Mobility Prediction in Dynamic Location Area in Cellular Network using Association Rule Mining

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***Abstract*— In Cellular network, movement of mobile user are may be predicted or random based on the mobility. Resources of the wireless network are limited. In cellular network, if we can able to predict mobility of users then we can provide the resource in advance without occupying resources in all the Base stations (BSs) near to that users. Using the mobility prediction we can reduce the location management cost and resource reservation. In this paper, using Association Rule mining we can able to predict mobility of the mobile users in cellular network.**

Keywords—Mobile users, Dynamic Location Area, Cellular Network, Apriori algorithm, Associatin Rule mining, Location Management Cost, Location Update and Paging

I. INTRODUCTION

To provide better quality of services to mobile users (MU) are now necessary of every cellular network companies. For that mobile user's location and its movement in cellular network must be known in advance. Proper cellular network design and architecture are required for better QoS. In GSM, for betterment different methods are available using which we can divide the cellular networks into Location Area (LA) or Reporting Cell structure. In this paper, Dynamic location area is used to find next possible cell movement of MUs by Association rule mining. Apriori algorithm is used to create Dynamic LA from cellular network. Based on that, we can create size and shape of the LA as per MUs movement in cellular network. Dynamic LA can reduce total location management cost, which is sum of Location Update (LU) and paging cost.

Dynamic methods are classified into State based and Profile based methods. For static LA planning methods two approaches are available never update [1, 2]and Always Update[1,2]. Third approach Select-update is useful with dynamic methods. In Select- update [8], the registration process occurs only when certain condition are met. In this case, it needs to page the cells where the MU is possibly in to get the MU's current location. Therefore, the location update/registration cost is reduced and the paging cost is also reduced up to measurable amount. Dynamic LA planning contains numbers of methods: Time based [5, 8, 19], Movement based [5, 8, 19], Distance based [5, 8, 19], Cartesian product based [5], User Profile based methods [19, 20] and etc. All these methods are useful for creation of dynamic LA for mobile user with some pros and cons. In this paper we have used Apriori Algorithm for creation of dynamic LA for MUs using their User Profile information which also used for finding MUs next movement in cellular network using Association Rule mining. If mobility prediction, next movement, of MUs are known in advance then we can provide better services, resource reservation, to MUs and reduce the call dropping rate. Mobility Prediction is also useful for cellular network for bandwidth management and call management.

The rest of paper is organized as follow. In section II, we describe introduction of Apriori algorithm. In section III, we describe how Apriori algorithm is used for creating Dynamic LA. In Section IV, represent how association rule mining is used to describe next position of MUs in Cellular network. Section V, results obtain during program implementation. And at last in section VI, we conclude the work with future enhancement.

II. APRIORI ALGORITHM [23]

R. Agrawal and R. Srikant have proposd Apriori algorithm, which is a seminal algorithm, in 1994 for mining frequent itemsets for Boolean association rules. Prior knowledge of frequent itemset is necessary for this algorithm. Apriori employs an iterative approach known as a level-wise search, where k-itemsets are used to explore (k+1)-itemsets. First, the set of frequent 1-itemsets is found by scanning the database to accumulate the count for each item, and collecting those items that satisfy minimum support. The resulting set is denoted L1.Next, L1 is used to find L2, the set of frequent 2-itemsets, which is used to find L3, and so on, until no more frequent k itemsets can be found. The finding of each Lk requires one full scan of the database. How Apriori algorithm is execute stepwise on any transaction database is mentioned below.

Apriori Algorithm: Find frequent itemset using an Iterative level-wise approach based on candidate generation
Input:
D, a database of the Transaction
min_sup, the minimum support count Threshold

Output: L, frequent itemsets in D.
Method:

1. L_1 = find_frequent_1-itemsets(D);
2. for(k=2; $L_{k-1}\neq\emptyset$; k++) {
3. C_k = Apriori_gen(L_{k-1});
4. For each transaction t ∈ D { /scan D for counts
5. C_t = subset(C_k, t) ; // get the subsets of t that are candidates
6. For each candidate c ∈ C_t
7. c.count++;
8. }
9. L_k = { c ∈ C_k | c. count >= min_sup}
10. }
11. Return L = $U_k L_k$

III. IMPLEMENTAION OF APRIORI ALGORITHM

MUs are freely moves in Cellular network. Based on mobility history and call records we can easily create dynamic LA for MUs. There are three types of users are categories based on mobility in Cellular Network; Predictable, Expected and Random. In the current implementation, experiment run on 10 MUs 10 days Mobility History. Each user follow regular or irregular pattern to reach at work place from home by crossing multiple cells. Based on that, we have created inputs for Apriori Algorithm. Below figure shows flow of implementation.

