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Semantic Web Representation for Phytochemical Ontology Model

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***Abstract*—Nowadays people are more health conscious; they monitor the ingredients and nutrients of what they eat. Fruits and vegetables, which are rich of phytochemicals, are always chosen as a good diet. Phytochemicals are rich of nutrients and can give health benefits to the takers. Previous research has modelled the phytochemicals into its chemical structure and colours according to group of fruits and vegetables ontologically. However, there is no semantic web representation of that ontology model that makes the information more sharable among users. Therefore, in this paper, we develop a semantic web for phytochemical ontology model by linking the user interface to ontology model using JENA framework. The data from the ontology is read by using SPARQL query to display information to the front-end user. By having this semantic web representation, it is hoped that the knowledge is more accessible and shareable among intended users.**

***Index Terms*—Model; Ontology; Phytochemical; Semantic; Web.**

I. Introduction

Nowadays, people are health conscious. According to [1], instead of going to gym to get fit, most people look on what they eat. Ingredients and nutrients of foods are becoming main reason for the foods to be served. Fruits and vegetables are good for diets. However, people mostly do not know the goods of consuming vegetables and fruits. Plant foods are rich in phytochemicals, which give different colour to different food and contain different nutrient. Phytochemicals is a natural compound produced by plants. Phytochemicals are responsible for the colour, flavour, and odour of plant foods [2]. According to [3], consuming foods that are rich in phytochemicals could give health benefits.

Previous research by [4] has ontologically modelled this phytochemical according to its chemical structure and colour. It is constructed to relate the phytochemical with its benefits and properties according to selected fruits or vegetables. From the result, it shows that each type of vegetable or fruit can contain more than one phytochemicals and may contain more than one benefit. However, this ontology model is not yet being implemented into semantic web representation. It is significant to apply this ontology model into semantic web representation to provide a better overview of the knowledge [5] and make the knowledge sharable. Hence, with a specific end goal to make such information sharable, it is important to have both a workable technique and a helpful representation plan that is called semantic web representation.

II. Literature Review

A. Knowledge Management & Ontology

According to [6], knowledge management (KM) is a field of administration, which concentrates on execution by making the correspondence between individuals, process and innovation. Every organization creates a lot of information and data. Hence, without powerful management it will be hard to recognize and spot the data required at some circumstance. KM is known as a procedure to create organizational knowledge and capability to create important data. KM involves a scope of procedures and practices used as a part of an association to distinguish, make, speak to, distribute, and enable appropriation insights and experiences. There are many types of KM, which include knowledge modelling to encode knowledge in systems base of intelligent. As more people prefer digital form of information, an automated knowledge model can be used as one of the solutions as searching words in the printed book. Automated knowledge model is a piece of information management which helps to explain and store the information with methods that can be recognized and managed by computer. It is a way to deal with catch and design learning into a reusable organization for a reason to continuing, revising, sharing, consolidating and reapplying it. Typically, a knowledge model includes a diagram of the full domain schema such as UML class diagram, ontology and ER data model- domain model. This conceptual model should be constructed after the knowledge acquisition stage by the knowledge engineer. Then, the model will be translated or transformed into a workable code or program.

In Information Technology, ontology is defined as a practical term denoting an artefact that is built for a meaning, which to allow the modelling of information about some domain, imagined or real. Ontology was initially proposed to enable shareable and reusable representations in computer science [7], which include sharing information bases, semantic representation for business models, representation of a characteristic language vocabulary, representation of semantics for administration and complex programming applications, and providing knowledge-enhanced search. Other than that, the role of ontology in Knowledge Management (KM) processes aids in knowledge creation, storage, retrieval, transfer, and application together with performance improvement. Developing ontology is like the essential set of data and their organization for other programs to use. Problem-solving methods, software agents and domain-independent applications use ontology and knowledge bases built from the ontology as information. There are a few approaches such as hybrid and task based approach to develop ontology. However, declarative approach to ontology is needed for the knowledge preservation because ontology is a method where the domain is represented in structured and may provide the benefits to those who implemented it especially in a semantic web representation.

B. Semantic Web Representation

The World Wide Web can be characterized as a techno-social system to relate humans based on technological networks although it is not the same as the Internet [8]. The web and related technologies has been advanced over the past two decades. Currently, semantic web has become an extension to the current WWW. Semantic web can deliver things in the way the computer can understand with the main objective is to make both humans and machines to understand the web. There are few layers of semantic web architecture according to [9], which include IRI/Unicode (unique identifier for resources), RDF model and schema (describe classes and properties of resources), OWL (describe domain with inference ability), logic and proof layer (making new inferences by reasoning system) and trust layer (specific end goal for quality information).

