Stimulation of Reflection and Discussion in Museum Visits through the Use of Social Media

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ABSTRACT

In this paper, we examine how social media can be linked to cultural heritage and in particular how we can incorporate games, social networks, history reflection and culture. More specifically, we explore the following aspects: (a) how social media sites can be integrated into the museum user experience (b) how user interactions within the social media, both within the context of the museum experience and outside it, can be exploited to enhance the quality of recommendations made to the users, (c) how trending topics from social media can be used to link museum exhibits with today's topics of interest and (d) how multi-level related terms extraction from social media data can lead to proposals for reflections to users. The end goal is to provide increased stimuli for users to study exhibits deeper and reflect on them, as well as to trigger discussion between the users, thus maximizing the impact of a museum visit.

Keywords
social networks; user profiling; cognitive style; reflection; communication; big data

1 INTRODUCTION

Living in Europe we are surrounded by history and culture. When it comes to physical items there are currently more than 19000 museums in Europe and even more archeological sites (EGMUS, 2017). Most European cities, towns and villages either have, or are themselves, historical landmarks. And, as far as digitized items are concerned, Europeana already connects more than 30 million objects from over 3 thousand institutions. In fact, the preservation of cultural heritage is at the very core of the foundations of the European Union; the Lisbon treaty, a constitutional basis of the European Union, states that the Union "shall respect its rich cultural and linguistic diversity, and shall ensure that Europe's cultural heritage is safeguarded and enhanced" (European Union, 2007).

As a result, in the period 2007-2013 alone the EU invested approximately 4.5 billion EUR in cultural heritage and related research. Most of these funds were directed towards the preservation of heritage, and thus mainly to actions related to the conservation, digitization and related infrastructures. The aim, of course, has been to achieve long term preservation, and thus much emphasis has been given to the sustainable exploitation of cultural heritage assets (Licciardi and Amirtahmasebi, 2012; Greffe, 2004). More recently it has started to emerge that cultural heritage is not just a matter for sustainable, in other words financial, exploitation, but also a powerful social tool that can help strengthen the connections between European people (Dümcke and Gnedovsky 2013).

In this scope, we are now starting to examine not just how cultural assets can be used to generate profit but also how then can help us understand more about ourselves; about our past, present and future; and about the way we are all alike and all connected. In order to achieve this, it is not enough that people visit museums and archaeological sites and pay a ticket. What is truly desired is that such visits make people *think* and *talk* about what they saw and how that relates to themselves, their lives and their closer and broader communities.

In other words, the goal is to use the cultural items and locations as triggers, through which more important issues can be raised, in both internal (reflective) and external (communicative) processes. In this paper we explore how we can pursue this goal by incorporating social media intelligence in the cultural content delivery process and more specifically in museum visits. Specifically, we trigger and monitor user interaction with Facebook and Twitter; via the

gathered information we are able to identify and promote connections between the user and the content/exhibits, thus leading the user to contemplate on these connections (reflection) as well as connections between different users, thus supporting ad hoc socializing and leading visitors to exchange views on what they have been presented with (discussion).

More specifically, specially designed Facebook games are used to determine user cognitive profiles and user similarity, whilst twitter trending topics are used to determine current topics of general interest. This information allows us to prepare personalized cultural experiences, tailored to the cognitive style (long term parameter) and current interests (short term parameter) of museum visitors. Social media games are not only used for personalization purposes, but also to increase engagement (Reeves and Read, 2013) and to promote the app and the museum, also functioning as advergames (Goh and Ping, 2014). Moreover, gathering information from social media and interconnecting them with social media data can enhance reflections. Semantics are used in order to support and partially automate the identification of connections between the past (exhibits) and the present (user). Visitor compatibility is also estimated, based both on style and interests, allowing us to identify groups of otherwise unconnected visitors who might enjoy discussing with each other on the museum visit experience.

This work is loosely based on and forms a major extension of paper (Bampatzia et al., 2016), which was presented at the 11th International Workshop on Semantic and Social Media Adaptation and Personalization (SMAP 2016).

The rest of the paper is organized as follows: In section 2 we review related work and identify the approach that is most suitable to form the basis for our own work. Section 3 presents the proposed system architecture while section 4 is where we outline our proposed methodology towards the incorporation of social media in museum visits in order to stimulate reflection and communication. In order to facilitate the presentation of the details of our work, in section 5 we briefly present CrossCult, the EU project in which the proposed methodology is currently being used and tested in a real life setting. In this section, we describe one of the project's pilots and present how user profiles are extracted, how intelligent recommendations of exhibits and similar users are made and how Twitter trending topics are exploited. Finally, in section 6 we list our concluding remarks.

2 RELATED WORK

Our work falls in the area of Digital Cultural Heritage, which refers to the use of IT for the preservation, understanding and presentation of cultural heritage. More specifically, we focus on the presentation of cultural heritage content and aim specifically to stimulate reflection in a museum context, i.e. to cause the visitors to contemplate on what is presented and how that relates to them, a goal in which technology has already been found to have a positive impact (Hsi, 2004).

