Analytical Appraisal of Recommender Systems in E-Commerce

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***Abstract*— In recent years Recommender Systems have evolved to become a major business tools that are transforming the world of E-Commerce. With a growing demand for automated techniques to identify, locate and retrieve products to reduce customer's decision complexity, many large E-Commerce web sites have implemented Recommender Systems that facilitates users to locate relevant products among all available products without any hassle. The Recommender Systems in E-Commerce assists in collection and analysis of data on business and its impact on customers which includes there opinion by providing a valued feedback on the potential influence of E-Business. The Recommender Systems incorporates data mining techniques which assist in gathering knowledge from the behavior and attributes of the users. In this paper we first construct the Recommendation System taxonomy along with explanations to various approaches employed, we then present an assessment as to how Recommender Systems are employed to improve the sales of the E-Commerce site. We conclude with discussing current issues in Recommender systems and Future work that could resolve the issues.**

Keywords- Recommender Systems, Web Usage Mining, Collaborative Recommender Systems, Sentiment analysis

I. INTRODUCTION

Amid a constantly evolving Electronic market, the existence and the constructive stability of the trade and business is dependent on establishing a competitive dominance through effective and aggressive marketing strategies. With the prolific amount of information that is continuously being made available through the electronic media, the web users are unable to take advantage of these resources due to the lack of appropriate tools to utilize. Due to this it has become strenuous for web users to access relevant information productively. Furthermore, the significant increase in the number of websites puts forward a challenging task to organize the contents of the websites to cater to the needs of the users. An effective and broadly used remedy to this is the 'Information filtering' method applied to manage abundant information flow. The fundamental purpose of information filtering is to introduce users to information that would be pertinent to them. A system that facilitates this is called the Recommender System; it is productively used in e-market by emphasizing on customer behavior, generating communities of interest and building trust among users

II. RECOMMENDER SYSTEMS AS AN INSTRUNMENT IN E-MARKET

The rapid growth of the World Wide Web, its effortless access in our daily lives and the subsequent inevitable emergence of e-commerce has led to the development of *recommender systems* [1]. In the recent years, Recommender Systems (RS) have been implemented for various applications such as recommending movies, music, products that a customer is most likely to purchase, associating and recommending web pages of interest, it can also suggest an alternative way of searching for the required information. This information filtering technique can be utilized to predict, if a certain customer will like a particular product or to recognize a set of N products that would be of some interest to the customer (Top recommendations for the user).

Web Mining [2] is the application of data mining techniques that deals with extraction of knowledge from web data, where the web page content or the hyperlink structure or the usage data is used in the mining process. Web Mining can be broadly classified into three categories depending on the data to be mined. They are web content mining [3], web structure mining and web usage mining [4]. In this paper we focus on web usage mining and its application in RS. Web Usage Mining is the implementation of data mining techniques to discover interesting and relevant usage patterns from the web data to comprehend and better serve the needs of web based applications [5][6][7]. It is used for personalization, recommendation system improvement and site exploration by accumulating data from the main server, the client, proxy servers or even obtained from the business data of an organization [8].

III. RECOMMENDER SYSTEMS – TAXONOMY

The Recommender Systems mostly falls into two categories; The Content based Filtering and The Collaborative Filtering. The content based filtering (CBF) algorithms make use of the users profile to identify items that would be of interest to the user. For instance, the algorithm could consider the users age in the profile to recommend the items that were previously purchased by people of same age, it can also make use of the items profile to discover items similar to the once which are of interest to the user, this method is most productively implemented in recommending a list of movies based on the genre desired by the user [9].

The collaborative filtering (CF) algorithm accepts information in terms of ratings given by user for items, products, or web pages and user preferences. It then refers ratings given by other user that are closely similar to the current user and makes apt recommendations. Currently, CF systems are being widely adopted for web recommendation applications. Collaborative filtering systems are realized by two approaches, the first approach is denoted as *user-based*, which is based on the logic that each user must belong to a larger group of users with similar behavior, thus the products purchased by numerous members of the group can be used to form the recommendation list [10] [11]. The second approach, referred to as *model-based* [12], examines the history of purchase information to identify connection between various items. For instance user's purchasing an item occasionally leads to purchase of another item, this relation between items produces the recommendation list.

