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**PREDICTING CONSUMER BUYING BEHAVIOR USING A DATA MINING TECHNIQUE**

**ARATHI CHITLA**  
**ASSOCIATE PROFESSOR**  
**DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING**  
**TELANGANA UNIVERSITY**  
**DICHPALLY**

**ABSTRACT**

Consumer is the most essential source of revenue for business organizations; therefore his behavior is of significant importance for achieving market survival and financial prosperity. Consumer buying behavior is a complex phenomenon, which is comprised of a bundle of decision making processes, economic determinants and market stimuli. Data mining involves extracting interesting patterns from data and can be found at the search of the Operational Research (OR), as its aim is to create and enhance decision support systems. Traditional OR methods linear programming, quadratic optimization, genetic algorithms and concept based on artificial ant colonies. Data mining application domains ranges from credit risk, marketing and fraud detection to counter-terrorism. In all of these, data mining is increasingly playing a major role in decision making as well as in consumer buying behavior. This paper outlines the upcoming trends and challenges in data mining and identifies a technique to predict consumer purchase patterns.

**KEYWORDS**

consumer, data mining, decision making, purchase patterns.

**INTRODUCTION**

In the globalization era, consumer plays a key role in determines what a business is. Consumer behavior focuses on the study of both physical activities and decision making processes that occur in the process of search, evaluation, acquiring, use and disposal of products. Data mining involves extracting interesting patterns from data and can be found at the search of the Operational Research (OR), as its aim is to create and enhance decision support systems. Traditional OR methods linear programming, quadratic optimization, genetic algorithms and concept based on artificial ant colonies. Data mining application domains ranges from credit risk, marketing and fraud detection to counter-terrorism. In all of these, data mining is increasingly playing a major role in decision making as well as in consumer buying behavior.

**SURVEY OF LITERATURE**

Data mining techniques are more effective tool for analyzing consumer behavior. However the data mining methods have disadvantages as well as advantages. Therefore it is important to select appropriate tool to mine database.

The Junzo watada et al. in their paper "A Data mining approach to consumer behavior" tried to improve data mining analysis by applying several methods including fuzzy clustering, principal component analysis and discriminate analysis. Many defects included in the conventional methods are improved in this paper. [4]

Parvinder S. Sandhu et al. in their paper "Mining utility-oriented association rules" explains, An efficient approach based on profit and quantity" Association rule mining has been an area of active research in the field of knowledge discovery and numerous algorithms have been developed to this end. In this paper, they propose an efficient approach based on weight factor and utility for effectual mining of significant association rules. Initially, the proposed approach makes use of the traditional Apriori algorithm to generate a set of association rules from a database. The proposed approach exploits the anti-monotone property of the Apriori algorithm, which states that for a k-item set to be frequent all (k-1) subsets of this itemset also have to be frequent. Subsequently, the set of association rules mined are subjected to weight age (W-gain) and utility (U-gain) constraints, and for every association rule mined, a combined utility weighted score (UW-Score) is computed. Ultimately, they determine a subset of valuable association rules based on the UW-Score computed. The experimental results demonstrate the effectiveness of the proposed approach in generating high utility association rules that can be lucratively applied for business development. [6]

Jyothi Pillai in "User centric approach to itemset utility mining in Market Basket Analysis" describes Business intelligence is information about a company's past performance that is used to help predict the company's future performance. It can reveal emerging trends from which the company might profit. Data mining allows users to sift through the enormous amount of information available in data warehouses; it is from this sifting process that business intelligence gems may be found. Within the area of data mining, the problem of deriving associations from data has received a great deal of attention. This problem is referred as "market-basket problem". Association Rule Mining (ARM), a well-studied technique in the data mining field, identifies frequent itemsets from databases and generates association rules by assuming that all items have the same significance and frequency of occurrence in a record. However, items are actually different in many aspects in a number of real applications such as retail marketing, nutritional pattern mining, etc. Rare items are less frequent items. For many real world applications, however, utility of rare itemsets based on cost, profit or revenue is of importance. For extracting rare itemsets, the equal frequency based approaches like Apriori approach suffer from "rare item problem dilemma". Utility mining aims at identifying rare itemsets with high utility. The main objective of Utility Mining is to identify the itemsets with highest utilities, by considering profit, quantity, cost or other user preferences. Also valuable patterns cannot be discovered by traditional non-temporal data mining approaches that treat all the data as one large segment, with no attention paid to utilizing the time information of transactions. Now, as increasingly complex real-world problems are addressed, temporal rare itemset utility problem, are taking center stage. In many real-life applications, high-utility itemsets consist of rare items. Rare itemsets provide useful information in different decision-making domains such as business transactions, medical, security, fraudulent transactions, and retail communities. For example, in a supermarket, customers purchase microwave ovens or frying pans rarely as compared to bread, washing powder, soap. But the former transactions yield more profit for the supermarket. A retail business may be interested in identifying its most valuable customers i.e. who contribute a major fraction of overall company profit. In this paper, these problems of analyzing marketbasket data are considered and important contributions are presented. It is assumed that the utilities of itemsets may differ and determine the high utility itemsets based on both internal (transaction) and external utilities. [9]

