

Design and development of a suitable model with supporting technologies for aiding a tourism information retrieval system

Synopsis of thesis submitted to the Jadavpur University for
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Science

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Chapter 1: Introduction

The act of defining tourism is very complex. Though tourism is usually considered to be a leisure activity, concepts like business tourism, medical tourism, etc. also exist. With the evolution of different purposes for travel the act of defining tourism in a particular way has become more challenging. Due to globalization mobility of people has also increased significantly over time. To co-opt with this age some visible changes related to the tourism domain are e-versions of guidebooks supplementing hard copies, tour operators moving online, hotels and resorts investing to increase online visibility etc. To summarize, businesses are investing more to build up their online presence parallel to the increase in internet connectivity. Tourism is a sector where information plays a vital role in decision making (Inkpen, 1998). But above all, a semantic organization of information in a way that the relationships between the concepts become explicit is required. Concepts and relationships can be effectively organized and expressed using knowledge organization systems (Biagetti, 2020). Knowledge organization systems like ontologies are important constituents that can help in realizing the ‘Semantic Web’. From existing literature, it is evident that the multi-faceted, continuously expanding, economically important nature of tourism provides an interesting field for experimenting with semantic web technologies. This is also the primary motivation behind choosing this field for study.

1.1 Objectives, Research Questions & Statement of the Problem

In this thesis, knowledge organization of the tourism domain carried out using techniques from the field of Library & Information Science has been presented. The field of Library & Information Science is fundamentally concerned with organization of information (Bawden & Robinson, 2012). Many important theories stemming from the domain of Library & Information Science are relevant in dealing with the current demands of knowledge organization. Using some of such theories, the demonstrated domain models have been designed to facilitate information retrieval pertaining to accessible leisure tourism and the semantic organization of reviews by tourists. Due to the provisions for mapping within the domain models they can be used together in a tourism information retrieval system. The statement of the problem of the work presented in this thesis is as follows:

“Designing suitable domain models for touristic knowledge management using semantic web technologies”

The thesis has been organized into 6 chapters. In Chapter 2, a quantitative analysis and thorough review of existing literature on the use of semantic web technologies in the tourism domain have been presented. In Chapter 3, sources of data and information, existing standards and vocabularies that are relevant to tourism have been discussed. The objective behind Chapter 2 & 3 is to study and present the research landscape surrounding the applications of semantic web technologies in the tourism domain. The corresponding research question that has driven the study is ‘What are the semantic web compliant technologies, standards and methodologies that are relevant for the tourism domain?’ Chapter 4 illustrates different concepts related to the tourism domain that have been encountered while going through the constituents of Chapter 3. The objective is to define the core concepts belonging to the tourism domain and their associated interrelations while delineating the scope. The research question corresponding to the objective that has driven the study is ‘Who are the major actants (see Latour (1996, p.373)) in the tourism domain?’ Chapter 5 contains a discussion on domain models followed by discussion on two domain models (for tourists and destination managers) constructed for the purpose of this study. The research question ‘What are the needs of the end users?’ has stimulated the study presented in this chapter. Chapter 6 concludes the study by stating the limitations of the work and the prospective usage of the domain models in a tourism information system. The search for answers to the research question ‘What are the prerequisites of touristic knowledge management systems?’ has helped in organizing the content of this chapter. The section titled Reference List, presents according to the APA (7th ed.) style, a compiled list of all the sources cited in this thesis. Appendices have been appended at the last which supplement the discussions presented in the preceding chapters.

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Chapter 2: Literature Review

In this chapter, a quantitative analysis followed by a thorough qualitative review of existing literature on the applications of semantic web technologies in the tourism domain has been presented. Literature published after 2001 up to 2020 were considered for the study as the semantic web was introduced by Berners-Lee et al. (2001) in 2001. The Bibliometrix package by Aria and Cuccurullo (2017) for R (R Core Team, 2020) was used for performing the computing and the obtained results were then analyzed.

2.1 Quantitative analysis

Quantitative methods used in scientometrics help in studying the development of science (Leydesdorff & Milojevic, 2015). Keyword based analysis can help in identifying the trends of development in a research field (Li et al., 2017). Also keyword co-occurrence can help in visualizing emerging research topics in a field of study (Fang et al., 2017). Both the Authors' keywords and Scopus assigned keywords were considered for the presented analysis. The graph showing the growth of the Scopus assigned keywords has been presented in Figure 1.

