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Mobi-X Architecture Modelling for Mobile Agent using Association Pattern Mining

N. Priyadharshini, V.Narayani

Abstract*: *In a mobile agent system, if agents' functionality can be assessed and evaluated between peers of environmental modelling, it can reduce the exploration burden of unvisited states and unseen situations, thus an effectual learning process has to be accelerated. So as to construct an accurate and effectual model in certain time period is a significant problem, specifically in complex environment. To overcome this crisis, the investigation anticipates a model based data mining approach based on tree structure to achieve co-ordination amongst the mobile agent, effectual modelling and less memory utilization. The anticipated model suggests Mobi-X architecture to mobile agent system with a tree structure for effectual modelling. The construction of tree for real time mobile agent system is utilized to generate virtual experiences like elapse time during mining of tree structure. In addition, this model is appropriate for knowledge mining. This work is inspired by knowledge mining concept in mobile agent systems where an agent can built a global model from scattered local model held by individual agents. Subsequently, it increases modelling accuracy to offer valid simulation outcome for indirect learning at initial stage of mining. In order to simplify mining procedure, this anticipated model relies on re-sampling approach with associative rule mining to grafting branches of constructed tree. The tree structure provides the functions of mobile agents with useful experience from peer to peer connectivity, indeed of combining all the available agents. The simulation outcomes shows that proposed re-sampling can attain efficiency and accelerate the functionality of mobile agents based cooperation applications.

Keywords*: *Mobi-X architecture, knowledge mining, tree structure, associative rule mining, peer to peer connectivity

I. INTRODUCTION

In general, sensor networks are resourcefully organized in various detecting and monitoring applications [1]. In this applications, mobile networks produces huge amount of data streams. Those streams from mobile networks are mined to haul out knowledge about sensing environment (for instance, mining behaviours) and network (e.g. analyzing faulty nodes), and offers confronts for DM approaches [2][3], established in conventional database which attained superior attention as promising tool to haul out knowledge from mobile data [4].

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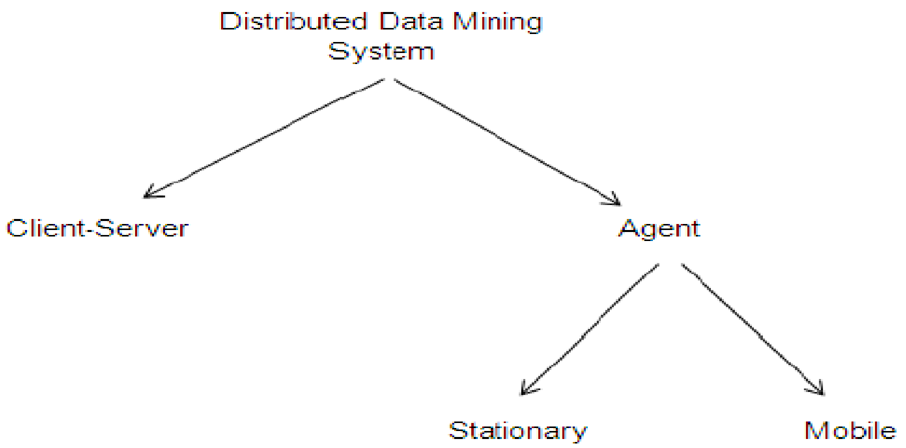
With knowledge discovery in networking, interest is to acquire behavioral nodes, progressed from meta-data determining data behaviors [5]. Discovering behavioral patterns (that is, associated patterns) from network are extremely helpful in various applications necessitate observation of physical circumstances (for example, transportation networks, buildings, battlefields) which may handle crucial environments such as gas leaks, fire explosion [6]. Association patterns are cast off to identify future event sources. Discovering the future event source may cause the prediction of faulty nodes, in any mobile network [7]. For instance, association pattern mining recognizes the event of occurrence from a specific node, however no such event has been reported sequentially; this specifies the probability of mobile node failure [8]. It can as well recognizes the origin of subsequent event when associative patterns lies over chain of associated events, for example, fault encountered in specific process on mobile, may triggers faults in subsequent process also [9]. Associative patterns can disclose a series of temporally correlated mobile nodes [10]. Those patterns can enhance operation features (For example, recognizing missed reading and effectual resource management, sleep awake schedule nodes on mobile).

