IJCSE International Journal of Computer Sciences and Engineering Open Access
Research Paper Volume-2, Issue-9 E-ISSN: 2347-2693

Radial Basis Neural Network Technique based Web Page Recommendation System

Pushpa C N[1*], Thriveni J[2], Venugopal K R[3] and L M Patnaik[4]

[1*,2,3]Department of CSE, University Visvesvaraya College of Engineering, Bangalore University, Bangalore
[4]Indian Institute of Science, Bangalore

www.ijcaonline.org

Received: Aug/26/2014 Revised: Sep/09/2014 Accepted: Sep/20/2014 Published: Sep/30/2014

***Abstract*—** The exponential explosion of various contents on the Web, made Recommendation Systems increasingly indispensable. Innumerable different kinds of recommendations are made on the Web every day, including movies, music, images, books recommendations, query suggestions, tags recommendations, etc. The proposed system uses the historical browsers data for search key words and provides users with most relevant web pages. All the users' click-through activity such as number of times he visited, duration he spent, his mouse movements and several other variables are stored in database. The proposed system uses this database and process to rank them. We have proposed a Radial Basis Function Neural Network [RBFNN]. The results obtained using the standard measures like precision, coverage and F1 measure on the proposed technique, produces the most relevant results as compared to aggregation technique based method and iPACT method. The RBFNN algorithm shows better prediction precision, coverage and the F1 measure than the iPACT method. The proposed framework can be utilized in many recommendation tasks on the World Wide Web, including expert finding, image recommendations, image annotations etc.

***Keywords*—** *Image Recommendation, Neural Network, Query Suggestion, Recommendation System, Webpage Recommendation.*

I. INTRODUCTION

The growth of Web information is diverse and explosive, the organization and utilization of the information effectively and efficiently has become more and more critical [1]. This is especially important for Web 2.0 related applications where huge data is produced every day by the users. The proposed system is utilizing these data to recommend most relevant queries or web pages to the users. In order to satisfy the information needs of Web users and improve the user experience in many Web applications, Recommender Systems have been well studied in academia and widely deployed in industry. Typically, recommender systems are based on Collaborative filtering [2]-[3] which is a technique that automatically predicts the interest of an active user by collecting rating information from other similar users or items. The underlying assumption of collaborative filtering is that the active user will prefer those items which other similar users prefer [4]. Based on this simple but effective intuition, collaborative filtering has been widely employed in some large, well-known commercial systems. Typical collaborative filtering algorithms require a user-item rating matrix which contains user-specific rating preferences to infer user's characteristics. We have applied this collaborative filtering approach for our proposed method by taking number of parameters to recommend latent semantically relevant web pages to users.

When we are designing a framework for recommendations there are so many challenges that we need to consider. They are (i) it is not easy to recommend latent semantically relevant results to users. (ii) Queries containing ambiguous terms may confuse the algorithms which do not satisfy the information needs of users. (iii) Short queries are more likely to be ambiguous; always the users tend to submit queries consisting of only one or two terms under most circumstances. (iv) In most cases, the reason why users perform a search is because they have little or even no knowledge about the topic they are searching for. In order to find satisfactory answers, users have to rephrase their queries constantly and (v) how to take the personalization feature into account.

Personalization is desirable for many scenarios where different users have different information needs. As an example, Amazon.com has been the early adopter of personalization technology to recommend products to shoppers on its site, based upon their previous purchases. The adoption of personalization will not only filter out irrelevant information to a person, but also provide more specific information that is increasingly relevant to a person's interests.

This paper aims at solving the problems analyzed above using a framework for the recommendations on the Web. The framework for the proposed method is built upon the Radial Basis Neural Network and normalizing the parameters that we are considered, has several advantages: (1) It is a general method, which can be utilized to many recommendation tasks on the Web; (2) It can provide latent semantically relevant results to the original information need. (3) This model provides a natural treatment for personalized recommendations; the empirical results on several parameters

Corresponding Author: *Pushpa C N, pushpacn.uvce@gmail.com*

shows that our proposed framework is effective and efficient for generating high quality recommendations.

