Research Article

A Cultural Tourism Ontology for Lower Northern Thailand

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Abstract
Cultural Tourism is a problem-specific area of the tourism domain therefore being the subject of enquiries from prospective tourists. Keyword searching is usually a challenge to tourists, not well versed in structuring queries, and due to the ambiguity inherent in Internet searches, and the unique characteristics of tourism assets which vary, often significantly, from area to area. A semantic search is a key aspect of any information management solution for the unsophisticated end user. The concept of ontology comes into consideration because of its strength in resolving the unanbiguity of user's search.This research introduces a cultural tourism ontology that enables users to search semantically to satisfy their particular interests. The evaluatin of the performance of the ontology in term of the correctness and of the data retrieval is measured by traditonal methods F-measure, precision and reall. The quality and effectiveness of the designed ontology was evaluated using OntoQA.

Keywords: Cultural tourism ontology, Semantic search, E-Tourism, OntoQA

1 Introduction

Cultural tourism is a significant area of tourist interest, together with the many other kinds of tourism, such as ecotourism, agritourism, historical tourism. Given the great variety of cultural attractions in many different countries around the world, providing prospective tourists with easily accessable information is now essential to support the local tourist industry, wherever situated. Cultural tourism presents the manners, customs and way of life of the local people.

Our project focused on an area of historical and cultural interest in Lower Northern Thailand. An example ontology was developed encompassing the specific and identifiable characteristics of this area.

Basically, tourists search information of their interest via the Internet. Information in the Internet has grown at an explosive rate with constant additions and modifications occuring rapidly. As a result, users can be overwhelmed with huge amounts of data that are difficult to search. This leads to a time consuming and often frustrating and unsuccessful search. The ordinary would-be tourist is almost inevitably unable to enter the correct keywords that will satisfy their query.

An ontology is one of the solutions that can lead the user to a correct answer to their search. One of the key factors that enables the ontology to retrieve the precise information are the relationships inherent in the information stored in the ontology. The ontology allows information to be searched using keywords that may otherwise result in irrelevant information from a different knowledge domain.

Given the variety of cultural characteristics, icons, beliefs and history within a particular culture, and between cultures, an ontology is an entirely appropriate approach to providing this information in a simple way, with correct outcomes from the search. Existing ontologies were considered insufficient and not

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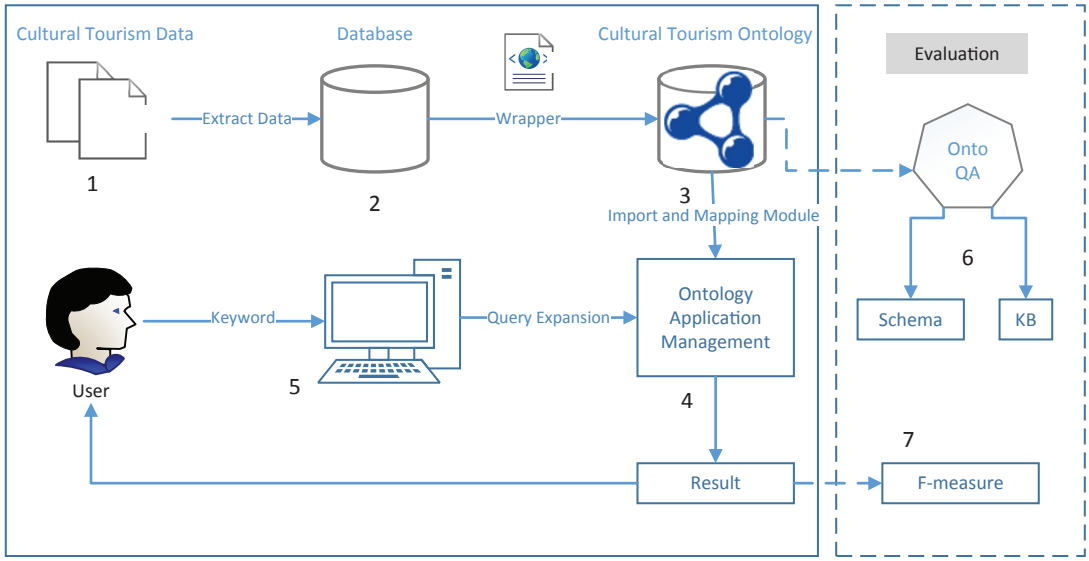

