

# Web Mining techniques, process and applications in Ecommerce

**Prof. Rajesh R. Gawali**

Asst. Professor

Sinhgad Institute of Management and Computer Applications, Pune

**Dr. Shivaji D. Mundhe**

Director\_ MCA

Sinhgad Institute of Management and Computer Applications, Pune

## *Abstract*

Web Personalization is the need of the time due to huge and ever growing volume of web content that is open for access to any user. It will be make the web useful in all walks of life. Web personalization involves prediction of the web content required by a surfer at any time and delivers them simultaneously. Web mining is the application of data mining techniques to extract knowledge from Web. Using Web mining different techniques have been proposed for a variety of applications includes Web Search, Classification and Personalization etc. Most research on Web mining has been from a 'data-centric' point of view. Good web personalization can be achieved by implementing personalization activities at various levels in the web. web structure mining and web content mining can contribute to complete web personalization.

In this paper I discussed techniques, process of web mining, applications and opportunities of Data Mining in Ecommerce.

**Keywords:** Web personalization, E-commerce, usage mining, website, structure mining, content mining

## 1.0 INTRODUCTION

The continuous growth in the size and use of the World Wide Web imposes new methods of design and development of online information services. Most Web structures are large and complicated and users often miss the goal of their inquiry, or receive ambiguous results when they try to navigate through them. 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. Web personalization is defined as any action that adapts the information or services provided by a Web site to the needs of a particular user or a set of users, taking advantage of the knowledge gained from the users' navigational behavior and individual interests, in combination with the content and the structure of the Web site. The objective of a Web personalization system is to "provide users with the information they want or need, without expecting from them to ask for it explicitly" Therefore it is necessary to stress the difference between layout customization and personalization. In customization the site can be adjusted to each user's preferences regarding its structure and presentation. Every time a registered user logs in, their customized home page is loaded. This process is performed either manually or semi automatically. In

personalization systems modifications concerning the content or even the structure of a Web site are performed dynamically.

Principal elements of Web personalization include (a) the categorization and pre-processing of Web data, (b) the extraction of correlations between and across different kinds of such data, and (c) the determination of the actions that should be recommended by such a personalization system.

Web data are those that can be collected and used in the context of Web personalization.

**Content** data are presented to the end-user appropriately structured. They can be simple text, images, or structured data, such as information retrieved from databases.

**Structure** data represent the way content is organized. They can be either data entities used within a Web page, such as HTML or XML tags, or data entities used to put a Web site together, such as hyperlinks connecting one page to another.

**Usage** data represent a Web site's usage, such as a visitor's IP address, time and date of access, complete path (files or directories) accessed, referrers' address, and other attributes that can be included in a Web access log.

**User profile** data provide information about the users of a Web site. A user profile contains demographic information (such as name, age, country, marital status, education, interests, etc.) for each user of a Web site, as well as information about users' interests and preferences. Such information is acquired through registration forms or questionnaires, or can be inferred by analyzing Web usage logs.

**2.0 Web mining:** Web is an important part of our daily life. The web is now the best medium of doing business. Large companies rethink their business strategy using the web to improve business. Business presence through a company web site has several advantages as it breaks the barrier of time and space compared with the existence of a physical office. Appropriate strategies for ecommerce are key to improve competitive power. One effective technique used for ecommerce is data mining. Data mining is the process of extracting interesting knowledge from data. Web mining is the use of data mining techniques to extract information from web data.

Web mining is the application of data mining techniques to extract knowledge from Web. Web mining has been explored to a vast degree and different techniques have been proposed for a variety of applications that includes Web Search, Classification and Personalization etc. Most research on Web mining has been from a 'data-centric' point of view. Therefore it is important to study significance of the evolving nature of the Web personalization. Web usage mining is used to discover interesting user navigation patterns and can be applied to many real-world problems, such as improving Web sites/pages, making additional topic or product recommendations, user/customer behavior studies, etc. A Web usage mining system performs five major tasks: i) data gathering, ii) data preparation, iii) navigation pattern discovery, iv) pattern analysis and visualization, and v) pattern applications. The Web mining research is a converging research area from several research communities, such as Databases, Information Retrieval and Artificial Intelligence.

