# LOGIC BASED PATTERN DETECTION BASED ON MULTI-LEVEL PROPOSITIONAL PROCESS

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**ABSTRACT**

Data mining is the procedure of hauling out enviable information or remarkable patterns from presented databases for precise purposes. The effectiveness of the rules produced depends on the support threshold, which consecutively involve decisions finished employing these rules. Nearly all of the earlier strategies put a distinct minimum support threshold for all the items or item sets. But in genuine applications, diverse items might have diverse criteria to review its significance. The support necessities ought to then differ with diverse items. The existing work presented a structure for discovery of patterns based on propositional logic which evaluate the coherent rules (i.e., knowledge discovery). The discovery of association rules openly from the logical rules with no minimum support threshold is evaluated. Nevertheless it processes on distinct level of propositional logic, where hierarchical schemes of the knowledge domain cannot be derived. To enhance the pattern discovery process, the proposed work extends the pattern discovery process with coherent rule generation framework in terms of multi-level hierarchical property propositions. The multi-level coherent rule structure produce rules coming from diverse levels and determine highest recurrent item sets at inferior level. The propositional logic process formed the multilevel connection rules from logical rules and utilizes bottom-up progressive extending technique. The bottom up progressive method develops the effectiveness of rules being produced devoid of minimum support threshold. Experimentation are carried out using real data set to assess multilevel association rules capably using concept hierarchies, which describes a series of mappings from a position of low level concepts to advanced level. The presentation of rule creation is measured up to that of the presented single level coherent rule miners.

**Keywords: Association rules, data mining, mining methods.**

## 1. INTRODUCTION

Knowledge discovery in databases (KDD) has turn out to be a procedure of substantial attention in current years as the quantities of data in numerous databases have developed enormously large. KDD means the relevance of nontrivial measures for recognizing useful, logical, potentially helpful, and formerly unidentified patterns in huge databases. The KDD procedure usually comprises of pre-processing, data mining and post-processing. Owing to the significance of data mining to KDD, discovering useful information and significant appropriate patterns in huge databases, therefore helping decision-makers simply examine the data and create good choices concerning the domains concerned.

Let $I = \{i_1, i_2, \ldots, i_m\}$ be a collection of items and $D$ be a collection of communication, where every operation $T$ (a data case) is a collection of items such that $T \subseteq I$. An association rule is an allegation of the structure, $A \rightarrow B$, where $A \subseteq I$, $B \subseteq I$ and $A \cap B = \varphi$. The rule $A \rightarrow B$ embraces in the operation position $T$ with confidence $c$, if $c$% of communication in $T$ that supports $X$ also supports $Y$. The rule contains *support* $s$ in $T$ if $s$% of the communication in $T$ holds $A \cup B$. Given a collection of transactions $D$ (the database), the trouble of mining association rules is to identify all association rules that contain support and confidence higher than the user-specified minimal support (termed *minsup*) and minimum confidence (termed *minconf*).

A priori is an emblematic algorithm supported the structure and numerous other algorithms are a priori-like. Devoid of this threshold precise, classically, no association rules can be revealed since the process to determine the rules will rapidly wear out the presented resources. Even so, having to constrain the discovery of association rules with a preset threshold, in turn, requires in-depth domain knowledge prior to the detection of rules can be computerized. The exercise of min sup normally imagines that a domain authority can present the threshold value precisely the information of interest have to happen regularly at any rate equal to the threshold.

A distinct threshold is sufficient to recognize the knowledge required by an analyst. In practice, there are cases where these suppositions are not suitable and rules accounted guide to incorrect actions.

By bearing in mind this novel approach in deciding data model, an elucidation to satisfying domain-driven data mining necessities can be finished. The proposed algorithm proposes a clarification in diverse regions:

- ☞ It eradicates the requirement to exercise diverse intelligence representations and its mixtures as suggested in to decide suitable threshold for the drawing out algorithms.
- ☞ The proposed algorithm determines the ordinary threshold supported on the surveillance of data set. The diverse aptitude representations can be exercised in combination with the proposed algorithm in shaping the intention item(s) to be measured through the mining procedure.
- ☞ The proposed algorithm can integrate with numerous intellect representations to decide the objective item(s) as an appearance of commerce crisis that one needs to resolve.
- ☞ It provides a rational supporting to the detection procedure of patterns. At present, the design of the mapping of restraints to the detection procedure in this paper is based on support value. Nevertheless, it might be returned by one more constraint.
- ☞ The confronts is in deciding suitable mapping of restraints uttered in diverse aptitude models into a comparative logic correspondence that is renowned by the proposed algorithm.