Even though there are enormous mining approaches have been investigated in the past to extract rules from mobile nodes connected in the network, association rule mining in cause of real time mobile connectivity from data stream is not so easy and simple as in fig 1. An instance of agent based association rule generation could be $(MA_1, MA_2 \rightarrow MA_3, 80\%, \lambda)$, which can be translated as trails: if events from MA_1 *and* MA_2 are received, 80% chance for event from mobile agent MA_3 with 'λ' time period. Rule strategy is based on constraint named as minimum support threshold (MST) represents minimum lower bound for association rules support outcome. If MST is high, then higher value knowledge is extracted.

Subsequently, if MST is lower, a very huge amount of association rules are produced, as these rules are non-informative. Here, correlation amongst data objects of mobile agents acquires invalid sampling of data because of pointless rules. As mobile agents establish events amongst mobile nodes, it is essential to utilize suitable measures to attain behavioral patterns that have stronger correlation of data. Therefore, re-sampling of data objects in mobile agents can be performed. So as to resolve this crisis, in this investigation, an association rule based mining approach with a design of tree structure is anticipated. The framework is termed as Mobi-X architecture. The anticipated behavioral patterns not only captures association rules of mobile agents but also construction of tree for real time mobile agent system is utilized to generate virtual experiences like elapse time during rule mining. As mining of association events related to agent data is very significant in diverse real time applications, no framework is modeled yet.



The significant challenge in mining association events of mobile agents are:

(1) A suitable formulation to discover associated patterns of mobile events by preserving the properties of mobile connectivity to guarantee search space reduction;

(2) Modelling a tree structure for real time mobile agents that are competent to acquire data content in event establishment and to acquire superior mining performance.

(3) Previous information from mobile agents may turns to be more unimportant for upcoming event establishment amongst mobile nodes, it is essential to design the tree structure more adaptive. Therefore, latest information can be captured more effectually, thereby making optimal utilization of memory and haul out complete set of current events based association rule set. To provide such tree construction, suitable data re-sampling has to be determined.

This work offers techniques to mine association rule for agents and based on this following contributions are made:

- To define a novel type of Mobile agent termed as Mobi-X architecture for association rule generation to mobile agent and to acquire the correlation amongst data objects.
- So as to attain such association rule, an extremely compact trees structure termed X-association mine tree (X-AMT) and mining algorithm that can effectually discover pattern from mobile agents with single scan of data objects.
- X-AMT tree is further improved with re-sampling approach with sliding window approach and mining algorithm is anticipated. This hauls out recent association pattern over data objects in both time efficient and memory utilization. Re-sampling is adapted in tree construction to deal modifying nature of data objects and guarantee superior memory utilization.

Remainder of the work is organized as. Section 2, backgrounds are described in detail. Section 3, mining associated patterns based problem formulation and proposed Mobi-X tree structure is presented. Section 4, results are analyzed. Finally, Section 5 is conclusion.

II. Related Works

In [11], A.Saleem Raja, offer overview of Agent based distributed DM architecture; Distributed AR Mining algorithms and view of prevailing agent sourced ARM and specify issues in prevailing architecture. At last, author provides architecture termed MAD-ARM, tried to eliminate communication overhead and guarantee MA security.

In [12],G.S. Bhamra et al, provides effort to reconsider functionality of MAs in Distributed ARM. The perspective of inside view of prevailing structures in domain offered and novel implementation and design termed AeMSAR from Distributed Data Sources is provided. Outcomes are validated and be integrated in upcoming work.

In [13],Gongzhu Hu et al, explained numerous kinds of agents are utilized to carry out decryption and encryption of secure sum operations and union. In this investigation, with 8000 transactions, the outcome (optimal frequent k-item set) by this method utilized to data distributed moves over three sites is similar as an outcome that attained from Aprior with similar data resides over single host. Data performed using agents are identical and scrambled by decrypted and encrypted when entire hosts participate.

