

# A RECENT REVIEW ON ASSOCIATION RULE MINING

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## Abstract

Recently more encroachment has emerged in the field of data mining. One of the hottest topic in this area is mining for hidden patterns from the existing massive collection of databases. The knowledge obtained from these databases are used for different applications like super market sales-prediction, fraud detection etc. In this article, the various advancements in data mining using the association rule mining is discussed. The role of Association rules in temporal mining, utility mining, statistical mining, privacy preservation mining, particle swarm optimizations etc., are reviewed. Therefore, this survey guides the researchers to know the progress of pattern mining using association rules for the intended purposes.

**Keywords:** Temporal mining, utility mining, statistical mining, privacy preservation mining, Particle swarm optimizations.

## 1. Introduction

Data mining refers to the process of extracting knowledge from large amounts of data. The mining process is an iterative sequence [17] of steps. Since the data has come from various sources, we cannot expect them to be in the clean format. Presence of noise can disturb the Predicting procedure. Therefore, Cleaning of data has to be performed first. As the data belongs to different sources integration is to be done. Not all the data is related to our task of mining, therefore data selection should be done and then the data should be transformed to the required form for mining process. Finally, the Data Mining Engine with the help of knowledge base uses various tools for mining the data repository which contains the transformed data for pattern evaluation. The Knowledge discovery process concept in databases is given in [32].

## 2. Association Rule Mining

Normally there exists two categories of data mining. (i) Descriptive data mining (ii) Predictive data mining. For carrying out summarizations or generalizations descriptive data mining is used. Wherein for finding out the inference or predictions, Predictive data mining is used. Association rule mining falls under the descriptive category. Association rules aims in extracting important correlation among the data items in the databases. Shichao Zhang et al [36] have given association mining methods and the importance of rule interestingness measures. Association rule, basically extracts the patterns from the database based on the two measures such as minimum support and minimum confidence. To select the best measures for mining rules based on constraints such as multiple criteria is discussed in [31]. The support and confidence measures are described as stated in [17] for mining frequent itemset mining and association rule generation.

### 2.1. Support:

The rule  $(A \Rightarrow B)$  holds in the transaction set D with support  $s$ , where  $s$  is the percentage of transactions in D containing  $A \cup B$ .

$$\text{Support}(A \Rightarrow B) = P(A \cup B) \quad (1)$$

## 2.2. Confidence:

The rule  $(A \Rightarrow B)$  has confidence  $c$  in the transaction set  $D$ , where  $c$  is the percentage of transactions in  $D$  containing  $A$  that also contains  $B$ .

$$\text{Confidence}(A \Rightarrow B) = P(B|A) \quad (2)$$

In general, association rule mining can be viewed as a two-step process.

- (i) Generating all item sets having support factor greater than or equal to, the user specified minimum support.
- (ii) Generating all rules having the confidence factor greater than or equal to the user specified minimum confidence.

Mining of both Positive and Negative association rules in databases is discussed [49]. This paper introduces pruning strategy and interestingness measures for scaling to large databases. Since decision making in applications such as product placement and investments analysis involves many factors, there is a need to minimize harmful rules at the same time to increase the profits. Therefore, mining negative association rules plays a vital role in decision making scenario. Also, mining Negative association rules is discussed in [48]. The article employs hierarchical graph structured taxonomy of domain terms. This method efficiently discovers rules from large databases. The concept of least frequent item sets in association rule discovery is discussed in [33]. Manisha et al [24] have presented a framework of association rule mining from sensor data. They have utilized three data mining techniques such as Positional Lexicographic Tree (PLT), Sensor Pattern Tree (SPT) and Frequent Pattern (FP) Growth for mining the sensor data. The concept of application of ARM in Database Reverse Engineering is presented by Nattapon [28]. In this the authors have proposed a conceptual schema discovery process to reduce the number of generated rules. Apart from the traditional mining procedure for frequent pattern mining, the numerical frequent pattern approach is discussed by Norwati Mustapha et al [29]. A combined approach which integrates association rule mining and classification rule mining called associative classification using medical data set is discussed by Sunita et al [37]. The application of fuzzy association rule in Banking database is discussed by Wai-Ho Au et al [44] the authors have presented FARM II – a Fuzzy Association Rule Mining II for handling both relational and transactional data . With the results of mining procedure, the bank discovered patterns about the customers for effective decision making. Mining association rules from ordinal data is discussed by Yen-Linag Shen et al [50]. There are possibilities of impreciseness in the data to be mined. This paper presents a new direction for mining rules from this scenario. Ontology based Fuzzy association rules can be mined in large databases is discussed in [53]. This Ontology based mining helps in mining of more visual and understanding rules. David Taniar et al., [9] have proposed a exceptionality measure to evaluate candidate exception rules. The rules appear in the form of negative as well as positive association for essential decision making.

