) forbade for human in the Qur'an. When the query is executed, a triple is generated and by this triple a SPARQL query is formed in the Fuseki server. It can be done by running the SPARQL query above. Here, we are retrieving the object by supplying the subject (Allah) and the predicate (Forbade) in the query. The answer is returned corresponding of that triple Allah forbade Qur'an and a query variable is used to retrieve the answer. In this case it is 'Qur'an'.

Query-2: What are the provisions mentioned in the Qur'an that Allah sent down?
Generated Triple: provisions sent Allah
SPARQL Query:
SELECT ?Allah
WHERE {Food: provisions Food: sent? Allah}
In this query, user want to know which food Allah (SWT) sent in the world as provisions specially for followers of MUSES(A).For that user query above triple is generated by Triple Extraction Algorithm and above SPARQL query is formed in Fuseki server and The following answer is returned according to the corresponding SPARQL query.

Query-3: In hell, which foods will provide to sinners?
Generated Triple: hell provide sinners
SPARQL Query:
SELECT ? sinners
WHERE {Food: hell Food: provide? sinners}

4.1. Comparisons with others proposed model and this food ontology model
In this research work, three kinds of comparison is performed with proposed food ontology model work. In Table II shows the comparison chart between Wikidata query service, QNature ontology and food Ontology based on the answering capabilities. On the other hand, in Table III shows the comparison between others Quranic search engines and the food ontology based on the searching type and input type. In Table IV shows the comparison between others research papers and our research based on the domain, input type and used Algorithm.

4.1.1. Comparison between Wikidata Query Service, QNature Ontology and Food Ontology based on the Answering Capabilities
During literature review, various research papers and search engines are

reviewed. But there could not find any search engine or research papers which are fully based on the food domain of Qur'an. There are only two search engines are found such as Wikidata query service and QNature ontology that contain partially food related concepts. For that reason comparison have been done between this proposed work and wikidata query service and QNature ontology.

Wikidata Query Services: It is a SPARQL query search engine which consists of various domains such as rivers, chemistry, mountains, geography, economics and business, food and drinks etc. Here this engine also include food and drinks related domain which is also same to this topics.

QNature Ontology: This is a SPARQL query search engine which consist of basically nature related topics of Qur'an. This search engine also includes the small part of food related concept of the Qur'an but didn't investigate extensively.

Table II: Comparison between Wikidata Query Service, QNature Ontology and Food Ontology based on the Answering Capabilities.

Question	SPARQL Query	Wikidata Query Service	QNature Ontology	Food Ontology
Which fruits are mentioned in Qur'an?	SELECT ? Qur'an WHERE{Food: fruits Food: mentioned ? Qur'an}	No matching records found	No data available in table	Food:pomegranate Food:grapes Food:cucumbers Food:dates Food:banana Food:fig
Which water will be given in hell?	SELECT ?hell WHERE{Food: Water Food: given?hell}	No matching records found	No data available in table	Food:boiling_water
In hell, which foods will provide to sinners?	SELECT ? sinners WHERE{Food: Hell Food: provide?sinners}	No matching records found	No data available in table	Food:boiling_water Food:zaqqum Food:al-Ghasleen Food:festering_ water Food:boiling_fluid
In paradise, which foods will provide to righteous people?	SELECT ? people WHERE{Food: Hell Food: provide ?people}	No matching records found	No data available in table	Food:ginger Food:purifying_ drink Food:rivers_of_ honey Food:kafur Food:rivers_of_milk Food:Wine_of_ paradise

Question	SPARQL Query	Wikidata Query Service	QNature Ontology	Food Ontology
Which food Allah forbade in Qur'an?	SELECT? Qur'an WHERE{Food: Allah Food: forbade ? Qur'an}	No matching records found	QNature: Dead Animals QNature: Swines QNature: Wine QNature: Blood	Food:Dead Animals Food:Swines Food:Wine Food:Blood
For which prophet followers manna and quails are send That mention in Qur'an?'	SELECT? mention WHERE {Food:prophet Food:sent? mention}	No matching records found	No data available in table	Food:moses
What are the provisions mentioned in the Qur'an that Allah sent down?	SELECT?Allah WHERE{Food: provisions Food:sent? Allah}	No matching records found	QNature: Quails QNature: Manna	Food:manna Food:quail
Which are the water related verse of Qur'an?	SELECT ? Qur'an WHERE{Food: Water Food: related?Qur'an}	No matching records found	No data available in table	Chapter:16 & verse_Number:10 Chapte:77 & Verse_Number27 Chapter:2 & Verse_Number:164 Chapter:23 & Verse_Number:18

For example, in this table II, the triple of the question is "Which water will be given in hell?"- only matched for that triple which is saved in Food Dictionary. Since this question was for searching a single water and the triple of the question is only matched with a triple that return the result Boiling water. If the question would be "In hell, which foods will provide to sinners?" - matched for searching multiple water then Boiling water and festering water will return as a result.

