



## Critical Analysis of Various Recommendation Systems

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**Abstract:** Recommender systems predict the requirements and interests of users-based on historical data. All the users having same liking for an item are clustered in the same group through which the recommender system identifies the strengths or pertinent likelihood of an item/product. Different techniques are used to predict the user preferences such as content-based system, collaborative-based filtering, knowledge-based system, multi-attribute trader and e-commerce. Among the several proposed techniques presented in the literature, the content-based and collaborative approaches are the most efficient and effective techniques. These techniques are used in all the hybrid techniques. The content-based identify the description of items and collaborative techniques collect the same preference of users in the same cluster or group. In this paper, we present a survey of recommender systems proposed in the contemporary literature. We have studied the various techniques being used in the recommendation systems and have evaluated them critically by finding their strengths and weaknesses. We have also identified the research gaps related to these techniques and have also suggested the probable improvements in the proposed techniques to make them more effective The critical analysis of the recommendation techniques is presented in this paper.

**Key words:** Recommender System, Recommendation System, e-commerce, e-business, content-based recommender system, Collaborative-based recommender system, Knowledge-based systems.

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### 1. Introduction

Recommender systems are normally used to predict user preference for an item. Through recommender systems, user can read newspapers and any sort of articles which are not possible to write in newspaper because of the shortage of space. A limited amount of data can be written in a newspaper, every book cannot be displayed and only the most read books are displayed in the shops because of the limited space. But recommender system overcomes all these problems. Recommender system provides the facility to the users to select the best item of their choice and can

find any sort of information about an item. The user profile holds the preference of the user and rate assigned to the item through which the user likes or dislikes an item. Most of companies used recommender systems to boost their sale items and services on daily basis. Recommender systems predict the requirements and interests of users. All those users having same liking for an item are clustered in a single group through which the recommender system identifies the strength or requirement of an item/product. Large amount of data creates problem in searching. Whenever a customer searches for a specific product on the online system such as Amazon, the recommender system provides and displays the related items corresponding to that product. Content providers normally follow all the media content and their customers filter through which the recommender system understand the priority of an item that the users have rated it, and try to suggest the best products to their costumers that they might not have ever tested before. Recommender systems use different techniques and every technique has certain advantages as well as holds some disadvantages that make them suitable for applications in various domains. Recommender systems hold a set of different techniques to achieve its goal. Recommender systems are used to overcome the problem of large volume of data storage. Techniques used in recommender systems are heuristic search mean users can select a best item in the massive items in minimum time. The recommender system collects the entire related item in the same place that users can easily find the required items. Maintenance model is used to maintain the interaction between users and recommender system, to find best items for users in short time with best solution, and to the correlation between items all these are functionality of maintenance model.

## 2. Literature Review

A recommender system application is proposed by Lu et al. [1] to handle the increasing online information overload problem and improve customer relationship management. The recommender system application development combines the features of eight different techniques in a single cluster: e-government, businesses-, e-commerce/ e-shopping, e-library, e-learning, e-tourism, e-resource services and e-group activities, and summarizes the related recommendation techniques in a single cluster. Fuzzy logic have been applied in all kinds of recommender systems application domains to handle various uncertainties as fuzzy logic offers handling several values instead of the Boolean values. Many of the largest commerce websites, such as Amazon and eBay, already use recommender systems to help their users find items to purchase more appropriate items at cheaper rates. E-shopping recommender systems (Web-based and mobile-based) are usually implemented in online purchasing for both digital products (music, movies, etc.) and physical goods (books, bags, etc). Some recommender system users share sources to the Internet so that other users can access the resources that interest them the most. The proposed technique agent based system is suggested by Mohanty and Passi [2] manipulates multiple attributes for a car such as color, cost, speed, first hand/second hand are the attributes of car and car is itself a product. The attributes are aggregated through fuzzy logic to rate the product. Rate each attribute first, after rating each attribute collect the rated attribute in a

cluster to obtain the products final rate. The objective of the proposed technique is to explicitly define user's preference which are in their mind (implicitly) by using fuzzy logic. Fuzzy logic defines the attributes of item and weighs each attribute according to the user preference.