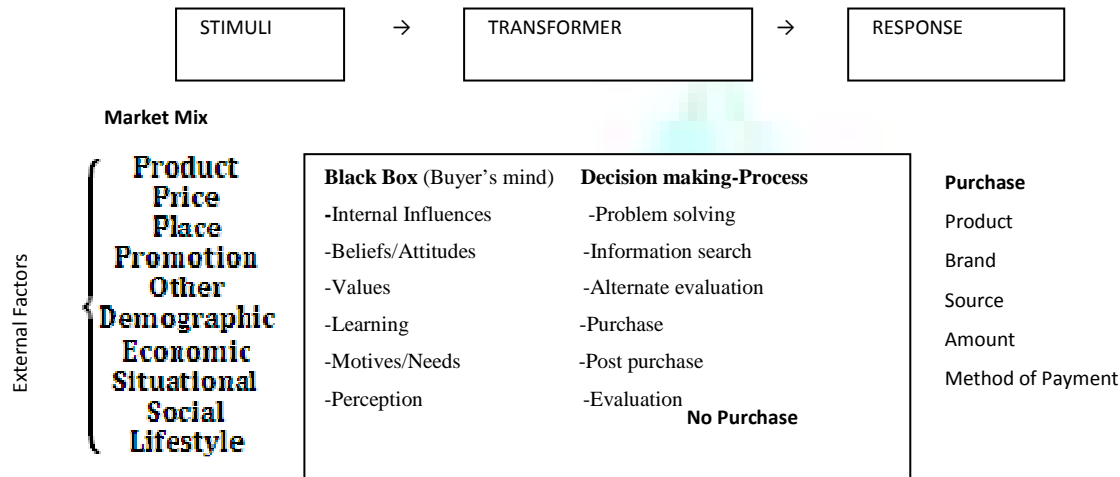
"Efficient Association Rule Mining for Market Basket Analysis" Shrivastava A., Sahu R. writes in that Data mining is an attitude that business actions should be based on learning, that informed decisions are better than uninformed decisions, and that measuring results is beneficial to the business. Data mining is also a process and a methodology for applying the tools and techniques. Association rule mining is also one among the most commonly used techniques in Data mining. A typical and the most running example of association rule mining is market basket analysis. This process analyzes customer buying habits by finding associations between the different items that customers place in their "shopping baskets". The discovery of such associations can help retailers develop marketing strategies by gaining insight into which items are frequently purchased together by customer and which items bring them better profits when placed with in close proximity. The algorithms for single dimensional association rule mining, such as apriori and the FP-tree developed are in a greater use today. However, candidate set generation in apriority is still costly, especially when there exists a large number of patterns and/or long patterns. And both these algorithms prune the item sets based on their frequencies (i.e., if their frequencies exceed minimum support threshold then they term them as frequent and the rest of them as infrequent). But this pruning technique is insufficient to help market analyst to make decisions such as planning the supermarket's shelf space, changing the layout new store layouts, new product assortments, which products to put on promotion so as to improve their marketing profits. So the focus of

this paper is to enhance these algorithms in a way that it provides frequent profitable patterns which help market analyst to make the best informed decisions for improving their business. [10]

**CONSUMER BUYING BEHAVIOR**

The study of how and why people purchase goods and service is termed consumer buying behavior. The term covers the decision-making processes from those that precede the purchase of goods or services to the final experience of using the product or service. Models of consumer buying behavior draw together the various influences on, and the process of, the buying decision. They attempt to understand the proverbial ‘black box’ of what happens within the consumer between his or her exposure to making stimuli and the actual decision to purchase.

**TABLE 1: BLACK BOX MODEL OF CONSUMER BUYING BEHAVIOR**



Source: Keegan et al. (1992, p. 193)

**BUYING DECISION**

The buying situation can vary from routinized responses behavior to limited problem solving to extensive problem solving. The process of buying takes place in the mind of buyer. In this process two activities take place.

