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Research Article

Web Page Recommendation System using Self Organizing Map Technique

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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 and tags recommendations, etc. The paper aims to provide the users with most relevant results (URL's) to the respective query word. The developed System uses the K-means technique and the Modified System uses the Self-Organizing Map technique. Both the methods use historical browsers data for search key words and provide users with most relevant web pages. All users click-through activity such as number of times he visited, duration he spent, and several other variables are stored in database. The Systems use this database and process to cluster and rank them. The results obtained shows that the Self Organizing Map technique produce most relevant results for a particular query word compared to K-means technique. The Self Organizing Map technique is the optimal method for Web Page recommendations. The Modified System can be utilized in many recommendation tasks on the World Wide Web, including expert finding, image recommendations, image annotations, etc. The experimental results show the promising future of our work.

Keywords: *Web Page Recommendations, K-Means Technique, Self-Organizing Map Technique.*

1. Introduction

One of the application areas of data mining is the *World Wide Web* (WWW or Web), which serves as a huge, widely distributed, global information service for every kind of information such as news, advertisements, consumer information, financial management, education, government, e-commerce, health services, and many other information services. The Web contains a rich and dynamic collection of hyperlink information, Web page access and usage information, providing sources for data mining. The amount of information on the Web is growing rapidly, as well as the number of Web sites and Web pages per Web site. Consequently, it has become more difficult to find relevant and useful information for Web users. The requirement for predicting user needs in order to guide the user in a Web site and improve the usability of the Web site can be addressed by recommending pages to the user that are related to the interest of the user at that time. The growth of Web information is diverse and volatile, the organization and utilization of the information effectively and proficiently has become more and more critical (Hao Ma *et al*, 2012). This is especially important for Web 2.0 related applications where enormous 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 broadly deployed in industry. Typically, recommender systems are based on Collaborative Filtering (A. S. Das *et al*, 2007; J. L. Herlocker *et al*, 2004) 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 (H. Ma *et al*,, 2007). Based on this simple but useful 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 users' 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: 1) The first challenge is that it is not easy to recommend latent semantically relevant results to users. Take Query Suggestion as an example; there are several outstanding issues that can potentially degrade the quality of the recommendations, they are: i) The ambiguity which commonly exists in the natural language. Queries containing ambiguous terms may confuse the algorithms which do not satisfy the

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information needs of users. ii) Another consideration is that users tend to submit short queries consisting of only one or two terms under most circumstances, and short queries are more likely to be ambiguous. iii) 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 the satisfactory answers, users have to rephrase their queries constantly. 2) The next challenge is how to take into account the personalization feature. 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 developed system recommends text with normalization of parameters from the database. After normalizing the parameters of web pages, we have applied K-means clustering technique to these parameters to obtain good and efficient results that are of interest to the users. The database contains query word, for each query word we manually collected fifty URLs, for each URL, the parameters that are considered here for the proposed system are 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. Normalization is done on these parameters individually to eliminate redundant and ambiguities in data. After eliminating all irregular data from the database, we rank the database based on these clustered results for the given input query. Based on these ranking, analyses and sorting, these parameters are written in descending order. We have considered first three web pages based upon this parameter ranking as recommended web pages and remaining web pages as searched web pages.

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 provide better results without many difficulties when compared to other existing methods. This motivates us to use Radial basis neural network in this paper.

Contribution: We have proposed a Self-Organizing Map Technique for recommending web pages of user interest. Here we have implemented recommendation systems using K-means Technique and the Self-Organizing Map (SOM) Technique and compared the results. A result obtained from SOM Technique is more accurate than K-means clustering technique system. The proposed method aims to give more specific web pages to users while removing unwanted web pages based on Self-Organizing Map Technique.

Organisation: The rest of the paper is organized as follows. The Section 2 provides a brief overview of related research work. Section 3 presents the Architecture of the Web page Recommendation System and Algorithm, the Section 4 demonstrates the empirical result and conclusions are given in Section 5.

2. Related Works

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 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.

