DESIGN OF A RECOMMENDER SYSTEM FOR ONLINE SHOPPING USING DECISION TREE AND APRIORI ALGORITHM

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ABSTRACT

With the growing data available on the Internet, customization of the web sites information has become a requirement for users. A procedure for the appropriate customization of web data is configured by automatic extraction of combined knowledge of the log file and user profile information. In this paper, integrating decision tree and association rules for user profile information and log information of website in an online shopping store is targeted. The tangible results of such a framework for decision makers and marketers are customization of web pages and statistical analysis for sale improvement. Applying association rules, the website users' patterns are mined and utilizing decision tree users are classified and their interests are determined. By combining the results of two algorithms and its analysis, the behavior models from user profile, user interests in terms of age and gender, and the most visited web pages by subject can be achieved.
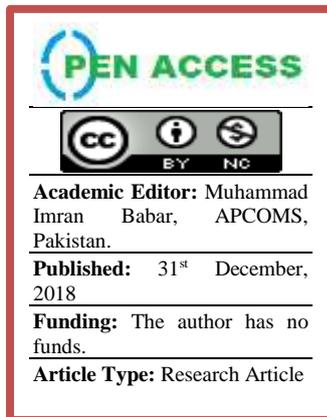
Keywords : recommender system; on-line shopping; association rules; customization; decision tree;

1. INTRODUCTION

The rapid evolution of the Internet has led to the proliferation of accessible information and customization of this information has become a requirement for the users. Knowledge gained from trail of users on the web site is very useful, because merchants and managers can adapt website structure based on user behavior.

Automatic extraction of knowledge from web logs is useful to identify the patterns of visiting for customization. Different works in the field of web personalization and prediction of dynamic web pages with regard to the behavior of the users were done. In [1] a recommender system called webpum was used to predict users' favorite pages online. The system models user interaction patterns with graph partitioning during the pattern recognition phase. Then in order to predict the next action of users, the longest common subsequence algorithm is used to classify the user in clusters. In [2], the basic concept of web personalization was explained; the method described in this paper was composed of two components, an offline component for data preparation and user mining and an online component that is a recommendation engine. In the [3], authors proposed some suggestions to improve web personalization regarding to the website data along with the settings that the user has specified during registration on the website. In [4] hybrid algorithm based on distributed learning automata was presented to learn user behavior as well as exploring weighted association rules. In weighted association rules mining algorithm, the length of time each user spends on each page and the number of meetings of each page, contribute in the weight assigned to each page. Also HITS algorithm that is an algorithm for ranking pages was used to develop a set of proposals. In [5], the author was keen to explore ways to combine the meanings of web documents with the motion pattern obtained from blog users and used them to make better recommendations. In [6], a data structure called a web pattern tree access for efficient extraction of access patterns of web logs was proposed. In [7], an intelligent web model using genetic algorithm for users' web pages visits was proposed. In [8], IPACT system was introduced which aims to improve the accuracy of proposals by classification of users. After clustering user sessions, by calculation of vector of center of that cluster, a profile was created for each cluster. The online phase allocates the current user's activities to the best profile among the profiles obtained. The list of proposals including the visits of pages that are used by the user in clusters is a statistical classification taking into account the most visited adapted pages. In [9], a recommender system was provided to predict the next destination of user and to allocate him to the best profile obtained from the last user interaction. Also, for the customization of

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information environment and to discover favorites of users, user profile information can be used. Today, for automatic extraction of knowledge, data techniques are used.

Samples of similar works carried out are given next. In [16], a decision-making framework was presented by combining various data mining algorithms to achieve precise marketing of products. In this study, real-world data, including historical monthly support and information of every customer of a company in China were collected. The goal was to provide a model that can classify target customers and predict the support rate and provide a strategy for marketing. Depending on the characteristics and needs of each stage of the marketing model, framework of decision-making uses four data mining algorithms namely, K-means algorithm, decision tree, ratio Pareto and RFM model. K-Mean algorithm is frequently used for data preprocessing or clustering due to its simplicity and efficiency. Decision tree is used for customer segmentation and extraction of rules that represents the relationship between input and output variables. Pareto principle, which states that for many events, 80% of the impact is due to 20% of reasons which is a common law in trade. RFM model is popular in customer value analysis and is appropriate to measure customer value lifetime. In the past researches, customer profile information and logs of websites were analyzed separately and were used in customization.