These technologies enable persons to make information stores on the Web, manufacture vocabularies, and compose rules for handling information. Technologies such as RDF, SPARQL, and OWL are empowering the interconnected data. RDF provides the foundation for publishing and linking data. Different innovations allowed user to insert information in documents or uncover what the user have in SQL databases. Vocabularies or ontologies are built by using OWL. SPARQL is the query language for the semantic web. There are few layers of semantic web which include IRI/Unicode, RDF Model, RDF Schema, OWL/Rules, Logic Framework, Proof and Trust by [10] as in Figure 1.

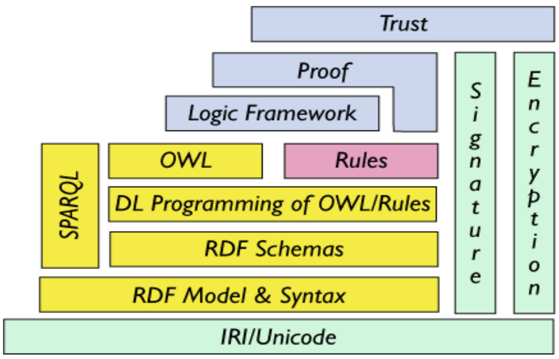


Figure 1: Layered Semantic Web Architecture [10]

Each layers of the semantic web architecture have their own purpose. For the bottom layer, Unicode represent any character uniquely in any kinds of language it is written while URI are unique identifiers for resources of any types. RDF is used to describe relationships between the resources in terms of named values and properties and it used URIs to identify web-based resources. Next, RDF Schema provides basic type system for RDF models which describes properties and classes of the resources. Ontology which is OWL can be called as a collection of terms used to describe a certain domain with the inference ability. The layer of OWL described relation and properties between properties and different. On top of it is Logic and Proof layer which used to make new inferences by an automating reasoning system. It is enable to make reductions by using such reasoning systems whether certain resources satisfy their requirements. Lastly, the highest layer in the architecture is Trust. It addresses trust with a specific end goal to give a confirmation of quality of the information on the web. Hence, before semantic web representation is built, ontology must be constructed first.

C. Phytochemical Ontology Model

All the subclasses have a relationship with other subclasses. For instance, as shown in Figure 1; Orange hasPhytochemical 'some' Myrcene and Myrcene hasProperty 'some' Antioxidant. It is shown that phytochemical can have properties and benefits and vegetables and fruits can have more than one phytochemicals.

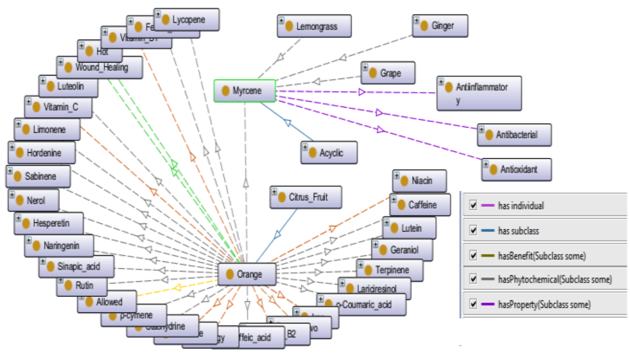


Figure 2: Myrcene Instance [4]

Even though this information has been modelled, however, there is no semantic web representation yet for this knowledge. Hence, to provide a better overview of the knowledge [5] and make the knowledge sharable, semantic web representation of phytochemical ontology model should be developed.

III. Methodology

The whole research consists of five phases, which are analysis, design, development, implementation and evaluation. However, in this paper, the focus is on the development phase, which concentrates on the semantic web development as the ontology has been constructed in the previous research [4]. The development of semantic web is important as it will give user better overview and more user friendly than just read the onto-graph from the .owl file as not all the user understand the structure of instances in the onto-graph.

This study sets out to answer the following research questions: (i) how to link the user interface with the ontology (OWL) file? and (ii) how to fetch data from the ontology (OWL) file to be displayed to the front-end user? The detail of development phase is explained accordingly in the later section of this paper.