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In [14], P.T.Kavitha et al, spotlights mining frequent item sets crisis on distributed and dynamic data sets in diverse distributed and parallel systems with static and mobile agents. Author anticipate technique to reduce response time and rises knowledge mining accuracy for global set of frequent item sets, to determine frequent item patterns over infrequent item sets. In further direction, static agents are substitute using indexing approach is utilized in regions such as unmanned vehicles, robotics and so on. It offers communication procedure among distributed systems in an effectual manner.

In [15], Yue Fuqiang et al, acquire an attain a superior outlier detection algorithm accuracy, to ensure algorithm in space and time efficiency, sourced on anticipated DDMMMA of displaced clusters, large DM crisis distributed to every agent on autonomous, therefore to be distributed algorithm to diminish space complexity, however also diminishes time complexity of algorithm, the modelling of novel frequent pattern-based local outliers detection. Here, node in data stream in certain time period is frequently related with global distribution, node detected outliers extremely distributed to significant data. Henceforth, every node considers local outlier detection is not suitable.

In [16], Yashaswini Joshi et al, anticipated MADFPM algorithm for FPM of distributed databases utilizes MAs and determined to be superior based on performance. MADFPM performance is superior than traditional client-server model as pre-processed compact data in disjoint matrix form is modified to central site instead of transferring complete data to site and processing is performed. MADFPM performance is superior in contrast to MA based techniques, PMFI and PMFI-A as it diminishes network traffic and computational cost.

In [17], Darshana Patel et al, examined MA algorithms in application of DM domain and merging of agent algorithm and novel design of D-Apriori algorithm and attain quicker data retrieval for distributed DM. MA consumes decreased bandwidth and latency. It is observed when local model is lesser than local data; transmitting model, diminishes load on network and requirement of bandwidth.

As well, sharing merely model, indeed of data, offers reasonable security for certain organizations as it prevail over privacy issues. Consequently, entire local models are aggregated to offer model by aggregation, reduced transfer is subsequent key attribute of resourceful DDM. As well difficult and robust characteristics are depicted with mild code.

In [18], Xining Li et al, depicted MAs deployment in applications. Adopting MAs for DDM are to scale large, dynamic and remote data sources, where diverse databases distributed over Internet. Author modelled database management module and data service discovery module. Programming interface is to construct recognizes competency to merge logic programming language with functionality of placing data services and managing remote databases. Based on system tools, MAs investigate data, move over internet to accumulate helpful communication with everyone to produce global perspective of data aggregation in distributed computations. In [19], Vuda Sreenivasa Rao et al, illustrated DDM field based on confronts in examining DD and provides numerous solutions to carry out diverse data mi ning in basically distributed way that provides concentration to resource limitations. As MA systems are frequently distributed and agent's reactive and proactive characteristics are extremely resourceful for KMS, merging MAS with DDM for intensive applications. In [20], Romeo Mark A. Mateo et al, anticipate EMA to carry out DM to assist patient diagnosis. EMA utilizes neuro-fuzzy to develop consultation function. As well, pre-processing of appropriate data sourced on expert profile to train fuzzy systems effectually. Outcomes after simulation demonstrate neuro-fuzzy performed other superior accurate classifiers. As future direction, functionality of anticipated approach works on MA framework in ubiquitous healthcare.

III. PROPOSED METHODOLOGY

In general, software agent specifies intelligent program that carry out some tasks with respect to users and functions like personal assistant. Agents are equipped with mobility property and it is termed as mobile agents. Usually, mobile agents are an autonomous transportable program which can move or transfer from host control from one node to another in network to carry out certain tasks.

Subsequently, program that functions over host are suspended during execution, and moves to another host (request host to destination) and execution commences from suspension. Agent is persists to work though user is disconnected. They execute metaphor to people carry out business in daily routine that is, visiting place, use service. When agent acquires server, it is partitioned to agent execution environment. As well, it possesses certain credentials; then commencement part is initiated.

To carry out this task, MA can move to subsequent server in determination of service/resource, spawn new agents or communicate with other stationary agents.

