NEW APPROACHES IN CONTEXT MODELLING FOR TOURISM APPLICATIONS

David Buján[1], David Martín[2], Ortzi Torices[2], Aritz Uriarte[1]

[1] Deusto Institute of Technology - DeustoTech, University of Deusto,
Avda. Universidades 24, 48007 - Bilbao, Spain
{david.bujan,aritz.uriarte}@deusto.es
[2] Cooperative Research Centre in Tourism - CICtourGUNE,
Mikeletegi Pasealekua, 56, Edificio 201. 20009, Donostia-San Sebastián, Spain
{DavidMartin,OrtziTorices}@tourgune.org

Abstract. The notion of context has been widely studied and there are several authors that have proposed different definitions of context. However, context has not been widely studied in the framework of human mobility and the notion of context has been directly imported from other computing fields without specifically addressing the tourism domain requirements. In order to store and manage context information a context data model is needed. Ontologies have been widely used in context modelling, but many of them are designed to be applied in general ubiquitous computing environments, do not contain specific concepts related to the tourism domain or some approaches do not contain enough concepts to represent context information related to the visitor or tourist on the move as we need in the TourExp project. That is why we propose a new approach to provide a better solution to model context data in tourism environments, adding more value to our solution reusing Open Data about touristic resources from Open Data Euskadi initiative and publishing it as Linked Data.

Keywords: Context Modelling, Knowledge Representation and Management, Ontologies, Open Data, Linked Data, Tourism.

1 Introduction

Information and services personalization is essential for an optimal user experience. Furthermore, this customization becomes even more important in mobile scenarios, where users have to interact with small devices and they usually require very specific information at a given time. That is the case of the tourism domain, where visitors need personalised information about points of interest and activities nearby. This way, it is crucial for services to be able to acquire data about the visitor's context on the move at a given time and place in order to adapt the functionality of the system to the gathered context data. But this personalization is complex, because information from different heterogeneous and distributed sources has to be acquired and it has to be

transformed into a data model to make it machine-processable. Then, the populated data model has to be managed to get the visitor's situation and adapt the system to it.

The notion of context has been widely studied and there are several authors that have proposed definitions of context. Some of these definitions consider context as the surroundings of the interaction between the user and the application [1] [2] [3]. Other authors consider the activity or the task of the user as the main context information for the system [4] [5]. A third group of authors consider that context is the required information to characterize the situation of an entity [6] [7].

In mobile environments, location is the main context parameter to be considered in order to personalize the behaviour of context-aware tourism systems [8]. Most of the existing commercial mobile guides make use of the visitor´s location and user profile as the main context parameters [9]. However, context has not been widely studied in the framework of human mobility and the notion of context has been directly imported from other computing fields without specifically addressing the tourism domain requirements.

Most of the existing context models are designed to be applied in general ubiquitous computing environments or do not contain specific concepts related to the tourism domain. There are some approaches for context modelling in tourism domain but they do not contain enough concepts to represent context information related to a visitor or tourist on the move as we need in the TourExp project. That is why we propose a new approach to provide a better solution to model context data in tourism environments. This solution tries to add even more value reusing Open Data about touristic resources from Open Data Euskadi initiative and publishing it as Linked Data.

The rest of this paper is structured as follows. In Section 2, we introduce different data structures and techniques that can be used in order to represent context information. Section 3 describes our TourExp context data model, remarking aspects to consider for context management and some particular details of our solution, including how the information represented by our data model is published. Finally, we describe our work in progress in Section 4, referring to different applications that are being developed in this project and will access TourExp context information.

2 Background

In order to store and manage context information a context data model is needed. There are several data models that can be used in order to represent context information [10]. These are classified by the data structures that are used to store contextual information.

- *Key-value pairs*: this is the most simple data structure for modelling contextual information. This data model is easy to manage, but lack capabilities for enabling efficient context retrieval algorithms and data inference mechanisms.
- *Markup scheme models*: this model is based on a hierarchical data structure consisting of tags with attributes and content. An example of this approach is the extensible markup language (XML).