2.1 Collaborative Filtering

Two types of collaborative filtering approaches are widely studied: neighbourhood-based and model-based. The neighbourhood-based approaches are the most popular prediction methods and are widely adopted in commercial collaborative filtering systems (G. Linden *et al*, 2003; P. Resnick *et al*, 1994). The most analysed examples of neighborhood-based collaborative filtering include user based approaches (J. L. Herlocker *et al*, 1999) and item-based approaches (G. Linden *et al*, 2003). 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.

2.2 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 (P. A. Chirita *et al*, 2007; J. Xu *et al*,, 1996) query substitution (R. Jones *et al*, 2006) and query refinement (R. Kraft *et al*, 2004; B. Velez *et al*,1997), all these papers 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 (W. Gao *et al*, 2007). Since most of these methods are only designed for query suggestions, the extensibility of these methods is very limited.

2.3 Click-through Data Analysis

In the field of click-through data analysis, the most common usage is for optimizing Web search results or rankings (E. Agichtein *et al*, 2006). In([X. Wang *et al* ,

2007), 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 (T. Joachims *et al*, 2007), 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 analysed and applied to several interesting research topics, such as Web query hierarchy building method (D. Shen *et al*, 2007) which consists of two stages: generating candidate queries and determining *generalization/specialization* relations between these queries in a hierarchy. Extraction of class attributes method (M. Pasca *et al*, 2007), 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.

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/her query from the web search engine.

3. System Architecture

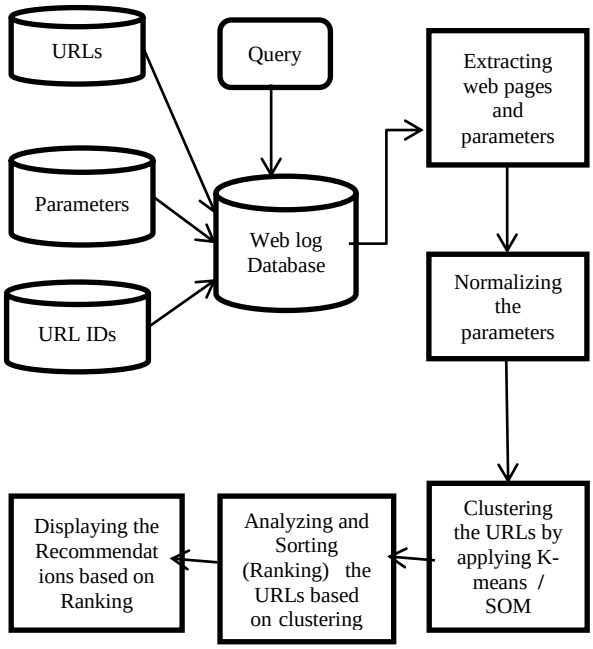

Fig. 1 Architecture of Webpage Recommendation System

The Fig. 1 shows the Architecture of the Webpage Recommendation system, contains web log database for which URLs collected from the web for the respected query word, parameters, these are numerical values for the corresponding URLs, taken based on the previous user's data taken from the respective URLs, are inputs to this database, query given by the users to search the data base and extract the related web pages from the datasets. Extracted webpage parameters are then normalized individually, clustered, analyzed and sorted. First, we rank the output of K-means according to the highly used and frequently visited URLs. 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.

Next the same architecture is used to recommend the web pages of user's interest, but we have used Kohonen Neural Network algorithm in SOM Technique and rank the output of SOM according to the highly used and frequently visited URLs. 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.

