A semantic approach implemented in a system recommending resources for cultural heritage tourism

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In the last few years the tourism industry has profoundly changed. Today, a large number of tourists use the internet to find destinations, itineraries, services or travel packages, rather than asking experts in the field. For this reason, Information and Communication Technologies play an important role in tourism promotion. In particular, recommendation systems are interesting because they are able to offer more appropriate support than traditional search engines to the user seeking places to visit. Recommendation systems, in fact, are able to suggest a personalised set of options according to the user's needs and preferences. But, as widely recognized in the literature, with these systems the quality of the recommendation is closely linked to the description of both resources and users. For them to become effective tools for promoting the knowledge, culture and traditions of a territory, it is necessary to integrate semantic information into the descriptions of resources, that can capture relationships among them. In this way, it is

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possible to enrich the list of recommendations by adding those resources which, although not explicitly related to the user's request, have some semantic relationships with those included in the list. This can help to promote the discovery of new scenarios and the spread of knowledge about the cultural heritage of a territory. In this scenario, the paper presents a semantic approach amplifying cultural resources recommendations. This approach was used to enrich the list of recommendations of *CulTuRek*, a system that promotes the exploration of tangible and intangible cultural heritage in the Apulia Region.

1 Introduction

The wide number of resources available in the web increases each day thanks to the tools available for web 2.0, which has changed internet users from simple consumers into producers (Giurgiu, 2008). Such an explosion, on the one hand, is making the spread of information more complete and faster, but on the other, extending the problems related to the difficulties in picking those resources best suited to the individual needs. This increases the risk that the user may develop a feeling of disorientation and frustration during the search process. One of the most interesting challenges in research fields that aim to manage the web information overload, such as Information Retrieval and Information Filtering, is to offer suitable, personalised support to the user. In particular, in the field of Information Filtering a new technology has been developed to face the information overload problem: Recommender Systems (RSs). These are intelligent applications that are able to suggest products, information or services that best fit users' needs and preferences, using information about the content of the items, the user profile and, rarely, context information (Baltrunas *et al.*, 2011).

In the tourism domain, recommender systems are particularly interesting because they are able to suggest a set of tourist products and services tailored to the user's needs and preferences. Thanks to the development of such systems, in the last years tourism promotion has profoundly changed because, first of all, the web is the main source of information where travel products and services can be retrieved, and, secondly, mobile phones have become one of the main platforms used to access the web. For this reason, in the last few years the number of applications (available both on personal computers and on mobile devices) built to support travellers before, during and after the trip has grown (Ricci & Nguyen, 2006). Such systems, besides offering support to the user seeking places to visit, can promote a better knowledge of the culture and traditions of a territory, but to do so they need to be integrated with semantic technologies that can capture the intrinsic properties of the resources, going beyond their own representation or coding to enhance differences and to offer context-aware suggestions.

The paper describes the semantic approach used in *CulTuRek* (Di Bitonto *et*

al., 2011a; Di Bitonto *et al.*, 2011b; Laterza, 2012) a recommendation system designed to promote local cultural heritage tourism which is able to enrich the set of suggestions by adding those resources that have important cultural relationships with those which explicitly satisfy the user's request. One of the main strong points of the defined approach is that it is general enough to be applied to any type of resources, such as points of interest, tourist services, or in-depth material that could enhance the value of a tourist trip or educational tour. The paper is organised as follows: section 2 describes the state-of-the-art of recommendation systems which use semantic approaches; section 3 presents the defined hybrid recommendation process in which a semantic approach for the enrichment of recommendation is used; section 4 reports the implementation of the described recommendation process in a recommender system for the promotion of cultural tourism in the Apulia region. Finally, some conclusions and future works are discussed.