The proposed technique multi-agent system is suggested by Rosaci and Sarnè [3] to supports different activities of trader such as business-tocustomer, e-commerce activities, including announcements and clearance. The proposed system maintains and updates profiles information of both the user's preference and the sellers trading. Multi agent system for trader is complied of a group of XML-based brokers to handle the profiles and messages of brokers and users in more easy way that represents the different groups of people having different interest for an item and communicates to broker which connects both users and sellers. The proposed technique is to construct the profile of individual user and seller. Ontology is based on XML-Schema that defines the category of item as an entity and its each product category as an element and its every event (i.e., item). Multi agent systems adopt the ability of inheritances from decision support mechanism to provide enough facility in e-business. These multi agent decision support systems are of particular assistance in processing large amounts of data. A program recommender framework is proposed by Chang et al. [4] which perform better than other previously proposed intelligent systems. The proposed recommender system is based on a smart and social TV program recommender framework for Smart TV. This recommender system integrates Internet and Web 2.0 features into television sets to take off the properties of a smart TV. The earlier TV program recommender systems are based on only features offered by the olden television sets. While the proposed TV program recommender framework uses TV program content analysis module, user profile analysis module and user preference learning module in order to suggest the more pertinent TV programs to the users.

The suggested technique personalized recommender system is proposed by Wang et al. [5]. The suggested approach is constructed by the combination of three different set of customers, association of items and rating. Set of algorithm that divides uses into different sections according to their preferences and having same behavior. The proposed personalized recommender system gives better performance than the previous techniques. In this system they combined three types of technique Data mining; Association rules; Clustering that give more better result for large amount of data in business and market and relationship among the data .Sequential pattern analysis integrates association rules algorithm through can find customers behavior, their liking, relationship among items and also integrate cluster through which the similar purchasing demands of customers are group in a separate cluster.

The Social knowledge-based recommender system is proposed by Carrer et al.[6]. The proposed technique is hybrid technique the combinations of different techniques such as knowledge-based and collaborative techniques. The performances of the recommender system are better than the previous recommender systems. Hybrid system place the concepts collaborative and knowledge in a same cluster that permits recommendation on the basics of

(1) similarity between customers preferences and contents. and (2) recommendations are inherit from the customer's social network. Users have strong effect on the recommendation of social network. The proposed system avoid the issue of cold start. The proposed technique update new users profile and also cluster the same preferences of user for same item. The system of social network works better than other of recommender system.

The recommender systems of designing utility- based are proposed by Huang [7]. The proposed technique are constructed for e-commerce by using different variables , one variable is dependent , one variable is moderating and the few variables are independent to update the preferences of all users in their profiles. Accuracy of items recommendation are count when the customers are interested in the items. Time expense counts the time that customers spend for constructing their profile. The proposed technique provides higher accuracy of recommendation through decomposed of utility- based approach. Different recommender systems are used in the proposed technique to find the accurate preferences of users, time expense and accuracy such as content-based and utility-based systems.

The proposed technique which app? Is suggested by Cheng et al. [8] to resolve the data overload issues that customer faces, by choosing to download a new applications from a market. The suggested technique is a fully recommender system that integrates five various approaches of filtering and complement the result of each other. The first-rater, cold-start are solved by using the combination of these five techniques. The proposed hybrid technique solved the issue found in collaborative system which decreases the performance of generated preference. The first- rater and cold-start are solved by the combination of these five techniques. Each application is defined by a set of tags. By the combination of these five techniques user can only download the appropriate application over a bundles of applications.

