A METHODOLOGY OF PERSONALIZED RECOMMENDATION SYSTEM ON MOBILE DEVICE FOR DIGITAL TELEVISION VIEWERS

Chumsak Sibunruang[1], and Jantima Polpinij[2]

Intellect Laboratory, Faculty of Informatics, *Mahasarakham University*, *Thailand*
[1]*inspire.ch@gmail.com*
[2] *jantima.p@msu.ac.th*

ABSTRACT. With the increasing of the number of digital television (TV) channels in Thailand, this becomes a problem of information overload for TV viewers. There are mass numbers of TV programs to watch but the information about these programs is poor. Therefore, this work presents a personalized recommendation system on mobile device to recommend a TV program that matches viewer's interests and/or needs. The main mechanism of the system is content-based similarity analysis (CBSA). Initially, the viewer defines favorite programs, and then the system utilize this list as query to find their annotations on the WWW. These annotations will be used to find other programs that are similar by using CBSA. Finally, all similar programs are grouped to the same class and stored as a dataset in a personal mobile device. For the usage, if a TV program matches the interest and specified time of viewer, the system on mobile device will notify the viewer individually.

Keywords: Television (TV), TV program annotation, content-based similarity analysis, personalized recommendation

INTRODUCTION

With the increasing of the number of digital networks, television (TV) devices, and the digital TV channels, enormous amounts of information, news, shows, and programs are developed and provided by many channels (Martinez *et. al*., 2009). This becomes a problem of information overload for TV viewers, because there are mass numbers of TV programs to watch but the information about these programs is poor. As this, the TV viewers have to spend more time for browsing in order to get the best one for their needs.

As a problem mentioned above, a personalized recommendation system is required, where it can be used to suggest some satisfactory TV programs to the viewers. Personalized recommendation is a process of collecting and storing of information about website visiting, handling of the digital content assets, analyzing of user profile, analyzing of current and past user behavior and interaction, including a delivery of the right content to each user (Chu & Park, 2009; Zhang *et al*., 2014). It has been found that the personalized recommendation services have been used widely to increase sales and customer satisfaction in e-commerce (Zhou *et. al*., 2012; Zhang *et al*., 2014), where these systems help to deal with the problem of information overload by filtering vital information fragment out of large amount in order to generate information according to user's preferences and interests (Konstan & Riedl, 2012).

With the advantages of personalized recommendation concept, this work applies this concept to a personalized recommendation service for digital TV viewers to recommend program that matches their interests and/or needs. Thus, this work presents a methodology of personalized recommendation system for TV viewers. This system is a main component on a mobile application, since the TV program notification will be performed through the mobile device.

The remainder of this paper is organized as follows. Section 2 describes the literature review of personalized recommendation system. Section 3 presents the proposed methodology and its evaluation can be shown in Section 4. Finally, Section 5 presents the conclusions.

THE PERSONLIZATION RECOMMENDATION

Traditionally, *recommendation systems* provide opportunities of retrieving personalized information on the Internet (Isinkaye *et al*., 2015), while *personalization* is to provide appropriate contents and services tailored to individuals based on their preferences and behavior (Adomavicius & Tuzhilin, 2001). Thus, the term of "*personalized recommendation*" is to recommend appropriate information/service to users based on personalized preference models (Abel et al., 2011; Dai *et al*., 2014). The personalized recommender systems for TV viewers are one important application of personalized recommender systems.

In Lekakos and Giaglis (2002), they presented an approach for the delivery of personalized advertisements in digital interactive television. The proposed methodology provided user models based on classification rules. Later, Ardissono *et al*. (2003) presented the recommendation techniques that were used in a program, called Personal Program Guide (PPG). The PPG suggests TV programs to users by using the integration of heterogeneous user modeling techniques. Furthermore, Hara *et al*. (2004) studied and classified the contents by considering the similarity of the TV programs that had watched and examined the groupings by TV viewers. In Hsu *et al*. (2007), they proposed a modified *Personal Video Recorder* (PVR) with a generic recommendation system based on a Bayesian classifier. Also, PVR is adapted for the television applications. Then, new choices of content is generated by analyzing of user's TV watching behavior.

In Bjelica and Peric (2011), they studied and proposed a personalized recommender system that captured the user's viewing habits. Their proposal used adaptive feedback schemes to represent and retrieve program, user modeling, and aggregation of users' estimated interests. After testing with TV viewing application, they showed that their system promptly understands about the user's preferences and provided valued recommendations.