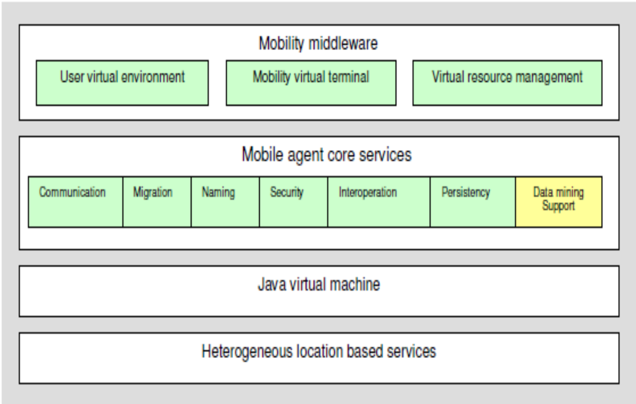

Fig 2: Mobility based mobile agent services

With completion, mobile agents acquire the outcomes to transmitting client or another server.

A. Pattern mining through mobile agent

This section in detail specifies the nominal definition of significant ideas required to handle related patterns of object data to generate association rule [21]. As no universally acquired metric prevails over to evaluate pattern, entire confidence is raised as measure to acquire temporal association between objects which is utilized in recent investigations as in fig 2.

However, all confidence evaluation preserves downward closure property. Henceforth, this confidence measure is utilized to mine patterns from data. Assume two cases, former is identifying associated patterns from entire data streams, latter is determine recent association pattern from data streams as in Table I.

Table I: Time slot and epoch of mobile data stream

Time Slot	Period
1	$D_1\ D_2\ D_3\ D_4\ D_7\ D_8$
2	$D_1\ D_5\ D_6$
3	$D_2\ D_5\ D_6\ D_7\ D_8$
4	$D_1\ D_2\ D_4\ D_7$
5	$D_1\ D_2\ D_4\ D_5$

Lemma 1 (Associated Pattern): Data stream is said to be associated pattern, if confidence pattern is higher or equal to provide MCT, $\min\_patt\_conf$

For certain and parameters: minimum support threshold for data object patterns is specified as $\min\_sup$ and $\min\_patt\_conf$ performed by application/user, the crisis associated with associated pattern can be provided as: describing complete pattern set with support and confidence which is not lesser that specific threshold.

It is considered that architecture comprises set of nodes deployed in ADHOC and report collected data to sink. Afterwards, sink models periods/epoch (as in Table I) from received data and preserves it in database.

B. Mobi-*X* architecture

For Mobi-X architecture, consider mobile network architecture, with epoch tuple and time slots [22]. Diverse cases encountered in mobile communication through mobile agents are considered and determined as various cases, they are given below:

Case 1: Define a mobile data stream formally with an infinite sequence of epochs, Mobile data stream = $D_1, D_2, \ldots D_n$, where $E_{TS(r)}, r \in [1, n]$, where 'r' is arrived epoch. All epoch is considered as tuple $E(E_{TS}, Y)$. Sliding window 'W' is specified as set of entire epochs amongst r^{th} and s^{th} (s > r) epochs and 'W' window size is $|W| = s - r$. MDS (mobile data stream) with sliding window comprises of three batches. If 'M' epoch, 'N' batches of 'W", every batch comprises of M/N epochs; therefore, every batch size is provided as $\left|\frac{M}{N}\right|$.

In this place, sliding window is provided batch-to-batch, that is, sliding accumulates batch and eliminates prior batch from present window.

Case 2: (Support for data patterns in sliding window 'W'): Support of data stream pattern 'X' in window 'W' is specified as $Support_W(X)$ specifies amount of epochs in 'W' comprises 'X'. Henceforth, data stream patterns is termed as frequent in sliding window 'W', if support is not lesser to $\min\_sup$, that is, $0 \leq \min\_sup \leq |W|$.

Case 3: (Association data pattern 'X' in 'W'): Data pattern 'X' is termed as association pattern of 'W', if the confidence is higher or equal to provided MCT of 'W'.

For a provided MDS, |W|, min_sup and min_conf, problem in mining data stream is to determine entire pattern in|W| which has a measure lesser than respective thresholds, which is set of recently received pattern in mobile data stream.

