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How "What You Seek is Already Seeking You" in Large Social Networks?

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***Abstract*—In the recent years, recommender systems have been used extensively in various social networks. Any social networks like blogs, forums, social network websites, social bookmarking websites, video portals, chat portals use these recommendation systems to improve the networking between people. Everyone these days on the social networking is trying to seek something that is important to them, as is the person's enthusiasm to find the required information, so is the networks enthusiasm to provide people on the internet with the information they need to keep them interested in the various aspects of the network. Recommendation systems are extensively used in all these social networks basically to help the users view or know about contents and products that are of theirinterests. This paper main aim is to give a comparative and comprehensive study on research articles published from 2016 to 2019 by implementing a methodological decision analysis in six aspects, including data mining techniques, recommendation approaches and types, datasets used in specific research domains and the evaluation of the recommender systems utilized. The aim of this paper was accomplished by analyzing the extracted articles on various recommendation approaches used. Social media domains where recommender system are being used have also been identified. The various datasets that are available publicly are also reported. The datamining techniques, performance measures and recommendation types are reported as per various technical aspects. Further, open research directions are also presented for researchers to work in Large Social Networks.**

***Index Terms*— Large Social Networks, Recommender Systems, Optimization assisted Recommendations in Social Networks, Recommendations for communities in Social Networks.**

I. INTRODUCTION

With the advent of the internet, the scope of a person's reach for information has increased by leaps and bounds. If the individual wants to know about anything, the first resort for the person is the internet. Internet these days is not just being used for gathering information or just to know about something, people have started using them also to find out other people with similar interests forming a kind of networkonline which is also known as social networking.

The size of these social networks that are formed isgenerally very huge because it lacks the restraint of physical limitations. Any social networks that are formed today have different people from different backgrounds and possibly from different geographical locations with different interests.

The main interests of these social networking groups are of various types. As the people in these social networks are not known personally, a method of understanding what their requirements are is through observing their

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pattern of behaviour in the network. To keep the people interested in a social networking it is very important to understand what theindividual wants and would like to see.
Social media technologies are available in different forms, such as blogs, business networks, CQA forms, photo sharing,information sharing, social bookmarking and gaming also known as virtual worlds.[1]
Figure 1 shows a diagram of the various categories of thesocial networking groups that we find online.

