Group recommendation in an Hybrid Broadcast Broadband Television context

Oskar van Deventer[1], Joost de Wit[1],
Jeroen Vanattenhoven[2], Mark Guelbahar[3]

[1] TNO, Brassersplein 2, 2612CT, Delft, The Netherlands
[2] iMinds – KU Leuven, Belgium
[3] IRT, Munich, Germany

Abstract. This paper presents insights and learning experiences on the development of an integrated group recommender system in the European FP7 HBB-Next research project. The system design incorporates insights from user research and evaluations, media industry players, and European HbbTV standardization efforts. Important differences were found between providing content recommendations for HbbTV and e.g. on-line purchases. The TV user experience is very "lean back", so the user interface and interaction has to be minimalistic. The TV broadcast schedule changes continuously, so the system has to be continuously updated. TV is typically consumed with family or friends, so it should support group recommendations. Furthermore, an important challenge is the HbbTV business ecosystem, where the content originates from multiple broadcasters and the recommendations provider may be different from the HbbTV platform provider. The resulting system is a Java-based recommender framework with open interfaces for content metadata provisioning, user-profile and identity management, group recommender algorithms, and group recommendation retrieval. A metadata provision system was developed, automatically enriching EPG metadata with content metadata from open Internet sources. Users are identified via QR-code scanning and face recognition. The recommender uses a genre-based collaborative “least misery” group-filtering algorithm. The client side application is an HbbTV application. Whereas most requirements could be fulfilled, further study is needed to find acceptable solutions for collecting user preferences and user identification in the HbbTV context.

Keywords: Group recommendations, recommender systems, system design

1 Introduction

Television is becoming more and more interactive. Connected TV sets receive television channels through broadcast, whereas additional applications, content and services are obtained through broadband internet. Hybrid Broadcast Broadband Television (HbbTV) [1] is a standard that enables connected TVs to automatically start the broadcaster application that belongs to the selected TV channel. It is being implemented and used in a growing number (over 10 by October 2012) of European coun-

tries. The European FP7 HBB-Next research project [2] is developing technologies for next-generation HbbTV. One of its research topics is multi-user content recommendations in a HbbTV context. The central use case reads: “One person watches television and retrieves a list of content recommendations. Then a second person enters the room, and is also identified by the system. Subsequently, the recommendation list changes, tailored to the taste of the two persons together.” Accordingly, the focus of this paper is on HbbTV content recommendations to a relatively small group of users consuming the content together.

Providing content recommendations in an HbbTV context provides many challenges. In addition to the already enormous amount of TV programs broadcasted, the availability of online content via broadband (both live and on-demand) will further increase the content offered on the TV. Developers of recommender systems that will be deployed in this context face numerous challenges concerning the acquisition of user preferences, identification of the users, the calculation of multi-user recommendations and the presentation thereof. Furthermore, the business environment is challenging as there are many different players in the HbbTV business ecosystem, and there are different, and sometimes conflicting, business interests [3]. All of these aspects are important challenges in the development of a viable group recommender system for HbbTV.

2 Related work

Content recommender systems are well-known for books (Amazon), on-line videos (YouTube) and movies (Netflix, TiVo). Traditionally, recommender systems are primarily applied in a single-user on-line / web context and a large body of research is available within this area [4, 5]. However, like regular TV, HbbTV content will typically be consumed by multiple users. Group recommendation is a research area that receives a lot of attention [4, 6, 7]. Well-known group recommender systems are, amongst others, MusixFX (music in a fitness centre) [8], PolyLens (movies) [6], Intrigue (tourist attractions) [9] and CATS (holidays) [10].

In the TV domain, where content is typically consumed by multiple users, group recommender research is performed as well. Yu’s TV recommender “TV4M” recommends TV programs to multiple users by merging their individual profiles [11] using total distance minimization. However, this recommender is not deployed in a television context, but instead runs on a PC. The challenges faced when providing content recommendations in a TV context differ significantly from the PC/web context. Whereas PC has a "lean-forward" experience with active user involvement, TV is "lean-back" where the user is a passive consumer expecting minimal effort [12]. Furthermore, the user input for TV is (until recently) limited to the buttons on the remote control, and there is limited space on the TV screen.

Research questions related to the TV context are addressed by the academia as well. Vildjiounaite et al. for instance, presented a method to construct group profiles based on implicit feedback of individual users [13].

3 Methodology

As part of the HBB-Next project, a recommender system was developed as a collaborative effort by its partners. During its development, four sources of feedback have been used to improve and consolidate the design and implementation. Firstly, user requirements were determined via a diary study on video use in 15 households [14]. Then, different user interfaces were explored using paper prototyping. Secondly, an experiment investigating how people decide what to watch was conducted [15]. Thirdly, business aspects have been checked with service providers and broadcasters outside the consortium in feedback workshops, providing valuable input on the distribution of technical functionalities over the different business roles. Fourthly, industry adoption has been verified by contributing proposals to European HbbTV standardization, surfacing conflicting interests on identity management between broadcasters and consumer-electronics vendors.

4 Results & Discussion

A generic Personal Recommendation Engine Framework (PREF) was created (and can be obtained from the authors for free for R&D purposes), since different recommender systems have so much in common and recommendation algorithm developers like to focus on the algorithms instead of the underlying cogs and gears.