Next, Chang *et al*. (2013) studied about TV program recommender systems. Also, they presented a smart and social TV program recommender framework for Smart TV. The proposed framework is to integrate the Internet and Web 2.0 features into television sets and set-top boxes (STB). Furthermore, Xiaobin and Qingjun (2013) applied many technologies such as data mining (DM) and artificial intelligence (AI) with a view of developing a personalized TV program recommendation system. This system has driven on the framework of the multi-agent. In Vanattenhoven and Geerts (2015), they studied about the contextual aspects in order to determine TV and video viewing situations in the home. The results of their study were used to design recommender system algorithms, including interface design for TV and video content. These can make a better recommendation with different viewing situations in the home.

THE METHODOLOGY OF PERSONALIZED RECOMMENDATION SYSTEM FOR DIGITAL TV VIEWERS

This section describes the proposed methodology shown as Figure 1. This methodology consist of four main steps and each step can be detailed as follows.
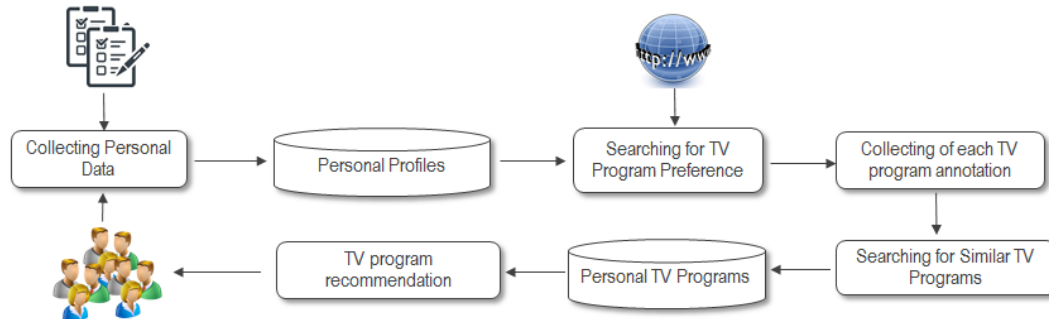
Figure 1. The Proposed Methodology of Personalized Recommendation for Digital TV Viewers

Collecting Personal Data

We have collected data by using questionnaires. A questionnaire is a set of questions for gathering information from individuals. It is a good way to collect perception data from people. Initially, we collect 30 personal profiles of TV viewers. The main information that is required is gender, age, preferred time, including the TV program preferences and examples (at least three examples per program).

Searching for TV Program Preference and Collecting Its Annotation

After having specified personal profiles of TV viewers, we use the TV program preferences and their examples to search for TV program annotations from the WWW. Finally, the annotation of each TV program preference will be collected as a set of queries. Simply speaking, this process is called "*query expansion*" (Vectomova & Wang, 2006), where this process is to reformulate a seed query to improve retrieval performance in information retrieval operations. This is because it can help to overcome vocabulary mismatch issues by expanding the original query. An example of searching for TV program preference and making its query expansion can be illustrated as Table 1.

Table 1. An example of searching for TV program preference and making its query expansion

TV program preference	Example of TV program preference	Examples of TV program Annotation in short (download from the Internet)
TV series	NCIS	NCIS is an American action police procedural television series, revolving around a fictional team of special agents from the Naval Criminal Investigative Service, which investigates crimes involving the U.S. Navy and Marine Corps.
	Criminal Minds	Criminal Minds is an American police procedural crime drama television series. It is set primarily at the FBI's Behavioral Analysis Unit (BAU) based in Quantico, Virginia. The series follows a group of FBI profilers who set about catching various criminals through behavioral profiling.

Searching for Similar TV Programs

After having required annotation of each TV program, it is used as being of TV viewer's interest, and then the system searches for other TV programs that are similar based on comparison of this TV program annotation. Finally, a collection of favorite programs will be collected as a list of personal TV programs. The main technique used to find similar TV programs is called *Content-based Similarity Analysis* (*CBSA*) (Pazzani, & Billsus, 2007). CBSA applies machine learning algorithms as the key mechanism for content-based analysis. Then, these algorithms generally learn a function that creates the model of each user's interests. By using the model, it helps to predict the new program that user would be interested.

This work applies a simple technique, called the *keyword-based vector space model*, to determine the similar TV programs that are relevant to viewer's interest (Salton, 1989). The Vector Space Model (VSM) is a model for representing text documents. By using this model, each TV program is represented by a vector of n-dimension, where each dimension corresponds to a keyword from the overall vocabulary of a given annotated document collection of TV programs. Also, all keywords in the vector are weighted, of term weights, where each weight points to the degree of association between the annotated document and the keyword.

