Personalized Recommendation Framework for e-Government Services

Mohammed Wasid[1], Rashid Ali[2], Ravi Gupta[3]
{erwasid@gmail.com, rashidaliamu@rediffmail.com, raviguptabtp@gmail.com}

[1] Department of Computer Science & Engineering, Government Engineering College, Bharatpur, India
[2] Department of Computer Engineering, Aligarh Muslim University, Aligarh, India
[3] Department of Electronics & Communications Engineering, Government Engineering College, Bharatpur, India

Abstract. The primary goal of e-Governance has been conceived as an approach to deliver government services to the citizens and business, by making use of Information and Communication Technologies (ICT) to enhance the efficiency, interactivity of government services, quality, increase the interaction between government and stakeholders. Moreover, the use of e-Governance is the way towards accelerating smart cities initiatives. In our research, personalized e-services will make e-Governance the more accurate and effective approach. To achieve this, we proposed a recommendation framework where e-service recommendations are done based on the similarity between likeminded hybrid user profiles through clustering. The Compact user profile is used to calculate the correlation between different users and to identify likeminded users to generate similar recommendations.

Keywords: Collaborative Filtering, e-Governance, Fuzzy Logic, ICT, Recommender Systems.

1 Introduction

e-Governance is generally known as the use of Information and Communication Technology (ICT) with the aim to increase the interaction between government, citizens and business at all levels of Government departments [1]. This is basically a mechanism for the exchange of information between different stakeholders in a speedy, efficient, convenient and transparent manner. It is a move towards SMART governance for smart cities. e-Governance can be identified as the most significant challenge of smart cities initiatives in order to encourage citizen participation in decision-making processes [2]. The main challenge facing e-Governance is how to suggest stakeholders with e-services specific to their requirements, rather than an undifferentiated mass of information [3]. One possible solution for this is by designing and developing a personalized e-Governance recommender system.

Recommender System (RS) is a type of information filtering method which is used to suggest product recommendations to the online users while interacting with mass information spaces [4]. RS suggest from movies, books, news and jokes to more complicated suggestions for matrimonial matches, loan services, etc. Recently, researchers have proposed and designed new recommendation algorithms in almost every filed but there are few studies being done in

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the area of ICT, more specifically in e-Governance, and the developed recommendation approaches are quite simple that too focuses on a very limited number of applications [5, 6]. To this purpose, a personalized recommender system framework is the need of the hour, to generate personalized recommendations. The suggestions not only allow for more appropriate e-services, but also upsurge the users' engagement and satisfaction in e-government services [7].

Thus, there is a need to understand the pattern of all likeminded user group in the system as similar group people are generally have same type of preferences. Machine learning is the most widely used area of research to analyze the given users dataset. The user dataset can be used to identify the important features for preparing the profile of the citizens [8, 9]. The Compact user profile is then used to calculate the correlation between different users and to identify likeminded users for similar recommendations.

The rest of this paper is organized as follows: Section II describes an overview of e-Government and recommender Systems. In Section III, we describe the three phases of our proposed framework. Finally, Section IV provides concluding remarks and suggest future research direction.

2 Background

In the last decade many developing countries, including USA and UK, increases their budget into creating and expanding the information communication technology based infrastructure for providing services using electronic medium, which are connected across different institutions and departments to the stakeholders [10]. The reason being that these countries are already running services using e-governance, for instance, social security, better education system, and quality health facilities and most importantly ICT infrastructure but in India it is still an developing technology [11]. Therefore, this research proposed with an aim to improve the Indian citizens' interactions with the government policies.

2.1 Personalization of e-Government services

The primary aim of personalized e-Governance is to achieve a high level of interaction of government-based e-services with accurate, user-friendly, more precise and target oriented government services to both citizens and businesses. The traditional approaches of e-Governance are usually a non-personalized one which cannot satisfy the actual requirement of the online user. Literature proves that there is a need of new direction of e-Governance for personalized e-services to the individual users [12, 13]. Although there are some agencies which have launched the personalized e-Governance system but it provides only simple personalized recommendations. Therefore, implementation of a compact user framework for e-service recommendation appears to still be in its infancy [14]. For instance, there are many schemes which are initiated by the Government but a few schemes are relevant to an individual user; like recommending a minority scholarship to those who belongs to the minority category rather informing everyone. Similarly, suggestion of agricultural services to a businessman doesn't make any sense. Therefore, we are going to build an effective e-

Governance recommender framework to suggest the e-services which are really useful for the stakeholders [15].

