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Abstract:

In this era of the internet and with the easy availability of data at a very low cost, searching for information is growing at an exponential rate. So, it is now impossible to find the desired information without proper guidance. Here is the need of the recommendation system. The system will recommend which information relevant to the user according to their searching pattern. It will also explore hidden results with a minimal effect. The goal of this paper is to describe the famous recommendation systems which are used mostly and to explore what is the need of these kinds of systems and also what kind of technology has been used to provide better services to its users. Finally we would like to show how one recommendation system is different from another as per user need.

Keywords: Recommendation system, Collaborative filtering, Content based recommendation system, Hybrid recommendation system, Web2.0 application, Amazon, Google, Netflix, LinkedIn, Facebook, Instagram, YouTube.

Introduction:

Recommender system is one kind of innovative service. The prime motive of this system is to analyze user profile, analysis items and correlate between them. This will lead to predicting the behavior of the user. Recommender systems more accurately capture the demands of the real time user. It is always better to have recommendations for anything because this will help users to recommend a good choice at least time. Recommendation system is a tool and technique that provides suggestions to the user according to the usage pattern of others. For example we can say that useful videos on Youtube, web series on Netflix, friends' on Facebook, books on Amazon, homes on Zillow, movies on MovieLens etc. From a librarian's point of view, a recommendation system can be seen as a form of catalog enrichment or as a substitute for traditional subject classification. The recommendation systems assist librarians in setting up and keeping up-to-date

the library's holdings. From a more technical viewpoint, a recommendation system may be seen as a web 2.0 application (Mönnich & Spiering (2008)).

Recommendation system:

The primary purpose of the recommender system is to recommend users to make better decisions among the enormous web resources. It mainly consists of four types: collaborative filtering recommendation system, content based recommendation, knowledge based recommendation and hybrid recommendation system. The collaborative filtering recommendation system deal with similarities between queries and items simultaneously that means interactions between user and item such as ratings, buying behavior etc. to provide recommendations. For example, we can say that If a user says X is similar to user Y and user Y likes Tom and Jerry cartoon, then the system can recommend Tom and Jerry cartoons to user X (in spite of the fact that user X hasn't seen any cartoons similar to Tom and Jerry). Content based recommendation system practice similarity between items. It recommends items similar to what the user is keen on. For instance, if a user X likes videos about luxury cars, the system can recommend other luxury car videos to that user automatically. This kind of RS concentrated on the ratings of every single user rather than every user. In knowledge-based recommender systems, the recommendations are based on explicitly specified user requirements. Instead of using historical rating or buying data, external knowledge bases and constraints are used to create the recommendation (Aggarwal, 2016). Now the last one i.e. Hybrid recommendation systems are the combination of all these recommendation systems. It includes different types of machine learning algorithms. It is developed using all the positive parts of different types of recommendation systems that can execute more strongly.

Review of Literature:

To understand the goals and nature of recommendation systems, Aggarwal (2016) discussed about some popular examples of current recommender systems like GroupLense, Amazon, Netflix, Google News, Facebook etc. which shows the broad diversity of recommender systems that are presently available. Kumar & Singh (2019) did a survey on popular recommender systems like Amazon, Netflix, Tapestry, LinkedIn, Facebook and Yahoo: answers. They showed the problems faced by some famous websites of the web while handling the large number of users and the probable solutions through the recommender systems. They have also concluded that effectiveness of the recommender system is highly dependent on the quality of features. Mortensen (2007) discussed Pandora and Last.fm two music recommendation systems in his thesis. He showed how these recommendation systems are different in features in spite of that they fulfill the same purposes.

Objective of the study:

The objective is to describe the famous recommendation systems which are used mostly and to explore what is the need of these kinds of systems and also what kind of technology has been used to provide better services to its users. Also we would like to show how one recommendation system is different from another as per user need.

Scope:

Recommender systems have been extensively used in various web based applications. This system will definitely help users to find relevant items with least time. The study focuses on the different famous recommender systems and their characteristics which may pave the way for future developments of recommender systems.