Our work is provoked by the objective of simplifying ahead of market baskets and association rules utilized with them. Extend methods to excavate widespread baskets, which are defined to be a compilation of subsets from an item space, for instance an amount of wording documents (where the items are words) or poll data (where the items are Boolean or numeric answers to queries). As a result, expand the concept of mining rules that make out associations (generalizing associations) and also take into deliberation the deficiency of items as a source for engendering rules.

Proposed work measuring significance of rules via the chi squared test for correlation from classical statistics. This guides to a appraise that is rising closed in the network of subsets of the article space, allowing us to decrease the mining difficulty to the exploration for a border among connected and uncorrelated item sets in the network. Based on this inspection and some clipping strategies, efficient algorithms are presented for the resultant trouble. It also reveals the efficacy of our algorithms by researches on survey data and ruling term dependence in a quantity of text documents.

## 2. LITERATURE REVIEW

In the data mining field, association rules are uncovered holding province knowledge précised as a least support threshold. The accuracy in situating up this threshold sincerely weights the amount and the distinction of association rules exposed [1]. Concerns with shaping association rules resound concerning pasting of rules and distinction of rules uncovered. Chiefly, if rules are absent, it is misleading to report an partial position of rules and at the equal time construct a acumen that all reachable rules have been recognized.

Some regular association rules are absent owing to the heuristics engaged in placing a least support threshold. Use of a least support threshold to recognize common patterns imagine that an ultimate least support threshold lives for recurrent patterns, and that a user can identify this threshold correctly. Assuming that a standard least amount support exists, it is indecisive how to determine this threshold [2]. This chiefly owes to the detail that there is no general habitual to illustrate the notion of being widespread enough and tempting. The authority worth of association rules has been hardly ever conversed in statistics. In one situation, Babbie et al. disputed among the authors in [3], [4]. The disagreement hubs on the steadiness engaged during data assessment. For example, in sell fruit commerce, fruits are frequently practical but uncommonly bucks are also experimented. Some substances are unusual in situation or unusually recognized in a data set. These items are characterized as rare items [5]. The method of giving a smallest amount item support threshold is ad hoc and wants abundant revisions [6].

Some widespread association rules are misplaced due to the heuristics concerned in placing a smallest amount support threshold. Exercise of a least support threshold to distinguish a persistent pattern considers that an pleasant minimum support threshold exists for recurring patterns, and that a user can identify this threshold exactly [7]. Sequential item set mining [8], is an essential mission, holding frequent applications with customer, market and web log assessment, item set discovery in protein series.

When evaluating association rules, rules that deviate in both support and confidence have to be assessed; an enhanced support has to be agreed next to a superior confidence. The clarification which we propose for this predicament is to develop the expected correctness that the association rule will hold for future data. In a Bayesian construction, the authors choose the support of confidence and support to the likely correctness on future data. The author in [9] offered a rapid algorithm that recognizes the n finest rules which develop the ensuing measure. The algorithm strongly shortens redundant rules and components of the hypothesis space that

cannot surround enhanced solutions than the finest ones established so far. Evaluating rule interestingness is the groundwork of triumphant requests of association rule discovery. The author in [10] offered a new purpose of interestingness named IP EE. It contains the restricted feature of uniting the two subsequent characteristics: first, it is sustained on a probabilistic representation. Surely, due to their unproven nature [11], the data mining algorithms can make enormous rules, many of which have no concentration. To support the user (a decision-maker committed in the data considered to recognize appropriate knowledge in this compilation of information, one of the main results comprises in assessing and cataloging the rules with interestingness measures [12].