K-Means Clustering Technique

Clustering is the task of grouping a set of objects in such a way that objects in the same group (called cluster) are more similar (in some sense or another) to each other than to those in other groups (clusters). It is a main task of exploratory data mining, and a common technique for statistical data analysis used in many fields, including machine learning, pattern recognition, image analysis, information retrieval, and bioinformatics. In K-means clustering, clusters are represented by a central vector, which may not necessarily be a member of the data set. When the number of clusters is fixed to k, k-means clustering gives a formal definition as an optimization problem: find the cluster centres and assign the objects to the nearest cluster centre, such that the squared distances from the cluster are minimized. K-means is one of the oldest and most commonly used clustering algorithms. It is a prototype based clustering technique defining the prototype in terms of a centroid which is considered to be the mean of a group of points and is applicable to objects in a continuous n-dimensional space. K-Means is a simple learning algorithm for clustering analysis. The goal of K-Means algorithm is to find the best division of n entities in k groups, so that the total distance between the group's members and its corresponding centroid, representative of the group, is minimized.

K-Means Algorithm

K-means analysis is a divisive and non-hierarchical method of defining clusters. This is an iterative process, which means that at each step the membership of each individual in a cluster is revaluated based on the current centres of each existing cluster. This is repeated until the desired number of clusters (or the number of individuals) is reached. Thus, it is non-hierarchical because an individual can be assigned to a cluster, and reassigned at any later stage in the analysis. Clusters are defined based on Euclidean distances so as to reduce the variability of individuals within a cluster, while maximizing the variability between clusters.

Drawbacks of K-Means Clustering Technique

The System built with K-means technique, does not yield most relevant results to the query word. K-means has problems when clusters are of differing Sizes, Densities, Non-globular shapes and has Problems with outliers. Difficulty in comparing quality of the clusters produced.

Different initial partitions can result in different final clusters. Hence there is a lot of scope for the improvement in this web recommendation system, by using Kohonen Neural Network Technique (SOM).

Self-Organizing Map Technique

The Kohonen Self-Organizing Feature Map (SOFM or SOM) is a clustering and data visualization technique based on a neural network viewpoint. As with other types of centroid-based clustering, the goal of SOM is to find a set of centroids (reference or codebook vector in SOM terminology) and to assign each object in the data set to the centroid that provides the best approximation of that object. In neural network terminology, there is one neuron associated with each centroid. As with incremental K-means, data objects are processed one at a time and the closest centroid is updated. Unlike K-means, SOM impose a topographic ordering on the centroids and nearby centroids are also updated. The processing of points continues until some predetermined limit is reached or the centroids are not changing very much. The final output of the SOM technique is a set of centroids that implicitly define clusters. Each cluster consists of the points closest to a particular centroid. SOM is a clustering technique that enforces neighborhood relationships on the resulting cluster centroids. Because of this, clusters that are neighbors are more related to one another than clusters that are not. Such relationships facilitate the interpretation and visualization of the clustering results. Indeed, this aspect of SOM has been exploited in many areas, such as visualizing Web documents or gene array data.

A self-organizing map consists of components called nodes or neurons. Associated with each node is a weight vector of the same dimension as the input data vectors and a position in the map space.

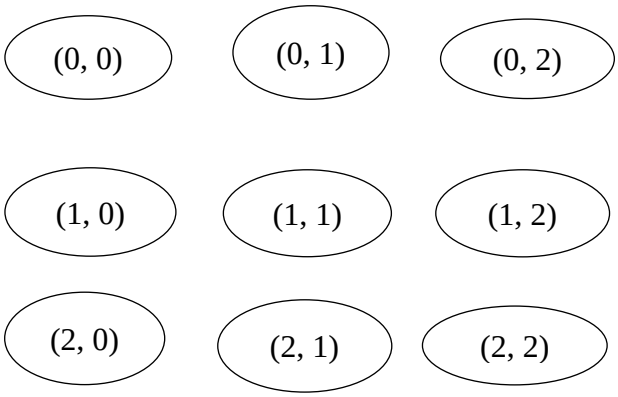

Fig. 2 Two-Dimensional 3-by-3 rectangular SOM Neural Network

The usual arrangement of nodes is a two-dimensional regular spacing in a hexagonal or rectangular grid. The self-organizing map describes a mapping from a higher dimensional input space to a lower dimensional map space. The procedure for placing a vector from data space onto the map is to find the node with the closest (smallest distance metric) weight vector to the data space vector. While it is typical to consider this type of network structure as related to feed forward networks where the nodes are visualized as being attached, this type of architecture is fundamentally different in arrangement and motivation. Useful extensions include using toroidal grids where opposite edges are connected and using large numbers of nodes. It has been shown that while self-organizing maps with a small number of nodes behave in a way that is similar to K-means, larger self-organizing maps rearrange data in a way that is fundamentally topological in character.