The explosive growth of documents in the Web makes it difficult to determine which are the most relevant documents for a particular user, given a general query. Recent search engines rank pages by combining traditional information retrieval techniques based on page content, such as the word vector space [3, 4], with link analysis techniques based on the hypertext structure of the Web [5, 6]. Traditional search engine has dealt with searching information on the web to a large extent, but it also has some problems at present. [2]

- The web information has enlarged from quantity to types, showing the trend of exponential growth, so the search engine cannot index all the pages;
- The web information has changed dynamically, so the search engine cannot be sure to update in time;
- Traditional search engine cannot meet the increasing need day by day that people want personal service for information retrieve;
- Search engine requires hardware owning more storage capacities, even hundreds of GB, and more servers.

Besides the above stated problem a recent research has shown that only 13% of search engines show personalization characteristics. Hence web personalization [1] is one of the promising approaches to tackle this problem by adapting the content and structure of websites to the needs of the users by taking advantage of the knowledge acquired from the analysis of the users' access behaviors. One research area that has recently contributed greatly to this problem is web mining. Web mining aims to discover useful information or knowledge from the Web hyperlink structure, page content and usage log. There are roughly three knowledge discovery domains that pertain to web mining: Web Content Mining, Web Structure Mining, and Web Usage Mining.

Web content mining is the process of extracting knowledge from the content of documents or their descriptions. Web document text mining, resource discovery based on concepts indexing or agent based technology may also fall in this category. Web structure mining is the process of inferring knowledge from the World Wide Web organization and links between references and referents in the Web. Finally, web usage mining, also known as Web Log Mining, is the process of extracting interesting patterns in web access logs. A key

part of the personalization process is the generation of user models. Commonly used user models are still rather simplistic, representing the user as a vector of ratings or using a set of keywords. Even where more multidimensional information has been available, such as when collecting implicit measures of interest, the data has traditionally been mapped onto a single dimension; in the form of ratings. In particular profiles commonly used today lack in their ability to model user context and dynamics. Users rate different items for different reasons and under different contexts. The user interests and needs change with time. Identifying these changes and adapting to them is a key goal of personalization. We suggest that the personalization process be taken to a new level, a level where the user does not to be actively involved with the personalization process. All that the user needs to do is to have an active profile file and when the user logs onto a web site, the browser checks for that profile file as it checks for the cookies. The profile file describes the user's interest and the levels at which the user wants a particular personalizable feature. Since the profile file is in a standardized format, the web sites would be able to provide the content according to the profile file. This would enhance the user's personalization process without their active involvement. vector space with one dimension per term. Each document or query is represented as a term vector in this vector space. Entries of terms occurring in the document are positive, and entries of terms not occurring in the document are zero. More specifically, the entry of the term is usually a function that increases with the frequency of the term within the document and decreases with the number of documents in the collection containing the term. The idea is that the more documents the term appears in, the less characteristic the term is for the document, and the more often the term appears in the document, the more characteristic the term is for the document.

## 2.1 Web Mining Techniques Used and Web Mining Categories

For Web mining following points are to be considered

- Resource Finding: It is the task of retrieving intended Web documents.
- Information Selection and Pre-processing: Automatic selection and pre processing of specific information from retrieved Web resources.
- Generalization: Automatic discovers general patterns at individual Web sites and also across numerous sites.
- Analysis: Confirmation and interpretation of the mined patterns.

Web Mining techniques make use of the web information and are based on web content mining, web structure mining, and web usage mining. They provide clustering analysis, web link analysis, pattern analysis, association analysis and correlation analysis.

The web consists of a large number of unstructured text-based documents using information retrieval, where the user needs effective techniques like keyword based retrieval and indexing techniques. The study of web servers and web log analysis are helpful in applying the web mining techniques [10].

In the mining process it is projected that either the hyperlink structure of the web or the web log data or both have been used. Web mining is the application of data

mining techniques to discover patterns from the Web. According to analysis targets, web mining can be divided into three different types, which are Web content mining, Web structure mining and Web usage mining.