Hence, suggestion of personalized e-services can be a step towards intentions-based technique and will become an emerging field in the area of government e-services.

2.2 e-Service personalization and Recommendation

Recommendation of personalized e-government service is the ability to use information filtering technique to suggest product and e-services to the users' based on their past behavior and preferences [13]. Researchers in the literature identified RS as the most popular technique for product and e-service recommendations [12]. RS uses its techniques to predict the usefulness of the product or e-service based on users' interest. The most three distinguished techniques of RS are [8]:

I. Collaborative filtering (CF) technique. In this filtering technique, recommendations are generated based on the matching preferences of the similar users to the stakeholder. Here, similar users are those who have common preferences on a set of e-services. This technique is inspired by the real life scenario where people make decisions based on the advice given by their family or friends. CF further classified into memory-based, model-based, and hybrid based on their working style [4].

II. Content-based (CB) technique. As the name suggests, the content of the product or e-service is used for generating appropriate recommendations to the stakeholders. Typically, a profile of users' past history is created based on the features or contents of the e-services availed in the past and based on this profile other similar e-services are recommended to the stakeholder [16].

III. Hybrid filtering (HF) technique. Both of the above discussed techniques independently suffers from many problems such as new user, cold start and sparsity. Therefore, researchers combined both CF and CB techniques to alleviate such problems and to attain better recommendation accuracy. One possible way to implement HF is to implement CF and CB methods separately, and then combine their predictions by a combining function.

The proposed recommendation framework is based on the concept of collaborative filtering technique and used to recommend not only those services which are actually relevant to the users but also increase their satisfaction and engagement into the e-Governance.

3 Hybrid e-Governance Recommendation Framework

In India, various research activities are going on in several premier institutes and universities. In some instances, these works are supported and funded by Government of India [10]. The e-Governance division of Govt. of India annually organizes a National Conference on e-Governance to provide a platform for the research on e-Governance in India. In order to implement e-Governance with effective technologies, IT department has passed several drafts so that efficiency, security and transparency can be enhanced in e-services. The proposed

framework will take the e-Governance to a different level by improving the citizens' experience through personalized recommendations.