Figure 1: The Research Framework.

applicable to cultural tourism information in Thailand, leading us to develop an ontology appropriate to the particular 'cultural domain' of Lower Northern Thailand.

2 Related Work

This section reviews various papers related to tourism ontologies. Harmonize is a well-known tourism ontology proposed by Kathrin P., Ying D., Michael L., and Zhixian Y., which attempts to integrate various different tourism ontology standards to enable information exchange between different ontologies without changing the ontology data model [1].

Based on Harmonize, an e-tourism ontology titled QALL-Me Ontology was developed by Shiyan, Ou., Viktor, P., Constantin, O., Christian, S., and Matteo, N. [2]. This ontology provides tourism destinations, accommodation, events, and information on transportation. The ontology also includes aspects of Cultural Tourism. However, this ontology provides only static information rather than dynamic information, and the diversity of the classes and relationships is insufficient for and not applicable to tourism information in Thailand. Elsewhere a preliminary cultural tourism ontology encompassing the Dusit district part of Bangkok has been developed [3]. However, this is not considered sufficient or adequate to present information on cultural tourism assets in Thailand.

These prior efforts demonstrate the need to evaluate the appropriateness, sufficiency and quality of such ontologies, in order to ensure that the information provided in the ontology is correct and effective for its purpose. Since 2000, various tourism ontologies have been developed to fulfill specific user requirements, as each country has tourism categories and dimensions based on and often unique to its own tourism assets and targeted tourists [4]. Samir T, I. Budak A., Michael M., Amit P. S., and Boanerges Aleman-Meza proposed OntoQA which measures several metrics of the key characteristics of an ontology [5]. The outcome of an evaluation using OntoAQ provides the users with the confidence that the ontology has sufficient scope and depth of information to fulfill their information requirements.

3 The Cultural Tourism Ontology

3.1 *The research framework*

Figure 1 shows a research framework for the development of a cultural tourism ontology and an associated information extraction system. The two main tasks indicated in the framework are, first, the design and development of the ontology, and then the subsequent evaluation of the ontology.

This research firstly collected all relevant information necessary for users to query their desired cultural tourism assets, which included historical information, geographical location and surroundings, information centers and contacts, available services, transport options and so on. The collected information was organised into an ontology using OWL [6], thereby providing the ability for semantic searching. The Jena API is employed to manage the information in the ontology which is stored in the OAM [7] ontology application manager (see Figure 1).

The users' queries are processed by the SPARQL [8] to retrieve and present the information and relationships stored in the ontology.

To evaluate the ontology (the second task in the evaluation framework, as shown in Figure 1) the depth and breadth of the information and relationships described by the ontology structures are evaluated using the statistical methods in OntoQA, to provide a measurement of the quality of the ontology. The accuracy of the retrieved information is measured in terms of the precision and recall, using an F-measure.

3.2 *The design of the ontology*

The ontology developed in this research project includes 12 classes, 88 concepts and 42 relationships, which are sufficient to encompass all of the cultural assets available in Thailand. The twelve classes are