## 3. ANALYSIS OF MULTI-LEVEL PROPOSITIONAL LOGIC BASED KNOWLEDGE DETECTION

In this work, we present a novel association rule mining structure that can determine association rules devoid of the requirement for a least support threshold. This allows the user, in hypothesis, to determine knowledge from any transactional evidence with no the conditions information of an appliance domain regularly essential to institute a threshold previous to mining. To initiate the procedure of ascertaining the knowledge discovery structure, this section initiates with the difference among an association rule and the diverse forms of an insinuation as defined in propositional logic. The procedure involved in the expansion of multilevel propositional logic based knowledge discovery involves the subsequent phases

- Mining Association rules

The association rule mining framework determines association rules devoid of the need for a least support threshold.

- Propositional Logic for logical rule creation.

The procedure of generating the coherent rule creation procedure for improving the propositional logic to attain the domain knowledge

- Multi-Level concept hierarchy

In multilevel association rules mining, diverse propositional reason is employed at diverse concept levels.

- Performance evaluation on engendered rules.

The process of the analysis of multi-level propositional logic based knowledge detection is shown in fig 3.1.

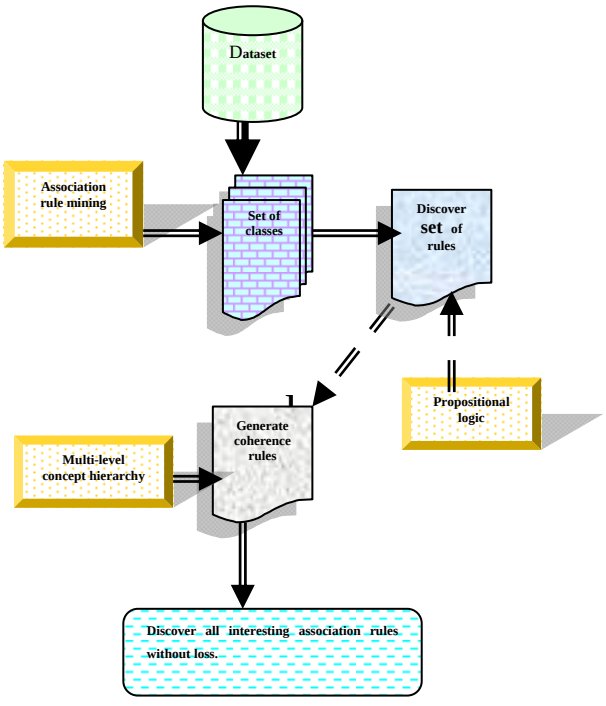


Fig 3.1 process of multi-level propositional logic based knowledge detection

From the fig 3.1, it is being observed that the dataset normally have set of classes to be processed. By mining association rule process, set of rules have been discovered for the classes specified. With the propositional logic applied to the set of rules, coherent rules might be generated. In addition to multi-level concept hierarchy, all interesting rules have been produced without any loss of data.

To initiate our framework, this section initiates with the difference among an association rule and the diverse modes of an implication as proceeded in propositional logic. The subject of inference from logic is lifted

since our proposed mining representation is based on an association rule's capability to be mapped to a form of inference. If an association can be mapped to an inference, then there is rationale to report this relation as an association rule. Or else, devoid of a priori for instance the least support threshold, numerous association rules would be established. An inference having a law where the left-hand side is associated to the right-hand side associates two item sets together. This inference subsists since it is factual consistent with rational grounds, pursues a precise truth table value, and does not require to be judged to be accurate by a user. The rule is accounted as a remarkable association rule if its analogous inference is true.

**3.1 Mining association rules**

The association rule mining framework proposed in this paper (fig 3.2), determine association rules devoid of the need for a least support threshold. This facilitates the user, in hypothesis, to determine knowledge from any transactional evidence with no the locale knowledge of an appliance domain regularly essential to institute a threshold prior to mining. The difference among an association rule and the diverse modes of an inference are termed in propositional logic.

The inference from logic is elevated since the proposed mining representation is based on an association rule's capability to be planned to a form of inference. If an association is charted to an inference, then there is motivation to account this relation as a connection rule. Or else, with no a priori for instance the minimum support threshold, numerous association rules are established, and account all of them. An inference containing a rule where the left-hand side is associated to the right-hand side associates two item sets mutually. This inference subsists since it is true consistent with rational grounds, pursues a precise truth table value, and does not require to be judged to be accurate by a user. The rule is accounted as an appealing association rule if its analogous inference is true.