In this paper, analyzing user profile information using decision tree and log information of website by association rules algorithm, customization of web pages along with decision-making and marketing are proposed. It will be shown that by combining and analyzing data profiles and web logs, accurate marketing efforts and better decisions. Also, a case study in Digikala online shopping store is implemented.

The remainder of this work is organized as follows. Next, the materials and methods employed to propose the framework are presented. In Section 3, data extraction and preparation are demonstrated. In Section 4, analysis on data and report provision are given. Finally, we conclude in Section 5.

2. METHODS AND MATERIALS

In this section, the methods required for our proposed framework are briefly described.

2.1 Data mining

Data mining is to extract information and knowledge and to discover hidden patterns of a large and complex database [17]. Data mining is very strong and high-potential methodology that helps organizations to explore data on their systems, for future patterns, trends and behaviors for better decision-makings [18].

The data mining of databases and massive collections of data is sought after the discovery and dissemination of knowledge in an automated manner. Such studies and explorations can, in fact, be the same as the continuation of ancient and all-embracing knowledge. The main difference is the scale, scope and variety of fields and applications, as well as the dimensions and sizes of today's data that require machine-related techniques for learning, modeling, and training. Different definitions have been used in data mining, but one of the definitions is mentioned in most of the resources. Data mining is: "Extracting information and knowledge and discovering hidden patterns from a very large and complex database" [18]. Data mining is a very powerful and high potential methodology that helps organizations focus on the most important data from their data repository [20]. Data mining helps organizations explore and predict their data, system, trends, and behaviors by looking at them and make better decisions. Data mining uses a prediction analysis employing past analysis and provides answers to questions that have not been answered by the mountain in the past or required a great deal of time. Data mining tools discover and predict hidden patterns that may not be considered and achieved by experts, because they do not have the information and the algorithm out of their expectations. Data mining will allow organizations to reach the level of data at higher levels of unknown knowledge and patterns. With the knowledge of the definition of data and the high pyramid, the role of data mining in the organizations can be further understood. Many of the techniques and algorithms generated in data mining have not been created from the beginning for specific data-mining applications. Data mining uses a wealth of techniques borrowed from statistics, computers, logic, artificial intelligence, etc. The choice of technique used is dependent on the work to be done and the nature of the existing data, and the data taker [18]. In all systems, based on their features and nature, data is generated from which the data is derived and the system itself. In Data mining, the process of creating data is reversed and started from the data created and returned to the system itself and discovered the features and properties of the system.

One of the main reasons for the data mining attraction is that the data mining tool makes it possible to analyze the data of large databases. Therefore, one of the key elements of the data mining is large and complex databases. Also, data mining can work well when it runs on high-speed computers with parallel processing power. On such computers, databases can be analyzed and responded to questions like the following: "Which customers are more likely to affect our future development and why?"

2.2 Top-down and bottom-up approaches

Dowel techniques can be divided into two types of direct techniques (with a top-down approach (and indirect) approach from bottom to top). The first approach, which is the premise test, is a top-down approach. Assuming that what is actually done by all statisticians and scientists is to prove or reject a default statement using data. The test and assurance testing assumptions may simply be made using existing data or that the need to provide data. In data mining, this approach is said to be top-down because the higher levels of data (knowledge and information) are assumed to be hypothetical, and then we enter the data and the lower levels from above and test the target within the data. Second approach is an approach from bottom to top which is called "knowledge discovery." In this approach, we start with data and try to obtain higher levels of data by gaining information and knowledge. Knowledge can be obtained directly or indirectly, and expressing an explanation about a specific feature or specific variable. This is not the case in indirect data mining and there is no target specificity. In this kind of data, we usually look for a series of relationships between variables or find groups of similar records. Examples of this kind of data mining are market basket analysis or clustering of customers [18].

