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Contribution of Semantic Web on Customer Relationship Management in E-Tourism

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Abstract. This paper presents an ongoing research on the development of a customer relationship management in e-tourism. Based both on techniques of the Semantic Web and Adaptive Hypermedia Systems, this paper presents a solution for dynamic adaptation of the offer according to semantic criteria characterizing the Internet. A case study about tourism in Côte d'Or department in Burgundy is presented.

Keywords: e-tourism, semantic web, adaptive hypermedia systems, profiling

1. Introduction

Since 1970, with the reservation systems by computers, to nowadays with the Internet, innovations in technology have radically transformed the tourism process and strategies [1]. During this period: 1/ the link between customer and supplier has been shortened, removing intermediaries, 2/ opportunities for direct access to the offers have multiplied and 3/ the low cost strategy seems to have become the only criterion of quality. However, these innovations have significantly reduced customer support in their choices and consultancy services and customization of the offer as they exist in travel agencies. Managing customer relationships is a strategic thinking based on a watch and a careful analysis of the client, establishing a relationship of trust, involvement of staff and partners, continuous monitoring for continuous innovation. A new technology is booming: profiling (or behavioural targeting). This new area of web marketing is to analyze the requests of users to better understand and target, more efficiently, expectations and demands. Through the research of a surfer, you can not only know what type of service he likes, if he has children or even if it has responded positively to an electronic newsletter. The impact of these new fields of study likely to exceed the current investigations and help to adapt efficiently and calculated the tourism demand of users. Based both on techniques of the Semantic Web and Adaptive Hypermedia Systems, this paper presents a solution for dynamic adaptation of the offer according to semantic criteria characterizing the Internet. *The Semantic Web is an evolving development of the W3 Consortium in which the meaning (semantics) of information and services on the web is defined*[1].The Adaptive Hypermedia Systems have traditionally attempted to deliver dynamically adapted en personalised presentations to users through the sequencing of reconfigurable pieces of information [2]. This paper is articulated in three parts. The first part presents the context. The second part presents a quick state of art on Semantic Web and Adaptive Hypermedia Systems and the third part presents our proposal.

2. Tourism and technology, a case study.

Since 2006, the company "Côte d'Or Tourisme" is conducting research to develop a website to unite all tourism offerings of the department of Côte d'Or. This department is located in the heart of Burgundy (Bourgogne). It has an area of 8 763.21 km2 with a population of about 500 000 inhabitants. The vineyards

[1] http://en.wikipedia.org/wiki/Semantic_Web

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of Burgundy (Marsannay, Gevrey Chambertin, Chambolle Musigny, Aloxe Corton, Meursault ...) are located on this department with the Yonne and Saône et Loire departments. In 2008, the department of Côte d'Or received over 1.8 million tourists (data from hotels, campgrounds and bed & breakfasts in France). Figure 1 shows the impact of technical developments of the website on the Internet crowd. In 2007, the site is developed in HTML with some Java applets for animation. The tourism offer is not structured. Suppliers may not directly fill the website. In 2008, almost 4,000 suppliers are federated in a database. Filling processes are developed. However, the use of these new solutions shows a real digital divide between the suppliers. Oversight mechanisms to help providers have been established. However, site traffic has multiplied by 5. The Access to a complete set of up to date data seems to be a factor of attractiveness. In 2009, the company wants to offer web sites dedicated to specific audiences. This first step results from an analysis of profiling users. The website becomes a portal, providing access to a variety of websites: nearby tourism (http://www.tamtam21.com/), tourism dedicated to vineyards (http://www.divine-comedie.com/), nature tourism (http://www.bouger-nature-en-bourgogne.com/). Professionals also their website dedicated to the filling process and support process to help them on technical aspects.

