Vorabfassung des Artikels

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Recommender Systems for Spoken Word Radio

***Abstract*—The radio broadcasting industry had less innovation pressure compared to the music industry over the last years. But in the meantime, broadcasting agencies are increasingly competing with new music streaming services for listeners' limited attention and time. Radio broadcasting agencies react by building up personalized radio next to their linear playout, but have to face the difficulty that spoken word radio recommendation is more complex than music recommendation due to the heterogeneity of contents. We depict the requirements for radio recommendation, present the current data situation of broadcasters and a rough sketch of an architecture for a radio recommender system.**

I. Introduction

Recommender Systems are on their way to enter a wide field of applications, and now also reach industries that had less innovation pressure in the last years, such as the radio broadcasting industry. Radio broadcasters are currently facing the challenge to build up a personalized experience for mobile radio on smartphones, next to their traditional linear program which comes out of the kitchen radio.

Radio broadcasters have their traditional business model and for many years did not feel much pressure to innovate. But in the meantime, broadcasting agencies are increasingly competing with new music streaming services for listeners' limited attention and time. Spotify had 100 million active users in mid 2016 [1] and 40 million subscribers in September 2016 [2] and is the market leader for music streaming services in many countries. As the music and film industry made significant advances, the radio broadcasting industry also more and more feels the pressure to innovate. Increasing music consumption might drain listeners from radio consumption, as time and attention of listeners are limited. Music and radio may find themselves competing for the attention of the same listeners. Radio broadcasters react by creating new channels to distribute their content, and one of the most promising new ways to bring content to users is a personalized radio experience on smartphones. Furthermore, personalized playlists have already become an expected standard for the younger generation, and the usage patterns that music and video streaming services established will very likely be expected of radio apps as well. Some broadcasters fear that if they do not manage to serve these usage patterns and keep up with state-of-the-art digital products, a generation tear-off might take place and broadcast organization will lose certain segments of listeners.

Especially recommender systems will become an important part of a radio broadcaster's new digital strategy. Few radio broadcasters like the U.S. National Public Radio (NPR) have already made advancements in the area of designing radio specific recommender systems and personalized radio.

Although radio broadcasting is a billion-euro-industry (134 billion US$ revenues of the U.S. broadcasting industry in 2014) [3][4] and reaches from 60 up to 90 percent of the population of all ages [5], there has been surprisingly little research on radio recommender systems.

The contribution of this paper is threefold: first, we present the most relevant requirements with respect to radio recommender systems; second, we present the current situation in broadcasting agencies, and third, we depict a generic solution approach for radio recommender systems.

The remainder of this paper is structured as follows: In the next Section, we resume on related work. In Section 3, we depict the requirements we elicited with focus on recommender systems for radio and the current data situation of broadcasters in Section 4. We present an appropriate solution design in Section 5. We follow up with a discussion and limitations in Section 6 and conclude with future research.

II. Related Work

Not much research has been done on radio recommender systems. Hirschmeier et al. state challenges of radio recommendation in contrast to music recommendation [6]. Publications about radio recommendation sometimes cover music recommendation only, e.g., [7]–[12], as the term radio is also frequently used for pure music streaming services. Focusing on radio in terms of spoken work, Liu et al. [13] propose an approach about recommender systems that suggest which linear radio channel to switch to in the car. Also Moling et al. propose a client side recommender system that suggests which radio channel to switch to [14].

In this work, however, we focus on radio recommendation in terms of a non-linear playout of spoken word radio content.

Xie et al. [15] propose a mobile application that allows users to listen to personalized radio with focus on news. Casagranda et al. propose a hybrid content radio [16], enhancing the traditional broadcast radio experience and augmenting

it with context-aware and personalized audio content from the internet, considering context like the listener's emotional state and activity, geographical position, and weather.

Schatter and Zeller [17] research on radio recommender systems with the focus on Digital Audio Broadcasting (DAB). Ala-Fossi et al. [18] and Anderson [19] also present studies about future delivery technologies of radio, but without placing a lot of emphasis on personalized content.

