Interconnecting Objects, Visitors, Sites and (Hi)Stories across Cultural and Historical Concepts: the CrossCult project

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Abstract. Human History, is a huge mesh of interrelated facts and concepts, spanning beyond borders, encompassing global aspects and finally constituting a shared, global experience. This is especially the case regarding European history, which is highly interconnected by nature; however, most History-related experiences that are today offered to the greater public, from schools to museums, are siloed. The CrossCult project aims to provide the means for offering citizens and cultural venue visitors a more holistic view of history, in the light of cross-border interconnections among pieces of cultural heritage, other citizens viewpoints and physical venues. To this end, the CrossCult project will built a comprehensive knowledge base encompassing information and semantic relationships across cultural information elements, and will provide the technological means for delivering the contents of this knowledge base to citizens and venue visitors in a highly personalized manner, creating narratives for the interactive experiences that maximise situational curiosity and serendipitous learning. The CrossCult platform will also exploit the cognitive/emotional profiles of the participants as well as temporal, spatial and miscellaneous features of context, including holidays and anniversaries, social media trending topics and so forth.

Keywords: Adaptation, user profiles, mobile applications

1 Introduction

"CrossCult: Empowering reuse of digital cultural heritage in context-aware crosscuts of European history" is a newly started project, supported by the European Union under the H2020-REFLECTIVE-6-2015 "Innovation ecosystems of digital cultural assets" funding scheme. The CrossCult project aims to help European citizens understand and perceive their common past and present in an holistic manner, while fostering retention and promoting reflection. To this end, the CrossCult project adopts guidelines formulated in recent research [5][6] regarding the design of the interactive experiences and their narratives; these guidelines can be codified as four major principles as follows:

- Raise consciousness about the importance of History
- Tackle the study of History from a multi-faceted perspective
- Approach History not only through the written texts from successive eras, but also through all the traces left by those societies (archaeological remains, iconography, epigraphy, numismatics, architecture, art, etc.)
- Reckon that there are no absolute truths in History, but various possible interpretations of the archaeological remains and contrasting viewpoints

In this light, the cultural heritage sites, historic events and (digital) cultural assets are not presented as disconnected but rather they target at increasing understanding of the interrelated nature of culture and history. In doing so, the CrossCult project and platform allows the interconnections of objects, resources, visitors, sites and (hi)stories across European Cultural and Historical concepts and events. In addition, CrossCultCrossCult uses an extensive knowledge base, using existing cultural repositories (e.g. Europeana) and a specially designed technological platform to maximize situational curiosity, serendipitous learning and reflection on different historical and social phenomena, like for example the place of women in societies, the movement of populations historically and today, establishment of healing practices, etc.

The project is using cutting edge technology to allow meta-history research from pilot experience with narratives built from cross-border connections and crosscutting topics. Furthermore, new technologies for smart venues and whole cities allow the multi-level, cross-repository interconnection of venues and digital cultural heritage resources. Personalized, adaptive and context-aware experiences are at the heart of the project in attempt to increase the Quality of Visitor Experience [13].

The project approach will be implemented and validated through a number of pilots, designed to operate under different parameters (individual vs. collaborative participation; authoritative vs. crowdsourced content; narrative vs. exploratory vs. serendipitous content delivery; intra-venue vs. inter-venue connections; temporal, vs. spatial vs. topic-related connections; physical presence vs. virtual presence), and will provide valuable insight on the effect that these parameters have on cognitive aspects, such as reflection, (re)interpretation, relation and comparison.

The remaining of this paper is organized as follows: section 2 focuses on the personalization aspects in CrossCult, considering that personalization is considered a key feature to achieve the goals listed above and section 3 describes the CrossCult infrastructure, outlining the architectural modules of the platform and their functionality. Finally, section 4 concludes the paper and outlines future research.

2 Personalization in cultural heritage

Previous research has shown the importance of personalized applications for cultural heritage since they are found to increase the quality of visiting experience[1][12]. Personalized applications in cultural heritage are not only increasingly popular among cultural institutions [3] but visitors also seem to prefer them [7]. Personalized content can target the needs of a diverse audience and allow the targeted presentation of big amounts of available cultural information, providing different information to different people[19]. Cultural heritage institutions also use personalized applications as means to attract visitors. For a detailed survey on the use of personalization approaches in cultural heritage institutions one may refer to [4].