IV. APPROACHES TO RECOMMENDER SYSTEMS IN E-MARKET

There are two approaches to recommender systems in electronic market, one is based on user's navigational behavior [13] [14] and the other is based on user ratings [15] [16]. The navigational behavior of the user is analyzed based on the pages visited by the current user in a specific session, while the user rating approach is constructed on the ratings

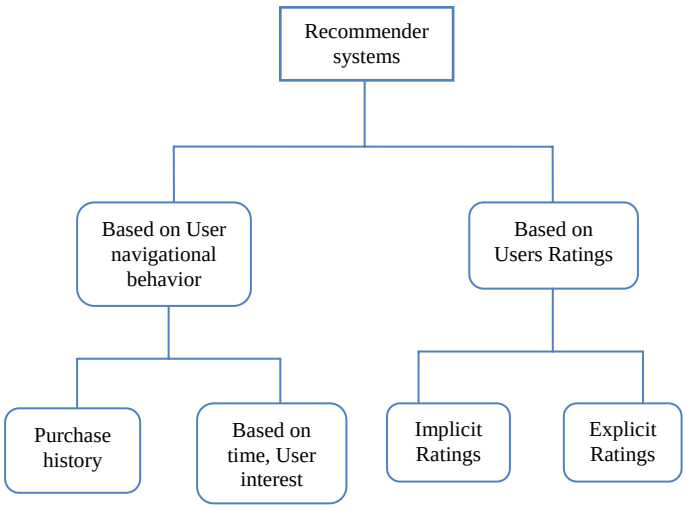

Figure 1. Recommender System categories

provided by the user to a particular product in the E-commerce websites. Fig.1 shows the relation between navigational behavior and users rating which either is of form implicit or explicit. *Explicit Rating* is when the user directly rates the product. For instance the star rating systems on IMDB or Amazon, the thumb up/thumb down rating system on YouTube. *Implicit Rating* is where the users are not asked to provide any direct ratings instead we observe the users behavior. That is the system tracks the user clicks on a particular site in different sessions, with this record of multiple session the system would have developed a sensible profile of the user. For instance Amazon keeps track of what users click, in each session and over time it develops a record of what users likes

V. RECOMMENDER SYSTEMS BASED ON USER RATINGS

In this segment, we discuss notable work in the area of RS based on user ratings. With remarkable development in the domain of Web Mining Engineering, several advanced techniques such as Association rule mining [17], Probabilistic Latent Semantic Analysis [18] [19] [20], the matrix factorization [21] K-Means clustering [22], and K-Nearest Neighbor algorithm [22] [23] are being implemented to address web usage mining. Such techniques is said to refine web based applications such as web personalization and recommendation systems [24]. The web prediction system uses the content based and collaborative based filtering algorithm, where the content-based system typically develops recommendations based on pre-constructed and pre-defined user profiles by contrasting the similarity between the contents of each user profile. While the collaborative filtering develops recommendations by considering the ratings made by the user for products, items or web pages. In this case, if the user explicitly gives ratings for the items, the CF algorithm would be exposed to the insertion of biased data. Hence the researches have proposed an alternative method to web recommendation by extracting knowledge based on the navigational behavior and explicit ratings given by the users.

Though explicit rating system is simple to implement, the ratings given could be subjective and not judged on quantitative data, also the ratings are usually on the scale of 1-10 or 1-5, users tend to rate items without really knowing the significance of what each number in the scale means. These weaknesses can be easily overcome if the ratings are captured from the reviews given by the user. There has been a significant amount of research done to analyze and convert the comments and reviews posted by users on blogs, comment section of a page, feedback form etc. into ratings. There has been exponential rise in use of Blogs in the recent years, it has become a customary way for web users to publish, share and discover content on the World Wide Web. This led researchers to propose a Blog Network Model [25], this model contains four types of explicit links;

comments, citations, blog rolls and trackbacks. Each of these sections together represents the relationship among various bloggers. The comments or review section allows customers to relay there opinion about the product, these shared experiences are convenient source of knowledge about customer preference and tastes. Such implementation in recommender system is highly beneficial for the business [26]. They also proposed a prioritizing mechanism which involves the representation of information in a common format referred to as Ontology Generation, along with computing rating for a product by analyzing the numerous user opinions and selecting the most relevant one to make recommendations in response to the request made by the user. Fig.2 shows the IMDB interface where the section "*People who like this also liked*" makes movie recommendations to the current user based on the preference of other customers, it is also tailored to past views and ratings made by the group of members with similar interests, "*Your rating*" section allows users to give explicit star ratings on the scale of 1-10, the interface also permits users to add their reviews, which serves as a citation to other users.