Data mining is commonly used by customer-driven organizations, such organizations (airline stores, manufacturers, retailers and internet stores) can use data mining to link their actions with internal factors such as commodity prices, discounts, the cost of advertising and other internal factors with external factors such as the characteristics of customers (Sun, Genocide, Income and Exclusivity), competitors and market agents (public income level, prosperity and economic recession) can be found. In addition, the power of the horn such as customer satisfaction, income and profits of the organization, total capital expenditures and current and upward costs extracting over time.

The applications for data mining are very wide. For further examples, data mining applications can be listed in the following areas:

➢ Management systems, for example customer relationship management or CRM
➢ Security software, such as network monitoring software and virus scanners
➢ Banking systems, such as assigning credit to customers and classifying them
➢ Financial and economic, for example, the prediction of the price of one or more stocks or indicators
➢ Planning and locating, for example, the internal arrangement of a large store or the allocation of urban amenities
➢ Medical sciences, for example, predict possible risks of a specific surgery

Data mining has taken its name from the similarity between "Searching for hidden patterns in a large database and Kavind Mountain to find the main ore segments" [18]. Today, data mining with the support of three technologies that have reached puberty is fully prepared. These three technologies are:

1. Collect and store bulk data
2. Multiple and parallel computers
3. Advanced Data Mining algorithms

Data mining in the last decade has been developed with the support of technologies such as science, statistics, artificial intelligence and machine learning. To better understand what data mining is doing, it is better to first understand the concepts of applications, operations (data mining). Applications, operations and data mining methods are:

Operation

1) Categories
2) Prediction
3) Clustering
4) Estimates
5) Determine the relationship between variables

Applications

1) Categories of Customers
2) Identifying irregularities.
3) Analysis of Internet sites
4) Data analysis in marketing
5) Analyzing and forecasting developments in market

Exchange techniques

1) Neural networks
2) Decision tree
3) Nearest neighbor algorithms
4) Cluster analysis
5) Inference algorithms
6) Genetic algorithm

2.3 Data mining practices

Data mining will receive business opportunities that are created for the organization and bring them to turn the information into action. But what matters to an important organization is that at this stage, due to the fact that data mining results may lead to hidden patterns that need to be familiar with the business process, and that it is necessary to be aware of people who are interested in obtaining valuable information. Analyze the datasheets of the business process. Also, in doing the data mining, you have to pay attention to some points that affect the success of data mining and the acquisition of valuable information, including:

1) The data is not stored properly. It is possible to use five-digit codes when nine digits are required.
2) Confusing data in various fields. For example, the delivery date in a system as the delivery date is in accordance with the schedule and in the other system the delivery date is real and this point is not taken into account.
3) Failure to correctly and accurately enter data
4) The unwillingness of some organizational groups to change, especially when there is no incentive to change.
5) Not considering time, for example, when the results of the data mining are out, is no longer applicable and the opportunity is lost.

The step of data mining in this cycle also includes several steps that include:

1) Determine past information.
2) Data cleansing and initial processing. At this point, data errors are corrected and the wrong data is replaced. This may involve up to 60% of the time of data mining [18].
3) Data integration: Because data is usually collected from different sources, it must be in the form of an appropriate data repository to make data mining operations better.
4) Select the target data set.
5) Find the features to be used and identify new features.
6) Display the data so that it can be used for data mining.
7) Selection of data mining operations (categorization, clustering, prediction, determination of affiliation, etc.).
8) Selection method of data mining (neural networks, decision tree, and Genetic algorithm and ...).
9) Data mining and searching to find the right pattern.
10) Evaluation and analysis of the obtained pattern and the removal of inappropriate patterns.
11) Interpreting the results of data and deductions from valuable information.