Within our project personalization goes beyond the current state of the art, aiming to appropriately tailor content, functionalities and presentation so as to foster reflection, (re)interpretation, relation and comparison, taking into account aspects such as the users cognitive profile, the current group dynamics, non-typical connections of cultural objects and so forth.

2.1 The cold start problem and the role of social media

However, although personalization in cultural heritage is useful, creating correct visitor profiles is a rather demanding task basically due to the short duration of most visits and the fact that most visitors might only visit a specific space only once. Within these time restrictions, visitor profiles need to be created quickly and effectively in terms of their appropriateness for the different visitors. The question raised though is how to start creating these profiles and where to find the necessary information.

Different approaches have been employed like using heuristic techniques [9], probability-based algorithms[11] or user prototypes/ personas [15]. The problem is that although visitors enjoy the benefits of personalized applications in cultural heritage, they are at the same time reluctant at dealing with form-filling activities and researchers have to become more creative in applying indirect approaches for the collection of the needed information for the creation of user profiles.

Over the last years, more and more people are using social media for social interaction, information seeking, pass time, entertainment, relaxation, communicatory utility, convenience utility, expression of opinion, information sharing, and surveillance/knowledge about others. While interacting with these media, people

provide vast amounts of personal information that can be further exploited for the creation of user profiles.

It has been demonstrated that peoples behavior on social networks reflects actual personality traits [17]. Therefore social media can be rich sources of information to efficiently create user profiles for personalized content in cultural heritage, also dealing with the cold start problem.

Recently a European project explored the potential of Facebook in providing the necessary information for the creation of museum visitor profiles [2]. However, research is still at the early stages and algorithms are not always reliable[16]. In this framework, CrossCultCrossCult aims at providing the necessary infrastructure for the effective elicitation of user profiles using different means, including social networks.

2.2 Group Adaptation

Although the above may apply for individuals and the elicitation of individual user profiles, adaptation for group visitors and elicitation of group profiles is a whole different story. Visitors rarely visit alone[14], yet most cultural heritage technologies, such as the ones discussed in the previous paragraphs, are made for individuals.

Early approaches have provided group visitors with a shared device for a common experience, but in more recent studies although each visitor has her own device, the experience is cooperative; for example the CHESS system that uses interactive storytelling for group visitors[18]. Context-aware applications for small groups have been also discussed [10] and the mobility of visitors has been also taken into account[8].

2.3 Personalization and adaptation in CrossCult

The CrossCult platform will address personalization and adaptation by realizing both *item recommendations* and *path recommendations*.

Item recommendations include points of interest, exhibits, or even individual resources. Content-based recommendation techniques will be used here to match the candidates for recommendation (POIs, exhibits or resources) against the profile of the visitor; additionally, matching the candidates for recommendation against the current context (e.g. semantics of currently viewed collection, characteristics of exhibits viewed so far within the visit etc.) may provide opportunities for re-contextualization of entities and increased serendipity. Collaborative filtering techniques will also be employed, to enhance the visitors experience using information from the visits of other users with similar profiles (e.g. similar preferences, interests, visit goals and so forth). The recommender system will exploit the full set of semantic information that will be available for candidates for recommendation, by accessing the relevant ontological descriptions that are stored in the CrossCult repository.

Path recommendations will not only arrange for suggesting routes that include exhibits that are deemed of high interest to the user, but also arrange for

making the visiting experience meaningful. To this end, path formulation will strive to lead the visitor through routes in which the exhibits tell a certain story (e.g. they relate to social aspects of life in antiquity) or allow the visitor to reinterpret History from the items that s/he will view along the suggested route. Furthermore, path formulation will take into account real-time data regarding the location of other visitors, so as to avoid annoyances, such as high waiting times or overly crowded areas; due to the real-time nature of crowd location data, routes may be re-planned to adapt to the current situation. Finally, route planning will consider the visiting style of the visitors, i.e. their usual pattern of movement into cultural venues as well as constraints on their available or planned time; an initial estimate for the duration of the visit can be projected from previous visits, considering both the venue statistics and the individual visitor statistics, while the user may modify the estimated value.