Comparative Analysis of Recommendation Systems (RS):

To make a comparative study between different world famous recommender systems, we have selected a few characteristics or features. Here, we have shown the different characteristics/features in a tabular format.

SL	Names of RS	Type	What	Technique	RS Based on
1.	Airbnb	Content-Based Recommendation System	It is a vacation rental online marketplace company	AirBnb uses automated machine learning with structural modeling technique for their system to provide effective recommendation.	It is based on a search algorithm that supports deep learning and neural networks.
2.	Amazon	Item-to-Item Collaborative Filtering.	E-commerce website (It sells books, furniture, computer products etc. etc.)	It uses RS as a targeted marketing tool. It uses neural networks and created DSSTNE, (Deep Scalable Sparse Tensor Neural Engine) to handle the real time data of millions of customers with ease.	It is based on three factors: i) Ratings ii) Buying behavior iii) Browsing behavior of the user. In their website user can give ratings on any products on a 5point scale according to their choice of the product.

3.	Best Buy	Collaborative filtering	E-commerce website	It creates cluster models to make recommendations.	It's technology based on mainly three techniques : i. Query search and click data. ii. Customer centricity model & iii. Price matching policy
4.	Facebook	Collaborative filtering	Friends, advertisements	It uses ball tree data structure in their algorithm. Its policy is somehow different from other RS. It doesn't directly suggest any items or products; it is mainly focused on more and more social contacts, which indirectly increases it usability and advertising benefits.	RS is based on Apache Giraph. It also uses Matrix factorization and compute top user recommendations.
5.	Google	Hybrid recommendation system	Advertisement, News	The architecture for RS consist of following components: • Candidate generation • Scoring • Re-ranking	It uses an ML-based recommendation model. Its recommendation system uses matrix factorization.

6.	Instagram	Rule-based personal assistant	Photo and video sharing social networking service	The algorithm collects all the data in the form of like, comment, share, keywords, hastags and other attributes. These data are ranked according to relevance; and then provides the results.	The RS depends on machine learning techniques. There are three main factors of instagram i.e. interest, recency and relationship. There are few other factors too like frequency, following and usage habit.
7.	MovieLens	Collaborative filtering	MovieLens is a research site run by GroupLens. It is a non commercial, personalised movie recommendation system	MovieLens find movies which audience will like, rate movies, and then it recommends other movies.	Based on movie ratings, MovieLens generates personalized predictions for movies and researching various aspects of personalization and filtering technologies.
8.	Last.fm	collaborative filtering technique	It is a music recommender system.	Its main objective is to match similar users. It is based on two techniques named crowdsourcing scrobbling.	RS is depends upon the co-relations between users with similar preferences.
9.	LinkedIn	classical collaborative filtering based recommendation	Social networking websites mostly used by business people. LinkedIn recommends jobs to users.	LinkedIn uses a technique called 'online learning'.	Linkedin has used Amazon's mechanical turk for building the crowd sourcing and skill inference algorithm. A core component of this system is a machine learning library, called Photon-ML on top of Apache Spark.

10.	Netflix	Hybrid	Technology and media services provider. It is a subscription based video streaming platform.	It uses personalized recommendation algorithms. It RS uses different techniques like reinforcement learning, matrix factorization, neutral work etc.	Netflix is based on Machine learning and data science. It uses rating data to recommend movies and shows to the subscribers.
11.	Pandora Radio	Content-based approach	It is a music recommender systems	The RS is designed on the basis three factors: artificial intelligence, machine learning and analysing the listening habits of users.	It is based on a multi-tiered approach. It also uses personalized filtering based on user's choice. The RS of Pandora are based on inherent qualities of the music.
12.	Spotify	collaborative filtering	It is a music recommendation system	It is a machine learning algorithm; it uses Hadoop clusters to scale recommendations. It also uses a technique called Release Radar.	It depends on three models: i)Collaborative Filtering ii)Natural Language Processing (NLP) iii)Audio models
13.	Tapestry	Collaborative based filtering	It is a commercial, non personalised mailing recommendation system. It is the first RS came in the year 1992.	It is filtering the queries in the mailing list. Here users can only see the messages which are reviewed other users before. Users are allowed to rate the message as Good or Bad.	It is based on a client-server model. Users are encouraged to annotate documents and then these are used for filtering.