## 3. Temporal Mining

Generally adding time factor to the association rules are called as temporal association rule mining. A Transaction with time information can be defined as:  $\{TID, I_1, I_2, \dots, I_n, T_s, T_e\}$ , where  $TID$  is the ID of each transaction. It means an item set containing  $n$  items.  $T_s, T_e$  gives the start and end of the valid time of a transaction [52]. An association rule is said to be strong association rule if it satisfies minimum support threshold and minimum confidence threshold. Temporal association rules can be more useful and informative than the basic association rules. For example 70 % of sales of snacks items jump between 5 pm to 7 pm. This sort of inference can be got by adding temporal factor to the rule mining. The following section shows the temporal rule mining directions.

### 3.1 Temporal Miner review

Mining of time related information from large databases plays a vital role in effective decision making processes. [2]. In this regard, JUNHENG-HUANG et al [19] have presented an efficient method called SPFA – segmented progressive filter method for segmenting the databases. This method seems to be more effective as the size of the database increases. An approach to handle the temporal mining in publication databases is discussed by Chang-Hung Lee et al .The algorithm introduced in [5] is PPM – Progressive Partition Miner and this method is suitable for mining publication-like databases such as bookstore databases, video rental store records, etc. An attempt of temporal mining for numerical attributes is presented by Wei Wang et al [46]. TWAIN - Two-End Association Miner with precise frequent exhibition periods are discussed by JEN-WEI HUANG et al [15]. Incremental Mining in crime patterns discovery is given by Vincent Ng et al [43] .As

temporal mining plays a crucial role in medical domain, mining using the clinical dataset with temporal factor is attempted by Khanna Nehemiah et.al [20]. The approach of handling the temporal databases in case of updations is discussed by Tarek F Gharih et al [40]. The authors have presented an incremental algorithm for maintaining the temporal association rules. The article uses sliding window filtering algorithm [6]. In traditional methods rerunning a temporal mining algorithm costs minimum two database scan. In this approach scan reduction technique is used, which just uses only one database scan for temporal database updations.

#### **4. Utility Miner**

Generally researches have proposed various interesting measures for analyzing the patterns from the data. The term utility stands for usefulness of the itemsets. Motivated by the decision theory, Shen et al., stated that the “interestingness of a pattern = probability with utility “. Based on the user’s specific objectives and the utility of the mined patterns, utility - based approaches may be more useful in real applications, especially in decision making problems. Utility Miner finds all item sets in a transaction database with utility values higher than the minimum utility threshold. Utility mining refers to the process of allowing a user to conveniently express his or her perspectives concerning the usefulness of patterns [11]. To achieve a user’s goal two types of utilities are stated (i) transaction utility and (ii) external utility. Transaction utility of an item is directly obtained from the information stored in the transaction data set. The external utility reflects user preference and can be represented by a utility table. By considering both transaction database and utility table together, data mining can be guided by the utilities of item sets. Hence, the discovered knowledge is useful for maximizing a user’s goal. This is specified by Hong yao et al., [12]. The issues related to utility based mining is discussed by various researches are discussed as follows.

##### **4.1 Utility Miner review**

The concept of Utility based temporal mining is discussed by G. Maragatham et al in [25]. In [25], the concept of pattern mining using utilities and temporal concept is discussed with scan reduction technique. Next, the method to extract useful association rules based on statistical property such as support, confidence and semantic property is given by Yi-Dond Shen et al [51]. This paper addresses an approach OOA – Objective Oriented utility based association mining method. Also, Vid podpecan [41] has presented an algorithm called FUFM – Fast Utility Fast Mining approach for mining external frequent itemsets. The algorithm works on the fact that utility-frequent itemsets as a special form of frequent itemsets. The algorithm works by constructing a hash tree for mining “external frequent itemsets “ , using utility frequent itemsets. Mining a complete set of high utility itemsets by a bottom up traversal of a compressed utility pattern is introduced by Alva Erwin et al [3]. A fast high utility itemsets mining algorithm is given by Ying Lie,Wei [52]. Considering the weight factor along with the utilities is a different approach presented by M.Sulaiman et al [39]. They have discussed the concept of WUARM – Weighted Utility framework for mining association rules. Incremental Concepts with utility is given by Jieh-shah et al [18]. The author [18] have introduced two algorithms IUM - Incremental Utility Mining and FIUM – Fast Incremental Utility miner. Since the users may be interested to mine high-temporal utility itemsets in a particular period, for which this paper suggests a good direction. High Utility Association Rules for Business developments is discussed by Parvinder S. Sandhu et al in [30]. Utility mining in time series is given by Sven F. Crone et al [38].

