



A STUDY OF RECOMMENDATION SYSTEM IN E-COMMERCE

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ABSTRACT:

Recommendation Systems (RS) are commonly employed in the e-commerce business to deal with the problem of information overload. Because there is so much information available these days, users are having trouble discovering relevant product and service information that matches their tastes and interests. The technique of obtaining relevant knowledge from enormous databases is known as data mining (DM). DM's job is to describe and forecast data so that information may be retrieved. Information retrieval (IR) is a subfield of RS, which is a subfield of data mining (DM). Recommendation engines are essentially data filtering and information retrieval tools that employ algorithms and data to suggest the most relevant item to a given user. Content-based (CB) filtering, Collaborative Filtering (CF), and hybrid filtering techniques are some of the strategies and methodologies employed by RS. This study explains the function of data mining in recommendation systems and provides an RS process. Also includes a methodological overview, RS difficulties, and a comparison of several e-commerce website recommendation systems.

KEYWORDS: E-COMMERCE, DATA MINING, RECOMMENDATION TECHNIQUE, AND RECOMMENDATION SYSTEM, REVIEW

I. INTRODUCTION

In this era of “new normal” after the great pandemic of corona unforeseen and unprecedented growth has occurred in the digital world and e-commerce sectors people have started opting to use e-commerce websites not only in metro cities but even in rural-urban areas.[1] Even e-commerce is not united to shopping but has given enormous business opportunities. Hence we have come across 100's of e-commerce websites for any layman do we think is it possible to get the best choice from various options available?

Hence comes the role of recommendation in the picture. Now, what is a recommender system? A recommender system is a filter used in filtering information.[2][3] We all have come across applications like Netflix, YouTube, Amazon, tinder, etc. which makes use of recommender system. It seeks the preference or rating that a user would have given to an item.[4][5]

Data Mining is a powerful technology that Recommendation Systems use to assist the e-commerce sector boost sales and preserve customer-organization ties. It is a criss-crossing of computer science and statistics that is used to uncover hidden patterns in databases [6]. The main goal is to sift through big datasets for relevant information and organise it into a

structured style for future use. This method may be used to analyse any type of unstructured data, including multimedia, network, and transactional data [7]. Knowledge discovery in databases (KDD) relies heavily on the use of data mining (DM). Data cleansing, data integration, data selection, data information, data mining, pattern evaluation, and knowledge presentation are all important elements in the knowledge discovery process [8]. Classification, regression, time series analysis, prediction, and clustering, summarization, association rule, and sequence discovery are examples of predictive data mining techniques [9]. The massive proliferation of products and services in the e-commerce business on the internet has made it difficult for users to find things that are affordable. The programme is called RS. that make recommendations to users about items and services in the e-commerce business [10], and that make recommendations to users about books, clothes, shoes, and watches, among other things. Amazon, Flipkart, YouTube, Netflix, and many other e-commerce sites and applications rely heavily on RS. Increased sales, user happiness, the sale of various things, user fidelity, and a better knowledge of what users want are some of the reasons why e-services providers implement RS. RS may be used to express oneself, propose a product sequence and bundle, annotate in context, locate some nice thing, find all good stuff, merely browse, enhance one's profile, help others, and influence others [11].

The suggestion procedure is divided into three stages:

- Collection: RS must first collect information about user preferences such as search history likes/dislikes, rating of an item previously purchased by the user, and the user's present location at this step.
- Learning: In this phase, RS are educated to better comprehend user taste utilising information gathered in the previous phase.
- Prediction: In this phase, RS ultimately guesses which things are appropriate to the user for recommendation [12].

II. PROCESSING FLOW OF RECOMMENDATION SYSTEM

As illustrated in fig.1, the suggested RS workflow is separated into two phases: a) data collection, and b) analysis and suggestion. First, RS is built using the techniques discussed in section IV, and user information such as searching, buying habits, and so on is gathered. This gathered information about the user is then used to analyse user taste, i.e. predicted information about the user's choice, which is then used to generate recommendations.