However, in table II, the query is "In paradise, which foods will provide to righteous people?" - where "Food: Hell" is appeared in the SPARQL query. In this case, the SPARQL query conflicts with another triple in the database. For this reason in the future, we will improve this feature.

4.1.2. Comparison between others Quranic Search Engines and the Food Ontology Search Engines

In the following table, comparison have been done between this proposed work and various Quranic search engines based on the searching type and input type where most of the search engines are keyword based but this work is semantic based and most of the search engines take input as keyword but this proposed work take input natural language query.

Table III: Comparison between Others Quranic Search Engines and the Food Ontology based on the Searching Type and Input Type.

Search Engine	**Search type**	**Input type**
1.Shahih International	Keyword	Specific word or keyword.
2.Qur'an.com	Keyword	Keyword
3.Alfanous.org	Keyword	Any word or ayah
4.Qur'an.ksu.edu.sa	Keyword	Sura,verse
5.The Quranic Arabic Corpus	Keyword	Any keyword
6.Virtuoso SPARQL QUERY Editor/ HTTP://dbpedia.org	Semantic	SPARQL query
7.Quran Ontology.com	Semantic/keyword	SPARQL query
8.Ontobee	Semantic	SPARQL query
9.Holyquran.site/	Keyword	Keyword
10.Search-the-quran.com/	Keyword	Any word
11.QNature Ontology	Semantic	SPARQL query
12.www.islamicity.org/quransearch	Keyword	Any word
13.www.quranexplorer.com/search/	Keyword	Keyword
14.qurananalysis.com	keyword	keyword
15.Our proposed model Food Ontology.	Semantic	Natural language query as the user want

4.1.3. Comparison between Others Research Papers and Food Ontology Model

In the following table, comparison is showed between this proposed work and various research papers on the basis of input type, domain and using algorithm where different research paper works on different domain but this domain is unique. This research is based on the food domain of Qur'an. The input type of the most research papers are also SPARQL query based but the input type of this proposed work is natural language query based and various research paper used various types of algorithms but triplet extraction algorithm have been used in this research work.

Table IV: Comparison between Others Research Papers and This Research based on the Domain, Input Type and Algorithm

Title of the Article / Paper	Input type	Domain	Use any algorithm
"Applying Ontological Modeling on Quranic "Nature" Domain"	SPARQL query	Nature related verse of Qur'an	No algorithm is used
"The Quranic Nature Ontology: From Sparql Endpoint to Java Application and Reasoning"	SPARQL query and in a GUI select subject,relation, object	Nature related verse of Qur'an	No algorithm is used
"Hybrid Search Approach for Retrieving Medical and Health Science Knowledge from Quran"	Keyword	Medical and health science domain	No algorithm is used
"Ontology Based Semantic Search in Holy Quran"	SPARQL query	Animals and birds	No algorithm is used
"Ontology Semantic Approach to Extractionof knowledge from Holy Quran"	Naturallanguage query	Noun concepts	Ranking algorithm is used
"Semantic Web Application for Historical Concepts Search in Al-Qur'an"	Naturallanguage query	Historical concepts	Maximum likelihood estimate model is used
"A Systematic Review on Semantic-based Ontology for Quranic Knowledge"	Keyword	Placenouns, themes, pronouns, antonyms andIslamic knowledge in the Qur'an.	No algorithm is used
"Ontology-Based Model for Arabic Lexicons: An Application of the Place Nouns in the Holy Qur'an"	Keyword	Place noun	No algorithm is used
"Semantically Answering Questions from the Holy Quran"	Natural language query in Arabic		NLP Algorithm
"Salaat Ontology: A Domain Ontology for Modeling Information Related to Prayers in Islam"	Natural language query in Arabic	Salat	No algorithm is used
"Concepts Extraction in Ontology Learning Using Language Patterns for Better Accuracy"	Natural language query.	Hajj related verses	Regex patterns NLP
"Developing a semantic search method for retrieving food related verses and concepts from holy Qur'an using ontology" (Proposed food ontology)	Natural language query	Food related verses of Qur'an	Triplet Extraction Algorithm.