Personalization has been used in cultural heritage to provide the visitor with relevant information and relevant cultural experiences, increasing the Quality of Experience (Naudet et al., 2013). The main reasons of the necessity of personalized applications are: i) to cover all the different needs of the museum's visitors (Gaeta, Gaeta and Ritrovato, 2007; Muntean and Muntean, 2007; Wakkary and Hatala, 2006) and ii) perform this in a time-effective manner, since typical museum visits are very short (Falk et al., 2010; Serrel, 1997). The challenge of personalization in cultural heritage has been at the core of several projects such as EXPERIMEDIA BLUE (Naudet et al., 2015), a social and mobile visit personalization system analyzing user's cognitive profile and CHESS (Pujol et al., 2008), which enables personalized interactive stories for visitors of cultural sites. Moreover, Oppermann and Specht (1998) proposed a personalized guide, which uses both user interests and her position inside the museum. Another similar research was performed by van Hage et al. (2010). Their research identified visitor preferences and computed a personalized visit based on visitor walking patterns.

In addition, a connection between game playing and personality factors has been established (Granic, Lobel and Engels, 2014). Games can be used to identify different personal preferences and characteristics and can be thus used for profiling purposes and in particular for museum profiling purposes, since other direct profiling methods might require more time (Antoniou et al., 2013).

Furthermore, according to Farnadi et al. (2016), social media websites provide a unique opportunity for personalized services to capture various aspects of user behavior and characteristics. Users provide large amounts of information in their profiles in a variety of ways, such as textual information (e.g., status updates, blog posts, comments) or audiovisual content (e.g., uploaded photos and videos). Many latent variables such as personality traits, emotions and moods —even if they are not explicitly given by users— can be extracted from user-generated content.

However, a model to retrieve the profile of the player and the personality traits from games has not been fully exploited yet, although many digital games are connected to social media platforms (Konert, 2014a; Konert, 2014b). An initial attempt to extract the user profile through Facebook games was elaborated by Naudet et al. (2013), where games were used to extract the players' cognitive styles and museum preferences.

During the last decade, museums were mostly involved with one-way communication strategies using Facebook and Twitter to focus on event listing, reminders, and reaching larger or newer audiences by increasing the number of fans and promotional messaging. According to Fletcher et al. (2012), museums are currently trying to increase their use of social media for multi-way communication strategies. Nevertheless, museums can exploit social networks further than just one-way communication strategies. Museums are a meeting ground for both "official" versions of the past, their histories offered through exhibitions, and the individual or collective accounts of reflective personal experience. Social media can enable informal ways of drawing together this knowledge by providing tools for participatory engagement, which have the potential to distribute new forms of learning. In social media, users/visitors can organize ideas and interpretations to create meaningful associations between their own and others' experiences (Russo, Watkins and Groundwater - Smith, 2009). Learning in environments such as museums and cultural sites can be enhanced with social networking. Russo et al. (2009) have proposed a framework for museum visitor's experiences through social networks for enriching physical learning. This model includes rapid publication of museums, personalization of the museums' content, content sharing and content creation by the audiences. In this context, Weilenmann et al. (2013) tried to explore how one particular photo sharing application, Instagram, is used to communicate visitors' experiences while visiting a museum of natural history.

The wide use of social media in museum practices raises however several ethical questions. Wong (2011) asserts that museums need to train their employees to understand the nature of the social media landscape in order to understand limitations and opportunities.

In the domain of using social media information for the recommendation process, Bakshy et al. (2012a) examine the role of Social Networks in the recommender systems within a field experiment that randomizes exposure to signals about friends' information and the relative role of strong and weak ties. Bakshy et al. (2012b) measure social influence via social cues, demonstrate the consequences of including minimal social cues in advertising and measure the positive relationship between a consumer's response and the strength of her connection with an affiliated peer. Both these works establish that social network information is a valuable asset for recommender systems. Oechslein et al. (2014) also assert that a strong tie relationship positively influences the value of a recommendation. Margaris et al. (2016) use the tie strength to create a hybrid recommender system, which considers tie strength into the collaborative filtering process, generating more accurately personalized recommendations.

More recently, a new generation of attempts to combine technology and cultural heritage in order to enhance visitor's experience has emerged, including, projects such as PLUGGY,

ViMM, EMOTIVE and CHESS that create applications for museums. Through these applications visitors can have a technologically enriched experience.

PLUGGY, in particular, is expected to be a social platform providing innovative curation tools by which citizens will be able to act as skilled “storytellers”. Participants will be able to create fascinating personalized stories and share them through social networking with friends, associates and professionals. The content will be both crowd-sourced and retrieved from digital collections, allowing users to create links between seemingly unrelated facts, events, people and digitized collections (PLUGGY, 2017).

ViMM has started to develop a communication platform that, when completed, will be highly interactive and wide-reaching so that everyone can contribute to Virtual Museums and Digital Cultural Heritage (ViMM, 2017). The purpose of EMOTIVE is to put tools in the hands of professionals to create engaging, memorable stories for cultural heritage, and to enable the public to enjoy and share these stories, from any location. It will engage audiences in a new way, putting emotional stories at the heart of museums and heritage sites (EMOTIVE, 2017).