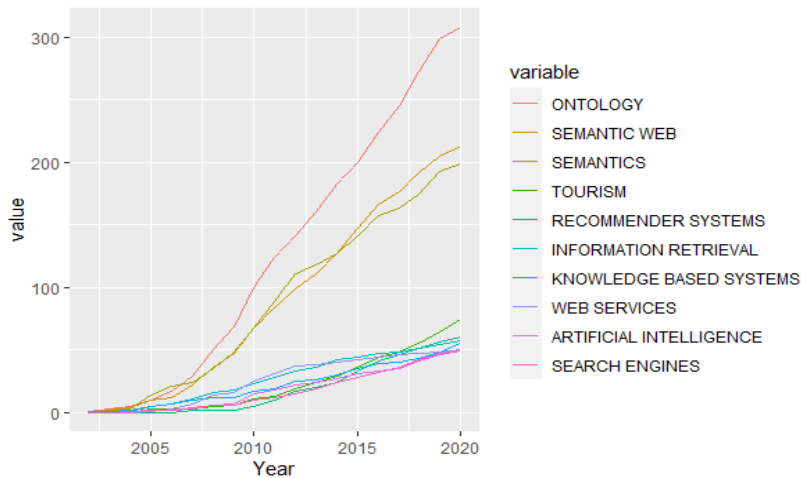


Figure 1: Graph demonstrating the growth of Scopus assigned keywords

The formulas for calculating the value of the indices were applied for studying the keywords during the period 2006-2020, divided into three sections viz., 2006-2010, 2011-2015 and 2016-2020. The obtained values have been presented in Table 1. The value of the indices for the period before 2006 was not calculated since significant growth in the usage of the keyword was noticed since Only in 2006, Linked Data came into the picture (Berners- Lee, 2006). So, the usage count

of the keywords ‘Linked Data’ and ‘Linked Open Data’ in the documents was not found to be among that of the top keywords. Thus, the value of the Popularity index for Linked Data and Linked Open Data for the period 2006-2010 and consequently, the value of the Promising index for the period 2011-2015 could not be calculated. From Table 1, it can be seen that during each period ‘Ontology’ has registered a high popularity index among the others. In 2016-2020, the value of promising index of ‘Linked Open Data’ is higher than the others followed by ‘Ontology’.

	2006-2010 (AC:143)		2011-2015 (AC: 221)			2016-2020 (AC: 229)		
Author keywords	AC	P1	AC	P1	P2	AC	P1	P2
Linked Data	Not in top 20	-----	14	6.33	-----	16	6.99	0.66
Linked Open Data	Not in top 20	-----	6	2.71	-----	12	5.24	2.53
E-tourism	10	6.99	6	2.71	-4.28	9	3.93	1.22
Scopus assigned keywords								
Ontology	90	62.94	100	45.25	-17.69	108	47.16	1.91
Semantic web	57	39.86	80	36.20	-3.66	67	29.26	-6.94
Knowledge based systems	12	83.92	18	8.14	-75.78	20	8.73	0.59

Table 1: Values of the indices of selected keywords corresponding to different periods (AC:Article count;P1:Popularity Index;P2:Promising Index)

2.2 Review

There exist several studies on the application of semantic web technologies in the tourism domain. For example, Ryu (2017) has presented a semantic system that helps in planning customized itineraries using Android smart phones by providing travel related information. Mountasser et al. (2019) have discussed about an ontology-based centralized platform that uses different open data sources for supporting tourists in tour planning. Ontology based tourist knowledge recommendation has been also demonstrated in Pai et al (2019) that uses a tourist knowledge structure constructed from online travel reviews. Sengloiluean et al. (2020) have demonstrated an ontology based semantic text extraction process validated through Recall, Precision and F-measure scores that has been exemplified on the tourism domain.

Cheniki (2018) have developed a context-aware service discovery system. The system is based upon a model that describes properties of context-aware services and is enriched with instances from linked open data. Based on descriptions, matchmaking algorithms have been used to provide contextual services to users. Wang (2018) has proposed a context-aware tour recommendation system that uses ontology for describing spatial, temporal and causality relationships. Aslam et al.

(2020) have proposed an ontology based recommender system where queries can be made in natural language and answers are returned based on user demand and offer relevance.

