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WAREHOUSE MANAGEMENT USING MACHINE LEARNING ALGORITHM

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Abstract : Warehouse management plays important role from receiving raw material to the shipping of final product and in automobile warehouse this is a critical task as so many parts are involved in it. Because of which Proper warehouse management adds efficiency and quality control to process by movement of goods at highest speed. Ordering stock out items plays an important role in warehouse management of automobile companies as most of cost and time is involved in ordering a stock out products. Currently different methods like ABS,VED, Economical order quantity etc used for warehouse management. Out of all these Economical order quantity is widely used for ordering stock out product. The problem with this method is that it will order each product separately based on Economical order quantity. Suppose if there is some pattern in stock out of two or more product then they can be ordered simultaneously this will reduce transportation cost and ordering cost. This article is about identifying this pattern from stock out data set and for this Apriori algorithm which is one type of Machine learning algorithm is used. Currently Apriori algorithm is used in market basket analysis for identifying customer behavior by identifying pattern from data of purchased products by using Association rule. In this article Apriori algorithm is used to identify relationship between stock out items of warehouse of an automobile company so that they can be ordered simultaneously to reduce cost, save the time and avoid shortage of Goods in automobile warehouse.

Keywords*:* Warehouse management, Machine learning, Association rule, Apriori algorithm.

Introduction

The aim of warehouse management is to order, store and handle the goods such that cost and time is efficiently used.The key characteristics of an engineering production system are high quality, low cost, short production Time.That why warehouse management is an essential part of an organization. warehouse management greatly affect the profitability and quality control of the product. Profitability mainly depends on whether the product is in range of economical order quantity or not and also whether it is ordered before stock out or after stock out.in traditional method this problem is handled by using production model for ordering item. but in this model each product is analysed separately and then it is ordered before stock out or after stock out. But in this model each product is analysed separately and then order of each item placed separately. now if there is some relation with slight time lag between two or more itemsets and this product is to be ordered from same vendor then placing separate order for each product increases ordering as well as transportation cost.To find out this relationship from a large data machine algorithms plays important role. currently Apriori algorithm is used in market basket analysis to find out relationship between frequent itemsets to study customer behaviour. In this article Apriori algorithm used to find out the relationship between stock items of warehouse by association rule. In this article it is first time implemented in automobile industry to find out relationship between stockout items. By using relation two or more products can be simultaneously order, this will reduce both ordering cost because of bulk order and also transportation cost and time is optimised, this is the main purpose of this article. In order to tackle this problem like ordering product having relation separately use of this method is suggested.

Materials and methods

A. Traditional method

There are several methods for warehouse management like ABS classification, VED analysis reorder level, EOQ etc out of this EOQ is efficient and mostly used in warehouse management to order the stock out product. the flow path for traditional method is as follows

Fig. 1. Traditional flow path for ordering product.

In this method for economical order quantity mostly production model is used where replenishment rate and production rate are uniform. after this economical order quantity is identified as below[8]

$$EOQ = \frac{\sqrt{2CD}}{\sqrt{c}} * \sqrt{\frac{p}{p-d}}$$

C=ordering cost

D=Annual demand

c=holding cost

p=production rate

d=consumption rate

Limitations

The main limitation with traditional method is that it will analyze each product separately and then calculates its economical order quantity and place the order, now if there is some pattern with stock out of two or more items then it is possible to order them at a time but this is not possible with traditional method.

B. Apriori Algorithm method

Apriori algorithm is one of type machine learning algorithm. It comes in category of Supervised learning, It is used in market basket analysis to identify customer behavior. it uses association rule to find out frequent itemsets.

Advantages

Apriori algorithm uses association rule to find out relationship between frequent itemsets. this algorithm is used in market basket analysis to identify customer behavior in ordering particular itemsets. By identifying this behavior one can place this product together with same quantity for ease of customer. in this article same Apriori algorithm is used to identify relationship between stock out items so that they can be ordered at same time to reduce cost and time. When Apriori algorithm used the flow path is as below:

