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# ONTOLOGY-BASED PERSONALIZED DIETARY RECOMMENDATION FOR TRAVELERS

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## ABSTRACT

Tourism is a fun activity that allows a person to know different cultural aspects of the world. In a tour plan, food searching according to nutritional value plays an important role. However it is a challenging task to facilitate the tourists to be healthy and fit while traveling by selecting food according to their requirement. This paper aims to develop an ontology based solution that will help tourists / travelers to develop a healthy food plan with personalized options keeping food safety recommendation according to the region of interest. The proposed approach is tested on a sample dataset based on a traveler visiting Asian region.

## Keywords

Semantic Web, Ontology, Food Tourism, Personalized recommendation system, Food safety.

## INTRODUCTION

Traveling is a fun activity and as an industry generates revenue reaching approximately 11% of the global gross domestic product (GDP) and serves around 700 million tourists worldwide. This figure is expected to double by the year 2020 (Roe and Urquhart, 2001; Maswera et al., 2009). For some it is just a professional venture to fly from one part of the world to another and some are interested in experiencing different countries and cultures.

Technological innovations, such as online tools for travel planning, have facilitated tourism industry to a great extent. With the online services of e-tourism (electronic tourism) making travel arrangements is no longer a burdensome job involving going to the counter at the airport or waiting on the handset of a telephone for the customer service representative to provide flight and ticket related information. You can check online for the availability of flight and get your ticket using e-ticketing facility in just few seconds. Compared to the conventional methods, this way is time-efficient, cost-efficient and convenient (O'Connor, 1999). Moreover, there are online forums available for sharing views and suggestions which are based on the experiences of other tourists. These forums help a person to better plan the trip. Around 70 to 75 percent of the travelers consider this aspect of technology usage as a reliable source of information while planning their trips (Gretzel and Yoo, 2008). However, it is a time-consuming chore to discover the information satisfying personal interest and this sometimes leads a potential traveler to lose interest (Wolfe's et al., 2004).

Over the last decade food has emerged as an important factor and played a vital role in the travel industry. However, searching for food in a foreign location according to the nutritional requirements is a challenging task. Most restaurants are not equipped with services to facilitate tourists in keeping healthy and fit on travel. However, the lure of exotic foods has been a big reason for the brisk popularity of the food tourism, with respect to the travel-sellers and the tourists as well. Though there are quite a lot of recommendations available in online forums regarding traveling dos and don'ts - what to eat and what to avoid - still it is very time-consuming task to search for the desired information. Sometimes these online forums and travel guides do not perform as a good advisory platform due to the problem of "one-size-fits-all" approach. Different travelers may have different preferences and requirements – for instance some may have allergies to a specific type of food, or may follow a particular diet or may have some medical conditions, for example diabetes, which will have an effect on their tour if they don't plan for their diet accordingly. This lack of personalization in online forums is a shortcoming that personal food recommendation systems can address (Kabassi, 2010).

Personalization is the main characteristic of the advisory or the recommender systems. Recommendation systems have their application in searching for the right content including travel destinations, books, papers, music, schools etc. Recently

tourists have found interest in recommendation systems to get assistance regarding tour planning (Ricci, 2002; Ricci and Werthner, 2002; Wallace et al., 2003; Loh et al., 2003; Rabanser and Ricci, 2005).

Most tourists like comfortable to know about different types of food products offered by the destination along with the climate, accommodation, scenery etc., while planning for a trip. Recommender systems in the form of travel guide sites are there to facilitate the tourist in searching for different foods available in different regions. Research is under way to find ways to support food tourism industry by providing platforms which could provide advice in a time-efficient manner. Semantic web implementation provide us with the facility where the machine i.e.; computer can understand the statement written in the search box and get the precise information. BooRah restaurant services are an example of the use of semantic web where traveler can search for the best rated restaurant in a particular region. Diet planner project is another example of semantic web implementation which helps the customer to plan a menu according to the diet plan he/she follows. However, there is a gap regarding the food search for a tourist according to his/her need; as none of the current recommendation services offer the tourists the mechanism where he/she can enter a search query and a near exact matched solution appear on the screen. This paper aims to provide such a solution to food tourism industry by recommending a tourist visiting a restaurant with a platter that can offer a healthy and tasty food.

## RELATED WORKS

Many researchers have put in efforts to model the concept of food in order to develop applications for food tourism industry. There is a need to find relevant information regarding food in foreign locations that suit individual needs and preferences. In this regard (Fodholi et al., 2009) designed and developed a semantic web application using a rule-based inference engine in which the researchers suggested the daily menu according to the personal information entered by the users.

Literature reveals that researchers have focused diabetes control from nutrition point of view using the Food ontology. (Chang-Shing et al., 2008) proposed a web-based expert system that helps users to plan menu after nutrition analysis providing the search options utilizing which user can get food composition and their nutritional value with quantity used. The organization of food in the system is according to Kurean menus.

