User-Centered Design for Personalized Access to Cultural Heritage

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Abstract. The volume of digital cultural heritage is huge and rapidly growing. The overload of art information has created the need to help people find out what they like in the enormous museum collections and provide them with the most convenient access point. In this paper, we present a research plan to address these issues. Our approach involves: (1) use of ontologies as shared vocabularies and thesauri to model the domain of art; (2) an interactive ontology-based elicitation of user interests and preferences in art to be stored as an extended overlay user model; (3) RDF/OWL reasoning strategies for predicting users' interests and generating recommendations; and (4) The Rijksmuseum Amsterdam use case for a personalized museum tour combining both the virtual Web space and the physical museum space to enhance the users' experience. We follow a user-centered design for collecting requirements, testing out design choices and evaluating stages of our prototypes.

Keywords: CHIP (Cultural Heritage Information Presentation), user-centered design, user modeling, personalization, Semantic Web, RDF, recommendations.

1 Introduction

Since early 2005 the CHIP research team has been working at the Rijksmuseum Amsterdam within the context of the Cultural Heritage Information Personalization project, part of the Dutch Science Foundation funded program CATCH[1] for Continuous Access to Cultural Heritage in the Netherlands. CHIP is a collaborative project of the Rijksmuseum Amsterdam, the Technische Universiteit Eindhoven and the Telematica Instituut. As a PhD student, I joined this project in July, 2006 when it has already been running for a year. As mediators between the technical and the art worlds, working inside the museum allowed us to realize a real application-driven approach by performing frequent interviews with curators and collection managers as well as having a close contact with real museum visitors to extract realistic use cases and requirements. CHIP aims to provide personalized experience for various visitors to allow for the disclosure of the rich Rijksmuseum collection. In this context, my

[1] CATCH project: http://www.now.nl/catch

PhD research goal is to explore the following: (1) an ontology-based domain model to bridge the visitor-expert vocabulary gap; (2) interactive user modeling to collect user characteristics and preferences; (3) providing optimal response with regard to the computational complexity of adaptive recommender systems and; (4) designing use cases for adaptive recommender systems, e.g. a personalized museum tour.

The rest of this paper is organized as follows: Section 2 describes the background and research problems. In section 3, we present a brief description of the state of the CHIP project, focusing on personalization in museum collections, the CHIP recommender system and the RDF/OWL domain model. Section 4 discusses the main research questions, the approach and evaluation study results. Finally, section 5 presents a work plan of the PhD project.

2 Background and Problem Statement

Since Picard outlined the need for personalization of online museum collections in 1997 [1], there have been various examples of museums directing their efforts to provide personalized services to users. The CHIP project is now in the process of exploring various tours from famous museums inside/outside the Netherlands (e.g. Multimedia/PDA tour[2] at Van Gogh museum, Online tour at Tate Modern[3] and Guided/Audio tour at the Rijksmuseum Amsterdam) in order to extract requirements to build personalized museum tours on mobile devices. In this area, the PEACH project[4] shows that creating an interactive and personalized guide can enhance the cultural heritage appreciation of the individual users. Other studies show that personalization enables the change of the museum mass communication paradigm into a user-centered interactive information exchange, where the 'museum monologue turns into a dialogue', and becomes 'a new communication stratagem based on a continuous process of collaboration, learning and adaptation between the museum and its visitors' [2].

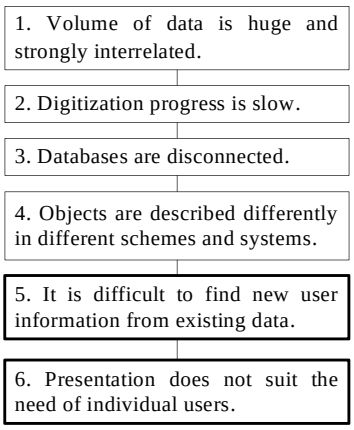

Fig. 1. Problems bundle

However, despite large investments and efforts, the cultural heritage/museum domain encounters a number of obstacles/problems, as illustrated in Figure 1. Problems 5-6 are the core problems in this research. A main bottleneck here is the vocabulary gap between descriptions of the collections created by domain experts, which do not align with the implicit and often not domain related preferences of the end users. Moreover, there is a vast space of possibilities and perspectives in which museum collections can be presented to the end users.

[2] Van Gogh museum Multimedia PDA tour, 2005 Muse SILVER Award of Educational/ Interpretive http://www.mediaandtechnology.org/muse/2005muse_art.html
[3] Tate Modern online tour: http://www.tate.org.uk/modern/multimediatour/
[4] PEACH (Persoal Experience with Active Cultural Heritage): http://peach.itc.it/home.html

To solve these problems, our current approach is to collect user preference data to use in a recommender system of artworks and to provide dynamic generation of personalized presentations depending on the user, his/her current task and final goal. In the last decade, dedicated recommender systems have gained popularity and become more and more established practice in online commerce. Amazon recommends books to users based on the feedback of similar users. Considering that explicit feedback is the most reliable source of information for personalization [3], in our system, we let users rate artefacts to get recommendations. In such a way, we collect user preference data and minimize disturbing them to the extent possible.

3 Overview of the CHIP Demonstrator

The CHIP functional prototype provides recommendations of artefacts and art-related topics based on user's ratings of artifacts in a five-point scale. Additionally, it allows users to rate the recommended items as well. In this way, the system gradually builds a profile of the user, which can be further used for generating personalized museum tours. Figure 2 depicts the process of interactive user modeling and generating of recommendations, with corresponding CHIP demonstrator screenshots.