Let D be a set of TV program annotation, $D = \{d_1, d_2,..., d_N\}$, and T be the set of keywords in the corpus, $T = \{t_1, t_2,...,t_n\}$. Each annotated document d_j can be represented as a vector of n-dimension, denoted as $d_j = \{w_{1, j}, w_{2, j},...,w_{k, j}\}$. Then, $w_{k, j}$ is the keywords t_k with weighting in an annotated document d_j.

Fundamentally, annotated document representation in the VSM raises two issues: *weighting the terms* (*keywords*) and *measuring the feature vector similarity*. The common technique used for term weighting scheme is *tf-idf* (*term frequency-inverse document frequency*), where *tf-idf* can be calculated by using its *tf* and its *idf* (Baeza-Yates & Ribeiro-Neto, 1999). *tf* is the number of times that keyword *t* occurs in annotated document *d*, while *idf* can be defined as follows

$$idf = 1 + log_{10} (N/df) \qquad (1)$$

where *df* is the number of documents that contain keyword *t* and *N* is the size of the annotated document collection.

In general, if content-based recommender systems is driven on VSM approach, the *cosine similarity measure* is often used (Salton, 1989).

After searching for the similar TV programs on the WWW through the use of the technique mentioned above, all relevant programs will be collected as a personal TV program list. The details of each program contain program name, type of program, time of show, running time, and performers/characters.

TV Program Recommendation

After having required list of personal TV programs, the personalized recommendation engine will find a program that matches to the viewer's interest. If the TV program also match the specific time of viewer's appetence, the system will notify this TV program to the viewer.

EXPERIMENTAL RESULTS

This work uses the common performance measure techniques to evaluate the proposed methodology (Baeza-Yates & Ribeiro-Neto, 1999). These techniques are *precision*, *recall*, and *F-measure*. These evaluation measurements can be described as followed.

$$Recall \qquad = \qquad \underline{\#relevant\ TV\ program\ retrieved} \qquad (2)$$

$$Precision = \frac{\text{#relevant TV program retrieved and correct}}{\text{#retrieved TV program}} \quad (3)$$

(with #relevant TV program shown above the numerator)

$$F\text{-}measure = \frac{(2 \times Recall \times Precision)}{(Recall + Precision)} \quad (4)$$

Thirty TV viewers who give us their profiles evaluate our system. After testing, the results of system evaluation has been shown as Table 1.

Table 2. The results

Recall	Precision	F-measure
0.90	0.80	0.84

Consider the results in Table 1. After testing by *precision*, *recall*, and *F-measure*, it can be seen that the proposed methodology is more effective for retrieving the relevant TV programs relating to viewer's interests. Furthermore, it uses a small time to retrieve the favorite TV program because all of favorite TV programs are already stored in a personal mobile device. However, although our personalized recommendation system can recommend and notify the relevant TV program to the viewer. This list of the TV programs is in a mobile application.

CONCLUSION

This work has applied this concept to a personalized recommendation service for digital TV viewers in order to recommend a TV program that matches their interests and/or needs. This work aims to present the methodology of personalized recommendation for digital TV viewers. The main mechanism of the proposed methodology is content-based similarity analysis. Initially, the TV viewer defines favorite programs, and then the system utilize this list as query to find their annotations on the WWW. These annotations will be used to find other programs that are similar by using CBSA. Finally, all similar programs are grouped to the same class and stored in a personal mobile device. For the usage, if a TV program matches the interest and specified time of viewer, the system on mobile device will notify the viewer individually. After testing by precision, recall, and *F*-measure, the results are satisfactory. This demonstrates that the proposed methodology is effectiveness for TV program recommendation system that can be used to choose the appropriate TV program to TV viewers based on their interests.

ACKNOWLEDGMENTS

REFERENCES

Abel, F., Gao, Q., Houben, G.J., & Tao, K. (2011). Analyzing Temporal Dynamics in Twitter Profiles for Personalized Recommendations in the Social Web. *Proceedings of the ACM Conference on Web Science*.

Acilar, A.M., & Arslan, A. (2009). A collaborative filtering method based on Artificial Immune Network. *Expert Systems with Applications*, 36 (4), 8324–8332

Adomavicius G., & Tuzhilin A. (2001). Using Data Mining Methods to Build Customer Profiles. *IEEE Computer*, 34(2), 74-82

Ardissono, L., Gena, C., Torasso, P., Bellifemine, F., Chiarotto, A., Difino, A. & Negro, B. (2003). Personalized Recommendation of TV Programs. *Lecture Notes in Computer Science: Vol. 2829. Advances in Artificial Intelligence* (pp. 474–486). Berlin, Germany: Springer-Verlag. doi: 10.1007/978-3-540-39853-0_39

Baeza-Yates, R., & Ribeiro-Neto, B. (1999). *Modern information retrieval*. New York, NY: ACM Press.