Another such example found in relevant literature is the food ontology for diabetes control (Jaime et al., 2005) which is developed to provide guidance for diabetes patients.

There are some counseling systems for menu planning using ontology based expert system (Snae and Brückner, 2008). Another system “FOODS” uses two user interfaces one for the chefs and the other for users.

Tummark et al. have extended food ontology to focusing on the athletes where they provide an ontology based personalized dietary recommendation for weight-lifters (Tummark et al., 2013).

From a traveler’s point of view restaurants can provide tourists with a facility to have personalized menu selection environment. BooRah restaurant services are an example of such a facility where travelers can search for the best rated restaurant in a particular region. However, these solutions provide the tourists with the best available restaurant in the particular region based on the reviews from the foods blogs. In this paper the interest is to integrate the concept of travel and food to provide the tourist with the luxury of selecting their own personalized menu.

## ONTOLOGY

It is surmised in this paper that for achieving the above mentioned goals, a knowledge based framework is required. A unified ontology needs to be developed combining food, nutrition and travel concepts.

Ontology is a formal, explicit specification of a shared conceptualization (Gruber, 1993). Here two terms are to be considered “conceptualization” and “explicit”. Conceptualization refers to the schemata where a logical description of shared data is provided defining the relationships between data thereby representing knowledge. Conceptualization should be generalized and shared. The second term – explicit refers to an important aspect of ontological world where the line between the concepts of Close World Assumption (CWA) and the Open World Assumption (OWA) becomes clear. According to CWA the information which not known to be true must be considered false whereas in light of the OWA what is not known to be true must be considered unknown. For example, consider the statement “Asim is a citizen of Pakistan”. If we now want to ask “Is Asim a citizen of Canada?”, under the CWA the answer would be *no* while according to OWA the answer would simply be *we don’t know*. The basic idea of building an ontology is to make a concept machine understandable i.e.; providing the machine a vocabulary so it can process data without human intervention (Musen 1992; Gruber 1993).

As it becomes obvious from relevant literature there are four main elements of ontology, concepts (or Classes), individuals (or instances), properties and relationships that together are considered as a knowledge base.

Ontologies are organized in the form of hierarchies similar to the classes where there are root classes under which there are subclasses based on the domain of the root class. For example, Dishes class would contain different subclasses such as Dishes type and Dishes suitability. Individuals or instances can be considered as a concrete concept such as specific dish “Chicken Biryani”. Properties are the attributes that will define the classes or individuals. Data properties and Object properties are the two types of properties available to help describe a concept. Data properties are used to assign literals to an object (e.g.; Dish\_1 hasProteins 12g.) whereas the Object properties are used to define the relationship between two objects (e.g.; person hasMedicalCondition MedicalCondition). It shows ontology as an exact description of things and the relationships that exist among them.

## IMPLEMENTATION

We developed the unified Traveler and Nutrition ontology in Protégé<sup>1</sup>, an open-source platform that allows users to develop ontology in the Web Ontology Language (OWL). Protégé allows the use of Semantic Web Rule Language (SWRL) rules (Horrocks et al., 2004) and queries. PELLET<sup>2</sup> is used as the reasoner in this paper.

## DEVELOPMENT OF ONTOLOGY

There are four main elements that help in the development of the ontology namely classes (or concepts), individuals (or instances), properties and all the relationships. Here we considered menu planning for tourist, who may have specific medical condition, visiting a country by following a top-down approach, defining the most general concepts in the domain. Three concepts that are vital for modeling such ontology are: Dishes, Person, Medical Condition.

### Dishes Concept

Dishes are categorized as Breakfast, Lunch, Snack-time and Dinner. The concept is about dishes with specific nutritional value described using the property hasNutrition where content of calories, carbohydrates, fats, proteins and vitamins are described. The concepts of Dishes and its data properties are depicted in Figure 1 and 2 respectively.

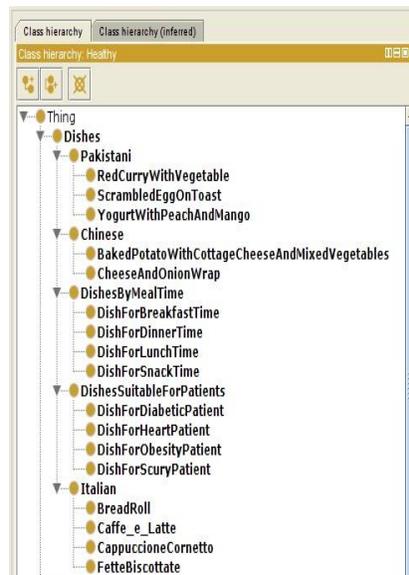


Figure 1: Concept of Dishes

<sup>1</sup> Protégé [Online]. Available: <http://protege.stanford.edu/>

<sup>2</sup> Pellet: OWL 2 Reasoner for Java [Online]. Available: <http://clarkparsia.com/pellet/>