A little earlier in time, he objective of CHESS was to research, implement and evaluate personalized interactive stories through mobile and mixed reality technologies (Pujol et al., 2008).

In comparison with the aforementioned projects, the novelty of CrossCult lies within two main dimensions. Firstly, it does not only enhance visitor's experience but it also supports history reflection and reinterpretation both in individual and in a collective manner. Secondly, CrossCult creates real-time experiences and not only pre-constructed. For instance, real-time information from twitter trending topics can come at any time during the experience.

In this work, we choose to follow this approach and to use social networks and particularly Facebook and Twitter, as one of the most popular networks for a number of purposes:

- To promote the application and attract users
- To extract user profile information quickly and efficiently, thus overcoming the cold start problem without burdening the user with questionnaires
- To enable visitors to share their experience
- To facilitate sharing of views and reflection topics
- To exploit sharing and communication activities through the social media for generating personalized recommendations
- To link current affairs and news with the topics and items of the museum and allow museum curators to effectively promote exhibits and collections, thus bridging the gap between the cultural experience inside the museum and the current events of the outside world
- To trigger visitor history reflection further.

3 System Architecture

The actual architecture of our system is multi-level and multi-tier. More specifically, the proposed system is divided into four main parts: (a) front-end, (b) intermediate, (c) system core / back-end and (d) storage layer. All four layers communicate and co-operate in order to achieve the system’s described goals. Figure 1 depicts the system architecture. In this section we describe the functionality of each layer, while in subsequent sections we elaborate on the internal modules of each layer.

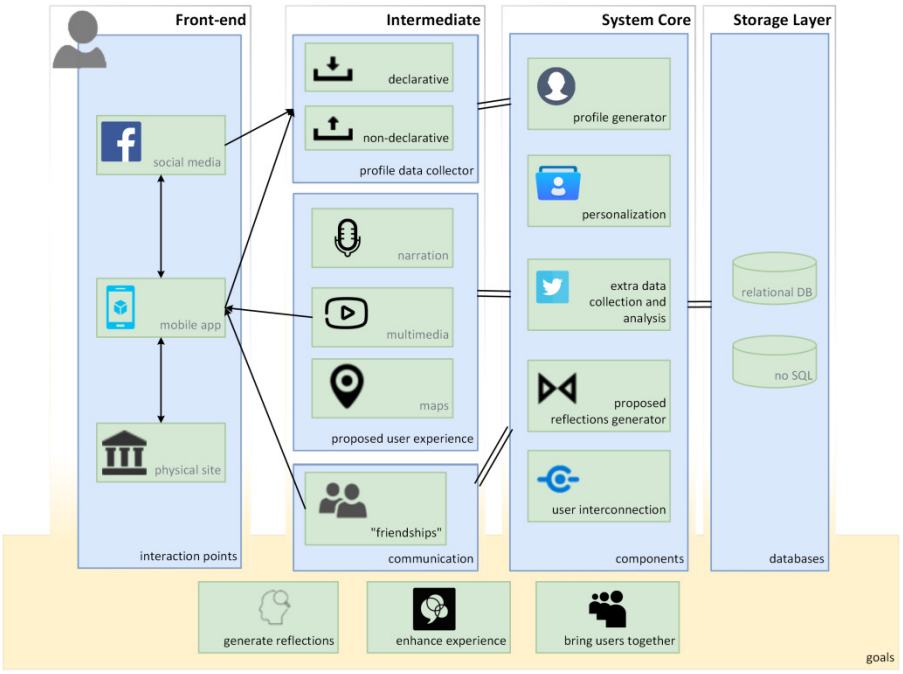

Figure 1: System architecture

3.1 Front-end

The front-end is the part that is directly related to the end users of the system. It is the actual point of interaction that includes all the functionality that is related to collecting information about the user profile, enabling the interaction between users and offering personalized and differentiated experience through a mobile application.

From the front-end the user is able to interact with the parts of the system that are of her interests. In overall, the user is offered enhanced experience through a mobile application: this includes delivery of additional contextualized information for exhibits and collections (e.g. descriptions, reviews, related exhibits and resources, panoramas and augmented reality presentations etc.), presentation of interactive maps, multimedia, narrations and offering of personalized recommendations for tours or visits to specific exhibits. Moreover, the end user is able to locate information about other users with similar profile and begin ad-hoc conversations.

The user profiling procedure, needed to drive the personalization features of the platform, is mainly performed (a) through social games and (b) by monitoring and analyzing user behavior within the application. Social media games and interaction tools are also available through the mobile application, so that the users do not have to switch between devices or systems once their museum visit has begun.

We should note that the role of the application is to provide additional content, meaning that its use is optional and complementary. The user is not forced to interact too much with the device and the core user experience is not ruined.

3.2 Intermediate

The level that lies between the system core and the front-end is what we call an intermediate. The role of this layer is twofold. On the one hand this level receives information from the user and formats the information accordingly so that the system core will be able to receive, store, analyze and parse the data, while on the other hand the same layer gets information from the system core and prepares it for the presentation layer which is the front-end. In this respect, the intermediate level is a data selection and formatter layer, and includes information about the user's end devices so that it is able to serve the correct information with the appropriate format. Keeping this layer separate from the system core reduces constraints and facilitates the development of the overall system.