In a case, the reality and inaccuracy of an inference (also termed as a complex scheme) essentially rely on logic. Each inference, containing met precise reasonable principles, can be recognized (for instance, one might be a substance inference, as the other might be correspondence). Every one has a set of diverse truth values. Underline here that an inference is created employing two schemes p and q. These proposals can be also true or false for the inferences elucidation. A material inference gathers the rational standard of a contraposition. If an inference contains the truth values of its challenging positive, it is a material inference. An equivalency is one more form of inference. In particular, it is an individual case of a material inference. For any inference to become licensed as an equivalency, settle in the truth table values created. An equivalency contains an additional essential provision. Owing to this provision, proposald are now estimated both essential and adequate transmits with ("iff," in short).

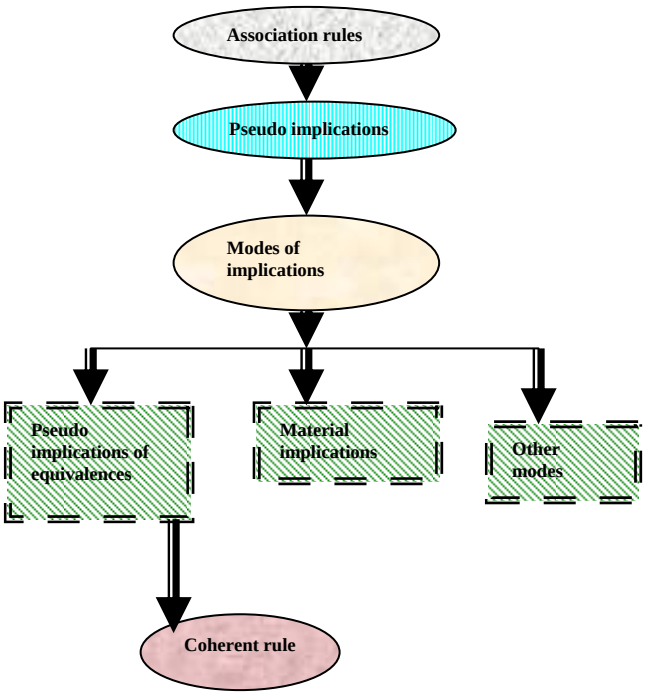


Fig 3.2 Association rule formation

An absolute mapping among the association rule and equivalency are recognized in three progressive steps. In the first step, item sets are planned to schemes in an inference. Item sets can be either experimented or not experiential in an association rule. Likewise, a proposition can either be true or false in an inference. Analogously, the occurrence of an item set can be planned to a factual scheme as this item set can be processed in transactional records.

Comprise mapped item sets and association rules; currently map association rules into precise forms of inference that contain predefined truth table values focused on correspondence. Supported on a distinct operation record in association rule mining, the planning from association rules to equivalences is finished. An item set contain two conditions. In single operation evidence, an item can either be current or not present from the operation record. It pursues then that a proposal can either be true or false. If an item set is experiential in a operation record, it is comparable to containing a true proposal. In the similar way, item sets are mapped to schemes p and q as follows.

- Item set X is mapped to p ¼ T, if and only if X is observed.
- Absence of item set X, that is, :X is mapped to p =F, if and only if X is not observed.
- Item set Y is mapped to q = T, if and only if Y is observed.
- Absence of item set Y , that is, :Y is mapped to q = F, if and only if Y is not observed.

Every component of an association rule is now planned to proposals. Employing the similar mapping notion, an association rule can be planned to a true or false inference. An association rule comprises of two item sets X and Y. Subsequent the mappings over is expressed as,

- Item sets X and Y are planned to p and q = T, if and only if X and Y are experiential.

Specifically, an association rule X-> Y is mapped to an inference and is considered appealing if and only if both item sets are experiential from a distinct operation record. Likewise, all four mappings from the association rule to its inferences are specified below

- X-> Y is mapped to implication p ! q, if and only if both X and Y are observed.
- X->:Y is mapped to implication p !:q, if and only if X is observed and Y is not observed.
- X-> Y is mapped to implication: p ! q, if and only if X is not observed and Y is observed.
- X->Y is mapped to implication: p !:q, if and only if both X and Y are not observed.