IV. Result

This section is divided into two parts; which the first part covers the development of semantic web and the second part covers the data query from the ontology file.

A. Semantic Web Development

The development of a prototype of Phytochemicals information is to implement the knowledge model gained in the previous research. Semantic technology is a common term used for any software that engages any type and level of understanding the meaning of the processed data it deals with. The technology that is suitable for dynamic database, which is getting from many sources to manage, is called as semantic technology [11]. Many semantic web applications use a framework of integrated components. The framework provides storage and retrieval of RDF information and interpretation of OWL semantics. The common semantic web frameworks are Jena semantic web framework, which is used in Eclipse IDE. The semantic web process is shown in Figure 3.

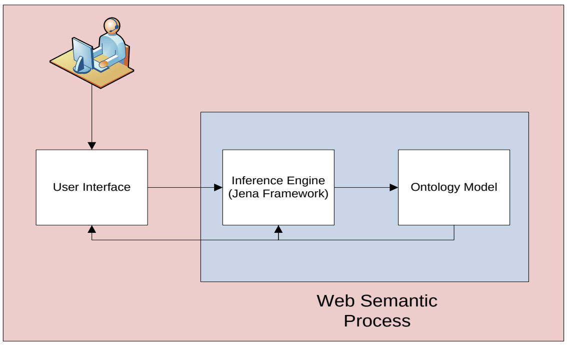


Figure 3: Semantic web process.

Each component in this prototype describes as follows:

- User interface – This is the situation where interaction between humans and machines occurs.
- Inference engine – This component will infer knowledge semantically. It consists some encoding of rules production of OWL/XML. The engine here is where the Jena framework is connected to Eclipse IDE to process the ontology model in .owl file.
- Ontology model - It includes the information about phytochemicals that has been modelled.

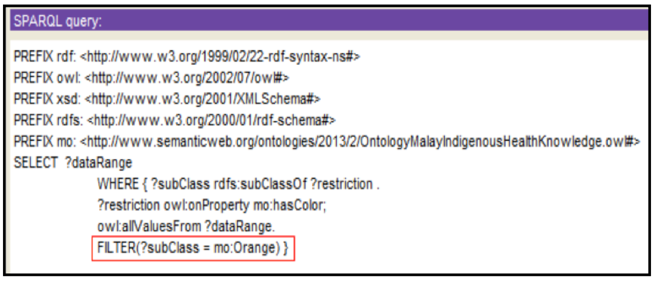
User requests for information and the system then attempts to provide information inferred by the inference engine after examining the ontology model. The ontology model will act like a database where it holds all the information regarding the phytochemical information. The main semantic web interface is shown in Figure 4.

Figure 4: Semantic web interface.

This answer the first research question on how to link the user interface with the ontology file which is using the JENA framework.

B. Data Retrieval Using SPARQL

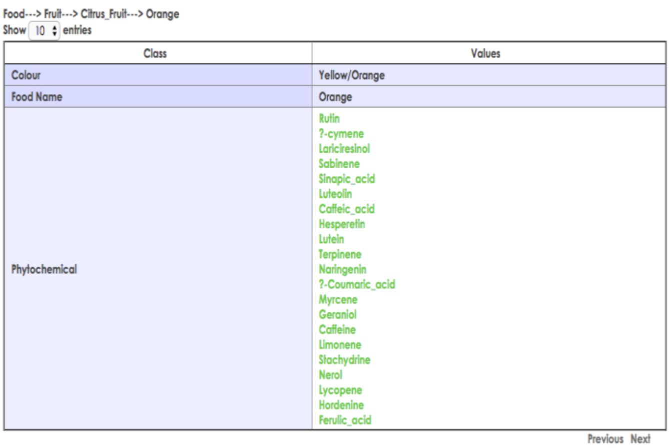
After the interface has been linked with the ontology file, the second part of the development is how to fetch data from the ontology file and display it as per user request. The query to retrieve the information in an ontology model through the Jena framework is by using SPARQL as shown in Figure 4.



```
SPARQL query:
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
PREFIX owl: <http://www.w3.org/2002/07/owl#>
PREFIX xsd: <http://www.w3.org/2001/XMLSchema#>
PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#>
PREFIX mo: <http://www.semanticweb.org/ontologies/2013/2/OntologyMalayIndigenousHealthKnowledge.owl#>
SELECT ?dataRange
        WHERE { ?subClass rdfs:subClassOf ?restriction .
        ?restriction owl:onProperty mo:hasColor;
        owl:allValuesFrom ?dataRange.
        FILTER(?subClass = mo:Orange) }
```

Figure 5: SPARQL query example

Based on Figure 5, the query will check the prefix value in the ontology model, if the prefix is true, then it will select data range. Data range will select the colour that belongs to the selected food name, for example Orange. The query will check the prefix value in the ontology model, if the prefix is true, then it will select data range. Data range will select the colour that belongs to Orange which yellow/orange. Next, it will pass to the semantic web application as shown in Figure 6.