- *Object oriented models*: this approach is based on the benefits of encapsulation and reusability. An example of these kinds of modelling techniques is the Java programming language, which is based on classes and objects to represent data.
- *Ontology Based Models*: ontologies can specify concepts with properties and interrelations between those concepts. Also, they offer a very expressive language in order to define axioms and restrictions over those concepts.

Ontologies have been widely used in context modelling, so they can be considered as a valid approach in order to represent context data. One of the first examples of context ontologies is the Context Broker Architecture (CoBrA) ontology [11]. It is expressed in OWL and it represents a collection of terms describing places, software agents, events, and their associated properties. The Standard Ontology for Ubiquitous and Pervasive Computing (SOUPA) ontology is an evolution of the previous ontology [12]. It represents a shared ontology that includes modular vocabularies to represent software agents with associated beliefs, desires and intentions, time, space, events, user profiles, actions and policies for security and privacy. It is divided in two different ontologies, namely SOUPA–Core and SOUPA-Extensions. SOUPA-Core defines a set of classes and entities common to almost all scenarios within pervasive computing, while SOUPA-Extension ontologies extend from the Core and define additional vocabularies to support specific domains. The GAS ontology [13] was developed in order to semantically describe the basic concepts within a ubiquitous computing environment. Its main objective was to provide a common vocabulary for heterogeneous devices that constitute a pervasive computing environment. The ONCOR [14] ontology is basically thought to provide a flexible and practical ontology to describe locations, devices and sensors within ubiquitous computing systems that delivers personalized information in a building environment.

On the one hand, all the above ontologies are designed to be applied in general ubiquitous computing environments, but do not contain specific concepts related to the tourism domain. On the other hand, there are several ontologies in order to represent the tourism domain [15] [16] [17], but these approaches do not contain concepts to represent context information related to the visitor. This way, there is a need to extend and merge the existing modelling approaches in order to provide a better solution to model context data in tourism environments.

3 TourExp Context Model

The main goal of this project is to define the steps to follow when analyzing mobility users, i.e. users of mobile technologies that are constantly on the move. There is also a definition of such users' context so that offers made by the system are bound to valid criteria. As explained in the introduction, tourists are mobility users that have needs of specific information on the go such as information about events, information about interesting places to visit and so on. Contextual systems are ideal to cover those needs because they take into account additional contexts like actual placement of the user, social context, preferences, device types, the weather, etc.

3.1 Aspects to consider for the context management

It was decided to take into account two kinds of aspects when managing the context: human factors (those of the own user) and environmental factors (those that have to do with the environment).

Human Factors

Information about the user. User ID (e-mail), password, gender, country of origin, birth date, physical limitations (blindness, reduced mobility, deafness, etc.), feeding intolerances, religious tendencies and preferences.

Social environment of the user. Information related to the user's social networks (Facebook, Twitter, FourSquare, etc) and travel type (family/ friends/ business/ couple).

User tasks. Track of the user's interactivity with the system to register information about bookings, ratings, selected favorites, check-ins, etc. In addition to this, it is relevant to save information about the travels made by the user and keep them saved on the travel profile (type and motivation of the travel, cost, duration, area of activity, etc). This way, it is possible to make suggestions to the user and create user profiles from the recommendation module that is being developed in this project.

Environmental Factors

User location history. The tracking of the travelers can be made by GPS or by detecting the placement of the network they are using at the moment. Apart from the actual localization, TourExp context model allows to represent historical data about the traveler's placement.

Infrastructure. Having information about public transports and other touristic resources is useful for travelers on the move. Because of this, the recommendation module can grant such information to the user describing the list of resources close to him/her at the time or describing the resources related to the experience selected. The information given might vary depending on the device used by the traveler (mobile device or tourism platform "fixed access point").

Weather. The weather forecast is retrieved from web services like Yahoo Weather so the recommendation module could suggest suitable activities in each case.