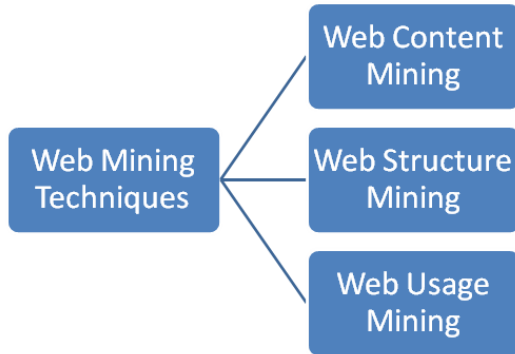


Fig.1 Web Mining

### 2.1.1 Web Content Mining:

Focuses on techniques for assisting a user in finding documents that meet a certain criterion (text mining).

It deals with discovering useful information or knowledge from web page contents than hyperlinks and goes beyond using keywords in a search engine. Web content consists of information like unstructured free text, image, audio, video, metadata and hyperlink. Cluster analysis, intelligent agents, search engines, subject directories, and portals are used to find out users needs or requirements or the user searches for which information.

### 2.1.2 Web Structure Mining:

Aims at developing techniques to take advantage of the collective judgement of web page quality which is available in the form of hyperlinks.

Web structure mining deals with modeling and discovering the hyperlink structure of the web pages which is based on the topology of the hyperlinks. It gives comparison between sites or the sites for a particular topic or web communities.

It deals with the challenge of structure of the hyperlinks within the Web itself. Link analysis is an older area of research. But with the growing interest in Web mining, the research in structure analysis increases and results in a newly emerging research area called Link Mining. It is located at the intersection of link analysis, relational learning and inductive logic programming, hypertext and web mining and graph mining. There is a wide range of application areas for this new area of research, including Internet.

### 2.1.3 Web Usage Mining:

Focuses on techniques to study the user behaviour when navigating the web (also known as Web log mining and click stream analysis).

It deals with understanding user behavior with a web site and to obtain information that may assist in web site reorganization to suit user needs. Web usage mining is automatic discovery of user access patterns. The mined data includes data logs of users web interaction, having web server logs, proxy server logs and browser logs, having data about referring page, user identification, user spent time at site and sequence of pages visited. Also cookies files contain

information. Web structure mining shows that page X has link to page Y, but web usage mining shows who or how many people look that link, from which site they came from and where they went when they left page Y.

The most important factors we have to consider here is that hyperlinks, dynamic content generation as per user preferences, quality of the content in web pages, huge size of the data.

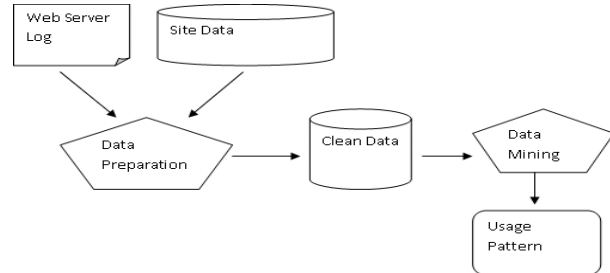


Fig. 2 Usage Mining

### Web Usage Mining Applications to E-commerce

The results of Web usage mining can be applied to understand and analyze Web usage data. So, we can apply web usage mining techniques to e-service, especially e-commerce. The following are some examples.

#### Personalization

The tremendous growth in the number and the complexity of information resources and services on the e-commerce site has made Web personalization an indispensable tool for both Web-based organizations and for the end users. The ability of an e-commerce site to engage visitors at a deeper level, and to successfully guide them to selection and purchase products is now viewed as one of the key factors for e-commerce company ultimate success. Making dynamic recommendations to a Web user, based on her/his profile in addition to usage behavior is very attractive to many applications, e.g. cross-sales and up-sales in e-commerce.

#### System Improvement

Every customer using e-commerce system expects that the system has high performance and other service quality attributes such as databases, networks, etc.

#### Site Modification

The attractiveness of a Web site, in terms of both content and structure, is very important for a product catalog of e-commerce.

#### Business Intelligence

Information on how customers are using a Web site is critical information for marketers of e-commerce. By mining the relationship between customers' behavior and purchase, we can understand the customers' purchasing intention much better, find the customers' purchasing characteristics and trends, and identify the potential purchaser.