4.2. Result of proposed work

For evaluating the performance of this system, a popular precision and recall technique is used. Precision and recall methods were used to measure the effectiveness of the search system. The recall measures of how many of the relevant documents were retrieved while precision measures of how many of the retrieved documents were relevant (Yauri, Kadir, Azman, & Murad, 2013). After collecting the verses from authentic sources, this work made a food dictionary in the corresponding verses. If any names are missing, they are from the query output, which will be discarded and the user query result will be displayed accordingly. To measure the effectiveness of the search system 105 experimental queries is run based on the food domain of Holy Qur'an.

Number of query	Number of relevant result retrieved	Number of retrieve relevant result	Number of irrelevant result	Number of relevant result not retrieved
105	98	95	3	7

$$\text{Recall} = \frac{\text{Number of relevant result retrieved}}{\text{Number of relevant result retrieved} + \text{Number of relevant result not retrieved}} * 100$$

$$\text{Precision} = \frac{\text{Number of relevant result retrieved}}{\text{Number of relevant result retrieved} + \text{Number of Irrelevant result}} * 100$$

So,

$$\text{Recall} = \frac{98}{(98+7)} * 100 \quad = 93.33\%$$

$$\text{Precision} = \frac{98}{(98+3)} * 100 \quad = 97.02\%$$

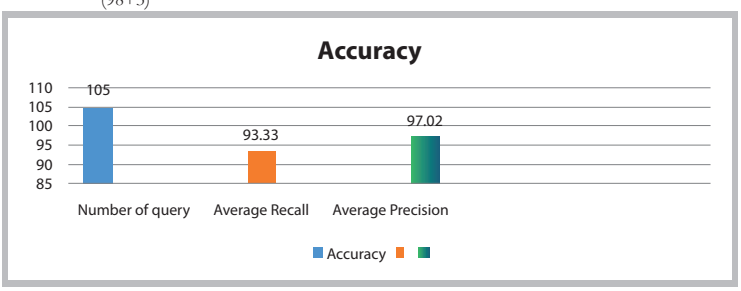

Fig 6: Accuracy of proposed model

In this research work, 105 experimental queries based on the food domain are run, with 98 of them finding the answer and 95 of them finding the exact answer. As a result, this proposed method has a precision of 97.02 percent and a recall of 93.33 percent.

5. Conclusion

In this research work, during implementation and result analysis faced some limitations such as: User question must be according to grammatical rules.

Otherwise during generating parse tree, incorrect or irrelevant parse tree generated. Also, the food ontology dictionary is created based on 105 user queries. So, results are limited between 105 queries. And, user can only search about Quranic food. Hadith food is not included in this proposed ontology.

So, in future, will try to overcome these limitations and will increase our food domain to the Hadith and food science, because a lot of information about food are discussed in Hadith. Since the present age is age of science so the future aim is to include in this research food science related concept.

This work proposed a semantic search system for retrieving food related knowledge from holy Qur'an using a combination of the natural language processing approach and semantic technology based on Quranic food ontology. People from any religion either Muslim and non-Muslim can search semantically information from the food related domain. Since this proposed work is done about food domain from holy Qur'an only, in future we want to enhance our system to combine both the Qur'an ontology and Hadith ontology in order to build a system capable of handling more possible user queries.

In the field of Quranic search concepts, a number of researchers have worked upon the Quranic search technique. Most of the research work focused either on the whole Qur'an, which is large in size, or on the domain of the Quranic knowledge base (Sadi, et al., 2016; Khan, et al., 2017). The holy Qur'an is basically divided into a number of domains. This thesis proposed a semantic search approach to retrieve food-related verses and concepts from the Qur'an using natural language query. To analyze the natural language query triplet extraction algorithm is used which generates triplet from user query. Furthermore, to run the SPARQL query apace Jena Fuseki server is integrated because it is more appropriate and efficient for running SPARQL query. For creating food ontology Protege 4.3 version is used in this work. At last, run more than 105 experimental queries on the food-related domain by using natural language query. Most of the queries are perfectly run and have 93.33% recall and 97.02% precision. In this thesis, English translation of the Qur'an published by Sahih International has been used. Since this proposed work is done about food domain from holy Qur'an only, in future we want to enhance our system to combine both the Qur'an ontology and Hadith ontology in order to build a system capable of handling more possible user queries.

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