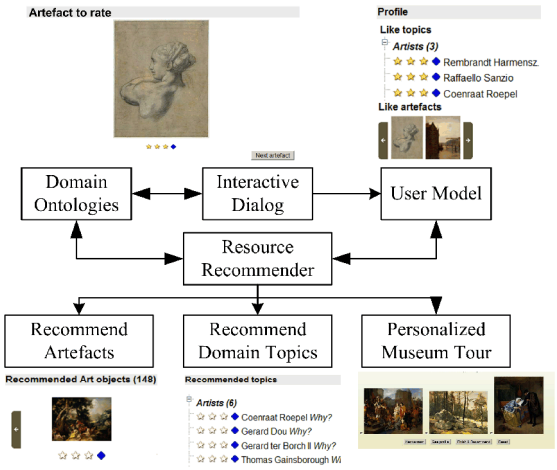

Fig. 2. Interactive UM & Recommendation

The user model (profile) is an extended overlay of the CHIP RDF/OWL domain model. To process RDF data, we use the Sesame [5] semantic repository and the SeRQL [6] query language. The initial RDF/OWL model is provided by the MultimediaN N9C E-Culture project [7] and is extended with IconClass mappings done by the STITCH project [8]. The data model contains mappings to the common vocabularies (Getty [9], Inconclass [10] and ARIA [11]) and uses open standards, like VRA, SKOS and OWL/RDF.

This rich semantic modeling of the Rijksmuseum collection allows us to maintain a lightweight user profile and perform a dynamic, real-time calculation of the user's interest. We also store the presented but non-rated items, so that we can use this

[5] Sesame: open source Java framework for storing, querying and reasoning with RDF (schema)
[6] SeRQL: Sesame RDF Query Language, http://www.openrdf.org/doc/sesame/users/
[7] MultimediaN N9C Eculture project http://e-culture.multimedian.nl/
[8] STITCH project: http://www.cs.vu.nl/STITCH/
[9] Getty vocabulary http://www.getty.edu/research/conducting_research/vocabularies/
[10] Iconclass thesaurus http://www.iconclass.nl/libertas/ic?style=index.xsl
[11] ARIA vocabulary http://www.rijksmuseum.nl/collectie/ontdekdecollectie?lang=en

information for optimization of the presentation sequence. The system calculates the likelihood of preference based on the user's ratings and it directly links to a given node in the semantic domain network. We use these links as properties of nodes in applying content-based recommendation techniques [4].

4 Research Questions and Approach

The main research question is: How can we develop methods and tools for generating personalized presentations of cultural-heritage objects both in the virtual (Web) and physical (museum) spaces? We identify here four main issues:

- Vocabulary gap. How to bridge the discrepancy between the descriptions of cultural heritage collections defined by domain experts and the implicit and often not domain related preference of end users?
- Serendipity of discovering new user information. How to acquire unknown/new user information based on the users interactive behavior and similarities to other users for which a user profile is available?
- Unobtrusive information gathering. What is the best way to minimize the amount of information a user must provide explicitly, in favor of information obtained (incrementally) by inducing user preference from ratings of a limited subset of artefact collections? In this way, will the system gather enough information for the user model?
- Avoid the cold-start problem. How to allow the user to profit immediately from the recommender system, without forcing the user to engage in the tedious task of providing a lot of information beforehand?

To bridge the vocabulary gap, we deploy a domain model based on existing ontology-based thesauri that allows for mappings to the Rijksmuseum collection model concepts. This model may be extended to capture additional information needed for a full user profile.

In the CHIP prototype recommender, the rating of recommendations provides a first means of incrementally rating preferences generated from rating a minimal subset of artefacts. When applying recommendations to the construction of personalized tours, we will analyze the user's navigation behavior in order to incrementally refine the user model and provide better recommendations. To avoid bothering the user, we minimize the explicit preference statements by providing users with a small set of artefacts, for which an explicit rating is required. To the extent possible we derive a user model from the initial ratings as an overlay of the domain data model. By providing a small set of samples, we minimize the amount of information the user must provide. Initial recommendations can then later be improved by incremental refining preference ratings. An interesting research issue here is, what is the minimal subset of artefacts sufficiently covering all potential topics of interest and allowing for a proper overlap among user profiles?

Following a user-centered design cycle, we have so far reached two steps: (1) collect, analyze and structure the domain data model, and (2) perform a first evaluation based on our first prototype of the recommender system. After collecting data and feedback from real users, as a next step, we will revise/improve the design of

the CHIP system, preparing for the next design cycle, such as creating and testing the personalized museum tours.

During August to October 2006, a first user study of the CHIP demonstrator was performed at the Rijksmuseum Amsterdam. Our goal was: (1) to test the effectiveness of the CHIP recommender system with real users; (2) to gain insight in user characteristics of our target group. In total 39 users participated in this study, including actual visitors and museum employees. The empirical results confirmed our hypothesis that the CHIP recommender indeed helps novice users elicit art preferences from their implicit knowledge/interest in museum collection. Additionally, we generated some main user characteristics, like small groups with 2-4 persons, well educated people in mid-age, no prior knowledge of the museum collections. For more details about the user study, please see our paper of the Rijksmuseum case study [5].

5 Work Plan

In the first year of my PhD project I have performed an initial domain analysis and worked on requirements extraction and assessment of the CHIP recommender prototype. The goal is to continue with the user-centered process of design, improve and apply recommendations in the construction of personalized tours, both virtual and physical, through the museum's collections. To achieve this goal, we now use a small scale user model that captures user preferences as an overlay of the domain collection model (e.g. artists, artefacts, styles). Based on our initial assessment and further user studies, we target to extend the user model with explicit characteristics, such as level of expertise and group characteristics derived from the ontological modeling of the collection. In this way, we aim at a user profile enriched with semantics and a rich set of characteristics, to allow for more advanced applications of recommendation systems, yet is minimal with respect to the effort required of the individual user.

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