Motivation: Though there are many number of Recommendation Systems, but a very few adopted neural network approach to recommend. The Neural Network approach is very efficient method to adopt for recommendation system as this method will provide us better results without many difficulties when compared to other existing methods. This motivates us to use Radial Basis Function Neural Network for web page Recommendation System.

Contribution: We have proposed Radial Basis Function Neural Network algorithm for recommending web pages of user interest. Here we have implemented two systems; Aggregation based Ranking Technique (ART) and Radial Basis Function Neural Network (RBFNN) Technique and compare results with both the systems. A result obtained from RBFNN is more accurate than ART system. The proposed method aims to give more specific web pages to users while removing unwanted web pages based on Radial Basis Function Neural Network.

Organization: The rest of the paper is organized as follows. The Section II provides a brief overview of related research work. Section III presents the Architecture of the Web page Recommendation System and Algorithm, the Section IV demonstrates the empirical result and finally, conclusions are given in Section V.

II. RELATED WORK

Recommendation on the Web is a general term representing a specific type of information filtering technique that attempts to present information items (queries, movies, images, books, Web pages, etc.) that are likely of interest to the users. In this section, we review several work related to recommendation, including collaborative filtering, image recommendation methods, and click-through data analysis.

A. *Collaborative Filtering*

Two types of collaborative filtering approaches are widely studied: neighborhood-based and model-based. The neighborhood-based approaches are the most popular prediction methods and are widely adopted in commercial collaborative filtering systems [5]-[6]. The most analysed examples of neighborhood-based collaborative filtering include user-based approaches [7] and item-based approaches [8].User-based approaches predict the ratings of active users based on the ratings of their similar users, and item-based approaches predict the ratings of active users based on the computed information of items similar to those chosen by the active user. In the model-based approaches, training datasets are used to train a predefined model.

B. *Query Suggestion*

In order to recommend relevant queries to Web users, a valuable technique called query suggestion has been employed by some prominent commercial search engines, such as Yahoo!, Live Search, Ask and Google. The goal of query suggestion is similar to that of query expansion [9]-[12], query substitution [13] and query refinement [14]-[15], all these papers are focus on understanding users search intentions and improving the queries submitted by users. Query suggestion is closely related to query expansion or query substitution, which extends the original query with new search terms to narrow down the scope of the search. Query expansion is different from query suggestion which aims to suggest full queries that have been formulated by previous users so that query integrity and coherence are preserved in the suggested queries [16]. Since most of these methods are only designed for query suggestions, the extensibility of these methods is very limited.

C. *Click-through Data Analysis*

In the field of click-through data analysis, the most common usage is for optimizing Web search results or rankings [17]. In [18], Web search logs are utilized effectively to organize the clusters of search results by (i) learning interesting aspects of a topic and (ii) generating more meaningful cluster labels. In [19], a ranking function is learned from the implicit feedback extracted from search engine click-through data to provide personalized search results for users. Click-through data has been analyzed and applied to several interesting research topics, such as Web query hierarchy building method [20] which consists of two stages: generating candidate queries and determining *generalization/specialization* relations between these queries in a hierarchy. Extraction of class attributes method [21], initially relies on a small set of linguistically motivated extraction patterns applied to each entry from the query logs, and then employs a series of Web-based precision-enhancement filters to refine and rank the candidate attributes.

D. *Image Recommendation*

Image recommendation systems, like Photoree, focus on recommending interesting images to Web users based on users preference. Normally, these systems first ask users to rate some images as they like or dislike, and then recommend images to the users based on the interest of the users. In the academia, few tasks are proposed to solve the image recommendation problems since this is a relatively new field and analysing the image contents is a challenging job. Recently, by employing the Flickr dataset, Yang et al.[22] proposed a context-based image search and recommendation method to improve the image search quality and recommend related images and tags.

However, since it is a context-based method, the computational complexity is very high and it cannot scale to large datasets. The iPACT method [23] is an improved recommendation system using Profile Aggregation based on Clustering of Transactions. While in our framework proposed in this paper, we first ask for text query by the user to search and we recommends most relevant images to

the user. The result of image recommendation shows very promising future.