2.4 Decision tree

Decision tree is one of the strong and common tools used to classify and predict the behavior of customers. Decision tree produces laws it means that it explains its forecast of in the form of a set of rules. Decision tree classifies the data in each group so that no data will be deleted. This user friendly technique is useful in marketing. Created model by the decision tree is easy to understand. In other words, even though algorithms that make up the tree may not be so simple, but it's easy to understand results and extracted patterns. Categories that are created in decision tree are of the same data stored in the predictive parameters. The decision tree algorithm starts with test selection that does the best isolation for categories. In the later stages of tree, the same thing is done for next nodes with less data to ensure the best laws. Tree gets large enough so that better isolation for data nodes can no longer be done. Sometimes this algorithm is used as the first step for pre-processing of data [18].

2.5 Web mining

Web mining is one of the research areas using data mining techniques automatically to discover and extract information from documents and web services [10]. In fact, web mining, and knowledge discovery process of

information and useful web data is unknown [11]. Web mining methods are based on what type of data is explored and are divided into three categories: Web content mining, web structure mining and web usage mining.

Web content mining: Web content mining is the process of extracting useful information from the content of web documents. The content of a web document is corresponding to the concepts that the document sought to transfer it to the users [12].

Web structure mining: Web can be represented as a graph that its nodes are documents and edges are links between documents. Web structure mining, is the process of extracting structural information from the web [13].

Web usage mining: Web usage mining is part of web mining process that is responsible for mechanized mining of user access patterns from one or more web server(s). Web sites often collect and produce large volumes of data. Most of this information is usually automatically generated by the web server and are collected by server access logs. Server access log analysis and users recorded data can provide valuable information [14] and [15].

This article focuses on web usage mining.

3. DATA PREPARATION

Overall process of web personalization is based on web usage mining consists of three steps:

- preparation and data modeling,
- discovery of pattern from usage data,
- use of discovered patterns to customize the web.

Here, first data are collected and are pre-processed. Web usage mining techniques are applied for the data and the obtained results are analyzed. The tools used in this research are Apriori algorithm and decision tree, which are explained in details.

Also, note that the data are collected from Digikala online shopping store.

3.1 Collection, combination and pre-processing of data

Log files, often are used for web usage mining and are classified in to three formats namely, public, developed and proprietary formats. In this study, the log file format used to store information is the public one. An example is shown in Figure 1 in the form of an Excel file.

	A	B	C	D	E	F	G
1	Ip Address	Date	Page Number	Request	Country	ID	
2	85.9.79.18	9/11/2016 19:50	1002	Login	Iran. Islamic Repblic	NFy2xT3h8ZHG385LdIxHWZo124	
3	85.9.79.18	9/11/2016 19:57	301	DigitalProduct-Mobile	Iran. Islamic Repblic	NFy2xT3h8ZHG385LdIxHWZo124	
4	85.9.79.18	9/11/2016 20:12	302	DigitalProduct-Laptop	Iran. Islamic Repblic	NFy2xT3h8ZHG385LdIxHWZo124	
5	85.9.79.18	9/11/2016 20:14	image	Image	Iran. Islamic Repblic	NFy2xT3h8ZHG385LdIxHWZo124	
6	85.9.79.18	9/11/2016 20:20	1001	Logout	Iran. Islamic Repblic	NFy2xT3h8ZHG385LdIxHWZo124	

Figure 1. Sample log file

According to Figure 1, the log file contains information about the IP address of the user, date and time of user requests, code of requested page, the requested page by user, and finally unique proprietary code given to each user. Of course, just some of these features are useful in web usage mining and will be explained further in data pre-processing purpose. The total number of records collected is 13,500 records, with 6 features that are related to the period of July to September 2016. After transferring to SQL Server 2015 and performing cleanup and integration with C# .net 2015, records are cut down to 8000.

In the pre-processing stage, for preparing data, all requests such as images that are related to the area of the screen are eliminated and only the rows that were about visits and shopping from the store were kept. This command is so that every page of the site is identified by a number. In the next step the user features such as IP address and country are deleted from the log file and the following file is created:

Date< Page Number < Request.

The above format is as follows: the time and date of the request to visit the page, then the page number, code of visited page.

After cleaning the data the last stage of pre-processing is creation of sequence of visited pages by each user.