#### **5. Privacy – Preserving Miner**

As a database is a collection of voluminous storage. There exist various methods for mining information from them. Mining data from the database reveals sensitive data also. How to disclose all these information is a major concern in data mining. Incorporating privacy protection mechanism plays a vital role in the mining process. The issues concerning privacy – preservation mechanism are discussed in [4][10][23][47].

##### **5.1 Privacy preserving review**

A new practical framework [35] called p4p – Peers for privacy is a hybrid architecture combining P2P and client-server paradigms. It provides practical private protocols for user data validation and general computation. The arithmetic operations used for verifiable secret sharing cost is same as that of a normal arithmetic operation. A Fast cryptographic privacy preserving Association rules on Distributed homogenous databases is presented by Ashraf El-sisi[1]. This paper addresses a semi-honest model with negligible collision probability. The flexibility of extending to any number of sites without any change in implementation is discussed. Privacy preserving association rule mining in vertically partitioned data is discussed by Jaideep et al., [14]. Justin Zhan et al [16] have presented a new approach to a problem of data sharing and multiple parties with out disclosing the data between the parties. The focus is mainly on the data sharing among the parties

involved in the data mining task. A secure protocol using homomorphic encryption technique is designed to exchange the data.

## 6. Statistical association rule Mining

Normally, the association rule mining algorithms generates more rules. To present relevant and precise interesting rules to the users is of more main concern. Generally interestingness measures plays a good role in decision making process. Decision making can be effectively done with less number of rules. Therefore, the concept of post processing or filtering out the less relevant rules can be done using statistical measures. Then patterns-mined are based on the user's interest and the rules can be ranked. Support, confidence, leverage, lift, prevalence, recall, specificity etc., are some of the statistical measures. Finding out the statistical significance among the data items can be done using chi-square, correlation coefficient etc. The discussion of statistical rule mining is presented in the forthcoming session.

### 5.1 Statistical rule mining review

Recently Iawan Nizal [13] has presented a framework for mining interestingness measures on rule. This articles discusses how to arrive a more reliable and interesting set of rules using data mining and statistical measurement techniques, the core part of this work is that , the method filters the redundant misleading, random and coincidentally occurring rules by ensuring the accuracy of the rule set. A method of discovering the alternate choices in purchasing is discussed in [45]. These rules are named as substitution rules. Interesting measures in data mining is given by LIQIANG GENG et al in [22]. This article reviews the interestingness measures for rules i.e., summarizing and classifying them from several perspectives and comparing their properties and also it identifies their roles in data mining process. Computing chi-square values directly using the confidence, support and lift measures are given by Sergio et al [34]. Mining statistical and fuzzy association rule mining is given by Vijay Krishna G et al [42].

## 7. Particle Swarm Optimization

Particle swarm optimization (PSO) is an optimization technique developed by Dr. Eberhart and Dr. Kennedy in 1995. Initially the process begins with an initialization of random solutions. These solutions are called particles, flies in the problem space by following the current optimum particles. Each particle maintains its coordinates in the problem space which are associated with the best solution it has achieved so far called *pbest*. Next, the best value obtained so far by any particle in the neighbors called *lbest*. At each step, the PSO changes the velocity of each particle towards its *pbest* and *lbest* locations. PSO finds its applications in wide range of applications such as time series problems, scientific problems etc.