The literature survey proves that there is a need of web page recommendation system for the user to recommend the useful information related to his query from the web search engine

III. SYSTEM ARCHITECTRE

We have developed the system that recommends both text and images with normalization of parameters in our data base. After normalizing the parameters of web pages, neural network concept is applied to these parameters to obtain good and efficient results that are of interest to the users. The database contains parameters of web pages such as URLs, URLs ID, Reference count, time spent on the URL, number of times the URL is visited, number of times the URL is visited in last twenty four hours, and number of times the URL is visited in last one week. First we have applied normalization for these parameters individually to eliminate redundant and ambiguities in data. After eliminating all irregular data from the database, Radial Basis Function Neural Network (RBFNN) is used to rank the database to the given query. Our recommendation system will search from database for the given input query word and applies RBFNN to rank the list for the input query. Based upon this ranking parameters are analyzed and sorted in descending order. The first three web pages based upon this parameter ranking are considered as recommended web pages and remaining web pages as searched web pages.

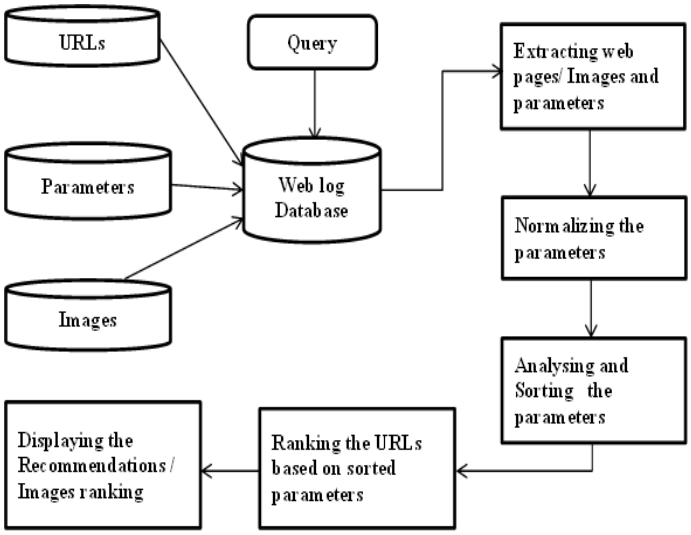

Fig. 1. Architecture of Web Page Recommendation System

The Fig. 1 shows the architecture of Web Page Recommendation system, that includes web log database for which URLs, parameters/images are inputs. The query given by the users to this system search the database and extract the related web pages or image webpages from our database.

Extracted webpages or webpage image parameters are then normalized individually, analysed and sorted in descending order using Aggregation based Ranking Technique System. The output obtained from this method is similar to the query word but the resulting URLs are not regular and recent URLs which would degrade our system performance. We have proposed a RBFNN based system to overcome this problem where the resultant URLs are more specific and are highly relevant and very relevant to the input query given by the user.

The first thirty percent and last thirty percent of the normalized datasets are taken as training datasets and remaining forty percent are taken as test datasets. We will train the RBFNN with training dataset and then test the RBFNN with test data. The output of RBFNN is ranked according to the normalized URLs. The RBFNN gives the output based on training data, the output obtained is of interest to the users and are more relevant to the input query word. The first three results are classified as recommended and rests of the results are classified as search results.

A. Radial Basis Function Neural Network[RBFNN]

The Fig. 2 shows the Radial Basis Function Network (RBFNN). It consists of 3 layers. They are

i) Input layer
ii) Hidden layer
iii) Output layer

The hidden units provide a set of functions that constitute an arbitrary basis for the input patterns:

1) Hidden units are known as radial centres and represented by the vectors c_1, c_2, …….c_h
2) Transformations from input space to hidden unit space is nonlinear whereas transformation from hidden unit space to output space is linear
3) Dimension of each centre for a p input network is pX1.