Considering radio program management, the book of Eastman and Ferguson presents an in-depth view on media programming [20]. Keith [21] specifically outlines program management for radio purposes.

III. Requirements for Radio Recommender Systems

In the following, we sum up the requirements that we elicited over the last months in discussions with representatives of broadcasting agencies, from presentations and talks, and from published articles. All requirements presented have a specific impact on the design of recommender systems for radio broadcasting. We however neglect all requirements that deal with the user interface and the appearance of personalized radio.

R1. Radio recommender systems need to reflect that radio is a mix of diverse contents

Radio is a mixture of diverse formats, such as news, talks, interviews, stories, radio plays, audio dramas, concerts, biographies, and long features. In contrast to music recommendation, where pieces are mainly characterized by a genre and an interpreter, radio pieces are much more multifaceted [6]. Apart from the diversification in formats, we also find diversification in topics (sports, music, politics, science, etc.), topicality (news vs. timeless content), depth with regard to content (funny, serious, in-depth, etc.), and duration (from less than a minute to more than one hour).

A radio recommender system has to cope with this diversity of content. Also, practitioners have the requirement that subgroups of content have their own recommendation technique or, at least learn the user's behaviour independent from each other. A user not interested in biographies of musicians might well be interested in other content about music. The diversity of radio content therefore feeds the assumption that groups of contents should be built, each having their own recommendation algorithms.

R2. Personalized radio also needs program management

In traditional radio, editors assemble the sequence of radio content, and over the years have built up personal or organizational knowledge how to assemble a good radio program. The program management of traditional radio is reflected in several levels: First, the broadcast schedule determines, which radio shows are being sent early in the morning, which ones in the evening, and on which day. It is the macro level structure of radio shows throughout the week and typically does not change a lot over time. Second, every hour in the week has a special clock – the broadcast clock – which is a template of contents being sent. The hour from Friday 3 pm to 4 pm, e.g., may start with a 3 minute newscast, continue with a 30 seconds music bed, then radio show segment A for 13 minutes, followed by an optional music bed for 2 minutes, radio show segment B, etc. Third, every show has its own clock and templates which editors use to structure their radio show.

The broadcast schedule at the macro level reflects what editors believe what suits their target group best, like a breakfast radio show in the morning or a newscast every full hour. On the other hand, the broadcast schedule represents a fixed timetable that listeners might integrate into their daily routine, so they know they can turn on the radio every morning at 7 am for their favorite radio show. Apart from the macro level program management, the micro level program management determines the contributions within a show. Radio editors decide from show to show, which contributions to send, and in which order. Radio editors have a certain feeling of how to assemble the parts of their radio show, and how to make the show enjoyable.

Assumably, the program management is one of the major factors what makes radio radio. Therefore, program management has to be reflected in personalized radio as well. Radio programming denotes the processes of selecting, scheduling, promoting and evaluating programs, and it does not matter, whether the programmer is a paid employee or the user [20]. Whereas in linear radio, the program management has been done by editors only, in personalized radio, the programming shifts to a multi-component issue, where three acting parties are involved: Editors, users, and algorithms. Whereas editors choose, which content is available for listening, recommender algorithms assemble a personalized selection and sequence of contents, and users give their input that makes the algorithms improve the playouts. Whereas users take over part of the programming, they still expect a ready-to-consume playlist, as Eastman and Ferguson state: "Viewers tend to choose channels and websites, but expect someone else to have filled those channels/sites in an expert way" [20].

R3. Interstate broadcasting treaties bring in special requirements

Considering personalized radio experiences, radio broadcasters have diverse objectives, depending on their mission and their funding. The question arises what determines the target function of a recommender system for radio.