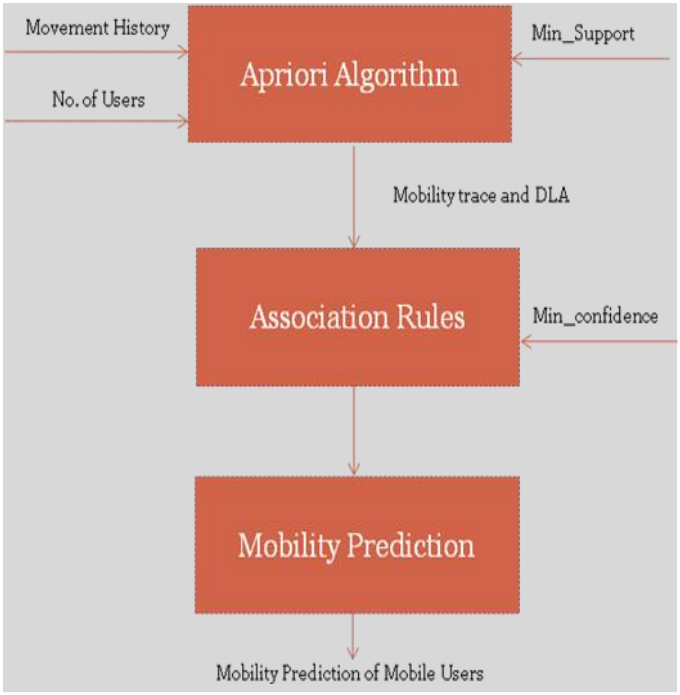

FIGURE 1. FLOW OF IMPLEMENTATION

As per figure I, input of Apriori algorithm is Movement history of MUs. Based on the min_support dynamic LA is created, which is output of Apriori algorithm. From dynamic LA and mobility trace, Mobility Rules are generated using Association Rule mining by providing min_confidence. This Mobility Rules are useful to finding next location, mobility prediction, of MUs in Cellular network.

Below table I shows, the MUs frequently visited cells during 10 days in cellular network from their home to work place. Based on movement frequently visited cells of every MU are different. Also ID of each frequently visited cells, during 10 days, are mentioned in third column.

TABLE I.. MUS 10 DAYS FREQUENTLY VISITED CELLS INFORMATION WITH ID NUMBER

MU	No. of Frequent cells	Cell IDs
1	6	1, 25, 35, 26, 24, 23
2	9	12, 15, 39, 48, 57, 16, 42, 14, 15
3	7	3, 8, 9, 5, 6, 4, 15
4	9	55, 45, 32, 33, 43, 42, 30, 40, 54
5	8	9,45, 42, 43, 57, 48, 8, 46
6	8	1, 9, 8, 16, 7, 10, 6, 14
7	10	14, 25, 26, 34, 51, 33, 11, 1, 28,24
8	7	3, 6, 10, 12, 8, 5, 1
9	4	1, 5, 6, 8
10	5	11, 14, 16, 15, 12

From above information we can find out frequent Cells ID of each MU which is required to run Apriori algorithm Table II is required to drive for each user that shows information of mobile user pattern for each day. Table II shows 10 days visits of MU-7 in its frequently visited cells listed in table I. Second row of the table mentioned all the cells ID that user crossed during 10 days. If user has crossed any cells or stay within that cells during mobility that mentioned by 1 and if user not travelled any cells that mentioned by denoting 0. It is not compulsory that user follow regular movement so in table someday some cells are not visited by MU.

TABLE II. MU-7 INFORMATION BASED ON VISITED CELLS BY DENOTING 1 AND 0

MU- 7 Information									
14	**25**	**26**	**34**	**51**	**33**	**11**	**1**	**28**	**24**
1	1	1	1	1	1	1	1	0	0
1	1	1	1	0	1	1	1	0	0
1	1	1	0	1	1	1	1	0	0
1	1	0	0	1	1	1	1	1	1
1	1	1	1	0	0	1	1	0	0
1	1	1	0	0	0	0	0	0	0
1	1	1	1	0	1	1	1	0	0
1	1	1	1	1	1	1	1	0	0
1	1	1	1	1	1	1	1	0	0
1	1	0	1	1	0	1	1	0	0

Table II is input parameter, transaction of MU, of the Apriori Algorithm. After applying Apriori Algorithm on that we can get result of most frequently visited cells for individuals MUs, which are useful for creating dynamic LA for MUs.

Based on min_support taken for Apriori Algorithm we can get result as mentioned in below table III. From the result we can concluded that if we take 100% min_support then only those cells ID are appears in which MUs take visit regularly. So dynamic LA creation is become more easy if we take all those cells ID in LA of each MUs when min_support above 80%. While below 80% min_support results are useful as an adaptive search when MUs not able to find in their dynamic LA.

TABLE -3. MUS FREQUENTLY VISITED CELLS AS PER MIN_SUPPORTS.