Including mapped association rules to inferences, we employ the similar mapping notion to plan association rules to equivalences supported on precise truth table values. An equivalence contain truth table values (T,F,F,T) (see Table for inferences p ! q, p !:q, :p ! q, and :p !:q, correspondingly. An association rule is mapped to equivalence if every inference is either true or false.

- Appreciate how the records are stored on to the record buffer in a file having diverse kinds of record.
- Be capable to pronounce a file having diverse types of record.
- Recognize the troubles of asserting print-line records in the FILE SECTION.
- Be capable to affirm and employ print files.
- Recognize how to group diverse kinds of variable length record.
- Recognize how variable length records, confirmed with the DEPENDING ON axiom, work.
- Be capable group a file so that the file name can be allocated at run-time quite than at compile-time.

Containing mapped the item sets, an association rule can currently be mapped to an inference in a second step. An association rule contains four diverse mixtures of occurrence and deficiency of item sets. Likewise, there are four diverse inferences depending on the precision value detained by its proposals. Therefore, an association rule can be processed to an inference that contains a truth value (either true or false). At last, the association rule contains a position of four truth table values.

**3.2 Propositional Logic for Coherent Rule Generation**

The pseudo inferences of equivalences are further processed into a concept termed as coherent rules. Not all pretend inferences of equivalences can be formed employing item sets X and Y. However, if one pseudo inference of equivalence can be formed, then one more pseudo inference of equivalence also coexists. Two pseudo inferences of equivalences forever subsist as a pair since they are formed based on the similar conditions. As they distribute the similar conditions, two pseudo inferences of equivalences, coexist having mapped to two rational equivalences. The outcome is a logical rule that gathers the similar conditions.

Logical rules convene the essential and enough circumstances and contain the truth table values of rational equivalence. The rational rule comprises of a match up of pseudo inferences of equivalences that contain senior support values contrast to one more two pseudo inferences of equivalences. Every pseudo

inference of equivalence is an connection rule with the further possessions that it can be processed to a rational equivalence. Association rules decoupled from logical rules contain the subsequent strengths:

☞ Association rules decoupled from logical rules can be consistent as logical inferences, but association rules cannot. This is as logical rules come into logic property for instance contra positives containing truth table values of rational equivalence.

☞ The notion of coherent rules is sovereign from any conditions information for instance a precise perceptive of an appliance domain. Consequently, logical rules do not need a user to predetermine an uninformed minimum support threshold to describe a recurrent pattern. Logical rules can be recognized using truth table values. The detection of logical rules and their connected association rules thus evades lots of the difficult problems.

**3.3 Quality of logic based association rules**

Logical rules are processed based on judgment. This develops the superiority of connection rules revealed since there are no mislaid association rules owing to threshold situation. A user can determine all connection rules that are rationally accurate devoid of containing to recognize the domain knowledge. This is primary to different application provinces. For instance, one can determine the associations in a sell business devoid of containing to learn the probable relations amongst items. Any connection rule that is not detained by logical rules can be deprived of its significance. These rules are either in disagreement with others (amongst the positive and negative connection rules) or less severe contrast to the description of rational equivalences.

**3.4 Multi-Level concept hierarchy**

In multilevel association rules mining, diverse propositional logic is employed at diverse concept levels. Determine recurrent patterns and sturdy association rules at the highest notion level. By means of this user can discover a set of distinct recurrent items (every termed a frequent 1-itemset), a position of pair-wised recurrent items (each termed a recurrent 2-itemset) and a position of sturdy association rules. At the subsequent level, user discovers recurrent 1-itemsets and recurrent 2-itemsets and sturdy association rules. The procedure replicates at even inferior concept levels in anticipation of no recurrent models can be established. Through multilevel association rule mining, the classification for every (grouped) item is prearranged as a series of digits in the operation table. Frequent items (i.e., items with the similar encoding) at some level will be pleasured as one item in one operation.