3.2 Applying the data mining techniques

After converting data of the log file to a suitable format, we will discover the patterns. Below is a brief description of employed techniques and algorithms. The purpose of the association rules is to discover dependencies between items that their occurrence is at the same time. The rules of argumentative statements are displayed in the form A→B. A is priori and B is the result. Support and confidence are of important measures of association rules that can be used to evaluate the discovery rules that respectively are the number of presences of discovered rules and certainty of a discovered rule. Association rules are important in suggesting engines. In other words, association rules are the basis for any suggestion.

Decision tree is used for classification and decision-making in the marketing. The decision tree has a root node at the top and at leaves at the bottom. A record enters the root node and a test determines it goes to each one of the child nodes. There are usually several ways to select this initial test, but they all have one goal being to choose the best method for separation target clusters. This process will continue to reach the leaf node. All records that reach a leaf are grouped in a category. To reach from root to a leaf, there is only one way and that way, in fact, is the expression of the law that was created to classify records. There might be lots of leaves that have the same group, but every leaf to be in a category has different justification. Any way created from the roots to the leaf is a law and some laws are better than other laws. In fact, sometimes cutting some branches of trees improves the predictive power of trees.

4. DATA ANALYSIS

To verify the proposed framework has been carried out using Apriori algorithm for pattern discovery and extraction of association rules. The algorithm is encoded in MATLAB by C programming language to be able to run on the desired dataset. In these tests, by selecting different values as components of test and assessing the answers, we reach the results to be an input for the next step. In the following instance a series of transactions has been shown, that is obtained from log file after purification performing algorithm.

In Table 1, it is shown how the data is purified for analysis of movement patterns. For example, in the transaction (1), first, person goes to page 307 and then moves to 308 and in page 403 this transaction is completed. Products purchased are of home appliance. Each transaction includes set of patterns and mentioned algorithms are used for pattern recognition to evaluate the pattern for comprehensive statistics.

Table 1. Example of user transactions

Row	Transaction	Products Bought
	Page number:	
	DP [digital: 101-112]	DP [6]
	HP [house: 301-308]	HP [7]
	MP [makeup: 401-403]	MP [8]
	SP [sport: 501-507]	SP [9]
	AP [Art: 201-209]	AP [10]
1	307 308 401 403	7
2	103 101 105 106 110 111 112	6

In Table 2, part of the patterns discovered by the implementation of Apriori algorithm is given. For example, row 1 shows that 78% of users who visited pages 301 and 302 will visit page 307. This applies for 16% of rules, so Page 307 is an appropriate option to offer to users who visited Page 301 and 302.

Table 2. Association rules implementation

Row	Confidence	Support	Rule
1	0.78	0/16	301,302 ⟶ 307
2	0/82	0/23	105 ⟶ 106
3	0/9	0/27	101 ⟶ 112,108

In Table 3, for example, row 2 shows that with minimum coverage of 0.2 and the accuracy of 0.3, 0.5 and 0.6, the number of laws is minimal so that they can be neglected. Row 3 shows that taking into account the minimum coverage of 0.1 and 0.3 of accuracy the number of laws are 47 and in accuracy of 0.5 and 0.6, respectively, 41 and 32 laws are generated, correspondingly.

Table 3. Number of laws discovered after determining the repeatable sets

Row	Support	Confidence=0/3	Confidence=0/5	Confidence=0/6
1	0/3	-	-	-
2	0/2	6	8	9
3	0/1	47	41	32

In Table 4, the most visited page a long with information about the number of visits and subject of these pages are provided. From the analysis of these pages, the most visited pages and selling goods can be found. The high number of visit of pages with a particular issue highlights the importance of the issue or the product for particular users. Most visited pages on this site are pages of digital goods that the importance of this issue can be realized among the users.

Table 4. Example of most visited pages

Row	Page Number	Subject	Number of visits
1	101	Digital Products - Mobile	1793
2	108	Digital products - HiFi	1439
3	302	House products - Mixer	503
4	503	Sports – Sports Wear set	409
5	307	House products - Kitchen Product	232
6	403	Make up Products	201
7	506	Sports – Hiking Boat	171

The tests of categorization of users using decision tree was conducted to determine interests of users in a product in terms of age and gender. User profile information is coded after analysis and pre-processed. Output of decision tree algorithm based on three characteristics of age, gender and purchased products are listed in Table 5.