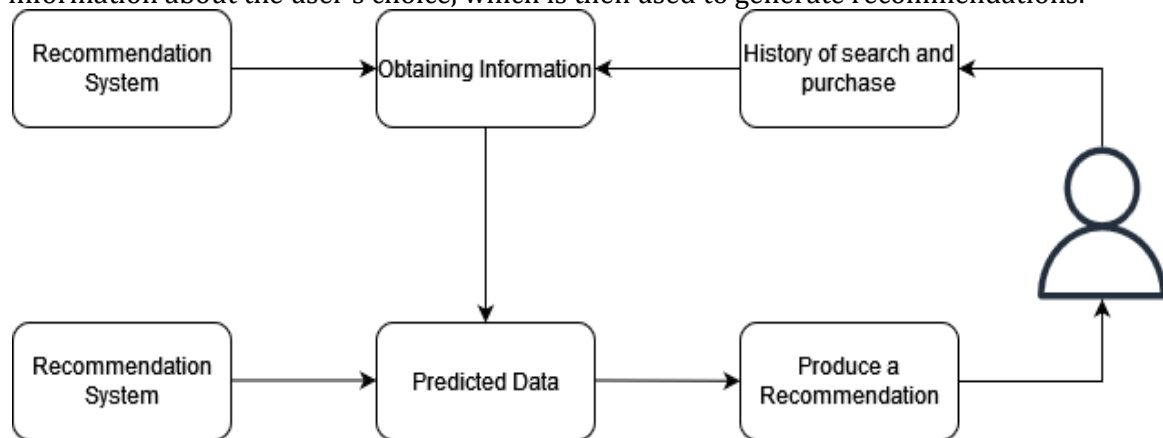


Fig.1 PROCESSING FLOW OF RS

Recommender system helps e-commerce and retail companies leverage the power of boosting sales and also enhances customer experience. In the overwhelming number of choices, there is a need for a filter or priority. In this overloaded information era recommendation system is

the perfect solution. In this paper, we will explore different techniques to predict as a measure for research.

The filtering of data is fragmented out of large amounts dynamically based according to the user’s preference or behaviors or user interest about the item. The system would be able to predict if a particular item would be preferred by a particular user or not based on his previous dates.

Recommender system is useful for both businessperson and the user as. It is time-saving on the user end with an improved decision-making process and the seller end has definitely increased sales on a larger scale.Recommender system helps one with detailed reports that are accurate and up-to-date.It also reduces the workload on IT staff, as it automates the volume of data required for a personal user experience for each customer.When recommendations are shown to the user, which relates to their interest, they are more likely to be added to the buy list.The recommendation makes users live deeply into the product without repeated searches.The system performs a great job in creating customer satisfaction.Right suggestion and in right place makes the user more likely to get retention.After knowing about the meaning of recommendation system now let us know more about its types.

III. METHODS OF RECOMMENDATION SYSTEM

RS approaches are classified into three groups in this paper: As indicated in Figure 2, there are three types of techniques: a) traditional techniques, b) modern techniques, and c) hybrid techniques.