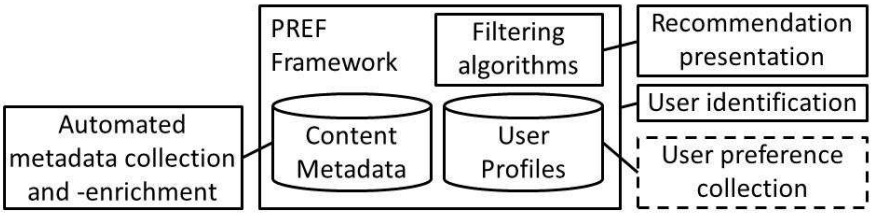

Fig. 1. PREF framework and system components.

4.1 Group recommendation algorithms

The PREF features an internal API that enables recommender system researchers and developers to easily create (group) recommendation algorithms (see Fig. 1). To calculate recommendations, generally three steps are taken:

1. Prediction – The ratings of a user or group with respect to a list of candidate items are predicted.
2. Filter – All items that are not relevant to the group or user, regardless the predicted rating, are removed from the list of candidate items.
3. Clipping – The list of candidate items is turned into the actual recommendation list.

The current recommender system implements a scalable genre based collaborative filtering (GBCF) prediction strategy [16]. This prediction strategy is similar to item-

based collaborative filtering, but instead of items, similar genres are calculated. This results in a much smaller and very dense user-genre matrix, which is used to predict an item's utility. The group preferences are modeled by merging the profiles of the individual users using the least misery aggregation strategy. This strategy is applied, as it is effective for small groups [7]. A utility-based filter is applied on the list of all candidate items. This filter removes all items with a predicted utility below a certain threshold. To create the final list of items that are recommended to the group several list characteristics are taken into account. All (near-)duplicate series are removed to prevent very similar episodes of the same TV series to fill the list. This makes the resulting list more diverse, which proves to contribute to the overall user satisfaction [17]. When the list contains similar items, broadcasting time determines which one remains. TV programs that are on air when the user likes to watch TV are preferred over others.

4.2 Automated metadata collection and enrichment

As the TV schedule changes day by day, automated metadata collection is essential for the presentation of recommendations and also if content-based filtering is used (e.g. to improve cold start). Furthermore, extensive genre information is essential for genre based CF. Fortunately, basic TV metadata is readily available through metadata brokers, in some countries even enforced by law. A system was built that collects metadata and enriches it with additional semantic metadata that is freely available via the Internet, e.g. from DBPedia [18].

4.3 Collecting user preferences

Collecting user preferences is a major bottleneck for TV program recommenders. Industry feedback taught us that users are unwilling to provide explicit content ratings in practice since providing it through a remote control is cumbersome. Therefore, an implicit (or hybrid) system is needed, based on the watching behavior of the users. This system must be able to identify who is watching TV and what content they consume. However, providing automated access to the user identities and clickstream runs into major privacy issues especially in a situation where devices that collect implicit feedback send this to a central location for processing. Another serious issue is the lack of a viable business-model to broker this profile information. In order to support content recommendations to a group of visiting friends, their profile information might need to be shared among different recommender system providers. There is probably no business incentive to share this information [3], but as long as recommender systems remain stovepipes this issue is avoided. Besides this, the collection of implicit ratings in a group context is not straightforward either. The current implementation uses a fixed user preferences database combined with explicit feedback and leaves the collection issue for further study.

4.4 HbbTV recommender application towards the user

The recommender front-end was implemented as an HbbTV application, running in an HbbTV browser. The user interface was kept minimalistic and clean. The user pushes the red button on the remote control to activate the recommender. Then recommendations are requested for the identified users. The resulting recommendations are provided in a simple grid layout as shown below, which was found the most effective based on user feedback with various mock-ups. The user interface also shows who is watching, and for whom the recommendations are meant. Once an item is selected, a pop-up page presents further information about the program and offers the user various viewing/recording sharing options. The playout itself was not implemented, as these are standard TV set and HbbTV functionalities.

Fig. 2. User interface for obtaining group recommendations for television

Several options for user identification have been considered and implemented. The web default, a recurring manual login screen, was rejected as too user-unfriendly. Instead a QR-code with an associated smart-phone app was implemented to enable quick and reliable user identification. Users can identify themselves by scanning the unique QR-code that is displayed in the HbbTV app (see bottom right of Fig. 2). Furthermore a face and voice recognition system is integrated for an even user-friendlier identification of a limited set of predefined users. A Kinect camera that is placed on top of the TV provides an audio and video stream in which a predefined set of faces and speakers are to be recognized.

User identification proved to be a contentious issue from the industry feedback. Whereas broadcasters need access to user identity, equipment vendors are unwilling to provide it as they either want to keep the user identity for their own services, or they see no business in identity management services. Also some blocking privacy issues were identified, e.g. strict laws on the use of cookies in browsers.

5 Conclusion & Future Work

In this paper, we have presented a group recommender system for the HbbTV context, including solutions for user identification, automated metadata enrichment, group recommender algorithms and user interaction. The system was developed with active involvement of end users, players in the media industry and European standardization.

Whereas most technical challenges seem solvable, conflicting requirements have been identified between user experience and business models. There is no clear place for an "identity provider" role in the current HbbTV ecosystem, and the collection of implicit feedback runs into both business and privacy objections.

Future work will focus on how to use implicit feedback derived from observed group behavior in the dynamic home context. How does the "real group preference" relate to the least-misery aggregate of preference? How should the system explain the recommendations ("reasoning"), given the limitations of the TV environment? How can the system shield the user's privacy to third parties, including co-watching friends and family? And most importantly, what is the business for group recommendations for TV programs?

6 Acknowlegements

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