

THE ROLE OF RECOMMENDERS IN CULTURAL HERITAGE

George Pavlidis

Research Director, Athena Research Centre,
gpavlid@ceti.athena-innovation.gr

Abstract

Recommenders are, typically, systems that exploit knowledge regarding preferences of users on a set of items, in order to create user recommendations for unknown items. Recommenders are meant to create meaningful recommendations, enhancing the content personalisation and reducing the information overload. Applications of this type of technology have already appeared in the domain of cultural heritage, mainly in the form of museum and tourism recommenders. This paper reviews and explores the role of recommenders in cultural heritage and briefly discusses the main concepts, limitations, challenges and future directions.

Keywords – artificial intelligence, cultural heritage, museum guide, recommendation, recommender

Introduction

The goal of recommenders is to create meaningful recommendations for users regarding unknown items. The reasons for such systems mainly include the tackling of the information overload due to the vast amounts of information that overwhelm the users, and the personalisation of the served content, which, in general, relates to content that matches a user's profile, state of mind and information consumption context (i.e. educational, recreational) (Adomavicius and Tuzhilin, 2005; Aggarwal, 2016b; Asanov et al., 2011; Melville and Sindhvani, 2011). The relevant technology draws mainly on cognitive science, approximation theory, information retrieval, forecasting, management, and consumer modelling (Adomavicius & Tuzhilin, 2005). The most simplistic, yet highly effective recommender, suggests items based on popularity; this recommender is considered as the baseline against which any new method should be compared and win.

Tapestry (Goldberg, Nichols, Oki, & Terry, 1992) and GroupLens (Resnick, Iacovou, Suchak, Bergstrom, & Riedl, 1994), are considered to be the fathers of modern recommenders. It was then that a highly persistent approach in this field, collaborative filtering, was introduced, formulating the problem as an optimisation, seen either as a minimisation of a cost of an inaccurate prediction, or as a maximisation of a user's utility or satisfaction (Good et al., 1999; Jaquinta, de Gemmis, Lops, Semeraro, & Molino, 2010). In the bibliography in this domain three approaches are identified, the content-based systems, the collaborative filtering systems, and the hybrid systems (Adomavicius & Tuzhilin, 2005; Aggarwal, 2016b; Anand & Mobasher, 2005; Bobadilla, Ortega, Hernando, & Gutiérrez, 2013; Jannach, Zanker, Felfernig, & Friedrich, 2011; Kaminskas & Ricci, 2012; Konstan, 2004; Lü et al., 2012; Ricci, Rokach, Shapira, & Kantor, 2011). Various evaluation methods applicable to recommenders and an in- depth discussion can be found in Aggarwal (2016c).

This paper focuses on their recommender system applications in cultural heritage, where they appeared, mainly, as techniques to enhance museum visits and tourism applications. The most significant advances are being listed and a brief discussion concludes on the main concepts, the limitations, the challenges and possible future directions.

Recommenders in Cultural Heritage

There is a high volume of published works related to recommenders in the cultural heritage domain. An identification of the most influential and interesting works in this field leads to a list of around two innovations per year since 1999. This section lists some of those works in a chronological order to convey the essence of the progress in this domain.

In 1999 the Hippiie guide (Oppermann & Specht, 1999) was developed as an electronic guide for adaptive exhibition guidance. The innovation included exploiting awareness of visitor location and user modelling.

In 2002, the Sotto Voce (Aoki et al., 2002) was developed as a PDA audio guide focused on social aspects of museum visits, by supporting a mediated sharing of audio content (termed eavesdropping), and providing location-based recommendations.

Rocchi, Stock, Zancanaro, Kruppa, & Krüger (2004) developed a mobile system focused on cinematic techniques to enhance engagement, using also user localisation.

Chou, Hsieh, Gandon, & Sadeh (2005) developed a collection of PDA applications that adapted the recommendations to visitor profiles and visitor behaviours, focusing of context awareness using a number of sensing technologies, based on approaches by Miller et al. (2004).

The ARCHIE mobile guide (Luyten et al., 2006) focused on social awareness, influenced by studies like (Falk & Dierking, 2000), in which Wi-Fi-based visitor localisation was used.

Grieser, Baldwin, & Bird (2007), presented a recommender based on user modelling and item features, extracted from textual descriptions, using the typical *tf*

– *idf* approach for the text-based similarity estimation and a probabilistic approach to assess the likelihood of a path.

Basile et al. (2008), under the framework of the CHAT project, developed a content-based recommender capable of learning user profiles from static and user-generated content, as a type of extension of the IItem Recommender (Degemmis, Lops, & Semeraro, 2007).

Luh & Yang (2008) focused on recommendations based on visitor lifestyles based on collaborative filtering and a set of lifestyle factors proposed by the authors.

Between 2007 and 2010 several versions of a museum recommender were developed under the framework of project CHIP (Rijksmuseum). Initially, Pechenizkiy & Calders (2007) developed a content-based personalisation framework. Wang et al. (2008) proposed the creation of recommendations based on semantically-enriched museums collections adopting, again, a content-based approach for PDAs and sensor based localisation. A 2009 version appeared in a student research competition, focused on a mobile implementation for on-site museum visits (Roes, Stash, Wang, & Aroyo, 2009). Van Hage, Stash, Wang, & Aroyo (2010) presented a more advanced version of the system, equipped with routing functionalities based on localisation information.

