Representing GeoData for Tourism with Schema.org

Oleksandra Panasiuk, Zaenal Akbar, Thibault Gerrier and Dieter Fensel
University of Innsbruck, Technikerstrasse 21a, Innsbruck 6020, Austria

Keywords: Semantic Annotation, Geographical Data, schema.org, e-tourism.

Abstract: A large amount of tourism data on the web, representing different touristic services, refers to information which is geographically located. With the intensive development of artificial intelligence, interest in the annotation of data is continuously increasing. It is therefore important to describe all tourist needs. To be understandable to search engines, chatbots or other personal assistant systems, content data should be structured, well-formed and semantically consistent. Schema.org is a de-facto standard for marking up structured data on the web. In this paper we show how to annotate geographical information related to different touristic services and activities (e.g. hotels, restaurants, events, hiking and climbing trails) available on an interactive map using the schema.org vocabulary.

1 INTRODUCTION

When visiting tourist destinations, especially new or big ones, tourists are typically challenged to decide the best plan on how to visit a number of points of interest with limited resources such as time and budget. This challenge can be seen as a tourist trip design problem (Vansteenwegen and Van Oudheusden, 2007), where the best route can be determined by combining user interests, attraction, and trip information in respect to time and budget constraints. Different expert systems for trip planning has been developed to overcome the challenge, for example for a city trip (Vansteenwegen et al., 2011) and multimodal tour (Gavalas et al., 2015). To make decisions, those systems built a knowledge base where points of interest's data were obtained from tourists offices, tourist portals, or Wikipedia.

Various tourism related information can be found at numerous information sources including geographical data which are usually presented on maps. These data could be represented differently among systems, causing problems for data integration or data linking. A way to overcome this data representation disparity is through data annotation. Annotation can be seen as a process of connecting two pieces information, typically with a purpose to give a better explanation of the data. Specifically for semantic annotation, the additional information is intended to connect data with its "meaning", in a way so that it can be represented and accessed uniformly. Data that are available in distributed sources can be read and processed by machine automatically. Semantic annotation can be performed manually or (semi)-automatically for different purposes, for example to annotate digital music in such a way that a music item can be located easily according to users choice (Rahman and Siddiqi, 2012), improving search accuracy for web searches (Fuentes-Lorenzo et al., 2013), including geographical data (e.g. points of interest) on a map (Ruta et al., 2012; Stadler et al., 2012).

Semantically annotated content impacts the tourism industry significantly. It feeds search engines structured data in a way that can be presented in a more interesting way visually, for example Google Search has rich features where events will be presented in a structured layout, or recipes in a carousel[1]. It increases online visibility of a typical hotel's website by up to 20% (Fensel et al., 2016). The annotated content can be consumed by intelligent applications, for example to guide a semi-automatic distribution of content to multiple online communication channels (Akbar et al., 2014). Latest technologies such as chatbots and personal digital assistants process annotated content to answer users requests in an automatic fashion.

In this paper, we present our work to annotate geodata (geographical data) which are related to the touristic domain in the region of Tyrol, Austria by using the Schema.org vocabulary. Our intention is clear, annotating geo-data information will not only increase

[1]https://developers.google.com/search/docs/guides/search-features

Panasiuk, O., Akbar, Z., Gerrier, T. and Fensel, D.
Representing GeoData for Tourism with Schema.org.
In *Proceedings of the 4th International Conference on Geographical Information Systems Theory, Applications and Management (GISTAM 2018)*, pages 239-246
ISBN: 978-989-758-294-3
Copyright © 2018 by SCITEPRESS – Science and Technology Publications, Lda. All rights reserved

the region's online visibility but also enable intelligent applications to consume it. We did not use any vocabulary that was developed specifically for geo-data, because most of this vocabulary did not receive sufficient adoption. Instead, we use more common vocabulary that has been widely adopted where an extension will be proposed whenever necessary. To be precise, our contributions are: (i) domain specification for geo-data, (ii) an approach to integrate annotation to a website, (iii) a significant amount of annotation of geo-data of the Tyrol region. The paper will be organized as follow, Section 2 lists a few existing related works and discusses our contributions. Section 3 presents our analysis and defined specification for geo-data, followed by our method to create annotations based on the defined specification in Section 4. Sections 5 and 6 discuss our results and their evaluation, and finally we conclude our work and list some potential future works in Section 7.