- Attractions: the main class contains cultural attractions such as museum, religious place, ancient city as well as detailed information of each attraction.
- Attraction_type: This class serves types of attraction.
- Cutural_asset: This class represents the interest place and/or must see things in each attraction.
- History: class that details the history of the attractions that serves to tourists.
- Accomodation: defines detail of accommodations offered to tourists such as price, location, service.
- Accommodation_type: This class clarifies the type of the accommodations such as hostel, homestay, apartment, etc.
- Transportation: From this class, tourist can find the transportation information i.e. intratransportation and intertransportaion to the desired attraction.
- Activity: defines classes of activities that serves to tourists in each attraction such as such as adventure, ceremony, festival, exhibition, relaxation, and sightseeing.
- Contact_place: To serve complete information for the tourist, the contact information of accommodation, attractions, and transportation are shown in this class.
- Contact: shows detail of the contact of each category.
- Location: This class expresses the location of the all places shown in ontology.
- Service: The information of special service will be shown in this class, if the accommodation provides.

The twelve classes and their properties are shown below in Table 1

Table 1: The twelve classes of the ontology

Class: Attraction		
Attraction_id	Datatype Property	Integer
hasName	Datatype Property	String
hasType	Object Property	Attraction_type
hasLocation	Object Property	Location
hasActivity	Object Property	Activity
hasTransport	Object Property	Transportation
hasTicket_price	Datatype Property	String
hasAssets	Object Property	Cultural_Assets
Nearly	Object Property	Attraction
hasHistory	Object Property	History
openTime	Datatype Property	String
hasContact	Object Property	Contact
Class: Attraction Type		
hasID	Datatype Property	Integer
hasName	Datatype Property	String
Class : Cultural Asset		
hasID	Datatype Property	Integer
hasName	Datatype Property	String
hasAttraction	Object Property	Attraction
Class: History		
hasID	Datatype Property	Integer
Founded	Datatype Property	String
FoundedBy	Datatype Property	String
hasHistory	Datatype Property	String
hasAttraction	Object Property	Attraction
Class: Accomodation		
hasID	Datatype Property	Integer
hasName	Datatype Property	String
hasType	Object Property	Attraction_Type
hasLocation	Object Property	Location
hasPrice	Datatype Property	String

Table 1: (Continued) The twelve classes of the ontology

Class: Accomodation		
hasService	Object Property	Service
hasTel	Object Property	Contact
hasWWW	Object Property	Contact
Nearly	Object Property	Attraction
Class: AccommodationType		
hasID	Datatype Property	Integer
hasName	Datatype Property	String
Class: Transportation		
hasID	Datatype Property	Integer
hasName	Datatype Property	String
hasLocation	Object Property	Location
hasContact	Object Property	Contact
Class: Activity		
hasID	Datatype Property	Integer
hasName	Datatype Property	String
hasPrice	Datatype Property	String
Class: Contact Place		
hasID	Datatype Property	Integer
hasName	Datatype Property	String
Class: Contact		
hasID	Datatype Property	Integer
hasName	Datatype Property	String
hasTel	Datatype Property	String
hasWWW	Datatype Property	String
hasContact_place	Object Property	Contact_place
hasLocation	Object Property	Location
Class : Location		
hasID	Datatype Property	Integer
hasName	Datatype Property	String
Class : Service		
hasID	Datatype Property	Integer
hasName	Datatype Property	String

Figure 2 shows the relationship of classes and subclasses in the cultural tourism ontology. The ontology is designed in such a way that the users could search semantically based on their interests. Information retrieved from the ontology can support the users' plan, activities, and other requirements they may need.

We use Hozo-Ontology editor as a tool to develop and adjust the designed ontology. In the later stage, the Ontology Application Management (OAM) [9] developed by NECTEC is applied in order to connect the knowledge base with the designed ontology to retrieve the desired information requested by the user.

The evaluation part are divided into two different methods F-measure and OntoQA for evaluating the accuracy of the retrieved information and the structure of the ontology respectively.