- The thought process-analyses and decides what to buy, when to buy, etc...
- The resultant activity-accepting or rejecting a product.

Buying is not a single act but a multi component decision on the need class, generic class, product form, brand, vendor, quantity timing and method of payment. Consumer decision behavior is the behavior with most consumers has the general objective of creating and maintaining a collection of goods and services that provides current and future satisfaction.

**TYPES OF CONSUMER DECISION MAKING**

Routine response behavior is usually found in the cases of frequently purchase and low cost items. The products through its type are purchased quickly with less effort.

Limited decision making is pertinent in the case of purchases made by the consumers less frequently, the investment needed also will be comparably high. This requires a moderate amount of time for information gathering and deliberation.

Extensive decision making is require when a consumer wants to produce unfamiliar products which is totally new, having high unit value and bought once in his life time. This is the most complex type.

**FACTORS INFLUENCING CONSUMER BUYING BEHAVIOR**

Consumer buying behavior is determined by:

- Level of involvement in purchase decision. Importance and intensity of interest in a product in a particular situation.
- Buyer’s level of involvement determines why he/she is motivated to seek information about a certain precuts and brands but virtually ignores others.

**Consumer buying Process** What influences consumers to purchase products or services? The consumer buying process is a complete matter as many internal and external factors have an impact on the buying decisions of the consumer. The six stages to the consumer buying process include:

- Problem Recognition** (awareness of need)-difference between the desired state and the actual condition. Deficit in assortment of products.
- Information search**
  - Internal search, memory.
  - External search if you need more information. Friends and relatives (word of mouth). Marketers determined sources; comparison shopping; public sources etc.
- Evaluation of alternatives** need to establish criteria for evaluation, features the buyer wants or does not want. Rank/weight alternatives or resume search. Information from different sources may be treated differently. Marketers try to influence by “framing’ alternatives.
- Purchase decision** Choose buying alternative, includes product, package, store, method of purchase etc.
- Purchase** may differ from decision, time lapse between 4 & 5, product availability.
- Post-Purchase Evaluation** outcome. Satisfaction or Dissatisfaction. **Cognitive Dissonance**, have made the right decision. This can be reduced by warranties, after sales communication.

What can data mining do? Data mining is primarily used today by companies with a strong consumer focus-retail, financial, communication, and marketing organizations. It enables these or staff skills, and “external” factors such as economic indicators, competition, and customer demographics. And, it enables them to determine the impact on sales, customer satisfaction, and corporate profits. Finally, it enables them to “drill down” into summery information to view detail transactional data. With data mining, a retailer could use point-of-sale records of customer purchase to send targeted promotions based on an individual’s purchase history. By mining demographic data from comment or warranty cards, the retailer could develop products and promotions to appeal to specific customer segments.

For example, Blockbuster entertainment mines its video rental history database to recommend rental to individual customers. American Express can suggest products to its card holders based on analysis of their monthly expenditures.



## BENEFITS OF DATA MINING TO CONSUMERS

Data mining, or knowledge discovery, an estimated \$ 1.85 billion industry, requires the computer-assisted process of digging through and analyzing enormous amounts of data and then extracting the meaning of the data. But for business owners, data mining can be a powerful tool to take their company from zero to profitability in relatively short order. Data mining includes:

- **Market segmentation** identifies the common characteristics of customers. Market segmentation allows a company's marketing or sales arm to focus on prospects that are "most likely" to buy products.
- **Customer chum** predict the factors that cause customers to leave a business and go to a competitor. Understanding these factors helps companies take action to reduce their churn rate.
- **Fraud detection** identifies which transactions are most likely to be fraudulent.
- **Direct marketing** predicts what online buyers are most likely to respond to in order to obtain the highest response rate.
- **Interactive marketing** predicts what online buyers are most likely to respond to in order to optimize website advertisements and increase conversion rates.
- **Trend analysis** analyzes changes over a period of time to forecast future performance.

## STAGES OF DATA MINING IN CONSUMER BEHAVIOR

One "official" definition of consumer behavior is "The study of individuals, groups, or organizations and the process they use to select, secure, use and dispose of products, services, experiences, or ideas to satisfy needs and the impacts that these processes have on the consumer and society."