2 RELATED WORKS AND MOTIVATION

In this section, we outline our main motivation for annotating geographical data as well as a few existing related works. Touristic industry can not be separated from the development of the region of Tyrol, Austria. In 2015/2016, 11.5 million guests were visited the region, produced 47.6 million overnight stays[2] A way to help the industry is by utilizing semantic web technologies, including semantic annotations (Akbar et al., 2017).

2.1 Motivation

Intelligent applications require a system that feeds them with knowledges in order to make decisions. A widely used system known as Knowledge Graph[3], popularized by Google, uses a graph database to provide structured and detailed information integrated from distributed sources. It has been used in various sectors, for example for sales assistant (Kim, 2017) and question answering system (Kumar et al., 2017). Knowledge graph can be built from semantically annotated content, and therefore it is necessary to have a large amount of annotation to produce a complete knowledge. According to the Web Data Commons[4], in 2016 there were around 1.24 billion HTML pages contain structured data, it is about 38% of the whole pages available on the Web. The number of Resource Description Format (RDF) triples has been increased significantly, about 44.2 billions in 2016, compared to 24.4 billions in 2015.

Annotating geo-data with specific vocabulary is not a new topic, there are a few existing works have been done with variety purposes. The LinkedGeoData project[5] transformed and published OpenStreetMap[6] geographical data using Linked Data principles[7], enabling semantic-spatial search as well as geo-data syndication (Stadler et al., 2012). Linking concepts detected in books to locations (spatial information) could produce a novel location-based recommendation system (De Meester et al., 2015). And there are a few standard exists for digital geographic information, including ISO/TC 211[8].

2.2 Contribution

More than just about structuring data in a uniform representation, semantic annotations approach presents many advantages, including reasoning capability. This reasoning capability is highly needed when developing an intelligent application, for example to determine whether the description of a concept is more general than the description of another concept (subsumption of concepts), or to find all individuals that are instances of a concept (retrieval of individuals).

There are a few existing works that have been producing a large amount of annotation for touristic related informations (Akbar et al., 2017), but none of them include geographical data yet. This work will enrich those existing annotation and providing a base for tourism related geographical data annotation.

Our work is taking advantage of the wide adoption of Schema.org, where classes in this vocabulary have been used more than 50% on average (Meusel et al., 2015). With the support of major search engines including Google and Bing, the rate of adoption is increasing. And therefore we are quite confident that our approach, annotations of geographical data with Schema.org, will also receive the same rate of adoption.

[2]Tirol Werbung, 2016, "Der Tiroler Tourismus Zahlen, Daten und Fakten 2016", http:// www.tirolwerbung.at/ tiroler-tourismus/zahlen-und-fakten-zum-tiroler-tourismus/.

[3]https://en.wikipedia.org/wiki/Knowledge_Graph

[4]http://webdatacommons.org/structureddata/

[5]http://linkedgeodata.org/

[6]https://www.openstreetmap.org/

[7]https://en.wikipedia.org/wiki/Linked_data

[8]https://en.wikipedia.org/wiki/ISO/TC_211

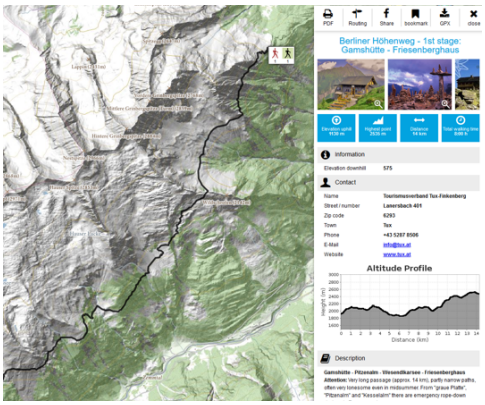

Figure 1: Example of Hiking trail.

3 METHODOLOGY OF GeoData ANNOTATION

In this section we describe the methodology for annotating the touristic services based on their geographical data and discuss the main challenges that arise". As a pilot we use the maps of the Tourismusverband (TVB)[9], Mayrhofen-Hippach[10] and Seefeld[11]. The methodology consists of the following parts.

3.1 Data Content and Format Analysis

Tourist Maps are built based on the information necessary for tourist needs and related activities. That's why, for the annotation process, it is important to analyze the real world representation and to extract existing service types relevant in certain tourist areas according to tourist preferences (Gretzel et al., 2004).