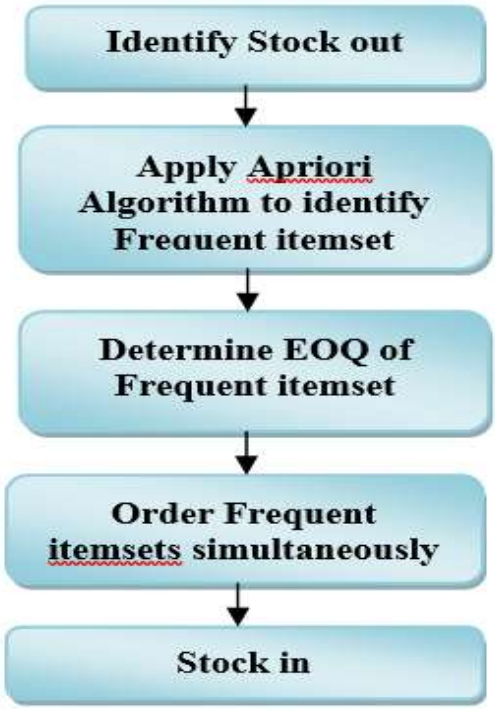

Fig. 2. Apriori algorithm flow path for ordering product

1. Data analysis

Following is the small portion of warehouse data of XYZ vehicle manufacturing automobile on weekly basis

Table 1 Warehouse data of stock out products

Transaction	Product stock out			
Week 1	Nut	Bolt	Bearing	Piston
Week 2	Nut	Bolt	Piston	-
Week 3	Nut	Shaft	Cam	-
Week 4	Nut	Piston	Shaft	-
Week 5	Bolt	Piston	Shaft	-

2. Important terms

Support:

Support is the frequency of occurrence of an itemset. Support is the ratio of transactions which include all items in numerator to the number of total transactions in denominator mathematically it is represented as below [1].

Support(A,B) = support count(A∪ B)=Frequency(A,B)/Total Transactions.

Where A and B be subset of I data, then support for (A ∪ B) is Support of A with respect to B.

Confidence:

It is defined as measure of certainty or reliability associated with each discovered pattern. mathematically it is represented as below [1]

Confidence(A -> B) = Support count(A ∪ B) / Support Count(A)

Where A and B be subset of I data.

Frequent Itemsets:

This are the itemsets which obeys minimum threshold value decided based on statistical study. frequent itemsets are the items filtered from large data set that obeys the condition set by operator.

3. Assumptions

Apriori algorithm yet not used in warehouse management in this article it is first time used that's why based on study of market basket analysis, where it is used we assumed certain value for support and confidence. based on organizational need these values can be varied the assumed value as follows

Table 2 Assumptions for Minimum Values

Term	Value
Minimum Support	50%
Minimum Confidence	75%

Based on above values the data is filtered and the results are obtained.

4. Apriori algorithm flow chart

Warehouse data goes through below process to recognize whether there is any relationship between products or not. for the data in this article the step by step procedure as follows

