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Influence And Potential On Research Problems In Recommender Systems

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Abstract. With the constant proliferation of web applications around the world, it is difficult to obtain the appropriate information needed by the user in a short period of time.The number of handheld mobile devices is growing, and the majority of business revolves around data search. It is quite difficult to obtain essential information from online apps without a robust recommender system. Recommender systems are used in web applications to give relevant data to users depending on their preferences and interests. Different types of recommender systems have been presented to meet various needs. Collaborative filtering recommender systems and content based recommender systems are the two most fundamental forms of recommender systems. These two recommender systems are sometimes combined to improve the efficiency of a recommender system. The new recommender system that was created is known as a hybrid recommender system. This paper's goal is to assist readers grasp the fundamentals of recommender systems. This report lists significant research fields that are open to new researchers. After reading this work, new researchers will have a better understanding of the fundamental challenges with recommender systems that need to be addressed.

Key words: Recommender systems, Research problems

1. Introduction

Recommender systems assist us in obtaining the information we require. It only displays information that the user requires. Any system today contains a large amount of data.YouTube, Netflix, and other e-commerce platforms such as Flipkart and Amazon are examples of systems that require recommenders. The current situation is that data is expanding while screen size is diminishing. We mean screen size when we state that initially systems were used from desktop and laptop computers that were roughly 15 inches in size, and now it is used by mobile devices.

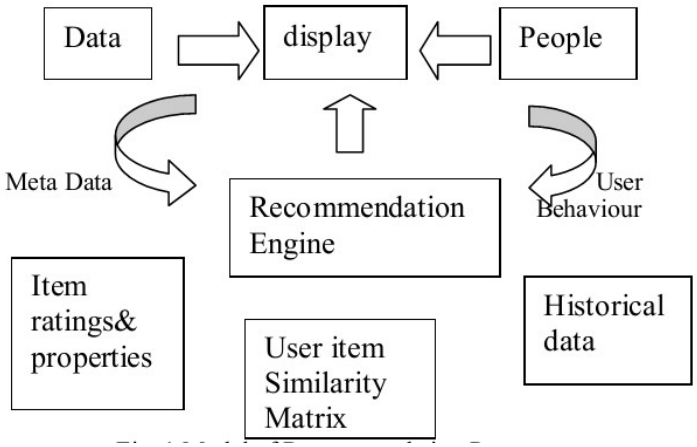

Figure 1. Model of recommendation process

It runs from 4 to 7 inches in length.When a user searches for an item and it is not found within the first 5 or 10 searches, he exits the system and attempts the item on another system. The greatest irony is that an item is available but did not appear at the top of the user's searches. In this situation, he will purchase the item from a different computer ECommerce platform rather to the platform that was unable to make a recommendation. A recommendation system can boost the sales of a specific application. Many E-Commerce platforms failed due to a lack of a strong recommendation mechanism on their platforms. A good recommender system also saves consumers time and keeps them engaged in the system, which leads to more income.

Google, YouTube, Netflix, Flipkart, Amazon, Prime, gaana.com, and many other well-known companies use recommendation systems. Every system has advantages and cons. As a result, recommendation systems face numerous challenges that have yet to be effectively addressed.

So the goal of this study is to familiarise the reader with recommender systems and their primary techniques. The paper will also investigate research challenges in recommender systems based on our comprehensive research using the works cited in the reference section. We have listed some significant areas of research that are open to new researchers in this publication. Students in their Masters and PhD programmes can use this field as their subject of research and contribute to the development and improvement of recommender systems of the next generation.

We offer papers ranging from early 1997 to 2020. The research includes more than 50 papers. We have not only highlighted difficulties, but we have also included the most recent solutions to problems publications to help academics grasp the subject in depth.

2. GENERAL CONCEPTS

A recommender system is a system that assists users in selecting goods that they may require. To attain this result, various artificial intelligence and machine learning approaches are used.

Google.com, Amazon.com, Netflix, and other popular online e-commerce, music, and video portals are instances of recommender systems.These systems cannot function correctly without a solid recommender system because they contain millions of things.

In some applications, such as proposing books or CDs, the space S of possible objects might be very extensive, ranging in the hundreds or even thousands of items. Similarly, a person's area might be extraordinarily large—millions of square miles in some situations.

The rating of an item determines its usefulness in a recommender machine. A rating is a measure of how much a user likes an item. Because it is provided by the user, the dependability of this rating is enhanced in comprehending the user's selections. The rating can be interpreted in several ways. Some typical kinds of rating include being questioned on a 1 to 5 scale, as in the case of Google Play apps. It can also ask on a scale of 1 to 10, as many rating methods do. This grading scale is widely used by customer

service organisations. You can use whichever rating scale you choose and describes like and others end describes the extent of dislike.