14.	Tinder	Collaborative based filtering	Recommendation system for matching people. It is a dating application	Tinder uses information that is personal to create matches. GPS technology has been used to search potential partners form the close proximity on the basis of their profiles.	The RS is based on TinVec and Word2Vec mechanics The ML algorithm is trained across Tinder's large population base using right swipes as positive samples and left swipes and negative samples.
15.	Twitter	Hybrid recommendation system	It is a famous micro-blogging platform	There are 3 main recommendation products that Twitter recommends to its customers: i. Users to follow ii. Tweets & iii. Trends/Events	RS is based on hashtag ranking method.
16.	Uber Eats	friends' recommendation	It provides restaurant recommendations.	The RS uses machine learning technology and semantic understanding of each user.	It is based on representation learning approach. The RS is based on GraphSAGE and uses two techniques: candidate generation and personalized ranking.
17	Tripadvisor	Content based filtering	Travel products. It provides hotel recommendations also.	Tripadvisor is fully dependent on the reviews from the users. So it uses various reviews gathering tools like review express and review reminder etc. for better recommendation.	RS is highly dependent on defining an appropriate similarity measure. It uses Pandas in Python and k-means visualizations (for validation)

18.	Yahoo: Answers	Collaborative filtering	It is a question answering system	It uses the textual description of question. Every user can give thumbs up and thumbs down to any questions. An user can star an interesting question	It is based on user-user methods. It uses a multi-channel approach.
19.	You Tube	Collaborative filtering	It is an online video-sharing platform	It uses candidate generation technique and also second neural network.	It uses the batch oriented pre computed approach instead of on demand computation. It uses deep neutral network
20.	Zillow	Hybrid recommendation system	It is a home recommendation system	They are using a technique called interleaving and also machine learning technique.	It is based on Siamese network model.
21.	Literature map	Content-based recommendation	It is mainly a Literature Map. It is used for visualization.	It is based on Gnooks, Gnod's literature recommendation system.	It is using mainly two techniques: artificial intelligence and new user interfaces.
22.	Kindred Works	Content-based recommendation	It is a WorldCat Recommender Service which includes books, eBooks, music, video etc.	It provides basic search facilities. Users can search by author, title, ISBN, or OCLC number.	It has mainly two concepts : user interface and application programming interface (API)

Analysis:

It is seen that most of the recommendation system uses collaborative filtering (ten) and hybrid recommendation system techniques (four) rather than content based recommendations (five). Most of the recommendation systems heavily rely on artificial intelligence. As we are comparing the world's best recommendation systems, it is needless to mention that all of them are quite strong with their algorithm. They spent a huge amount of money for the research and development of the algorithms. Now we are analysing the features between two similar kinds of recommendation systems like:

i.   Instagram vs Facebook :
These two are very famous social networking sites. Presently almost 2.7 billion people use Facebook and 850 million people use Instagram worldwide (Source: https://www.statista.com/statistics/578364/countries-with-most-instagram-users/). Another interesting fact is that Instagram is owned by Facebook. Instagram is mainly a photo sharing app and Facebook is a social networking site which easily connects friends and family members. The features of these two are somewhat different. Instagrams RS is a rule based personal assistant one and Facebook's RS is based on collaborative filtering techniques. Facebook is multifaceted while Instagram mainly used for photo and video sharing purposes. Instagram is very easy to use as it has limited functionalities whereas Facebook has a lot of functions. There are three main factors of instagram i.e. interest, recency and relationship where Facebook has only one aim, which is building more and more connections. Although Facebook is used by most of the people of the world, Instagram is getting popular everyday due to its simplicity.