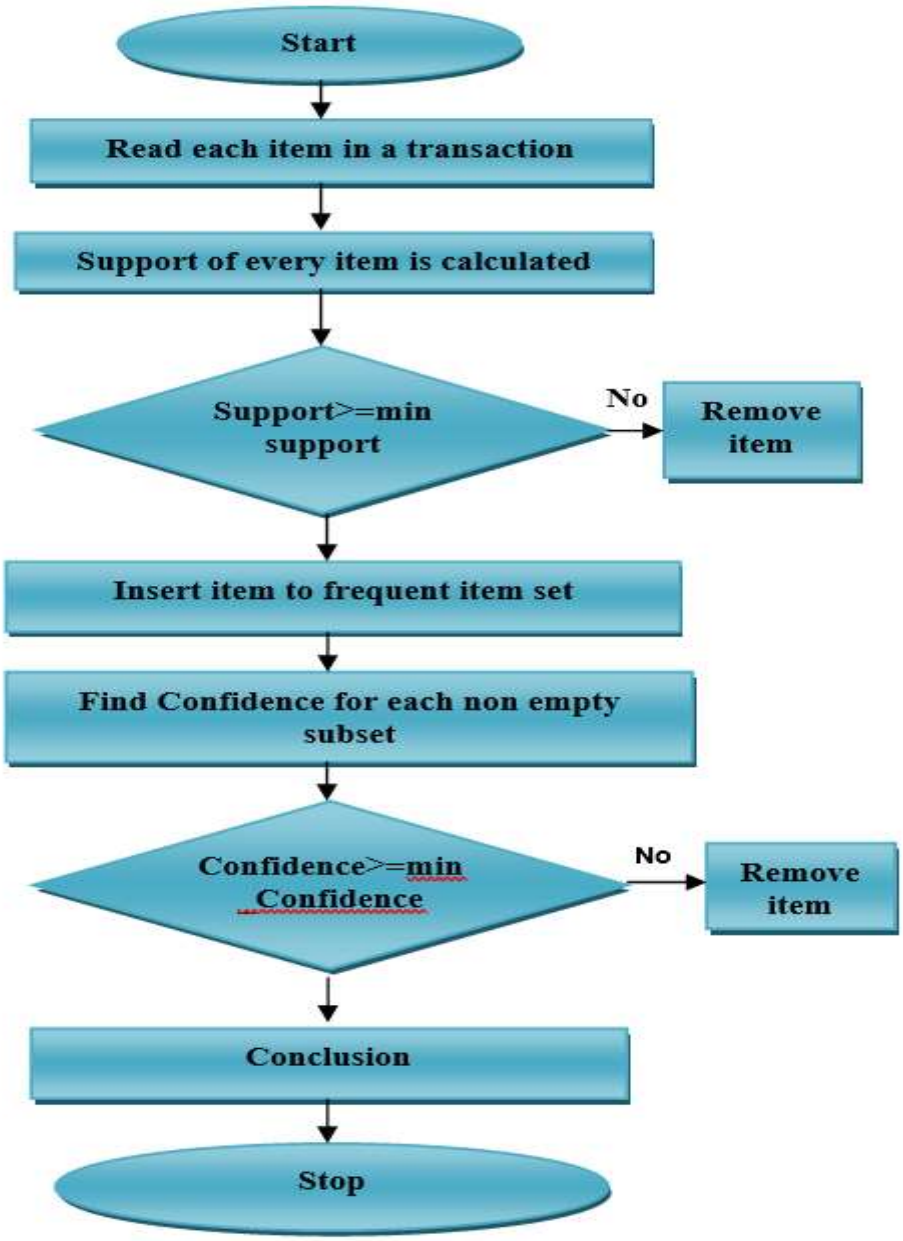

Fig.3 Apriori Algorithm Flow Chart

We first calculate support of every product in the data set to make sure that the product should be repeated at least for certain times means it should satisfy minimum threshold support value. Those products which satisfies minimum support are accepted for further calculation the support of each product in above mentioned data is as shown below

Table 3 Support value of each product

Item	Frequency	Support	Decision
Nut	4	4/5*100=80%	Accept
Bolt	3	3/5*100=60%	Accept
Bearing	1	1/5*100=20%	Reject
Piston	4	4/5*100=80%	Accept
Shaft	3	3/5*100=60%	Accept
Cam	1	1/5*100=20%	Reject

2. After calculating support of each product we found that only Nut, Bolt, Piston, Shaft are obeys minimum support value now to find whether there is any relationship between their stock out or not we calculate support of each product with another as follows

Table 4 Support value of paired products

Pairs	Frequency	Support	Decision
Nut, Bolt	2	2/5=40%	Reject
Nut, Piston	3	3/5=60%	Accept
Nut, Shaft	2	2/5=40%	Reject
Bolt, Piston	3	3/5=60%	Accept
Bolt, Shaft	1	1/5=20%	Reject
Piston, Shaft	2	2/5=40%	Reject

3.After calculating Support value pairs those pairs accepted which satisfies minimum Support value. now we have choices among the accepted pairs that is for Nut, Piston we have two choices Nut stock out first and then piston or piston stock out first then piston similar for Bolt, Piston pair we have two choices Bolt first stock out then Piston or Piston stock out first then Bolt stock out now to make decision we evaluate Confidence of each possible pair as follows

Table 5 Confidence of each possible pair

Pairs	Confidence	Decision
Nut, Piston	(3/5)/(4/5)=75%	Accepted
Piston, Nut	(3/5)/(4/5)=75%	Accepted
Bolt, Piston	(3/5)/(4/5)=75%	Accepted
Piston, Bolt	(3/5)/(3/5)=100%	Accepted

All pairs are satisfying minimum Confidence hence based on this we evaluate results and conclusion.

5. Results and Discussion

Table 6 Result table

First stockout product	Product having relation	Support	Confidence
Nut	Piston	60%	75%
Piston	Nut	60%	75%
Bolt	Piston	60%	75%
Piston	Bolt	60%	100%

The results obtained shows the relationship for only two itemsets. This itemsets satisfies both the minimum threshold value for support which is 50% and minimum Confidence value which is 75% As they satisfies both the criteria they are considered as frequent itemsets from a large data. As they are found by association rule from a stock out data of warehouse means they have following same pattern in stock out. From above result tables Nut and piston are considered as a group of one frequent itemsets and as they have relation in stock out means when Nut stock out we can say probability of piston stock out is 75% hence we order both at a same time to reduce transportation cost and time. Similarly if bolt stock out along with it we initiate process of ordering piston and vice versa.

Conclusions

From the results obtained we made conclusion that whenever Nut stock out instead of ordering it individually along with it also order Piston and vice versa because they are frequent itemsets from the Apriori algorithm Similarly when Bolt stock out instead of ordering it individually along with it also order Piston and vice versa because they are frequent itemsets from the Apriori algorithm. Ordering them simultaneously help in reducing transportation cost and saves the time.

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