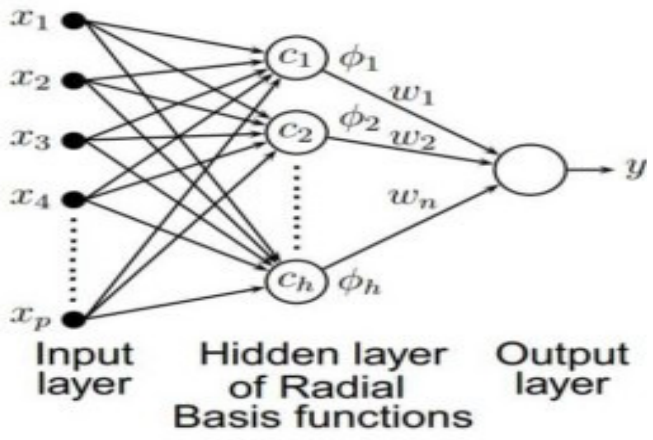

Fig. 2. Radial Basis Function Neural Network

TABLE 1. WEB PAGE RECOMMENDATION ALGORITHM

Input : User query word
Output: Web pages as recommendations and Search Results.

Step 1: Search query word related web pages from the database of URLs.
Step 2: Extract all query related URLs with their parameter.
Step 3: SCount Total Number of Pages extracted in Step 2 (TP).
Step 4: Processing Extracted Web Pages.

a : Normalization.
b : Summing and first Level Scoring.
c : Arrange in Descending Order.
d: Choose Top 30% and Bottom 30% of extracted web pages.
e : Assign 1 to Top 30% and 0 to bottom 30% as Target 2nd Level Score.
f : Make the Training Set with above known second level Scores.
g : Remaining Web Pages will form Test Set.
h : Train RBNN with Training Set.
i : Test RBNN with Test Set.
j : Pass now all data to RBNN to get final (second level) Score for all webpages.

Step 5: Display top 3 scored Web Pages as RECOMMENDATIONS and display all others as Search Result .

The radial basis function in the hidden layer produces a significant non-zero response only when the input falls within a small localized region of the input space. Each hidden unit has its own receptive field in input space. An input vector x_i which lies in the receptive field for centre c_j , would activate c_j and by proper choice of weights the target output is obtained. An algorithm using RBFNN to recommend web pages to users for their input queries is given in Table 1.

IV. EXPERIMENTS AND RESULTS

We have created manually 1000 query words and each query word has 50 URLs, so totally there are 50000 URLs in our database for recommendations. For images we have taken 50 images for each of the 100 image query words, so totally there are 5000 images in our data base. We have conducted experiments on our data base using the proposed system.

Normalization means in one parameter for example in total time spent, the minimum value is 202 and maximum value is 903 but in *href* count minimum value is 2 and maximum value is 200, when we compare these two parameters, the minimum value of total time spent and *href* count are really incomparable. So we set minimum value for all parameters as 0(zero) and maximum value as 1(one) irrespective of their corresponding values. After setting all parameter value to their respective minimum and maximum values, we add all parameter values to get one single value for each URL. This is the 1st level Scoring. Then arrange these values in descending order with their respective URLs.

We have conducted experiments on our data base using the proposed system. The recommendation results of ART and RBFNN system is given in Table 2. The results obtained from the RBFNN are more relevant when compared to ART. This is very clear from the Table II that the results obtained from RBFNN is more recent and it shows the results that are most recently visited web pages. This we checked manually from the parameters that are considered here to recommend web pages.

We have used DePaul University CTI logs file dataset for our experiments; it contains the preprocessed and filtered sessionized data for the main DePaul CTI Web server (http://www.cs.depaul.edu) and compared the measures with the iPACT method. The data is based on a random sample of users visiting this site for a two-week period during April 2002. The original (unfiltered) data contained a total of 20950 sessions from 5446 users. The filtered data files were produced by filtering low support Pageviews and eliminating sessions of size 1.The filtered data contains 13745 sessions and 683 Pageviews. We used the precision, coverage and F1 standard measures in order to evaluate the recommendation effectiveness. Assume that we have active current session *A* taken from the evaluation set and we have *R* as a recommendation set using the prediction engine over the navigation profiles. *W* represents the items that have already been visited by the user in *A*. Precision measures the number of correct relevant recommendation to the total recommendations.