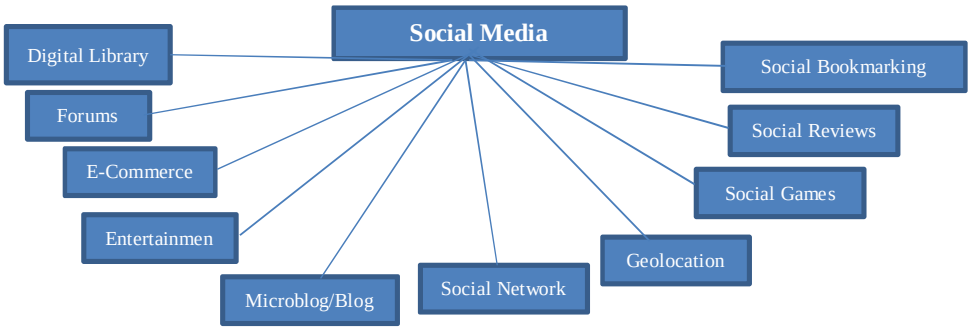

Figure 1: Categories of Social Media

Information overload has always been a problem for many people who use social networks to find data and people of their interests. Recommender Systems (RS) takes off a lot of the load of finding the wrong information or reaching dead ends while searching for information on the internet [4].
The important input for a recommender system is reviews and feedbacks from other users. Any information or reviews and ratings are used extensively by any recommender system to identify other users who might have similar tastes in the internet [13]. Many effective algorithms and techniques have been defined and identified to obtain dependable recommendations in any social network. RSs can be of great help to the user by saving both time and cost, which in turn refines the decision making strategies of the users [23].
The basic advantage of having a large social network is the sheer amount of data available. As these networks are independent of the cultures and geographical locations, a huge amount of data is collected in different formats. As the number of people increases in these networks people are all the more interested in obtaining various requirements and making innovative designs and products that can be used by these users. As people use ecommerce websites for buying majority of their products, the reviews, ratings and feedback are of essential importance to many others in the network. The recommender systems use extensively all these ratings, implements an algorithm on this data and generates an effetive mechanism to recommend various products and data that is of interest to the user [6]. The major problem in any social network is the size of the data also called as information overload. RSs are effectively implemented and improved by implementing various techniques of datamining, machine learning algorithms and deep learning methods. Broadly the approaches used in developing RSs are categorised into four types, which include content – based filtering (CB), collaborative based filtering (CF), hybrid – based filtering (HB), and knowledge based filtering.
In collaborative based filtering technique, we try to find out users with similar interests in the social network. Based on their ranking of various products and services utilised, we try to find out users that have the same interests and show each other their preferences to give each other better options to choose from in the social network [17].
A combination of both CF and CB is hybrid based filtering technique. KB filtering is based on authorised knowledge of user preferences and recommendation criteria.
Among the various data mining techniques used in recommender systems, the most used are classification and regression, (1) clustering (2), association rule mining (3), discovery with models (4), outlier detection (5), social network analysis (6), test mining (7), sequential pattern mining (8) and visualization techniques (9) also referred to as distillation of data for human judgment [1].
In the past few years many reviews and surveys are published on RS in social media [13],[16], [20], [22]. This paper attempts to bring out a study on six aspects of social media namely (1) recommendation approaches (2) social media subdomains (3) datasets (4) data mining techniques (5) recommendation types and (6) performance measurements. To sum up the following can be found in this paper

- This research provides a summarised overview of social media and RSs in social media. It also provides a comprehensive survey of recommendation approaches used in the design of RS.

- Various datasets and data mining techniques usedin developing a recommender system have been listed.

The popularly used performance metrics have been summarized.

II. Review and Analysis

In a recent journal, the implicit feedback data was studied. the problem was modelled as an optimization problem. The algorithm is implemented to take the emotions of the users while giving feedback to increase the efficiency of the program, as emotions play a very important role while giving feedback. The drawback of this paper is that it does not implement online recommendations. It just takes the implicit feedback data. The author wants to find a mechanism to merge the implicit feedback with the feedback data displayed on the website as a future study [27]. Most of the times in any recommender system the data, algorithm and the ratings are kept hidden from the user and only the recommendations are displayed to him. Another way of collecting the data is using the smartphones of the data that already has enough data that can be fed into recommender system by categorising it as feedback for movies, restaurants and public places. This paper suggests that the user's smartphone can build its own dataset and make its own recommendations. Here the user has complete power for accessing the information as the mobile is in his control all the time. In this paper the author has tried to design a mobile architecture that collects data and exchanges it between the mobile and the recommender system also highlighting the challenges and opportunities. As a future study for this paper, the author suggests to identify a platform where multiple smartphone data can be collected together are recommendations for groups can be suggested. In this paper, the data is being collected in three ways being, tracking the context data automatically, requesting the service provider to provide the data and also letting the user manually enter the ratings in the mobile phone. However, this papers fails to discuss about the security aspects of clubbing information from multiple smartphones and also the intrusion issues of privacy of the user which is suggested as future study [7].

There are few recommendation models that are based on ratings, reviews and social relationships, in this paper the author tries to propose a recommendation model called Word2Vector that transforms text into vectors. He proposes another model to detect communities which he calls CoDA and for predicting ratings he has another model called LR. He uses the techniques of matrix factorization model (PMF) and improves the accuracy significantly for predicting ratings for users in a social network. Though this model defining is good, it lacks the ability to predict ratings accurately for datasets with sparse friend relationships [29].

There has been a lot of work on recommendations systems for social media unlike just for products and services. In [16], the author tries to tackle the challenge for specifying the various features of the media objects that can be used as useful information to do a recommendation. He also tries to discuss five critical aspects that effect the designing of a model that recommends for social media in a large social network. The author also provides ideas to optimize and improve the social media recommender systems. As a future work the author suggests to investigate the interactions of the various aspects of social media and designs a system prototype or a generalized model development that takes into account all these aspects and gives a personalized recommendation for media on a social networking platform [16].

