Developing an Ontology for the Online Travelling Domain

Tom de Lange
University of Twente
P.O. Box 217, 7500 AE Enschede
The Netherlands
t.c.b.delange@student.utwente.nl

ABSTRACT
During the last decade, more and more people started to book their trips online. Typically there are two possible options when booking a trip online: let an agency take care of all the trip aspects or book the trip yourself using multiple websites. Choosing the second option implies that you have to visit multiple websites and enter the same data multiple times on these different websites visited. In this research we have investigated, via an online research, what data is required when booking a trip online using multiple independent websites. We identified the most common concepts, and based on that we proposed an ontology, representing a conceptualization of the online travelling domain. This ontology enables to “semantically describe” the data required in multiple independent websites used in the process of booking a trip. The use of such semantic level descriptions will enable the creation of tools and services to facilitate the process of booking trips online.

Keywords
Online Travelling Sector, Ontology, Metadata, Semantic Web

1. INTRODUCTION
In the travelling sector, consumers often make use of multiple service. When planning a trip for example, there are multiple objectives that need to be addressed. The user can choose to stay in a hotel or an apartment and he can decide to go by car or take an airplane. This shows that users can make use of multiple complementary services for booking a trip.

Using multiple complementary services implies that a user should enter the same data multiple times. This research focuses on identifying the common data that is handled in the online booking process. In this work we have identified the common sets of concepts that appear in online travelling related websites (e.g: flight, hotel and rent-a-car websites). Based on the findings, we have developed an ontology, which represents the common set of concepts and their relations. will

The ontology makes it possible to store the data in a structured way. The goal is that different websites can be described with the same “domain conceptualization”, which

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enables to define better interoperability between different websites. This should lower the threshold of using complementary services online. For example, the ontology can be used for user-centric service composition processes, which aims at creating composition of different services in order to personalize service delivery to the requirements of a specific end user [5].

This paper is organized as follows. Section 2 states the objectives and the motivation for this study. Section 3 introduces the research question and methods. Section 4 discusses existing literature. Section 5 describes the online research we have performed. In section 6 the results of the online research are presented. Section 7 discusses the research and results obtained. Section 8 answers the research questions and gives recommendations for future work.

2. OBJECTIVES AND MOTIVATION FOR STUDY
Nowadays, many people use the Internet to book their trips. The evolution of the Internet made trip booking much easier. Booking a trip can be done by contacting an ‘all in one’ travel agency or you can choose to contact all the service providers (flights, hotels, car rentals) for the trip yourself. Choosing the latter option has several consequences: in general, when you do some research, the cost of your trip can be significantly lower and you are free to combine several independent services. However, this choice also leads to a drawback.

Much of the required information must be filled in repeatedly on each different website again. Entering this data multiple times at different websites is time-consuming and arouses annoyance. It would be much better when all this data can be safely stored away and re-used when it is required on yet another website.

However, there are some problems that arise when data has to be re-used by various websites. The first problem is that many travel agencies use different descriptions for the same concepts. For example one uses ‘surname’, while the other uses ‘family name’, both referring to the same notion. Sometimes data is entered differently, like entering only the full name in a single field rather than using two fields, one for the first name and another for the last name. Here arises another problem: among the different countries, there are various representations of people’s names. In some countries for example, the surname comes before the given name. Not only the descriptions, but also the representations that different websites use are important.

Another example is the representation of a date. There are many different ways of representing a date. A date can be represented using one or more input fields. Also, there are
In the travelling domain there are online services that allow you to make use of several offers. For example, Expedia makes it possible to book a hotel and flight, hire a car and book a daytrip. However, when using Expedia, you are still bound to the hotels and flights Expedia offers. We speak of Expedia as a mashup, where the software engineer or company decides which requirements of the end-user he is going to fulfill. This often leads to requirements that are not fulfilled [10].

In the light of this research a better example is when a user books his flight using Ryanair and books his hotel using Booking.com. Ryanair and Booking.com are complementary services, and the user combines these services to fulfill his needs: he wants to trip to a certain destination. This trip exists of a flight and a stay in a hotel. Of course, Booking.com and Ryanair can be substituted by another website that provides the same service. This way, the user plays a central role and makes use of different complementary services of his choice.