The precision is defined as:

$$\text{Precision}(R, A) = \frac{|R \cap (A-w)|}{|R|}$$

Coverage is the ratio between the number of relevant Web pages retrieved and the total number of web pages that actually belongs to the user session. The coverage measure is defined as:

$$\text{Coverage}(R, A) = \frac{|R \cap (A-w)|}{|(A-w)|}$$

The harmonic mean for both precision and coverage is used and defined as F1 measure:

$$F1(R,A) = \frac{2 \times \text{Precision}(R, A) \times \text{Coverage}(R, A)}{\text{Precision}(R, A) + \text{Coverage}(R, A)}$$

The F1 measure attains its maximum value when both accuracy and coverage are maximized. Finally, for a given prediction thresholds, the mean overall sessions in the evaluation set is computed as the overall evaluation score for

each measure. Table 1 depicts the Precision, Coverage and F1 performance measurements for the proposed RBFNN and iPACT method with various recommendation thresholds for the recommendation score.

TABLE 2: Precision, Coverage and F1 experimental values for RBFNN and iPACT

Threshold	Precision		Coverage		F1 measure	
	iPACT	RBFNN	iPACT	RBFNN	iPACT	RBFNN
0.1	0.562	0.574	0.6294	0.631	0.5937	0.601152
0.2	0.572	0.5798	0.6294	0.635	0.5993	0.605654
0.3	0.564	0.568	0.6441	0.654	0.6013	0.607974
0.4	0.55	0.56	0.6759	0.68	0.6064	0.614194
0.5	0.59	0.589	0.604	0.61	0.5969	0.599316
0.6	0.62	0.632	0.5963	0.599	0.6079	0.615058
0.7	0.642	0.654	0.532	0.54	0.5818	0.591558
0.8	0.67	0.68	0.5701	0.585	0.616	0.628933
0.9	0.693	0.712	0.5503	0.56	0.6134	0.626918
1.0	0.73	0.743	0.506	0.512	0.5977	0.606241