Nahari et al. (2017) have reviewed the measures for quality assessment of data and have presented a linked data fusion and quality assessment framework. Yang and Chen (2020) have developed a tourism recommendation platform based on linked open data. Paramonov et al. (2016) have discussed about the generation of graphs using linked key phrases that have been automatically extracted from text. The demonstrated approach for key phrase extraction involves a combination of key phrase extraction algorithm and thesaurus-based procedure for better results. Zhang et al. (2020) have presented a tourism knowledge graph using knowledge from encyclopedia and web pages.

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Chapter 3: Data & Information Sources

Guide books have been serving as tourism information source since long. They are used by both tourists and service providers. Nowadays, people refer to travel blogs (for example, <https://www.travelblog.org/>) which are usually sources for learning about tour experiences. Examples of some of the sources have been discussed in this section. Tour related information is available in social media networks (for example, travel related groups or state tourism pages in Facebook), where experiences, recommendations, packages, comparative evaluation etc. are available. Information sources on accessible tourism are a little different from generic tourism information sources by virtue of their focus on accessibility features. Ideally, online sources on accessible tourism should adhere to the Web Content Accessibility Guidelines (<https://www.w3.org/WAI/standards-guidelines/wcag/>). Examples of some of the data and information sources, standards and vocabularies have been discussed in this section. In this section, standards and vocabularies that are used in the tourism and geo-spatial domain have been discussed.

TripAdvisor: Before becoming one of the most popular sources of reviews, TripAdvisor (<https://www.tripadvisor.in/>) used to provide information aggregated from different sources (Keates, 2007). At TripAdvisor visitors rate (using click buttons) and review (using free text) destinations which can be viewed publicly. Reviews in languages other than English can be read using translation. A lot of people study TripAdvisor reviews for learning about travel experiences of others (Keates, 2007).

India Tourism Statistics: It is published regularly by the Tourism Ministry of the Government of India. Based on a methodology developed by the Market Research Division, it provides statistical data on foreign tourist arrivals, foreign exchange earnings through tourism etc. using information aggregated from the World Tourism Organization, different divisions of the Tourism Ministry and different departments of the Government of India like the Bureau of Immigration, Archaeological Survey of India etc (Ministry of Tourism, 2020).

scandichotels.com: In addition to the options for exploring and booking the services offered by the Scandic hotel chain (<https://www.scandichotels.com/>), the website has travel guides and provides information on accessible destinations. The organization adheres to a common standard of accessibility measures followed across the chain of hotels (Scandic, 2012).

Thesaurus on Tourism & Leisure activities: The WTO's multilingual (Spanish, English and French) thesaurus (UNWTO, 2001) provides terminology for enabling standardization and interoperability at a global level.

Service Interface for Real time Information: SIRI is a CEN (Comité Européen de Normalisation) standard format based on Transmodel. 'Public Transport Reference Data Model' (EN 12896) or 'Transmodel' aims to help in establishing interoperability between the transport information processing systems (<http://www.transmodel-cen.eu/>).

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Chapter 4: Domain Study

For the purpose of constructing domain models a thorough study of the concepts belonging to the domain is required so that information required for structuring the domain model is at hand. Concepts and their interrelationships in totality represent a domain. The contextual definition and usage of the terms representing the concepts can be obtained from authoritative resources relevant to the domain. In this chapter, a discussion on some of the basic concepts belonging to tourism and allied domains has been presented. The discussion has been supplemented by definitions that have been taken from different sources that are relevant to the tourism domain.

Accessible tourism: It refers to the tailoring of tourism services and environment for enabling access and enjoyment by all tourists (World Tourism Organization, 2016a). One of the earliest definitions of ‘Accessible Tourism’ that covers different dimensions of access has been provided by Darcy (2006) who has described it as “A process of enabling people with disabilities and seniors to function independently and with equity and dignity through the delivery of Universal Tourism products, services and environments”.

Disabled person: A disabled person is “Any person whose full and effective participation in society on an equal basis with others in travel, accommodation and other tourism services is hindered by the barriers in the environment they are in and by attitudinal barriers” (World Tourism Organization, 2013).

Universal Design: For achieving accessibility, the World Tourism Organization (2016b) has advocated the usage of “Universal Design”, a term coined by Ronald L. Mace, that has been defined by the United Nations Organization (2006) as “The design of products, environments, programmes and services to be usable by all people, to the greatest extent possible, without the need for adaptation or specialized design. “Universal Design” shall not exclude assistive devices for particular groups of persons with disabilities where this is needed.”