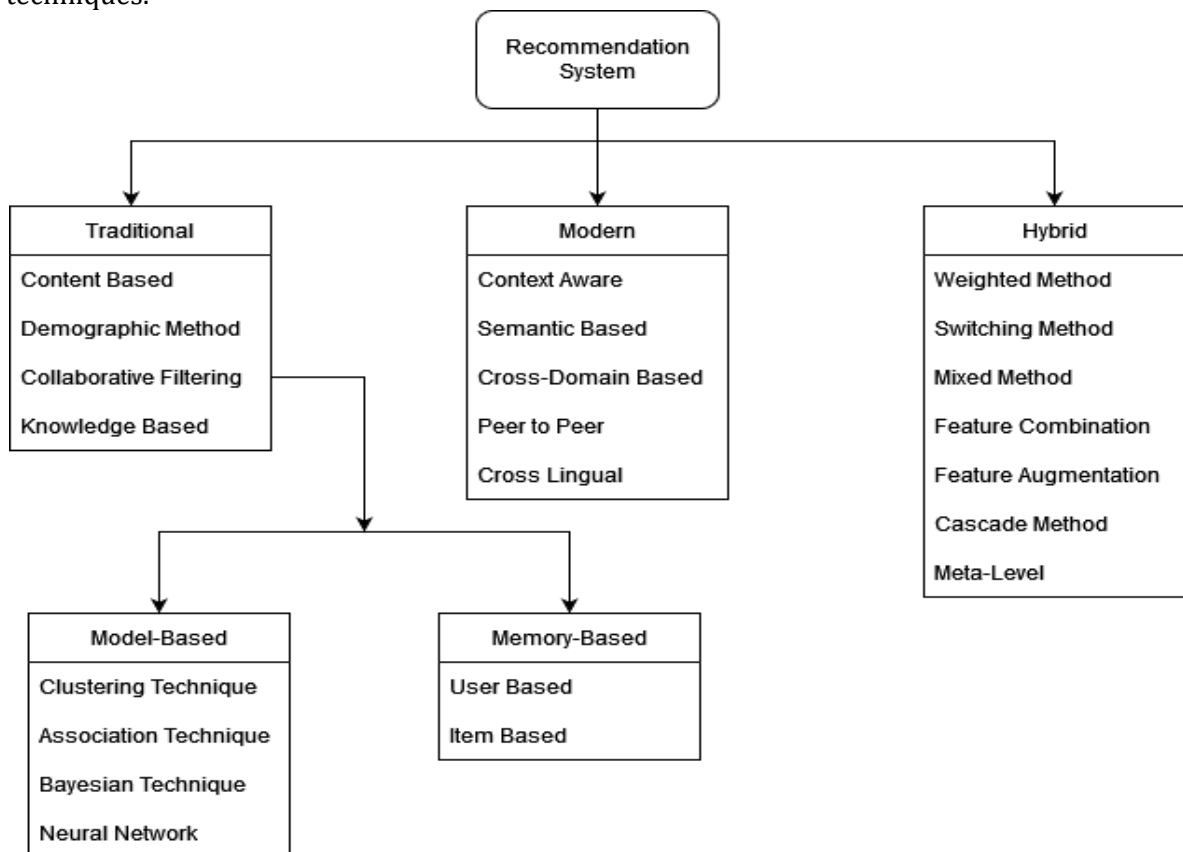


Fig2. Methods of RS

Mainly there are three types of recommender system that is implemented in e-commerce websites they are as follows. Let us know about each in brief.

1. Traditional Techniques

a. Content-Based (CB): This strategy uses a series of various features retrieved from an item's contents to propose additional things to users with similar features rather than relying on the opinions of other users [15],[18]. Algorithms for learning user preferences [14] are the focal point. Approaches to Recommendation Top-n recommendations, where n is determined by the organisation, and rating scale recommendations, where a threshold value is determined, say t, recommend goods that are more than or equal to t. CB employs a number of methods, such as naive Bayes classification and decision trees [13]. The technique that collects the data of a user while their first login. It reads the profile of the user and learns about user interest. Content-based has outgrown and continuous flow of data that helps in filtering. From the age of user it would recommend the products which another user of similar age has liked in past. Thus, it shows the trends for a particular age group.

b. Demographic Method (DM): This approach is quick and easy to apply, and it generates recommendations based on the demographic history of the user profile with only a few observations [15]. An easy technique to implement for many industries is based on demographic class. It works based on the data collected from the market search for a specific region with a survey and then categorized it. Thus it aims to categorize users based on attributes. A demographic-based system does not depend on the user's history of rating unlike content or collaborative systems.

c. Collaborative Filtering (CF): This method creates a database model (a user-item matrix) and finds users with relevant interests or preferences by assessing similarities between their profiles in order to provide recommendations [12],[19]. Collaborative is the most widely used technology for e-commerce websites. It works based on the ratings given or check for common behavior and generate a report that helps find a new recommendation for the user. This technique is independent, as it does not depend on any machine-readable presentation of the object.

Assumption: people who agreed in the past will agree in the future as well and thus they would also have similar likings towards the product. In essence, it necessitates user engagement, i.e., millions of users evaluating item reviews to communicate their preferences for item suggestions, yet user participation is typically low [14]. If user U1 likes products I1, I2, and I3 and user U2 enjoys I2, I3, and I4, we may conclude that their tastes are nearly identical. As a result, RS can advise U1 on I4 and U2 on I1. Figure 2 illustrates the division of CF into two groups and subcategories:

- Model-Based
- Clustering Technique: Unsupervised learning is another name for it. It's utilized to connect a group of people who have similar preferences. The approach of iterative clustering that makes advantage of user-item connections. Users and items are grouped first, then predictions are produced using the k-mean technique [20]. Clustering approaches may be classified as follows: a) partitioning methods, b) hierarchical agglomerative or divisive methods, c) density-based methods, d) grid-based methods, and e) model-based methods [21].
- Association Technique: Where DM is administered, the association rule (AR) links things with comparable features. The implementation employs the Apriori algorithm [22]. AR is classified into three categories: multilevel, multidimensional, and quantitative association rule [21].
- Bayesian Network (BN): It is a probabilistic training approach that belongs to the Bayesian classifier category [23]. It's a directed acyclic graph, with the curve representing the