2 Related works

The literature contains ample experimental evidence proving that the semantic approach is effective in recommendation systems. In the last few years, in fact, a new generation of systems has been emerging. They use the web semantic and web 2.0 technologies to improve the computational performances of recommendation methods and hence the quality of suggestions supplied. These systems are known as *Semantic and Social Recommender Systems* (Oufaida & Nouali, 2009). In (Szomszor *et al.*, 2007); for example, the use of collaborative tagging, known as folksomies, is proposed to enrich users' profiles and improve the recommendation. The prediction of the user interest, in fact, is calculated according to the semantic similarity between the user and items tagclouds. In (Baltrunas *et al*., 2011; Sungrim & Kwon, 2007) the semantic approach is used to produce a context-aware recommender system that can adapt the recommendation on the basis of the user's changing contexts of interest. In other words, if during the interaction the user transfers his/her interest from one type of content to another, thanks to a multi-level ontology the system changes the list of suggestions to adapt it to the new context. In other research, moreover, semantic technologies are used to reduce the problem of over-specialization, typical of content-based systems. News@hand (Cantador *et al*., 2008), for example, is a recommender system in which both the news to be suggested and the users are described as concepts in domain ontologies, and these descriptions are enriched by drawing semantic relations among the concepts in order to produce enhanced recommendations.

In the tourism domain, Compass (COntext-aware Mobile Personal ASSistant) (van Setten *et al*., 2004) is a context-aware recommender system which,

by means domain ontologies, supplies information and services, ranging from lists of buildings to friends, that are best suited to the user's interests and the goal of the trip. Another example in the cultural tourism field is Art Recommender (Cramer *et al*., 2008; Wang *et al*., 2008; Wang *et al.*, 2009), developed in the CHIP (Cultural Heritage Information Personalization) project in collaboration with the Rijksmuseum Amsterdam (Netherlands). Like Compass, Art Recommender exploits semantic relations among items in the recommendation process to suggest to the user other works of art (paintings and sculptures in the museum) related to those of his/her main interest. Each artwork is described by features derived from standard taxonomy-based vocabularies (such as artist, place and time, themes, and so on) and the system calculates predictions of user interest using the semantic relationships between the user's request and artworks of interest to him and all the artworks in the system database. In other words, on the basis of the semantic relationships Art Recommender calculates a Belief value to predict the user's interest in semantically related artworks and topics.

As previously described, the semantic enrichment process, implemented in *CulTuRek* to produce a recommender system promoting local cultural heritage, uses semantic relationships among the resources in the system to find links among them and supply a list of recommendations that could foster a knowledge and exploration of other items, allowing the user to make new discoveries. Unlike other described solutions, *CulTuRek* uses the web 2.0 social approach to gather resources: in fact, the community of users can upload and describe them. The structured descriptions are stored in the metadata and used to compute semantic relationships. In this way, an advanced tool is made available for tourism promotion, in which the semantic relationships include not only those derived from the resource contents but also those derived from the resource description inserted by the user.

3 Semantic approach in the recommendation process

The main objective of the defined recommendation process is to promote local cultural heritage, suggesting places to visit, events to attend, interesting items about folk culture, and so forth. A consideration of the cultural value of each item during the recommendation process is therefore crucial. For this reason a hybrid and cultural context-aware approach was defined that could estimate the utility of an item for the current user. The approach consists of three main steps: *Retrieval, Ranking and Semantic Enrichment* (Laterza, 2011; Di Bitonto *et al*., 2011a; Di Bitonto *et al*., 2011b). The semantic approach is used in the last step, but in order to show how the semantic relationships are used, the whole recommendation process is briefly described.