### 7.1 Particle Swarm Optimization review

Swarm Intelligence is discussed in [7] [8] [26]. Since association rules generates more rules. Getting limited relevance rules is of more concern. Therefore for Optimizing generated rules, Particle swarm optimization technique is used. R.J Kuo et al [21] have proposed Particle swarm optimization technique to obtain quality association rules. Since defining support and confidence measure is a challenging issue in pattern mining, the authors have introduced a novel approach for suggesting suitable threshold values for generating quality rules. Initially the data is transformed in to binary values and using suitable fitness function in the PSO, the rules are generated. Also, the results are demonstrated by using real world stock market database. A New Quantum behaved Q-QPSO (Quantum behaved particle swarm optimization) algorithm starts like the usual QPSO. At the end of the iteration, the quadratic interpolation recombination operator is invoked to generate a new swarm particle. The new particle is accepted as swarm only if it is better than the worst particle present in the swarm. This process gets repeated until a better solution is obtained. And a method of extracting the best rules in reasonable time using large databases with QSO is presented by Mourad Ykhlef [27].

## Conclusion

As association rule mining is one of the hottest topic in the area of data mining. The research activities on this topic is reviewed Hence, the survey guides the researchers to get an idea about the recent advancements with association rule mining. ARM related to different aspects such as Temporal, Utility, Statistics, Privacy preservation issues and Particle Swarm Optimization are specified. In spite of these progressions, the scope of ARM extends in Distributed environment , Conditional pattern mining applications etc.,