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integrated possibilities between the variables[24]. $P(m|n)$ is posteriori probability, $P(m)$ is observing probability of m , and $P(n)$ is observing probability of n [25].

$$P(m|n) = \frac{P(m) * P(n|m)}{P(n)}$$

- Neural Network(NN): In the e-commerce business, neoteric assistance has been concerned with NN for product suggestion and has shown positive results [26]. Back propagation [21] is used to learn the NN algorithm.
- Memory Based
- User Based Neighborhood: It discover the similarity ratings among customers and select person with comparable flavor and prediction ($P_{u,i}$) of an object for a person u is calculated as [27]: Where $P_{u,i}$ stands for item prediction, $r_{v,i}$ for user v 's rating of item I and $S_{u,v}$ stands for user similarity [17].

$$P_{u,i} = \frac{\sum_v (r_{v,i} * S_{u,v})}{\sum_v S_{u,v}}$$

- Item Based Neighborhood: It's similar to user-based, except instead of users, we use things, and the prediction is derived as: Where $R_{i,N}$ is the item's rating and $S_{i,N}$ is the similarity value [27].

$$P_{u,i} = \frac{\sum_N (S_{i,N} * R_{u,N})}{\sum_N (S_{i,N})}$$

d. Knowledge Based (KB): This method proposes goods based on what you want to use them for and what you think they could be useful for. The aspects of the item that fit the user's liking are included in this information[15]. The table I shows what input has been used in the various strategies for developing a recommendation system. based on knowledge this system recommends on preference about a user's need algorithm they study is to get knowledge on how would a particular product meet particular user's requirement and hence create a good relationship between user need on requirement along with the possible recommendation. This helps in bringing customer satisfaction as the seller can recommend as per the user's needs.

Technique	Inputs
CB	Rating of User + Attributes of Item
CF	Rating of User + Rating of Neighborhood
KB	Preferences of User + Attributes of Item + Domain Knowledge

Table I: Summary of traditional techniques

2. Modern Techniques

a. Context Aware: It makes advantage of contextual information such as weather forecasts, day-night timing, and so forth. The majority of RS use this strategy for business-like information consumption, such as in the e-commerce industry and social media.

b. Semantic Based: In the guise of metaphysics, this sort of system exists on the internet Various RS express their attitudes about semantic approaches such as trust management, decision making, and social interaction groups, among others [28].

c. Cross-Domain Based: Linked-domain suggestions are another term for the same thing. There are three major elements in this procedure. a) transfer of domain knowledge b) user-item overlap c) suggestion generation It makes suggestions to target [29] based on what it has learnt from the source.

d. Peer to Peer (PP): This is a suburbanized strategy that can address scalability concerns. Every peer in this cluster has a committed peer that has similar tastes to them. It makes suggestions based on the basis of history [25].

e. Cross Lingual: Information is retrieved using dictionaries and machine translation. This method [30] employs a variety of categorization techniques. This approach's goal is to assist users in locating text, documents, news, and other content in their native language rather than the source language [31].

3. HYBRID TECHNIQUES (HT)

HT is a combination of more than two methods for detecting flaws and optimising single-system performance. [32] Hybrid Recommendation: lastly come into the picture hybrid system that combines two various recommender systems like content and collaborated or content and knowledge. Thus hybrid is a combination of two or more recommender systems. Major e-commerce website uses a hybrid system to take advantage of and eliminate the drawback of individual recommendation system. Here are a few strategies for achieving hybridization:

a. Weighted Method: To construct a single suggestion, a score of many objects is combined.

b. Switching Method: Depending on the current condition, this procedure shifts amongst RS approaches [18].

c. Mixed Method: At the same time, a large number of contradictory system proposals are represented.

d. Feature Combination: To create a single algorithm, a variety of attributes from several information sources are combined.

e. Feature Augmentation: In this case, the output of one strategy is used as the input for the next.

f. Cascade Method: Before breaking the chain of higher score, the recommender is given inflexible primacy instead of the lower primacy.

g. Meta-Level: A single strategy is concerned with the construction of a model, the output of which is employed by the following approach [33].

IV. DIFFICULTY IN RECOMMENDATION SYSTEM

Although it has a number of drawbacks, RS is useful for suggesting. The following are a few points to consider:

1. Data Collection: It's possible to do it both openly and implicitly. User input is explicit data that is submitted voluntarily by the user. Implicit data is gathered from readily available sources such as user profile data such as searching patterns, purchasing history, and so on [34].