The ***Retrieval*** step evaluates the utility of the items on the basis of the user's preferences in terms of cultural/educational objectives and requirements about the trip such as geographical area and time period of the trip. The peculiarity of this selection is that the set of constraints (time and space) that the resources must comply with has been enlarged, so as to avoid excluding from the recommended set some resources that might be interesting and could allow the user to gain a better knowledge of the territory. The next step after the selection of resources that meet the user's request is the ***Ranking*** step. It identifies the items which are likely to be best suited to the user on the basis of other users' opinions. The peculiarity of this ordering process is that it considers multi-criteria information as well as the user's objectives at the time when the recommendation was requested, in order to guarantee as precise an ordering as possible. The *Retrieval* and the *Ranking* steps are combined in a *cascade*, i.e. according to the hybridization method in which one recommendation technique is firstly employed to produce a coarse ranking of candidates and a second technique refines the recommendation from among the candidate set (Burke, 2002). The result of the first step is selection from the set of available items of a subset of items that have the same utility value according to the user's request and that are suited to the user's preferences. This result is the input of the second step, that ranks the selected subset using the feedbacks on each item provided by the community of users. In this way, the items to be suggested will be ordered according to the utility assigned to each item by users with similar characteristics to the target user. The result of the first two steps is a recommendation list suited to the user characteristics and goals, but that does not take into account relations among resources. Then, the recommendation process ends with the *Semantic Enrichment* step, that identifies items that have not been explicitly sought by the user but that are semantically related to those requested. The peculiarity of this enrichment phase is that, thanks to the semantic approach, it is able to include in the recommendation set resources that could stimulate the user to learn more, owing to their correlation with the resources that have been explicitly requested. The ***Enrichment*** step is combined in *mixed* mode with the *Ranking* step: the recommendations from both steps are presented together at the same time. The result of this last step is a selection of resources which have not been considered during the selection process, but that are interesting because of their semantic relationships with those already selected, and so are included in the final recommendation list.

3.1 Semantic relationships among the resources

Thus, the semantic approach used in the proposed recommendation process considers semantic relations among items in order to offer a more complete

list of items to visit and to foster a wider knowledge. In particular, starting from a set of selected resources, all resources that have some kind of semantic relationship with the resources with the highest predicted utility are added to the recommendation set. In this way, a better learning is fostered by discovering associations among resources. The semantic approach that carries out this enrichment process is based on the assumption that if two resources have properties in common they are mutually related. Considering two sets of resources, for example, R and S, where R is the set of resources with the highest-predicted utility values (result of the retrieval and ranking steps), and S the set of available resources in the system, the semantic enrichment process consists of two main steps. First of all, it compares the metadata of each resource in R with the metadata of each resource in S. If there is any resource s, in S, that has some properties in common with a resource r, in R, the system infers that there is a relationship between r and s. For example, two artworks are created by the same artist. All the resources in S correlated with the ones in R are added to the recommendation list (Figure 1a).

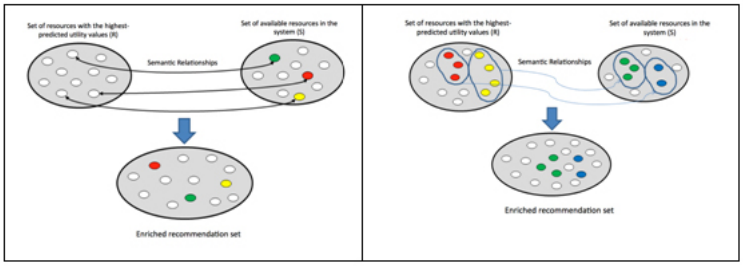

Fig.1 - Semantic enrichment: (a) first step and (b) second step

The next step of the semantic enrichment identifies the relationships among resources in R by comparing the metadata. In other words, for each pair of resources in R, it checks if they have properties in common and so, on the basis of the common properties, creates a set of correlation properties. For each set of correlation properties, the set of resources in S is checked for the same properties. These are considered to be semantically related to the resources already included in the recommendation list and are therefore added to this list. Figure 1b depicts the result of the process.

4 CulTuRek: a recommender system to promote local cultural heritage turism

The defined Semantic Enrichment approach was implemented in an innova-

tive recommender system prototype: *CulTuRek*. The prototype of the system, described in greater depth in (Laterza, *op.cit.*; Di Bitonto *et al*., *op. cit*.), is able to suggest both tangible items (such as castles, museums, churches, etc.) and intangible ones (such as festivals, religious parades, legends, cooking traditions, etc.) of interest to a general tourist and to teachers aiming to arrange a tour for their students in the Apulia Region to learn more about its cultural heritage.