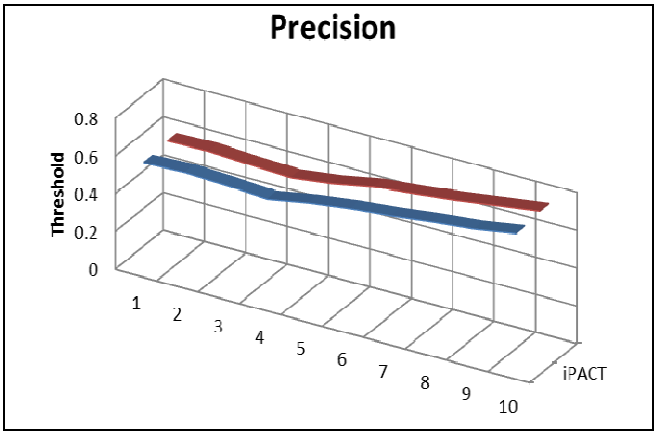

Fig 3. Comparision of Precision values with RBFNN and iPact Method

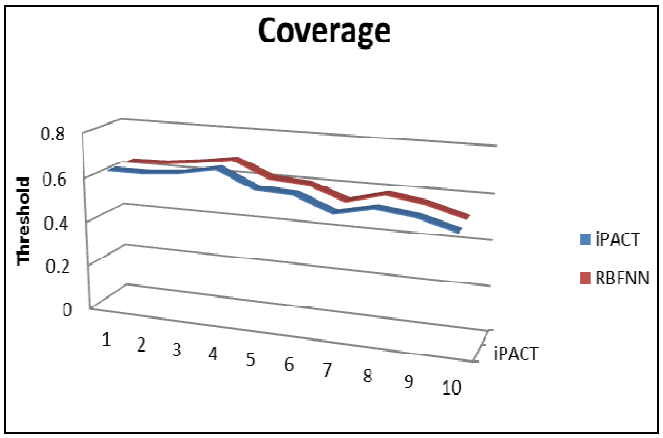

Fig 4. Comparision of Coverage values with RBFNN and iPact Method

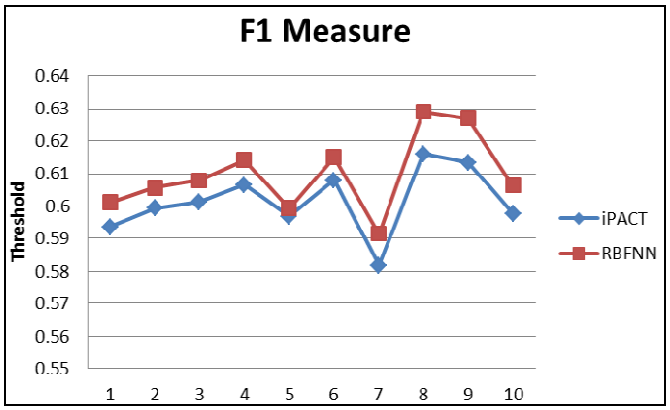

Fig 5. Comparision of F1 Measure values with RBFNN and iPact Method

The Figures 3, 4 and 5 shows the comparison values of Precision, Coverage and the F1 Measures between RBFNN and iPact Methods. TABLE 3 shows the results of RBFNN and ART methods of different query words.

TABLE 3. Recommendation Results of ART and RBFNN

Query Word	Aggregation based Ranking Technique (ART)	Radial Basis Neural Network (RBFNN)
Facebook	http://www.forbes.com/companies/facebook https://en-gb.facebook.com/youtube http://www.facebook.com/ieeeuvce	http://www.facebook.com http://www.facebookstories.com http://www.en.wikipedia.org/wiki/Facebook
UVCE	http://gopuc.com/uvce-review-by-students/ http://www.infinitecourses.com/ http://www.uvce.ac.in/content/uvce	http://www.uvce.ac.in/ http://www.uvcebangalore.batchmates.com http://www.uvce.ac.in/content/uvce
YouTube	http://www.youtube.com/music http://www.youtube.com/user/YouTubeMoviesIN http://www.youtube-global.blogspot.in	http://www.youtube.com/ http://www.youtube.com//user/Apple http://mashable.com/category/youtube.com
Java	http:// oreilly.com/java http://www.java.com/en/ http://www.javaworld.com/	http://www.javaworld.com// http://dictionary.reference.com/browse/java http://www.java.com/en
Job	http://www.findjobsinfo.com/ http://jobsearch.monsterindia.com/search http://dictionary.reference.com/browse/job	http://www.timesjobs.com/ http://www.monsterindia.com/jobs http://www.indeed.co.in/jobs
Fitness	http://www.mensfitness.com/ http://en.wikipedia.org/wiki/Fitness_(biology) http:// en.wikipedia.org/wiki	http://tr.fitness.com http://en.wikipedia.org/wiki/Fitness_(biology) http://www.fitness.com.au
Flowers	http:// www.2flowers.com http:// flowerdelivery.com http:// www.globalflowerdelivery.com	http://www .flower.com http:// www.a1delhiflowers.com http:// www.a1bangaloreflowers.com
Wedding	http:// www. weddingchannel.com http:// www. indianweddingsite.com http://en.wikipedia.org/wiki/Wedding	http:// www.wedding.com.au http:// www.mywedding.com http:// www.1weddingsource.com
Camera	http://www.justdial.com/Kolkata/nikon-camera-dealer hhttp://www.amazon.com/Camera-Photo-Film-Canon-Sony/b?ie=UTF http://www.infibeam.com/Cameras	http://www.camera.org http://www.camera-camera.com http://dictionary.reference.com/browse/camera

The parameters that are considered here to recommend web pages are checked manually. The Fig. 3 shows the accuracy comparisons by five different experts for different methods based on the number of suggestions returned for text recommendations