A user profile can be created by saving characteristics such as age, gender, location, email, and mobile phone number. Based on the features of the item, an item profile can be generated. In the case of a book, it is the language, the author, the publisher, and so on. In the case of television, it is the brand, power consumption, and a variety of elements that can be utilised to form the profile. The manner in which we develop the profile has a significant impact on the recommendation system. Ratings are assigned to a subset of data rather than the complete dataset. A rating matrix is constructed between the user and the item, which serves as the heart of the recommender system. The recommender system is defined by how the rating matrix is assessed. Different domains employ various ways to retrieve data from the user-item matrix.

Recommender systems recommend various goods to the user depending on the rating matrix's machine learning or artificial intelligence capabilities.With user feedback, good recommender systems improve. A solid recommender system makes good recommendations even when there are minimal ratings. The accuracy of a competent recommender system grows as the system's user history grows.

3. TECHNIQUES USED IN RECOMMENDATION SYSTEM

The grading mechanisms used by the system are used to categorise the recommender systems. The Recommender systems are defined by how a system takes ratings or anticipates user preferences. Figure 2 depicts the fundamental approaches employed in recommender systems. We will detail them in the following parts. We have provided a brief overview of the fundamental strategies utilised in recommender systems in this work. There are more strategies that can be coupled to create hybrid recommender systems. Figure 4 depicts them.

3.1. Collaborative Filtering

The collaborative filtering system is a method in which we take user input and utilise it to form relationships with other users and products. In a collaborative filtering system, for example, any user is requested to rate a specific item. Similarly, other users rank other goods. As a result, we have a user-item rating matrix. The user's rating provides historical statistics as well as the user's preferences. We can develop a user profile based on their decisions. Then, based on his past and profile, we may figure what new products we can buy.

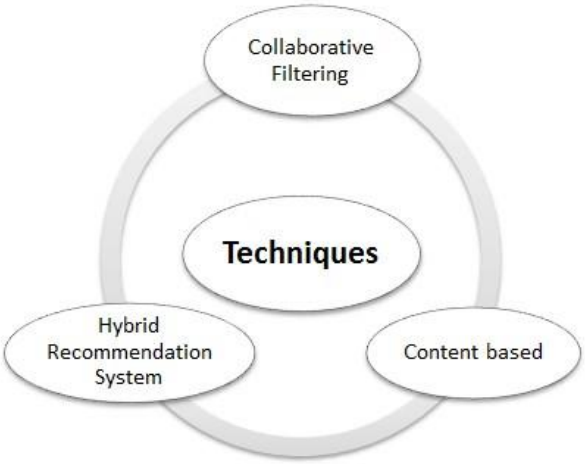

Figure 2. Techniques used in Recommender systems

Movie recommendation systems and social networks are two instances of collaborative filtering systems.

3.2. Content based

A content-based approach requires the item to be presented to the user based on the item's description rather than the user's history. Newspapers and article recommendation systems employ these types of recommender systems. These recommender systems may have limited knowledge about the user. Figure 3 depicts the suggestion procedure.

These recommender systems do not have a user history. Item profiling is the most prevalent technique employed by content-based recommender systems. This item's popularity is documented. User profiling is also done with the system's limited fundamental information about the user. The attributes of items are used to create item profiles. The attributes are used by the recommender system to recommend articles to different users. They lack rating information, as opposed to collaborative filtering recommender systems. User profiles can also be developed based on a user's likes and dislikes for a certain item.

When we wish to propose an item to a user, we match user interests to item attributes. This is also known as item content features, and it contains Using the elements of gadgets and users, one can develop more tailored recommendations. The main characteristics of an object define its profile. A book, for example, can be described using its title, genre, language, publisher, price, and so on. Similarity between things can be calculated using the weighing process. In some domains, elements can be represented by boolean values, whereas in others, values can be represented by a set of restricted values. Consider the newspaper, where we analyse the newspaper articles based on the remarkable form of themes. The Boolean cost indicates whether or not a phrase exists. whether or not it is mentioned in the article. Integer cost may wish to define the categorical manner in which a term appears in an article. Without utilising explicit ratings, this strategy yields a successful recommendation in content-based recommender systems.