The next step is to analyze online representation of touristic services displayed on the maps, data content and its format. Very often data represent different types of information for the same touristic service, and are semi-structured or unstructured, which causes difficulties for the semi-automatic annotation process. The Interactive Maps of the TVB Mayrhofen-Hippach and Seefeld, which we analyzed, contain a variety of tourism-related information, including hiking or biking routes, accommodation, infrastructure and so on. Besides information about geodata objects, the maps also contains metadata information about points on the map, for example, a contact point for a store, the distance or altitude of a hiking route, or real-time bus schedules at a given bus stop. The content consists of the information from the Contwise Maps, an interactive map provided by General Solutions[12], and information from the external source Feratel[13].

There are two main data structures in the Contwise Maps: (i) Object Types (Forms) and (ii) Categories. The Object Types define the attributes of an object. Every resource (content entry) in the Contwise Maps can have only one object type.The Categories are the menu items and can be nested into a tree structure. They are completely independent from the object type. Resources of any object type can appear in one or more categories and subcategories.

All this information can be accessed through a web API which serves data in a JavaScript Object Notation (JSON) format.

3.2 Domain Definition

In this step we construct the set of domains which we want to annotate. Each tourist object from the map belongs to an object type and categories as mentioned above and may have some subcategory. This is why our primary task is to define domains and select proper types from schema.org based on data structures in the Contwise Maps. We extract the list with object types, categories and subcategories and select a proper type from schema.org, as shown in Table 1. The main challenge here is that the data structures used by General Solutions and schema.org were built for different purposes, leading to discrepancies between their types and properties. Some categories and object types are too general or too detailed, some don't have correct English matches, and some are not covered by the schema.org vocabulary.

3.3 Mapping to a Domain Specific Subset of schema.org

From the domain definitions we get the set of different domains. The next step is to map the data content of these domains to schema.org in a way which suitably represents its types and properties. The main challenge here is to find the best and most suitable way to map the data, i.e. to choose the right class with properties from schema.org. For example, for a Cable Car we choose the type CivicStructure with the following properties: name, description, amenityFeature, contactPoint, image, address, geo, containsPlace, potentionAction,hasMap, and url. Each property has its range, e.g. Text, Url, DateTime, QuantitativeValue.Some elements can have external properties, and we considered them too. Geo in schema.org has the

[9]Destination Management Organization
[10]https://maps.mayrhofen.at/
[11]https://maps.seefeld.com/
[12]https://general-solutions.eu
[13]http://www.feratel.at/

Table 1: An example of the domain definition.

Object Type	Subcategory	Category	Schema.org type
biking	-	Mountainbike-Tour	SportsActivityLocation
hiking	Wandern	Sport & Freizeit	SportsActivityLocation
infrastructure	Pizzeria	Restaurant/ Pizzeria	Restaurant
serviceProvider	Ferienwohnung / Appartement	Ferienwohnung / Appartement	LodgingBusiness
crosscountry		Klassisch	SportsActivityLocation
webcam	-	Video	VideoObject, Place
gdi-lift	-	Ubersicht Sommer-Bergbahnen	CivicStructure
extern-link	-	Skibus; Wanderbus	BusStation
gdi-piste	-	Skigebiet	SkiResort
infrastructure	-	Veranstaltungsort	Event
infrastructure	Hallenbad	Baden; See; Schwimmbad	PublicSwimmingPool
...			

range GeoCoordinates, where GeoCoordinates is defined by longitude, latitude, elevation.

3.4 Domain Specification

This section, based on previous steps, provides the common models for annotating different touristic domains presented on the map. For this purpose we analyze the results from sections 3.2 and 3.3 and choose the wide use domains. Then for each domain we model a domain specification, i.e. select or combine the most suitable defined properties and classes, including the range types. These domain specifications give us the patterns, that can help to automate the annotation process and make it easier (Panasiuk et al., 2018). In Table 2 an example of SportsActivityLocation domain specification is shown.

4 IMPLEMENTATION

In this section, we explain our implementation of the annotation for the content Interactive Maps of Contwise Maps from General Solution. The implementation consists of (i) getting data from the source, (ii) the mapping process from the input to structured data with the vocabulary from schema.org and (iii) annotation deployment. For implementation we use Node.js, as it is good for HTTP requests as well as manipulating data in the JSON format.