In the system, each item is described by a metadata schema that allows the resources to be contextualised in the culture of the territory (Di Bitonto *et al*., *op.cit*.). As previously described, in order to identify relationships between resources the semantic enrichment approach compares the values of metadata describing the resources themselves. In particular, when comparing descriptions of the resources of the two sets (R and S) the metadata values express a structural dependence or englobement of the resources considered. If there is a dependency between a resource r in the recommendation list, consisting of the resources considered most useful to the user (set R), and a resource s in the system database (set S) - for example, one resource is part of another resource or one resource is inside another - the resource is added to the recommendation list.

Let us consider, for example, the "*Crypt of St. Nicholas*" in the province of Taranto, where there is the "*Christ Pantocrator*" a fresco painting. This structural dependence is described in the metadata through relationships such as "*it contains*" and "*it is inside*". Let us suppose a user who intends to travel to Taranto is willing to move some kilometers away, and is interested in religious architecture and particularly fascinated by the medieval period. Based on these requests, the resource "*Crypt of St. Nicholas*" is selected in the first two steps of the recommendation process, while the resource "*Christ Pantocrator*" is excluded. The first phase of the enrichment process, by comparing the semantic descriptions of resources, notes that there is a structural dependence between the two resources and that the community of users has considered a visit to see the fresco a must when visiting the crypt. The "*Christ Pantocrator*" is therefore added to the recommendation list. Furthermore, since the painting does not correspond exactly to the user request, the system provides an explanation of why it is suggested, for example: "The fresco painting *Christ Pantocrator* is inside the *Crypt of St. Nicholas*". The enrichment process continues by comparing the descriptions of resources in the recommendation list in order to identify common properties among them. In this case only the metadata values *Creator*, *Typology* and *Original_location* of each resource are taken into account. These are compared with the values of all metadata of each other resource in the recommendation list. If the list contains "*Crypt of St. Nicholas*" and "*Crypt of S. Angelo*" in Mottola (Taranto), and "*Castle at Gioia del Colle*" (near Bari), when comparing the values of metadata it will be discovered that

the set of items {"*Crypt of St. Nicholas*", "*Crypt of S. Angelo*"} has in common the *Typology* metadata value = " hypogeal Crypt". The semantic enrichment process, therefore, will select from the set of resources not yet considered the item "*Spanish Cellar*" in Laterza (Taranto), that even if it is not a medieval building, is a hypogeal structure and so could allow the user to learn more about other hypogeal structures in the territory.

Conclusions and future works

The web has become the primary source for searching for travel products and services for leisure, business or cultural purposes. The huge amount of information and sources available, however, can make the search frustrating, and it is not always easy to find what one is looking for. In this scenario, recommendation systems assume a key role in the process of selecting the most appropriate solutions for specific user needs and, in particular, they become essential in the promotion of cultural tourism. There is ample experimental evidence that semantic web technologies can help to enrich the list of suggestions produced by recommendation systems by adding resources that, while not explicitly related to the user's request, have some semantic relationship with those selected by the recommendation process. This is the trend of the proposed solution, in which the defined recommendation process, apart from combining different techniques to obtain an effective suggestion, enriches the set of recommendations by using the semantic approach to analyze the resource descriptions and to extrapolate any interesting relationships among them. In this way, the system is able to add to the recommendation list all those resources that, even if they do not satisfy the user's precise request, have semantic relationships with those selected. This approach has been implemented in CulTuRek (Di Bitonto *et al*., *op. cit.*), a recommender system that is able to suggest tangible or intangible cultural heritage items of interest when planning a tourist trip or an educational tour in the Apulia region. In future work, the next step will be to allow the process of semantic enrichment to recognize similar characteristics among the values of the properties so as to promote the selection of the most suitable resources even if the resource descriptions are not exactly the same.

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