3.2 Data Modeling for Context Management

The general data model that represents all the information related to TourExp system has been designed after the analysis made taking into account different input sources: touristic experiences defined at Euskadi Turismo website [18], open datasets at Open

Data Euskadi initiative website [19] and requirements extracted from TourExp's applications. Figure 1 only shows part of the huge data model diagram related to context modeling entities, although the general data model developed in this project is documented in E2.2 deliverable at TourExp website [20].

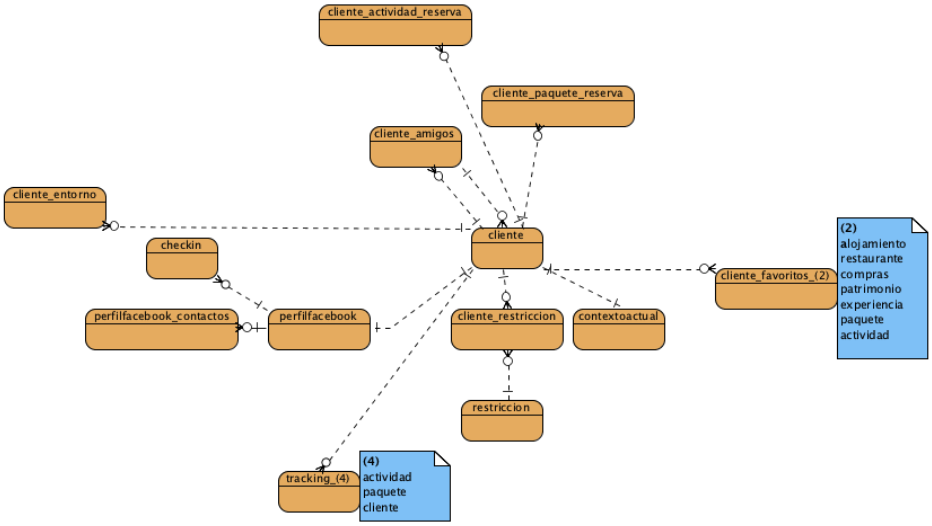

Fig. 1. Diagram with some entities related to context modeling at TourExp.

We invite the reader to look for more details of the whole data model in the TourExp project's website [20], where several aspects taken into account about the relation among the new entities for context modelling and those already present in this project's general model are described. Besides, there are some other aspects of the user context modelling that affect the development of certain modules of the project and that are represented in our model, such as TourExp does not keep track of the use made of it by not logged in users, locates the traveler periodically to keep a tracking record of him/her, relates the actual context of a user during a booking or stores ratings (experiences, activities, touristic resources) made by users. Another remarkable aspect of TourExp developments is that retrieving personal data from a user's social network profile to fill the registration form makes it more user-friendly. On a side note, the data mining process being developed in this project is leading to create traveler profiles for describing the behaviour of the users and enabling the search of "twin-souls" within it to be used in the recommendation module.

Other approaches do not contain enough concepts to represent context information related to the visitor or tourist on the move as we need in the TourExp project, so we have proposed a new approach to model context data in tourism environments.

3.3 TourExp Ontologies to Model Context Data in Tourism Environments

As explained in Section 2, the ontologies from related work designed to the tourism domain [15] [16] [17] and others like QALL-ME, Harmonise, Hi-Touch, DERI

eTourism, cDOTT, Cruzar, ebSemantics and ContOlogy [21] revised in E7.2 deliverable at TourExp website [20] are not enough for this project. Therefore, we have developed a TourExp ontology [22] for touristic resources and related concepts of the project and extended ContOlogy [22] to represent as much context information as possible, matching and adding some entities and properties as shown in table 1.

Table 1. Example of entities and properties matched on ContOlogy.