4.1 Getting the Data

We get the data via General Solution API. All the requests are simple HTTP GET requests and the results containing all of the data are in the JSON format, which has key value pairs. From the requests we obtain an array of JSON objects for each category and the images for each individual resource. Figure 2 shows the process of getting data via General Solution API.

4.2 Mapping Process

The structure of JSON objects is as follows: a unique identifier, a name, a description, a field for geographic coordinates, an array of category ids and a ”metadata” field containing different information such as address, phone number, and more specific information like the length of a trail, if the trail is suitable for children, the number of beds for a hotel and so on.

The first step of the mapping consists of finding out what schema type the resource should use based on its categories. For that, a list is made with every possible category id and its appropriate schema type. Those categories were often very vague and thus were followed by subcategories. The next step is to map those properties that can always be mapped the same way, those are: id, name, description, coordinates, fields concerning address (street address, postal code, ...), images and URLS. The structure of the program is shown in Figure 3 and can be summarized as follows: if the resource has this or that property then map it in this or that way. So, the program goes through all possible fields the data can have and maps it according to our previous mappings.

The result of this mapping is an array of JSON-LD objects using the schema.org vocabulary, where all meaningful data from the source was annotated as described by our mapping.

4.3 Annotation Deployment

The next step was getting those JSON-LD files into semantify.it[14]. The platform has a nice API where

[14]https://semantify.it/

Table 2: An example of the domain specification for SportsActivityLocation.

Domain Types	Set of properties	Range Type	Attributes
SportsActivityLocation	name	Text	required
	description	Text	required
	image	URL, ImageObject multitype	required,
	hasMap	Map or URL	required
	address	PostalAddress	
PostalAddress	addressCountry	Text, Country	
	name	Text	optional
	addressLocality	Text	required
	addressRegion	Text	required
	postalCode	Text	required
	streetAddress	Text	required
	geo	GeoCoordinates, GeoShape	required
GeoCoordinates	longitude	Number	required
	latitude	Number	required
	elevation	Number	optional
...			

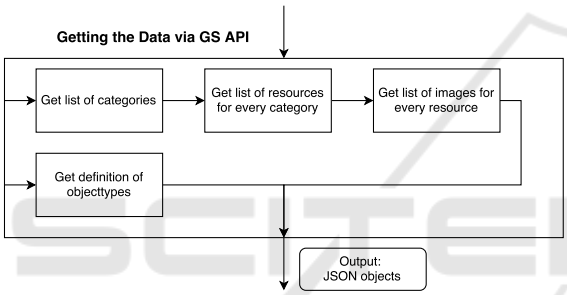

Figure 2: Architecture of getting data via API.

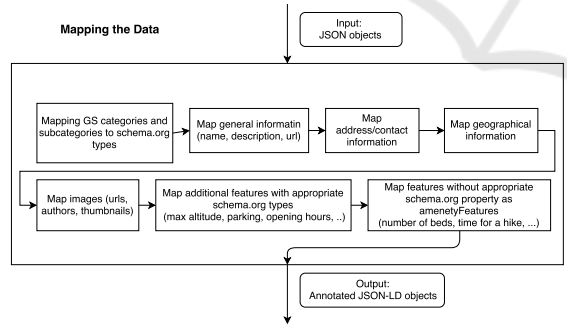

Figure 3: Architecture of mapping the data.

you can upload a few hundred JSON files at a time to a given API-key (linked to an account or organization). So, with just a few requests all the data is transmitted and ready for the customer. (**?**)

5 EVALUATION

We evaluate our annotation model with formally validation the functional requirements of our domain specifications with answering the competency questions (Uschold and Gruninger, 1996). We translate questions into queries, use SPARQL and to answer them and hence formally evaluate our ontology (Stolz et al., 2017). We use Ontotext GraphDB [15] as a software product for storing our annotation and querying them with SPARQL.

As explained in Section 2, the semantic annotations approach was utilized to not only representing data uniformly but also to obtain reasoning capability. Therefore, in the following SPARQL queries, we discuss the capabilities introduced by semantic annotations with Schema.org.