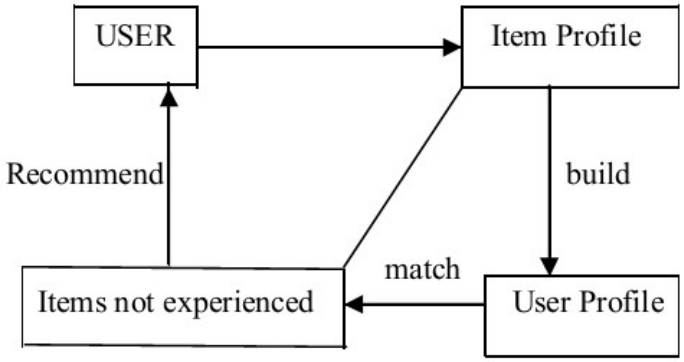

Figure 3. Content based Process

3.3. Hybrid Recommendation System

This system makes recommendations based on a combination of techniques. One of the most recent trends in the recommendation system is this. The table below depicts various sorts of suggestion techniques. The Hybrid employs a hybrid of these recommendation techniques. All of these strategies appear to be used by Facebook's recommendation algorithm. The hybrid advice uses all of the strategies, but be cautious because hybrid might involve a lot of calculation and produce contradictory results.

Figure 4 depicts some popular strategies that can be used to create hybrid recommender systems. When these strategies are coupled, the results of the recommendation are improved.

4. RESEARCH PROBLEMS

These recommendation systems have a bright future ahead of them. Some issues remain unresolved by the research community today in order to improve research efficiency. Some of the issues that we believe can be resolved are outlined below. Figure 5 depicts all of the research issues that will be addressed in the next sections. These research problems can provide inspiration for future work in the field.

4.1. Gathering Known Ratings for Matrix

It has been found that the majority of users do not provide ratings. As a result, a study dilemma arises: how to determine whether or not they are satisfied with the product and by how much. There are two methods for assigning ratings. When is explicit, such as after they have purchased or inspected any item. Another method is to estimate their ratings for a specific item based on their preferences for another item. This is referred to as an implicit way of rating collection. According to our findings, there is a sufficient gap between explicit and implicit approaches, allowing academics to begin research in this sector.

4.2. Cold Start Problem

A cold start problem occurs when no information about the user or object is found in the system. A collaborative filtering recommender system that requires necessary data

Recommendation Technique	Environment	Input to System	Method
Collaborative	Rating from users of items	Rating Unit	Identify user's rating and recommend accordingly.
Content - Based	Features of items	User's rating of items	Classify user's rating / behavior
Demographic	Demographic information of user and their rating	Demographic information about the user	Recognize user which are demographically similar to other user
Utility – Based	Properties/ Features of items	A utility function over item that describe the user properties	Apply the function over the item and determine the rank
Knowledge – Based	Knowledge of how these items meet the user's requirement	A account of user's need of interest	Deduce the match between item and users need

Figure 4. Techniques used by Hybrid Recommendation

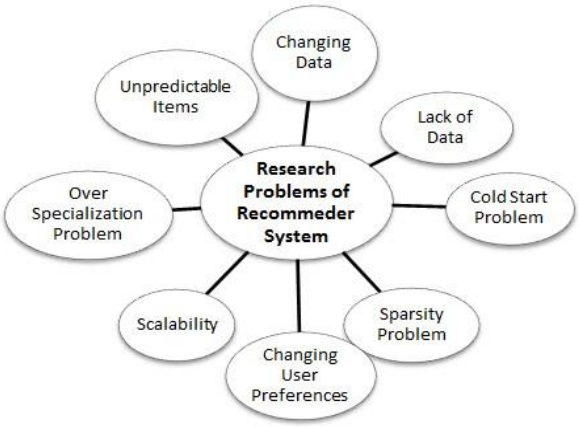

Figure 5. Research Problems in Recommender systems

Before advising, gather information about the user and the item. In the realm of cold start difficulties, we can have three distinct subproblems. The first issue emerges when we have no knowledge about the new user accessing the system. This only happens the first time a user logs into the system. For example, if you are joining Amazon or Flipkart for the first time, this type of issue may arise. This is referred to as the new user cold-start problem. The second issue emerges when we add a new item to the system. This object is quite unique in its category. The recommender system was unable to locate any ratings for this item. The collaborative filtering system, which requires a user-item rating matrix to make a suggestion, is unable to start, and this is known as the cold start item problem. The third issue emerged when we first tried to use the system. We don't have any user information or item information in this situation. In other words, we lack the user-item rating matrix that is essential for collaborative recommender systems to function successfully. This is referred to as the cold start system problem. Cold start difficulties can be solved using well-known content-based techniques. Other solutions employ a combination of machine learning approaches.