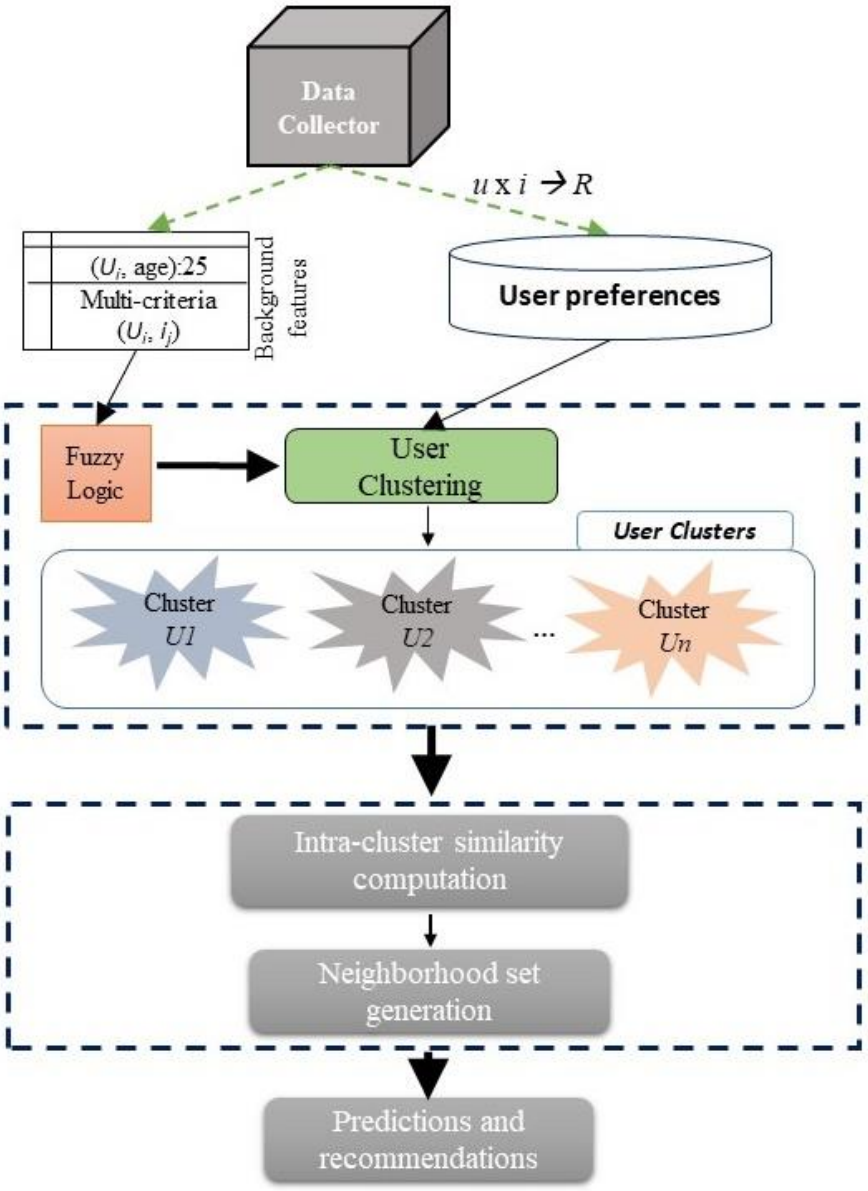

Fig. 1. Hybrid e-Governance Recommendation Framework.

In the proposed framework, as shown in figure 1, there are three phases needed to achieve the recommendation task through fuzzy logic and user clustering.

3.1 Phase I (user profile creation)

The Data collector is responsible for collecting the user-scheme related information, including personal information, demographic data, and past preferences on e-services. In order to deal with the multidimensionality problem occurs in the database, the complete data is separated into two parts namely; background features and user preferences. Background features generally consists the background information of the user and e-services such as age, occupation, and type of e-services (scholarship, health, etc.). Whereas user preferences contains the rating information of experienced schemes of the user.

Table 1 depicts a user profile having preference on a particular scheme, demographic feature of the user and multi criteria represents the total number of schemes availed by a user denoted by '1^{s}'.

Table 1. *profile(u,s)*- Typical user profile.

Rating	Age	Gender	Occupation	Multi-Criteria schemes
4	25	Male / 0	Student / 16	000010000000101000

In real life scenario, a user may have different age group instead of having a crisp value for example; two users having age 14 and 19 will have age distance of 5 but in real life both of them are from same age category i.e. 'teenager' therefore the use of fuzzy logic comes into the picture [16], where there will be three age groups i.e. young, middle-aged, and old as shown in figure 2.

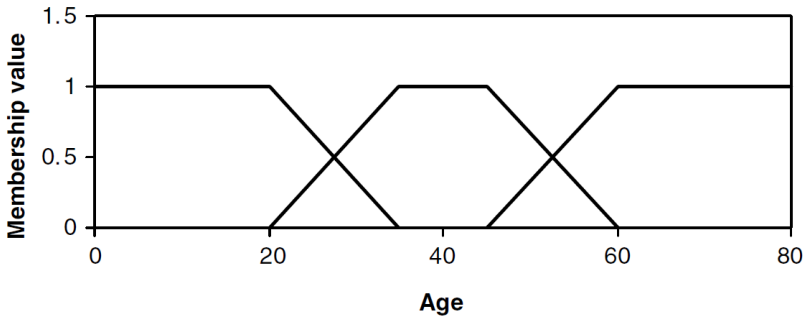

Fig. 2. Fuzzy membership set for age feature of the online user.

Similarly, for e-schemes people usually call as; very good scheme or very bad scheme, such features also fuzzified into six fuzzy sets namely very bad, bad, average, good, very good, or excellent as shown in figure 3.