Question 1. Return all trails with average difficulty in Seefeld region.

```
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
PREFIX schema:<http://schema.org/>
SELECT ?s ?name WHERE
{
    GRAPH ?g
    {
       ?s rdf:type schema:SportsActivityLocation.
       ?s schema:name ?name.
       ?s schema:amenityFeature ?feature.
       ?feature schema:name "Difficulty".
       ?feature schema:value "average".
    }.
    FILTER(str(?g)="http://maps.seefeld.com")
}
```

According to the “SportsActivityLocation” specification of Schema.org[16], the type covers variety more specific types such as “BowlingAlley”, “GolfCourse”, “PublicSwimmingPool”. By using this single query, instances of all those specific types will be

[15] http://graphdb.ontotext.com/

[16] http://schema.org/SportsActivityLocation

also included in the result, in consequence of type and sub-type relationships.

Question 2. Return all cable cars and their length in ski resorts of Mayrhofen-Hippach map and with the altitude of mountain station more then 1815m.

```
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
PREFIX schema:<http://schema.org/>
PREFIX dbp: <http://dbpedia.org/resource/>
SELECT ?s ?name ?distance ?elevation WHERE
{
    GRAPH ?g
    {
       ?s rdf:type schema:CivicStructure.
       ?s schema:additionalType dbp:Cable_car.
       ?s schema:name ?name.
       ?s schema:potentialAction ?action.
       ?action rdf:type schema:TravelAction.
       ?action schema:distance ?distance.
       ?action schema:toLocation ?place.
       ?place schema:geo ?geo.
       ?geo schema:elevation ?elevation.
       FILTER (?elevation >= 1815).
    }.
    FILTER(str(?g)="http://maps.mayrhofen.at")
}
```

This second query requested instances of "CivicStructure" which have an additional type of "Cable_car" from DBpedia[17]. This is another advantage of using semantic annotations with Schema.org, where data can be linked with specific types from external vocabularies, for instance to avoid ambiguity.

6 RESULTS

In this section, we discuss results from our work of annotating geo-data available in the maps of TVB Mayrhofen-Hippach and Seefeld. First, we describe the statistics of produced annotations, then discuss in detail about entities that were annotated with multiple types.

6.1 Annotation

In total, we produced about 58k annotations from both maps, where an annotation could has exactly one type or combination of several types known as multi-type entity (MTE). Table 3 shows the statistics of produced annotations.

As shown in this table, more than 93% of annotations were produced from geo-data available in the map of TVB Seefeld, annotated with less than 100 types available in Schema.org. Type "Event" was dominated the annotation (above 73%), followed by

[17]http://dbpedia.org/resource/Cable_car

Table 3: Statistics of Produced Annotations.

No.	Description	Maps of TVB	
		Mayrhofen	Seefeld
1.	Annotations	3.986	53.997
2.	Used types	78	97
3.	Annotations with MTE	1.096	2.481

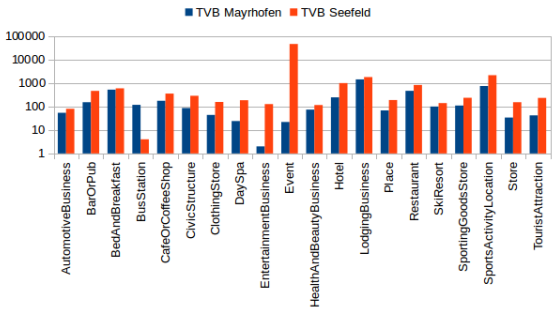

Figure 4: Distribution of types usage (top 20).

"LodgingBusiness" (5%), "SportsActivityLocation" (5%), "Restaurant" (2%), "Hotel" (2%), "BedAndBreakfast" (2%), and the other types were used about less than 1%. About 22% of annotations for TVB Mayrhofen-Hippach were used MTE and only about 4% for TVB Seefeld.

We examined further the top 20 of types used in the maps as shown in Figure 4. The most dominant types found are "LodgingBusiness" and "Event" in the maps of TVB Mayrhofen-Hippach and Seefeld respectively. Also, location for doing sport activities (annotated with type "SportsActivityLocation") was dominating annotations in both maps. For mobility support (indicated with type "BusStation") was dominated by geo-data available in the map of TVB Mayrhofen-Hippach.