3.3 System core

The system core or back-end of the system includes the functionality that enables the application of low level, complex algorithms on the collected data. This layer provides the facilities for the construction of a complete profile of the user, using the profile data gathered from the games that the user played and the logs of the user interaction with the system. Moreover, clustering and collaborative filtering algorithms are applied on user profiles in order to obtain information about similar groups of users according to a number of variables. Additionally data mining procedures that dig for information from the social media are executed in order to correlate this information with user data, so as to simulate the reflections procedures of the human mind. In general this part of the system is the place where all the internal procedures are performed, so as to support the delivery of the required functionality to the user and the enhancement of her experience.

3.4 Storage layer

The database/storage layer of the system is separated from the processing layer and offers a generalized interface for data storage and retrieval, encapsulating data-related operations such as indexing for increased performance or data enrichment and enhancement to facilitate semantic search. To achieve these goals, we employ both SQL and noSQL (indexer) databases. Through the usage of Database Abstraction Layer intermediates within the storage layer we are able to utilize relational database management systems and a noSQL system that suits our needs. In our case, MySQL and Apache Solr (Apache Group, 2017) are used as relational and noSQL systems, respectively.

4 Methodology

The combination of technological advances and more precisely the use of cutting-edge technologies in the field of cultural heritage is a challenging procedure. Not only from the viewpoint of combining these ostensibly dissimilar fields but also because people are accustomed to specific routines while visiting cultural venues (typically following predefined paths and studying the exhibits, possibly with the aid of human guides or audio guides). The proposed approach disrupts these routines, providing additional stimuli and content and allowing the user to interact with other users and the content they generate. Taking these facts into account, well-defined research methodology is needed to support the development of the proposed approach.

At first we examine how we will approach the procedure, from both the technological and the user perspective. All of our goals (reflection generation, experience enhancement and bringing of users together) necessitate extensive knowledge about the user profile, to generate successful recommendations, present appropriate content in suitable modes, and so forth. Profile information needs to be gathered in a non-intrusive manner, without distracting the user from the goal of her museum visit. In parallel, we strive to engage the visitor into a technological procedure which includes social media and data that derive from them. Through this participation, users may exchange opinions, become aware of other viewpoints and discover new associations, triggering and facilitating their reflection process.

From the technological perspective, the system, and especially the core of it, are designed with a focus on the desired results. These include involving social media usage within the procedure of visiting a museum, extracting information about topics that could be relevant to the users, their feeling and reflections from social media and identifying link between users with similar interests, profiles and reflections. In order to obtain information from social media we need to interconnect with them in a manner that enables us to get, store and analyze such kind of information. This aspect is handled in the social network data exploitation subsystem, whose overall architecture is illustrated in Figure 2. This subsystem utilizes similarity algorithms that can provide us with evidence on similar topics or similar users and appropriate recommender systems to generate suggestions for museum curators (trending topics associated with museum content) and visitors (suggestion of people and groups based on the users' activity and profile,

their social network activity; to make more focused recommendations, the user interests considered in the match making process are limited to those covered by the museum content).