In [5], the author has tried to device a neural network – based solution to recommend for a group. All the work done before focused on how to recommend for a person in the social networking, but very less work has been done to recommend for a group. When we talk about group recommendations we have to consider the weights of group members and how many people are following others in the group. In [5], the author does just that by giving a neural network based solution. They first formed an attention network to find out the most influential person in the group by dynamically analyzing the data from the group. Then the social followed information is fed into the group to identify individual preferences and ranking and finally they also collect and analyses user – item interaction in the model. The author feels that this is a right way to consider both the collective and individual preferences of users in a group. Extensive experiments on the scope of both macro-level performance comparison and micro-level analyses justify the effectiveness and rationality of our proposed approaches. In this model, the author proposes AGREE which will find the influential person in the group and SoAgree is the people who are following the AGREE users. Both are implemented using the concept of NCF. This model however fails to address or consider the fact that both the user and the group preferences change over time. Also troubles in group like cold-start and data sparsity problems are given as future study in this paper [5].

The author in [8], introduces a novel time – aware recommendation algorithm that handles the problem of overlapping community structures among the users. The users might belong to different communities and are bound to shift among the different communities that becomes a challenge to have a personalized recommendation system. The algorithm tries to minimize the sparsity effects because of this overlapping

community structure of the users. The algorithm is tested on two real world datasets and proofs are given that it overcomes the sparsity effects. A new time aware recommender algorithm is designed that overcomes the problem. It uses time weighted association rules to design effective recommendations and the author has given proofs as to the algorithm being more effective than those that are used in large social networks so far [8].

Ontology – based recommendations systems for e – learning was done by [14]. In the paper, they surveyed all the articles that have used ontology technique to design recommendation systems and have concluded that it is a very effective way of designing a recommendation system. As a future study this paper has suggested to include knowledge collection and representation system with ontology based knowledge to improve on the recommendations provided in a large social networking [14].

The trend has not stopped with just recommendations from existing items but also making modifications to existing items to make them appealing to a particular user is proposed in [24]. The author here has tried to generate a model that would try to understand the preferences of the user from images of fashion dresses. This model can also produce generatively based on the product category and user generate new images that would appeal to the user's personal tastes. This recommender system goes one step ahead is suggesting styles and helps in the designing of new products in the fashion line.

The author has extended previous work on visually-aware recommendation using an end-to-end learning approach based on the Siamese-CNN framework. The resulting model is more accurate. This model can further be used to explore possible fashions and also to modify existing items to generate tailor made items to the individual's preferences tailored to an individual. This paper suggests the usage of recommendation systems for designing purposes as well, not just for recommendations [25].

Basically all recommendation systems work based on the feedback and recommendations given by the different users in the Large Social Network. The major problem comes when an item has no review of feedback or very little feedback and reviews. This problem is called as a cold start problem that can be classified into two categories namely Complete Cold Start (CCS) and Incomplete Cold Start (ICS). Overcoming both these problems has been proposed in [26], where the model combines a time-aware collaborative filtering (CF) model time SVD++ with a deep learning architecture SDAE. The deep learning neural network SDAE is responsible for the extraction of item content features, while the time SVD++ model is responsible for prediction of unknown ratings. It considered temporal dynamics of user preferences and item features. This paper designs a model that effectively tackles the problem for recommendations of CCS and ICS items by taking into account the latent factor model of CF. The author suggests as future work to make two separate recommendation models for CCS and ICS. The author also tries to implement the same model to other products like online music, he has implemented the models on Netflix movies for movies that have a cold start problem [26].

In [11], the author has proposed a novel matrix factorization model with neural network architecture. The author constructed a user and rating matix with explicit and non –preference implicit feedback and designed a new loss function based on binary cross entropy for feedback optimisation. The author has also tested the model on several datasets and evaluated the performance with many existing recommender systems.