ii.   Pandora vs Last.fm:
Both are commercial recommendation systems. The mechanisms are quite different for these two, Pandora uses content based RS, while Last.fm uses collaborative filtering technique. Pandora is a music recommendation system, an internet radio and a product of Music Genome project, Last.fm is an internet based music and radio community. Last.fm is multilingual, whereas Pandora is mostly available in English. Last.fm is based on crowdsourcing and scrobbling technology, whereas Pandora is based on a user's stated preferences. Both Pandora and Last.fm stream music directly from the website in-browser, but Last.fm also provides another facility called desktop client, using this one can play the songs via Windows Media Player. Last.fm is quite popular than Pandora as it has some extra features like intimation of upcoming music events and concerts.

iii.   MovieLens vs Netflix:
MovieLens is non-commercial and free of advertisements, while Netflix is purely commercial. MovieLens is mainly used for movie recommendations while Netflix is used for both movie, web series and TV shows etc. Netflix is based on a Hybrid recommendation system and MovieLense is based on collaborative filtering techniques. Netflix uses personalized video ranker (PVR) and top-N video ranker techniques for recommendations while MovieLens is depending on personalized movie ratings and generates personalized predictions. Although MovieLense is free but Netflix users are more in number as has some additional features

iv.   Amazon vs BestBuy:
They both are world famous companies. Amazon is mainly an e-commerce site whereas BestBuy is a retail industry. They are using collaborative filtering techniques for RS.The signature product of Amazon is books and BestBuy's signature product is audio products and consumer electronics. BestBuy is based on mainly three techniques i) Query search and click data. ii) Customer centricity model & iii) Price

matching policy whereas Amazon depends on i) Ratings ii) Buying behavior, and Browsing behavior of the user. It is seen that worldwide Amazon has much more customers than BestBuy due to its technology and variety of products.

    v.   AirBnb vs Tripadvisor:
These two are well-known vacation rental sites. According to the market survey AirBnb is the market leader in this field whereas Tripadvisor is a market leader in terms of site visits by travelers. AirBnb uses automated machine learning to recommend products and Tripadvisor is highly dependent on defining an appropriate similarity measure.

    vi.   Kindred vs Literature Map:
These two are newly lunched recommender systems basically used in educational purposes. They are somehow different from the above mentioned RS. These two are based on content based recommendation system. Kindred RS are used in WorldCat for searching books, eBooks, music, video etc. Users can search by author, title, ISBN, or OCLC number, whereas Literature Map is a literature recommendation system. It is a kind of map which shows the proximity between authors. The authors are become close to each other when users like them. Both the RS is based on two basic features: user interface and application programming interface (API).

Conclusion:

In this paper we have discussed several recommendation systems, their features, techniques, technology behind the RS. What we have gathered is that every RS changed their algorithms according to the user need and the results are quite promising. When we compare among two similar kinds of RS, we have seen that one is growing very rapidly than the other, only due to some technical changes in the algorithms, which reflects in the features of the system. So every recommender system has been modified to solve the problems faced by the users. The companies are making huge amounts of profit using this RS, so they are spending a lot in improving the R&D of RS. It is very much inspiring to see RS has been implemented in libraries and in literatures too. Hope in recent years there will be more such cases. It is expected that in the near future RS will grow at a jet speed.

Limitations:

There are some limitations of this study. These are as follows-
i) Only twenty two recommendation systems have been considered.
ii) Convenience sampling logic has been followed for selecting the recommendation systems. This kind of sampling logic is not a good way of sampling, biasness may occur during analysis.
iii) Only a few of the categories were considered for comparative study. There may be some other categories also.
iv) Detailed study of each recommendation system is not explained here.
In spite of these kinds of limitations, we hope that this study would depict different internal aspects of recommender systems and its different prospects for further improvements.

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