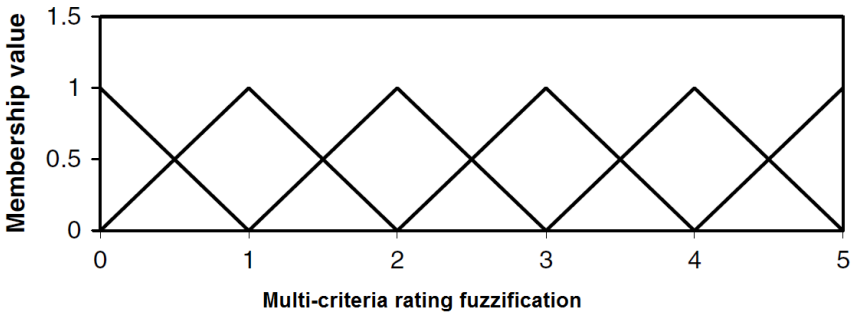

Fig. 3. Fuzzy membership sets for multi-criteria of scheme features.

Table 2 shows a hybrid user profile after performing fuzzification on the features of the user profile in order to handle the uncertainty associated with the user-scheme features. After preparing hybrid user profile for all the users, a clustering algorithm (e.g., K-means) is used to form group of users based on their background features. The clusters will consist users with their respective past preferences.

Table 2. Representation of a hybrid user profile in our proposed framework.

	User Age			**Multi-Criteria of Schemes**					
Quantifier	*young*	*middle*	*old*	*Very bad*	*Bad*	*Average*	*Good*	*Very Good*	*Excellent*
Membership value	0.35	0.65	0	0	0.3	0	0.7	0	0

3.2 Phase II (Neighborhood set formation)

Neighborhood set formation is the major step in collaborative filtering as the performance of the recommendation engine depends upon the similar users selected for prediction and recommendations. After computing the similarity among the users, there are many ways to select the size of neighborhood set. Some researchers choose a fixed value of K while some keep it flexible by choosing the users whose distance value is greater than certain threshold. Pearson correlation, cosine similarity, and Jaccard similarity are some of the well-known similarity measure. The most widely adopted Pearson correlation formula to calculate the similarity between two users u and v is given below:

$$PC(\mathbf{u},\mathbf{v}) = \frac{\sum_{s\in N}(r_{\mathbf{u},s}-\bar{r}_{\mathbf{u}})(r_{\mathbf{v},s}-\bar{r}_{\mathbf{v}})}{\sqrt{\sum_{s\in N}(r_{\mathbf{u},s}-\bar{r}_{\mathbf{u}})^2}\sqrt{\sum_{s\in N}(r_{\mathbf{v},s}-\bar{r}_{\mathbf{v}})^2}}, \quad (1)$$

where N is the set of services rated by both users u and v and $r_{u,s}$ represents the rating of user u on service s.

3.3 Phase III (Prediction and recommendations)

After obtaining the top-*K* neighbors in the phase II, many approaches are available to combine the preferences of the neighbors to know (predict) the preference of the stakeholder for the unseen services. The predicted preference is then analyzed by at what extent the stakeholder will like the e-service and the service with higher predicted value, is recommended. One of the most widely used method to compute the prediction $pre_{u,s}$ for service *s* for a user *u* is given below:

$$pre_{u,s} = \bar{r}_u + \frac{\sum_{u' \in N} d(u,u') \times (r_{u',s} - \bar{r}_{u'})}{\sum_{u' \in N} | d(u,u') |}, \quad (2)$$

where $\overline{r_{u'}}$ is the average rating of user u', and $d(u,u')$ is the distance between active user and its neighbour. *N* denotes the set of neighbors who have rated services N_s.

4 A Summing Up

The proposed framework is designed to improve interaction with citizen, business and industry by providing better delivery of government e-services to the stockholders through retrieval of relevant information and more effective government management. The exact benefits to the citizens are increased interaction, greater convenience by having only relevant e-governance recommendations and reduced cost of running government. The recommendation framework is based on the user information and collaborative filtering technique is used to identify likeminded users for a perticular government services. So that similar type of government services can be suggested to the users based on their requirements. Fuzzy set has been incorporated to handle the issue of uncertainty associated with some of the features of both user and e-services and used to build hybrid user profile. This allows users to identify most similar neighborhood for better recommendation. For instance, whenever a school student avail a government scholarship, the same scheme will be suggested to other likeminded students based on their feature similarity. In the future work, a detailed framework of personalized e-services in a particular domain will be tasted on a real world dataset to identify its applicability in the real life scenario. Moreover, use of smart cities can be considered in the design and implementation of e-governance recommender systems, for instance, exploitation of real-time sensor data from the internet of things may help the online users for appropriate recommendations.

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