III. Recommendations based on Optimization of Events In Large Social Networks

In 2019, Imane et al. [27] have established a social regularization scheme, which has incorporated social network data for benefiting the recommender systems with the trust information among users. Both rating tags (records) and trust were deployed for predicting the missing tags (values) in the arrays of user-items. Particularly, an algorithm was exploited for optimal selection of recommended trust paths and for determining a combined path for producing diverse final recommendations. The adopted scheme was further computed and the investigational outcomes have illustrated the superiority of the introduced scheme over the other existing schemes through experimental analysis.

In 2018, Pablo et al. [20] have introduced a relationship oriented recommender system for an employment and business social network. The adopted scheme was operated by mining the appropriate information from the social network that was further exploited for recommending new job offers and contacts to users. The recommender system utilized the data collected from user profiles, users' actions and job offer descriptions. Subsequently, diverse metrics were deployed for discovering novel ties, which were likely to be converted into relationships.

In 2018, Porcel et al. [2] have introduced "Sharing Notes" that was an intellectual social network, which generated modified recommendations for improving learning and teaching processes. To accomplish this objective, a hybridized recommender system was incorporated that exploited ontology for characterizing the

degrees of trust amongst network users. In addition, fuzzy linguistic modelling was adopted for enhancing the demonstration of the information.
Subsequently, this platform had permitted in offering education to every student based on their circumstance. Finally, the computations have revealed the efficacy of the presented network while working and interacting with it.
In 2018, Yu and Li [25] have established a probabilistic matrix factorization scheme for multiplying social networks depending on joint probability distribution. This approach has examined diverse kinds of distribution function and traditional social networks of user similarity preferences. Subsequently, unified recommendation model was presented based on joint recommendation technique. For validating the effectiveness of the presented scheme, indexes of accuracy and errors were taken into account and their outcomes were found to be feasible and efficient.
In 2019, Flora et al. [9] have implemented a novel recommendation system for big data applications, which was capable of offering recommendations based on the interactions amongst users and the produced multimedia content in one or more social media networks. The adopted approach was based on a "user-centred" model. An investigational operation, was carried out using the data arrived from numerous social media networks and the enhancement of the suggested model was demonstrated in terms of its feasibility.
In 2018, Ogundele et al. [22] have established a novel personalized event recommendation model that deployed the multi-criterion decision making model for ranking the events. In the adopted model, preference designs were constructed for computing the temporal, categorical, geographical, and social influences, and accordingly, a personalized weight was computed for every criterion. In addition, wide-ranging experimentations were performed using the data gathered from "Meetup.com" for evaluating the SoCaST performance. Finally, the outcomes have shown the superiority and practicability of the adopted scheme.
In 2017, Wu et al. [3] have introduced "Kaleido, a real mobile system" for attaining solution for online social recommendation by considering sentimental context. Particularly, a machine learning model was designed for inferring the sentimental pulse of social media. In addition, a cluster-oriented Latent Bias Model (LBM) was offered for mutually training the user's behaviour, social contexts, and location. Finally, the investigational outcomes have revealed the betterment of the adopted scheme in terms of prediction accuracy. This presented approach also enabled the users in achieving speed-up factor of 1,000 against the implementation on smart phones.
In 2017, Seo et al. [28] have established a novel technique for computing the intimacy among the user's in a social circle, like, the friendship strength. Here, a friendship strength- oriented personalized recommendation system was proposed, which recommended the topics on which the users might have interest for analysing the big social data (particularly twitter). The adopted approach has offered accurate recommendations in various environments with different topics. Finally, the results attained from simulation have demonstrated the efficiency of the adopted scheme for maintaining friendship strength.