Support: Rules hold with support (Sup) in mobile transaction dataset, if support % of transactions comprises of $D_1 \cap D_2$. Probability of comprises transactions A and B data transactions.

Confidence: Rules in 'T' with confidence conf % of transactions comprise D_1 and D_2.

C. Quality Check Mobi-X data tree (X-AMT)

In this section, the design of Mobi-X tree structure is provided in an ordered structure with pre-defined mobile nodes in canonical order as in fig 3, that is, in descending or ascending process. It is designed by reading epoch from mobile data stream with pre-defined manner and maps every epoch in the path of prefixed tree. Therefore, prefix tree can be specified as data stream in compressed form, while diverse epochs have diverse data. This path type overlapping is specified as pre-fix sharing [23]. Pre-fix tree structure turns to be compressive while prefix-sharing happens. As an outcome, prefix sharing brings tremendous gain in entire mining process.

The initially anticipated Mobi-X tree structure is designed by evaluating epochs from mobile node database with merely one scan. Subsequently, MDS is unbounded, continuous and ordered data sequence. Henceforth, it is incapable to preserving entire elements of mobile data stream in tree over huge time. However, previous information are out-dated and current information may turns to be more significant from the point of knowledge discovery. To deal with this scenario, Mobi-X tree structure is constructed with sliding window model which utilizes sliding window to observe recent epochs.

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D. Mobi-X tree functionality

The preliminary concept behind Mobi-X tree structure is

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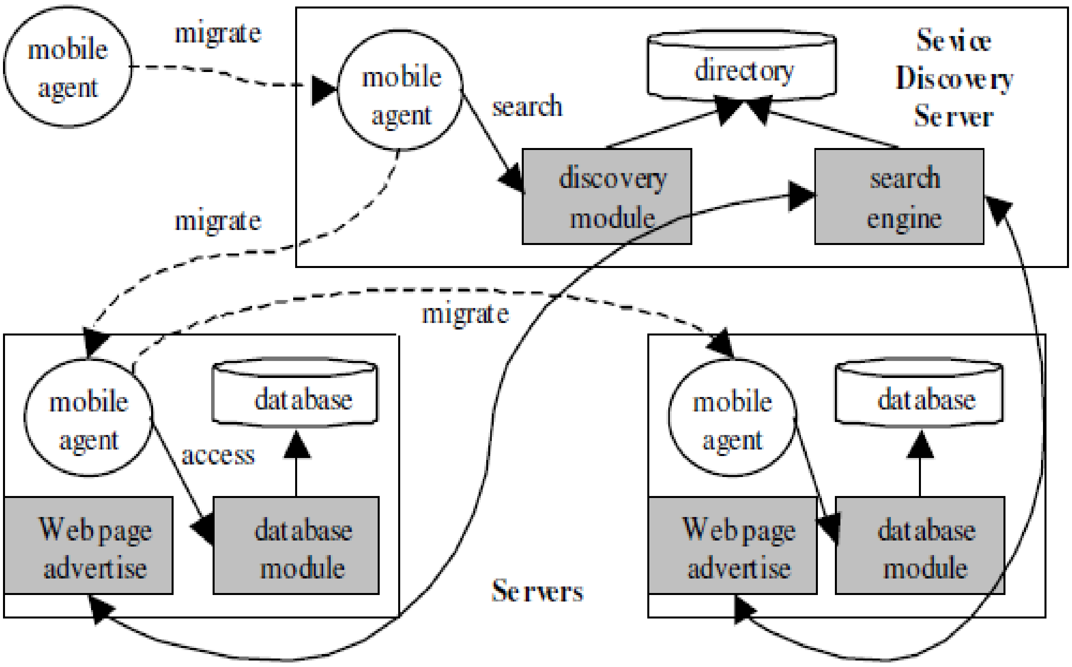

Fig 3: Mobile agent functionality

the construction of pre-fix tree which is built based on data stream order into node connectivity, after that restructure tree in frequency descending manner and compression tree by integrating support mobile node in every branch of tree. Then pattern growth technique is used to mine related data pattern from Mobi-X tree structure [24]. This tree construction comprises of two phases: compression and insertion phase. Construction of Mobi-X tree is sourced on mobile node database.

