A FORMAL TOURISM ONTOLOGY
(A CASE STUDY OF NIGERIA)

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Abstract
Tourism is the business activity connected with providing accommodation services and entertainment for people who are visiting a place for pleasure. Information sharing and application interoperability with the use of ontology as data source for tourism domain application have not fully been utilized. Since ontology is the process of specifying the entities, properties or relations that are peculiar to a domain in a formal way, this article builds a formal tourism ontology that captures the domain concepts and relationships between the concepts of tourist centres. The language of representations was description logic. Standard ontology development procedure, which include knowledge elicitation, formalisation and development using ontology development tool were imbibed. This formal tourism ontology serves as a guide for tourists who are interested in specific tourist centres to get adequate and quick information about their area of interest. It can also serve as a reuse ontology for researchers who have common interest.

Keywords: Ontology, Tourism, Description logic, Formalisation, Information sharing.

1. Introduction

Knowledge sharing over computer networks has made people more efficient in different tasks because it has broken down the barrier of time and distance. People can now work in virtual offices, communicate and interact with others around the world. This has been facilitated majorly by advances in computer science such as the internet and the World Wide Web [1]. Although, information has become readily available, information users are now faced with the new problem of information overloading because so much information is scattered across the internet which has made it difficult to aggregate and reuse the right set of content required for specific tasks [2].

The semantic web which is an extension of the World Wide Web has proven to be the solution to the problem of information overloading because it enables the creation of data stores on the web, build vocabularies and write rules for handling data [3]. Since it enables computers to process data semantically [4], irrelevant information can

be filtered and new information can also be inferred from the information available within applications running over the internet. The Semantic Web inherits the power of representation from existing conceptualizations, such as Semantic Networks, and enhances interoperability at both syntactic and semantic levels [5].

Ontology is the specification of conceptualisation in form of a semantic network. It specifies entities or classes, properties or relation that is peculiar to a domain in a formal way [6]. This description is done using some formal languages such as Extensible Mark-up Language (XML), Resource Description Framework/Schema (RDF/RDFS), and Web Ontology Language (OWL) [7]. Ontologies are used in artificial intelligence, semantic web, software engineering, biomedical information, library science, recommendation systems and information architecture as a form of knowledge representation about the world or some part of it [8].

Ontologies (the building blocks of knowledge based systems) are now considered as a tool that can be used for the development of large number of applications in different fields such as knowledge management, e-tourism, among others. But the merits of Knowledge based systems have not been fully tapped as many application developers still rely on the conventional relational databases as the primary source of data thereby limiting the chances of information sharing among systems which has been the major drive of the semantic web. Creating ontologies in various domains in order to provide a centralised data model for system development in specific fields will foster information sharing and application interoperability with the use of ontology as data source for application developers. To achieve this goal in the tourism domain, a tourism ontology was developed for the Nigeria tourism domain, by formalising elicited tourism domain knowledge using description logic, analysing and classifying the knowledge into rules and facts and finally the tourism ontology was evaluated using ontology reasoners.

2. Related Works

Some works have been done in developing ontologies for the tourism domain. Most of the related works reviewed on tourism domain were carried out in other countries as government projects attempted to boost the reach of their tourism sector and to make access to information as easy as possible, some of the ontologies reviewed are discussed below:

i. THE HARMONISE ONTOLOGY: Its goal was to support tourism organizations with data exchange and information without changing their local data structures and information systems. Key concepts in the ontology include events, accommodation, food and transport. Harmonise is based on mapping different tourism ontologies by using a mediating ontology. This central Harmonise ontology is represented in RDF. [9, 10].

ii. THE MONDECA ONTOLOGY: It was built on the World Tourism Organization (WTO) thesaurus managed by the WTO. The thesaurus includes information and definitions of the topic tourism and leisure activities. The dimensions which are defined within the MONDECA Ontology are tourism object profiling, tourism and cultural objects, tourism packages and tourism multimedia content. The

used ontology language is OWL and the ontology itself contains about 1000 concepts [12].