Administrative unit: Administrative or territorial division refers to set of districts defined for administrative purposes. It can be defined as “Units of administration, dividing areas where Member States have and/or exercise jurisdictional rights, for local, regional and national governance, separated by administrative boundaries” (Directive 2007/2/EC, 2007). For example, Country (e.g. India), District (e.g. Hooghly), City (e.g. Serampore) are administrative units. Administrative data

supports the implementation of administrative regulations (<https://www.unwto.org/glossary-tourism-terms>).

Transportation: Transportation is the movement of beings and things from one location to other using vehicles such as bus, tram etc. that aid the process of transportation. Transportation network includes spatial network that supports the movement of vehicles or commodity. Transportation operations like passenger exchange, service booking etc., transportation infrastructure like roadways, railways, waterways, terminals, stations etc. are important constituents of transportation network. Public transportation data that includes frequency and availability of services, timetable

References:

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Chapter 5: Domain Models

Among all types of Knowledge Organization Systems, ontologies by virtue of semantic richness are the most evolved (Biagetti, 2020). Ontology based models are highly suitable for systems where multiple agents are involved and are required to cooperate (Biagetti, 2020). Gruber (1993) had observed that “An ontology is an explicit specification of a conceptualization.” There exist different methodologies for construction of ontologies. Faceted classification has been widely used for the purpose of constructing ontologies. Ranganathan’s approach to faceted classification has been found suitable for organization and retrieval of online content (Hudon 2020, p.329). The efficacy of Ranganathan’s methods centering facets for dealing with digital content has been recognized by contemporary researchers (Hudon, 2020, p. 329). Subsequently, different facet categories have been proposed based on modern day requirements that are inspired from Ranganathan’s facet categories.

The discussion on knowledge organization in Dutta et al. (2011) are in reference to Ranganathan’s approach to faceted classification. A domain ontology for the field of library and information science has been developed by Ghosh and Panigrahi (2015) primarily based on the 7th edition of the Colon Classification (Ranganathan, 1987) while also using the Dewey Decimal Classification (23rd edition) by (Dewey, 2011) and the standard edition of Universal Decimal Classification (Universal Decimal Classification, 2005). The YAMO methodology discussed in Dutta et al. (2015) also demonstrates the use of Ranganathan’s vision of the faceted approach to classification and has been exemplified by constructing an ontology on the food domain. Ghosh et al. (2020) have demonstrated the construction of a tourism ontology using a combination of Ranganathan’s faceted approach to classification and the theory of Selective Dissemination of Information for dealing with context.

In the next sections of this chapter, an ontology based model of the accessible leisure tourism domain has been discussed in section 5.1 and the domain model discussed in section 5.2 is for organizing reviews. Several domain models and frameworks for supporting accessible tourism exist. Kehagias et al. (2008) have demonstrated an ontology based architecture that annotates web services for discovery and retrieval with the aim of aiding mobility impaired users. An ontology based system for providing information service to people with special needs has been designed by Alonso et al. (2012).

5.1 Domain model of accessible leisure tourism

The UNWTO's (2001) Thesaurus on Tourism & Leisure Activities was followed to get a grasp over the concepts and extract terms related to the tourism domain. From Scandic (2012) information about the accessible features that are necessary at accommodations were obtained. The elements for denoting accessible provisions in heritage sites that have been mentioned in Hooi and Yaacob (2019) were also useful for learning about potential accessible tourism related requirements. The study by Rodríguez-Rodríguez (2013) was also helpful, where a classification standard for tourist facilities based on the provided technological services has been discussed such that the offered services can be subjected to a quantitative and qualitative evaluation system. In addition to these studies, the information sources discussed in Chapter 3 also helped in gathering information on the domain under study and also guided the process of ontology construction. Any kind of ambiguity regarding the use of a concept was resolved during this phase. The extracted information was analyzed and representative terms for the identified concepts were identified. Some of the terms are trip, eatery, hotel, lodge, terminal, transport, beach, campsite, park etc. Terms denoting concepts with similar properties were grouped together and were labeled. In this way, facets were synthesized.