## References

- [1] Ashraf El-sisi (2010) "Fast Cryptographic Privacy Preserving Association rules mining on Distributed Homogenous database", The International Arab journal of information Technology, vol 7, No.2, April.
- [2] AhaiLiang, TANG Xingmang, LI Lin JIANG Wen Liang, (2005) "Temporal Association with Rule mining Based on T-Apriori algorithms and its typical application", Proceedings of International Symposium on Spatio-temporal Modeling, Spatial Reasoning, Analysis, Data Mining and Data Fusion. August 27-29, Peking University, China.
- [3] Alva Erwin, Raj P. Gopalan, N. R. Achuthan.(2007) "A Bottom – Up Projection Based Algorithm for Mining High Utility Item sets", 2nd workshop on Integrating AI and Data Mining –AIDM Gold Coast, Australia. Conferences in Research and Practice in Information Technology ( CRPIT) vol 84, kok-leong Ong, Junbin Gao, Wenyuan aLi, Ed. constraint based mining and learning at ECML/PKDD2007, CMILE 2007, str 10-20.
- [4] Alexandre Evfimievski, Ramakrishnan srikant, Rakesh Agrawal, Johannes Gehrke(2002) " Privacy preserving mining of Association Rules ", SIGKDD ACM.
- [5] Chang-Hung Lee, Ming-syan chen, Cheng-Ru Lin (2003) , "Progressive partition miner : An Efficient algorithm for mining general Temporal Association rules ", IEEE transactions on knowledge and data engineering , vol 15 , No.4, july/august
- [6] Chang-Hung Lee, Cheng-Ru Lin, Ming-syan Chen (2005), "Sliding Window filtering: an efficient method for incremental mining on a time-variant database ", Information systems 30, 227-244.
- [7] Crina Grosan, Ajith Abraham and Monica chis (2006), " swarm Intelligence in Data Mining ", studies in computational Intelligence (SCI) 34, 1-20.
- [8] Eberhart RC, Shi Y (2001), "Particle Swarm optimization: developments, applications and resources. In Proceedings of IEEE Congress on Evolutionary Computation (CEC), Seoul, Korea.
- [9] David Taniar , Wenny Rahayu, Vincent Lee, Olena Daly (2005) , "Exception rules in association rule mining ", Applied Mathematics and Computation ,Vol 205, Issue 2, 15 November , pages : 735-750.
- [10] Dragos Trinca and Sanguthevar Rajasekaran (2007), "Towards a collusion – Resistant Algebraic Multiparty protocol for Privacy – preserving Association Rule Mining in vertically partitioned data ", 1-4244-1338-6107.
- [11] Hong Yao, Howard J. Hamilton and Liqiang Geng (2006), "A unified framework for Utility based measures for mining itemsets ", UBDM 2006 August, Philadelphia, Pennsylvania, USA .
- [12] Hong Yao, Howard J. Hamilton and Cory J. Butz (2004), "A foundational Approach to mining itemset utilities from Databases ", Proceedings of 4<sup>th</sup> SIAM conference on Data Mining.
- [13] Izwan Nizal Mohd. Shaharance, Fedja Hadzic, Thram s.Dillan (2011), "Interestingness measures for association rules based on statistical validity", Knowledge-Based systems 24,386-392.
- [14] Jaideep Vaidya, Chris Clifton, (2002), "Privacy preserving association rule mining in Vertically partitioned data ", knowledge Discovery and data mining , pg: 639 – 644.
- [15] JEN-WEI HUANG, BI-RU DAI and MING-SYAN CHEN – TWAIN,(2007) "Two-End association Miner with precise frequent exhibition periods", ACM transactions on knowledge Discovery from data, Vol 1, No.2 , Article 8 , August 2007.
- [16] Justin Zhan, Stan Matwin and Liuiu Chang (2005), "Privacy Preserving collaborative Association Rule mining ", Proceedings of the 19th Annual IFIP WG 11.3 Working Conference on Database and Applications Security.
- [17] Jiawei Han and Micheline Kamber, (2006), "Data Mining: Concepts and Techniques, 2nd edition ".Elsevier publications.
- [18] Jieh-shan Yeh, Chih-Yang Chang, Yao – Te Wang (2008), "Efficient Algorithms for Incremental Utility Mining", Proceedings of the 2nd International Conference on Ubiquitous Information Management and Communication, ICUIMC 2008, Suwon, Korea, January 31 - February 01, ACM 2008, ISBN 978-1-595912.
- [19] JUNHENG-HUANG , WANG- WEI "- IJCSNS ,(2007) "Efficient Algorithm for Mining Temporal Association Rule", International journal of computer science and network security, vol 7., no.4, April
- [20] Khanna Nehemiah H, Kannan .Aet.al.,(2007) " Employing Clinical Datasets for Intelligent Temporal Rule mining and Decision making , A comparative study ", ICGST – BIME journal , vol 7, Dec 2007 : 37-45.
- [21] Kuo. R. J, Chao C.M, Chiu Y. T (2011) , " Application of Particle Swarm Optimization to Association rule Mining ", Journal of Appliedsoft computing", vol 11, Issue 1, Jan 2011.
- [22] LIQIANG GENG AND HOWARD J.HAMILTON (2006) , " Interestingness Measures for Data Mining : A Survey ", ACM Computing Surveys, Vol 38, No.3, Article 9 .
- [23] Lindell Y , Pinkas B (2002), " Privacy Preserving Data Mining ", Journal of cryptology 15(3):177-206.
- [24] Manisha Rajpoot, lokesh Kumar sharma,(2011) " Comparative study of Association rule mining for sensor data ", International Journal of computer applications ( 0975 – 8887 ) , vol 19, no:1, April 2011.
- [25] Maragatham G , Lakshmi M (2010), "A strategy for mining utility based temporal association rules ", In Proceedings of 2<sup>nd</sup> International Conference on TRENDZ IN INFORMATION SCIENCES AND COMPUTING – TISC, Dec 17 – 19, IEEE Xplore.
- [26] Milliepant, Radha Thangaraj,Ajith Abraham (2008), "A New Quantum behaved Particle Swarm Optimization ", GECCO 2008, July 12-16,ACM.
- [27] Mourad Ykhlef (2011) " A Quantum Swarm Evolutionary Algorithm for Mining association rules in large databases ", Journal of King saud University – computer and Information sciences 23,1-6.
- [28] Nattapon pannorat et al., (2010), " DataBase Reverse Engineering Based on Association Rules ", International Journal of Computer science Issues, vol. 17, Issue 2, No.3 March
- [29] Norwati Mustapha et al.,(2005-2009) " A Numerical Method for frequent pattern mining ", Journal of Theoretical and Applied Information Technology, pg : 92-98.
- [30] Parvinder S. Sandhu, Dalvinder S. Dhaliwal and S. N. Panda (2011), "Mining utility-oriented association rules " , An efficient approach based on profit and quantity. International Journal of Physical sciences vol 6(2) , pp 301-307, 18 Jan 2011.
- [31] Philippe Lenca, Patrick Meyer, Bonoit vaillant, Stephae lallich,(2008), " On selecting interestingness measures for association rules : User oriented description and multiple criteria decision aid ", European Journal of operation research 184 610 – 626.
- [32] Qi Luo , " Advancing Knowledge Discovery and Datamining" (2008) IEEE, Workshop on knowledge Discovery and Data Mining, DOI 10.1109/WKDD.2008.153.
- [33] Rani J. Swargam , Mathew J. Palakal,(2007), " The Role of Least Frequent itemsets in Association Discovery ",2nd International Conference on Digital Information Management ,ICDIM (2007), vol 1, Pg : 217 – 223
- [34] Sergio A. Alvarez, BC-CS- 2003-01, July (2003), "Chi-squared computation for association rules: Preliminary results ", Technical report BC-CS-2003-01 July .
- [35] Sven F. Crone, StefenLessmann, Robert stahlbock,(2007), " Efficient Privacy – preserving ARM : P4P style ", Computational Intelligence & Data mining, CIDM 2007.