iii. THE QALL-ME ONTOLOGY: It was mapped with two ontologies WordNet and SUMO. It was funded by EU-Funded Project and describes most of the concepts in the domain. It contains 25000 terms and 80000 axioms. It is the largest formal ontology [12, 13].

iv. THE GETESS ONTOLOGY: It is a German Text Exploration And Search System (GETESS). Its aim was to retrieve tourism related information from tourism websites. Queries are issued by users using natural language processing technique and query results are also presented in user friendly way using the same technique. [13, 14].

v. OTA SPECIFICATION: The OTA (Open Travel Alliance) members are organizations that represent all segments of the travel industry, along with key technology and service suppliers. The OTA Specification defines XML Message Sets packages that contain about 140 XML Schema documents corresponding to events and activities in various travel sectors. [12].

vi. THE TAGA ONTOLOGY: The Travel Agent Game in Agent cities (TAGA) ontology is another travel-focused ontology that provides typical concepts of travelling combined with concepts describing typical tourism activities [12, 15].

Most of the tourism ontologies available were developed in RDF and XML. Only few of them were developed in OWL. Since ontology development does not necessarily require formalization in any logic based language, some of their concepts were not formalized. Furthermore as much as the domain is the same, there are some differences in the tourism domain across continent and countries due to their cultural, religious and government structure. Therefore a formalized ontology in description logic was developed.

3. Methodology

The methodology adopted majorly follows the knowledge engineering principles. Figure 1 shows the tourism ontology development life cycle

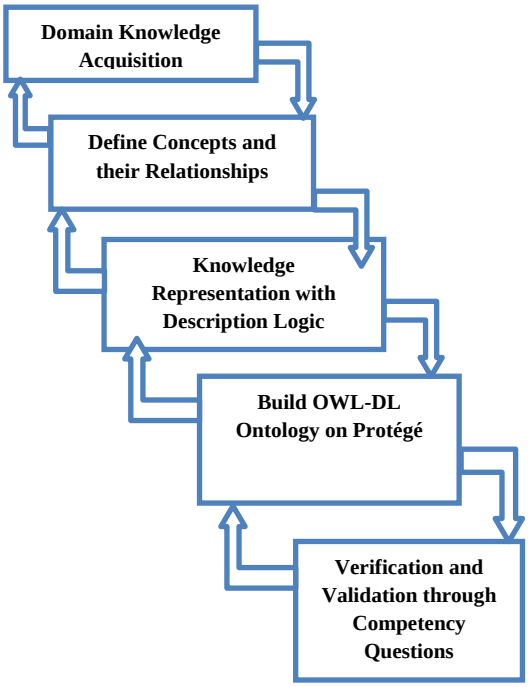

Figure 1: Tourism Ontology Development Life Cycle

i. Domain Knowledge Acquisition: Knowledge elicitation of the domain was carried out using a web crawler, unstructured interview with domain experts and tourists and observation

of the domain by visiting some tourist centres within the country.

ii. Define Domain Concepts and their Relationships: Domain concepts and the relationships between them were identified and documented.

iii. Knowledge Representation with Description Logic: The concepts and their relationships were formalised using description logic in other to add semantic reasoning capacity to tourism domain applications which is the goal of web 3.0 or the semantic web.

iv. Building OWL-DL Ontology: The formalised concepts and relationships were modelled into a tourism ontology using protégé ontology development tool.

v. Verification and Validation through Competency Questions: Some set of rules axioms were written in Semantic Web Rule Language (SWRL). Concepts within the ontology were used to construct SWRL rules axioms that characterised the basic deductive knowledge that the ontology ought to support. The ontology was able to provide answers to operational questions and deduction that were required in the domain.