"The main function of commercial media is to deliver an audience to advertisers" [20] one might say. In this regard, recommender systems help building exact profiles of listeners in order to keep them as long as possible engaged with digital products and to present them relevant advertisements. This is however not the target function of all radio broadcasters, especially not of publicly financed broadcasters. Those see their target function written down in the interstate broadcast agreement, usually referring to a formation of mature opinions of the public and balanced reporting. Whereas maximizing the length of stay on a digital product and maximizing the revenues from a listener's engagement seems a straight-forward goal for recommender systems, the normative influence of interstate broadcasting agreements on personalized playouts needs to be reflected in radio recommender systems as well.

With these objectives in mind, personalized radio faces a specific filter bubble challenge. Personalized radio may easily end up with users being trapped in an echo chamber, contradicting with the ideas of a public radio. As a consequence, radio broadcasters need to have special control over the program composing algorithms that assemble the personalized sequence of radio contents. The resulting sequence should therefore not only be a mix of recommended items, but also include externally induced items, allowing for serendipity and a wider horizon.

R4. Context-sensitivity

Whereas the previous requirements bear the intention to hold on to the characteristics of linear radio and transfer them to personalized radio, context sensitivity supports the idea to make personalized radio a richer experience than linear radio. As of today, only time of day and day of week can be reflected in the linear radio program. For mobile radio, more context factors are relevant like location, habits of the user, surrounding noise, surrounding light, activity, movement, temperature, weather, availability of bandwidth, output device, and other context parameters. Context-sensitivity may therefore influence both which content is played and in which sequence. A rich context-sensitivity is still more on the wish list of broadcasting agencies than on the requirements list. But broadcasters will move towards the goal to provide their personalized listening experience in a sophisticated, context-sensitive way.

IV. Data Situation of Radio Broadcasters

Current technical infrastructures of radio broadcasters are optimized for linear distribution of the content. These systems have not been designed to bring rich metadata along with the content. Typically, at the time when content goes on air for linear distribution, only few to none metadata about radio shows is available. Figure 1 shows the availability of metadata along the lifecycle of radio content in a typical scenario. Even if metadata is generated afterwards, e.g., for enriching the digital representation of content on the website or for archiving purposes, the dominance of linear distribution structures complicates the provisioning of digital content on websites, media centers, and especially for recommender systems. Whereas few broadcasters have already overthought their metadata generating processes, the situation depicted in Figure 1 still holds for many broadcasting agencies.

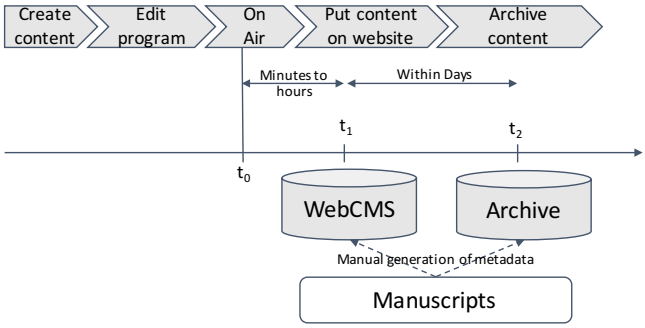

Figure 1. Availability of metadata along the lifecycle of content

The non-availability of metadata has two major implications: First, radio broadcasters will most likely focus on collaborative filtering techniques when initially building up a recommender system, and second, if they want to enrich the personalized listening experience with content-based recommendation approaches, they need to change processes, organization, and technical infrastructure accordingly, so metadata will be available in time.

V. Solution Approach

In the following, we present a generic architecture for radio recommender systems that match the requirements presented before. The architecture also reflects experiences that have already been made by innovative broadcasters that force the development of recommender systems.

The generic architecture foresees the division of all radio content into several groups. Each of these groups has its own recommendation algorithms and may also incorporate context information. Next to content groups, for which recommender

algorithms are applied, there is also content which should be kept out of the recommender system, e.g., news. A program composer component assembles a personalized playout in the end. Figure 2 depicts the generic architecture.