6.2 Multi-types Entity Annotation

Another important results are entities that were annotated with multiple types. A multi-type entity will be required whenever the entity can be represented with

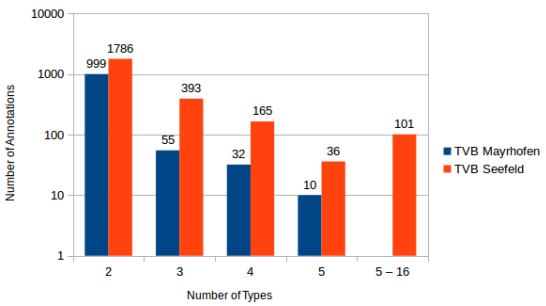

Figure 5: Annotations with multiple types.

a single type. For us, this situation leads us to identify types that are not covered by Schema.org yet, as well as to find types that share similar properties. As shown in Figure 5, an entity could be annotated with more than one type. While most of them were annotated with 2 types, an entity could has up to 5 or 16 types for TVB Mayrhofen-Hippach or Seefeld respectively.

6.3 Discussion

We highlighted the usage of MTE in our annotations because a point of interest on map could has variety of organizational functions. Each function was reflected by a different type. For example, a point of interest[18] has been annotated with 2 types, namely "ClothingStore" and "ShoeStore" to represent 2 different business functions offered by the entity. These business functions were based on categories and sub-categories defined by the data provider, obtained through the mapping to the defined types from the selected vocabulary (as explained in Section 4). Another possibility to represent multi-type entities especially those that related to e-commerce is defining the entity as "Shop" which offers various types of products such as "Clothing", "Bike", "Shoe", and so on.

7 CONCLUSION AND FUTURE WORK

In this paper, we presented a work on representing geographical data related to touristic information available on an interactive map using Schema.org. Our intention was to provide clear description to all identified points of interest such that can be consumed by intelligent application, such as search engines, personal digital assistants. Although many vocabularies for geographical data specific have been proposed, most of them have failed to get wide adoptions. Since Schema.org vocabulary has been widely adopted, we believe that our work will gained wider acceptance from the Internet users. In our work we analyzed data source and format, identified types and categories (including sub-categories) of available objects. For every type and category, proper types from Schema.org were identified, and domain specifications were produced. The software tool was developed to consume the produced mapping, retrieve content from the API, produce relevant annotations and deploy them to a platform in a way ready to be consumed by customers. At the end, we produced about 58k annotations for data obtained from two maps, utilized about 100 different types.

Unfortunately, schema.org doesn't offer every possible type and property for the tourism and travel industry, so a lot of classes and features were just mapped into a new key-value pair. For example, there are no specific types for sport locations and activities, such as: hiking and climbing trails, running and cycling routes and ski slopes, which are so popular for the Tyrol region. We annotate such objects with the help of schema's "SportsActivityLocation", "LocationFeatureSpecification", "TravelAction" and their properties (e.g. amenityFeature, potentialAction, distance) to describe the duration, length, start and end point of a trail and so on. There were also some mapping deficiencies, such as: language differences, different concepts and priorities for data types provided by Feratel, General Solution and schema.org. Also, it is worth mentioning that in some cases, a data instance might inherit properties from multiple types, known as a multi-type entity, as some objects appear in different categories or it is required to use two types to cover one object with schema.org.

Future work is to provide more specialized vocabularies for the touristic domain to build upon the core and start the process of extending the schema.org standard. For this purpose the Schema Tourism Working Group[19] is running. Our ultimate goal is to have all tourism related information in the region of Tyrol, Austria semantically represented on the Web. More than just providing a high online visibility for the region on search engines, these data also contribute to opening new marketing channels such as chatbots and other intelligent personal digital assistants.

ACKNOWLEDGEMENTS

This work was performed with cooperation and support from General Solutions, Tirol Werbung GmbH, TVB Mayrhofen and Seefeld . We would like to thank all the members of the Schema Tourism Working Group for their valuable feedback.

REFERENCES

Akbar, Z., García, J. M., Toma, I., and Fensel, D. (2014). On Using Semantically-Aware Rules for Efficient Online Communication. In Bikakis, A., Fodor, P., and Roman, D., editors, *Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)*,

[18] https://maps.seefeld.com/de#resourceDetail,1653626

[19] https://schema-tourism.sti2.org/

volume 8620 LNCS, pages 37–51. Springer, Prague, Czech Republic.