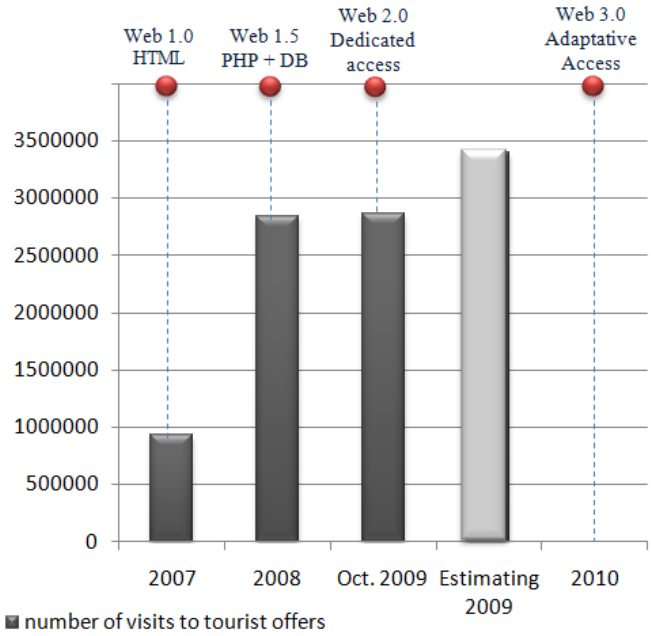

Fig 1. Evolution of attendance / Technical trends

The new features of Web 2.0 (Social Web) are available such as personalized access, blogs, forums, etc. Attendance at these websites increased by about 15%. The addition of Social Web features to tourist offers shows real involvement of some Internet users (comments, reviews, tips ...). Currently, the company wants to develop a relationship management customer much finer. The company continues its research work in the field of Semantic Web and Adaptive Systems. The idea would be to develop a site for dynamically profiling the user's behavior by offering him a combination of tourist offers tailored to their profile. For example, if the user wishes to find a restaurant that would welcome him with his children, the system will provide first restaurants with children's menus which are located near a public garden or park.

3. Background

The Adaptive Web Systems are commonly called Adaptive Hypermedia System (AHS). In the following section, the AHS main properties are introduced as well as the semantic Web technologies.

3.1. Adaptive Hypermedia Systems

The research in adaptive hypermedia system has been very prolific these last 10 years. It results in new terms, models, methodology and systems which revealed to be useful and powerful. Some systems have been developed these 10 last years, giving principally solutions for e-Learning which is considered as the first application domain, for example [3, 4, 7]. Moreover, attempts to define reference models have been made as

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shown in these projects [5, 6, 8, 9]). Each system and model brings its own architecture and methods. Most of them are based on a set of several layers also called models which separate clearly the different tasks to be done. It appears that all of them have at least in common a user model, a domain model and an adaptation model. The domain model contains the whole domain knowledge (information, documents, etc.), the user model contains his knowledge, his interests, etc., and the adaptation model manages the user model, matches the domain model with the user model, and provides adaptation. There are three main type of adaptation, according the researches:

- Content adaptation: consists in hiding/showing or highlighting (or not) the information.
- Navigation adaptation: consists in modifying the hypermedia structure by suggesting links or driving the user to a defined destination.
- Presentation adaptation: consists in focusing (or not) on pieces of content or links, and in adapting to the hardware or page setting preferences.

The adaptation model is the central master piece of the Hypermedia Adaptive System because it uses the others models in order to process the adaptation. In addition, most of the model definitions are driven by the Oriented Object Model (OOM). This design model is well adapted to define the architecture and the interactions between the different system components. Nevertheless, the use of OOM for the definition of the user and domain models to define the knowledge of the domain is not adapted in our opinion. Actually, the knowledge management and ontology domain which is strong of thirty years of research in artificial intelligence and description logic is of value in AHS in order to model the knowledge. The semantic Web takes also advantages of this previous research in AI by defining languages and associated tools allowing the processing of knowledge as well as assertions on the knowledge.

3.2. The semantic Web

The semantic Web led to a standardization of languages like OWL for ontology creation. In the context of computer sciences, an ontology defines a set of representational primitives which allows the knowledge modeling of a specific domain. Ontologies are widely used to capture and organize knowledge about a particular domain. Ontologies formally define relations between terms. A typical ontology for the web has taxonomy and a set of inference rules. The taxonomy defines object classes (concepts) and relation between them, and inference rules provide efficient reasoning on the terms. Thus, associating concepts with documents, keywords, etc. it is possible to reason directly on them. Beyond the possibility to do complex models quite easily, their standardization allows their sharing between applications. However, the challenges in Ontology development and management are great. Ontologies providing the semantics for the Semantic Web have to be developed, managed, and endorsed by committed practice communities. Whatever is the domain of application (meteorology, bank transactions, biology, tourism, etc.), concept definitions is required. In addition, the Semantic Web is not just for the Web. Actually, it represents a set of technologies that will work equally well on internal corporate intranets. The Semantic Web will resolve several key problems facing current information technology architectures as Web services [10]. Moreover, the nature of Web 3.0 technologies is difficult to define precisely, but the outline of emerging application has become clearer. The Web 3.0 applications are based on the Resource Description Framework (RDF) that provides a means to link data from multiple web sites or databases. With the SPARQL query language, a SQL-like standard for querying RDF data, applications can use native triple stores and extract RDF data from traditional databases. In RDF, if two data elements are recognized with the same URI, then they can be joined in a merged graph. RDF Schema (RDFS) and the Web Ontology Language (OWL) provide the ability to infer relationships between data in different applications or in different parts of the same application. These Semantic Web languages allow for the assertion of relationships between data elements. The term “linked data” is often used to describe the evolving RDF development space and “Semantic Web” is increasingly being used to describe coupling linked data with RDFS and OWL [11].