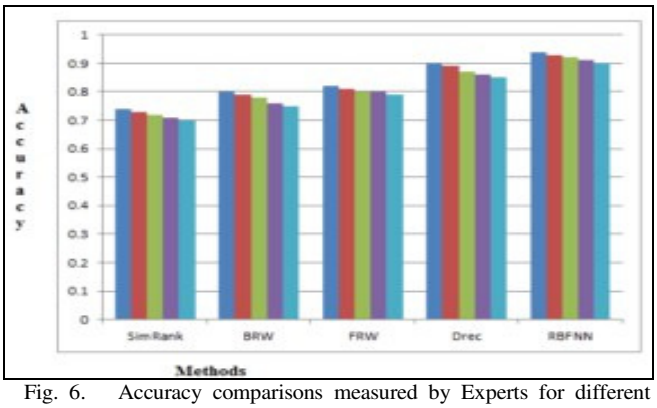

Fig. 6. Accuracy comparisons measured by Experts for different methods for Text recommendations

For images we conducted experiments using Neural Network technique only. As image recommendation is new area, it is very difficult to recommend images like texts, so the image recommendation is a very challenging job nowadays.. The proposed RBFNN recommends the first three images that are most and recently viewed images and other images are considered as searched images. The image recommendation from the RBFNN is shown in the Fig. 7, 8 and 9 for the query words *Horse, Fruit* and *Human* respectively. The proposed RBFNN recommends the first three images that are most and recently viewed images and other images are considered as searched images.

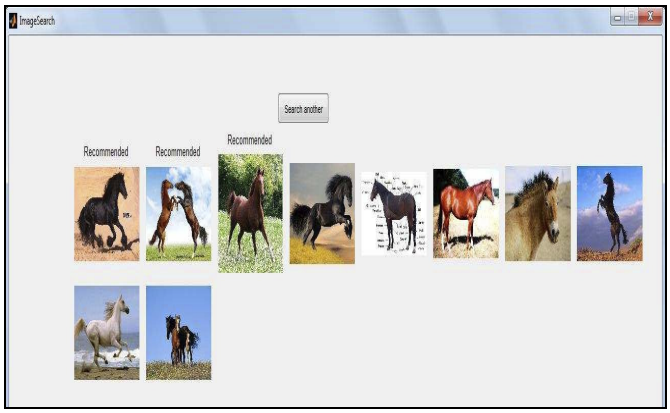

Fig. 7. Images showing for the query word Horse

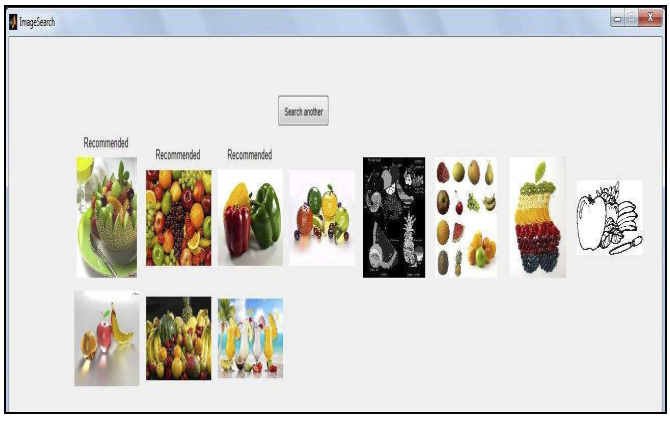

Fig. 8. Images showing for the query word Fruit

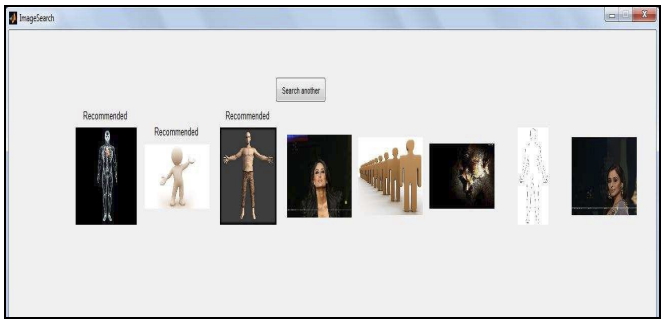

Fig. 9.. Images showing for the query word Human

The Fig. 10 shows the accuracy comparisons by five different Experts for different methods based on the number of suggestions returned for image recommendations.