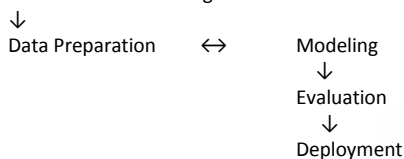
The ultimate goal of data mining is prediction of consumer buying behavior and predictive data mining is the most common type of data mining and one that has the most direct business applications. The process of data mining consists three stages: (1) the initial exploration, (2) model building or pattern identification with validation/verification, and (3) deployment (i.e., the application of the model to new data in order to generate predictions).

**Stage 1: Exploration:** This stage usually starts with data preparation which may involve cleaning data, data transformations, selecting subsets of records and – in case of data sets with large numbers of variables ("fields") performing some preliminary feature selection operations to bring the number of variables to manageable range (depending on the statistical methods which are being considered). Then, depending on the nature of the analytic problem, this first stag of the process of data mining may involve anywhere between a simple choice of straightforward predictors for a recognition model, to elaborate exploratory analyses using a wide variety of graphical and statistical methods in order to identify the most relevant variables and determine the complexity and/or the general nature of models that can be taken into account in the next stage.

**Stage 2: Model Building and validation:** This stage involves considering various models and choosing the best one based on their predictive performance (i.e., explaining the variability in question and producing stable results across samples). This may sound like a simple operation, but in fact it sometimes involves a very elaborate process. There are a variety of techniques developed to achieve that goal-many of which are based on so called "competitive evaluation of models," that is applying different models to the same data set and then comparing their performance to choose the best. These techniques-which are often considered the core of predictive data mining include: Bagging (Voting, Averaging), Boosting, Stacking (Stacked Generalizations), and Meta-Learning.

**Stage 3: Deployment:** That final stage involves using the model selected as best in the previous stage and applying it to new data in order to generate predictions or estimates of the expected outcome.

Business understanding ↔ Data Understanding



## TYPES DATA MINING ALGORITHMS IN CONSUMER BUYING BEHAVIOR

- Classification algorithms predict one or more discrete variable, based on the other attributes in the dataset. An example of a classification algorithm is the Microsoft Decision Trees Algorithm.
- Regression algorithms predict on or more continuous variable, such as profit or loss, based on other attributes in the dataset. An example of a regression algorithm is the Microsoft Time Series Algorithm.
- Segmentation algorithms divide data into groups or cluster, of items that have similar properties. An example of a segmentation algorithm is the Microsoft Clustering Algorithm.
- Association algorithms find correlations between different attributes in a dataset. The most common application of this kind of algorithm is for creating association rules, which can be used in a market basket analysis. An example of an association algorithm is the Microsoft Association Algorithm.
- Sequence analysis algorithms summarize frequent sequences or episodes in data, such as a Web path flow. An example of a sequence analysis algorithm is the Microsoft Sequence Clustering Algorithm.

### MICROSOFT DECISION TREE ALGORITHM

The Microsoft Decision Tree algorithm is a classification algorithm provided by Microsoft SQL to predict the consumer buying behavior. The marketing department of the company identifies the characteristics of previous customer that might indicate whether those customers are likely to buy a product in the future. The database stores demographic information that describes previous customers. By using the Microsoft Decision Tree algorithm to analyze this information, the marketing department can build a model that predicts whether a particular customer will purchase products, based on the states of known columns about that customer, such as demographics of past buying patters.

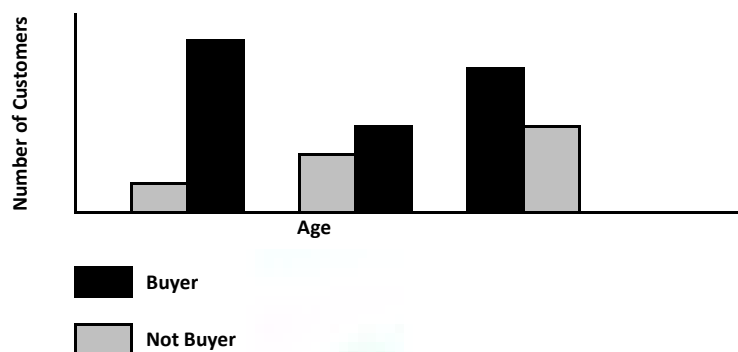
### HOW THE ALGORITHM WORKS?

The Microsoft Decision Tree algorithm builds a data mining mode by creating a series of splits in the tree. These splits are represented as nodes. The algorithm adds a node to the model every time that an input column is found to be significantly correlated with the predictable column. The way that the algorithm determines a split is different depending on whether it is predicting a continuous column or a discrete column.