A flexible electronic commerce recommendation system is proposed by Gong [9] which supports better recommendation than the previous recommendation systems. The proposed recommendation is based on flexible electronic commerce recommendation system. The strategy recommender approach is used to collaborative filtering, content-based filtering , mining association rule methods , knowledge -based filtering or the mixed method to handle multiple user at a time and support multiple recommendation system The aim of the proposed technique to support flexible and many recommendation system. The combination of these technique perform better result as an individual. The whole system will be redesign if any change adopt in the recommender strategy model. The recommendation strategy model is the combination of different technique and change in the recommender strategy model will change in whole recommendation system. The issue can be improved by knowledge-based system to the strategy model.

A hybrid recommender system is proposed by Asanov [10]. In the proposed technique different recommendation systems are compared such as content-based filtering, collaborative -based and hybrid. The recommender systems use the features of Web 2.0. Hybrid technique is the combination of content-based filtering and collaborative. Mobile devises also get hold on recommender systems. The recommendation system are decentralized with peer-

to- peer approach through which each peer connect itself to a cluster of other peer having same preference and get recommendations from the users of that cluster. The suggested recommender system Team-based organization system are proposed by Damiani et al. [11]. The proposed system works on the activities to develop a product, users support and activities of process-enhancement. The high likelihood gives better choices to users and resolving their problems. However, some difficulties are faces by group of collaboration such as information overload issue or misunderstanding because of misalignment goals. The computer-supported technique enhance the communication among team members and can easily take less time in recommendation. The suggested techniques increase the communication between the team members. Team members spend less time in information handling and also emerged more teams without recommendations.

The proposed technique ontology characteristic is suggested by Martinez et al. [12] to develop trust between customers through fuzzy linguistic modeling. The accounts of users do not take similar preference history but take all those customers in which every customer can trust. The ontology increases the relationship among customers and their prediction about the products. The customer preferences about items are represented and controlled by using a feasible methodology fuzzy logic. Most of recommender systems do not matter/ count the user’s feedbacks for item preferences in qualitative manners. The collaborative and item-based techniques are used in proposed technique. Sparsity issue arises among a large group of same behavior of users due to collaborative.

### 3. Critical Review

In this section, we present a critical review of the various techniques used for recommendation systems in the contemporary literature. Table 1 shows proposed techniques of the reviewed literature along with their strengths and weaknesses if any.

Table 1: Critical Evaluation of Recommender Systems

Ref #	Proposed technique	Strengths	Limitations/Weaknesses	Possible Improvement
1	An evaluation of hybrid RS techniques consisting of 8 different categories are discussed.	A hybrid technique collectively presents the strengths of all the included techniques and overcomes the drawback of individual recommendation systems. The eight techniques identified to work collectively include: e-government, e business, e-commerce, e library, e-learning, e-tourism, e resource services and e-group activities recommender systems.	The hybrid techniques however do not provide a solution to work on the mobile data as mobile data is usually more complex, heterogeneous, and noisy and require spatial and temporal auto-correlation. Given the widespread use of smart phones, we also need mobile recommender systems that are capable to handle all these aspects of diversified nature of mobile data.	The existing RS are good for TV programs, music, videos recommendations etc., but their performance is not good for mobile data as the mobile data is more complex in nature. To overcome the complexity of mobile data, we can add some other techniques such as artificial intelligence techniques with the existing techniques to make them work for mobile data.