Kohonen Neural Network Technique

The developed system recommends text with normalization of parameters from the data base. After normalizing the parameters of web pages, we have applied SOM (Kohonen Neural Network Technique) to these parameters to obtain good and efficient results that are of interest to the users. After eliminating all irregular data from the database, we rank the database based on these clustered results for the given input query. This framework is built upon the Kohonen neural network (SOM) and normalizing the parameters that we have 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. Based on these ranking, analyses and sorting, these parameters are written in descending order. We have considered first three web pages based upon this parameter ranking as recommended web pages and remaining web pages as searched web pages.

SOM Algorithm

A distinguishing feature of SOM is that it imposes a topographic (Special) organization on the centroids (Neurons). Fig. 2 shows an example of a two-dimensional SOM in which the centroids are represented by nodes that are organized in a rectangular lattice. Each centroid is assigned a pair of coordinates (i, j). Sometimes, such a network is drawn with links between adjacent nodes, but can be misleading because the influence of one centroid on another is via a neighborhood that is defined in terms of coordinates, not links. There are many types of SOM neural networks, but it will be focus on to two-dimensional SOMs with a rectangular or hexagonal organization of the centroids.

Even though SOM is similar to K-means, there is a fundamental difference. Centroids used in SOM have a predetermined topographic ordering relationship. During the training process, SOM uses each data point to update the closest centroid and centroids that are nearby in the topographic ordering. In this way, SOM produces an ordered set of centroids for any given data set. In other words, the centroids that are close to each other in the SOM grid are more closely related to each other than to the centroids that are farther away. Because of this constraint, the centroids of a two-dimensional SOM can be viewed as lying on a two-dimensional surface that tries to fit the n-dimensional data. The SOM centroids can also be thought of as the result of a nonlinear regression with

Table 1: SOM Algorithm

Step 1: Initialize the centroids.
Step 2: repeat
Step 3: Select the next object.
Step 4: Determine the closest centroid to the object.
Step 5: Update this centroid and the centroids that are close, i.e., in a specified neighborhood.
Step 6: until the centroids don't change much or a threshold is exceeded.
Step 7: Assign each object to its closest centroid and return the centroids and clusters.

Table 2 Comparisons of web page recommendation system using K-means and SOM techniques

Query Word	Recommendations from K-means Technique	Recommendations from SOM Technique
Facebook	http://www.insidefacebook.com https://www.github.com/facebook/xhprof http://www.facebookstories.com	https://www.facebook.com https://www.twitter.com/facebook http://www.en.wikipedia.org/facebook
UVCE	http://gopuc.com/uvce-review-by-students/ http://www.infinitecourses.com/ http://www.uvce.ac.in/content/uvce	http://www.uvcebangalore.org 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/e
Job	http://www.findjobinfo.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/wik	http://tr.fitness.com http://en.wikipedia.org/wiki/Fitness 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 http://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