### 2.2 Processes involved in web mining

Web mining is defined as the "process of studying and discovering web user behavior from web log data." Generally the web data collection is done over a long period of time. Later on, by applying different steps namely, Pre-processing, Discovery of Pattern and Analysis of Pattern of Web Data

are being indexed. Pre-processing of web data is the process of transformation of the raw data into a usable data model. Pattern discovery step uses several data mining algorithms is used to extract the user patterns. Finally, pattern analysis from web data uncovers useful and interesting user patterns and trends. These steps are normally executed after the web log data is collected.

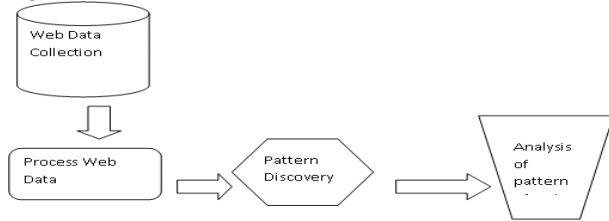


Fig. 3 Web mining process

**a) Web Data Collection**

Web data are those that can be collected and used in the context of Web personalization. These data are classified in four categories according to [11]:

- Content data are presented to the end-user appropriately structured. They can be simple text, images, or structured data, such as information retrieved from databases.
- Structure data represent the way content is organized. They can be either data entities used within a Web page, such as HTML or XML tags, or data entities used to put a Web site together, such as hyperlinks connecting one page to another.
- Usage data represent a Web site’s usage, such as a visitor’s IP address, time and date of access, complete path (files or directories) accessed, referrers’ address, and other attributes that can be included in a Web access log.
- User profile data provide information about the users of a Web site. A user profile contains demographic information for each user of a Web site, as well as information about users’ interests and preferences. Such information is acquired through registration forms or questionnaires, or can be inferred by analyzing Web usage logs.

**b) Pre-processing of Web Data**

The actual data that is to be collected generally have the features that incomplete, redundancy and ambiguity. Mining the knowledge more effectively, pre-processing the data collected is essential. Pre-processing provides accurate, concise data for data mining. Preprocessing of Data, includes data cleaning, user identification, user sessions identification, access path supplement and transaction identification.

**c) Discovery of Pattern from Web Data**

Pattern discovery gives us effective, novel, potentially, useful and ultimately understandable information and knowledge using mining algorithm. The main methods are classification analysis, association rule discovery, sequential pattern discovery, clustering analysis, and dependency modeling.

**d) Analysis of Pattern of Web Data**

Pattern analysis is mainly concerned with selecting pattern we are interested in from the pattern set found by model pattern discovery algorithm. The main aim is to find out a valuable model, namely, the rules and modes we are

interested in and providing graphical user interface using visualization techniques to users.

**3.0 Applications of Data Mining techniques in E-Commerce:**

**DM in customer profiling:** Acquiring new customers, delighting and retaining existing customers, and predicting buyer behaviour will improve the availability of products and services and hence the profits. Thus the end goal of any DM exercise in e-commerce is to improve processes that contribute to delivering value to the end customer.

Companies like Dell provide their customers access to details about all of the systems and configurations they have purchased so they can incorporate the information into their capacity planning and infrastructure integration. Back-end technology systems for the website include sophisticated DM tools that take care of knowledge representation of customer profiles and predictive modelling of scenarios of customer interactions. For example, once a customer has purchased a certain number of servers, they are likely to need additional routers, switches, load balancers, backup devices etc. Rule-mining based systems could be used to propose such alternatives to the customers.

**DM in recommendation systems:** Systems have also been developed to keep the customers automatically informed of important events of interest to them.

Method to build customer profiles in e-commerce settings, based on product hierarchy for more effective personalization. They divide each customer profile into three parts: basic profile learned from customer demographic data; preference profile learned from behavioural data, and rule profile mainly referring to association rules. Based on customer profiles, the authors generate two kinds of recommendations, which are interest recommendation and association recommendation. They also propose a special data structure called profile tree for effective searching and matching.

**DM in web personalization:** web usage mining activities required for this process, including the preprocessing and integration of data from multiple sources, and common pattern discovery techniques that are applied to the integrated usage data.

Pattern discovery techniques such as clustering, association rule-mining, and sequential pattern discovery, performed on web usage data, can be leveraged effectively as an integrated part of a web personalization system. The log data collected automatically by the Web and application servers represent the fine-grained navigational behaviour of visitors.