2	Agent based system for e commerce recommender system.	The proposed technique "agent based system" manipulates different attributes of a product in the start. After rating each attribute, it combines all the rated attributes to suggest the final rate of the items. The final rate presents a true characteristics of the product.	The proposed approach complexity based on the amount of items suggested by agent in the start. The issues becomes more complicated, if a large amount of attributes are suggested in the start.	To estimate the weights accurately, we need a vast number of market business data. Using data mining technique to the proposed agent based system can help find the weight accurately in the market business data.
3	Multi-agent system is proposed to update and maintain users and agent profiles simultaneously.	Ontology helps the brokers to show the involvement of both concepts and relationship among actor's interests in B2C and the behaviors of actors. Ontology is based on XML Schema that defines the category of item as an entity and its each product category as an element and its every event (i.e., item).	All the MAST parameters cannot be used for fetching different behavioral models i.e., the emerging behaviors of a customer account at specific period in B2C domain	All the MAST parameters can be used for fetching different behavioral models by developing a new MAST for both customers and sellers to take different parameters of account behaviors of B2C on the same period given for both accounts behaviors of customers and sellers accounts behaviors.
4	A television program recommender system is proposed for Smart TV.	Program recommended system framework integrates the Internet and Web 2.0 features into the television sets	The proposed recommender system only offers recommendations for TV programs and does not include news clipping, debates and advertisements etc.	TV program recommender systems can further be improved in terms of accuracy, diversity, novelty, explanation and group recommendation
5	Sparsity problem in personalized recommender system	The combination of different approaches in personalized system such as set of customers, association of items, and rating perform better performances to find the rate of items.	The proposed recommender system can only be used for general purchase behavior.	The product is divided into three groups of customer clustering, product associations generating and scoring which do not find clear relationship among items and user demand.
6	Hybrid Social knowledge based system is proposed for movie domain.	social-knowledge based emerge the concepts of web semantic model to reduce the deficiencies complexity and less understanding	This system is only validate for movie domain and not working in other system domain like tourism domain and leisure activities.	The system can be applicable for the domain of tourism and activities of leisure
7	Designing utility-based recommender system.	Constructed for e-commerce by using different variables, one variable is dependent, one variable is moderating and the few variables are independent to update the preferences of all users in their profiles.	The complexity depends on the number of different preferences of different users	The proposed technique can be improve for accuracy of nominal attributes for movie domain and can also improve the complexity of user profile
8	Which App? system is used for first-rater, cold-start and sparsity problem.	The proposed technique "Which App?" Integrated five different techniques, Appoke, AppBrain, Bubiloop, Related apps in Android Market, AppESP to	sparsity issue increase by increasing the amount of items or users and similarity between items and users could be difficulty identify.	The sparsity issue can be reduce by applying a singular value decomposition techniques in the collaborative recommender



		download accurate and diverse applications by users. The combination of these five techniques select the appropriate application for user and avoid the unnecessary application to be downloaded		
9	A flexible electronic commerce recommendation system	The recommender strategy model use collaborative filtering, content-based filtering, mining association rule methods, knowledge - based filtering or the mixed method to handle multiple user at a time and support multiple recommendation system.	The whole system will be redesign if any change adopt in the recommender strategy model.	The issue can be improve by knowledge-based system to the strategy model.
10	Team-based organization system	The proposed technique used computer-supported technique and collaborative. The suggested technique based on team work to enhance the communication among team members and take less time in communication.	The issues raised by the disagreement expectation about the content meeting which cause collaborative failure.	There must association among processes of patterns of that provide recommendation and that are enabled by recommendations and subsequent outcomes in laboratory.
11	Recommendation system using ontologies and fuzzy linguistic modeling.	Filter the vast amount of information available on the web and display only the required information to the users.	The users profile change with new items and it is difficult to update their profiles with the arrival of new item.	Automatic techniques to establish the user profiles in a more efficient manner could be analyzed.
12	A hybrid recommender system was proposed which is combination of content-based and collaborative based systems.	The recommender systems use Web 2.0 features. Recommender system collects data of users such as TV users preference are known by their channels selections, which movie or drama they like to watch according to their choice and preferences their profiles are updated.	Prediction of users in large volume are difficult task.	The possible improvement in the study could be to employ advanced statistical methods such as Markov Chain and regression techniques to generate ample size of the sample datasets and predicting the likely preferences from the set of sample datasets.