4.3. Sparsity Problem

It has been discovered that most consumers use the suggestion system but do not provide adequate feedback to the system. So, even if we have numerous people utilising the recommender system at different times, it is likely that we just have a few ratings from those users regarding various goods that they have liked, purchased, or even despised. Rating appears to be meaningless to users, so they avoid offering it, which can lead to fraudulent ratings such as providing 5 stars (considered best for them) or 1 stars (considered unlikely item) without even understanding what kind of product it is. This is used as input by the recommender system, which then displays the unwanted results to the user, perhaps losing the user's interest in that platform and leading to inefficient working. Because rating is meaningless to users, they sometimes don't even provide to bulk of products, which leads to the same situation.

The sparsity problem is caused by the sparsity of the rating matrix. The user-item rating matrix is being discussed here. The user-item rating matrix is sparse in mathematical terms, which gives rise to a unique challenge known as the sparsity problem in recommender systems.

This is a challenge in the domain of collaborative filtering recommender systems. This topic presents novel chances for fresh researchers to devise novel methods for predicting missing data.

4.4. Scalability

Scalability is a system attribute that defines whether or not the system will be able to cope as it increases. For example, in the case of recommender systems, scalability can be defined as a circumstance in which a recommender system performs very well with a small number of users, such as 1000, but when the number of users increases to 10,000 or 100,000, it begins to function in an undesirable manner. When the system encounters scale concerns, it becomes slow and begins to give problems that it never gave when the load of user recommendations was low.

Scalability concerns are classified into two categories: hardware scalability and software scalability. The hardware is scalability refers to the expansion of hardware to address the scalability issue. To remedy the problem, for example, one might increase the CPU, RAM, and server setup. However, increasing hardware air capacity will not address the problem.

Writing algorithms and employing approaches that function well when hardware configuration is expanded as needed in the future is what software scalability is all about. Despite the fact that this is a serious issue that is not as simple as it appears. because there are algorithms that perform very well while the amount of data on which they must operate is minimal, but as the amount of data grows, they begin to function inefficiently. As the amount of data increases, the prediction's accuracy diminishes. Some algorithms are unable to take advantage of the increasing efficiency of the hardware, resulting in a scaling issue.

4.5. Over Specialization problem

This issue happens when the recommended things are too similar to one another. One such example is a user who buys grocery items on a regular basis from a shopping website, and whenever he/she opens the website, the recommender system recommends only sugar, which may be of different brands (based on the maximum purchase), and seeing the same item again and again without any unique suggestion may lead the user to switch the shopping website whose recommender system offers better, interesting, and personalised results for the user. So, with this case, the user loses interest in recommended products; recommendation diversification is one solution to this problem. In this way, we list all of the elements that are dissimilar but relevant to the usage.

4.6. Lack of Data

The most significant challenge that recommender systems face is that they require a large amount of data to produce meaningful recommendations. It is typical practise in the recommender system domain to use a publicly available dataset from a different context to test the efficacy of recommendation algorithms. These data sets are critical since they serve as a standard for developing new recommendation systems. Most of the top companies, such as Google and Amazon, make good recommendations because they have a lot of consumer user data. A recommender system must first collect consumer/item user data (from various sources), then perform some statistical analysis based on some procedure (User behaviour observation or events), and then the Recommendation algorithm does its job. With additional consumer/item data, we will be able to make better recommendations with the help of the recommender algorithm.

4.7. Changing data

The most significant obstacle in the case of recommender systems is changing data, i.e. they are frequently biassed towards the old/past and have difficulties dealing with or advocating new. Many recommendation systems collect user data or use user past behaviour analysis, but this is not an efficient tool for making good recommendations because user trends and interests are constantly changing, making it difficult for the recommendation system to react in a changing data environment. To illustrate, a newlywed couple typically searches for dresses, beauty products, and lifestyle items, but as time passes and circumstances change, their interest shifts to baby products such as diapers, baby foods, and so on, which may confuse the recommender system and lead to the display of results that are no longer of interest to the buyer.

4.8. Changing user preferences

The next significant problem in the recommender system is changing user preferences and coordinating with constantly changing user preferences. As we have seen, user intentions towards browsing a particular item might vary over time, therefore recommendation systems that are entirely dependent on user preferences may provide incorrect recommendations. for eg. Assume I am perusing books for myself now, but I may be searching sports items for myself tomorrow. It can be said that a 10-year-old child is searching for multiple items without any thought just to scroll without any intention of purchase, and the recommendation system based on user preferences may recommend me the wrong items at that

time, so making coordination with frequently changing user preferences is the most important issue in recommendation system.

5. Conclusion

This paper introduced fresh researchers to recommender systems. This work has also identified important difficulties in recommender systems that require research. This article can assist PhD and Masters students in deciding on a research topic. The research gap is already presented in this study to construct various recommender system difficulties. The recommendation system is useful in many different aspects of web applications. As these issues are resolved, recommendation systems will become increasingly useful. Web apps will become more intelligent and usable as recommendations become more reliable.

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