

# Existing Trends and Techniques for Web Personalization

Rajesh K Shukla  
Research Scholar  
RGPV, Bhopal India

Dr Sanjay Silakari  
Professor and Head CSE  
UIT, RGPV Bhopal India

Dr P K Chande  
Group Director  
Truba Group of Institutes Indore India

## ABSTRACT

In the recent few decades the World Wide Web has become the biggest and most popular way of communication and information dissemination. World Wide Web is a huge repository of web pages and links and the volume of information available on the internet is increasing exponentially as approximately one million pages are added daily. The existence of such abundance of information, in combination with the dynamic and heterogeneous nature of the web, makes web site exploration a difficult process for the average end user. So in spite of the fact that users are provided with more information and service options, the average end users may not get the “right” information only, in what they are interested in. with the explosive growth of the number and the complexity of information resources and the advent of e-services; it has become more difficult to access relevant information from the Web. One of the recent advances throughout this decade has been the evolution of the web personalization to address the requirement of effective web navigation and now the web personalization has become an indispensable tool for both Web-based organizations and for the end users to deal with the content overload. In this paper we highlight a comprehensive overview of the personalization process and various web personalization Techniques and the significance of studying the evolving nature of the Web personalization because most major internet companies are implementing their personalization systems. Since a lot of

work has already been done and there is still much more to do, we are focusing here on what we have currently in this area, particularly the techniques to highlight the prominent features to provide support for web personalization.

## INTRODUCTION

Once Tim Berners-Lee of the Conseil European Pour Recherches Nucleaires (CERN) announced the World Wide Web (WWW) in 1991, the World Wide Web has become the most popular way of communication and the huge repository of information that can come either from the Web pages publicly available, or from the web usage logs daily collected by all the servers around the world to record the users accesses. The WWW has been adopted by the mass market more quickly than any other technology over the past century and Every day the millions of pages are added and accessed by the users from the different part of globe therefore the volume of information available on the internet is increasing exponentially and web logs files are also growing at a faster rate and the size is becoming huge.

Although with the explosive growth in the size and uses of the web; the users are provided with more information and service options but they have to consume their precious time more on the web to find the “right” or “interesting” information. Without proper guidance, a visitor often wonders

aimlessly without visiting important pages, loses interest and leaves the site sooner than expected because the individual's capacity to read and digest the lots of irrelevant information is essentially fixed. Therefore it has become more difficult for them to access and determine the information they are interested in before getting frustrated. The tremendous growth in the number, size and the complexity of information resources available on the world wide web, the users find it more difficult to access relevant information from the Web and they often miss the goal of their inquiry, or receive ambiguous results when they try to navigate through the World Wide Web therefore World Wide Web imposes new methods of design and development of online information services. One of the most promising approaches to solve this problem is web personalization. Web personalization is the approach to tackle the problem of content overload by predicting the user needs by taking advantage of the knowledge acquired from the analysis of the users' explicit and/or implicit access behaviors in combination with the content and the structure of the Web site. Web personalization is the process of customizing the content and structure of a web site to meet the specific needs of individual users, without requiring them to ask for it explicitly [1].

The Web personalization [1, 25, 26, 27] can be defined as any action that tailors the Web experience to a particular user, or a set of users [6]. Web personalization can be seen as broad area that includes several interdisciplinary researches domains from information retrieval, data mining human-machine interactions, social networks and recommender systems as special cases. Amazon is the best example for providing personalized information.

The objective of a Web personalization[25,26,27] system is to

provide users with the information they want or need, without expecting from them to ask for it explicitly [1, 13]. Therefore, the requirement for predicting user needs in order to improve the usability and user retention of a Web site can be addressed by personalizing it.