In insertion phase, Mobi-X tree organizes nodes in accordance to nodes' appearance into database and it is constructed by inserting each epoch is database after another. Here, Mobi-X tree preserves node order list. NO comprises of distinctive node in epochs in database in accordance to order and comprises of item support value in database.

Primarily, Mobi-X tree is empty with no branches, initiates construction with null root node as in fig. With mobile node database, as in Table I, first epoch (that is, TS =1) $\{D_1 D_2 D_3 D_4 D_7 D_8\}$ is inserted to tree $< \{\ \} \rightarrow D_1{:}1 \rightarrow D_2 : 1 \rightarrow D_3 : 1 \rightarrow D_4 : 1 \rightarrow D_7 : 1 \rightarrow D_8 : 1 >$ threshold. Therefore, initial tree branch is built with D_1 as primary node (root node) and D_8 is last node. Entries for mobile nodes $D_1 D_2 D_3 D_4 D_7 D_8$ are updated. Before epoch insertion, mobile node of TS = 2 are sorted in $\{D_1, D_5, D_6\}$ ordered as $\{D_1, D_2, D_3, D_4, D_7, D_8, D_5, D_6\}$ to preserve NO and insert to tree TS=2. Here, after all epochs (TS=6), Mobi-X tree is designed as above. Every node in Mobi-X tree comprises of frequent incidence of epochs. Final NO-list of constructed Mobi-X tree structure is provided as NO. Here, insertion and restructure compression phase.

Ultimate objective of restructuring compression stage is to attain extremely compact Mobi-X tree structure uses smaller memory and assist quicker mining procedure. Here, initially sort NO in descending in merge sort and re-structure tree structure in accordance to descending order. To reconstruct Mobi-X tree, tree restructuring approach is called as (branch sort approach) anticipated in CP-tree. Branch sort utilizes merge to sort each tree structure path. This technique initially eliminates unsorted paths; subsequently sort entire path and re-inserts into tree. In this section, a simple and an effectual compression approach that chooses similar support mobile nodes in branch merging into node. Finally, Mobi-X tree is structured and compressed.

Even though CP tree and Mobi-X tree possess certain resemblance in tree phase construction, however subsequent differences exist:

i) Mobi-X tree carry out compression to merges support nodes in single node and henceforth it is compact [25]. Mobi-X tree deals with lesser nodes than CP-tree.

ii) Subsequently, Mobi-X tree memory is lesser than CP tree.

iii) CP tree uses FP-growth sourced mining approach to construct frequent patterns.

Therefore, FP growth mining cannot be directly applied on Mobi-X tree as it mines not merely frequent node patterns, however frequent associated node patterns. Henceforth, pattern mining approach can be dealt with additional Mobi-X tree feature.

E. X-AMT mining

Here, construction of extremely compact Mobi-X tree facilitates consequent mining of related data object pattern using pattern approach. Alike of FP growth mining techniques, it mines recursively Mobi-X of lessening size to produce associated patterns by generating conditional pattern base and associating conditional trees devoid of any added database scan. To deal added features of Mobi-X tree, pattern mining method devised sourced on FP growth.

Essential associated pattern mining operations from Mobi-X tree are: i) concurrent nodes' counting length ii) generating conditional pattern for every node, and iii) modelling CT for every pattern base. Therefore, associated pattern are constructed from CT.