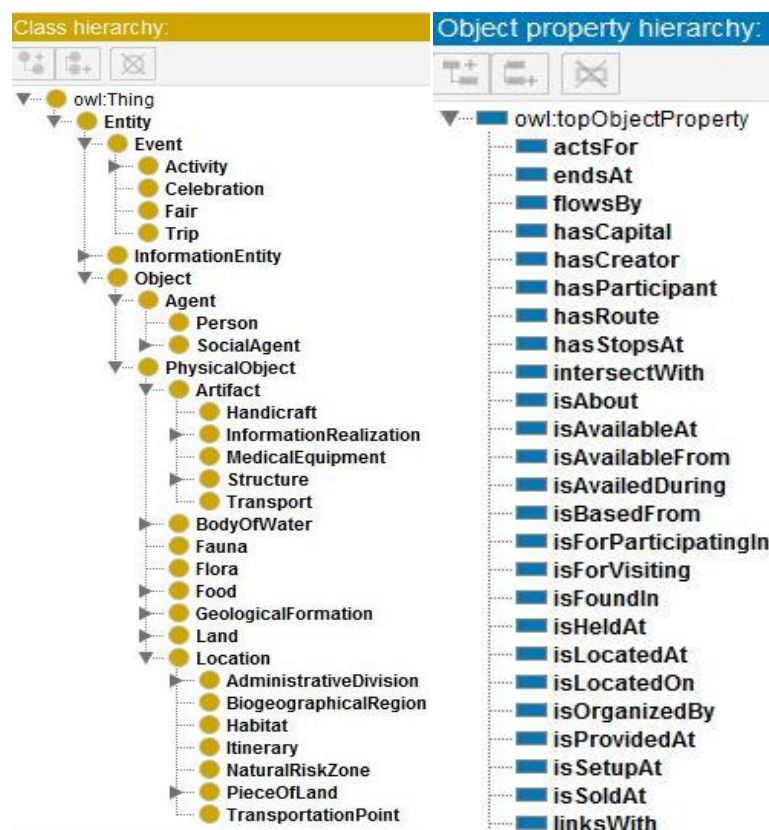


Figure 2: Partial display of classes and object properties used in the ontology

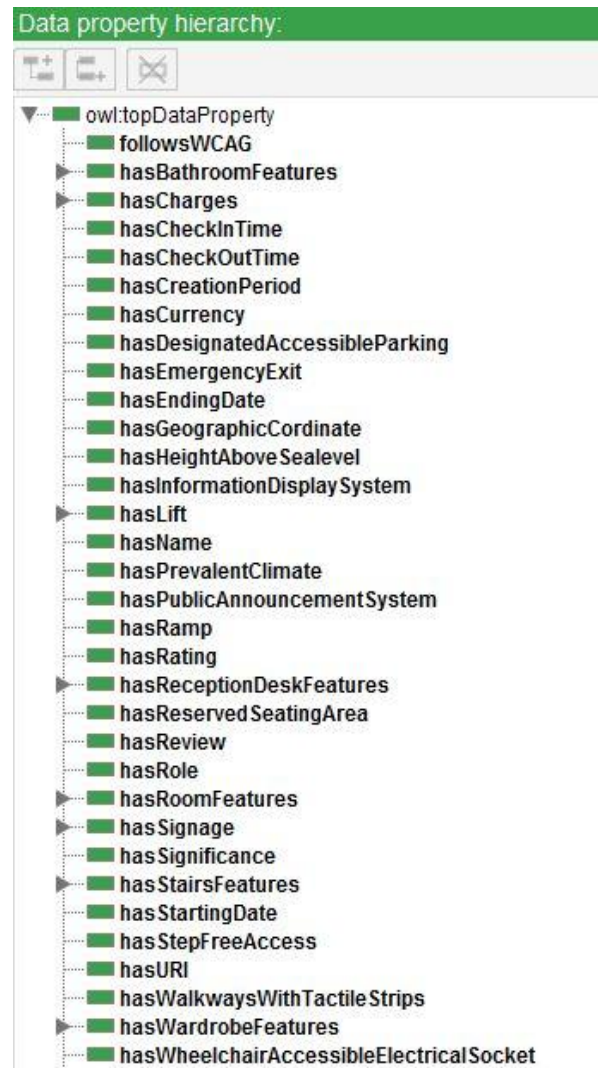


Figure 3: Partial display of data properties used in the ontology

The Protégé-5.5.0 ontology editor was used for building the ontology which is a freely available open-source ontology editor that has been developed by Stanford Center for Biomedical Informatics Research (<https://protege.stanford.edu>). In a Protégé ontology, there are OWL classes and two types of properties namely object properties and data properties. Object properties relate classes. So, next relationships were established using the features of the concepts. Also, the ontology was mapped with the DOLCE+DnS Ultralite (DUL) ontology (<http://www.ontologydesignpatterns.org/ont/dul/DUL.owl>). The demonstrated ontology was tested for consistency and syntactic correctness using the HermiT reasoner (<http://www.hermit-reasoner.com>) in Protégé. Figure 2 and 3 partially shows the classes, object properties and data properties used in the ontology.