Personalization requires implicitly or explicitly collecting visitor information and it uses the Users' behavior in different applications such as Personalization, content delivery as per users' interests, e-service sectors, e.g. e-commerce, e-business, e-learning etc to improve the system and to improve the system design as per their interest because the site owners are more interested than ever in making their sites automatically predict future navigational patterns of the users to improve the usability, structure, and user retention of their sites. One research area that has recently contributed greatly to web personalization is web mining [3,6]

## FUNDAMENTALS OF WEB MINING

The Web mining[15] research consists of research area from several research communities, such as Databases, Information Retrieval, Machine Learning, Artificial Intelligence and Natural Language Processing. The web mining (Etzioni, 1996) is used to analyze the data collected on the web and extract useful knowledge from it. The World Wide Web manages three kinds of vast, heterogeneous and distributing data content, structure and usage data [12]. In particular, content data consist of whatever is in a web page and Web Content Mining deals with the discovery of useful information from the web contents; structure data refer to the organization of the content and Web Structure Mining mines the structure of hyperlinks within the web itself; usage data are the usage patterns of web sites and Web Usage Mining mines the log data stored in the web server. The

application of data mining techniques for discovering and extracting information from these web data sets is at the basis of the three different research directions in the field of web mining: web content mining, web structure mining and web usage mining. Web mining techniques have been applied to a variety of applications that includes Web Search, Classification, E-Learning [28] and Personalization etc. Web mining aims to discover useful information or knowledge from the Web hyperlink structure, page content and usage log. Web Mining has a broad area of applications from Intelligent Web Search, Personalization, Recommendation Engines, Web commerce applications, Building the Semantic Web, Web page classification and categorization, News classification and clustering[29], Information / trend monitoring, Analysis of online communities, Web and mail spam filtering etc.

The web mining can be primarily categorized into following different categories

### **WEB CONTENT MINING**

Due to the exponential growth of www, the contents on the web are also increasing rapidly. Web contents encompass a very broad range of data and it corresponds to the collection of facts a Web page was designed to convey to the users. The contents on the web page may be in the form of text, image, audio, visual and hyperlinks. The Sheer number of documents consisting of relevant as well as irrelevant information may be retrieved in response of the search performed by the user. Web content mining [13] plays the significant role in addressing this problem. Web content mining is the process of extracting useful information from the contents of Web documents. This deals with the extraction of concept hierarchies/relations from the web, and their automatic categorization [15], [20].The unstructured nature of web content mining

allows the involvement of techniques from other disciplines such as Information Retrieval (IR) and natural language processing (NLP). The research on web content mining can be differentiated from two different points of view: IR (Information Retrieval) and DB (Database) views. The goal of Web content mining from the IR view is mainly to improve the required and relevant information retrieval from the web content and the goal of Web content mining from the DB view is to try to model the data on the Web and to integrate them for solving the problem of managing and querying the information on the web. Several frameworks supporting the claim that the incorporation of information related to the web site's content enhances the web personalization process have been proposed.

### **WEB STRUCTURE MINING**

The structure of the web may be represented as a graph representing web pages as nodes and hyperlinks connecting related pages as edges and the content within a Web page may also be organized in a tree like structured format, based on the various HTML(Hyper Text Markup Language) and XML(eXtensible Markup Language) tags within the page. Web Structure mining[13] is the process of using graph theory for discovering structure information from the Web or model underlying the link structures of the Web by analyze the node and connection structure of a web site therefore it generates the structural summary of web sites and web pages.

It is composed of mining the inter-document links, provided as a graph of links in a site or between sites. WSM pertains to mining the structure of hyperlinks within the web itself [20].

The structural summary consists of Interested information of the given interconnected web documents discovered by using the link information. Web Structure Mining can be performed either at the

Document Structure level or at the Hyperlink level. The first kind of web structure mining is extracting patterns from intra page documents in the web. An intra page link is a structural component that connects the web page to a web page at same location. The second kind of web structure mining is extracting patterns from hyperlinks in the web. A hyperlink or inter-page link is a structural component that connects the web page to a different location. This web structure mining is based on the topology of the hyperlinks and it can be used to categorize Web pages by measuring the frequency of local links for intra-related pages on the same server and measuring the frequency of links for interrelated pages on the different server. The connectivity features of the web graph have been extensively used for personalizing web search results, only a few approaches exist that take them into consideration in the web site personalization process.

