A Systematic Literature Review of Frequent Pattern Mining Techniques

Rashi Satnami[1], Girish Gogate[2]
[1]Dept of Computer Science & Engineering
[2]Assistant professor, Dept of Computer Science & Engineering
[1, 2] LNCT Indore (RGPV) M.P, India

Abstract- *In this paper, we are presenting an overview of existing frequent item set mining algorithms. Nowadays frequent item set mining is a very popular and computationally expensive task. We have also explained the fundamentals of frequent item set mining. We have described today's approaches for frequent item set mining. The frequent items are the raw elements to represent results in form of association rules From the broad variety of frequent item set mining algorithms that have been developed we will compare the most important ones. We have performed a literature review of association rule mining methods.*

Keywords- Data Mining, Association Rule Mining, Support, Confidence, Market Basket Analysis

I. INTRODUCTION

With the increase in Information and communication Technology the size of the databases created by the organizations due to the availability of low-cost storage and the evolution in the data capturing technologies is also increasing. It included retail, credit cards, insurance, banking and many others, for extracting the valuable data, it is necessary to explore the databases completely and efficiently. The Knowledge discovery in databases (KDD) helps to identifying precious information in such huge databases. Such valuable information can help the decision maker to make accurate future decisions. The KDD applications deliver measurable benefits including reduced cost of doing business enhanced profitability and improved quality of service. That's why Knowledge Discovery in Databases has become one of the most active and exciting research areas in the database community.

[1] Defined the problem of finding the association rules from the database. In this section, the basic concepts of frequent pattern mining for discovery of interesting associations and correlations between itemsets in transactional and relational database. Association rule mining is defined formally as follows:

An association rule is an implication of the form X -> Y where X,Y subset of I are the sets of items called Item sets and $X \cap Y = \Phi$. Association rules show attributes value conditions that occur frequently together in a given dataset. A commonly used example of association rule mining is Market Basket Analysis [1]. We will use a small example from the supermarket domain. The set of items for the example is-
I = {Milk, Bread, Butter,Beer}

An association rule for the shopping market could be **{Butter, Bread} =>{Milk}**meaning that if butter and bread are bought then customers also buy milk. For example the data are collected using bar-code scanners in supermarkets. A shopping market like this databases consist of a large number of transaction records. Every record lists all items bought by a customer on a single purchase transaction. All the managers would be interested to know if certain groups of items are consistently purchased together. Managers could use this data for adjusting store layouts (placing items optimally with respect to each other) also for cross-selling & for promotions to identify customer segments based on buying patterns.
An Association rules provide information in the form of "if-then" statements. Association rules are computed from the data and unlike the if-then rules of logic the association rules are probabilistic in nature. If 90% of transactions that purchase bread and butter , then also purchase milk.

Antecedent: the bread and butter
Consequent: milk
Confidence factor: 90%

As an addition to the antecedent (the "if" part) and the consequent (the "then" part) an association rule has two numbers that express the degree of uncertainty about the rule. Association analysis the antecedent and consequent are sets of items (called item sets) that are disjoint (do not have any items in common).

The **Support** for an association rule X->Y is the percentage of transaction in database that contains X U Y. The other associated term is known as the **Confidence** of the rule. The Confidence or Strength for an association rule X U Y is

the ratio of number of transactions that contains X U Y to number of transaction that contains X. Every itemset (or a pattern) is frequent if its support is equal to or more than a user specified minimum support (a statement of generality of the discovered association rules). The Association rule mining is to identify all rules meeting user-specified constraints such as minimum support and minimum confidence (a statement of predictive ability of the discovered rules). The key step of association mining is frequent itemset (pattern) mining which is to mine all itemsets satisfying user specified minimum support [5]

Generally, a large number of these rules will be pruned after applying the support and confidence thresholds. Therefore most of the previous computations will be wasted. To overcome this problem and to improve the performance of the rule discovery algorithm, the association rule may be decomposed into two phases:

1. Generate the large itemsets: the sets of items that have transaction support above a predetermined minimum threshold known as frequent Itemsets.
2. Using the large itemsets to generate the association rules for the database that have confidence above a predetermined minimum threshold.

The overall performance of mining association rules is depends primarily by the first step. The second step is easy. Once the large itemsets are identified the corresponding association rules can be derived in straightforward manner. The main consideration of the thesis is First step i.e. to find the extraction of frequent itemsets.