**Data to be captured by weblogs:** Depending on the goals of the analysis, e-commerce data need to be transformed and aggregated at different levels of abstraction. E-Commerce data are also further classified as usage data, content data, structure data, and user data. Usage data contain details of user sessions and page views. The content data in a site are the collection of objects and relationships that are conveyed to the user. For the most part, the data comprise combinations of textual material and images. The data sources used to deliver or generate data include static HTML/XML pages, images, video clips, sound files, dynamically generated page segments from scripts or other

applications, and collections of records from the operational database(s). Structure data represent the designer's view of the content organization within the site. This organization is captured via the inter-page linkage structure among pages, as reflected through hyperlinks. Structure data also include the intra-page structure of the content represented in the arrangement of HTML or XML tags within a page. Structure data for a site are normally captured by an automatically generated site map which represents the hyperlink structure of the site. The operational database(s) for the site may include additional user profile information. Such data may include demographic or other identifying information on registered users, user ratings on various objects such as pages, products, or movies, past purchase or visit histories of users, as well as other explicit or implicit representations of a users' interests.

Once the data types are clear, data preparation is easily achieved by processes such as data cleansing, pageview identification, user identification, session identification, the inference of missing references due to caching, and transaction (episode) identification. association rules, sequential and navigational patterns, and clustering approaches for personalization of transactions as well as WebPages.

**DM and multimedia e-commerce:** Applications in virtual multimedia catalogs are highly interactive, as in e-mails selling multimedia content based products. It is difficult in such situations to estimate resource demands required for presentation of catalog contents. The prediction is based on the results of mining the virtual mall action log file that contains information about previous user interests and browsing and buying behaviour.

**DM and buyer behaviour in e-commerce:** For a successful e-commerce site, reducing user-perceived latency is the second most important quality after good site-navigation quality. The most successful approach towards reducing user-perceived latency has been the extraction of path traversal patterns from past users access history to predict future user traversal behaviour and to prefetch the required resources. However, this approach is suited for only non-e-commerce sites where there is no purchase behaviour. Approach involves extracting knowledge from integrated data of purchase and path traversal patterns of past users (obtainable from web server logs) to predict the purchase and traversal behaviour of future users.

Web sites are often used to establish a company's image, to promote and sell goods and to provide customer support. The success of a web site affects and reflects directly the success of the company in the electronic market.

In the context of web mining, clustering could be used to cluster similar click-streams to determine learning behaviours in the case of e-learning, or general site access behaviours in e-commerce.

Now a day the Internet is used for information and knowledge are transmission and shared throughout the world. The Internet and the advance of telecommunication technologies permit us to share and manipulate information

in nearly real time. This reality is determining the next generation of Ecommerce. Ecommerce arose from traditional Commerce in order to cover the necessities of remote consumers and/or help the commerce process, reinforcing or replacing traditional commerce. The Internet takes this process of delocalization of the commerce experience to a new realm, where the lack of presential intercourse is, at least partially, replaced by an increased level of technology mediated interaction. Furthermore, telecommunications allow this interaction to take forms that were not available to traditional sellers and buyers.

This is e-commerce (web-based commerce), a new context for commerce where large amounts of information describing the continuum of the buying/selling interactions are endlessly generated and ubiquitously available. This could be seen as a blessing: plenty of information readily available just a click away. But it could equally be seen as an exponentially growing nightmare, in which unstructured information chokes the ecommerce system without providing any articulate knowledge to its actors.

Data Mining was developed to tackle such like problems to systematically extract information from data as a field of research; it is almost contemporary to e-commerce. It is rather difficult to define. Not because of its inherent complexity, but because it has most of its roots in the ever-shifting world of business. It can be understood not just as a collection of data analysis methods, but as a data analysis process that encompasses anything from data understanding, pre-processing and modeling to process evaluation and implementation [11]. It is nevertheless usual to pay preferential attention to the Data Mining methods themselves. These commonly bridge the fields of traditional statistics, pattern recognition and machine learning to provide analytical solutions to problems in areas as diverse as biomedicine, engineering, and business, to name just a few. An aspect that perhaps makes Data Mining unique is that it pays special attention to the compatibility of the modeling techniques with new Information Technologies (IT) and database technologies, usually focusing on large, heterogeneous and complex databases. E-commerce databases often fit this description. Therefore, Data Mining can be used to extract knowledge from e-commerce systems through the analysis of the information available in the form of data generated by their users. In this case, the main objective becomes finding the patterns of system usage by sellers and buyers and, perhaps most importantly, discovering the consumer's behavior patterns and predictions.