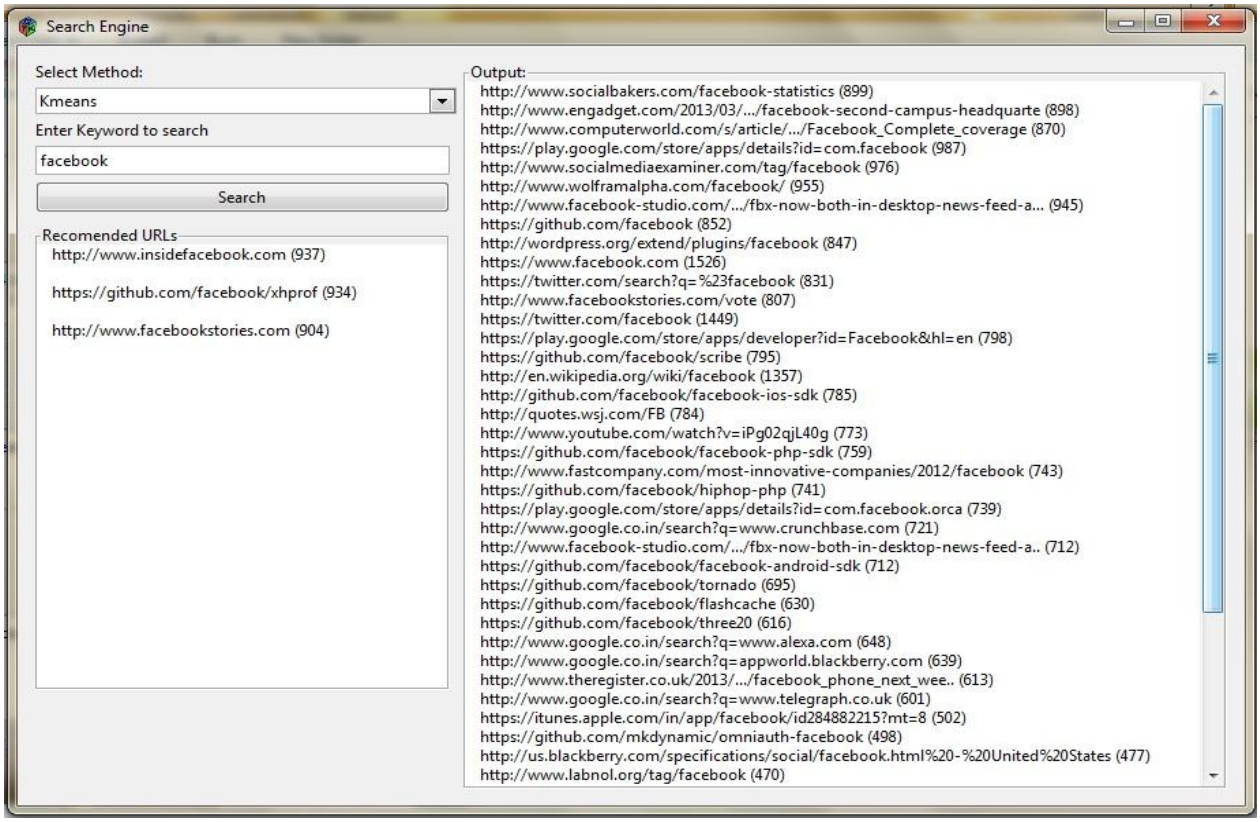

Fig. 3 Screen shot of the Recommendation system using K-means Technique for the query word 'Facebook'