Akbar, Z., Kärle, E., Panasiuk, O., Şimşek, U., Toma, I., and Fensel, D. (2017). Complete semantics to empower touristic service providers. In Panetto, H., Debruyne, C., Gaaloul, W., Papazoglou, M., Paschke, A., Ardagna, C. A., and Meersman, R., editors, *On the Move to Meaningful Internet Systems. OTM 2017 Conferences: Confederated International Conferences: CoopIS, C&TC, and ODBASE 2017, Rhodes, Greece, October 23-27, 2017, Proceedings, Part II*, pages 353–370. Springer, Cham.

De Meester, B., De Nies, T., Verborgh, R., Mannens, E., and Van de Walle, R. (2015). Reconnecting digital publications to the web using their spatial information. In *Proceedings of the 24th International Conference on World Wide Web*, WWW '15 Companion, pages 749–754, New York, NY, USA. ACM.

Fensel, A., Akbar, Z., Toma, I., and Fensel, D. (2016). Bringing Online Visibility to Hotels with Schema.org and Multi-channel Communication. In Inversini, A. and Schegg, R., editors, *Information and Communication Technologies in Tourism 2016*, pages 3–16. Springer, Bilbao, Spain.

Fuentes-Lorenzo, D., Fernández, N., Fisteus, J. A., and Sánchez, L. (2013). Improving large-scale search engines with semantic annotations. *Expert Systems with Applications*, 40(6):2287–2296.

Gavalas, D., Kasapakis, V., Konstantopoulos, C., Pantziou, G., Vathis, N., and Zaroliagis, C. (2015). The eCOMPASS multimodal tourist tour planner. *Expert Systems with Applications*, 42(21):7303–7316.

Gretzel, U., Mitsche, N., Hwang, Y.-H., and Fesenmaier, D. R. (2004). Tell me who you are and i will tell you where to go: Use of travel personalities in destination recommendation systems. *Information Technology & Tourism*, 7(1):3–12.

Kim, H. (2017). Towards a sales assistant using a product knowledge graph. *Web Semantics: Science, Services and Agents on the World Wide Web*.

Kumar, A. J., Schmidt, C., and Khler, J. (2017). A knowledge graph based speech interface for question answering systems. *Speech Communication*, 92(Supplement C):1 – 12.

Meusel, R., Bizer, C., and Paulheim, H. (2015). A Web-scale Study of the Adoption and Evolution of the schema.org Vocabulary over Time. In *Proceedings of the 5th International Conference on Web Intelligence, Mining and Semantics - WIMS '15*, pages 1–11, New York, New York, USA. ACM Press.

Panasiuk, O., Kärle, E., Şimşek, U., and Fensel, D. (2018). Defining tourism domains for semantic annotation of web content. *ENTER 2018 Conference on Information and Communication Technologies in Tourism, Research Notes in e-Review of Tourism Research*, 11.

Rahman, F. and Siddiqi, J. (2012). Semantic annotation of digital music. *Journal of Computer and System Sciences*, 78(4):1219–1231.

Ruta, M., Scioscia, F., Ieva, S., Loseto, G., and Di Sciascio, E. (2012). Semantic Annotation of OpenStreetMap Points of Interest for Mobile Discovery and Navigation. In *2012 IEEE First International Conference on Mobile Services*, pages 33–39. IEEE.

Stadler, C., Lehmann, J., Höffner, K., and Auer, S. (2012). Linkedgeodata: A core for a web of spatial open data. *Semantic Web*, 3(4):333–354.

Stolz, A., Hepp, M., and Hemminger, A. (2017). Representing fashion product data with schema. org: Approach and use cases. pages 254–272.

Uschold, M. and Gruninger, M. (1996). Ontologies: Principles, methods and applications. *The knowledge engineering review*, 11(2):93–136.

Vansteenwegen, P., Souffriau, W., Berghe, G. V., and Oudheusden, D. V. (2011). The City Trip Planner: An expert system for tourists. *Expert Systems with Applications*, 38(6):6540–6546.

Vansteenwegen, P. and Van Oudheusden, D. (2007). The Mobile Tourist Guide: An OR Opportunity. *OR Insight*, 20(3):21–27.

SCITEPRESS SCIENCE AND TECHNOLOGY PUBLICATIONS