2. Data Sparsity: Thousands of things are sold on the internet, yet the majority of active users only rate a handful. It's difficult to forecast user preference if they haven't evaluated enough products [35], and this leads to a lack of data for recommending user-relevant goods [36].

3. Scalability: As the number of items and consumers grows, the organisation need more resources to handle the data, and calculation skills are frequently required to make recommendations [37].

4. User Trust: Users with brief antiquity in their buying profile may not be as relevant as those with oofy antiquity. This issue of trust emerges when evaluating a specific user, and it may be resolved through priority distribution [38].

5. Cold Start Problem: The phrase comes from autos, which have trouble starting up when very cold, but operate smoothly once they reach their ideal state. This difficulty simply indicates that the elements for the engine to deliver the best potential suggestions or outcomes are not yet ideal [36]. Giving suggestions to new users who are utilising shopping sites for the first time and have not yet rated any things and have no prior online purchasing

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history is time consuming. Cold start problem [39] is the name of this issue. There are two approaches to approach the problem: a) VCS (Visitor Cold Start): It indicates that a new user is added to the dataset who has no prior experience in the e-commerce business, and the company is unaware of the user's preferences. As a result, making suggestions to the user is challenging. b) product cold start (PCS): a new product is brought into the market, and the organisation must demand user actions to prompt the product's value [48].

6. Gray Sheep Problem: The issue concerns a user whose decision is inconsistently accepted or rejected by a group of others, which is not beneficial to RS. The conflicting group of black sheep is characterised by idiosyncratic taste, which leads to suggestions that are often erroneous. However, while this is an RS failure, non-electronic recommenders also have a lot of problems, and the black sheep problem is a valid failure in these circumstances [36].

7. Synonymy: The majority of RS are unable to identify hidden interconnectedness, which is defined as a predisposition for a large number of similar things to have distinct entries, titles, and names. As a result, you should approach these products with caution. This challenge was dealt with using the SVD approach and the LSI (latent semantic indexing) method. However, because the majority of identical terms have many meanings [16], this strategy only provides a partial solution.

8. Privacy & Security: It's a huge problem. Users are concerned about the type of data gathered and how it is utilised from their profiles. The system must know more about the user's preferences in order to give customised and exact recommendations. Demographic data and user location are examples of the types of data collected. The issue of the offered information's secrecy, security, and veracity is legitimately raised. With the aid of specific algorithms and programmes, several shopping sites offer security and privacy of user information. [39].

V. DIFFERENTIATE VARIOUS E-COMMERCE RECOMMENDATION SYSTEMS

Table II compares top-rated websites in terms of: a) the recommendation system or engine approach employed, and b) how they propose items and services?

Website	Which Technique is Used	How they recommend?
Netflix	Machine Learning[42]	Netflix suggests films based on the user's viewing history, day, and device[43].
YouTube	Deep Neural Network[44]	It begins by gathering implicit data, such as the user's viewing history, and then chooses among hundreds of films for suggestion.
Facebook	CF (Matrix Factorization)[45]	Like Facebook, which recommends friends based on a shared friend list (i.e. individuals you may know), suggest on the basis of like-minded people.
Flipkart	Hybrid Technique[41] (Content-based (CB)+Collaborative Filtering (CF))	The CB algorithm is used in the catalogue for item attributes and images, while the CF algorithm is used to assess the user's searching history, such as pages seen,

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		Wishlist, add to cart, and so on, to locate more collaboratively sought things for a specific product.
Amazon	Item-Item Collaborative Filtering[40]	Instead of using people, RS operates using things. The list of objects visited by each user is first sorted in an item-to-item matrix, and then the cosine similarity is used to generate the recommendation method. Amazon analyses the type of item that the customer has been looking for and has previously viewed, and then suggests items that are extremely similar in form, size, and brand.

Table II: Summary of traditional techniques

VI. CONCLUSION

Recommendation systems are a crucial component of the e-commerce era's success. A large number of items are available on the internet in this era of online buying. Data mining is a business-like approach for extracting information from user data. By correctly applying DM algorithms to RS, we may improve its performance and eliminate its difficulties. In order to identify homogeneity between users and things, it is really beneficial to disentangle the RS issue. This document summarises a step-by-step approach for developing a recommendation system using a variety of techniques, similarity measure matrices, and obstacles faced by different recommenders.

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