4.2 Semantic Web and Ontologies

4.2.1 Semantic Web

Many websites are using different descriptions and representations for the same data. This is a serious problem for the interoperability between different websites. This problem can be overcome by using principles developed in the so called Semantic Web.

The Semantic Web aims at allowing computers to automatically reason on resources available at the web.

A good example of this phenomenon is an online search engine. These search engines can perform keyword-based searches. Based on these keywords, the search engine returns a list of pages that contain the keyword(s). This list often includes lots of pages that are not usable. Semantic Web can enable search engines to search more intelligent and efficient, enabling to filter which results in more useful to an user [9].

Semantic Web adds metadata to data. Metadata is data over data – it describes the actual data. Using these descriptions in a correct manner enables computers to understand the information.

The Semantic Web can be divided in several layers.

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layer, that is the key of this paper, allows making data models using Semantic Web.

4.2.2 Ontologies
Ontologies can make use of semantic web and structure the concepts using definitions and relations [9].

The term ontology has its origin in philosophy, where an Ontology is a systematic account of Existence [3].

There are many definitions that describe the term ontology. In 1993, Thomas R. Gruber gave the following definition: An ontology is an explicit specification of a conceptualization [3].

This concise definition may lead to the question what Gruber exactly means with conceptualization. He defines conceptualization as follows: A conceptualization is an abstract, simplified view of the world that we wish to represent for some purpose [3].

But there are other definitions as well. Guarino for example distinguishes the term Ontology (with a capital O) and ontology. The lowercase form refers to a particular determinate object, while the uppercase form to a philosophical discipline refers [4]. Guarino also argues that Gruber’s definition is not sufficient and pleads that there are multiple explanations for the term Ontology.

![Figure 3: Travel ontology][1]

In this research we refer to an ontology as a conceptualization of a domain that describes the concepts and their relations, without explicitly stating the modeling language.

An example of an ontology is shown in Figure 3. This ontology contains activity providers that provide an activity and have a contact address. In this ontology the activity can be an adventure activity, but of course it is possible to add other activity types.

5. ONLINE RESEARCH

5.1 Online booking sites
For the actual research multiple websites in different categories will be analyzed and a profile will be set up for each category. The union of these profiles of the different categories will give the set of common concepts.

As said, the research will focus on different categories that exist in the travelling sector. These categories represent the different aspects of a trip. This is the list with categories that is used during this research:

- Airline
- Hotel booking
- Transport (car hire and shuttle transport)
- Hostel booking
- Daytrip

Of course this list can be extended much further, but this is out of the scope of this research. Since the limited time given for this research, not all these categories were examined. This is the list with categories that were examined:

- Airline
  - www.cheaptickets.com
  - www.easyjet.com
  - www.ryanair.com
  - www.southwest.com
- Hotel booking
  - www.booking.com
  - www.expedi.com
  - www.hotels.com
  - www.priceline.com
- Transport
  - www.autoeurope.com
  - www.enterprise.co.uk
  - www.rentalcars.com
  - www.shuttledirect.com

5.2 Determine the common set of concepts
For each website on this list, we have identified all the information that is required by that website. This was done by identifying all input fields that exist on that website, and by listing the format of the information and additional details.

For each website the following things were taken into consideration:

- The given description
- Input field type
- Format of the information
- The field name
- The field id
- Our own description

The given description is the description that is given to the input field by the website. In some cases this is done by assigning a label to this input field, in other cases the input field is just preceded by a text.

Input fields can have different types such as a textbox (where a user can enter text) or a radio button (where a user can select one and just one option). It is important to collect this information, since it can help us in making a mapping from the data in the ontology to a website. A website could keep track of somebody’s gender by adding a dropdown menu (a select input field) or two radio buttons representing male and

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[1]: image.png
female. However, in an ontology this will be recorded in one form and therefore should be mapped to another format when required.

Then there is also the format of the information that is entered in an input field. It shows how the information should be filled in. For example it can show if a date should be entered as dd/mm/yyyy or as mm-dd-yyyy. This aspect also gives us the values of dropdown boxes.