All recommendation techniques require that user characteristics, interests and interaction history are recorded in a user profile, so as to match them either against the data and metadata of recommendation candidates (for content-based recommendations) or against profiles of other users (for collaborative filtering-based approaches). Users however may not offer to directly enter information through profile completion pages since the related for them is high and the benefits are not always apparent; moreover, for users that have been recently registered with the system, formulation of successful recommendations will be inhibited due to the cold start problem. To tackle these issues, techniques for implicit profile population and interest extraction are employed complementary to explicit input. Mini-games and quizzes are used to offer an insight to characteristics and interests of the users, while mapping visitors to personas or stereotypes is used to assist in identifying recommenders (i.e. other people with similar interests or characteristics, often called nearest neighbors) for collaborative filtering recommendations. Mini-games and quizzes will be delivered through social network platforms, exploiting their widespread and dissemination dynamics to maximize the potential of information gathering.

Recommender systems in CrossCult will exploit trending topics information from social media to allow venue content curators to promote exhibits or collections relevant to topical issues; this feature will enable venues to take advantage of subjects publicity, turning it into interest on their content. In this context, trending topics are read from social media and matched against the metadata of exhibits and collections; subsequently, the highest matches are presented to venue content curators who can then choose how (and if) these matches can be best used to trigger visitor interest and promote the venue content.

Regarding the aspect of group adaptation, the CrossCult project is in line with recent developments in museum/visitor studies listed earlier and it recognizes the need for the development of collaborative applications targeting group visitors as well as individuals. For this reason, group profiles will be created and content will be adapted according to the groups requirements. To this end, the personalization mechanisms in the CrossCult project include algorithms to determine whether an individual is visiting alone, or in a group. While this

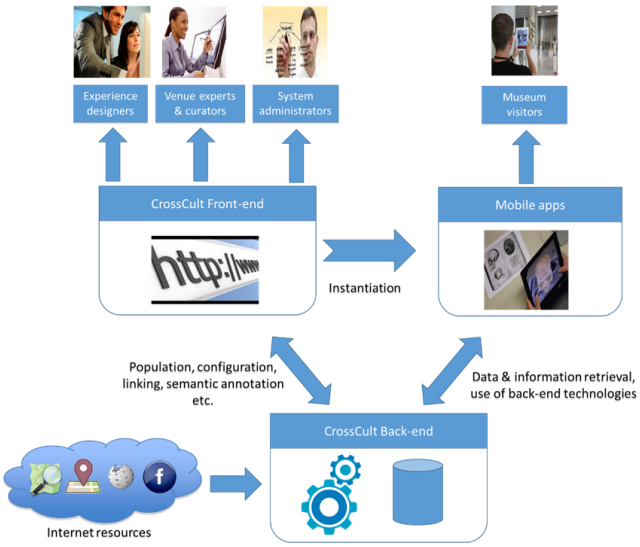

Fig. 1. The CrossCult platform overall architecture

can be extracted using a direct question, additional technological means will be exploited to facilitate user profiling, such as near-field communications, identification of previously paired Bluetooth devices, identification of users that have an established friend relationship in social networks and so on.

Finally, recommenders in CrossCult will foster the creation of sporadic social networks by recommending connections among people that co-visit a venue. In this respect, the profiles of current venue visitors will be analyzed and groups of people with related interests and matching personalities will be determined; then suggestions will be forwarded to members of each group to join an online group through which they can engage in collaborative live discussion, participate in educational games or even formulate a physical group. These recommendations will respect user anonymity, and only after explicit consent of all interested parties the electronic IDs of the users will be exchanged.

We expect that user interaction within the context of sporadic social networks will promote the creation of new views on the venue content and the connections between exhibits, enriching the venues informational content. Some of the connections are expected to outlive the duration of the visit (e.g. through an establishment of a friend relation in social networks), supporting post-visit actions (including discussions, diffusion of information to other social network members and so forth), which could extend the benefits of the visiting experience.

3 CrossCult infrastructrure

To accommodate the functionalities listed in the previous section, the CrossCult platform employs a layered approach targeting all stakeholders in the user experience delivery process. These include experience designers, venue experts and curators, system administrators and visitors.

In this process, venue experts and curators undertake the tasks of (a) curating digital content, providing textual and multimedia descriptions for exhibits as well as the associated metadata, and (b) establishing semantic links between exhibits/exhibit elements. Semantic links may be either established directly, e.g. by linking a painting depicting a loom to a statue of woman under the relationship uses, or indirectly by linking two items to the same ontology concept (e.g. two exhibits representing a loom and a horse are linked to the everyday life ontology concept). Furthermore, semantic links may be established among exhibits of different venues, or venue exhibits may be linked to resources in cultural repositories such as Europeana.