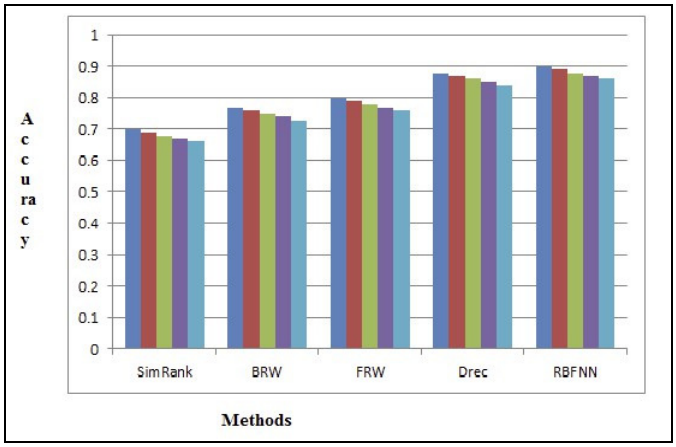

Fig. 10. Accuracy comparisons measured by Experts for different methods for Image recommendations

V. CONCLUSIONS

In this work, we have implemented two types of recommendation techniques and most relevant datasets collected through click-through behavior of users. Most of the existing recommendation systems are built by the ratings data given by users even though reliability of such ratings is not known. However in this work, we capture the parameters such as number of times he visited the page, duration he spent, most recent visits etc., which overcomes errors in ratings data. The proposed systems built with both the techniques, i.e., Aggregation based Ranking Technique and Radial Basis Function Neural Network based ranking technique. The System built with Radial Basis Function Neural Network yields most relevant results to the query word as compared to aggregation based technique. By comparing Precision, coverage and F1measures the RBFNN method yields better results than iPact method.

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AUTHORS PROFILE

Pushpa C N has completed Bachelor of Engineering in Computer Science and Engineering from Bangalore University, Master of Technology in VLSI Design and Embedded Systems from Visvesvaraya Technological University. She has 14 years of teaching experience. Presently she is working as Assistant Professor in Department of Computer Science and Engineering at UVCE, Bangalore and pursuing her Ph.D in Web Mining.

Thriveni J has completed Bachelor of Engineering, Masters of Engineering and Doctoral Degree in Computer Science and Engineering. She has 4 years of industrial experience and 20 years of teaching experience. Currently she is an Associate Professor in the Department of Computer Science and Engineering, University Visvesvaraya College of Engineering, Bangalore. Her research interests include Networks, Data Mining, Distributed Systems, Cloud Computing and Biometrics. She has authored one book and has more than 50 research papers to her credit.

Venugopal K R is currently the Principal, University Visvesvaraya College of Engineering, Bangalore University, and Bangalore. He obtained his Bachelor of Engineering from University Visvesvaraya College of Engineering. He received his Master's degree in Computer Science and Automation from Indian Institute of Science Bangalore. He was awarded Ph.D. in Economics from Bangalore University and Ph.D. in Computer Science from Indian Institute of Technology, Madras. He has a distinguished academic career and has degrees in Electronics, Economics, Law, Business Finance, Public Relations, Communications, Industrial Relations, Computer Science and Journalism. He has authored more than 50 books on Computer Science and Economics, which include Petrodollar and the World Economy, C Aptitude, Mastering C, Microprocessor Programming, Mastering C++ and Digital Circuits and Systems etc. During his Four decades of service at UVCE. He has more than 400 research papers to his credit. His research interests include Computer Networks, Wireless Sensor Networks, Parallel and Distributed Systems, Digital Signal Processing and Data Mining.

L M Patnaik is a Honorary Professor in Indian Institute of Science, Bangalore. During the past 35 years of his service at the Institute he has over 700 research publications in refereed International Journals and refereed International Conference Proceedings. He is a Fellow of all the four leading Science and Engineering Academies in India; Fellow of the IEEE and the Academy of Science for the Developing World. He has received twenty national and international awards; notable among them is the IEEE Technical Achievement Award for his significant contributions to High Performance Computing and Soft Computing. His areas of research interest have been Parallel and Distributed Computing, Mobile Computing, CAD for VLSI circuits, Soft Computing and Computational Neuroscience.