We collected the field names and field ids. With the id or name of the field the field can be selected and the corresponding information can be filled in. This will be, however, not be part of this paper.

We have also given our own description to the fields. Sometimes the given definition can be confusing or is not complete and therefore we have also included our own definition. Our own definition will help us to determine common concepts.

6. RESULTS
For this research 12 websites have been examined in a way described in paragraph 5.1.

Most of the examined websites follow the following structure:
1. Search form
2. Results
3. Booking part
   a. Optional booking aspects
   b. Personal information
   c. Payment information

Many of the examined websites offer a standard search and a more advanced search where you can enter more preferences. This search often depends on the language and location that is selected. For this research we have held to the English (US) language.

<table>
<thead>
<tr>
<th>Table 1: Booking.com examination</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Initial search:</strong></td>
</tr>
<tr>
<td><strong>Given description</strong></td>
</tr>
<tr>
<td>none</td>
</tr>
<tr>
<td>Destination/Hotel</td>
</tr>
<tr>
<td>Check-in Date</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Check-out Date</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>I don’t have specific dates yet</td>
</tr>
<tr>
<td>Rooms</td>
</tr>
<tr>
<td>Adults</td>
</tr>
<tr>
<td>Children</td>
</tr>
</tbody>
</table>

| **Booking part:**                |
| **Given description**            | **Type** | **Format**       | **Own description** |
| First name                       | textbox  | “First name”     | Main booker: First name |
| Last name                        | textbox  | “Last name”      | Main booker: Last name |
| Email address                    | textbox  | “email@address.com” | Email address |
| Confirm email address            | textbox  | “email@address.com” | Email address confirmation |
| -Guest’s full name               | textbox  | “First and last name” | Room booker’s full name |
| -Guests                          | select   | “1”..”10”        | Number of guests in room |
| -Smoking                         | select   | “no”..”yes”      | Smoking preference for room |
| Special requests                 | textarea | “Special requests” | Special requests for room |
| Address                          | textbox  | “Address”        | Billing Address: Street |
| City                             | textbox  | “City”           | Billing Address: City |
| Zip code                         | textbox  | “1234AB”         | Billing Address: Zip code |
| Country                          | select   | “Afghanistan”..”Zimbabwe” | Billing Address: Country |
| Telephone                        | textbox  | “Telephone number” | Telephone number |
| Credit card number               | textbox  | “Credit card number” | Credit Card: Number |
| Card holder’s name               | textbox  | “Card holder’s name” | Credit Card: Cardholders full name |
| Expiration date                  | select   | “1”..”12”       | Credit Card: Expiration date: month |
|                                  | select   | “2012”..”2022”  | Credit Card: Expiration date: year |
| CVC-code                         | textbox  | “1234”           | Credit Card: Security code |
| Don’t miss out on great deals delivered right to your inbox! | checkbox | checked/unchecked | Accept advertisement emails |
After entering your preferences the website produces a list with results that match your criteria. From that list with results, you can select the result that you prefer and start booking.

The booking part most of the time requires personal information and payment information. Some websites (e.g. EasyJet) offer additional services when booking. In the case of EasyJet the website also offers hotels to book and travel insurance. Table 1 shows the examination of the website Booking.com. In this overview the field names and ids have been left out.

6.1 Common set of concepts
For all the websites given in paragraph 5.1 a similar overview was created. These overviews were used for determining the common set of concepts.

Every field of each overview was matched to the fields in other overviews in the category. If the field was required by all the websites, or most of them, the field was considered common.

For each category we created a set of common information that is required by the websites in that category. We unified these sets for a total overview of the common information.

When unifying these sets it is important to be careful with overlapping data. You must make sure that the required information of two fields represents exactly the same, preparatory to merging these fields.

Having this total overview of the required information enabled us of distinguishing different concepts. That is, make generalizations of the required information.

During the booking process for example, information of multiple ‘kinds’ of persons is required. We can make a generalization “Person” that has different subclasses, denoting different ‘kinds’ of persons.