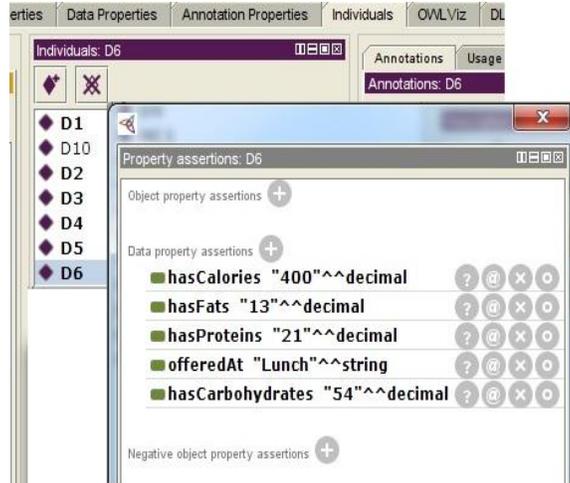


Figure 2. Data Properties of a dish

**The Person Concept**

The Person class represents the concept of the person profile with the traveler information saves in a database providing all the necessary information.

**Medical Condition Concept**

This represents the concept about the medical conditions that may be associated with the tourist. Five types of medical conditions are focused are: Diabetes, Scurvy, Heart problem, Obesity and Healthy. Concepts of Person and Medical Conditions are depicted in Figure 3.

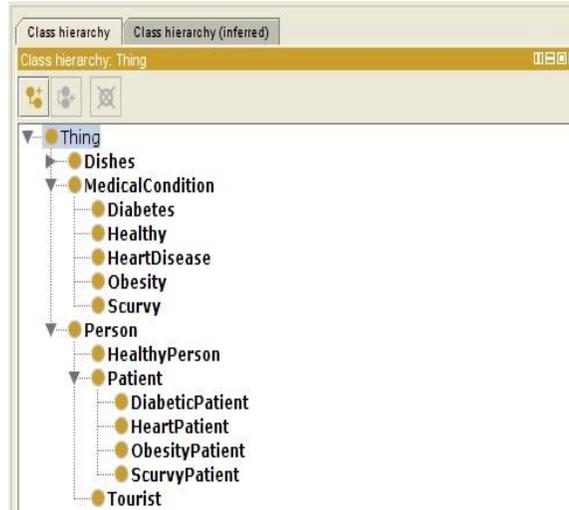


Figure 3: Concepts of Medical Condition & Person

**RULE ENGINE**

Semantic Web Rule Language (SWRL) is used to write the rules so that the query result can be provided to the user. Protégé editor is used for development of rules. By combination of Nutrition and travel knowledge for specific Medical condition, rules can be defined. Those rules then can be used to identify the dish suitability for a tourist with defined medical conditions. Figure 4 shows the Rules written in SWRL, the highlighted rule implying that dishes having certain content of nutrition are equivalent to (→) the “DishForDiabeticPatient” concept.

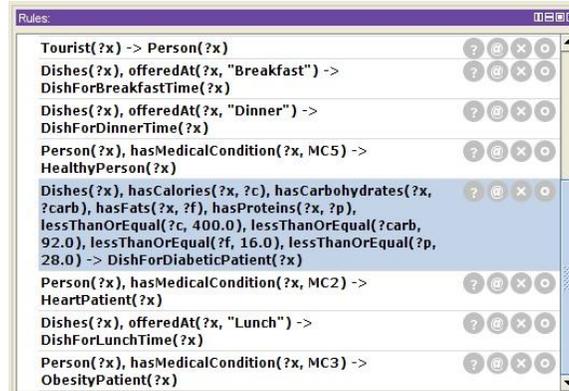


Figure 4: SWRL Rules

## CONCLUSION AND FUTURE WORK

This paper describes the development of a personalized food and nutrition ontology working with a rule-based knowledge framework to provide specific options for a tourist by identifying dish suitability according to the medical and cultural requirements of that tourist.

The work can be extended to use system time to identify automatically the time of the meal whether its breakfast, lunch, snack-time or dinner.

This work is based initially on a specific region. It can be extended to integrate different regions so that a tourist can get personalized information about the region he /she is planning the next tour for.

The cultural aspect is also very important where different cultures employ different concepts regarding food. In south-Asia, for example, there is a concept of open meal with no restriction of having a particular type of dessert with certain dishes.

Another angle that could be introduced is the concept of Halal (allowed to eat according to Islam) and Haram (prohibited to eat according to Islam) food which is considered important in Islamic countries or at least for Muslim tourists. The E-Codes described in ingredients of food items can easily be used to probe whether a particular dish is Halal or not.

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