Experience designers employ user profiling tools to arrange for user profile population, mainly through mini-games and quizzes. Experience designers identify the opportunities for personalization and exploit exhibit data/metadata, user profile information and data from analysis of previous visits to the venue to offer a personalized experience to the visitor. Experience designers also arrange for offering suitable opportunities to visitors to enter comments as well as personal views on exhibits and their relations; these inputs may then be presented to subsequent visitors as personal views of previous users or be reviewed and accepted by venue experts and curators, and be integrated into the venues officially delivered information. In this respect, user input handling constitutes a form of crowdsourcing. Experience designers finally cater for choosing data from external sources, such as trending topics, calendar information (such as holidays or events), external sources with POI evaluations and so forth, which will be exploited to promote personalization and foster topicality.

The last category of the venue-side stakeholders is system administrators, who will provide the necessary computing and communication infrastructure for the operation of the applications and the storage and retrieval of information.

All venue-side stakeholders perform their tasks from the CrossCult front-end, which constitutes a powerful and intuitive web-based environment within providing the above-listed features. The data entered through the front-end are stored and organized at the CrossCult back-end which hosts the information repository, as well as all services needed to support the visitors application runtime (the back-end is detailed below). Once all required elements have been entered and configured via the CrossCult front end, the mobile apps which the visitors will use can be instantiated.

App instantiation is an automated procedure within which the mobile app code is generated, using predefined code templates and venue-specific options. Options mainly pertain to the functionalities that will be available to the users of the mobile app (i.e. venue visitors), such as entering comments and personal views, formulating sporadic networks, participating in mini-games and quizzes,

sending messages to other users and so forth; in all cases, content (both official and user-contributed, such as comments and texts entered by other users) is retrieved dynamically from the CrossCult back-end. The mobile apps also arrange for receiving from the back-end recommendations, notifications and messages from other users and communicating them accordingly to the visitors.

The CrossCult back-end encompasses a repository for the storage, organization and retrieval of cultural information and pertinent metadata, while it additionally hosts modules for delivering the needed functionalities to both the front-end and the mobile apps. In particular, the back-end arranges for the following tasks (a) storing user profiles and unifying user profile information obtained from different sources (e.g. explicit input, mini-games, quizzes etc.); (b) gathering contextual data (including time of day, calendric information such as holidays, trending topics and related information from the internet); (c) collecting information about the number of visitors within each venue sub-location; (d) performing semantic reasoning over the ontological representations to deduce new relationships from the existing ones, augmenting thus the informational content; new relationships may be also detected among exhibits of different venues or exhibits of a venue and external cultural information repositories through metadata matching; (e) using all the previous listed information to generate recommendations for the users, regarding the exhibits to see, the paths to follow and venues to visit, and (f) supporting sporadic social network formulation (including identification of groups of visitors with common interests and generation of recommendations for joining sporadic social networks) and communication between their members,

4 Conclusions

In this paper we have outlined the main vision of the CrossCult project, which aims to provide the means for offering citizens and cultural venue visitors a holistic view of history, breaking cultural, local or viewpoint siloes in History-related experiences. In this respect, the CrossCult project approaches History as a huge mesh of interrelated facts and concepts, spanning beyond borders, encompassing global aspects and finally constituting a shared, global experience.

The main instrument to achieving this goal is personalization, through which narratives will be created for the interactive experiences that maximise situational curiosity and serendipitous learning. Personalization will exploit information in user profiles, either directly entered or more typically implicitly inferred and a semantically rich network of cultural information items; these items can be hosted in a single cultural venue, be dispersed among multiple venues or even be hosted in cultural repositories, such as Europeana. The CrossCult platform will also exploit the cognitive/emotional profiles of the participants as well as temporal, spatial and miscellaneous features of context, including holidays and anniversaries, social media trending topics and so forth. The CrossCult project will finally promote group exploration and group activities by employing group

adaptation techniques and fostering the creation and operation of sporadic social networks, which will interconnect people with similar interests.

The CrossCult project is currently at its development stage. The platform components, which capitalize on the participants existing technologies, are being built and will be integrated to form the front-end and back-end components. Within the CrossCult project four pilot applications will be built, each one targeting to a specific category of History-related experiences: pilot 1 targets large multi-thematic venues; pilot 2 targets a setting with many small, interconnected venues; pilot 3 targets a single venue that promotes non-typical cultural connections among exhibits; and pilot 4 targets a setting involving multiple cities, offering cross-cultural interplay with their past and present. Through these pilots, the CrossCult approach will be validated and further enhanced with new features, taking into account the reactions comments and requests of the users.

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