Table 5. User profile information after pre-processing and coding

Row	Age Under 18 [1] 18-34 [2] 35-50 [3]	Gender Female [1] Male [2]	Products Bought DP [1] HP [2] MP [3] SP [4] AP [5]
1	3	1	2
2	2	2	1

Categorization of decision tree based on the product code that includes five products (digital, home appliances, sporting goods, health supplies, art supplies) is shown in Figure 2.

The highest selling product is in the digital category and the highest sale rate is in the age range of 18-34 years, and buyers are also male and female. The highest sales of home appliances include women in the age range of 35-50 years. The highest sales of sport goods include males in the age range of 18-34 years. The highest sales

of health supplies include women in the age range of 18-34 years. The highest sales of art supplies include males in the age range of 18-34 years.
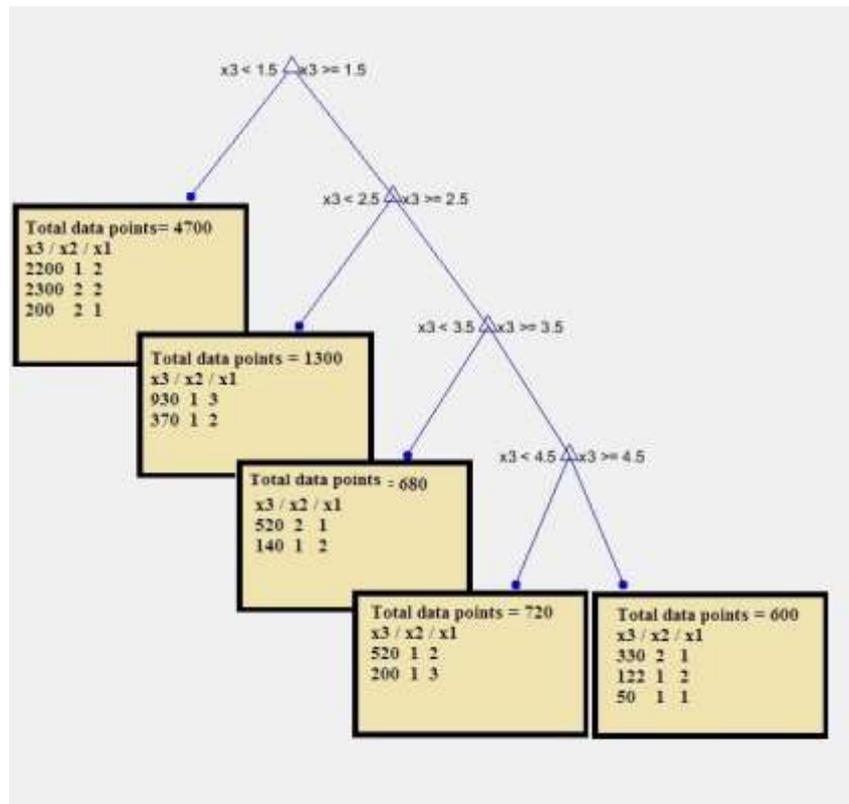

Figure 2. An output decision tree

Using the output of decision tree and Apriori algorithms present user's interests and the appropriate page of the website is offered for users according to the attributes such as gender and age range.

5. CONCLUSIONS

In this paper, a study has been made based on data mining techniques to extract knowledge in a data set that was related to records of users in an online shopping web store. The main goal was to address discovered patterns from data extracted from the user profile information and the log during a specified time applying usage mining and decision tree algorithms. Then, by comparing the outputs of decision tree and Apriori algorithms good strategies were made in marketing and customization of web pages. One of the results of the tests was that by the analysis of webpages, users' interests, gender and age range and the type of products they purchase, related pages of the online store can be realized. The high number of visits of the digital products indicated that the product was of high importance among users (both female and male) who were in ages of 18-34 years. So, digital goods were first recommended to users who are in this age range. Webmasters and marketers can use these statistics to take steps to improve the website.

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