Algorithm 1:

Input: Mobile database, node order, min_conf, min_sup
Output: Association pattern of mobile nodes
Step 1: Begin
Step 2: NO ← NO list
Step 3: Mobi-X tree ← tree with initialization
Step 4: while (NO end) do
Step 5: Scan epoch from location in mobile database
Step 6: Insert epoch into Mobi-X tree in FP tree construction
Step 7: end while
Step 8: Compute FP tree from NO in descending to with merge sort approach;
Step 9: for every branch in Mobi-X tree do
Step 10: Sort FP branch using sorting approach
Step 11: end for
Step 12: for every branch is re-constructed Mobi-X tree do
Step 13: Recognize support node in every branch and merge to single node
Step 14: end for
Step 15: while mining request from user do
Step 16: Input min_sup and min_conf from user
Step 17: for node from NO-list do
Step 18: Mining (NO list)
Step 19: end for
Step 20: end while
Step 21: end

Here, numerical analysis and discussion is performed in MATLAB environment. Simulation outcomes for Mobi-X tree structure are partitioned into three parts. Initially, Mobi-X tree compactness, second, association pattern mining. At last, scalability of association pattern mining.

F. X-AMT compactness

The anticipated Mobi-X tree structure specifies useful information in an extremely compressed form as epochs have numerous mobile nodes. With this type of tree structure, tree structure can reduce memory utilization. To reveal Mobi-X tree compactness were compared with existing approaches like FP-tree, PLT, SP-tree and so on for provided min_conf and min_sup thresholds. For FP-tree, SP-tree was measured with min_sup as they assist threshold sourced tree structure as in fig 4. The memory consumptions of data sets were compared. Outcomes depicts that Mobi-X tree structure attains compactness superior than FP-tree, PLT, SP tree for min_sup and min_conf correspondingly. It also determines fixed min_sup, memory utilization of Mobi-X tree reduces with raised min_conf.

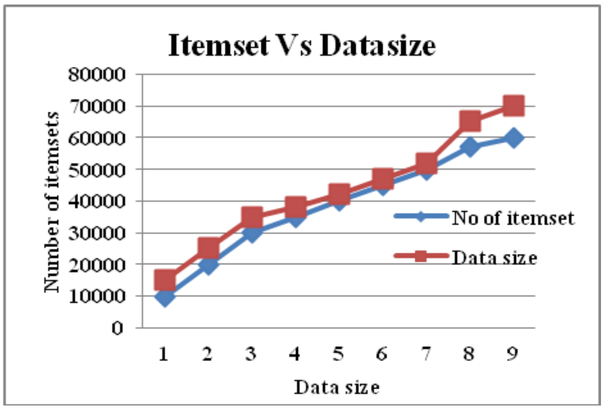

Fig 4: Comparison of Item set Vs Data size

G. Running time of Mobi-X architecture

Here, PLT and SP tree maintains frequent item set with certain threshold limit. Consequently, it is not probable to determine association patterns from Mobi-X tree structure.

Henceforth, this approach is compared with existing correlated pattern mining and well known algorithms from static database. Therefore, FP tree is used to specify information of SD based on user allocated min_conf and min_sup. Existing algorithms has to re-construct tree structure all user request as it does not preserve constructed and mined property. Mining was carried out by changing min_conf threshold where min_sup was maintained pre-dominantly for all dataset. Outcomes are offered in fig. 5. It is obvious that in min_conf value reduces run-time/execution time in both Mobi-X architecture and existing approaches. The ultimate cause of this is, with raised min_conf value, number of associated pattern is reduced; moreover, in all above mentioned cases Mobi-X architecture performed well than other approaches.

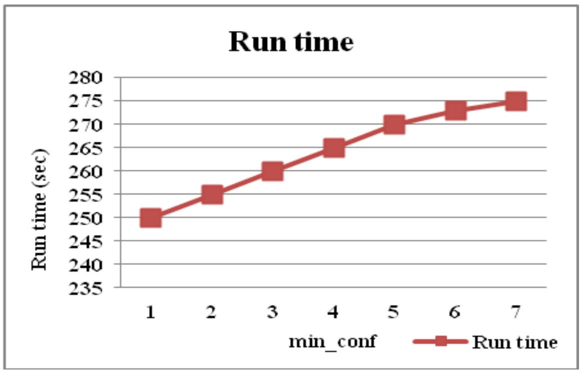

Fig 5: Comparison of run time versus minimum confidence

H. X-AMT scalability

The scalability of the Mobi-X architecture is sensed with the influence of changing amount of information transmission with node database on execution time as in fig 6.