5.2 Domain model for organizing reviews

Reviews about Ecopark located in India and Ontario Place located in Canada that were present in TripAdvisor (<https://www.tripadvisor.com/>) till August 2020 were collected for the purpose of the study by web scraping (see Bradley and James (2019)) using the packages *rvest* (by Wickham (2021)) and *dplyr* (by Wickham et al. (2021)) for R (by R Core Team (2020)). There may be different strategies with different justifications for choosing the destinations for the study. But one of the prime reasons for choosing the Eco Park for this study is that it is located in Kolkata where this research is being carried out. The Eco Park is a place with diverse kind of features. Many visitors have reviewed that the place is vast with growing popularity and cannot be covered in a single day. So, it was decided to consider this destination for the study so that the synthesized framework has provisions for organizing a variety of features. After choosing a familiar destination from within the context another destination of similar type was chosen from outside of the context with no familiarity. In contrast to the Eco Park, it was found that the Ontario Place is in a declining phase of growth and has got the attention of the World Monuments Fund. Many reviews about Ontario Place reveal the negative points and the things that the visitors miss about the place. So, use of reviews about Ontario Place provides an opportunity for testing the framework widely on negative reviews. It is envisaged that this strategy behind selecting the destinations for the study will make the framework robust and exhaustive.

The reviews extracted for this study were analyzed with the motive of learning about the destinations from different types of visitors and to know about the interactions of the visitors with different features of the destination. At first reviews about Eco Park from India were used to synthesize a faceted framework for organizing reviews. Then the reviews about Ontario Place from Canada were utilized to validate the framework. The reviews were subjected to a facet analysis as propounded by Ranganathan. Three broad categories of facets were obtained namely, Component, Aspect and Output. Each category of top-level facet consists of several sub-facets. The Component [C] facet consists of Convenience Facility [C1], Recreational Facility [C2], Event [C3], Eatery [C4], Attraction [C5], Greenery [C6], Staff [C7] and Policy [C8]. The Aspect [A] facet consists of Availability [A1], Accessibility [A2], Adequacy [A3], Ambience [A4], Maintenance [A5], Performance [A6] and Management [A7]. The Outcome [O] facet consists of Perspective [O1], Expectation [O2], Time Utility [O3] and Expenditure Utility [O4].

The approaches for facet based domain modeling discussed have guided the construction of the demonstrated ontology. The classes, object properties and data

properties of the ontology were synthesized using the facets belonging to the Component, Aspect and Output categories. As has been shown in Figure 12, the ontology was mapped with the DOLCE+DnS Ultralite (DUL) ontology (<http://www.ontologydesignpatterns.org/ont/dul/DUL.owl>).