VI. RECOMMENDER SYSTEMS BASED ON USER REVIEWS

The major issue with RS based on user review is, how to extract information from the opinion given by users in a way that could be comprehended and made use by the computers, as these user reviews are written text in natural language. Due to constant increase in the volume of text

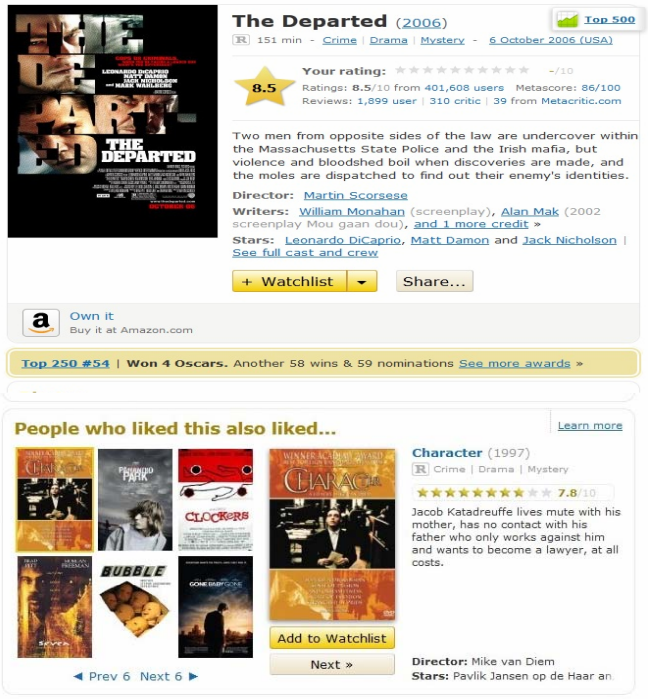

Figure 2. IMDB: suggestions based on user's navigation behavior

data, it is essential to extract previously concealed and potentially beneficial information to properly utilize the enormous source of knowledge, this is achieved through text mining. Text mining is merely the extension of data mining approach to the textual data that is concerned with functions such as, extracting knowledge that is implicitly incorporated in the collection of documents. In general terms, the collection of text expresses the user's opinion, but encodes the information in a form that is hard to decrypt automatically.

Hence numerous approaches involving artificial intelligence have been employed to deal with this problem; however the process of processing the natural language to extract contextual information form user review is still a strenuous task [27]. Hence the researchers proposed incorporating text mining techniques into recommender systems to analyze individual sentences of the user review. This technique classifies sentences into two categories, "contextual" and "preference", where the contextual category groups sentences which comprise information about the context in which the user has expressed his opinion, while the preferences category groups sentences which comprises knowledge about certain aspect of the product that the user has evaluated.

With social media playing a major role in technological advancement allowing web users to disseminate and share knowledge over internet, the information generated here is shared between various users communicating through computer or mobile devices, hence the content is usually textual information, some instances are social networking sites (Facebook, MySpace) Blogs (WordPress, BlogSpot) and Micro blogging sites (Twitter, Google Buzz). For scanning valuable chunks of information, it is required to capture and condense the sentiments from large amounts of data which would help web users to make informed decisions [28]. This led to the development of Sentiment Identification System which employs three different sentiment algorithms. The first algorithm incorporates basic compositional semantic rules. In the second algorithm, to avoid sentiments from being categorized simply as positive and negative, they are employed as a steady score to represent the degree of sentiment. That is, all word scores are computed on the basis of large measure of user reviews. Finally due to the use of special characters in the social networking sites, the third algorithm is used to analyze the negations, emoticons, word positions and domain specific words.