- [36] Shichao Zhang and Xindong Wu,(2011) ,“ Fundamentals of association rules in data mining and knowledge discovery “,John Wiley & Sons, Inc. WIREs Data mining Knowledge Discovery 2011, vol 1 March / April 2011
- [37] Sunita Soni , O.P Vyas ,(2010), “Using Associative classifiers for predictive Analysis in Health care Data mining”. International Journal of Computer Applications (0975 – 8887) , vol 4 – No.5, July 2010.
- [38] Sven F. Crone, Stefan Lessmann , Robert Stahlbock (2005) ,“ Utility based data mining for time series analysis: cost-sensitive learning for neural network predictors “ , UBDM 2005, Proceedings of the 1st International workshop on utility-based data mining , ACM Newyork, NY
- [39] Sulaiman Khan M, Maybin Mueyba, Frans Coenen (2008) , “A weighted Utility framework for mining Association rules”, Second UKSIM European Symposium on Computer Modeling and Simulation”, september 08, 2010.
- [40] Tarek F. Gharib, Hamed Nassar , Mohammed Taha, Ajith Abraham (2010), “ An efficient algorithm for incremental mining of temporal association rules “, Data & Knowledge Engineering , 69 ( 2010) 800-815.
- [41] Vid podpecan, Nada Lavrac and Igor Kononenko (2007), “A Fast Algorithm for mining Utility-Frequent Item sets “, International workshop on constraint based mining and learning at ECML/PKDD2007, CMILE 2007, str 10-20.
- [42] Vijay Krishna G and Radha Krishna P, (2008) “ A Novel approach for statistical and Fuzzy association rule mining on Quantitative data “, Journal of Scientific and Industrial Research , vol.67, July 2008, pp : 512-517.
- [43] Vincent Ng et.al., (2007) “Incremental Mining for Temporal Association rules for Crime Pattern Discoveries “ , 18th Australian Database conference, ADC2007 , CRPIT , vol.63.
- [44] Wai-Ho Au; Chan, K.C.C, (2003), “Mining Fuzzy Association rules in a bank-account database” ,IEEE Transactions on Fuzzy Systems Issue 2 , April , pg 238 – 248.
- [45] Wei-Guang Teng , Ming-Jyh Hsieh, Ming-syan chen (2005), “ A Statistical framework for mining substitution rules , Knowledge and Information systems pg :158-178.
- [46] Wei Wang , Jiong yang, Richard Muntz (2001), “TAR : Temporal Association Rules on Evolving Numerical Attributes”, 17th international conference on data engg “ ICDE ,pg. 283-292
- [47] WeiweiJing et al,(2006), “ An algorithm for Privacy – preserving Quantitative Association Rule Mining”, 2nd IEEE International symposium on Dependable, Automatic and Secure Computing.Pg:315-324.
- [48] Xiaohui Yuan, Buckles B. P , Zhaoshan Yuan, Jian Zhang ,(2002), “Mining Negative Association rules “ , Proceedings of Computer and Communications .
- [49] Xindong wu, Chengqi Zhang, Shichao Zhang, “Efficient mining of both positive and negative association rules”, (2004 ) – ACM Transactions on Information systems , vol 22, No3, july, pg:381-405.
- [50] Yen-Liang Chen, Chen-Hsiung Weng, “Mining association rules from imprecise ordinal data”, Journal of Fuzzy sets and Systems, vol 159, Issue 4, February (2008).
- [51] Yi - Dond Shen , Qiang Yang and Zhong Zhang (2002),“Objective - oriented utility-based associationmining “,Proceedings of the 2002 IEEE International conference on Data Mining.
- [52] Ying Liu, Wei – Keng Liao, Alok Choudhary,(2005), “ A fast high utility itemsets mining algorithm “ , UBDM 2005, Proceedings of the 1st international workshop on utility-based data mining, ACM, NY.
- [53] Zahra Farzanyar; Mohammadreza kangavari; Sattar Hashemi “,(2006) A New Algorithm for Mining Fuzzy Association Rules in the Large Databases Based on Ontology , Sixth IEEE International Conference on Data Mining , ICDM Worksops December 2006.