### **WEB USAGE MINING**

Web usage mining [13] is also known as Web log mining because most of the information is usually generated automatically by Web servers and collected in server log. Web usage mining is the application of data mining techniques to analyze and discover interesting usage patterns from these large web access log repositories, in order to produce results to understand and better serve the needs of Web-based applications. The web usage mining may use the data from servers access logs, proxy server logs, browser logs, user profiles[30] registration data, user session or transaction cookies, user queries or bookmark data so it is said that web usage mining works on the secondary data. It is made of mining the data generated by the users' interactions with the web. It data records the identity or origin of Web users along with their browsing behavior at a Web site when the user browses or makes transactions on

the web site. A Web server access log contains a complete history of file accesses by the user. Most WWW access logs follow the Common Log Format. Some of the typical usage data collected at a Web site includes IP addresses, user id, URL page references, protocol used and access time of the users. The usage data collected at different sources will represent the navigation patterns of different segments of the overall web traffic so it is an activity that involves the automatic discovery of patterns from one or more Web servers. Web usage mining techniques [8,9] capture usage patterns from users' navigational data; have achieved great success in various application areas such as Web personalization and recommender systems, link prediction and analysis, Web site evaluation or reorganization, and e-commerce[28] data analysis, to improve the web performance, the search engines, cross marketing strategies across products.

### **DIFFERENT PHASES OF WEB PERSONALISATION**

Web personalization is the process of customizing a Web site to the needs of a specific user, considering the knowledge acquired from the analysis of the user's navigational behavior in to the account in correlation with other information collected in the form of structure, content, and user profile data [3].The web personalization process can be alienated into different phases [6, 25, 27] namely collection of web data, preprocessing of web data, analysis of web data, and finally decision making or recommendation.

#### **a. Collections of Web Data/ User profiling**

The process of gathering information either explicitly or implicitly specific to each visitor for recording their interests and behavior while they browse a web site. The collection of activities completed in the past and recorded in Web server logs is known as

the Implicit data. This activity is performed by the web server and the user is not directly involved in collection of such data. The information submitted by the user at the time of registration or in response to the rating questionnaires is considered as the explicit data and it usually comes from the active involvement of the user. Explicit data collection requires users to exert most of the efforts. Web data in the form of content, structure, semantic, usage and user profile may be collected and used in the context of Web personalization. A user profile includes information about users' interests and preferences and it contains demographic information for each user of a Web site.

#### **Preprocessing of Web data**

The data collected consists of various irrelevant information for example the log data collected from the web server are in the form of text files with a row for each http transaction. These data need to be cleaned before putting them for analysis. The Preprocessing task is performed to clean the data from inconsistencies. It filters out irrelevant information according to the goal of analysis

#### **Log analysis and web usage mining**

In this phase the specific data mining techniques that are popularly used for mining of web data or the machine learning techniques are applied to the processed data to discover interesting usage patterns. These usage patterns may form the groups according to the users' behavior. It classifies the content of a web site into semantic categories in order to make information retrieval and presentation easier for the user. This step is applied offline for automatic user profiling without adding the burden to the web server.

#### **b. Decision making/Final Recommendation Phase**

This is the last phase deals with the actions that should be performed after taking the results of the previous analysis step.

This phase usually performs the recommendations to the users by determining existing hyperlinks, the dynamic insertion of new hyperlinks that seems to be of interest for the current user to the last web page requested by the user, or even the creation of new index pages. This phase is generally accomplished by a variety of CGI programming.

### **FUNCTIONS OF WEB PERSONALIZATION**

In these days of throat cutting competition; the main goal of the web site owner is to increase the number of loyal visitors of their website. A Web personalization [26] system helps in retaining and increasing the number of loyal visitors by performing variety of functions. A value-added browsing experience; may be in terms of money or time; is brought to the users of the www by the means of these functions. These functions may perform the varying degree of actions from simple routine actions, to more complex ones in order to save the visitors' time and to make the interaction with the web site easier. These functions may be divided into four categories and ordered as below from the simplest like user salutation to the most advanced such as personalized content delivery.