The following section gives the distinctive explanation for each of the three Sentiment algorithms;

Compositional Semantic Rule Algorithm:

The grammar used by users in the social media sites and the part of speech (POS) tagging used is not perfect, hence this algorithm augments some rules to catch these errors; However, it is important to keep in mind that these rules may not always be correct in identifying errors. For instance, consider the sentence "a path for horse *riding*" here the word

riding is a noun, but the words terminating with "ing" are occasionally tagged as verbs instead of nouns. In addition to these rules, there is a need for a method to assess the influence of these words on the polarity of an expression, which is addressed by the second algorithm.

Numeric Sentiment Identification Algorithm:
We face two major problems, while computing the numerical degree of sentiment; 1) how to equate the integer scores to various level of textual sentiment; 2) How to consolidate the scores of various words for each sentence. This algorithm is implemented based on the hypothesis that there are two kinds of phrases that facilitates the association with numerical scores; they are the Adverb-Adjective Noun (AAN) phrase and the Verb-Adverb (VA) phrase. For instance, "a tightly packed suitcase" is an AAN type phrase and "do not spend it all" is a VA type phrase. By this procedure, it is essential to define the significance of the sentiment of each word in each phrase.

Bag of Word and Rule based Algorithm:
Since social media texts usually contain special characters, it is necessary to define some rules to analyze sentiments for these characters. For instance, Facebook and twitter comments often contain representation of facial expressions called emoticons, such as ' ☺ ' to represent positive sentiment or ' ☹ ' to represent negative sentiment, such characters almost constantly expresses the concealed sentiment. However there are instances where the concealed sentiment of the comment or tweet is contradictory to that of the emoticon present, these are usually sarcastic and are very difficult for the algorithm to identify.

VII. SIMULATIONS

For simulations of Recommender Systems based on user ratings we utilize [29] which determines three estimation parameters precision, accuracy, the F1 metric and finally the Mean Absolute Error (MAE), Where;

Precision is the ratio of number of products in the recommendation list purchased by the customer to the total number of products in the recommendation list. Precision is also referred to as the hit rate.

Recall is the ratio of number of products purchased by the customer to the total number of products available in the system.

F1 measure achieves its maximal value when both Recall and Precision are at its maximum. The F1 measure is given as;

$$F1 = \frac{2*Recall*Precision}{Recall + Precision}$$

MAE measures the average magnitude of errors in a set of predictions. It is computed as the average over the verification sample of the total values of the distinction between prediction and the relative observation. MAE is an undeviating score, which indicates that all individual distinction is measured equally in the average.

The theoretical simulation results are validated with the help of following 3 graphs.