Huang, Liu, Lee, & Huang (2012) developed a personalised guide, focusing on museum learning settings, based on a rule-based recommender. The interesting in this work was that it seems to be among the first to present an experimental evaluation design that targeted user satisfaction factors, as defined in Ong, Day, & Hsu (2009).

Maehara, Yatsugi, Kim, & Ushiyama (2012) developed a recommender that relies on a semantic network on museum exhibits based on item relations and user preferences, taking into account the limited timeframe of a visit.

Benouaret & Lenne (2015) proposed a combination of semantics (content-based) and collaborative filtering to create personalised museum tours, on smart mobile devices. The researchers used relevance, contextual information, time limitations, localisation, even weather information, to provide accurate context-aware recommendations.

Keller & Viennet (2015) presented a recommender within the AMMICO project focused on enhanced audio guidance in museum tours, claiming to tackle the challenges of the cold-start, the data sparsity, and an inherent over-specialisation as expressed in (Ardissono, Kuflik, & Petrelli, 2012).

Rossi, Barile, Improta, & Russo (2016) developed a collaborative filtering-based system to increase both individual and group visitor satisfaction, adopting matrix factorisation, along with localisation aspects.

Tavcar, Antonya, & Butila (2016) designed a hybrid recommender system within the eHERITAGE project that is based upon strong mash-up approach influences, combining technologies such as intelligent virtual assistants, Google Street View and recommenders.

Hashemi & Kamps (2017) developed a hybrid recommender within project meSch, adopting the free-roaming museum visit model, thus using localisation, online and on-site user behaviours, and content- and context-awareness.

Cardoso, Rodrigues, Pereira, & Sardo (2017) developed an association rule-based

approach, within project M5SAR, clearly a hybrid method for museum visit recommendation, capable of supporting multiple visitors and multiple museums and sites, using the Apriori algorithm (Agrawal, Srikant, et al., 1994) to learn the rules, and utilised data from the open dataset of MoMA (Robot, 2018).

Kovavisaruch, Sanpechuda, Chinda, Sornlertlamvanich, & Kamolvej (2017) developed a probabilistic approach for a system capable of evaluating visitor paths in order to assess the effectiveness of a given museum exhibition organisation. Although the system naturally supports museum curators and exhibition designers, a very simplistic approach was described to exploit the model learned for visit recommendations.

Discussion

Most of the works on recommenders in cultural heritage, still conceptualise the museum as a gallery-like institution with linear narratives, which reveals a trend in the assumed visitor models or motivations by the involved researchers. This is a conception that needs to be revised since in the recent years the museums are transforming, mainly due to sustainability issues, adopting a different role closely related to education, study and enjoyment.

It is indicative that the “New toolkit for museum and heritage education” by ICOM-CECA proposed eighteen methods a museum can use to enhance its educational services (ICOM- CECA. (2017, Oct.)). In this report it is evident that the social and participatory factors are distributed among all the types of experiences, although there are strong requirements for support from the stakeholder, as these approaches need interesting storytelling, careful storyline organisation and fascinating narratives, meaningful and illustrative content and contextual structuring.

Social engagement and visitor participation aspects have already been considered, but the stakeholder’s role has not been properly defined and included in the loop, by being described as a type of repository curator. Although a modern view of an institution like a museum includes heavy investment on storytelling, history and narratives, aesthetics and education this new view has not been considered yet.

From a technical point of view, hybrid recommender approaches have proven their strength in the cultural heritage domain, matching the complexity inherent in this domain. Since this is a highly dynamic domain with a large variance in tastes and various biases, online methods that consider context awareness, temporal dynamics and biased behaviours can be considered as most appropriate. Modern approaches using methods like reinforcement learning and agent- based techniques have not appeared yet.

In addition, semantic data and linked open data approaches need to be more seriously included in the technology in the domain, as more and more repositories and collections move towards international standards for data interoperability.

Location and context awareness can be easily integrated into cultural heritage recommenders as the Internet of Everything becomes more and more pervasive with easily applicable solutions, along with always connected and low-cost high-power ubiquitous computing, even in small-form devices.

The fast-developing intelligent virtual assistants technology is another important

addition to cultural heritage recommenders, and there are already available cultural applications which incorporate intelligent guides.

Overall, there is room for further development both in the conceptualisation of the role of cultural institutions and the motivation of the visitors, and in the technologies that support an intelligent recommender. Impressive new developments are expected to appear in the near future.

Conclusion

Recommenders are artificial intelligence systems that have already been proven efficient in tackling information overload and personalisation in various contexts.

Recommenders have appeared in the cultural heritage domain over the past decade to tackle personalisation in museum visits and cultural tourism applications. This paper reviewed works focused on cultural heritage applications of recommenders, a rather complex domain, in which basically hybrid approaches have been the most successful, although with limitations and assumptions. Challenges and benefits have been identified and a critical discussion on the reviewed approaches highlighted the foreseen future developments.

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