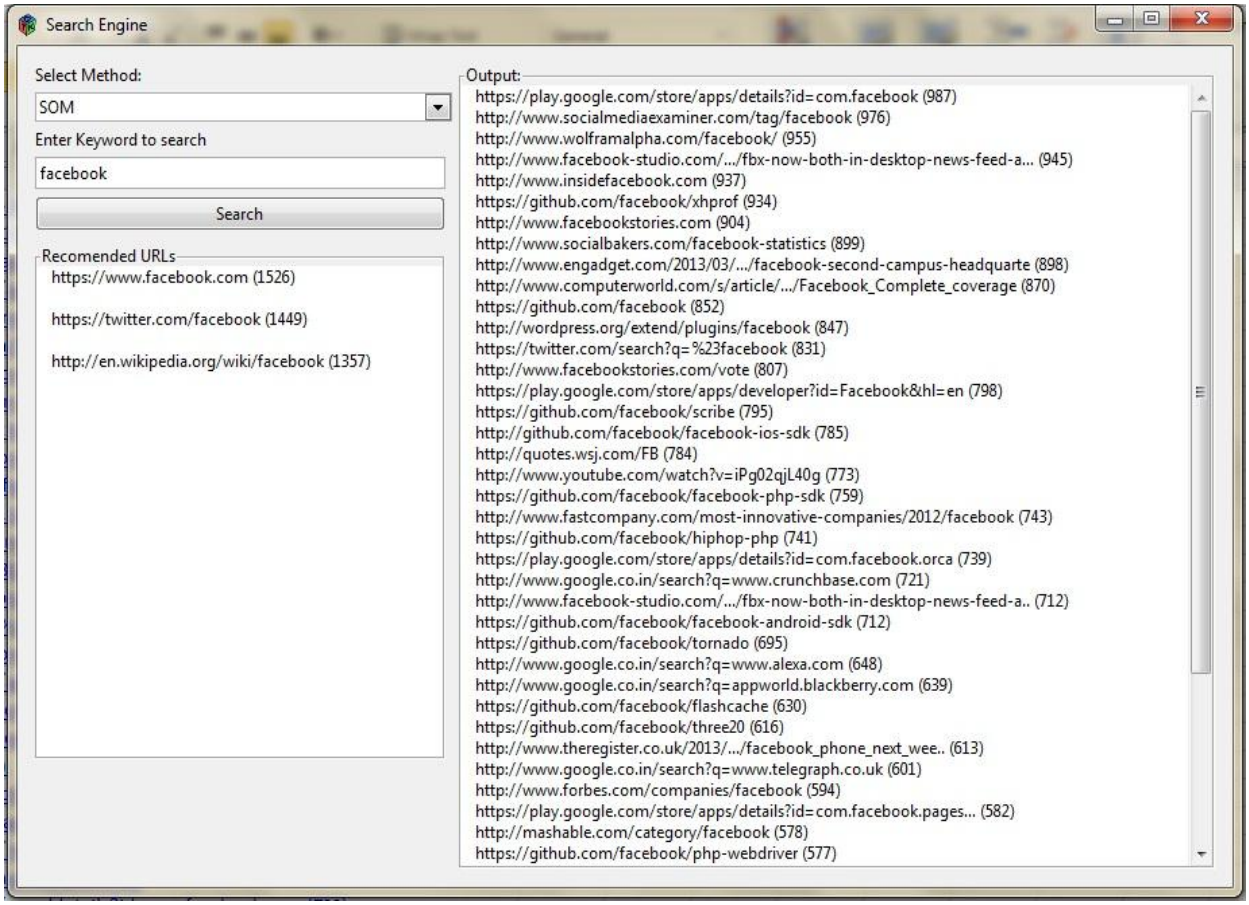

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Fig. 4 Screen shot of the Recommendation system using SOM Technique for the query word 'Facebook'.

respect to the data points. At a higher level, clustering using the SOM technique consists of the steps described in Table 1.

4. Results

We have created manually 100 query words, for each query word we have taken fifty URLs, so totally we have 5000 URLs in our database for recommendations. The Fig. 3 and Fig. 4 show the Screen Shots of recommendation system for the query *'facebook'* for both K-means technique and the SOM technique respectively. In figures, we can see the recommendations to the left side of screenshot which are most relevant to the query word and to the right side the other results which are relevant to the query word.

We experimented our database on the Recommendation systems using K-means and Kohonen Neural Network Technique (SOM). The few comparison results are shown in the Table 2. The SOM technique gives better results compared the K-means clustering Technique.

Conclusions

In this work, we have implemented two techniques for webpage recommendation system 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., K-means clustering Technique and Kohonen Neural Network (SOM) technique. The System built with Kohonen Neural Network (SOM) technique yields most relevant results to the query word as compared to K-means clustering Technique.

In future work, different kinds of recommendations can be made like Movies, Music, Images, Books, Query suggestion, Tags recommendations. Here the challenge is how to take into account the personalization feature. . The adoption of personalization will not only filter out irrelevant information to a person, but provide more specific information that is increasingly relevant to a person's interests.

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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.

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