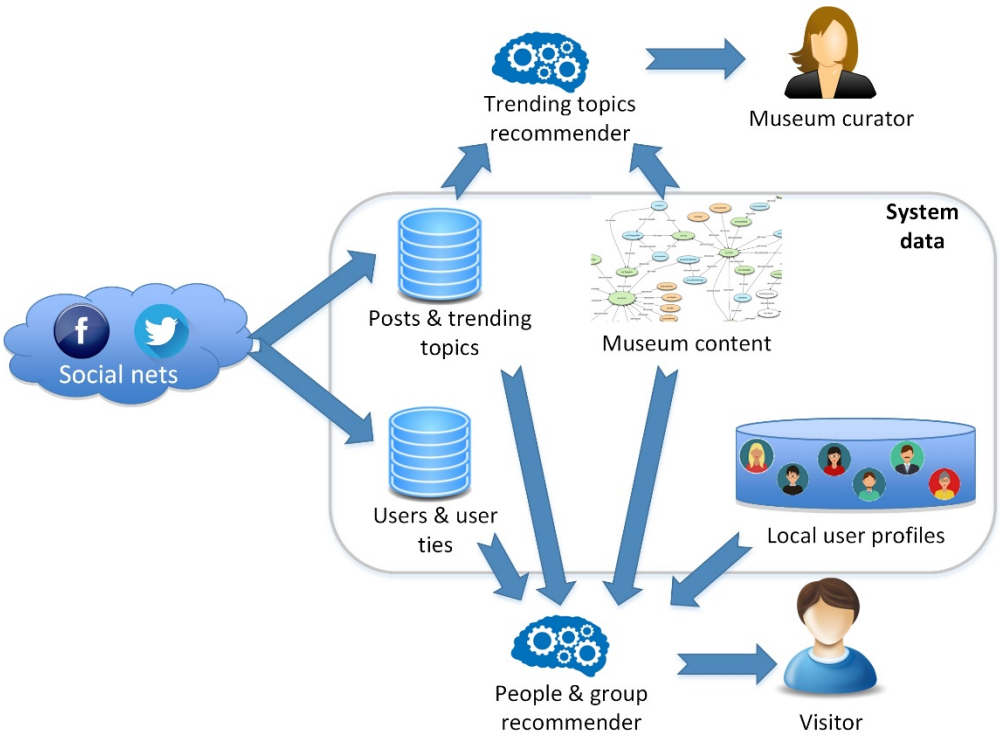

Figure 2. Social network data exploitation subsystem

In order to get information about the user, we utilize both declarative and non-declarative information. Non-declarative information can be gathered either by the profile of the users when we interconnect with social media or from derivative information from the declarative data. The latter kind of data can be obtained either by asking the user about their preferences or "forcing" them to provide us with this information through casual procedures like gaming. Creating a game for social media is a plain procedure, though in our case the methodology implies that we should focalize on serious gaming. In parallel we engage the user with the system by providing holistic information about the experience. Either experience related to the profile of the user, or direct linkage with something that they are accustomed with – the social media – we encourage users to exchange data through the "technological" part of the system.

As already mentioned, combining technology with culture is a challenging task. We do not consider transferring the user to a virtual environment neither do we want the user to stick to an "online – offsite" solution. On the contrary, our methodology focuses on interacting with the user within the venue of interest (which can be any cultural venue, e.g. an archaeological site, a museum, a gallery, etc.), and in this context stimulate and promote interaction, feeling creation, curiosity reactions and reflection.

Although the main focus of the methodology is placed at on-site interaction, still some procedures can be performed offsite. A notable case is the gaming procedure for profile creation, which is actually more valuable if it is performed *before* the visit to the cultural venue, since it caters for profile population facilitating the formulation of better recommendation during the visit. On-site and off-site interactions are combined to assist in achieving our goal and provide increased stimuli for users to study the cultural heritage deeper and reflect on them, as well as to trigger discussion between the users, thus maximizing the impact of a visit to a cultural heritage site.

5 Application Setting and Functionality

The methodology and architecture proposed herein is being put to use in a real life setting in the third pilot of the CrossCult project. CrossCult is a Horizon 2020 European project that aims to alter the way people view history and support multiple interpretations of the European past in a cross-border fashion. Using cutting-edge technology, CrossCult is enriching the cultural participation with digital cultural resources and proceeds with personalized interactive experiences to trigger cognitive and emotional responses for active history engagement. Within the framework of the project, 4 indicative pilots will be implemented which will run in 7 European sites (Vassilakis et al., 2016).

In particular, the third pilot of CrossCult aims at providing visitors with an unconventional manner of interaction with museum items by facilitating crosscutting and transversal viewings of the artifacts. Such interactions will allow the visitors to engage in deeper levels of reflection, compared to traditional means of history presentation (e.g., type of a statue, or its construction date), including social aspects of life in antiquity, power structures etc.

Quick profiling strategies, such as quizzes, games, and information gathered from social networks (e.g. Facebook) will be utilized for collecting user information. Such user profiles will be progressively updated using different feedback mechanisms including explicit forms of feedback (e.g., likes/dislikes, ratings and comments) as well as implicit ones (e.g., the fact that a user stands in front of an item, the number of times she replays an audio/video clip, whether he/she shares a piece of content with others or the likings of her social neighborhood). The recommendation and personalization engines will be based on state-of-the-art knowledge-based, diversity-based and collaborative filtering approaches.

In this light, Pilot 3 deals with the interconnection of the physical items of the museum with the reflection topics and with related digital objects and in the same time connecting the cultural experience with social media. Social media are used in multiple ways in pilot 3. Not only profiling information is gathered through them but also the cultural experience is shared on social media with the visitor's network of friends, thus allowing further discussions on the museum themes and the reflection topics. The interaction of a visitor with her social neighborhood is used to provide personalized recommendations to the visitor and further promote relationships through the social network, discussions and reflection. Finally, trending topics from social media can be used to link museum exhibits with today's topics of interest and provide increased stimuli for users to study exhibits deeper and reflect on them. The synthesis of physical and digital objects, reflection topics and social networks is expected to provide a meaningful and holistic cultural experience.

5.1 The Archaeological Museum of Tripolis

The Archaeological museum of Tripolis, Greece has been selected as the venue for this pilot due to a number of reasons:

- The site is less known or popular among tourists (both Greek and foreign) with lack of visiting motivation.
- The exhibits of this site have a deep historical value, however, they are unknown to the wider public.
- Minimum information regarding the exhibits of this museum is currently provided to visitors.

In such space, personalized experiences could be beneficial for the visit, since they can allow the visitor to explore the museum in a way that is relevant to her. As part of this pilot, personalization will consist of recommendations to the visitors regarding available items for interaction (digital resources, exhibits or Points of Interest), paths to follow during the museum visit or people they can interact with.

Despite the small size, similarly to any other archeological museum, the Archaeological Museum of Tripolis employs a number of archeologists who study its collections and catalogue their items. Therefore, the development of the content that is required for the implementation

of the pilot and utilization of our system is not an additional task; it is merely a question of incorporating and exploiting already existing information.

