NavProfiler for Multimedia Personalization in IPTV

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Abstract
User Profile forms the basis of personalized content recommendation in Recommender Systems. These systems value user-profile as a true representative for the user's interests. However, current methods used to construct user-profile on user's implicit behavior are limited. In this paper, we propose a mechanism to capture and evaluate user's navigational and content browsing pattern such as on IPTV content, and integrate extracted information into user-profile. The method enriches user-profile vector for accurate similarity evaluation among IPTV peers. We explain the design of profile agent, NavProfiler, which captures meta-data from user’s selected content, accurate viewing time and cache references. We extract the interests automatically without prior training. Our approach expands the vector components of the user-profile for better comparison and quality recommendations.

I. Introduction

Consumer Electronic (CE) devices are becoming powerful with the stupendous growth in hardware and software technologies. Compounding to these advancements, expanding infrastructure makes network-capable entertainment devices very popular. Users are creating, storing, and sharing more and more digital content through these internet capable devices. Search engines lessen the task of searching content by filtering contents that match user’s query but again in an inadequate capacity. Additionally, most of the search engines fail to take into account user’s taste. To fine tune user experience, the concept of recommender systems was introduced. A recommender system can be expressed as a type of information filtering (IF) engine [1] that recommends contents. The system creates a user-profile based on the content viewed by the user, compares the user-profile with some reference characteristics and finally computes the user’s likeness for a particular content. These characteristics may be extracted from the meta-data associated with the content i.e. Content Based technique or meta-data from other users i.e. Collaborative Filtering. The capability of a system to generate recommendation to a particular user means that it must be able to deduce what that user requires and be capable of aggregating similar users as accurately as possible so as to get finer result sets. This aggregation process is based on similarity evaluation which further is computed using user-profiles.

II. Related Work

Recommender system in consumer electronic devices, such as IPTV, suggests contents based on the opinions of other users or in other words, user-profiles [1]. These recommendation services on IPTVs can be fitted in a user behavioral model where the system captures accurate user likeness factor of multimedia content items. The likeness factor can be quantified for various contents by associating interest weight according to the navigational and browsing pattern of the user. The associate interest weight of an item is typically expressed as a numerical value reflecting the user’s level of interest in that item and can be integrated into the user profile which is generally a vector of keywords and weights. In order to calculate similarity, it is a common practice to represent this user profile in the bag-of-words (BOW) format [2] which is a set of weighted terms that best describe the entity so that the similarity between two entities can be computed using some standard approaches such as Cosine, Pearson, Jaccard Coefficient [3] etc.

In this paper, we describe a novel method that captures user’s navigational pattern in IPTV viewing into user-profile. This approach to enhance user-profile has not been used in previous work. Therefore, the resulting user-profile, an embedded tag extractor, facilitates better personalized content recommendation.

III. System Design

Formally, consider a user-profile can be viewed as a mapping of users and multimedia tags to a set of interest weights, suppose we a set of users $U = \{u_1, u_2, \cdots, u_m\}$, and a set of multimedia content tags, $MCT = \{mct_1, mct_2, \cdots, mct_n\}$. The profile for a user $u \in U$ is therefore an n-dimensional vector of ordered pairs:

$$u = (iw_{mct_1}, iw_{mct_2}, \cdots, iw_{mct_n})$$

where $mct_{i} \in MCT$ and $iw_{mct_i}$ is a interest weight (iw) function for user $u$, assigning weights to multimedia tags in MT.

Updating user-profile typically involves two stages:

- **a) User’s content watching context:**
- **b) Tag search and collection**

Our approach is designing a context-aware navigation agent in the IPTV. The agent performs two steps: First, the navigational agent identifies channel navigation and retrieves tags from the closed captions (CC) and EPG source as shown in Fig. 1.

Second, NavProfiler, developed over IPTV Architecture
(Fig. 2), further associates a weight to the collected tags. We do so by extracting, aggregating and correlating the tags of interest to the user, without any input from the user.

We provide further information on how the above steps are executed in the following sub-categories.

3.1 Calculation of Threshold Interval
A significant feature of the users’ navigation pattern is the time they spend on different multimedia content. We calculate the time spent watching multimedia content by a user. This should be the time that the user spent watching the content and it should exclude the time spent on receiving and loading the content (in case On-Demand). NavProfiler operates at the client end instead of the server end. The proposed scheme is designed to filter out the unwanted tags accumulated in a User Profile due to repeated navigation. It is normally observed that users tend to use the navigation keys to switch to programs of their choice if the desired program lies near the currently viewed program. In such a scenario a Recommender System with behavior based User Profile would accumulate the tags of the programs that lie in the navigated path to the desired program into the User’s Profile. Hence, we calculate a context based dynamic parameter, “Threshold Interval” (TI) to evaluate the validity of tags. The dynamic behavior can ensure that the TI adapts itself to the changing environment of multi-user multi-mood scenarios. All contents with viewing time less than the TI are not considered in User Profile formation and hence, ensuring the exclusion of unwanted tags. The TI window is moved forward with new pause intervals being created by the user while navigating as depicted in Fig 3.

![Figure 2: IPTV Architecture with NavProfiler](image)

![Figure 3: User Profile Enhancement Process](image)

As the behavior of each User is different hence the TI must be able to accommodate these differences. The calculation of TI is done for an individual user based on his navigational behavior. As the user navigates through the channels, the user may pause at several channels in his path of navigation for an interval, the “pause interval”. The Pause Interval may be considered as the time needed by a user to perceive whether a program being viewed is the one he wants to view or not. Hence to calculate the average pause interval we need to find the average of past pause intervals. This can be done by considering a set of past pause intervals using a TI window.

3.2 Identifying Potential tags
To generate user-profile correctly, NavProfiler needs to overcome two challenges: 1) Accurate recording of the time spent by user watching the content, 2) Detecting the links traversed by the clients. Our method identifies potential tags of interest to the user through the user’s current navigational state. Current navigational state refers to the tags that the user is evaluating at the time he desires to access relevant multimedia content for a particular channel. The method pinpoints the content rendered on IPTV and then aggregates metadata information and/or other associated data for the content being accessed. Aggregated metadata about a user’s viewing behavior is usually represented as a tag cloud.

3.3 Similarity Evaluation
Similarly between two users can be represented as a function of the two user-profiles as follows:

\[
\text{Similarity} = f(u_1,u_2)
\]

where u1 and u2 are the profiles of the two users. Similarity between two users is computed using the Pearson correlation coefficient defined below:

\[
r = \frac{S_{xx}}{\sqrt{S_{xx} S_{yy}}} \quad (-1 \leq r \leq 1)
\]

3.4 Algorithmic Steps
1. Obtain the CC and EPG meta-data related to the current IPTV content being watched by the user.
2. Extract keywords from the CC and EPG information.
3. Validate the keywords obtained in the previous step.
4. User Profile Integration is performed based on the extracted keywords from the CC and EPG.
5. User-profile personalizes recommendations.

IV. Conclusion and Future Work
In this paper, in order to provide each user with more personalized recommendation, we proposed an approach to capturing navigational pattern and processing it into user’s profile. Our approach is novel in that it allows each user the freedom of explicit ratings to content on IPTV, by capturing each user’s preferences. We identified experiments in order to verify the effectiveness of the approaches: (a) feedback mechanism and implicit approaches, (b) user profiles based on content watching pattern, and (c) user profiles based on the extended collaborative filtering better adapted to each user’s preferences.

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VI. Reference