The common set of concepts and their appearances for the categories airplane booking, hotel booking and transport booking that we have identified is as follows:

**Address**
- Billing address
- Hotel address

**Credit card**

**Date**
- Date of birth
- Credit card expiration date
- Flight departure date
- Flight arrival date
- Hotel check-in date
- Hotel check-out date
- Car hire pick up date
- Care hire pick up date
- Care hire return date
- Shuttle transport pick up date
- Shuttle transport return date

**Driver’s license**

**Email address**

**Flight**
- Outbound flight
- Return flight

**Hotel**

**Location**
- Flight departure location
- Flight destination location
- Car hire pick up location
- Care hire return location
- Shuttle transport pick up location
- Shuttle transport destination location

**Name**
- Person name
- Hotel name
- Airline name
- Driver’s license issuer name

**Number of people**
- Number of flight passengers
- Number of hired car passengers
- Number of shuttle transport passengers
- Number of guests in room

**Person**
- Booker
- Car driver
- Passenger
- Room booker
- Credit card holder

**Phone number**
- Home phone number
- Mobile phone number
- Work phone number
- Fax number

**Time**
- Flight departure time
- Flight arrival time
- Hotel check-in time
- Hotel check-out time
- Car hire pick up time
- Car hire return time
- Shuttle transport pick up time
- Shuttle transport return time
6.2 Ontology

Figure 4 shows the ontology that was created during this research. The relations and hierarchy follow the concepts and organization presented in the previous section.

For modeling the ontology, the free and open source ontology editor Protégé\(^1\) was used. We followed the guidelines that Horridge gives in his practical guide for building OWL Ontologies [7].

7. DISCUSSION

7.1 Common set of concepts

The common set of concepts is derived from the research that we have performed on the multiple online travelling websites. Although we have researched a small number of websites, we can observe several patterns of data used in the different websites (e.g.: departure dates and return dates appear multiple times, using slightly different representations). For these websites, the ontology has all the common concepts. However, we consider that there are many more websites in each category possibly containing other concepts. This common set of concepts should therefore not be considered complete. A complete ontology needs to be incrementally constructed over time by taking into consideration as much information as possible.

7.2 Ontology

In the ontology that is shown in Figure 4 you can see the concepts and relationships. Unfortunately, Protégé does not provide a way to include the relation names in a diagram.

Because of this we also included an overview with all the object and data property restrictions in appendix A.

During the creating of the ontology, several choices have been made regarding the hierarchy, data properties and the relations between concepts.

For the hierarchy the results of the online research were used. Still, the exact hierarchy is subject to subjective choices. For some concepts, the choice was made to model them as data properties but they can be modeled as classes as well. The choice of the data type always remains subjective and depends of the usage. It is for example possible to represent the gender of a person in many ways. You could use an integer – where for example 1 denotes a male and 2 a female – or use a string that can be “male” or “female”.

The ontology contains a lot of restrictions and depending on the application, these might have to be loosened. Some restrictions require the existence of relationships. When filling the ontology with data, it is possible that not all this information is available and therefore the restrictions should be loosened.

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\(^1\) http://protege.stanford.edu
The ontology that has been set up is completely based on the websites that were examined and therefore might not cover all the concepts that exist in the examined categories.

### 7.3 Application of the ontology

The derived ontology can be used in several ways. Websites can use Semantic Web to describe the required data using the given concepts of the ontology. This way, the websites share the same ontology and required data on a website can easily be matched to a concept in the ontology. This option, however, requires cooperation of the different companies.

There is another option that does not require the cooperation of the companies. Conducting an online research, as it was done in this paper, makes it possible to set up profiles for the different websites. These profiles contain all the required data in the form of input fields. Every input field can be matched to a concept or data property of the ontology.

A tool can be developed that handles these profiles and matches input fields to concepts and data properties. This tool should also support the conversion of data to other representations or formats. This way, the cooperation of the different websites is not required.

An example of this website mapping is given in Table 2. This table contains the input fields of Booking.com and their corresponding concept or data property.