#### **1. Memorization or 'User Salutation'**

This is the simplest and widely used form of personalization where basic information about the user such as name and browsing history is stored in the systems memory which is used as a reminder to the returning user. Such stored information is used by the web site to greet the returning user by displaying the use's name along with the welcome message. Most of the commercial web sites employ salutation for their customers or registered users and this kind



of 'User Salutation' helps in increasing the loyalty of the visitors, because users feel special rather than regular visitors but at the same time the memorization of users' information may also jeopardize their privacy. For Example rechargeitnow.com offers memorization

## 2. Customization

This is more advanced than memorization form of personalization where users' preferences, knowledge and interests regarding customizing the layout, content or structure of the web pages are taken from the users' registration form. Various commercial sites such as My Yahoo, AltaVista and Google employ customization for their visitors through the facilitation of the users' interaction with the site. The customization may be done in different ways like page layout customization, content customization, link customization etc. On the basis of the information provided by the users in their registration form; the particular Web page changes its layout or color in page layout customization. For example: Web portals of Yahoo and AltaVista. The content of the web page changes i.e. the content may either be presented in summarized manner, expended manner or same content may be presented to different users in content customization. An example of such a customized Web site is the UM2001 site.

## 3. Guidance

This is the most commonly used and more advanced than earlier two web personalization function. It refers to automatically recommending the hyperlinks depending on users past navigational behavior. This function also provides the alternative set of hyperlinks that are related to the interests and preferences of the user. This is supported by various systems such as the Web Personalizer [6]. It is usually implemented on the Web server and is described as adaptive web recommendation. The adaptive web recommendation may

guide the individual user at each step of the interaction with the web site. This function relies on data that reflects the user's interest implicitly or explicitly and can take the form of recommendation of links to certain products, topics of information

## 4. Task Performance Support

This is the most advanced web personalization function where, execution of a particular action is performed by the personal assistant software on behalf of a user. This function is heavily dependent on the personnel assistant software to facilitate access to relevant information. These are the client-side personalization systems with the limited scope that it cannot use information about other users with similar interests

## RELATED WORK

The Internet grew from 2000-2009 at an estimated rate of 380% [31]. This exponential growth of information resources and services available on www is making web site exploration difficult, therefore new information services like Web personalization are in high demand and distinguished personalization schemes have been suggested in the recent decade. Personalization can be automatic or customized. The web personalization has become an important tool for both Web-based organizations and for the end users. The focus of the researchers is on automatic, dynamic or a combination of the two approaches over customized personalization [32]. Web personalization is defined as any action that tailors the Web experience to a particular user, or set of users by Mobasher, Cooley, & Srivastava [3]. Letizia [5] is considered to be the first system that records the user's navigation behavior and gives interesting recommendations to the user. WebWatcher[7] is web content based system that provides navigation hints to the user, based on a knowledge acquired about user's interests, the location and relevance

of the items in the site, and the way in which other users interacted with the collection in the past and it performs well from the perspective of the end user who is searching the Web for information but it is less useful in E-commerce applications. This system uses personal profiles of users and recommends other items or pages based on their content similarity to the items or pages that are in the user's profile. WebWatcher [7] and Letizia [5] generally rely on personal profiles and content similarity of Web documents to these profiles to make recommendations.

Personalization techniques seek to learn about website users and create user profiles [30] for personalization of navigation or content. The research in the area of web mining and its applications to web personalization has been well documented and reported [1]. Analog [30] was one of the leading personalization systems based on the web usage mining methodology. The analysis of log data discovers valuable web usage patterns [33]. In 2000 Mobasher [6] proposed the web usage-based Web personalization system called Web Personalizer for recommending Web pages on Server-Side to users. The Web Personaliser provides a personalization framework based on web log mining and using data mining techniques for extraction of knowledge for generating the recommendations to current users based on their browsing navigational history. Initially the web usage mining was not considered extensively for personalization [3] rather its primary focus was on the extraction of decision-support knowledge, expressed in terms of descriptive data models to be evaluated and exploited by human experts but in the recent time the researchers have focused more on the application of web usage mining for web personalization to acquire the required robustness and flexibility. Several web personalization