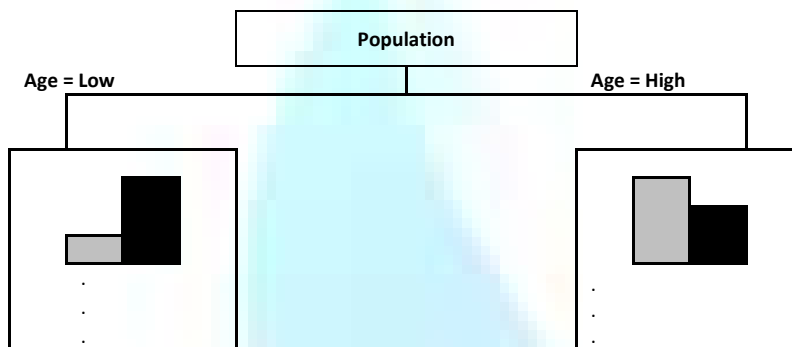
The Microsoft Decision Trees algorithm uses feature selection to guide the selection of the most useful attributes. Feature selection is used by all Analysis Services data mining algorithms to improve performance and the quality of analysis. Feature selection is important to prevent unimportant attributes form using processor time. If you use too many input or predictable attributes when you design a data mining modes, the model can take a very long time to process, or even run out of memory. Methods used to determine whether to split the tree include industry standard metrics for entropy and Bayesian networks.

A common problem in data mining modes is that the model becomes too sensitive to small differences in the training data, in which case it said to be over-fitted or over-trained. An over fitted model cannot be generalized to other data sets. To avoid over fitting on any particular set or data, the Microsoft Decision Trees algorithm uses techniques for controlling the growth of the tree.

The Microsoft Decision Trees algorithm builds a tree for a discrete predictable column can be demonstrated by using a histogram. The following diagram shows a histogram that plots a predictable column, Bike Buyers, against an input column, Age. The histogram show that the age of a person helps distinguish whether that person will purchase a bicycle.



The correlation that is shown in the diagram would cause the Microsoft Decision Trees algorithm to create a new node in the model.



As the algorithm adds new nodes to a model, a tree structure is formed. The top node of the tree describes the breakdown of the predictable column for the overall population of customers. As the model continues to grow, the algorithm considers all columns.

**Querying a Decision Trees Modes (Analysis Services – Data Mining)**

Queries help you better understand and work with the information in the model in the following ways:

- Making single and batch predictions.
- Learning more about the patterns found by the model.
- Viewing detail or the training cases for a particular pattern or subset of the mode.
- Drilling through to details of the cases in the mining model.
- Extracting formulas, rules, or statistics about all or a subset of the model and data.
- To create meaningful queries on the content of a decision trees model, you should understand the structure of the model content, and which node type store what kind of information.

**SAMPLE QUERY**

By querying the data mining schema the necessary nodes can be retrieved and is possible to predict the bike buyers of the company form the total customers.

```

Select MINING_PARAMETERS
From $ system. DMSHEMA_MINING_MODELS
WHERE MODEL_NAME='TM-Decision Tree'
SELECT NODE_CAPTION
FROM [<decision tree model name>]
WHERE NODE_UNIQUE_NAME= '<node id>'
SELECT Predict ([Bike Buyer]), Predict Node ID ([Bike Buyer])
FROM [<decision tree model name>]
PREDICTION JOIN
<input row set>
  
```

**CONCLUSION**

Consumers provide the economic rationale for business activity. The data mining ensures the consumer purchase pattern in the market. It predicts the purchasing behavior of the consumers like “what do they buy?”, “When do they buy?”, “why do they buy?”

Marketers have to meet the preferences of consumers, because the beliefs are passed down the generations. The market leader will try to encourage habitual buying behavior by running frequent reminder advertising, avoiding out of stock condition. Challenger firms will encourage variety seeking by offering lower prices, deals, free samples and advertising that presents reasons for trying something new. In the evaluation stage, consumer ranks and forms purchase intension.

Generally the consumer purchase decision will be to buy the most preferred brand. Many purchases involve some risk taking. The marketer must understand the factors that provoke feelings of risk in consumer and must provide information and support that will reduce the perceived risk.

Buyer motivation, a key component of consumption, is the stimulus inducement or purpose in a certain desire.

The advent of data mining enhances the customer behavior prediction accuracy. The decision tree model classifies the consumers into buyers/not buyers. Mining change for consumer behavior is useful for satisfying customer needs in dynamic business environments. The system is developed would enable the marketing managers to rapidly establish marketing strategies and increase the profit of the company.

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