In the planned notion hierarchy representation, items might have diverse propositional reason and taxonomic dealings to determine the huge item sets.. The propositional sense for an item set is positioned as the combinatorial sub logic ropes of the items controlled in the item set, as the propositional reason for an item at a senior taxonomic notion is positioned as the least sub logics of the items fitted in to it. Programming system symbolizes nodes in the predefined classifications for mining multilevel rules.

Nodes are programmed regarding their locations in the hierarchy employing series of numbers and the sign. It then strains out discouraging item sets in two phases. In the first phase, an item group is uninvolved if its happening calculation is less than the propositional sense. In the second phase, the count up of a propositional sense rules is checkered to decide whether it is huge. The planned algorithm then discovers all the huge item sets for the specified transactions by contrasting the count of every item set with its combinatorial reason. Besides, some pruning approaches are employed to decrease the number of candidate item sets produced.

**4. EXPERIMENTAL EVALUATION**

The proposed logic based pattern detection is efficiently done by implementing multi-level propositional logic. The proposed logic based pattern detection using multi-level propositional logic [LBPDMP] is implemented in Java. It is experimented with real and or synthetic data to assess the association rule and coherent rules devoid of having the domain knowledge. The results are also evaluated with logic based pattern detection representation with distinct level association rule mining representation in terms of amount of strong rules and weak rules produced. Effects of non sensitive rules are consequent in both the presented and proposed strategies to illustrate the effectiveness of novel association rule mining process.

The representations works well with troubles connecting ambiguity in data relationships, which are symbolized by multilevel notions for propositional logic rule derivation. The proposed LBPDMP mining algorithm can thus engender huge item sets level by level and then obtain notion multilevel association rules from operation dataset. The outcome revealed in the pattern implies that the proposed LBPDMP algorithm can obtain the multiple-level association rules under diverse propositional logic in an easy and valuable way. The performance of the proposed logic based pattern detection using multi-level propositional logic [LBPDMP] is measured in terms of

- Number of logical rules generated
- Number of rules

- Running time

## 5. RESULTS AND DISCUSSION

In this work, we efficiently evaluated the coherent rules established using the proposed LBPDMP with association rules. Two variants of thresholds are positioned for the a priori: The smallest support threshold is positioned at 5 percent and the least amount declaration threshold is positioned at 50 percent. Depends on this position, all association rules not continued by no less than 5 percent of procedure records are considered asymmetrical; or else, they are considered recurrent. Here, we group the association rules into two classes:

- Infrequent association rules contain fewer sensible classes
- Frequent association rules have frequently observed

In indulging the outcomes, the attribute values of the dataset are represented as attribute names followed by its feasible values. The below table and graph describes the performance of the proposed LBPDMP.

| No. of rules | No. of logical rule generation | |
|---|---|---|
| | Proposed LBPDMP | Existing single level association rule mining |
| 200 | 22 | 18 |
| 400 | 34 | 24 |
| 600 | 57 | 28 |
| 800 | 63 | 35 |
| 1000 | 72 | 40 |
| 1200 | 80 | 42 |

Table 5.1 No. of rules vs. Coherent rules generation

The generation of coherent rules created based on the number of association rules obtained by implementing both the proposed LBPDMP and existing single level association rule mining [13] and compare the results which are illustrated in table 5.1.

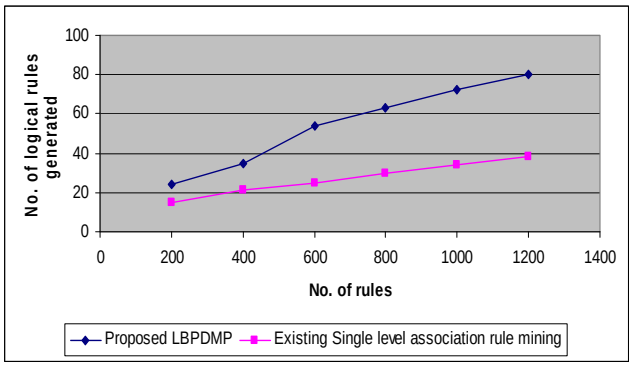


Fig 5.1 No. of rules vs. Coherent rules generation (%)