3.1 Domain Concepts

Some of the domain concepts are Art gallery, item, zoo, forest reserve, location, event, game reserve, rock, river, waterfall, spring, hill, GPS coordinate, artwork, cinema, club, park, restaurant, shopping mall, beach, cave, location, museum, recreation centre, attractions, natural heritage and tourist among others.

3.2 Formalisation with Description Logic

i. Concept: Art gallery
Art gallery is a cultural heritage that exhibits and sells artworks. It has exhibition events.
Description logic Formalisation:
$Art\_Galery \equiv Cultural\_Heritage \sqcap \exists hasevent.$

ii. Concept: Item
Item is a thing that has name, size, weight, price, description and item class.
Description logic Formalisation:
$Item \equiv Object \sqcap hasname.Name \sqcap hassize.S$
$\sqcap \exists hasprice.Price \sqcap \exists hasdescri$
$\sqcap hasitemcategories.Categories$

iii. Concept: Zoo
Zoo is a recreation centre where live animals are exhibited
Description logic Formalisation:
$Zoo \equiv Recreation_{Center} \sqcap \exists containAnimal.Ani$

iv. Concept: Forest Reserve
Forest reserve is a natural heritage and is a tract of land set apart for nature that contains plants
Description logic Formalisation:
$Forest_{Reserve} \equiv Natural_{Heritage} \sqcap haslocation.$

v. Concept: Location
Location is a point or place in physical space and has GPS_Coordinate, name, street, city and state.
Description logic Formalisation:
$Location \equiv Coordinates \sqcap Address$

vi. Concept: Event

Event is an activity that has an activity class, host, theme duration and probably age restriction.

Description logic Formalisation:

$$Event \equiv Activity \sqcap hasStartdate.Date \sqcap hasTheme.Theme \sqcap \exists hasLocation.Location \sqcap \exists hasEndDate.Date \sqcap hasAgerestriction.Age$$

vii. Concept: Game Reserve

Game reserve is a natural heritage that contains wild animals.

Description logic Formalisation:

$$Game_{Reserve} \equiv Natural_{Heritage} \sqcap \exists containAnimal.Wild\ Animal$$

viii. Concept: Hill

Hill is a location higher than greater than 100m and less than 300m

Description logic Formalisation:

$$"Hill \equiv Natura" "l" \_"Heritage" " \sqcap hasAltitude.\geq 100 \leq 300.Height"$$

4. Implementation

4.1 OWL Reasoning and Querying

A reasoner or rule engine is able to infer logical consequences from a set of asserted facts or axioms. It infers hierarchy of classes that are not explicitly described in the ontology. It also performs query processing and answering services. HermiT, Racer ELK and Pellet are some of the common OWL reasoners. Racer and Pellet reasoners were used during the implementation of this tourism ontology.

Querying was done using description logic query and The Simple Protocol and RDF Query Language (SPARQL). SPARQL is a query language like Structured Query Language (SQL) for RDF to retrieve and manipulate information stored in RDF format. SPARQL can be used to express queries across diverse data sources, whether the data is stored natively as RDF or viewed as RDF via middleware.

4.2 Results of Some of the Competency Questions (CQs)

Ontology verification and validation is the last process in the Tourism Ontology Development Life Cycle. It is without doubt that it is one of the most important processes within the development life cycle. It evaluates how applicable the ontology is in the domain. Competency questions were the questions that the ontology must answer with its axioms. These questions were written out before the ontology development started. They served as requirement specification for the ontology development.

The Tourism Ontology was evaluated using these competency questions. They were written in the ontology development environment in the SPARQL tab and DL query view in Protégé 5.0 ontology development environment.