This specific museum could be viewed as a representative type of museum in a small city. There are numerous small city museums around, exhibiting mainly a relatively small number of unknown artifacts. The study of the Tripolis' museum could be thus extended for many other similar type museums and the solutions suggested here could be applied (with the necessary modifications) to other cultural spaces of the same characteristics as well.

5.2 User profiling and sharing through social media

As previously discussed, the application will use features of the CrossCult platform and more specifically, the user profiling and social network profiling tools. In this pilot, the user experience starts with a Facebook game entitled "Which goddess is your guardian?". It is a quiz game aiming to match the player with an ancient goddess as her protector, according to the answers that the player has provided. The player answers questions, which have been designed based on the reliable tool for assessing individual's cognitive style, MBTI (Myers-Briggs Type Indicator) (Myers, McCaulley and Most, 1985). The MBTI is based on Jung's theory of psychological types. Individuals are described using four dimensions: extraversion-introversion (individual's focus of attention), sensing-intuition (the way an individual gathers information), thinking-feeling (the way an individual makes decisions) and judging-perceiving (the way an individual deals with the external environment). The combination of the four dimensions offers 16 personality types. Apart from the cognitive style, the following will be also used for personalization purposes: 1) available time for the visit 2) visitor's gender 3) age (Antoniou et al., 2013). Thus, taking account the answers of this mini psychological quiz and further demographic information about users from Facebook, suitable museum thematic tours will be presented to the visitor, which correlate with visitor interests.

In this way, CrossCult will be able to propose a list of possible thematic visits in the museum according to users' profile preferences. In a possible scenario (Figure 3), a visitor is presented with some museum topics that might be interesting to her and she chooses one to start her visit (e.g. Religion and Rituals). During her visit around the different objects, the user is able to exchange messages and information with her friends on Facebook. Also, the user receives different digital objects relevant to the selected topic. For instance, in front of the prehistoric female figurines from Sfakovouni, the user learns how poppies have been used for healing malaria in the antiquity. Then, visitor decides to share this interesting information with her friends on Facebook. Moreover, the mobile application will give the opportunity to the visitor to take pictures of the exhibits (e.g. figurines) and to post them on her personal Facebook account together with different digital objects about healing practices in ancient times presented to her (e.g. ancient inscriptions). The visitor can also post the different reflection topics presented to her (for example, "Can you see similarities between ancient rituals and today's religious practices?") to discuss these issues further on Facebook with her friends.

At the end of her tour, the visitor would be able to download a map with suggested tours in the wide area of Tripolis and the wide area of the museum, based on the initial location of the exhibits she visited. This map aims to trigger further cultural visits on some of the places that she learned about during the tour (e.g., Sfakovouni). Furthermore, she will be able to share this map with her friends on Facebook and to arrange their next trip. After the visit, the user can continue engaging with museum content and reflection topics in the visitor guest book, also available on Facebook. The virtual visitor's book offered by the app is a place to gather new, subjective interpretations of history that the venue experts can later study to extract relevant knowledge about the visitors and also enrich the knowledge bases of the CrossCult system.

Pilot 3 will incorporate physical objects, digital objects and reflection topics. In doing that, we will produce a well populated and semantically rich ontology that can assist historian and museum personnel (e.g. museum curators) to explore different connections between physical objects, digital objects and reflection topics and concepts. In addition, visitor cultural experience will be enhanced by the use of social networks and the underlying ontology can be

exploited further to allow cognitive processes such as reflection as well as social processes such as discussion on social media related to the museum visit.

5.3 Recommendation of people and items

Within a social network, "friendship" relationships are established among its members. The nature of the relationship holding among "social friends" may greatly vary: they may be close friends or strangers, with little or nothing in common (Gilbert and Karahalios, 2009). Some of the "social friends" of a user may be her close friends in real life, but they can also be acquaintances barely known to the user, such as actors, singers or politicians. According to Anagnostopoulos et al. (2008), three main causes of correlation in social networks exist: *influence* (also known as *induction*), *homophily* and *environment* (also referenced as *external influence*). Due to *influence*, an action of a user is triggered by one of his/her friend's recent actions (e.g. when a user may visit a venue because one of her friends has recently visited the particular venue). Homophily refers to the phenomenon that individuals often establish "social friendship" with others who are similar to them, and hence perform similar actions (e.g. sharing a common interest, such as study of Ancient Greek civilization). Finally, *environment* refers to the phenomenon that external factors are correlated both with the event that two individuals become friends and also with their actions (e.g. two visitors of the same museum posting pictures of the same items in the social network can become "social friends").