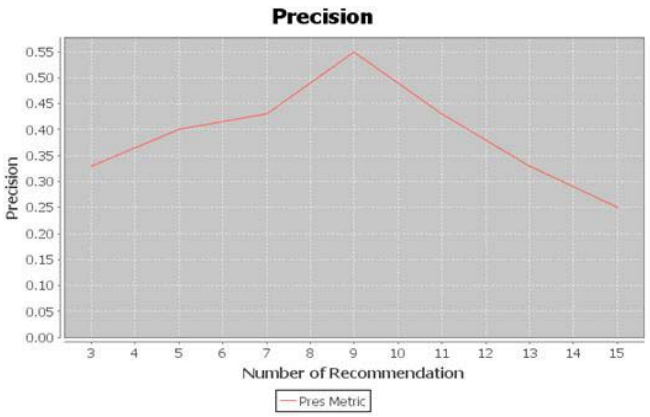

Figure 3. Precision metric

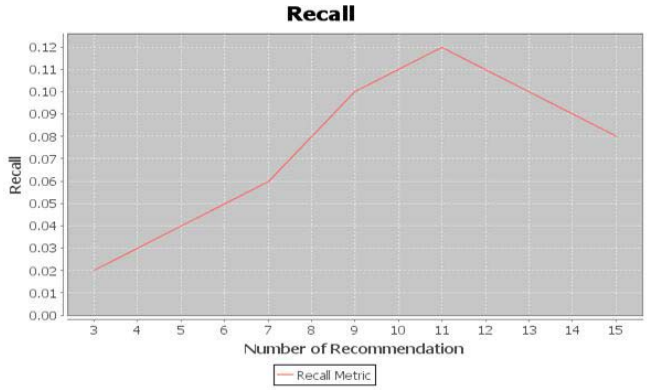

Figure 4. Recall Metric

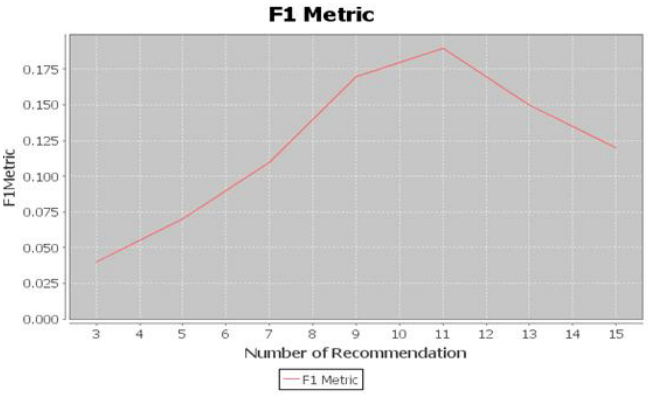

Figure 5. F1 Metric

VIII. CHALLENGES AND FUTURE WORK IN RECOMMENDER SYSTEMS

This section puts forward the challenges faced by the Recommender Systems and the several works in progress to overcome these challenges. The first challenge involves the issue of bringing users together in communities of interest. The second challenge involves privacy concerns of the users. A survey conducted by the kdnuggets [30] reveals that about 75 percent of users regard Recommendation Systems as a compromise to their privacy. Hence, it is essential to develop new tools that are transparent to the web users, by giving them access to the data accumulated by the system, and clarifying the use of these data. The recommender systems suffers from several weaknesses of which the most critical ones with respect to web usage mining are the new user problem, the newly logged item problem, the sparse rating problem, the restricted content analysis problem and the suggestion ability static problem. There have been several measures taken to resolve the new items and new user problems, while research is still being conducted to resolve other issues stated. Recommender Systems is an effective new technology to provide beneficial value to the business. It aids the customers in discovering relevant products at the right time. Recommender Systems are being stressed with large amount of customer data in the existing business database and this will continue to worsen with the increasing amount of customer data generated on the web. Hence it is essential to devise new technologies that could enhance the scalability of the Recommender Systems.

IX. CONCLUSION

The Recommender Systems in E-Commerce using web usage mining is a constantly emerging field that can assist in developing personalized web based systems. In this article we have appraised the application of Recommender System in the area of E-Commerce. This appraisal is intended to serve as source of idea for people currently working on the development of Recommender Systems. A key issue in this area is developing a system with an algorithm to analyze both preferences and sentiments from reviews, once accomplished the algorithm can convert user reviews into ratings which would then make it simple to group users with an efficient clustering algorithm. We hope that the assessments made in this paper will contribute to additional research in the field of Recommender Systems.

REFERENCES

[1] Resnick, Paul and Varian Hal 1997,"Recommender system" Communications of the ACM, March 1997/ vol. 40, No.3.

[2] Oren Etzioni "The World Wide Web: Quagmire or goldmine? "Communication of the ACM, 39(11): 65-68, 1996.

[3] Jiawei han and Michelin Kamber, "Data Mining Concepts and techniques "Morgan Kaufmann, 2001. Publishers 2nd ed. ISBN: 1558609016. ISBN 13:9781558609013.

[4] R Cooley "Web Usage Mining: Discovery and Applicationsof Interesting Patterns from Web data" PhD thesis, University of Minnesota, 2000.

[5] Magdalini Erinaki and Michalis Vazirgiannis "Web Mining for Web personalization", ACM transactions on internet technology (TOIT), 3(1):1–27,2003.

[6] Jian Pei, Jiawei han, Behzad Mortazaviasl and Hua Zhu "Mining access patterns efficiently from web logs" In Pacific-Asia Conference on Knowledge Dis- covery and Data Mining, Pages, 396-407, 2000.

[7] Corin R Anderson "A Machine Learning Approach to Web Personalization "PhD thesis, University of Washington, 2002.