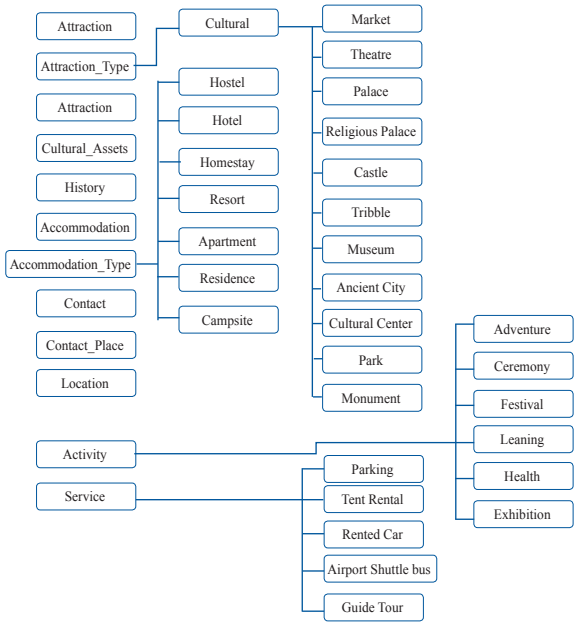

Figure 2: Class relationship.

4 Evaluation

In order to evaluate the correctness of the ontology, F-measure is used to evaluate the effectiveness of the ontology resulting from precision and recall which is calculated as (1)

$$F = 2 \cdot \frac{\text{precison} \cdot \text{recall}}{\text{precision} + \text{recall}} \quad (1)$$

Precision is the ratio of the correct result correspondence to the retrieved result while recall is the ratio of the correct retrieved result correspondence to the correct result in the database.

The experimental result was evaluated from 50 different complex queries which were randomly selected from 200 sample queries collected from various famous tourism searching websites in Thailand such as www.pantip.com, www.unseentravel.com, www.teeteawthai.com, and www.tamdoo.com. The evaluation of the ontology shows 100% precision and 89% recall.

The measured precision and recall are in turn used to calculate the F-measure, which is the effectiveness of the ontology in enabling the correct retrieval of the desired information. The result of the experiment shows that

$$F = 2 \cdot \frac{1 \cdot 0.89}{1 + 0.89} = 0.94$$

Evaluating the schemas and knowledge bases of the ontology in term of OntoQA, the quality of the ontology can be expressed. Various metrics of ontology can be measured so that the certain aspects of ontology and its potential for knowledge information can be evaluated. Table1 shows the schema metrics which are used to evaluate the ontology design and its potential of knowledge representation.

Table 2: Schema metrics

Schema Metrics	
Total Classes	88
Total Relationships	42
Relationship Richness (RR)	0.33
Inheritance Richness (IR)	5.73
Tree Balance	2.49
Attribute Richness	0.22

Table 2 shows that there are 88 classes and 42 relationships in the ontology. Relationship richness represents the variations of the relationship of the classes and the concepts in the ontology. This value ranges from 0 to 1; the lower the value, the lesser the relationship variation. The value RR can be computed using the equation (2)

$$RR = \frac{|P|}{|H| + |P|} \quad (2)$$

P is non-inheritance relationship

H is inheritance relationship

Despite the relationship richness, the inheritance richness demonstrates the depth of the subclass inheritance hierarchy per class. The value ranges from 0 to 1. The instance richness can be calculated by (3)

$$\mathbf{IR} = \frac{|\mathbf{H}|}{|\mathbf{C}|} \quad (3)$$

H is the number of subclasses

C is the number of class

The values shown in Table 2 demonstrate that, while the variation of the relationships in the ontology is low, there are few subclasses in the inheritance hierarchy of each class.

The tree balance metric shows that there are 2.49 subclasses in each class on average.

In order to evaluate the knowledge bases of the ontology, knowledge metrics are shown in Table 3.

Table 3: Knowledge metrics

Knowledge Metrics	
Total Instances	41
Class Richness (CR)	77.92
Average Populations (P)	0.46
Instance Coverage	3.12

The OntoQA analysis in Table 3, shows that there are 41 total class instances.