4.2.1 Answer to CQ "What are the classifications of Recreation Centres available in Nigeria?"

The result of this query is shown in Figure 2

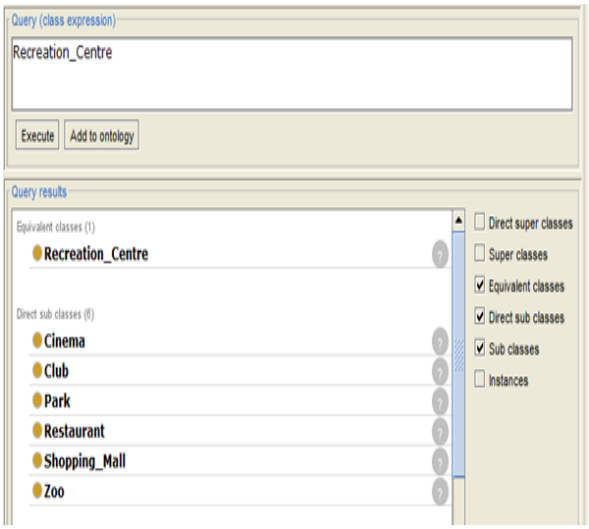

Figure 2: Result of the Query: “What are the classifications of Recreation Centers available in Nigeria”.

4.2.2 Answer to CQ “In what Recreation Centre in Nigeria can I find Wild Animals?”

This question queries the ontology for recreation centre that also contains wild animals. The result shows that wild animals like Lion, Owl, Python can be found in Nigeria, and that it is in Recreation Centres (Zoos) that they can be found. The query and the result of this question is presented in Figure 3.

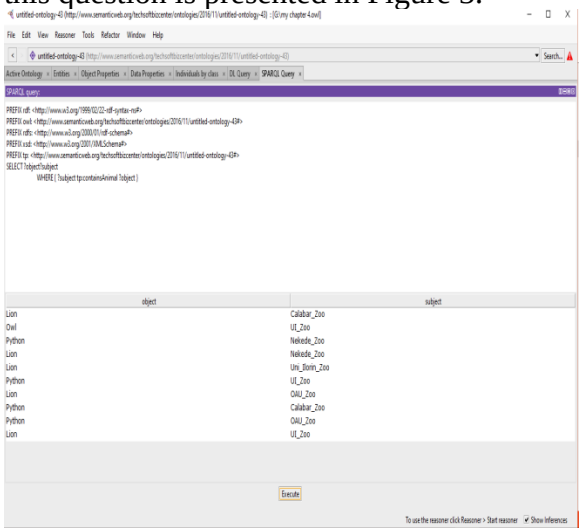

Figure 3: Result of the Query: “In what recreation centre can I see wild animal”.

4.2.3 Answer to CQ “What are the Attractions available in Nigeria and the kind of Activities that take place there?”

This question queries the ontology for all the available tourist attractions in Nigeria and all the recreational activities that take place there. Some of the Beaches in Nigeria were displayed as the result of this question among other attraction and it shows that activities like swimming, and photography can go on there. The query of this question and result is presented in Figure 4.

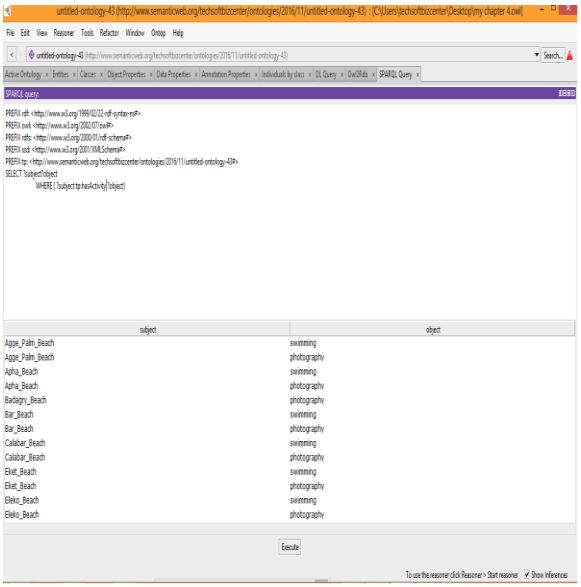

Figure 4: Result of the Query: “What are the Attractions available in Nigeria and the kind of Activities that go on there?”