Figure 4: Partial display of classes in the ontology

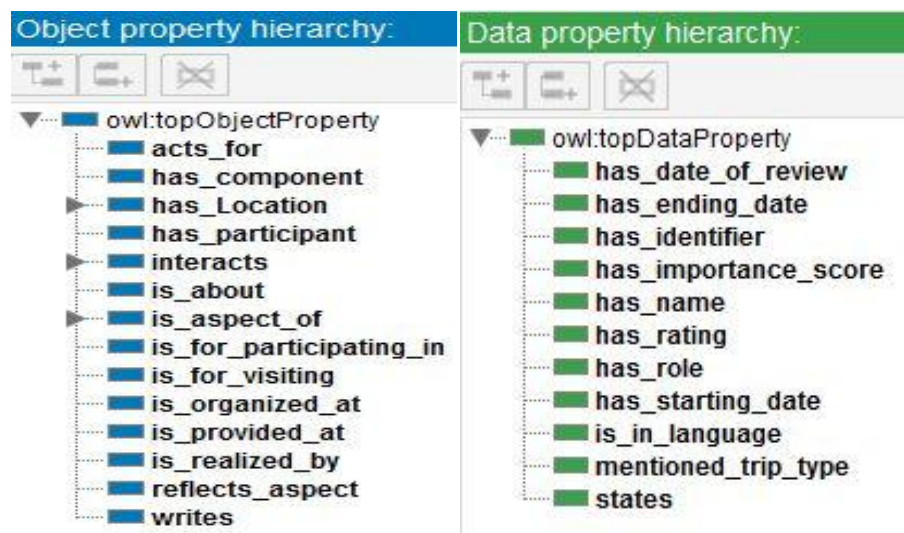


Figure 5: Partial display of object and data properties in the ontology

In GraphDB (<https://www.ontotext.com/products/graphdb/>), the ontology was implemented. A visualization has been presented in Figure 7 that shows the aspects discussed in perspective based reviews. Before populating the ontology, each review was assigned an importance score based on the formula, $S_I = (N_A \times I_R)/100$. Here, N_A represents the number of aspects covered in the review. I_R represents the inverse rating assigned to a review that ranges from 1 to 5. A review that has a rating of 5 in TripAdvisor has an I_R of 1 and a review with rating 1 in TripAdvisor has an I_R of 5. The reason behind this type of value assignment stems from the fact that if not contributed with vested interests, negative reviews have more credibility (Lee et al., 2011). Negative reviews must be dealt at the earliest by tourism development managers. The RDF-rank algorithm (<https://graphdb.ontotext.com/documentation/standard/rdf-rank.html>), which is similar to Google's Page Rank, has influenced the idea of the importance-score calculation. Figure 6 demonstrates a snapshot of a ranked list of reviews retrieved using S_I based on the following query:

```
select ?review ?content
where {
  ?review tro:states ?content.
  ?review tro:has_importance_score ?score.
}
order by desc (?score)
limit 5
```

review	content
A33	"I visited with my wife and 3 kids (10, 7 and 2 years old) and entered from Gate 1. This is the closest entrance to the kids play area. When we arrived in the mid afternoon it was c
A31	"A large open space which has been recently developed by the State Government as a tourist attraction.....it caters to all ages and has plenty of scope for improvement. The er
P42	"I visited Eco Park one afternoon in December. Huge crowds, no proper restaurants, badly maintained. There were plastic bottles floating on water bodies. The boat that was s
A32	"I have been to Eco Park for more than four times, each of my trip was as relaxing and refreshing. But this fifth visit (on Tuesday 11.10.2016) was a horrible and dreadful one.I, I
P41	"Having been born and brought up in Kolkata, I was quite excited to have a place like that in Kolkata. So one day wanted to go with a lot of time in hand. Unfortunately was quite

Figure 6: Output of query using S_I for ranked retrieval of reviews

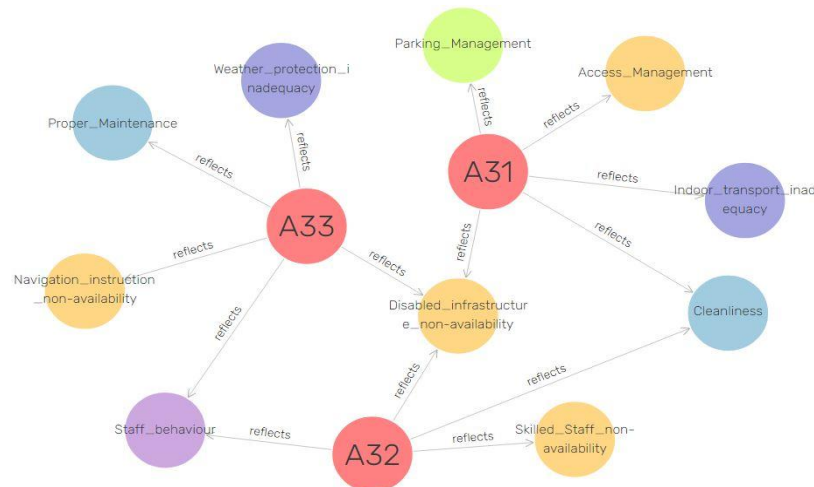


Figure7: Aspects discussed in reviews containing perspective of the reviewers

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Chapter 6: Conclusion & Future Work

It is important for stakeholders of a smart tourist city to be interconnected through a technological platform for exchanging information relating to tourism activities (Buhalis and Amaranggana, 2015). Digital and intelligent services help in efficient management of a city and its services (Hernández et al., 2020). In this concluding chapter of the thesis, the effective usage scenario of the tourism domain models in a prototype of a centralized tourism information system has been presented to which both tourists and destination managers can connect. Also, the limitations of the demonstrated domain models and avenues for improvement have been discussed.