The value of the class richness metric measures the number of instances across each class. This value varies from 0 to 100. The higher the value, the higher in variation and knowledge base in schema. The value shown in Table 3 demonstrates that the value of class richness which is calculated by (4) is 77.92.

$$CR = \frac{C'}{C} \quad (4)$$

C' is the number of classes that have instances

C is the total number of class in the ontology

The average population metric which is calculated by (5) indicates if there are enough instances compared to classes on average.

$$P = \frac{I}{C} \quad (5)$$

I is the number of instance in the knowledge base

C is the total number of class in the ontology

The analysis from OntoQA shows that the average population metric of this ontology is moderate. The instance coverage metric explains that there are 3.12 instances in each class on average.

From the metric evaluation shown in Tables 2 and 3, the designed ontology is in good condition in terms of quality of its schema and knowledge base which confirms that it can be reused efficiently and effectively as a tourism ontology.

5 Discussion and Summary

The purpose of this research was to construct an ontology for cultural tourism in Thailand which provides tourists with a way to search for their desired

information in a semantic manner. The measurement of the precision and recall of the ontology shows that it supports efficient retrieval of appropriate information in response to the search criteria stated by the user.

The schema and information representations of the tourism information are analyzed to confirm the quality and effectiveness. This research provides tourists to plan and search their interest upon their preferences. The designed cultural tourism ontology can be integrated with the semantic web service that serves the semantic queries for the user.

References

[1] K. Pranter, Y. Ding, M. Luger, and Z. Yan, "Tourism ontology and semantic management system: state of the arts analysis," in *Proceeding of IADIA International Conference*, 2007, pp. 111–114.

[2] S. Ou, V. Pekar, C. Orasan, C. Spurk, and M. Negri, "Development and alignment of a domain-specific ontology for question answering," in *Proceedings of the Sixth International Language Resources and Evaluation (LREC'08)*, 2008, pp. 2221–2228.

[3] N. Tachapetpaiboon and K. Kularbhettong, "Ontology based knowledge management for cultural tourism," *Journal of Theoretical and Applied Information Technology*, vol. 75, no. 3, pp. 384–388, May 2015.

[4] L. Bordon, "A technological infrastructure for cultural tourism," in *Proceedings "Italy in Japan 2011" initiative Science*, *Technology and Innovation*, 2011.

[5] S. Tartir, I. B. Arpinar, M. Moore, A. P. Sheth, and B. Aleman-Meza, "OntoQA: Metric-based ontology quality analysis," presented at the IEEE ICDM Workshop on Knowledge Acquisition from Distributed, Autonomous, Semantically Heterogeneous Data and Knowledge Sources, Houston, TX, November 27, 2005.

[6] M. Uschold and M. Gruninger, "Ontologies: Principles methods and applications," *The Knowledge Engineering Review*, vol. 11, no. 2, 1996.

[7] M. Buranarach, T. Supnithi, Y. M. Thein, T. Ruangrajitpakorn, T. Rattanasawad, K. Wongpatikaseree, A. O. Lim, Y. Tan, and A. Assawamakin, "OAM: An ontology application management framework for simplifying ontology-based semantic web application development," *International Journal of Software Engineering and Knowledge Engineering (IJSEKE)*, vol. 26, no. 1, pp. 115–145, February 2016.

[8] M. L. Sbodio, D. Martin, and C. Moulin, "Discovering semantic web services using SPARQL and intelligent agents," *Web Semantics: Science, Services and Agents on the World Wide Web*, vol. 8, no. 4, pp. 310–328, November 2010.

[9] M. Buranarach, T. Supnithi, Y. M. Thein, T. Rattanasawad, K. Wongpatikaseree, A. O. Lim, Y. Tan, T. Ruangrajitpakorn, and A. Assawamakin, "OAM: An ontology application management framework for simplifying ontology-based semantic web application development," *International Journal of Software Engineering and Knowledge Engineering (IJSEKE)*, vol. 26, no. 1, February 2016.