Now a days, Ecommerce Systems are being installed more and more by banks, businesses, government and even individual business in order to add web technology to their courses and to supplement traditional face-to-face interaction with the customer. Ecommerce systems accumulate a vast amount of information which is very valuable for analyzing the consumer' behavior and could create a gold mine of commerce data. They can record whatever buyer activities it involves, such as searching catalog, purchasing, feedback, performing various tasks, and even communicating with seller. However, due to the vast quantities of data these systems can generate daily, it is very difficult to analyze this data manually. A very promising approach towards this analysis objective is the use of data

mining techniques. Data mining techniques are extensively used in the fields such as business, marketing, bioinformatics, science etc. for product search to understand user query intent, product recommendation based on “collaborative filtering”, where aggregated choices of similar past users can be used to provide insights for the current user, fraud detection by monitoring online activities by statistical analysis and machine learning for technique of “anomaly detection” i.e. detecting abnormal patterns in data sequence, business intelligence to understand business operation, inventory, sales pattern. But the specific characteristics of data from e-commerce environments make their application particular. One important characteristic is the fact that it is difficult, or even impossible, to compare different methods or measures a posteriori and decide which is the best.

#### **4.0 Opportunities for the use of data mining in e-Commerce:**

Data mining is important in creating a great experience at Ecommerce. Data mining is a systematic way of extracting information from data. Techniques include pattern mining, trend discovery, and prediction. For Ecommerce, data mining plays an important role in the following areas:

##### **Product search**

When the user searches for a product, how do we find the best results for the user? Typically, a user query of a few keywords can match many products.

##### **Product recommendation**

Recommending similar products is an important part of Ecommerce. A good product recommendation can save hours of search time and delight our users.

##### **Fraud detection**

A problem faced by all e-commerce companies is misuse of our systems and, in some cases, fraud. For example, sellers may deliberately list a product in the wrong category to attract user attention, or the item sold is not as the seller described it. On the buy side, all retailers face problems with users using stolen credit cards to make purchases or register new user accounts.

Fraud detection involves constant monitoring of online activities, and automatic triggering of internal alarms. Data mining uses statistical analysis and machine learning for the technique of “anomaly detection”, that is, detecting abnormal patterns in a data sequence.

Detecting seller fraud requires mining data on seller profile, item category, listing price and auction activities. By combining all of this data, we can have a complete picture and fast detection in real time.

##### **Business intelligence**

Every company needs to understand its business operation, inventory and sales pattern. The unique problem facing eBay is its large and diverse inventory. eBay is the world’s largest marketplace for buyers and sellers, with items ranging from collectible coins to new cars. There is no complete product catalog that can cover all items sold on eBay’s website. How do we know the exact number products sold on eBay? They can be listed under different categories, with different titles and descriptions, or even offered as part of a bundle with other items.

Inventory intelligence requires us to use data mining to process items and map them to the correct product category. This involves text mining, natural language understanding, and machine learning techniques. Successful inventory

classification also helps us provide a better search experience and gives a user the most relevant product.

#### **Some of the challenges in e-commerce DM include the following**

**Data transformations:** There are two sets of transformations that need to take place:

(i) data must be brought in from the operational system to build a data warehouse,

(ii) data may need to undergo transformations to answer a specific business question, a process that involves operations such as defining new columns, binning data, and aggregating it. While the first set of transformations needs to be modified infrequently (only when the site changes), the second set of transformations provides a significant challenge faced by many data mining tools today.

**Scalability of data mining algorithms:** With a large amount of data, two scalability issues arise: (i) most data mining algorithms cannot process the amount of data gathered at web sites in reasonable time, especially because they scale nonlinearly; and (ii) generated models are too complicated for humans to comprehend.

## **5.0 CONCLUSION**

Web Mining is a developing domain .Web mining is increasingly reaching in mostly aspects of today’s environment. In this paper we present the techniques of web mining in the context of E-commerce and applications and opportunities of Data Mining in Ecommerce.

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