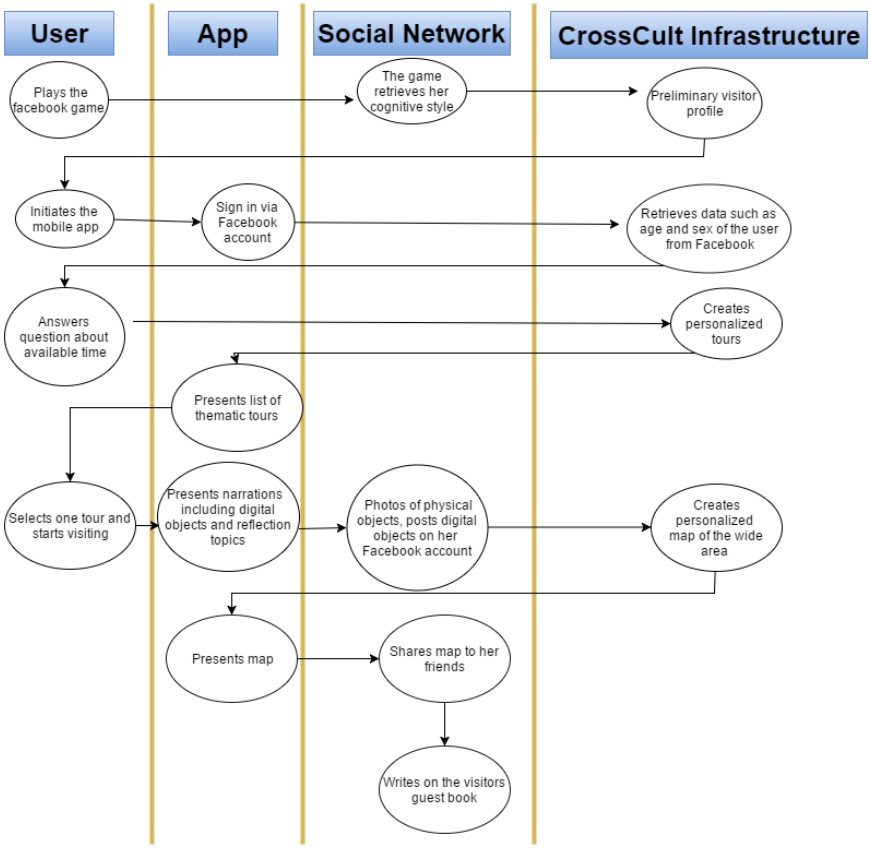

Figure 3. Activity diagram of a user story

In the context of the pilot, a user may post photos or digital objects to her Facebook account (c.f. Figure 3). In this respect, the users that post the same or highly similar objects can be identified and the system may propose to them the establishment of a "social friendship", since they fulfill the *environment* criterion. Additionally, profile attributes of users may be matched, both sourced from their Facebook accounts and determined through mini-games or other CrossCult profiling techniques, and when the level of matching exceeds a certain threshold, "social friendship" establishment can be again proposed due to the satisfaction of the *homophily* condition. It is expected that the establishment of new "social friendships" among visitors of

the museum will promote discussions regarding museum experiences and exhibits, as well as exchange of views, leading thus to more holistic understanding of the museum exhibits and promotion of learning.

Inversely, the likings and preferences of a user towards museum exhibits and items may be used to formulate recommendations to their social neighborhood, exploiting the *influence* aspect of social friendship. Bakshy et al. (2012b) assert that a social network user responds significantly better to advertisements that originate from friends of the social network to who the user has high *tie strength*. The tie strength can be also be exploited in managing *information diffusion* within the social network, through recommending to users of the social network activities that their "social influencers" perform (Margaris et al., 2016). These two aspects are exploited in the CrossCult pilot as follows:

(a) For the creation of a personalized tour, when the user is already in the museum. At this point, beyond considering the profile characteristics of the individual user, the preferences and likings of her "social influencers" are taken into account to formulate the personalized recommendation, which is presented to the user.
(b) When a user checks in the museum, posts photos and digital objects to the social network or engages in post-visit activities (commenting, conversations, etc.), appropriate notifications are forwarded to the users she influences, promoting thus the museum content, encouraging further museum visits and creative involvement in post-visit activities. Users have the ability to customize various parameters of notification delivery, including the selection of influencers that are considered in the process of generating notifications for them, the mode of delivery (e.g. as a notification item in the application; on the smartphone notification area; on their social network; through e-mail).

5.4 Promoting museum content related to trending topics

Twitter is a microblogging service, which has emerged as a new medium (Kwak et al. 2009), allowing people to share news, views and thoughts through short messages. Tweets are directed to the tweeting user's followers and are also available through topic-based hashtags. Topics that are particularly active within the latest period are characterized as *trending topics* and reflect current affairs and news.

Trending topics are often subjects of interest and discussion among people, hence museum curators can capitalize on this interest to promote items and/or collections that are related to trending topics, highlighting their relationship to them; through making apparent the relationship of exhibits with current news, visitors can reflect on various aspects of exhibits, such as ancient customs and practices that are still alive; social, ethical, cultural and technological developments followed from past times to the present; and so forth.

In pilot 3, a service is developed to match the Twitter trending topics against the museum informational content. The latter is represented by means of the ontology depicted in Figure 4. In this figure ovals correspond to exhibits, rectangles correspond to major classification terms and rounded rectangles correspond to minor classification terms. Twitter trending topics on the other hand are retrieved through the GET trends/place Twitter API (Twitter, 2017a); the museum location (Tripolis) and major world capitals are used as the places for which trends are collected. Subsequently, the text of the related tweets are retrieved through the GET search/tweets Twitter API (Twitter, 2017b). Once the tweet database has been populated, the tweet corpus is matched against the museum content using Apache Solr (Apache Group, 2017) with the Semantic Search in Numpy plugin (Berryman, 2013). The Search in Numpy plugin provides support for automatic generation of "synonyms" through collaborative filtering techniques, i.e. using words that commonly occur together to enhance the search. For instance, if the phrase "temple of Apollo" occurs frequently in documents, then the plugin will exploit this information to enhance the results of a query requesting the documents containing the word "Apollo" with documents containing *only* the word "temple".