Fig 5.1 describes the generation of coherent rules based on the number of rules created. The proposed LBPDMP efficiently identified the association rules that have the properties of propositional logic in terms of attaining the domain knowledge of the patterns identified. And a multi-level framework is used here to generate coherent rules by adapting in terms of adapting the pseudo implications of equivalences from a given data set. With the propositional logic, the proposed LBPDMP determine all association rules that are rationally correct devoid of having to recognize the domain knowledge in a less interval of time. In the proposed LBPDMP scheme, each generated coherent rules is decoupled into two pseudo inferences of equivalences which can be further mapped to a rational equivalence. Compared to the single level association rule mining [13], the proposed LBPDMP multi-level scheme provides a superior number of association rules employing propositional logic. The variance in coherent rules generation is 40-50% high in the proposed LBPDMP.

| No. of items | Running time (seconds) | |
|---|---|---|
| | Proposed LBPDMP | Existing single level association rule mining |
| 100 | 200 | 300 |
| 200 | 280 | 380 |
| 300 | 360 | 460 |
| 400 | 470 | 590 |
| 500 | 530 | 680 |
| 600 | 640 | 730 |

Table 5.2 No. of items vs. running time

The running time for the generation of coherent rules based on the number of items present in the given dataset are illustrated in table 5.2 for both the proposed LBPDMP and existing single level propositional logic.

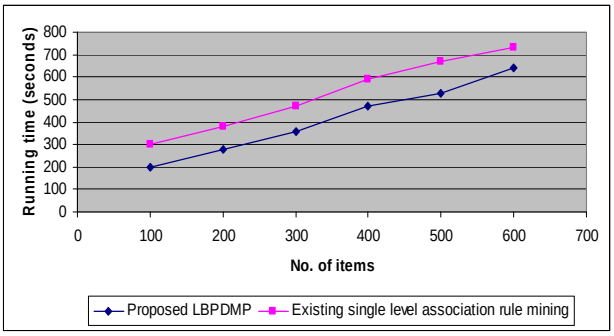


Fig 5.2 No. of items vs. running time

Fig 5.2 describes the consumption of time taken to produce the frequently and infrequently set of transaction records based on the number of items. Normally, coherent rules contain more rigorous restraints contrast to distinctive association rules with a minimum confidence value. Although the existing framework [13] that discover association rules supported on quantify of interests other than a least support (for example, a minimum confidence value). In this case, they require producing both positive and negative connection rules. So, the existing framework consumes more time to proceed in which the proposed LBPDMP generate the rules based on the threshold value with the propositional logic. Compared to a single level hierarchy for mining association rules, the proposed LBPDMP multi-level concept hierarchy based association rule mining consumes less time to process the coherent rules using propositional logic and obtained a high quality of knowledge.

Finally, it is being observed that the proposed LBPDMP eradicates the requirement to employ diverse intelligence models and its mixtures to decide suitable threshold for the mining algorithms. The proposed LBPDMP algorithm determines the normal threshold supported on surveillance of data set. It presents a rational reinforcement to the detection procedure of patterns by consuming less running time.

## 6. CONCLUSION

The proposed multilevel propositional logic based association rule mining map logical equivalences to determine all appealing association rules devoid of loss at diverse concept hierarchical levels. These association rules comprise item sets that are commonly and uncommonly processed in a set of transaction records.

As well as an absolute set of rules being measured, these association rules can also be consistent as rational inferences as they accede to propositional logic possessions. Having measured intermittent items, in addition to being implicational, these multilevel theoretical association rules are notable from representative association rules. These association rules decrease the risks connected by means of an unfinished set of association rules for resolution making. The structure used to determine association rules that have the possessions of propositional logic, and a precise structure (Coherent Rules Mining Framework) with an essential algorithm to produce coherent rules from a specified data set at numerous levels.

The exploration for coherent rules does not need a user to specific minimum support threshold. In contrast, an association rule is normally not implicational consistent with propositional logic, and the numerous approaches employed to provide association rules have misplaced rules connecting intermittent item sets. The multilevel coherent rules mining structure is respected for its capability to determine rules that are together implicational and absolute consistent with propositional logic from a specified data set at different theoretical levels.

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