#### 4. Gap Analysis and Future Work

Based on the critical analysis of the recommendation systems we have observed that the proposed techniques in the literature fall short of addressing various key issues and are also are less efficient. For instance, the technique proposed in [1] addresses only few features related to the mobile data which is generally more complex, heterogeneous, requires spatial and temporal auto-correlation, and is inherently diversified in nature. It is intuitive to have a recommender system that is capable to handle all these aspects of mobile data. Similarly, the approach used in [2] requires high volume of items preferences in the start. Such approaches fail to produce promising results if a large amount of items are suggest in the start. Ontology based approach for recommendation systems are also proposed

such as in [3] which suffer from the limitation that all the parameters cannot be used for fetching different behavioral models to formulate a proper ontology for recommendation systems. Some recommendation systems are exclusively developed to target a one particular item e.g., a recommender system for TV program and movies is proposed in [4] and [6] respectively. Instead, however, there is a need to develop recommender systems for a larger domains such as tourism and leisure domains. E-commerce related recommender systems are also developed to predict general purchase behavior of the users. The key challenge with such systems is that their complexity depends on the number of different preferences of different user groups; since the larger user or product base result in more complex preferences.

## 5. Conclusion

In this paper, we have made an attempt has been made in this paper to critically analyzed various techniques being used in the recommendation systems. The study discovers that the most common techniques are content-based and collaborative-based techniques. However, these Techniques fall short on one ground or the other. Some techniques were found to be more complex and some techniques found to be data-intensive. We found out strengths and limitations of these techniques and presented them in the form of a critical analysis table in Section 3. We also found research gaps related to these techniques which are discussed in detail in Section 4. To conclude, we have observed that there is not a single generic technique related to larger domains rather generally recommender system for specific items are proposed most commonly in the literature. There is a dire need to extend the theoretical foundation of the recommender systems to develop generic recommendation systems.

## References

1. Lu, J., Wu, D., Mao, M., Wang, W., & Zhang, G. (2015). Recommender system application developments : A survey. *Decision Support Systems*, 74, 12–32. doi:10.1016/j.dss.2015.03.008
2. Mohanty, B. K., & Passi, K. (2010). Agent based e-commerce systems that react to buyers' feedbacks—A fuzzy approach. *International Journal of Approximate Reasoning*, 51(8), 948-963.
3. Rosaci, D., Sarnè, G.M.L, (2013). “Multi-agent technology and ontologies to support personalization in B2C E-Commerce,” *Elsevier, Electronic Commerce Research and Applications*, pp.13-23, 2013.
4. Chang, Na & Irvan, Mhd & Terano, Takao. (2013). A TV Program Recommender Framework. *Procedia Computer Science*. 22. 561-570. 10.1016/j.procs.2013.09.136.
5. Wang, Yi-Fan & Chuang, Yu-Liang & Hsu, Mei-Hua & Keh, Huan-Chao. (2004). A personalized recommender system for the cosmetic business. *Expert Systems with Applications*. 26. 427-434. 10.1016/j.eswa.2003.10.001.
6. Carrer-Neto, W., Hernández-Alcaraz, M. L., Valencia-García, R., & García-Sánchez, F. (2012). Social knowledge-based recommender system. Application to the movies domain. *Expert Systems with applications*, 39(12), 10990-11000.
7. Huang, S. L. (2011). Designing utility-based recommender systems for e-commerce: Evaluation of preference-elicitation methods. *Electronic Commerce Research and Applications*, 10(4), 398-407.



8. Cheng, L. C., & Wang, H. A. (2014). A fuzzy recommender system based on the integration of subjective preferences and objective information. *Applied Soft Computing*, 18, 290-301.
9. Gong, S (2012) "A flexible electronic commerce recommendation system. *Physics Procedia*, vol.24,pp. 806-811,2012.
10. Asanov, D (2011). "Algorithms and methods in recommender systems *Berlin Institute of Technology, Berlin, Germany*.
11. Damiani, E., Ceravolo, P., Frati, F., Bellandi, V., Maier, R., Seeber, I., & Waldhart, G. (2015). Applying recommender systems in collaboration environments. *Computers in Human Behavior*, 51, 1124-1133.
12. Martinez-Cruz, C., Porcel, C., Bernabé-Moreno, J., & Herrera-Viedma, E. (2015). A model to represent users trust in recommender systems using ontologies and fuzzy linguistic modeling. *Information Sciences*, 311, 102-118.