5. CONCLUSION

This tourism ontology has proven to be a valuable tool. It will in no doubt increase the reach of tourism product and service providers. It will also make relevant information available to tourism users. Also this research has provided application developers with formalized tourism ontology that will foster interoperability and information sharing with the domain. The ontology can be hosted on the web for easy accessibility and sharing for both tourists and researchers in the same domain.

REFERENCES

[1]. Varlan, S. E. (2010). Advantages of Semantic Web Technologies in the Knowledge Based Society. Stiinte Economice, 417-422.

[2]. Bakshi, K., and Karger, D. R. (2005). Semantic Web Application. Cambridge,USA: MIT Computer Science and Artificial Inteligence Laboratory.

[3]. W3C. (2015). W3Consortium. Retrieved August 10, 2016, from W3Consortium website: https://www.w3.org/standards/semanticweb/

[4]. Grau B. C. (2004). A Possible Simplification of the Semantic Web Architecture. WWW2004 (pp. 704-713). New York: ACM.

[5]. Ding L., Kolari P., Ding Z., Avancha S., Finin T., and Joshi A. (2005). Using Ontologies in the Semantic Web: A Survey. Baltimore County: Department of Computer Science and Electrical Engineering, University of Maryland.

[6]. Gruber, T. R. (1993).A translation approach to portable ontology specifications. Knowledge Acquisition, **5**: 199-220.

[7]. Andreasen T. and Nilson J.F. (2004).“Grammatical specification of domain ontologies.”Data & Knowledge Engineering, 48(1): 221-230

[8]. Maniraj, V., and Sivakumar, R. (2010).Ontology Languages-A Review. International Journal of Computer Theory and Engineering, Vol. 2, No. 6, 887-891.

[9]. Werthner, H.and Klein, S., (1999). Information technology and tourism: a challenging relationship. Berlin: Springer. Werthner, H., 2003. Intelligent systems in travel and tourism. Proceedings of the 18th international joint conference on artificial intelligence (IJCAI-03), Acapulco, Mexico, August 9-15.

[10]. Prantner, K., Ding Y., Luger M., Yan, Z., Herzog, C. (2007). Tourism Ontology and Semantic Management System: State-of-the-arts Analysis. In J. Roth, J. Gutiérrez, A.P. Abraham (Eds.), IAD1S International Conference WWW/Internet 2007. Vila Real, Portugal (October 2007): IADIS Press.

[11]. Mathur A., Akshatha K., Shastry A. & , Anitha J. (2015). A Survey on Existing Tourism Ontologies. IJRET: International Journal of Research in Engineering and Technology eISSN: 2319-1163 | pISSN: 2321-7308 Volume: 04 Special Issue: 14 | NCGCT-2015 | Dec-2015, Available @ http://www.esatjournals.org

[12]. Inkpen, G., 1998. Information technology for travel and tourism. Edinburgh: Addison Wesley.

[13]. Ou, S., Pekar, V., Orasan, C., Spurk, C., Negri, M., 2008. Development and alignment of a domain-specific ontology for question answering. In: International Conference on Language Resources and Evaluation, LREC 2008. Marrakech, Morocco; pp. 2221–2228.

[14]. Staab, S. et al. (1999). GETESS – Searching the Web Exploiting

German Texts. In Proceedings of the 3rd International Workshop on Cooperative Information Agents III. Heidelberg, Germany: Springer, pp. 113-124.

[15]. Bachlechner, D., (2004). Ontology Collection in view of an E-Tourism Portal, Technical Report, Digital Enterprise Research Institute, Universität Innsbruck (info.slis.indiana.edu/~dingying/Publication/OnTourism-IADIS-cameraready.pdf) viewed on 17 December, 2016.