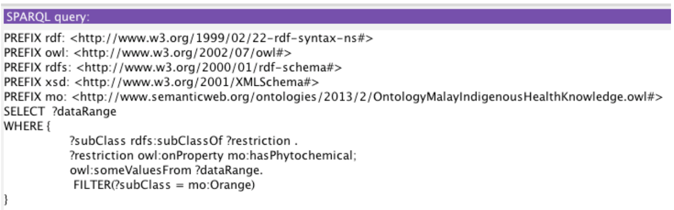
Food---> Fruit---> Citrus_Fruit---> Orange
Show 10 entries

Class	Values
Colour	Yellow/Orange
Food Name	Orange
Phytochemical	Rutin ?-cymene Lariciresinol Sabinene Sinapic_acid Luteolin Caffeic_acid Hesperetin Lutein Terpinene Naringenin ?-Coumaric_acid Myrcene Geraniol Caffeine Limonene Stachydrine Nerol Lycopene Hordenine Ferulic_acid

Previous Next

Figure 6: Information retrieved to end-user from the ontology file

Based on Figure 6, the result of colour for food name Orange is Yellow/Orange which contain various of phytochemicals. From the result screen, besides that, all of the phytochemicals are also fetched to the end user by using another SPARQL query as in Figure 7.



```
SPARQL query:
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
PREFIX owl: <http://www.w3.org/2002/07/owl#>
PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#>
PREFIX xsd: <http://www.w3.org/2001/XMLSchema#>
PREFIX mo: <http://www.semanticweb.org/ontologies/2013/2/OntologyMalayIndigenousHealthKnowledge.owl#>
SELECT ?dataRange
WHERE {
        ?subClass rdfs:subClassOf ?restriction .
        ?restriction owl:onProperty mo:hasPhytochemical;
        owl:someValuesFrom ?dataRange.
         FILTER(?subClass = mo:Orange)
}
```

Figure 7: SPARQL query to get phytochemical of Orange

From Figure 7 after executing all the SPARQL query, from the interface, when the individual phytochemical link is clicked, another SPARQL query will be executed to find the benefits of that phytochemical interface as shown Figure 8.

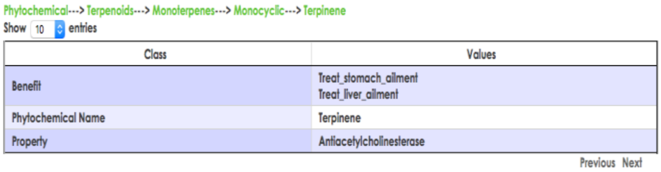


Figure 8: Information of benefits of Terpinene phytochemical in Orange is displayed.

Hence, second research question has been answered on how to fetch data from ontology file which is by using SPARQL query. Once the development is done, an evaluation of ontology model can be done. For the ontology evaluation and validation, Application-Based Evaluation method can be used. The ontology can be considered as good if it helps the users to retrieve the precise information from the application that used the model [12]. Hence, in this web application context, the user can retrieve data based on the web semantic representation that provide the foods and its phytochemical's benefit information.

V. CONCLUSION

In conclusion, referring to the phytochemical ontology model from the previous research, semantic web representation for phytochemical information is developed. Semantic web is important to deliver a better overview of the knowledge and make the knowledge sharable. There are two research questions that have been answered. JENA framework that is used with Eclipse IDE shows that user interface can be linked with the ontology file. Besides that, front-end user will retrieve the data from the ontology by using SPARQL that is processed at the back end of the web. Hence, by having semantic web for phytochemical ontology model, it is hoped that the knowledge is more accessible and shareable by the intended user.

ACKNOWLEDGMENT

The authors are grateful to the Research Management Centre (RMC) UiTM for providing and supporting the research (600-RMI/RAGS 5/3 (11/2014)).

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