projects have been developed correspond to the evolution of extensive research in Web usage mining. This includes trend analysis, and web access association/sequential pattern analysis. Good literature of the web usage mining field has been made available by Eirinaki [1], Koutri [2], Pierrakos [4]. Web usage mining, the main component of a web personalization system, is generally, a three step process, consisting of data preparation, pattern discovery, and pattern analysis. The web usage mining extensively focus on discovering the interesting patterns in order to understand the users' navigational behavior. The navigational behavior may play an important role in the decisions concerning site restructuring or modification [21,22]. The web personalization system based on web usage mining does not consider the context of the web page into account. Some efforts have been made to incorporate content [34, 35, 36] or the structure [37, 38] of the web site along with the usage patterns. The web semantics defines the context of a web page therefore recent researchers have considered web semantic as an important concept for web personalisation. Magdalini Eirinaki, 2006 [39,40] Proposed a semantic web personalization system, focusing on word sense disambiguation techniques which can be applied in order to semantically annotate the web site's content. A semantic web personalization framework is also presented [16, 17, 18, 14], which enhances the recommendation process with content semantics. These have suggested that the structural characteristics of Web sites, such as the site topology and the degree of connectivity, have a significant impact on the relative performance of recommendation models. The Recent Research [9, 10, 39, 40, 41,42] in the area of web semantic and its applications to web personalization has been well documented While [9, 10,39] have used both web usage

and web semantics mining the others have solely concentrated on semantic mining where the documents are clustered together based on their content and the user is recommended pages from the cluster to which the current document belongs. This method does not take into account the activities of previous users found in the web logs

The machine learning techniques [3, 6, 11] have also been applied to the web personalization. The machine learning techniques have been applied along with soft computing techniques to properly deal with the imprecision, uncertainty and partial truths underlying the personalization process [6]. The fuzzy logic and neuro-fuzzy is becoming popular for the web personalization system. The neuro-fuzzy strategy [23] has been applied to develop a Web personalization system that dynamically suggests interesting URLs for the current user. G. Castellano[24] proposed the web personalization[26] system using fuzzy C-Means clustering algorithm to categorize user sessions[29] in order to derive groups of users which exhibit similar access patterns. It enables generation of overlapping clusters to capture the uncertainty among Web user's navigation behavior. He also proposed a usage-based Web personalization [26] system called NEWER[23] that exploits the potential of Computational Intelligence techniques to dynamically suggest interesting pages to users according to their preferences. Veeramalai [43] proposed the Fuzzy-Temporal Association Rule Mining Algorithm (FTARM) to classify the Web user profiles dataset periodically to know the users behaviors and interests based on temporal pattern analysis. FTARM is used for reducing the search space of the Web user profiles dataset in which Fuzzy logic is used for intelligent classification

## APPLICATIONS OF WEB PERSONALIZATION

Web personalization has been recently gaining great momentum in research and in various commercial web applications. One of the interesting applications of personalization on Web is the recommender systems [44, 45]. Recommender systems are used to provide users with a richer experience and help them to make the selection process easier. In the web personalization, recommendation engines recommends object in the form of pages, products, advertisements etc depending upon the type and taste of the user. Now a days countless of new products are being advertised over the media everyday. Hence, various business strategies have been developed to retain the existing customers as well creating new customers. Web personalization recommendation is being used by various e business applications. Examples of some of such recommendation systems are Amazon.com, barnesnoble.com Ebay.com, FAIRWIS, LIBRA, CDNOW etc. The recommendations systems also recommend web pages for various web site MEMOIR, Phoaks, GAB, Fab, Alexa.com, Quickstep, R2P, SOAP. It has also been used for recommending music, movies, videos or other services. CDNOW, Moviefinder.com, Movie lens, Moviefinder.com, Firefly, Morse are among some systems which suggest interesting movies and songs to the users. Recommender systems are also used in news reading domain as well. Tapestry, GroupLens, PHOAKS, WebMate, Alipes and Personal View Agent, Lotus Notes, PVA are among some systems which suggest interesting news to readers. Another interesting application of personalization is in adaptive hypermedia systems. For example WebWatcher helps its users by modifying the page that the users browse. The web personalization system has also been used for e-learning [44,45]



## CONCLUSION

World Wide Web has come a long way over the last decade and has become one of the world's three major media, with the other two being print and television. Web Personalization is becoming more and more important with the explosive growth of information sources available on the World Wide Web and with the advent of e-services. We have looked at some fundamental aspects of personalization and we have outlined the different modes of web mining, namely web content mining, web structure mining and web usage mining [2,30,33,34,35]. We tried to summarize the significance of introducing the web mining techniques in the area of web personalization we also discussed the current trends, system proposals and approaches in web personalization. Also, we have introduced some useful applications of personalization that are being used on the Web. This paper is based upon the currently existing trends in the relevant context.

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