Min. Supp. / MT	20%	60%	100%
1	1, 25, 35, 26, 24, 23	1, 25, 35, 26, 24	1, 25, 26, 24
2	12, 15, 39, 48, 57, 16, 42	12, 15, 39, 48, 16	12, 15, 39
3	3, 8, 9, 5, 6	3, 8, 9, 5, 6	3, 8, 9, 6
4	55, 45, 32	55, 45, 32	55, 45, 32
5	9,45, 42, 43, 57, 48, 8	9,45, 42, 43, 48, 8	9,45, 43
6	1, 9, 8, 16, 7, 10	1, 9, 8, 16, 7	1, 9, 8
7	14, 25, 26, 34, 51, 33, 11, 1	14, 25, 26, 34, 33, 11, 1	14, 25
8	3, 6, 10, 12, 8, 5, 1	3, 6, 12, 8	3, 6, 8
9	1, 5, 6, 8	1, 5, 6, 8	1, 5, 6, 8
10	11, 14, 16, 15	11, 14, 16	11, 14, 16

IV. ASSOCIATION RULE MINING

Association Rule mining is useful to find out Association Rules from a relational database or other information repository. Association Rules are an important class of methods of finding regularities/patterns in data using the criteria support and confidence. Association rule is defined as an implication of the form $X \rightarrow Y$ where $X, Y \subseteq I$ (itemset) and $X \cap Y = \emptyset$ [21]. Formula for calculating support and confidence, which are useful for finding Association rules are as follow:

The Support supp(X) of an itemset X is defined as the proportion of transactions in the data set which contain the itemset.

supp(X)= no. of transactions which contain the itemset X / total no. of transactions

The Confidence of a rule is,

$$conf(X \rightarrow Y) = supp(X \cup Y) / supp(X)$$

Mobility Rules are generated using above formulas on Mobility data of MUs. Then it is easy to predict mobility of MUs in cellular network.

V. RESULT

In Mobile Network, next location of mobile users is predicted using mobility rule and current location of the mobile user. As shown in figure II, Mobility Rules of MU are generated. Mobility Rule contains two parts namely, head-the part before the arrow and tail- the part after the arrow. Head part contain the current cell of path followed by MUs. Based on current cell, search is made in mobility rules for finding all those rules whose head is current cell which are also known as Matching rules. In figure current cell is 6, and matching rules based on that are display under title of filtered rules. These mobility rules, matching rules, are required to sort in descending order based on their support plus confidence values. After that how many predictions for MUs required to predict is taken and based on the next probable cell's information are display. In figure only one prediction for next location is given based on that from sorted mobility rules next cell 12 is given. Meaning of that current cell of MU is 6 and if only one prediction is made then most probable next cell is 12. Likewise mobility prediction is possible for MUs, which is helpful in fever of MUs and cellular network.

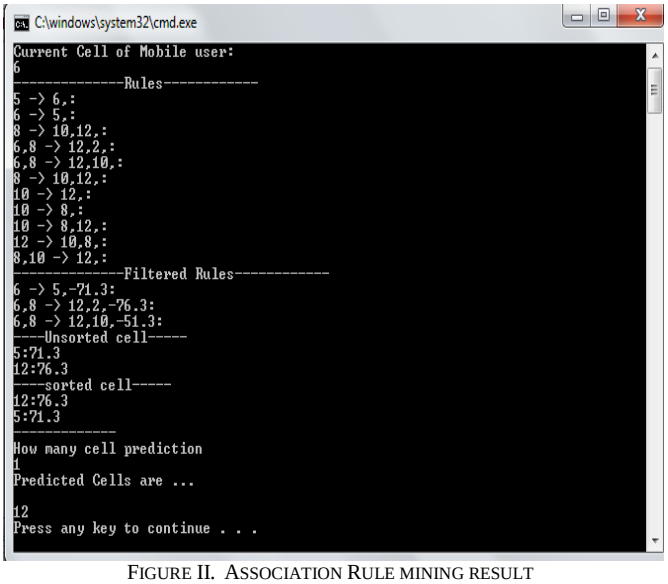

FIGURE II. ASSOCIATION RULE MINING RESULT

VI. CONCLUSION AND FUTURE WORK

Mobility prediction of particular MU is possible using the Apriori Algorithm and Association Rule mining. Apriori Algorithm is useful for creating dynamic LA of MUs based on the mobility history of the MUs. Association Rule mining is useful for finding Mobility Rules from created dynamic LA which are useful for finding MUs future or next position in cellular network. Mobility predictions of MUs are useful to provide good QoS to MUS and for resource point of view to Cellular network.

In future, we can also check applicability of other similar Algorithms and compare results. Also we can create generalize cluster irrespective of MUs to provide better

services and reduce total Location Management cost, resource consumption of Cellular Network.

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