TABLE I. REVIEW ON TRADITIONAL RECOMMENDATION SYSTEM IN LARGE SOCIAL NETWORKS

Author [Citation]	Adopted Methodology	Features	Challenges
Imane etal. [12]	Dijkstra algorithm	• Portraysthe aggregate paths • Improved accuracy	• Need more consideration on practical situations
Pablo etal. [20]	Case Based Recommendati on model (CBRModel)	• Stable acceptance rate • Portrays varied threshold	• Have to focus more on the independentevaluations.
Porcel et al. [2]	Fuzzy approach	• More flexibility. • Enhanced learning and teaching process.	• Needs analysis on the applications of specific measures.
Yu andLi [25]	Probabilistic matrix factorization scheme (PMF scheme)	• High precision • Enhanced score prediction	• Network correlation has to beconsidered.
Flora etal. [9]	Spearman'sRank Correlation	• Reduced error • Highly accurate	• Analysis could beextended to larger datasets
Ogunde le et al. [22]	Kernel DensityEstimation technique(KD E)	• Better precisionand recall • Determines the best	• Event locations have to be focused more.
Wu etal. [3]	Cluster-Based latent biasmodel (LBM)based method	• Optimal Latency • Better accuracyon prediction	• Need consideration on more media formats
Seo etal. [28]	Topic affinitybased model	• OptimalF1- measure • Reduced error	• Computational time have to be concerned.

IV. Proposed Solution

The study of these papers brings in the learning that any recommender system is built by analyzing the overall reviewsof any activity or place or idea. Based on the reviews given tothese online activities by different users, the recommendation system implements the algorithm and suggests, new users about it.
The first consideration is collecting the data from the social networking, it is always advised to use proper storage structure while collecting data from any social networking site.
The algorithm to be adopted should be based on the application and most importantly on the resources available for the implementation. If the major importance is given to the accuracy of the recommendation, then algorithms like Dijkstra algorithm, PMF scheme, Spearman's Rank Correlation, LBMbased Model are highly accurate algorithms, but the user willhave to compromise on other resources like memory and response time. If the recommendation needs to have the leasterror coefficient or F1 measure, then Topic Affinity based model can be suggested for those recommendations.
A better suggestion of making these recommendations is to take the reviews of various components of an activity. Suppose, the reviews are being taken about a hotel, the variousfeatures would include, hospitality, room service, food, etc. Ifthe user is giving separate reviews for these aspects of the hotel, it would be helpful if these individual reviews for features are taken into consideration instead of taking the overall rating of the hotel. The quality of recommendation would increase tremendously if recommendations are made using reviews for different features individually, instead of taking into consideration the overall reviews.
The results of the review lead to the following list

- There is an increased interest in identifying differenttechniques to design and evaluate a recommender system in social networking as everyone is going online.
- More number of experiments are done on entertainment datasets, like movies which are foundout in 22 among 56 papers. 19 papers used the datasets of general entertainment channels for their implementation. The recommender systems in other social media domains have to improve significantly
- Clustering technique is mostly used for classificationbased on data mining techniques, in most of the papers that were studied for this review. The techniques that were least used are Bayesian Text Classification and Link analysis
- The most highly used dataset for all experimental work in most papers is the MovieLens dataset, a stable benchmark dataset that contains user ratings for twenty-five million movies online. The possibility might be the free access for the dataset online and also its size.
- Most of the studies of Recommender Systems in Large Social Networks are done on Expert systems with Applications. Recommendations should also explore the fields of management and business.

V. Conclusion

This comprehensive study on recommender systems in large social networks, that contains the comprehensive studyof important work done during the time period of 2016 to 2019. The major concentration of this work is to understand thetechniques of providing optimized recommendations for personalized events recommendation to individuals in a large social network. The concept of just recommendations for individuals have been long forgone by providing optimum recommendation solutions to people in Large Social Networks. Optimization of the solutions have become of hugeimportance as the number of solutions available is more because of the sheer size of the social networks that are predominantly available today.
The classification of social media RS research in terms ofoptimization, events, personalized recommendations to individuals in large social networks, provides detail insights for future RS research in social media.
The study of these papers brings in the learning that any recommender system is built by analyzing the overall reviewsof any activity or place or idea. Based on the reviews given tothese online activities by different users, the recommendationsystem implements the algorithm and suggests, new users about it. A better way of making these recommendations is totake the reviews of various components of an activity. Suppose, the reviews are being taken about a hotel, the variousfeatures would include, hospitality, room service, food, etc. Ifthe user is giving separate reviews for these aspects of the hotel, it would be helpful if these individual reviews for features are taken into consideration instead of taking the overall rating of the hotel. The quality of recommendation would increase tremendously if recommendations are made using reviews for different features individually, instead of taking into consideration the overall reviews.

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