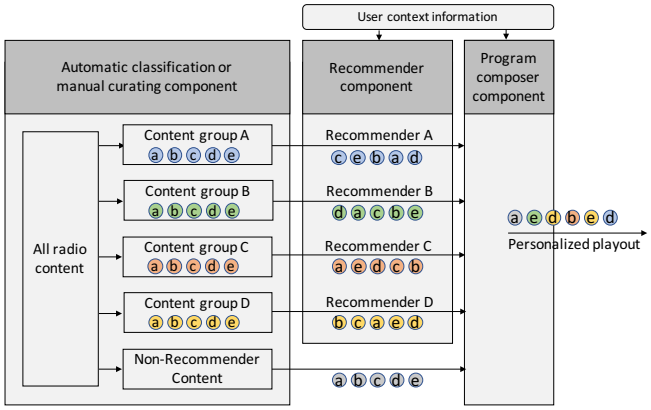

Figure 2. A generic architecture for radio recommender systems

A. *A recommender algorithm for each content group*

To meet requirement R1, all radio content should be subdivided into homogeneous groups. It is the broadcaster's decision which and how many groups to build. This decision, how many and which groups of content to build, and which recommender algorithms to implement, may well differ according to the needs and the orientation of the broadcaster and to the individual understanding what makes a good program.

Experiments have shown that with respect to listening satisfaction, recommender with curating outperforms recommendation alone. That is, the content is manually curated into groups (e.g., lead stories, core stories, break stories and invest stories, in the case of NPR [22]), and each group has its own recommendation technique.

B. *A separate program composer component*

To meet requirement R2, a separate program composer component exists that enables a sophisticated program management. The program composer algorithm, which defines the individual radio program sequence, then assembles the personalized radio program according to broadcaster-specific rules or patterns. In this program sequence, also non-recommender content such as newscast can be embedded. This way, the broadcaster not only maintains full control over how to assemble the recommended items from each content group, but also over the integration of content that prevents the user get into a filter bubble, in order to meet requirement R3.

As of current research, BBC Research & Development puts efforts in understanding what makes a good mix, and how to put this into templates or algorithms [23].

C. *Context awareness for both recommender algorithms and the composer component*

To meet requirement R4, context information may both influence the recommender algorithms and the program composer component. Ideally, context factors are already reflected in the recommender algorithms. But as the context of the user might change unexpectedly, the program composer component might adapt to the changed context much quicker, as it is the final sequence generator. Also for non-recommender content, the program composer can make use of context information.

Whereas a lot of knowledge about content-aware recommender systems already exists [24], more research has to be done specifically for the spoken word radio domain. The same holds for the architecture presented in general; it is still generic, as we still lack research results in detail.

VI. Discussion and Future Research

The requirements, situations and solution approaches depicted in this paper represent our view on the status quo of recommender systems in the radio broadcasting industry. Both requirements and solution approaches might still develop, as recommender systems for radio are just emerging and our perspective might not be all-embracing. More research has to be done on the questions what makes up a good radio program, and how to incorporate this into algorithms. The answers to these questions will presumably be case-centric, as every broadcaster might find an individual solution depending on their specific profile. The insight about the ingredients for a good program in turn determines which groups of contents to build before the recommendation takes place. Especially for publicly funded radio broadcasters, the question arises how exactly the influence of the interstate broadcast agreements should be shaped.

Further, practitioners and researchers have to think about the feedback channel of radio recommender systems. Whereas the feedback channel of the user's interactions is crucial for every recommender system in order to iteratively improve on the recommendation quality, in radio recommender systems the feedback goes far beyond the pure algorithmic improvement – it reaches back to the sphere of activities of the editors and producers. In other words, radio recommender systems should inform the editors and producers which content to produce more/less, how to improve meta-data, and how recommendations were taken up by listeners, i.e., gauge effectiveness of the recommendation algorithms. The feedback could also include explicit questions and comments from the consumers voiced through a mobile app.

Thus, radio recommendation should not be considered as a unidirectional communication like traditional radio – from producer to consumer – but as the possibility to enable the interaction of producer and consumer with respect to content.

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