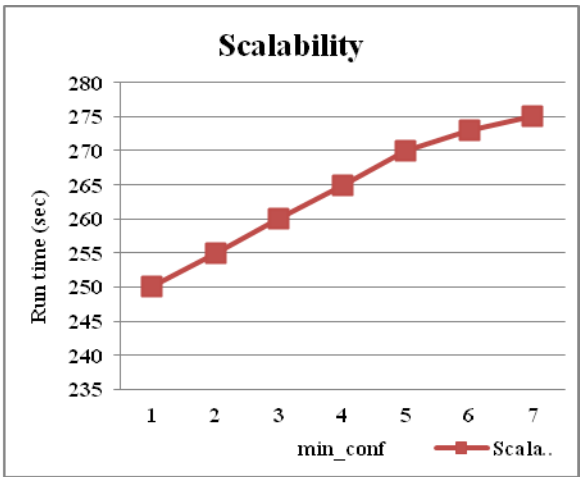

Fig 6: Comparison of run time versus scalability

For this experimentation, data movement amongst nodes is considered. Some huge dataset with higher amount of diverse items (41,000) and transactions (990,000) are known to develop a tree structure. This node dataset were partitioned into five portions, everyone is with 0.1 million transactions. Table II shows various windows sizing model. Table III depicts minimum support and confidence value of Mobi-X architecture.

Table II: Various window sizing

S.No	W1	W2	W3	W4				
1	6.3	7.6	10.2	9.5				
2	7.5	12.5	16.4	10.5				
3	25.5	35.9	44.5	37.2				
4	450	700	1000	1200				

Table III: Minimum support and confidence value of Mobi-X architecture

S.No	Min_sup (%)	Min_conf (%)
1	1.0	20
2	2	40
3	0.2	20
4	3	20

The experimental results are provided in Fig 7 given below, where min_sup is fixed as 0.1%, min_conf is fixed as 50% and min_sup is 3% and min_conf is 40% correspondingly for datasets. The total running time based on mining time and tree construction with changing database size. Mobi-X architecture illustrates superior scalability than existing approaches. Fig 3 shows window size and its corresponding batch size.

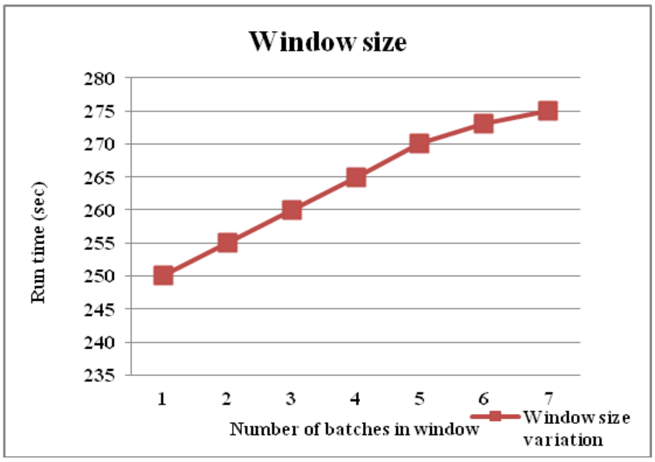

Fig 7: Comparison of run time versus number of batches

IV. CONCLUSION

Fig. 1. Example of a figure caption. (*figure caption*)

V. HELPFUL HINTS

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Ms.N.Priyadharshini, she holds a Distinction First Class Master's degree in Computer Applications (2008) and a First Class Under Graduation degree in Mathematics (2005). She has 9 years of teaching experience. She has been awarded with Silver Medal by Infosys Technologies under Inspire Faculty partnership. She has published many research papers in International and National Journals. She had presented papers in National and International Conferences. She is a reviewer in an UGC referred journal titled, "JETIR". She is a life time member of Indian Society for Technical Education (ISTE).

Dr.V.Narayani completed Ph.D Computer Application in March 2012, M.Phil Computer Science in 2005 and MCA in 2002. She has 12 years of Teaching experience and 5 years of Research experience. She has published more than 45 research papers in International Journals. She has presented many papers in International and National Conferences. She is a life member of Indian Society for Technical Education (ISTE), CSTA.

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