II. LITERATURE SURVEY

Mining frequent item sets is an important problem in data mining and is also the first step of deriving association rules [2]. Hence many efficient item set mining algorithms (e.g., Apriori [2] and FP-growth [10]) have been proposed. While all these algorithms work well for databases with precise values but it is not clear how they can be used to mine probabilistic data

For uncertain databases the Aggarwal [1] and Chui [9] developed efficient frequent pattern mining algorithms based on the expected support counts of the patterns. However Bernecker et al. [3] Sun[14] and Yiu [16] found that the use of expected support may render important patterns missing. Hence they proposed to compute the probability that a pattern is frequent and introduced the notion of PFI. In work done in [3] the dynamic programming based solutions were developed to retrieve PFIs from attribute uncertain databases. However their algorithms compute exact probabilities and verify that an item set is a PFI in O(n2) time. The proposed model-based algorithms avoid the use of dynamic programming and are able to verify a PFI much faster . In [16] the approximate algorithms for deriving threshold-based PFIs from tuple-uncertain data streams were developed. The Zhang et al. [16] only considered the extraction of singletons (i.e., sets of single items) our solution discovers patterns with more than one item. Recently Sun [14] developed an exact thresholdbased PFI mining algorithm. However it does not support attribute-uncertain data considered in this paper. In a preliminary version of this paper [15] we examined a model-based approach for mining PFIs. we study how this algorithm can be extended to support the mining of evolving data.

All the other works on the retrieval of frequent patterns from imprecise data includes [4], it studied approximate frequent patterns on noisy data then the [11], it examined association rules on fuzzy sets and [13], proposed the notion of a vague association rule. However none of these solutions are developed on the uncertainty models studied here.

For evolving databases there are a few incremental mining algorithms that work for exact data have been developed. Just For example in [6] the Fast Update algorithm (FUP) was proposed to efficiently maintain frequent item set & for a database to which new tuples are inserted. The proposed incremental mining framework is inspired by FUP. In [7] the FUP2 algorithm was developed to handle both addition and deletion of tuples. The work done by ZIGZAG [1] also examines the efficient maintenance of maximal frequent item sets for databases that are constantly changing. In [8] a data structure called (CATS Tree) was introduced to maintain frequent item sets in evolving databases. Another data structure called CanTree [12] arranges tree nodes in an order that is not affected by changes in item frequency. This data structure is used to support mining on a changing database.

The developments of computed technology in last few decades are used to handle large scale data that includes large transaction financial data, bulletins, emails etc. Hence information has become a power that made possible for user to voice their opinions and interact. As a result revolves around the practice, data mining [17] come into sites. Association rule mining is one of the Data Mining techniques used in distributed database. In distributed database the data may be partitioned into fragments and each fragment is assigned to one site. The issue of privacy arises when the data is distributed among multiple sites and no other party wishes to provide their private data to their sites but their main goal is to

know the global result obtained by the mining process. However privacy preserving data mining came into the picture. As the database is distributed, different users can access it without interfering with one another. In distributed environment, database is partitioned into disjoint fragments and each site consists of only one fragment.

Data can be partitioned in three different ways that is, like horizontally partitioned data, vertically partitioned data or mixed partitioned data.

Horizontal partitioning: - The data can be partitioned horizontally where each fragment consists of a subset of the records of relation R. Horizontal partitioning [20] [22] [23] [24] divides a table into several tables. The tables have been partitioned in such a way that query references are done by using least number of tables else excessive UNION queries are used to merge the tables sensibly at query time that can affect the performance.

Vertical partitioning: - The data can be divided into a set of small physical files each having the subset of the original relation, the relation is the database transaction that normally requires the subsets of the attributes.

Mixed partitioning: - The data is first partitioned horizontally and each partitioned fragment is further partitioned into vertical fragments and vice versa.

The market basket analysis used association rule mining [20][21] in distributed environment. Association rule mining [18][19][17] is used to find rules that will predict the occurrence of an item and based on the occurrences of other items in the transaction, search patterns gave association rules where the support will be counted as the fraction of transaction that contains an item X and an item Y and confidence can be measured in a transaction the item i appear in transaction that
also contains an item X

Privacy preserving distributed mining of association rule [21][17] for a horizontally partitioned dataset across multiple sites are computed. The basis of this algorithm [21][17] is the apriori algorithm that uses K-1 frequent sets. The problem of generation size of one item set may be carried out with secure computation on multiple sites by generating the candidate set, the pruning method, finding the union of large item set .

In [25], the authors conducted a comparative study to analyze the performance of FP-Growth & other frequent item set mining algorithms. The time complexity is the only performance metric used in this study. We have used the adult data set as the input data set. The results obtained are as follows:

Table: Comparison of algorithms on basis of time in ms

Support	FP-Growth	Eclat	Relim	SaM
30	0.56	0.54	0.49	0.47
40	0.50	0.50	0.44	0.44
50	0.49	0.45	0.42	0.41
60	0.48	0.44	0.40	0.40
70	0.42	0.40	0.39	0.37

The above table shows the execution time for all the algorithms with different support threshold for adult data set. The time of execution is decreased with the increase support threshold.

III. PROBLEM SPECIFICATION

The concept of frequent itemset mining was first introduced for mining transaction databases. Let I = {I1, I2, . . . , In} be a set of all items. Also A k-itemset α which consists of k items from I is frequent if α occurs in a transaction database D no lower than θ |D| times where θ is a user-specified minimum support threshold (called min_sup) and |D| is the total number of transactions in D.

IV. CONCLUSION

In this paper, we have surveyed existing association rule mining techniques. We have restricted ourselves to the classic frequent item set mining problem. Frequent item set mining is the generation of all frequent item sets that exists in market basket like data with respect to minimal thresholds for support & confidence.

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