Bjelica, M., & Peric, A. (2011). Adaptive feedback schemes for personalized content retrieval. *IEEE Transactions on Consumer Electronics*. 57(3), 1251 - 1257

Chang, N., Irvan, M., & Terano, T. (2013). A TV program recommender framework. *17th International Conference in Knowledge Based and Intelligent Information and Engineering Systems*, 22(2013), 561-570

Chu, W., & Park, S.T. (2009). Personalized Recommendation on Dynamic Content Using Predictive Bilinear Models. *The International World Wide Web Conference Committee* (*IW3C2*), 691-700. doi: 10.1145/1526709.1526802

Dai, C., Qian, F., Jiang, W., Wang, Z., & Wu, Z. (2014). A Personalized Recommendation System for NetEase Dating Site. *Proceedings of the VLDB Endowment*, 7(13), 1760-1765. doi: 10.14778/2733004.2733080

Engelbert, B., Blanken, M.B., Ralf, K.B., & Morisse, K. (2011). A User Supporting Personal Video Recorder by Implementing a Generic Bayesian Based Classifier Recommendation System. *IEEE International Conference on Pervasive Computing and Communications Workshops (PERCOM Workshops)*. doi: 10.1109/PERCOMW.2011.5766953

Hara, Y., Tomomune, Y., & Shigemori, M. (2004). Categorization of Japanese TV Viewers Based on Program Genres They Watch. *User Modeling and User-Adapted Interaction*. 14(1), 87-117

Hsu, S.H., Wen, M.H. Lin, H.C., Lee, C.C, Lee, C.H. (2007). AIMED- A Personalized TV Recommendation System. *Proceedings of the 5th European conference on Interactive TV: a shared experience*, 4471, 166-174. doi: 10.1007/978-3-540-72559-6_18

Isinkaye, F.O., Folajimi, Y.O., & Ojokoh, B.A. (2015). Recommendation systems: Principles, methods and evaluation. *Egyptian Informatics Journal*. 16(3), 261-273

Konstan, J.A., & Riedl, J. (2012). Recommender systems: from algorithms to user experience. *User Model User-Adapt Interact*, 22(1), 101–123. doi:10.1007/s11257-011-9112-x

Lekakos, G., & Giaglis, G. (2002). Delivering personalized advertisements in digital television: A methodology and empirical evaluation. *Proceedings of the Personalization in Future TV Workshop*, 119–129

Martinez, A.B.B., Pazos Arias, J.J., Vilas, A. F., Duque, J.G., & Nores, M.L. (2009). What's on TV tonight? An efficient and effective personalized recommender system of TV programs. *IEEE Transactions on Consumer Electronics*, 55(1), 286-294. doi: 10.1109/TCE.2009.4814447

Pazzani, M.J., & Billsus, B. (2007). Content-Based Recommendation Systems. *Lecture Notes in Computer Science: Vol. 4321*. The Adaptive Web (pp. 325-341). Berlin, Germany: Springer-Verlag. doi: 10.1007/978-3-540-72079-9_10

Salton, G. (1989) Automatic Text Processing. Massachusetts, MA: Addison-Wesley.

Vanattenhoven, J., & Geerts, D. (2015). Contextual aspects of typical viewing situations: a new perspective for recommending television and video content. *Personal and Ubiquitous Computing*, 19(5), 761-779. doi: 10.1007/s00779-015-0861-0

Vectomova, O., & Wang, Y. (2006). A study of the effect of term proximity on query expansion. *Journal of Information Science*. 32 (4), 324–333

Xiaobin, W., & Qingjun, W. (2013). Study on Personalized Recommendation Technology of Digital TV Programs. *Proceedings of the 2nd International Symposium on Computer*, *Communication*, *Control and Automation*, 3035-3038. doi: 10.4028/www.scientific.net/AMM.347-350.3035

Zhang, Y., Ahmed, A., Josifovski, V., & Smola, A. (2014). Taxonomy Discovery for Personalized Recommendation. *Proceedings of the 7th ACM international conference on Web search and data mining*, 243-252. doi: 10.1145/2556195.2556236

Zhou, X., He, J., Huang, G., & Zhang, Y. (2012). A personalized recommendation algorithm based on approximating the singular value decomposition (ApproSVD). *IEEE/WIC/ACM International Conferences on Web Intelligence and Intelligent Agent Technology*, 458-464. doi: 10.1109/WI-IAT.2012.225