<table>
<thead>
<tr>
<th>Table 2: Booking.com concept mapping</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Initial search:</strong></td>
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</tr>
<tr>
<td>Adults</td>
</tr>
<tr>
<td>Children</td>
</tr>
<tr>
<td><strong>Booking part:</strong></td>
</tr>
<tr>
<td>First name</td>
</tr>
<tr>
<td>Last name</td>
</tr>
<tr>
<td>Email address</td>
</tr>
<tr>
<td>Confirm email address</td>
</tr>
<tr>
<td>Roominfo:</td>
</tr>
<tr>
<td>-Guest’s full name</td>
</tr>
<tr>
<td>-Guests</td>
</tr>
<tr>
<td>-Smoking</td>
</tr>
<tr>
<td>Special requests</td>
</tr>
<tr>
<td><strong>Address:</strong></td>
</tr>
<tr>
<td><strong>City:</strong></td>
</tr>
<tr>
<td><strong>Zip code:</strong></td>
</tr>
<tr>
<td><strong>Country:</strong></td>
</tr>
<tr>
<td><strong>Telephone:</strong></td>
</tr>
<tr>
<td><strong>Credit card number:</strong></td>
</tr>
<tr>
<td><strong>Card holder’s name:</strong></td>
</tr>
<tr>
<td><strong>Expiration date:</strong></td>
</tr>
<tr>
<td><strong>CVC-code:</strong></td>
</tr>
<tr>
<td><strong>Don’t miss out on great deals delivered right to your inbox!</strong></td>
</tr>
</tbody>
</table>

### 8. CONCLUSIONS

The first question of this research stated:

**What is the common set of concepts that are needed when booking a trip using multiple websites?**

To answer this question, an online research has been performed. In this online research we have gathered all the information that is required by the websites when booking a trip online.

The research started with identifying the different aspects of a trip. For each aspect that was going to be examined, websites were selected and placed in categories.

For each category a profile containing all the information required in that category was set up. Based on the profiles we derived a common set of concepts that is used when booking a trip online. The online research showed that there are concepts that are common within categories and concepts that are common in all categories. This common set of concepts contains most of the information required by the websites we have examined.

The second question of this research stated:

**Is there an ontology that can represent the common set of concepts found in research question 1?**

After deriving the common set of concepts, we have tried to set up an ontology. This ontology is based on the results of our online research and the determined set of concepts we have derived. The ontology shows the concepts and the relationships between the concepts. This ontology, however, has his only base in the websites that were examined and can probably be extended further.

The third question of this research stated:

**In what way can the derived common set of concepts and the ontology that was set up help to facilitate the process of booking trips online?**
To make use of the ontology, the ontology must be shared between the different websites. Websites can use Semantic Web for describing their data, using the same “domain conceptualization”. It is also possible to create tools which manage the ontology and support data mapping and conversion. These tools can be used for user-centric service composition processes.

8.1 Future work
As already mentioned in this paper, the time for his research was limited. This limit on time has put a limit on the number of websites and categories to examine. The common set of concepts and the corresponding ontology that is set up, is based on the websites that have been examined and might not fully cover other websites. Profiling more websites will lead to a more complete ontology. Identifying and profiling more categories will lead to an expansion of the common set of concepts as well.

Also for the application of the results of this research, more research should be conducted. This research should focus on the conversion to the data that is saved in the ontology to match the format of the website.

9. ACKNOWLEDGEMENTS
In the first place I would like to thank Bart Nieuwenhuis for helping me set up and guiding me through the research. I would like to give special thanks to Eduardo Gonçalves da Silva for the feedback and suggestions he has given during this research.

10. REFERENCES
APPENDIX
A. OBJECT AND DATA PROPERTIES OF THE ONLINE TRAVELLING ONTOLOGY

To reduce the size of this overview, the only restrictions that belong to the max, exactly and some restrictions have been left out. These only restrictions ensure that the relationship relates to the correct concept. For reproducing the ontology in Protégé, these restrictions should of course be added.

<table>
<thead>
<tr>
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<th>Data restrictions</th>
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<td>CarHireBooking</td>
<td>hasNumberOfPassengers exactly 1 NumberOfPersons</td>
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