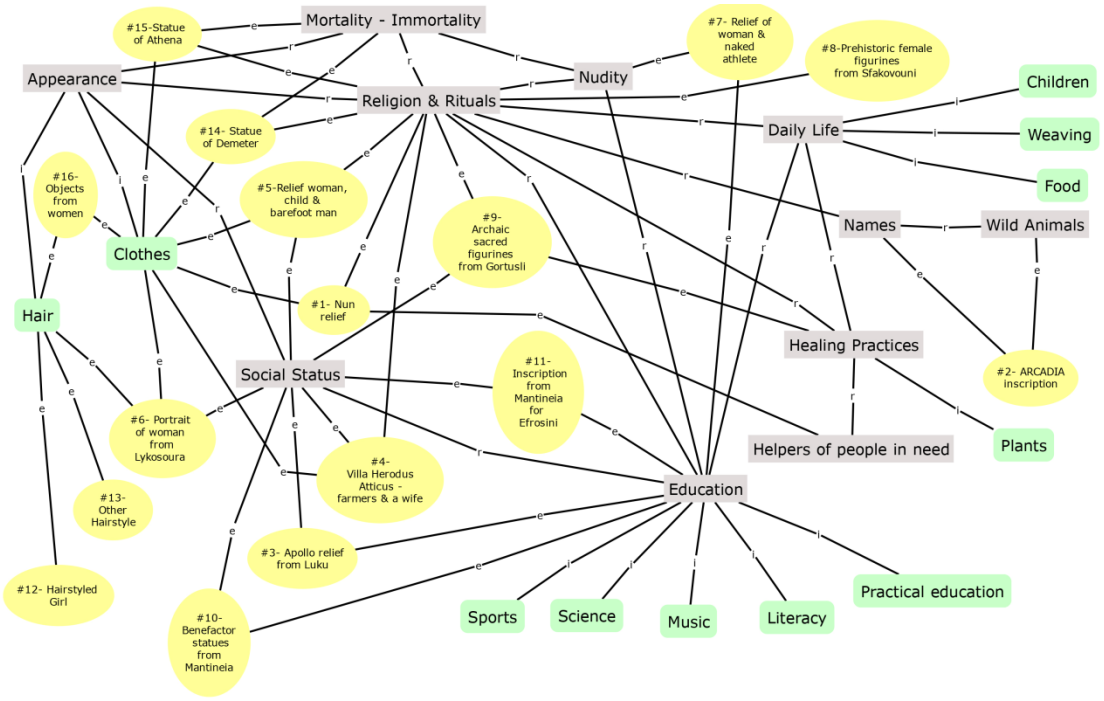

Figure 4. Semantic representation of the museum's exhibits

When a trending topic is found to match some museum concept (the matching score returned by Apache Solr exceeds a threshold), then the match is suggested to the curator, who can decide whether the identified relationship will be exploited for promoting the exhibit and on the most prominent means to implement the promotion.

6 CONCLUSIONS

In this paper we presented how social media content and social media interaction can be used in order to produce a new generation of cultural heritage delivery platform. The proposed method aims to leverage museum visit experience from just presenting the museum's exhibits, to a level of driving the visitor to reflect about how the history she is presented, taking into account her own knowledge, experiences and beliefs, and to stimulate discussion between unconnected but compatible visitors.

The proposed system is structured as a four layer generic architecture that allows for the incorporation of social media interaction, in the form of Facebook games as well as through enabling the exploitation of social media content (such as Facebook and Twitter posts) and other social network-derived data (e.g. Twitter trending topics and Facebook account information), in the museum content delivery process. Moreover, we elaborated on the specific methodological principles that need to be followed in the implementation of the system, in order to provide increased stimuli for visitors to study the cultural heritage deeper and reflect on them, as well as to trigger discussion between the visitors, thus maximizing the impact of a visit to a museum.

Finally, we reported on the application of the proposed methodology and system in the CrossCult H2020 project, where the notions proposed in this paper are implemented and applied in a real life pilot running at the Archaeological museum of Tripolis. We provided insight regarding the specifics of the implementation regarding the way to extract information from social media regarding visitors and the topics that might interest them (either because they match their particular user profile or because they are currently trending topics), the way to use that information to identify content that would interest a visitor and the way to use this information in order to identify other individuals with who the visitor might strike stimulating debates. These can lead to more interesting, but more importantly more meaningful and impactful, visits to the museum.

This being an ongoing work much more remains to be done. Once the pilot is fully implemented, the research team will have the opportunity to deepen the study of the dynamics of social media in the domains of cultural heritage, history reflection and history interpretation. It will also be interesting to examine how easy it will be and what adaptations will be required in order to transfer these notions to other settings, such as, for example, non-historical content (e.g. art exhibitions) or outdoors venues (e.g. archaeological sites).

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