6.1 Prototype System

The two domain models discussed in the previous chapter of this thesis have been used in combination to conceive a prototype of a tourism information system. The actual development and testing of the tourism information system is outside of the scope of this thesis. Figure 8 presents an outline of the proposed system. The prototype depicts two separate modules, one for serving tourists and external applications and the other is for serving destination managers. Each module has an ontology at the core that serves the purpose of the module. In the following section the feasibility (according to existence of relevant studies) of the development of the components of the prototype system has been presented. Figure 9 displays the already existing mapping between the demonstrated ontologies.

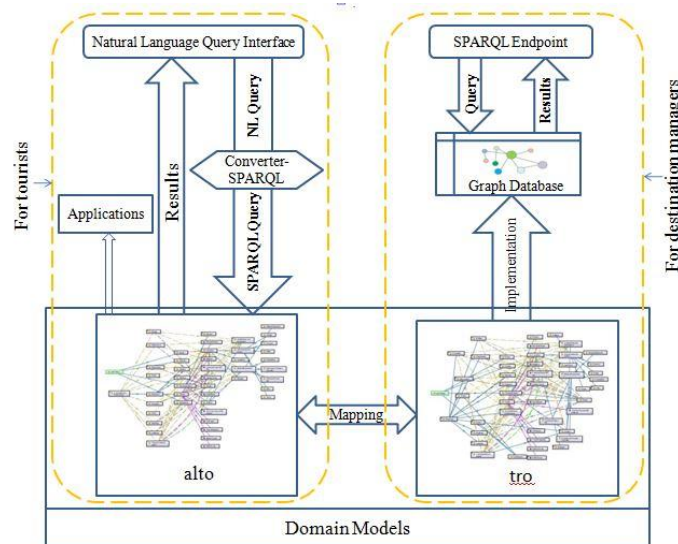


Figure 8: Outline of the proposed prototype system

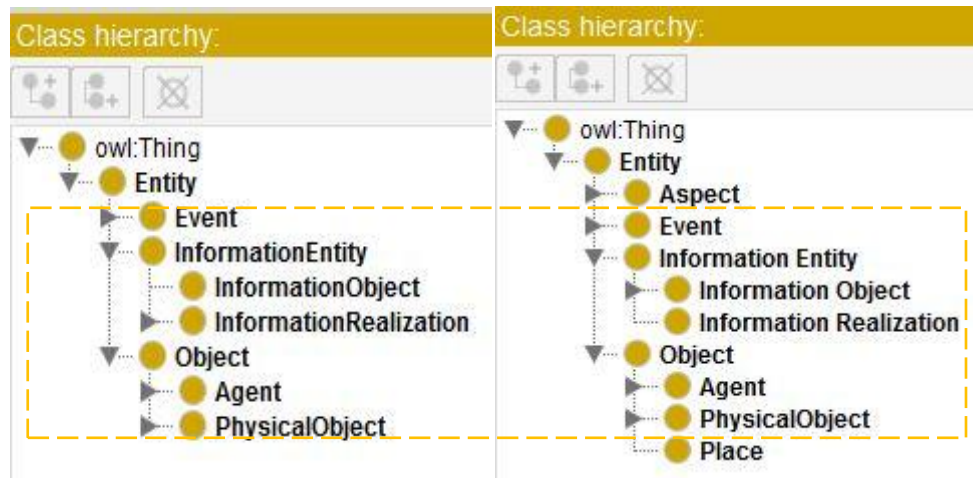


Figure 9: Already existing mapping between the ontologies

6.2 Limitations & Future work

The tourism ontology discussed in section 5.1 has been evaluated using competency questions but it is yet to be evaluated in a real usage scenario. Only then a real measure of its comprehensiveness, expressivity and usability can be obtained. The ontology has been populated from different tourism data sources on the web. Future research for automatically populating the ontology from Linked Open Data sources has to be carried out. It is envisaged that the facet framework discussed in section 5.2 will significantly influence research on knowledge organization centering reviews. But, as of now, the facet framework has been synthesized and validated using reviews from only two destinations. If it is tested on reviews from a wider variety of destinations, then a real measure of its exhaustiveness can be obtained.

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