Data model entities	Data model entities' columns	ContOlogy entities	ContOlogy properties
Actividad	id, plazas, lat, lng, coord, codlocalidad, idproveedor	Activity	Task
diassemana	id, dia_semana	DayOfWeek	-
contextoactual	tipo_dispositivo, GPS	Device	DeviceTerminalBrowser, DeviceTerminalHardware, DeviceTerminalSoftware, DeviceTerminalType,
-	motivo_viaje	Motivation	BusinessMotivation, PersonalMotivation
-	loc_actual, loc_anterior	Location	LocationAbsoluteLocation, LocationRelativeLocation
-	metereologia	WeatherConditions	SkyConditions
-	id_cliente	Visitor	
localidad	localidad, codlocalidad, municipio	Environment	Area, City, Neighbourhood
geometry_columns, tracking_cliente, actividad	-	Location	LocationAbsoluteLocation, LocationRelativeLocation
restriccion		Preferences	Demographics
idioma	id, idioma	Language	
tracking_actividad, tracking_paquete	-	Bookings	ActivityBundleBookings, ActivityBookings

3.4 Using TourExp Context Model

TourExp system publishes all its information in RDF as Linked Open Data by means of a D2R server [23] following the data model described in Section 3. This tool enables RDF and HTML browsers to navigate the content of the database, and allows querying the database using the SPARQL query language. This tool generates a mapping file that relates entities and columns from a database to entities and properties of

ontologies, and it is used by the D2R server to generate RDF files dynamically. We have ruled out a static RDF storage due to the dynamic nature of our database. Figure 2 shows a visual interface for any standard web-browser provided by our TourExp D2R demo [22] and the URLs of both SPARQL endpoint [22] and SPARQL visual browser [22] to query the RDF information.

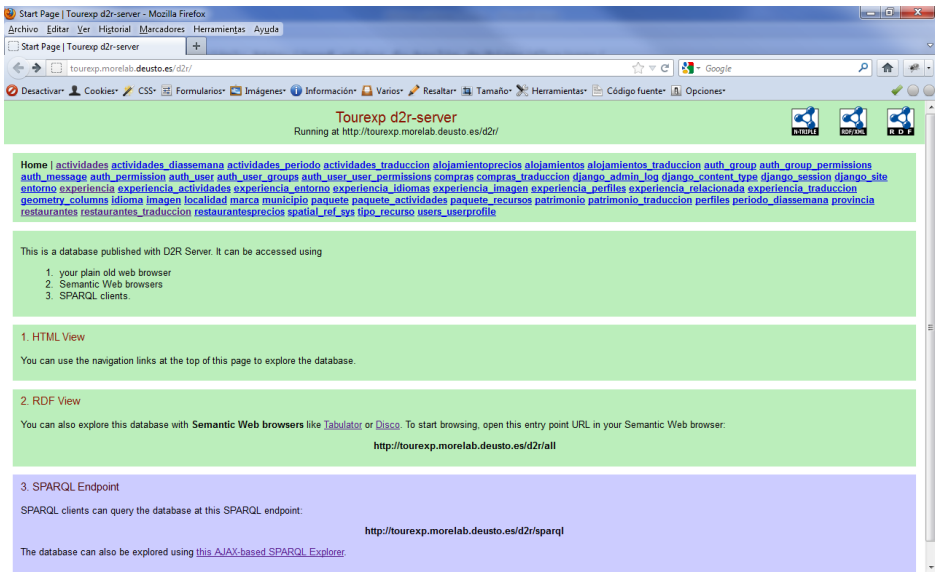

Fig. 2. Visual interface of TourExp D2R server.

4 Conclusions and Future Work

This research work presents a new approach to parameterize, model and share context data related to a visitor or tourist on the move. Human and environmental factors are the main domains that have been taken into account in order to represent the context of a certain visitor at a specific location and time. Also, the bookings of the visitor are being tracked in order to create a better recommendation system based on context data. All the entities that represent context data have been modeled on a relational database that has been mapped to created ontologies. This context data is used by other modules of the TourExp system and also by third party services. We invite the reader to look for more details about the TourExp general architecture at the project's website [20], since every module and application of the system is described in the corresponding deliverables, as well as how they use context data.

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