[8] Kosala and Blockeel, "Web Mining Research Survey", SIGKDD: SIGKDD Explorations: Newsletter of the Special Interest Group (SIG) on Knowledge Discovery and Data mining, ACM, 2(1):1- 15, 2000.

[9] R. Liu, V. Keselj," Combined mining of Web server logs and web contents for classifying user navi- gation patterns and predicting users' future requests", Data & Knowledge Engineering, Elsevier, 2007, pp.304-330.

[10] B.M. Sarwar, G. Karypis, J.A. Konstan, J.T. Riedl, "Item-based Collaborative Filtering Recommendation Algorithms", In Proc of WWW 10, 10th International World Wide Web Conference, 2001, pp.285-295.

[11] M. Deshpande and G. Karypis. "Item-based top-n recommendation algorithms". ACM Trans. Inf. Syst., 2004, pp.143-177.

[12] B. M. Sarwar, G. Karypis, J. A. Konstan, and John Riedl, "Analysis of recommendation algorithms for e-commerce", in Proceedings of the 2nd ACM Conference on Electronic Commerce (EC-00), Minneapolis, MN, USA, (October 2000), pp. 158-167.

[13] D Sule Gunduz, M.Tamer Ozsu "A web page prediction model on click-stream tree representation of user behavior", 2003 ACM 1-58113-737.

[14] Amit Bose, Kalyan Beemanapalli, Jaideep Srivastava, S.Sahar "Incorporating Concept Hierarchies into usage mining based Recommendations", WEBKDD'06 ACM.

[15] N.Ampazis "Collaborative Filtering via Concept Decomposition on the Netflix Dataset", ECAI 2008, pp. 26-30, 2008.

[16] F von Reischach, F.Michahelles and A.Schmidt "The Design of Ubiquitous Recommender Systems", MUM '09, ACM 978-1-60558-846-9 09/11 – 2009.

[17] JJ.Sandvig, B.Mobasher and R.Burke "Robustness of Collaborative Recommendation Based On Association Rule Mining" ResSys'07, pp 105-112, ACM - 2007.

[18] G.Xu, Y.Zhang and X,Zhou "A Web recommendation Technique Based on Probabilistic Latent Semantic Analysis", WISE2005, LNCS 3806, pp 15-28, - Springer 2005.

[19] X.Jin, Y.Zhou and B.Mobasher "Web Usage Mining Based on Probabilistic latent Semantic Analysis', KDD'04, ACM 1-58113 2004.

[20] JJ.Sandvig, B.Mobasher and R.Burke "A Survey of Collaborative Recommendation and the Robustness of Model-Based Algorithms" IEEE CCTC on DE - 2008.

[21] Y.Koren, R. Bell and C.Volinsky "Matrix Factorization techniques for Recommender Systems" IEEE computer society, pp 42-49, Aug-2009.

[22] JJ.Sandvig, B.Mobasher and R.Burke "A Survey of Collaborative Recommendation and the Robustness of Model-Based Algorithms" IEEE CCTC on DE - 2008.

[23] B Van Roy and X.Yan "Manipulation Robustness of Collaborative Filtering" April 1, 2010.

[24] B. Sarwar, G. Karypis, J. Konstan and J. Riedl, "Item-based Collaborative Filtering Recommendation Algorithms", Proceedings of the 10th International Conference on the World Wide Web, 285-295, 2001.

[25] Chih-lu lin and Hung-Yu Kao "Blog Popularity Mining Using Social Inter Connection Analysis" Published by IEEE Computer Society July-August 2010.

[26] Silvana Aciar et al "Recommender System Based on Consumer Product Reviews" Proceedings of the 2006 IEEE/WIC/ACM International Conference on Web Intelligence.

[27] Silvana Aciar "Mining Context Information from Consumer's Reviews" Proceedings of the 2008 IEEE/WIC/ACM International Conference on Web Intelligence.

[28] Kunpeng Zhang et al "SES: Sentiment Elicitation System for Social Media Data" Proceedings of the 2011 11th International Conference on Data Mining Workshops.

[29] G. Kowalski, "Information Retrieval Systems: Theory and implementation". Kluwer Academic publisher, 1997.

[30] www.kdnuggets.com.

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