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4. Semantic modeling of Tourism Offer

The semantic Web technologies can be easily integrated as a data format which allows to defined linked data. Actually, our adaptive hypermedia system is based on the semantic Web technologies, and especially on domain ontologies and their inference rules. Thus, the domain model is defined as an ontology of domain where each concept represents an abstract or concrete domain entity (accommodation, hotel, camping, activity, etc.) and where relations between concepts are defined (hierarchical links, possession links, etc.). The user model is constituted of several domain dependant and independent parts. The first part is represented using an overlay model on the domain model; it is an overlay enabling the definition of user interests on the concepts of the domain. The second part is a set of <attribute-value> pairs which is a centric user definition and independent of the tourism domain (age, sex, etc.). The inference rules are defined into the adaptation model to reason over ontology models, the domain model and the overlay part of the user model. The rules are first order rules well known as Horn clauses and use the syntax SWRL, a semantic Web rule language that combines OWL and RuleML. First order logic is simple and powerful and gives solutions to complex problems. The adaptation is processed with the use of an inference engine allowing the assertion of content, presentation and navigation from the domain rules on the domain ontologies. From the realized inferences on the user and domain models, adaptation model can provide different adaptations. Following the system creator desires, the adaptations are done differently using multiple data mining algorithms in the adaptation model. They consist in diverse algorithms like, for example, clustering algorithms to create clusters of concepts or users, basing on same features. Content and navigation adaptation are provided according the results of these algorithms. For the presentation adaptation, only domain independent user features are used, it has no impact on the content to be shown (only on the appearance).

4.1. Ontology construction process

In order to create and develop our ontology, we processed in three steps. First, the database developed to store all the offers of the supplier was used as a starting point to create the ontology of domain for the domain model in the AHS. Second, the following step consists to enrich the ontology with axioms not present in the database but well known by the professional of the domain. Most of the time, it is materialized by semantic links between concepts which are most of the time lost by the relational model. In addition, the hierarchical structure is refined with the help of the professional in order to define a more appropriate hierarchy related to the links previously added. Finally some axioms that permit to define necessary condition are added. For instant, the concept “gîte de france” is a restaurant and a hotel. In description logic, this rule is represented by: “$GiteDeFrance \equiv Restaurant \sqcap Hotel$”. Third, the last step consists to populate the ontology with instances from the database. In order to formalize the knowledge, we distinguished three types of tables in the database:

- “*Data*” tables corresponding to touristic objects like hotels, camping, etc.
- “*Const*” tables corresponding to constant tables like touristic labels, languages, etc.
- “*Relation*” tables corresponding to association tables between “Data” and “Const” tables.

For instance, the table “*rel_speak_res*” models the languages spoken by the restaurants. It connects the touristic object hotel with the constant table Language, and each row defines a language spoken by a hotel. A table “*Relation*” could also connects two “*Data*” tables. Due to complete lack of space the complete script of the database is not presented. In order to facilitate the population process, views are created due to the complexity of the base and the useless of certain tables and attributes. These views are listed in a centralizing table where their type is specified (“*Data*”, “*Const*” or “*Relation*”). This is done to simplify the base and select useful data for the ontology construction. It is a manual process done with experts help. All the view names are formatted to be explicit (for instance “*res*” becomes “*restaurant*”). A translator program has been developed to translate this set of views in ontology. Each “*Data*” and “*Const*” views becomes a concept into the ontology and each “*Relation*” views becomes relation between two concepts into the ontology. Then the program populates the ontology. This process consists in adding instances to concepts and relations to the ontology (for instance, adding the individual “*Hotel Ibis*” to the concept “*Hotel*”). This population is done by

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using the row of each view. Actually, we can consider that a data indexation is done on the database by the ontology. The phases of translation and population are automatic phases.

4.2. Interaction between user and adaptation models

User features are captured in a user model. These features are either domain dependant or independent. As said before, independent elements are <*attributes, value*> pairs and the dependant part is an overlay on the domain model. The overlay consists in a weighting of domain concepts in order to model interests on them. User model is initialized and kept up to date by the adaptation model following user interactions with the system. The proposed links are all (almost) relied to one or several concepts of the domain ontology. Basically, a click on a link generates a weight increasing of the associated concepts in the user model. Domain independent elements are principally collected by direct questions to the user (age, sex, job, etc.). The adaptation model comprises a set of rules about ontology concepts and relations. These rules are defined by domain experts. Following the user interests on concepts, rules are triggered. They can generate a user model update, which could also trigger other rules, etc. The adaptation model proposes information to the user from the domain model, corresponding to the user overlay model. It is a content adaptation if the content is directly shown to the user, or it is a navigation adaptation if links are proposed. Presentation adaptation is based principally on the non-overlay part of the user model. Indeed, the user context (hardware type, bandwidth, etc.), page setting preferences and so on, are in this part.

5. Conclusion

A lack of user adaptation and personalization has been shown in tourism oriented systems. To remedy to this, we propose the construction of an adaptive hypermedia system based on three models (user model, domain model, adaptation model) using semantic web tools. Indeed, ontology models are used to model complex and sharable knowledge structures, and to realize rules based inference. Beyond the use of domain, user and adaptation models, the trend is to use additional models like presentation, goals, context or others models but no generic model for adaptive hypermedia system has already integrated them. It will be the object of a future article.

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